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LEBANON STATE OF THE ENVIRONMENT AND FUTURE OUTLOOK:

TURNING THE CRISES INTO OPPORTUNITIES

SOER 2020

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SOER 2020

MoE FOREWORD

Welcome to the “Lebanon – State of the Environment and Future Outlook: Turning the Crises into Opportunities” (SOER 2020), prepared by the United Nations Development Programme (UNDP) in Lebanon, with support from the UN Refugee Agency (UNHCR) and the United Nations Children’s Fund (UNICEF), and in collaboration with the Ministry of Environment (MoE) and other national stakeholders, following a request by the Minister of Environment in early 2019.

By choosing to title this fourth edition of the SOER “Turning the Crises into Opportunities”, we are sending a message of hope. Major crises have hit Lebanon during the past decade, from the Syrian crisis and its implications since 2011 till the accelerated major events lately: the unprecedented political, economic and financial situation since October 2019, the COVID-19 outbreak in early 2020 and the tragic Beirut port explosion of August 2020. All have adversely impacted the environment. Let us join efforts to overcome these crises and reform firmly, recover sustainably and reconstruct greenly.

Starting with a brief introduction and methodology, the SOER 2020 takes us through the state of environmental governance, that of the four natural resources (water; air; land; and ecosystems) and of four environmental priorities (haphazard urbanization; solid waste management; climate change and energy; and chemical management), by analyzing driving forces and current state (including the legal and institutional framework), discussing State and Non-State responses to date, and reflecting on the way forward. In line with the foresight exercise to 2050 planned by Plan Bleu in the 2020 State of the Environment and Development in the Mediterranean (SOED), the SOER 2020 closes with a chapter on the decade ahead, overviewing the past decade’s significant and successful investment in drafting and adopting policies and legislation, to analyze two possible scenarios for the next decade: Poor Enforcement vs Robust Enforcement. The future state of the environment very much depends on the committed implementation of the past decade’s rich set of policies, strategies, legislation and regulations, substantively challenged these days by retention and efficiency of resources within the public sector, calling to act for its empowerment.

While all recommended initiatives are very important, if I have to select only one priority for each of the 9 themes addressed in the SOER 2020, and in line with the SOED 2020 key messages particularly on Enforcement, Institutional Capacity, Monitoring and Transparency, I will highlight the following, with inclusive dialogue as a cross-cutting approach:

1. Environmental Governance: appoint dedicated prosecutors and investigation judges for the environment as per Law 251/2014.
2. Water Resources: adopt a river catchment environmental management approach in diagnosing and implementing priority interventions at the basin level.
3. Air Quality: re-activate the Air Quality Monitoring Network in partnership with academia and publish results periodically in accordance with Law 78/2018 and Decree 6212/2020.
4. Land Resources: collect the quarrying sector’s dues to the National Treasury as per Decree 6569/2020, including fees, payment delays’ penalties as well as punitive claims related to environmental damage, and implement appropriate monitoring systems.
5. Ecosystems: establish new protected areas (Nature Reserve; Natural Park; Natural Site; Hima; etc.) as per Law 130/2019.
6. Haphazard Urbanization: develop and adopt missing strategic and detailed urban masterplans (with the needed Strategic Environmental Assessment studies as per Decree 8213/2012).
7. Solid Waste Management: introduce a proportional and gradual cost recovery system for integrated solid waste management as per Law 80/2018.
8. Climate Change and Energy: establish the Lebanon Green Investment Facility based on the Paris Agreement (Law 115/2019).
9. Chemical Management: undertake a national inventory of licensed and unlicensed chemical storage facilities.

To conclude, I do call for the alignment of the financial system with sustainable development. I would like to address a word of thanks to UNDP, UNHCR, UNICEF, MoE team and all experts who contributed to this valuable document for the years to come.

Dimyanos Kattar
Minister of Environment, Republic of Lebanon
August 2021

UN AGENCIES FOREWORD

Over the past decade, Lebanon has endured multiple crises, including political instability, the fast changing financial and economic situation, as compounded by the COVID19 outbreak, the Beirut Port explosions and the impact of the Syria crisis These compounded crises have significantly exacerbated pre-existing development challenges in the country, while contributing to the deterioration of an already fragile natural ecosystem, given the immense added pressure on resources.

Within this framework, the United Nations Development Programme (UNDP), with support from the UN Refugee Agency (UNHCR) and the United Nations Children's Fund (UNICEF) in Lebanon, have partnered to jointly prepare the "The State of the Environment and Future Outlook: Turning the Crises into Opportunities" in close collaboration with the Ministry of Environment. The purpose of the report is to consolidate, analyse and present the latest available data on the environment in various key sectors in Lebanon. Each chapter has been drafted and reviewed by experts across the fields of solid waste, water and wastewater, land management, air pollution and environment policies. The report ultimately seeks to make data and analysis available to the public, policy makers and humanitarian and development partners to support evidence-based policies, and to facilitate better planning and programme on environment issues.

It also provides forward looking scenarios for the future of the environment and natural resource management in Lebanon. These scenarios include (a) a negative outlook that is based on the current situation and status quo and (b) a more positive outlook that considers these crises as opportunities to build Lebanon forward and break the country's current unsustainable path. As the multiple crises that Lebanon is experiencing continue to negatively affect the environment across the board, there is a real risk that the positive gains made could be reversed and that the country could face accelerated environmental emergencies of greater impact. This is notwithstanding the fact that the continued environmental degradation will likely further exacerbate Lebanon's overall crises.

We hope that the report will contribute to a better understanding of the environmental challenges facing Lebanon in the current context and will foster a renewed commitment among all stakeholders to put in place forward looking, integrated and sustainable solutions for people and planet. The current challenges are many; through our collective engagement, they can also be turned into opportunities to support green financial recovery agendas, advocate climate-friendly economic growth, promote equitable and clean environments and move Lebanon towards realizing the Sustainable Development Goals, and its own climate ambitions.

Celine Moyroud
UNDP Resident Representative

Yukie Mokuo
UNICEF Representative

Ayaki Ito
UNHCR Representative

ACKNOWLEDGEMENT

The team of Sustainable Environmental Solutions (SES) and Ecocentra were commissioned by the United Nations Development Programme (UNDP) and on behalf of the United Nations Children's Fund and the UN Refugee Agency) to prepare the State of The Environment Report (SOER) of Lebanon for 2020.

We would like to express our gratitude and appreciation to the teams of SES and Ecocentra and staff and experts at the Ministry of Environment (MoE) and other ministries, academics, civil society, international organizations and the private sector, all of whom contributed to the report's contents.

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SECTION I

INTRODUCTION

1 Introduction and Methodology

Chapter drafted by	**Naji Chamieh, PhD,** Chairman and CEO, SES **Layale Abi Esber, PhD,** Senior Environmental and Social Expert, SES **Sara Hteit,** Senior Environmental and Social Expert, SES
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Abbreviations and Acronyms

EU	European Union
MoE	Ministry of Environment
SOER	State of the Environment Report
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNHCR	UN Refugee Agency

1. Introduction

The United Nations Development Programme (UNDP), with funding from the UN Refugee Agency (UNHCR), the United Nations Children's Fund (UNICEF), contracted Sustainable Environmental Solutions (SES) and Ecocentra, both local and regional environmental consultancy firms, to prepare the State of the Environment and Future Outlook Report (SOER) 2020.

1.1 Background

Three SOERs have already been developed for Lebanon in 1994, 2000 and 2010. This report, the SOER 2020, will focus on trends and threats that have occurred in the country between 2010 and 2020, with a focus on depletion and pollution of natural resources, resulting environmental costs and impacts on human health, as well as causes including the Syrian crisis which resulted in an alarming population increase in Lebanon.

The Syrian civil war, which began in 2011, has become the largest refugee and displacement crisis of our time. Today, ten years later, Lebanon continues to host the highest number of displaced persons per capita, in one of the smallest countries in the world, with a land area of 10,452 km^2 (GoL/UN, 2020). In September 2014, the MoE, with support from the European Union (EU) and the UNDP, published the "Environmental Assessment of the Syrian Conflict & Priority Interventions", which provided an extensive analysis of the incremental environmental impacts of the Syrian conflict and its summary was updated in December 2015. According to this study, the crisis has generated a large number of unfavorable environmental impacts including, among others, large stresses on water, electricity, sanitation and solid waste management systems, which were already facing 'acute pre-crisis challenges', and accordingly a major threat to water bodies, ecosystems and land. The report concluded that such large and growing negative impacts and the required stabilization costs are unsustainable given Lebanon's weak public finances (MoE/EU/UNDP, 2014). For this reason, the impacts of the Syrian crisis on the various environmental sectors in Lebanon are outlined in the different chapters of the current SOER.

The report also addresses the Beirut Port Explosion of August 4th, 2020 (Figure 1-1), which was also reportedly associated with negative environmental and health impacts. Additionally, during the year 2020, Lebanon reeled from an economic and financial collapse and a health emergency brought on by the Covid-19 pandemic. Both crises have potential significant impacts on the environment that are yet to be fully understood. These, along with the continuing Syrian displacement crisis and the aftermath of the August 4 Beirut Explosion, have crippled Lebanon's economy and public sector and continue to do so until today.

1.2 Purpose of the SOER 2020

The main objective of the SOER is to describe the current status and trends related to environmental resources including water, air, ecosystems and land at a state-wide level and focus on the main threats. The outlook for each topic is described and recommendations proposed at the end of each chapter in an effort to facilitate the work of decision makers in limiting or eliminating the threats and reducing impacts. Moreover, future scenarios for the various environmental topics covered by the SOER are assessed in Chapter 11 (The Decade Ahead), which also describes progress on the UN's 17 Sustainable Development Goals and their 2030 targets.

In fact, the SOER has the following objectives and aims to present them in a comprehensive and simplified manner:

Figure 1-1 Beirut Port Explosion
Photo Credit: BBC

- Update the information included in the SOER of 2010 and bridge information gaps.
- Provide reliable and statewide environmental data for the community, decision makers and private sector.
- Evaluate the status of significant and critical environmental resources in Lebanon and study environmental trends.
- Describe stresses that affect the environment and responses to those stresses.
- Prioritize challenges and recommendations.
- Identify key performance indicators for each sector.
- Identify and quantify the direct and indirect costs and benefits of healthy and sustainable ecosystems.
- Develop future outlooks based on different scenarios.

The SOER 2020 will aid decision makers in developing a strategic vision to tackle environmental, economic and social objectives with a high degree of efficiency, giving them a helpful tool for developing the National Sustainable Development Strategy, following its roadmap launched in 2015. The SOER will also assist planners, program managers and donors in prioritizing funding of new environmental projects based on the overall understanding of the country's environmental risks and challenges.

The SOER is also a major reference for environmental practitioners for preparing research and assessment studies such as Strategic Environmental Assessments, Environmental Impact Assessments, Initial Environmental Examinations and Environmental Audits, noting that the SOER provides an updated list of environmental laws and regulations, along with an extensive list of technical references on key environmental issues in the country. Moreover, the SOER will assist academia and students conducting research on a variety of topics. The SOER can be also used by the media to understand and monitor the most pressing environmental issues. This would allow civil society groups to enhance environmental awareness in Lebanon, promote environmental conservation, the use of green technologies and the circular economy, and advocate for better enforcement.

1.3 Methodology

The approach of the SOER 2020 followed to the extent possible the Driving Force-Pressures-State-Implications-Responses reporting methodology that was used in the SOER 2010. However, in addition to addressing drivers and pressures and how they lead to environmental change, the SOER 2020 report also shows how these drivers and pressures affect each other and are influenced by other anthropogenic factors. As such, the following process was followed:

- **Data collection and review:** This was done through desktop review of all relevant laws and regulations, governmental plans and reports, relevant scientific reports and papers, as well as published theses and dissertations. These references ensured that relevant data were collected from the concerned ministries and public establishments, local and international non-governmental organizations, consulting firms, as well as from universities and research institutes. Important resources that were identified in the previous SOERs were also noted and updates to these resources were sought. Document collection and research focused on all reports, papers and data published after 2010. For each chapter, the collected information was first summarized and then presented to and discussed with a list of relevant key stakeholders during a two-day workshop, which aimed at engaging representatives from the public and private sector, national and international organizations, funding agencies, educational institutions, as well as experts in relevant fields.
- **Update and analysis of data:** The collected data was then cleaned, processed and analyzed by each respective expert using various methods such as statistical models, Material Flow Analysis and cost benefit analysis. The analyzed data was then presented using informative and analytical graphs, tables and maps.
- **Priority recommendations and future outlook:** After identifying significant challenges and stressors on the environment and human health, recommendations were proposed for advancing each sector in the coming decade, building on existing achievements. Two scenarios were developed to provide a prediction of the overall state of the environment in the next 10 years for each scenario. The scenarios are "Poor Enforcement" and "Robust Enforcement" of the past decade's vigorous planning, strategizing and legislation adoption.
- **Financial analysis:** This activity attempted, to the extent possible, to estimate the environmental costs of lack of action on specific problem areas and compare them to the cost of the recommended actions.
- **Preparation of sector chapters:** Each chapter was developed based on the below outline:
  - Driving Forces

- Current Situation
- Legal Framework and Key Stakeholders
- Selected Responses
- Priority Recommendations and Future Outlook

- **Review of report:** Consultations were conducted during the drafting of the SOER 2020 to ensure that stakeholders can review and verify existing data and analysis before approval of the final report. The review process involved several phases: (1) content review to ensure that all aspects and available information have been included, (2) analysis review, which involved a review of the flow, consistency and rationale behind the conclusions and recommendations made, (3) preparation and delivery of presentations at the end of the review process to selected stakeholders to obtain and incorporate their feedback on the different chapters, and (4) final review and edits.
- **Approval and disclosure:** Once the chapters were approved, the final English version of the SOER 2020 was translated into Arabic and French to be published and distributed to stakeholders and the general public.

The SOER Team included the following subject-matter specialists, noting that the names of lead authors, co-authors, contributors and reviewers are listed at the beginning of every chapter:

1) Naji Chamieh and Lama Bashour, SOER Team and Deputy Team Leaders
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3) Ibrahim Alameddine, Water and Wastewater Expert
4) Rania Maroun, Water Expert
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8) Serge Yazigi, Land Management Expert
9) Sophia Ghanimeh, Solid Waste Expert
10) Renalda El Samra, Energy & Climate Change Expert
11) Sahar Issa, Chemicals Expert
12) Nisreen Salti, Economist

The review involved 13 subject experts from UNDP, UNHCR and UNICEF. Consultations were also held with 15 specialized staff from the Ministry of Environment (MoE).

1.4 Population Data

Lebanon ranks amongst the top 20 most densely populated countries in the world, with a population density of 669 inhabitants/km^2 (World Bank Group, 2018). Following the Syrian crisis, the population had grown considerably, which lead to an increase in poverty, made less tenable by the more recent economic collapse. In addition, due to intensified resource depletion to cater to a larger population, environmental degradation was exacerbated, and pressure was added on an already resource-strapped management infrastructure. Table 1-1 outlines the increase in population from 2011 to 2018, together with the increasing population density.

With respect to the age structure of the Lebanese population, 65% of the population is between 15 and 64 years old; women comprise 51.6% and men 48.4% of the total residential population (Figure 1-2).

Table 1-1 Population Number and Density (2011-2018)

Year	Total Population (including Refugees and Displaced)	Total Population Density in Lebanon (inhabitants/km^2)	World Population Average Density (inhabitants/km^2)
2018	6,848,925	669	60
2017	6,811,873	665	59
2016	6,711,121	656	58
2015	6,532,678	638	58
2014	6,262,410	612	57
2013	5,914,621	578	56
2012	5,538,634	541	56
2011	5,202,343	508	55

Source: World Bank Group, 2021

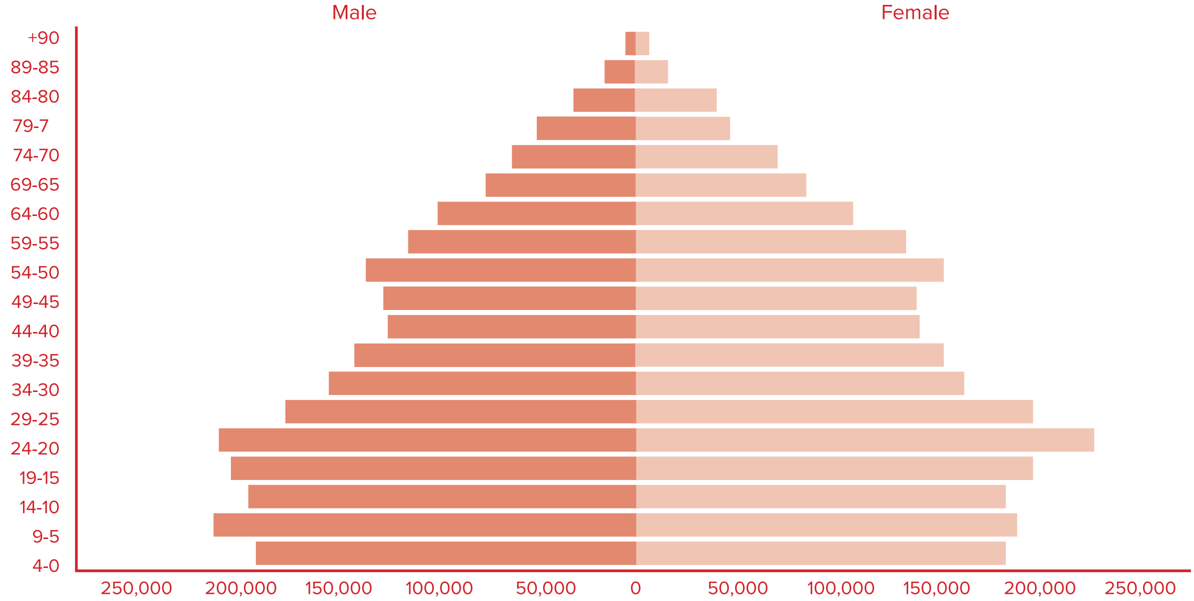

Figure 1-2 Age Pyramid for Lebanese Residents
Source: EU/CAS/ILO, 2019

1.5 Lebanon's Administrative Regions

Lebanon is divided into nine administrative governorate regions (called Mohafaza) and 25 sub-regions (called Caza), not including Beirut (Figure 1-3). Each Caza is made up of many cadastral zones (called Manateq iikarieh). There are about 1,500 cadastral zones in Lebanon. The largest governorate is Baalbek-Hermel and the smallest is the capital Beirut.

The area of each governorate and population distribution by caza and governorate are found in Table 1-2.

1.6 Reader's Guide

The SOER 2020 has a similar structure to the SOER 2010 with four sections and 11 chapters, as follows :

SECTION I: Introduction
Chapter 1 - Introduction & Methodology
Chapter 2 - Environmental Governance

SECTION II: State of the Environment
Chapter 3 - Water Resources
Chapter 4 - Air Quality
Chapter 5 - Ecosystems
Chapter 6 - Land Resources

SECTION III: Environmental Priorities
Chapter 7 - Haphazard Urbanization
Chapter 8 - Solid Waste
Chapter 9 - Climate Change and Energy
Chapter 10 - Chemical Management

SECTION IV: The Outlook - Towards 2030
Chapter 11 - The Decade Ahead

As with the SOER 2010, chapters are stand-alone documents that contain their own abbreviations and acronyms and list of legislations and references cited. The major difference is the addition of a new chapter on Chemical Management in the Environmental Priorities Section and adding a Climate Change component to the Energy Chapter. Cross-referencing has been made in all chapters to avoid redundancies and ensure that each chapter focuses on the topic at hand. A list of indicators has been selected and can be found in Chapter 11 - The Decade Ahead.

Figure 1-3 Administrative Map of Lebanon

Table 1-2 Population Distribution by Governorate and Caza

Governorate and Cazas	Governorate Capital	Area per Governorate (km²)[a]	Population per Caza[b]	Percentage of Total Population
Akkar	Halba	788	**324,000**	6.7
Baalbek-Hermel: Caza of Baalbek Caza of Hermel	Baalbek	3,009	**245,100** 214,600 30,500	5.1
Beirut	Beirut	19.8	**341,700**	7.1
Bekaa: Caza of Rachaya Caza of West Bekaa Caza of Zahle	Zahle	1,433	**297,600** 33,800 86,400 177,400	6.1
Mount Lebanon[1]: Caza of Aley Caza of Baabda Caza of Chouf Caza of Jbeil Caza of Matn Caza of Keserwan	Baabda	1,939	**2,032,600** 300,800 553,800 277,000 129,500 511,000 260,500	41.9
Nabatieh: Caza of Bint Jbeil Caza of Hasbaya Caza of Marjaayoun Caza of Nabatieh	Nabatieh	1,058	**379,100** 96,200 28,700 74,000 180,200	7.8
North Lebanon: Caza of Batroun Caza of Bcharre Caza of Koura Caza of Minieh-Danniyeh Caza of Tripoli Caza of Zgharta	Tripoli	1,271	**637,900** 58,900 22,100 84,600 140,800 243,800 87,700	13.2
South Lebanon: Caza of Jezzine Caza of Sidon Caza of Tyre	Saida	934	**584,400** 32,100 296,600 255,700	12.1
Total		**10,451.8**	**4,842,400**	**100**

Note: Excludes people living in non-residential units, such as army barracks, refugee camps and adjacent gatherings, and informal settlements.
Source: [a] IDAL, 2021; [b] EU/CAS/ILO, 2019

[1] In September 2017, the Government of Lebanon adopted Law 50 establishing the Governorate of Keserwen Ftouh-Jbeil. However, the decrees that organize the formation of this governorate have not yet been finalized.

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IDAL (Investment Development Authority of Lebanon). (2021). Invest in Regions. Retrieved from: *https://investinlebanon.gov.lb/en/lebanon_at_a glance/invest_in_regions*

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2 Environmental Governance

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Chapter reviewed by	**Manal Moussallem, PhD,** Senior Environmental Advisor, United Nations Development Programme (UNDP)-Ministry of Environment (MoE)
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Abbreviations and Acronyms

AFDC	Association for Forest Development and Conservation
AQMN	Air Quality Monitoring Network
BDL	Central Bank of Lebanon
BTVL	Technical Office of Lebanese Municipalities
CAS	Central Administration of Statistics
CBRN	Chemical Biological Radio Nuclear
CDR	Council for Development and Reconstruction
CIP	Capital Investment Plan
CNRS	National Council for Scientific Research
COED	Cost of Environmental Degradation
CoM	Council of Ministers
DGUP	Directorate General for Urban Planning
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPI	Environmental Performance Index
ETF	Environment Task Force
EU	European Union
GEF	Global Environment Facility
GoL	Government of Lebanon
IEE	Initial Environmental Examination
IRI	Industrial Research Institute
ISWM	Integrated Solid Waste Management
LARI	Lebanese Agricultural Research Institute
LCA	Lebanon Climate Act
LCEC	Lebanese Center for Energy Conservation
LCRP	Lebanese Crisis Response Plan
LEPAP	Lebanon Environmental Pollution Abatement Project
LPA	Lebanese Petroleum Administration
MEHE	Ministry of Education and Higher Education
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoI	Ministry of Industry
MoIM	Ministry of Interior and Municipalities
MoJ	Ministry of Justice
MoPH	Ministry of Public Health
MoPWT	Ministry of Public Works and Transport
NBSAP	National Biodiversity Strategy and Action Plan
NCE	National Council for the Environment
NCMS	National Center for Marine Sciences
NDC	Nationally Determined Contribution
NEEREA	National Energy Efficiency and Renewable Energy Action
NFE	National Fund for the Environment
NGO	Non-Governmental Organization
NOSCP	National Oil Spill Contingency Plan
NPMPLT	National Physical Master Plan for the Lebanese Territory
NSA	Non-State Actors
NT	National Team
OMSAR	Office of the Minister of State for Administrative Reform

PCM	Presidency of the Council of Ministers
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SOER	State of the Environment Report
StREG	Support to Reforms - Environmental Governance
TEDO	Tripoli Environment and Development Observatory
UNCSD	United Nations Conference on Sustainable Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
VNR	Voluntary National Review
YMCA	Young Men's Christian Association

2. Environmental Governance

"Environmental governance is a key driver for the achievement of sustainable development" (UNEP, 2020). The inextricable links between nature, social and economic dimensions of sustainable development require a sound decision-making process based on several factors including, but not limited to, effective institutions (2.1), laws (2.2), policies (2.3), systematic monitoring and enforcement (2.4), environmental research and development (2.5), scientific evidence (2.6), as well as access to environmental funding (2.7), advocacy of public participation (2.8) and incentivizing environmental protection (2.9). This chapter presents the various components that constitute environmental governance in Lebanon and progress that has been made in the last decade. Lebanon's Environmental Performance Index (EPI) score in 2020 was 45.4/100, a regression comparing to the 2010 score of 57.9. Going through a significant increase from 2012 to 2016 (from 47.35 to 69.14), a slight decrease in 2018 (61.08), before reaching its current score in 2020. Lebanon thus ranked 78th out of 180 countries (EPI, 2020). The Cost of Environmental Degradation (COED) in 2018 in Lebanon was estimated at 4.4% of the national Gross Domestic Product, corresponding to approximately USD 2.35 billion:(MoE/UNDP, 2019), compared to 3.4% estimated in 2000, which amounted to USD 0.56 billion (World Bank, 2004) - See Box 2-1 for definitions of EPI and COED.

Box 2-1 Environmental Performance Index and Cost of Environmental Degradation Definitions

The EPI provides a data-driven summary of the state of sustainability around the world. Using 32 performance indicators across 11 issue categories, the 2020 EPI ranked 180 countries on environmental health and ecosystem vitality (Yale University, 2020).

COED can be understood as a measure of the lost welfare of a nation due to environmental degradation (World Bank, 2004). Such a loss in welfare from environmental degradation includes (but is not necessarily limited to):

1. Loss of healthy life and well-being of the population (e.g. premature death, pain and suffering from illness, absence of a clean environment, discomfort).
2. Economic losses (e.g. reduced soil productivity and reduced value of other natural resources, lower international tourism).
3. Loss of environmental opportunities (e.g. reduced recreational value of lakes, rivers, beaches, forests).

2.1 Environmental Institutions

In the last decade, Lebanese environmental institutions have made a noticeable, yet often underestimated progress, despite the various challenges faced. The following section presents the current institutional set up to tackle environmental issues in Lebanon, with focus on the legislative body, the executive body and the judiciary.

2.1.1 Legislative Body

Lebanon's legislative body, represented by the Lebanese Parliament (www.lp.gov.lb), holds 128 seats and is organized into dozens of specialized committees. In addition to passing legislation, Parliament is empowered to conduct parliamentary investigations on specific subjects, which can be done for various environmental issues.

The Parliamentarian Committee for Environment, which has 12 permanent Members of Parliament, has as primary mission to review draft laws related to the environment prepared by the competent ministries. For each draft law, the Committee is required to submit its opinion within one month of its receipt (2 weeks in the event of an emergency). The committee also meets to discuss and follow up on various pressing issues such as waste, quarries, forest fires, nature reserves, hunting and others. The minutes of committee meetings (its work, discussion and vote) are confidential, unless the Committee decides otherwise. To ensure transparency and in line with the Right to Access Information Law 28/2017, it is important that the public have access to the proceedings of all the committee meetings.

Despite the various challenges the country has faced between 2010 and 2020, the Lebanese Parliament's activity in enacting laws pertaining to environmental protection has not stopped. Reforms that have been advanced by Parliament include enacting key legislation such as the Environmental Prosecution Law 251/2014, the Code of Water Law 77/2018 and its amendment Law 192/2020, the Air Quality Protection Law 78/2018, the Integrated Solid Waste Management (ISWM) Law 80/2018 and the Protected Areas Law 130/2019.

2.1.2 Executive Body

Lebanon's executive body is represented by the Council of Ministers (CoM) and is headed by the Presidency of the Council of Ministers (PCM) (www.pcm.gov.lb). The CoM enacts regulations in the form of decisions (henceforth denoted CoM Decision Number) and Decrees. The size of the ministerial cabinet is flexible and has over the last decade ranged between 20 and 30 ministers, including Minister of Environment. Lebanon has seen regular cabinet reshuffles since the publication of the 2010 SOER. The following paragraphs focus on the mandate and activities of the Ministry of Environment (MoE), as well as intergovernmental and other environmental committees.

2.1.2.1 Ministry of Environment

Environmental issues in Lebanon were first officially addressed in the CoM through the introduction of a Minister of State for Environmental Affairs in 1981. In 1993, through Law 216, the MoE was established and its mandate determined. This law was first amended by Law 667/1997, then by Law 690/2005, whose application decree was enacted four years later (Decree 2275/2009). The decree defines the function and responsibilities of each unit, including staff size and qualifications. A detailed organizational structure according to Law 690/2005 and Decree 2275/2009 is presented in Annex 1.

The MoE mandate, as per the Law 690/2005, covers all policy, oversight and guidance relating to environmental protection in Lebanon. To facilitate coordination between the different authorities in matters related directly or indirectly to the environment, the MoE created councils for specific sectors, such as the National Council for the Environment (NCE) (See Box 2-2), the National Council for Quarries and the Higher Council for Hunting, all chaired by the Minister of Environment, in addition to the councils and other committees where the MoE is represented, such as the Higher Council for Urban Planning, Industrial Permitting Committees and Health Councils. Furthermore, as per the provisions of the ISWM Law (Law 80/2018), the Minister of Environment formed the ISWM committee (MoE Decision 108/1 for 2019) to coordinate ISWM matters. In addition, the Nationally Determined Contribution (NDC) committee was formed in 2018. The committee will outline the mitigation targets and actions to reduce emissions at the national level. Furthermore, other committees are chaired by the Minister of Environment such as the Project Advisory Committee for the Lebanon Environmental Pollution Abatement Project (LEPAP) (Refer to Section 2.7.2.).

Box 2-2 National Council for the Environment

The NCE was established in compliance with Decree 8157/2012, based on Articles 6 and 7 of Law 444/2002. The NCE is composed of fourteen members as follows:

- Seven representatives of the ministries of Environment (represented by the Minister), Finance (MoF), Interior and Municipalities (MoIM), Agriculture (MoA), Public Works and Transport (MoPWT), Energy and Water (MoEW) and Industry (MoI) whose representative is designated by the relevant minister.
- Seven representatives of the private sector: Presidents of the Order of Medicine in Beirut / Tripoli (alternating), Order of Lawyers in Beirut / Tripoli (alternating), Order of Engineers in Beirut / Tripoli (Alternating) and Association of Banks and Association of Insurance Companies, head of a group of at least 20 environmental NGOs and assigned representative of the academic sector.

The NCE falls under the mandate of the MoE and is presided over by the Minister of Environment and, if absent, by the General Director of Environment. Its mandate is to present their recommendations and opinions on the following issues:

Public Policy and Planning Level:

- Environmental policies and strategies prepared by MoE.
- Mainstreaming environmental concepts in policies of the various development sectors to achieve sustainable development.
- Incorporating environmental concepts into urban master plans.
- Following up on international and regional conventions, treaties and protocols in line with environmental policies and needs of the country.

Technical:

- Evaluating the environmental performance of activities related to natural resources as a step towards evaluating the effectiveness of environmental safeguards put in place (Refer to Section 2.2.3.1).
- Reviewing studies and publications by the MoE and proposing additions and amendments.

Legislative:

- Preparing the necessary draft laws and regulations to protect the environment and ensure sustainable use of its resources.
- Preparing plans, programs and projects to improve compliance with international and regional conventions, treaties and protocols.

Administrative:

- Coordinating the orientation of public agencies related to environmental protection.

Financial:

- Activating the National Environmental Fund (as per Articles 8-11 of Law 444/2002).
- Financial incentives to facilitate environmental compliance by polluting sectors.

Internally, the NCE is composed of a general secretariat managed by the General Director of Environment with the assistance of the Department of Environmental Policy. The members should meet at least once a month upon invitation from the NCE President. The required meeting quorum is the absolute majority of the members and recommendations are adopted with absolute majority of the meeting attendees. The Council may seek the assistance of different public bodies and has the right to appoint experts from outside the administration. Its recommendations are raised to the Minister of Environment for appropriate action.

Ministers of Environment chose to sign cooperation memoranda with other ministers as well as Non-State Actors (NSA) to promote sustainable development through environmental conservation and protection of natural resources. These include the MoI, MoA, Office of the Minister of State for Administrative Reform (OMSAR), Ministry of Information, Ministry of Economy and Trade, Ministry of Justice (MoJ), Ministry of Labor, Ministry of Youth and Sports, Ministry of Tourism, Ministry of Culture, MoPWT and Ministry of Social Affairs. Recent examples of agreements signed primarily with NSA can be found in Box 2-3.

Box 2-3 MoE Selected Memoranda of Cooperation and Agreement (2014-2019)

- In 2014, Memorandum of Understanding with Technical Office of Lebanese Municipalities (BTVL)/Cités et Gouvernements Locaux Unis au Liban to promote cooperation with municipalities and unions of municipalities on environmental issues.
- In 2014, Memorandum of Cooperation with the Lebanese University, represented by the "École Doctorale des Sciences et de Technologie" on scientific and technical cooperation opportunities.
- In 2015, Cooperation agreement to preserve wild plants in cooperation with Green Hand Association.
- In 2016, Memorandum of Cooperation with the Lebanon Center for Volunteer Work to raise awareness and the promotion of volunteering in environmental matters.
- In 2016, Memorandum of Understanding with the Beirut Arab University to strengthen cooperation in the fields of education and scientific research in the field of environment.
- In 2016, Memorandum of Cooperation with the Lebanese Canadian University for initiating qualified specialists and experts in environmental fields.
- In 2016, Memorandum of Cooperation with the Lebanese University on the promotion and rehabilitation of the environment and raising awareness on agricultural and environmental issues.
- In 2019, joint work plan with MoIM to identify cooperation areas between the two ministries on matters related to quarries and crushers, solid waste, environmental impact assessment (EIA), treatment of pollution of the Litani River and Qaraoun Lake, plans to secure environmental protection for rivers and basins, random urban sprawl, biological diversity and the necessary measures to implement the Air Quality Protection Law.

Since 1993, a total of 17 Ministers of Environment have presided over the MoE, setting its agenda to move the environmental sector forward in Lebanon. Each minister proposed a Programme of Work in line with the Government's declaration reflecting the country's environmental priorities, building on previous initiatives and reiterating the country's commitments to multilateral environmental agreements.

Despite its vast mandate and responsibilities, the MoE staff's actual size has never reached 50% of the required positions set by the regulations, which themselves have become inadequate given the increased challenges in the sector. Human resources at MoE are bolstered by cooperation projects with international development partners. Through such projects, the Ministry receives experts and support staff who help implement various activities and functions related to legislation, research, training, monitoring and environmental awareness.

Furthermore, the budget of the MoE is one of the lowest among the government ministries. According to MoF records, MoE's annual budget steadily increased during the period of 2010 until 2018, reaching LBP 14 billion (USD 9.3 million) in 2017 and 2018 but decreased by 12.9% in 2019 to reach LBP 12.3 billion (USD 8.2 million) and LBP 8.9 billion in 2020 (less than USD 1 million at the current exchange market rate). With such a low budget, the capacity to procure consulting, operational and maintenance services is extremely limited.

Located in Central Beirut District, the MoE established so far four of the seven regional departments, foreseen under Law 690/2005 and its implementing Decree 2275/2009 in Saida for South Lebanon, Zahlé for the Bekaa, Tripoli for North Lebanon and Akkar for Akkar. In accordance with MoE Circular 15/1/2016, citizens and concerned parties living in Mount Lebanon, Nabatiyeh and Baalbeck-Hermel, where regional departments are absent, can refer to the closest regional department.

2.1.2.2 Municipalities and Unions of Municipalities

Municipalities and municipal unions in Lebanon are local administrations charged with the day-to-day management of all public works within their jurisdiction (municipal boundaries) in accordance with Legislative-Decree 118 dated 30 June 1977. Their responsibilities are wide and diverse and include (1) landscaping and beautification works; (2) public projects on municipal property and excavations for supply of street lighting; (3) water and wastewater projects; (4) internal roads; (5) recreational facilities; (6) waste disposal (subject to authentication of the Governor/Mohafez); and (7) urban planning in coordination with the Directorate General for Urban Planning (DGUP). According to Law 80/2018 (Article 20), municipalities are responsible for collecting and transporting solid waste from collection points to designated facilities in a manner that does not harm the environment, in accordance with the standards and conditions set by and subject to approval of MoE.

Lebanon has about 1,058 municipalities, which is considered an extremely large number relative to its geographic and population size. In comparison, it has 25 times more municipalities than Cyprus, which is comparable in surface area to Lebanon. Municipal councils are elected by their constituency and the number of their members depends on the size of the constituency. Municipal revenues include municipal taxes, revenues from renting municipal properties, fines and donations, as well as transfers from the Independent Municipal Fund. Unfortunately, despite significant administrative autonomy on paper, municipalities remain constrained administratively and financially.

Due to their large number, most municipalities are too small and therefore lack sufficient human resources to assume all their responsibilities, in particular with regard to environmental management and protection such as maintaining (1) public health by cleaning and removing litter and debris (particularly from water canals) and preventing pollution, (2) public safety by taking preventive measures against fires, explosions and floods, such as organizing the fire department, and controlling locations where flammable and explosive material including fuel are stored, and (3) public security by ensuring street lighting coverage within the municipality. Municipalities' vast responsibilities also include protecting landscapes and monuments, maintaining trees and forested areas and granting construction permits, as well as applying the provisions of the law to settle violations against building regulations.

Moreover, municipalities are procedurally bound by many government agencies such as MoIM, MoF and DGUP, limiting their autonomy. The lack of resources is partially addressed by the establishment of unions of municipalities, who have better access to funds and technical resources to implement development projects. The unions also help municipalities enhance their collaboration with institutions, non-governmental organizations (NGOs) and the public sector (UNESCO/UN-Habitat/Beirut Arab University, 2017).

In the last decade, and particularly in response to the Syrian crisis, municipalities in Lebanon have received significant support, including direct financing. The long-term impact of this support is yet to be determined. One key player has been BTVL/United Cities Lebanon, in charge of assisting local authorities from both a technical and institutional standpoint in strengthening the capacities of elected local representatives and local agents, in planning and implementing their development projects and in expanding their international relations. In 2020, BTVL has managed a network of 75 members (57 municipalities and 18 unions of municipalities), thus representing 335 cities and more than 70% of the Lebanese population. BTVL has recently implemented several projects as follows:

- Operational Support to Lebanese Municipalities in the Field of Environment Project (SOCLE) (2019-2021), which aims to build the capacities and skills of Lebanese municipalities and unions of municipalities in environmental management and renewable energy.
- Local planning for prevention and preparation to face the risks of disasters and crises (2018-2019)
- Capacity building of Lebanese municipalities in the field of local development (2016-2018)
- Cultural Heritage, Natural Heritage and Local Development in Lebanon (2014)
- Support for capacity building of Lebanese municipalities and dialogue with national authorities in the field of sanitation (2013 - 2015)
- Sanitation and protection of water resources in three southern unions of municipalities (2010-2013)

To support municipalities in their environmental capacities, MoE, with funding from international development partners, developed two guides and training modules. The first is the Practical Guide for Municipalities to Enhance Environmental Management, prepared in 2017 under the Support to Reforms: Environmental Governance Programme (StREG) in collaboration with UNDP and BTVL. This guide addresses municipalities and unions and emphasizes their role in reducing environmental degradation in six sectors: (1) air quality management, (2) solid waste management, (3) water resources management, (4) wastewater management, (5) land use and ecosystem management, and (6) environmental governance. StREG also developed a complete framework of applicable laws, regulations and taxation in which it stresses the importance of the establishment of the environmental police that includes municipal police for minor cases or the internal security forces for graver infractions (Refer to Section 2.1.3.2). The second is the Environmental Guide for Municipal Police that aims at strengthening environmental management within the municipal police force. These guides are available at the MoE website and are currently being used by BTVL to spread awareness among member municipalities.

Based on these training modules, in 2018, the Environment Task Force of the Lebanese Crisis Response Plan (LCRP) started to develop an Environmental Marker System to track LCRP's activities and ensure it meets national environmental safeguards. Furthermore, it prepared a Guide for Environmental Indicators (Outcome, Output and Activity level) to identify the environmental benefits for some LCRP sectors (Social Stability, Food Security, Water, Energy, Livelihood and Shelter) at the local level.

2.1.2.3 Disaster Preparedness Institutions

According to the United Nations Office for Disaster Risk Reduction (DRR), which is providing Lebanon with support and assistance in disaster preparedness, Lebanon has made “remarkable progress in adopting a comprehensive, popular and collaborative DRR agenda in a relatively short period of time”. However, challenges remain to achieving resilience, from political instability to economic uncertainty (UNDRR, 2013), and more recently the health crisis resulting from the Covid-19 pandemic. In 2005, the Government of Lebanon (GoL) endorsed and adopted the Hyogo Framework for Action that aims to build the resilience of nations and communities to disasters. It also adopted the Sendai Framework for DRR 2015-2030, the new global instrument to manage disaster risk. In line with both frameworks, Lebanon is institutionalizing many measures to prevent, mitigate and prepare for disasters, as well as fortifying and regulating its capacity to effectively respond to and recover from them (UNDRR, 2020).

Disaster Risk Management (DRM) strategies in Lebanon should be developed at sectoral and local levels by establishing a control room and action plan for each caza consistently. For example, Saida and Jbeil have developed their own risk strategies and have been recognized as cities with resilient capacities (L'Orient-Le Jour, 2020). However, Beirut and many other cities do not have a strategy aligned within the Sendai Framework. In case of a catastrophic event in Lebanon, an early intervention plan still does not exist, and an instructive example is the Beirut Explosion of August 4, 2020 (See Box 2-4) (UNDRR, 2020).

Box 2-4 Statement on the August 4th Explosion in Beirut, Lebanon

"I am mindful that the catastrophic disaster in Beirut comes at a time where the Lebanese people are struggling to respond to the COVID-19 disaster, and broader economic challenges. This traumatic event provides a stark reminder that disaster risk is systemic; we cannot see disasters in isolation. Disasters weaken entire systems and cascading impacts are felt across all aspects of life affecting the most vulnerable. There is a clear link between disaster risk reduction and sustainable development. Disasters undermine sustainable development; they contribute to ongoing poverty and impact on peace and security. The importance of disaster governance, which includes understanding the risk which we face and then making and funding plans to tackle it, is underscored at this time."

Special representative of the Secretary-General for Disaster Risk Reduction

Institutional responses to disaster risk in Lebanon are included in this section, except for the Weather Early Warning System, which is described in Section 2.5.1.3.

Institutional Measures and Committees

A draft law is currently being deliberated in the Lebanese Parliament that would establish a DRM administration in the country. This administration would be responsible to address natural and man-made disasters at the planning, response and recovery stages. It would be directly connected with the Prime Minister and have a higher council headed by the Prime Minister and whose members are the ministers of Defense, Interior and Municipalities, Public Health, Social Affairs, Public Works and Transport, Environment, Energy and Water, Agriculture and Finance.

National Coordination Committee for Disaster and National Crisis Response

By virtue of PCM Decision 41/2013, the National Coordination Committee was established with the objective of coordinating disaster response. Its tasks cover natural and manmade disasters or crises at the national level as follows:

- Receive calls related to the occurrence of any disaster, report and circulate instantly to all concerned administrations and agencies for immediate execution of preparedness measures.
- Propose measures to manage the disaster in coordination with relevant administrations and agencies.
- Coordinate response intervention of agencies during operations.
- Develop and disseminate the Flash Appeal relevant to phases of the disaster.
- Follow up on response operations at the national level.
- Activate communication and coordination among all response agencies.
- Supervise the rapid damage assessment program.
- Evaluate the response and propose adequate measures that enhance performance.

Disaster Risk Management Unit

Since 2009, the PCM, in cooperation with UNDP, has been implementing the Strengthening Disaster Risk Management Capacities in Lebanon Project over several phases. With the overall objective of mainstreaming disaster preparedness and management in national development framework strategies in Lebanon, several outputs were achieved including establishing a DRM Unit for the project at the PCM in 2010 to coordinate efforts during disasters and conflicts, developing and implementing the National Disaster Management Strategy and National Response Plan, building national capacities at central and regional levels, and enhancing local and community capacity for DRR to reduce losses to life and property. Programs and guides like the Crisis Recovery Program and the DRR Guide were also designed by this project to manage and decrease the risk of future disasters. Phase III of the project, which started in 2016 and is currently ongoing, aims “to help the GoL in establishing effective national institutions; including disaster risk information and disaster risk management systems, to increase societal resilience against disasters, especially in refugee-hosting high risk within major local authorities" (Box 2-5). Due to its success and effectiveness, the DRM Unit for this project is primed to be transformed into the DRM body once the draft law mentioned earlier is adopted. Until then, the PCM Circular 3 of 2019 has mandated the DRM Unit with the responsibility of ensuring cooperation and coordination among all public administrations, public institutions, councils, bodies, municipalities and unions of municipalities in the field of DRR.

Box 2-5 DRM Unit Activities

In response to the August 4th Beirut Explosion, a weekly situation report was prepared by the DRM unit aiming at fulfilling the needs and coordinating the resources of affected people through focusing on the different aspects of Response to Beirut Port Disaster being done by different national and international stakeholders.

A National Committee for Follow-up of Preventive Measures and Measures to Confront the Coronavirus in Lebanon was formed. A daily-situation-report on COVID-19 is released from the National Operations Room.

The DRM unit has also worked on forest fire preparedness and response. A Fire Weather Index is regularly reported with the support of National Council for Scientific Research (CNRS) and emergency numbers are always available. Moreover, with the support of the UNDP DRM project at the PCM, Regional Operation Rooms for crisis management in all Lebanese governorates are being established. These operation rooms will be adequately equipped and the response to the disasters will be properly supported with a communication system. In 2016, a Regional Operation Room was established in Akkar Governorate that suffers from several natural hazards, mainly forest fires.

The Chemical Biological Radio Nuclear National Team and the CBRN Program

The Chemical Biological Radio Nuclear (CBRN) National Team (NT) was established by virtue of PCM Decision 179/2013 under the jurisdiction of the Secretary General of the Higher Council of Defense. The NT includes representatives from the PCM, Lebanese Atomic Energy Commission, Lebanese Army, Internal Security Forces, General Security, State Security, Lebanese Customs Administration, Civil Defense, Ministry of Foreign Affairs, MoE and experts from the Ministry of Public Health (MoPH), MoA and MoI. One of the main missions of this team is to assess the adequateness of the national legal framework in the CBRN field and propose potential amendments to relevant laws and regulations. The CBRN NT has so far developed a list of all legislations applicable to CBRN, a list for all the relevant agreements with the international donors, a database of radiation sources in Beirut and suburbs based on their risk factors and a geographical list of all industries containing high risk chemicals. It has also completed the Integrated Nuclear Security Support Plans in cooperation with the International Atomic Energy Agency (CBRN, ND).

In September 2013, the MoPH prepared three plans related to chemical preparedness, which are the Preparedness for Chemical Hazards, the Preparedness for Chemical Events and the Hospital Emergency Plan. Under the CBRN Program, the MoPH, with the cooperation of the World Health Organization and the support of the Lebanese European Academy of Emergency Medicine at Saint Georges Hospital, implemented the first drill of national Hazmat Medical Program at Rafic Hariri University Hospital in 2017 in which fire fighters, the medical team of the MoPH and the Emergency team of RHUH participated. A second drill took place in 2018 in Rayak in the Bekaa Governorate with the support of MoPH team, the Lebanese Armed Forces, Internal Security Forces and the Civil Defense (MoPH, 2020).

Plans

In October 2013, the DRM Unit at the PCM published a Disaster Response Framework and Plan for Lebanon. The framework covers the main threats applicable to Lebanon, which are earthquakes, floods, tides, forest fires, landslides and armed conflict. The framework defined the strategies and objectives, readiness and capacity needs, early warning, data management, field coordination, training and implementation. It also identified standard operating procedures, as well as the main stakeholders and their roles and responsibilities.

Oil spills: Following the preparation of a Strategic Environmental Assessment (SEA) for the offshore petroleum sector that was commissioned by the GoL represented by the MoEW, many environmental recommendations were identified and led to the development of the Sustainable Oil and Gas Development in Lebanon (SODEL) Project. A draft of the National Oil Spill Contingency Plan (NOSCP) in Lebanese Waters was prepared in 2017, in collaboration with the Lebanese Petroleum Administration (LPA) and UNDP. The objective of the NOSCP is to protect human life, natural resources, and coastal and marine ecosystems from the detrimental effects of oil spills through responding to this event in the territorial sea and the exclusive economic zone that represent the public maritime domain, as well as oil spills from cross boundary sources. To implement the NOSCP at the LPA, standard operating procedures should be developed for each stakeholder, including the MoE who have already prepared theirs.

Forest fires: The DRM Unit, in cooperation with the CNRS and its early warning system the Sustainable

Natural Resource Management Platform (SuNar), the Civil Defense and the MoIM have worked on forest fire responses. Reports on forest fire predictions are regularly released and reported daily during the forest fire season. Moreover, the DRM Unit coordinates with municipalities during extreme weather events.

2.1.3 Judiciary System

Tackling environmental crimes within the judiciary system in Lebanon has seen significant developments over the last decade, with the adoption of legislation followed by assigning of environmental prosecutors, investigative judges and court experts. This is described in the following sections.

2.1.3.1 Environmental Prosecutors

In 2014, Law 251 was issued to allocate full-time public prosecutors and investigative judges for environmental matters. According to this law, the prosecutors are empowered to prosecute violations of environmental regulations against any perpetrators (known or unknown). Offenses considered as environmental crimes under this law can be found in Box 2-6.

Box 2-6 Environmental Crimes under Prosecution according to Law 251/2014

- Violation of laws and regulations related to the protection of forest resources, forests, natural reserves, biological diversity, and the protection of air, water, and soil from pollution, and those related to fighting damage caused by sound and noise.
- Violation of laws and regulations related to quarries, sand quarries and crushers.
- Violation of laws and regulations that define environmental conditions for classified establishments.
- Violation of environmental laws and regulations that protect public and private properties and territorial waters and for encroachments on marine and river properties.
- Violation of laws related to the disposal of all kinds of waste, especially medical, hospital, chemical and nuclear waste.
- Violation of the provisions stipulated in Law No. 444 of 2002.
- Violation of laws and regulations that protect antiquities and cultural and natural heritage.

For this purpose, the MoJ designated prosecutors and investigative judges to deal with environmental matters, though they are not solely dedicated for that purpose as required by Law 251/2014. Nonetheless and despite limited resources, the Lebanese judiciary system is becoming more specialized in environmental matters, the learning curve is growing and both judges and prosecutors are contributing to halting environmental crimes in the country. In fact, the judiciary has recently prosecuted a number of physical persons and corporations for environmental crimes.

According to Law 690/2005, environmental protection from damages and all forms of pollution is related to public order. Hence, environmental violations and criminal cases shall be immediately transferred by environmental prosecutors to the appointed civil or penal court depending on each one's competency. - *See Annex 2 for Identified Legal Avenues for People who have been affected by an Environmental Crime*. Registrars in competent tribunals are requested to notify the MoE of every final judgement issued no later than 3 months, to record it in a special register as per Law 251/2014. However, a mechanism for implementing this Article is yet to be put in place. The Council of State is the competent authority to receive an appeal in relation to administrative licenses issued that can cause pollution or environmental damage.

2.1.3.2 Environmental Police

The GoL issued in 2016 Decree 3989 providing for the appointment of environmental police officers, whose main mission is to curb environmental offences and crimes. Each appointed officer would be required to undergo six months of training on environmental legislation, crimes, damage and pollution control, including information on how to detect the location of the environmental crime and how to deal with environmental disasters. According to Article 3 of the Decree, a total of 40 police officers should be recruited. The MoE started the process of recruitment in 2017 and obtained the CoM prior clearance to the Civil Service Board in 2018. However, the exams have not yet been organized, likely due to a hiring freeze in place in the public sector since August 2017 as part of the government's austerity measures. This police force will be integral to preventing and prosecuting environmental crimes, provided they remain impartial and competent in exercising their duties. In addition to their recruitment, these officers should be equipped with the necessary tools and resources to adequately perform their duties, which involve implementing environmental legislation and monitoring its violations.

2.1.3.3 Environmental Court Experts

It is common that the assessment of material evidence on environmental offences and determining the guilt of perpetrators of environmental damages remain within the jurisdiction of the judge. However, during the past few years, a greater need has arisen for environmental expert intervention to tackle scientific and technical environmental challenges faced by courts. The environmental litigation is different indeed through its nature as it requires technical experts with relevant expertise to assist the judge in the decision-making process prior to the issuance of their sentence. Judges may have a wide understanding of environmental aspects and legislation, but it does not grant them the ability to settle such disputes alone as specialized scientific and technical knowledge may be needed. The key role played by environmental court experts guarantees a more efficient and effective process that safeguards the Lebanese environment. To be assigned, the experts need to first pass an exam and then follow continuous training that ensures their expertise is maintained at the highest level. Their mission also consists of providing assistance to environmental prosecutors who may seek their help in resolving environmental disputes as per Article 11 of Law 251/2014. As mentioned earlier (Section 2.1.3.1), appointments done by the MoJ were a positive first step, so was MoJ Decision 3330 of 2015 assigning environmental court experts (as environmental engineers or environmental specialists) at the various governorates. However, MoE has recommended in 2016 additional recruitment of environmental court experts and that they be further divided into sub-specialty by topic (solid waste, wastewater, air quality, etc.).

2.2 Environmental Laws and Regulations

Political instability, regional crises, parliamentary deadlocks and frequent cabinet reshuffles all contribute to delaying the adoption of new legislation and jeopardize policy making. However, this phenomenon has not had a detrimental effect on policy making at MoE as relevant government declarations and ministry work plans have remained consistent (refer to Section 2.3.3).

2.2.1 The Lebanese Constitution

There is no direct reference to the environment in Lebanon's Constitution (1923). However, Article 15 valorizes private property and bans any form of land acquisition except for the public interest (broadly interpreted as the provision of public services including roads, electricity and water). The perception that private property enjoys absolute protection under the Lebanese constitution has impeded sustainable land use planning, conservation efforts and delineation and demarcation of protected areas.

Lebanon's Constitutional Council has never issued any decision that refers to an "environmental right". However, and by reference to other political and judicial regimes, the council could recognize of constitutional value the protection of environment. For example, in an unprecedent decision dated 31 January 2020, the French Constitutional Council recognized for the first time that "the protection of the environment, the common heritage of human beings, constitutes an objective of constitutional value", which can justify any limitation to the right of free enterprise.

2.2.2 Multilateral Environmental Agreements

The next echelon in environmental legislation is multilateral environmental agreements, including conventions and treaties. Lebanon, a full voting member in the United Nations General Assembly since 1945, has acceded to and ratified many conventions and treaties related to the environment – see targeted list in Annex 3, for which MoE is generally the focal point. Some of these have reporting obligations for which Lebanon has recently submitted the following reports:

- Lebanon National Report to the Basel Convention (2019).
- Lebanon's Third Biennial Update Report to the United Nations Framework Convention on Climate Change (2019).
- Lebanon's Sixth National Report to the Convention on Biodiversity (2019).
- National Monitoring Programme for Marine Biodiversity in Lebanon under the UN Environment/Mediterranean Action Plan (MAP) (2019).
- Final National Report on Land Degradation Neutrality Target Setting Programme (2018).
- National Report of Lebanon to the Agreement in connection with the Conservation of African-Eurasian Migratory Waterbirds (2018).
- National Implementation Plans on Persistent Organic Pollutants (2017).
- Lebanon's Intended INDC under the United Nations Framework Convention on Climate Change (2015, updated in 2020).

Lebanon has received significant funding and support from international organizations as a result of ratification of these treaties and conventions and the country's adherence to their provisions entitles it to seek compensation from other members causing pollution within its territories (see Box 2-7 on compensation for the oil slick of 2006).

Box 2-7 Resolutions adopted by the UN General Assembly on the Oil Slick of 2006

On July 13 and 15, 2006, the fuel storage tanks at Jiyeh power plant (30 km south of Beirut) were bombed by Israel. Out of around 75,000 tons of heavy fuel oil stored there, an estimated 12,000 – 15,000 tons spilled, while the rest burnt. More than 70 sites (along 150 km of the coast of Lebanon) were affected by the spill: public or private, rocky, sandy, or pebble beaches, including cultural, historical and touristic resorts and harbours and fishermen's wharfs. Since 2006, the United Nations General Assembly issued 15 resolutions (resolutions 61/194 of 20 December 2006, 62/188 of 19 December 2007, 63/211 of 19 December 2008, 64/195of 21 December 2009, 65/147 of 20 December 2010, 66/192of 22 December 2011, 67/201 of 21 December 2012, 68/206 of 20 December 2013, 69/212of 19 December 2014 70/194 of 22 December 2015, 71/218 of 3 February 2017, 73/224 of 20 December 2018, 74/208 of 19 December 2019 and 75/209 of 21 December 2020) based on United Nations Conference on the Human Environment, especially Principle 7 of the Declaration of the Conference, in which States were requested to take all possible steps to prevent pollution of the seas and taking into account the 1992 Rio Declaration on Environment and Development, especially Principle 16, in which it was stipulated that the polluter should, in principle, bear the cost of pollution, and taking into account Chapter 17 of Agenda 21. Like earlier resolutions, the 2020 resolution states that "the oil slick has heavily polluted the shores of Lebanon and partially polluted Syrian shores and consequently has had serious implications for livelihoods and the economy of Lebanon, owing to the adverse implications for natural resources, biodiversity, fisheries and tourism, and for human health in the country" and acknowledges that "the value of the damage to Lebanon amounted to US$ 856.4 million in 2014" and requested the Government of Israel to assume responsibility for prompt and adequate compensation to the GoL. However, until today, the Government of Israel has not acknowledged "its responsibilities vis-à-vis the reparations and compensation to the Government and people of Lebanon".

2.2.3 Milestone Environmental Laws and Regulations

This SOER cites a plethora of environmental laws and regulations, as well as other legislation affecting the environment, listed chronologically at the end of each chapter (including this chapter). Between 2010 to 2020, Lebanon has seen the enactment of milestone environmental regulations addressing various sectors including governance, water, air, solid waste and protected areas that can be considered as a key step towards protection of the Lebanese environment.

2.2.3.1 Chapter 2: Environmental Governance

During the last decade, the following laws, decrees, decisions and circulars related to environmental governance were enacted by topic.

Environmental Advisory Functions: Decree 8157/2012 established the NCE, any advisory council presided by the Minister of Environment with members from several line ministries. Details on this council can be found in Box 2-2.

Environmental Assessment and Permitting: In 2012, two fundamental decrees of environmental safeguard tools were adopted and are currently implemented by MoE. The first was Decree 8213/2012 on SEA. According to Article 2, SEA is a planning and management tools for preventing or, at minimum, reducing sources of pollution and degradation of natural resources by assessing environmental impacts of a policy, program, study, investment or organization proposals that tackle a Lebanese region or an activity sector, identifying necessary mitigation measures and enhancing positive outcomes on the environment and natural resources, prior to its adoption. According to Decree 8633/2012 (Fundamentals of Environmental Impact Assessment), applicable to all development projects planned in Lebanon, EIA is an assessment of the likely environmental consequences of a proposed project, and determination of necessary measures for mitigating negative environmental consequences and increasing the positive impact on the environment and natural resources before approving or rejecting a project while an initial environmental examination (IEE) is preliminary study to capture potential environmental impact of a project in order to determine whether conducting an EIA study is necessary for a project. (Article 2).

Environmental Monitoring and Inspection: Decree 8471/2012 on Environmental Compliance for Establishments requires certain categories of establishments to conduct an Environmental Audit, another safeguard tool defined in Article 1 as a structured, detailed, documented, periodical and objective process to environmentally assess the industrial operation. It is the first step in an integrated program requiring documentation, application, and continuous follow-up of the action plan resulting from the audit, in order to effectively use natural resources and enhance the performance of the production process.

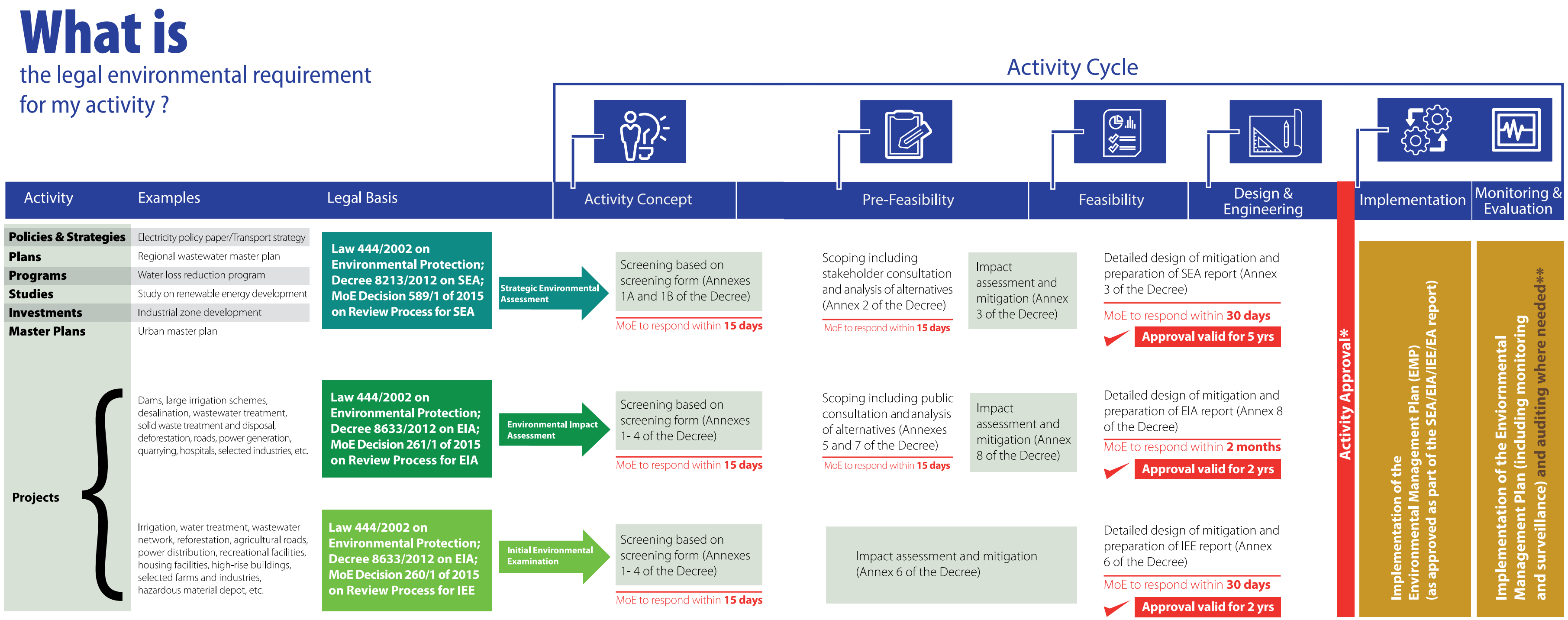
Since enactment of the three environmental safeguards decrees, MoE has issued several decisions detailing the procedures for their implementation and has been applying the decrees systematically throughout the country on both the public and private sector. The process for obtaining an approval from MoE for the environmental study of a proposal or existing activity has been mainstreamed into government procedures such that CoM approvals of policies and strategies and construction and operation permits are conditional on obtaining MoE's position on the prepared SEA, EIA or IEE. The final decision is then taken in light of MoE's position. Box 2-8 identifies some of the challenges in applying the safeguards process efficiently while Figure 2-1 presents a summary sheet on Environmental Safeguards in Lebanon prepared by MoE and includes a list of all relevant laws, decrees, decisions and circulars.

Environmental Enforcement and Prosecution: As described in Section 2.1.3, Law 251 adopted in 2014 relates to the allocation of full-time public prosecutors and investigative judges for environmental matters while Decree 3989/2016 establishes the environment police to be composed of 40 staff. Such regulations aim to bolster enforcement of environmental regulations.

Box 2-8 Challenges Facing MoE and the Safeguards Process

The Ministry's administrative processes still rely on a manual filing and correspondence system and function on an obsolete Information and Communication Technology infrastructure. Added to a limited number of staff and a small budget, this greatly slowed down work processes, negatively affected performance and the public perception of MoE and ultimately impacted its ability to carry out its mandate to protect against degradation of Lebanon's environment. The Ministry receives and sends out correspondence from/to other ministries, citizens, civil society and other stakeholders through the registrar. This correspondence consists of requests, letters, and EIA studies. It also receives citizen complaints on a broad range of issues, which often relate to uncontrolled and dangerous pollution. All these are handled manually, which sometimes results in loss of files or in delays that cannot be traced because the dossiers physically travel through different departments without always the possibility of being quickly tracked. EIA studies are one example of an area gravely affected by such delays, whereby project owners who submitted EIAs are compelled to constantly inquire about the status of their applications (Excerpt from GoL/MOE/GFA/EU, 2017).

In addition to administrative challenges faced by MoE, the safeguards processes were found to have some drawbacks when put in practice. The first is related to the legal review periods, as there are firm deadlines in the safeguards decrees for the various steps of the process, after which a submitted report, such as an EIA or IEE, is considered implicitly approved. However, this leaves room for ambiguity as no official approval is issued by the MoE, leaving some project owners, especially donors and implementing partners, reluctant to proceed with the next step until a response is received. More recently, and as a result of the COVID pandemic, all government deadlines were suspended to reduce pressure on public agencies. This has been interpreted by some as rendering the clauses on "implicit approval" void. However, this is not necessarily the correct legal interpretation, leaving this issue in bureaucratic limbo. Another challenge is decisions taken by some administrations to grant permits without going through the safeguards process, without waiting for MoE response when requested or ignoring MoE's position altogether without the needed justification. Concrete quick measures by CoM for such inter-ministerial "conflicts" are thus needed. In the meantime, a special expedited judicial course of action for such cases (for example in the form of conciliation agreements or significant monetary fines) should be used. Otherwise, these safeguards will fall short of contributing to sustainable development and become just another bureaucratic hurdle to be overcome by developers so they can proceed with their plans taking no account of the potential environmental impact.



* If a project is approved without undertaking an EIA/IEE although it requires one, and construction is not completed yet, at least an EMP should be undertaken; penalties are incurred (Article 58 of Law 444/2002)

** Environmental audits are required for establishments in order to obtain their Certificate of Environmental Compliance (Decree 8471/2012 and MoE Decisions 539/1 and 540/1 of 2015) and/or as requested by MoE following a proactive or reactive inspection.

Figure 2-1 Environmental Safeguards Description Sheet

2.2.3.2 Chapter 3: Water Resources

The main adopted legislation regarding water is Law 77/2018 and its amendment Law 192/2020, which comprises of 101 articles covering regulating, managing and monitoring water resources; water rights; administrative and financial procedures; managing water, wastewater and irrigation water facilities; protecting environmental and water resources; natural disaster readiness; liabilities and sanctions; and follow up on policies, data collection and public awareness raising. The law recognized the right for every beneficiary to enjoy any water resource, in a way that does not harm these resources or the interests of others. *See full analysis in Chapter 3 - Water Resources.*

2.2.3.3 Chapter 4: Air Quality

In 2018, the Lebanese Parliament enacted Law 78 on the Protection of Air Quality. The law comprises of 33 Articles related to identification, monitoring and assessment of air pollutants; prevention, control and surveillance; information management, research and capacity building; financial provisions; administrative procedures, liabilities and sanctions. *See full analysis in Chapter 4 - Air Quality.*

2.2.3.4 Chapter 5: Ecosystems

In 2019, Law 130 on Protected Areas was adopted by Parliament. The law comprises of 23 Articles regulating the management of the protected areas and stating conditions for their establishment. The law presents four categories of protected areas applicable in Lebanon and describes the management process of one of those categories, which is the Nature Reserve. *See full analysis in Chapter 5 - Ecosystems.*

2.2.3.5 Chapter 6: Land Resources

Unfortunately, no major legislation on land resources were introduced during the period 2010-2020. Although the matter of quarries is of main importance, the draft law organizing this sector, prepared with funding from the EU, has not been presented yet for adoption. However, for the first time, a policy on integrated management of the quarrying sector was adopted by the CoM through Decision 45 of 21/03/2019. Based on this policy, the MoE elaborated a new quarries master plan in 2019 (draft decree amending Decree 8803/2002 and its amendments), which has not been issued yet. *See full analysis in Chapter 6 - Land Resources.*

2.2.3.6 Chapter 7: Haphazard Urbanization

Addressing haphazard urbanization in Lebanon would progress significantly by simply enforcing existing legislation and even further through updating and implementing the provisions of the National Physical Master Plan for the Lebanese Territories. Not only has implementation been slow, disruptive decisions from MoIM gave municipalities the authority to issue construction permits of a single residential floor not exceeding 150 m^2 on agricultural parcels in rural regions. In addition, laws mandating the settlement of infractions continued to be adopted such as Law 139/2019 for building code infractions that occurred in between 13 September 1971 and 31 December 2018. Recently, the financial prosecutor started legal proceedings against violators of illegal constructions on the maritime public domain. Until today, violations regarding the construction code are still occurring even when judicial decisions are issued. Box 2-9 presents a glaring example. *See full analysis in Chapter 7 - Haphazard Urbanization.*

Box 2-9 Eden Bay Resort

The Eden Bay Resort project continued to trend in several media outlets between 2016 and 2017. Eden Bey Resort SAL was granted a building permit and an amended one on a plot of land located in Ramlet el Baida, at the southern coast of Beirut. Several environmental NGOs, with support from the public, voiced opposition to the project because they considered it to violate the maritime public domain and construction regulations. On 28 November 2016 and 27 February 2017, the Green Line Association brought two legal claims before the Council of State against Beirut Municipality, which issued the building permits, and requested suspension of the original and amended ones to immediately halt the ongoing construction works and their cancellation to ensure the resort never gets built.

On February 8 and on March 6, 2017, the Council of State issued two decisions ordering the suspension of the original and the amended building permits for violation of the urban planning, environmental protection (including inconsistencies with the submitted EIA), and property ownership regulations. Beirut Municipality, as well as the State, appealed this decision. Meanwhile, construction works on the resort continued despite the two decisions. On the 11th of April 2017, the Council of State reversed its decisions on the suspension of the permits allowing the company to complete the construction of the resort (Preliminary Decision 221/2016-2017 dated 11/4/2017 by State Consultative Council). As for the decision regarding the cancellation of the building permits, it is yet to be made.

One of the main arguments raised by the defendants is that the land is privately owned and therefore no violation against the public domain has occurred, as there is none. In this respect, the construction should be considered as legal. Furthermore, their claim is that no violation to the environmental regulations occurred. It is important to note that as construction works did not stop following issuance of the first and second decisions of the Council of State, these decisions were never enforced. Furthermore, the question remains on how private title deeds were issued to a private company on a land that is part of the public domain and in front of the sea. The same question applies to the entire coast of Ramlet el Baida.

2.2.3.7 Chapter 8: Solid Waste Management

The long awaited ISWM Law 80 was enacted by the Lebanese Parliament on 18 October 2018. Consisting of 38 articles, the law adopted the principle of integrated solid waste management, covering all stages from source reduction, reuse, source and plant sorting to recycling, composting, energy recovery and final disposal of residual waste. The law was complemented through the adoption of Decree 5605/2019 relating to sorting of household solid waste from the source and Decree 5606/2019 relating to Identification of the Fundamentals of Hazardous Waste Management and MoE Decision 108/1 of 2019 establishing the ISWM committee. However about 20 other application decrees and decisions are yet to be drafted and adopted for the law to be fully implementable. *See full analysis in Chapter 8 - Solid Waste.*

2.2.3.8 Chapter 9: Climate Change and Energy

Showing its commitment to the global effort of climate change mitigation and adaptation, the GoL signed the Paris Agreement in 2016 and ratified it through Law 115/2019 and Decree 5599/2019. In terms of encouraging renewable energy, Laws 288/2014 and 54/2015 were adopted, allowing the private sector to generate electricity in the renewable sector solely and exclusively and to export it to the national grid following the approval of the relevant authorities.

As for the oil and gas sector, Lebanon enacted Law 132/2010 on oil and gas activities in Lebanese territorial waters, followed by several relevant laws and decrees to identify and delineate the marine zones of Lebanon and open offshore licensing rounds for hydrocarbon exploitation. In 2012 and through Decree 7968, the LPA, an autonomous public institution mandated to plan, supervise and manage the upstream petroleum sector in Lebanon's offshore, was established. Decree 10289/2013, amended by Decree 1177/2017, provided for rules and regulations governing petroleum activities in Lebanon. *See full analysis in Chapter 9 - Climate Change and Energy.*

2.2.3.9 Chapter 10: Chemical Management

Chemical management in Lebanon is regulated by both international treaties and local regulations. Regulations that have been recently adopted are related to hazardous waste and include Decree 5606/2019 on the Identification of the Fundamentals of Hazardous Waste Management, and three MoE Decisions 998/1 of 2019 on the generators of hazardous waste, 999/1 of 2019 on the transporters of hazardous waste and 59/1 of 2020 on hazardous waste storage facilities. *See full analysis in Chapter 10 - Chemical Management.*

2.3 Environmental Policy/Strategies, Plans and Programs

The following sections present the strategies and action plans developed and adopted in Lebanon for environmental and sustainable development the last decade.

2.3.1 The 2015 Roadmap towards the National Sustainable Development Strategy

According to the Brundtland Report of 1987, "Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The legal framework of sustainable development in Lebanon is governed by Article 33(3) of Decree 2275/2009, designating the Minister of Environment the responsibility of coordinating sustainable development matters. In 2012, the GoL launched the National Report to the United Nations Conference on Sustainable Development (Rio+20) at the Presidential Palace and submitted it to its General Assembly Rio+20 in June of that year (Figure 2 -2).

Figure 2-2 The National Report to the United Nations Conference on Sustainable Development (Rio+20)

The preparation of this report was supported by UNDP and led by a ministerial committee composed of the ministries of Environment, Foreign Affairs, Social Affairs, and Economy and Trade, and consulted with many national research organizations, civil society and the private sector. Topics covered included the achievements, setbacks and the major developments of all the sectors in the country during the period of 1992-2012.

In 2015, the Roadmap towards National Sustainable Development Strategy was prepared by the PCM in coordination with MoE and relevant stakeholders, including the public and private sector and civil society, through e-participation, consultation meetings and working groups. This roadmap has defined its strategic objectives as follows:

1. Providing world class human capital.
2. Strengthening social cohesion.
3. Providing the citizens' daily priorities.
4. Enhancing economic growth.
5. Conserving the natural and cultural heritage.
6. Promoting good governance.
7. Repositioning Lebanon on the Arab, Mediterranean and international maps.

In 2017, a national committee chaired by the Prime Minister was formed to follow up on the status of the Sustainable Development Goals (SDGs) in Lebanon. This committee included representatives from various ministries, civil society and the private sector. One of its main priorities was to contribute to the Voluntary National Review (VNR) of the SDGs *(Refer to Chapter 11 - The Decade Ahead)*. Lebanon's first VNR was prepared in 2018 with the aim of identifying Lebanon's current conditions related to the SDGs and creating a baseline for the SDG process to attain Agenda 2030. However, efforts to prepare the strategy based on these findings and consultations have not been made yet.

2.3.2 Environmental Vision and Strategy

Following the 2006 draft National Environmental Action Plan, the Environmental Strategy Framework Paper that had been prepared in 1997 for the MoE by the World Bank was updated in 2013. This paper included a historical overview of the environment in Lebanon and its status during and after the 1975-1990 Civil War. It also described the main environmental challenges facing the country, such as the continuous depletion of resources, unbalanced growth, degradation of biodiversity, pollution of air, water, soil and food and high costs of environmental wastage. The proposed structure of the Environmental Strategy covered both environmental policy and management and comprises objectives, plans and various programs (MoE/UNDP, 2013).

In 2019, the consultancy Strategy& provided MoE with in-kind support to select their priority areas and enablers. The ecosystem priority areas were selected as follows:

- Rationalize waste generation, drive economic and responsible recovery, and ensure safe disposal.
- Streamline regional development masterplans and modernize regulations.
- Organize quarrying activities and drive the domestic sustainable supply of construction raw materials.
- Conserve our natural endowment, increase the number of protected areas and transform them into rural socio-economic engines.
- Enhance and protect ambient air quality.
- Catalyze efforts to meet our climate change NDC.
- Rationalize and regulate the use of chemicals in industrial and agricultural activities.

The enablers were as follows:

- Modernize and enforce environmental laws and regulations.
- Enhance sector-wide governance and institutional capabilities.
- Raise environmental awareness and responsibility, with NGO support.
- Secure funding and leverage support of international community.
- Ensure compliance with environmental basin management principles.

Identifying these priority areas and enablers fed into MoE's work within the framework of the Sectoral and Organisational Performance Measurement and Inspection Program, launched by OMSAR. As a result, key performance areas were selected, for the subsequent development of key performance indicators, as follows:

- Solid Waste Management.
- Chemical Profile Management and Hazardous Waste Management.
- Integrated Land and Environmental Basin Management.
- Ecosystem and Natural Heritage.
- Air Quality and Climate Change.
- Organizational and Institutional Strengthening.

This constituted the basis for the first Beirut Environment Conference of 2019 (Box 2-10).

Box 2-10 First Beirut Environment Conference 2019

The First Beirut Environment Conference held on May 3, 2019 and organized by MoE addressed Lebanon's environmental challenges through six panels that covered priority sectors: (1) Integrated solid waste management, (2) Sustainable quarrying and land management, (3) Ecosystems and natural heritage, (4) Air quality and climate change, (5) Integrated environmental basin management and (6) Environmental governance. The required measures and interventions were discussed in order to respond to challenges faced through implementing short-term and long-term strategies for environmental sustainability. The panels included participants from the public and private sectors, research organizations, civil society, international institutions and the media.

Environmental sector policies and strategies prepared/adopted in the last decade are as follows:

- National Water Sector Strategy (2010 – updated in 2020) *(Refer to Chapter 3 – Water Resources)*.
- National Strategy for Air Quality Management (2015) *(Refer to Chapter 4 – Air Quality)*.
- Marine Protected Areas Strategy (2012) *(Refer to Chapter 5 – Ecosystems)*.
- National Biodiversity Strategy and Action Plan (2016) *(Refer to Chapter 5 – Ecosystems)*.
- Lebanon National Forest Program 2015–2025 (2015) *(Refer to Chapter 5 – Ecosystems)*.
- Quarries Policy (2019) *(Refer to Chapter 6 – Land Resources)*.
- Policy for Integrated Management of Solid Waste (2017) *(Refer to Chapter 8 –Solid Waste)*.
- Lebanon's NDC to Climate Change (2015 and its update of 2020) *(Refer to Chapter 9 – Climate Change and Energy)*
- Update of Policy Paper for Electricity Sector (2019) *(Refer to Chapter 9 – Climate Change and Energy)*.
- Renewable Energy Road Map (2020) *(Refer to Chapter 9 – Climate Change and Energy)*.
- POPs National Implementation Plan (2017) *(Refer to Chapter 10 – Chemical Management)*.

2.3.3 The 2010-2020 MoE Plans / Programs of Work

Between the years 2010 and 2020, the MoE has published five reports that present its achievements based on plans/work programs prepared in line with the respective ministerial statements (Box 2-11).

Box 2-11 Environmental Perspectives in the Declarations of the Ministerial Statements

Six Ministerial Statements were released between 2010 and 2020, most of which directly addressed issues related to environmental protection. The declarations featured most prominently:

- Protecting Lebanon's natural resources and safeguarding them for future generations.
- Completing and implementing solid waste management plans, with focus on ISWM in the last three declarations.
- Adopting and implementing the quarries master plan.
- Increasing green cover in the country and combatting forest fires.
- Ensuring application of EIA Decree for all projects.
- Implementing the law on depollution of the Litani River and Lake Qaraoun and preparing similar plans for other rivers/watersheds.
- Limiting haphazard urbanization sprawl by preparing and implementing a policy to protect mountain tops, beaches, agricultural lands and green spaces.
- Implementing the approved National Biodiversity Strategy and Action Plan 2016 – 2030.
- Issuing the implementation decrees of the Law 78/2018 to protect air quality and stimulating climate action.
- Finalizing the National Sustainable Development Strategy in cooperation with the public and private sectors and civil society.

While the first three publications covered MoE achievements for the years 2009-2011, 2011-2012, and 2014-2016, the two that followed covered the periods 2010-2015 and 2016-2020 and briefly summarized the corresponding achievements while detailing the results of the MoE-UNDP partnership (Figure 2-3).

2.4 Environmental Monitoring, Inspection and Enforcement

The cycle of environmental management in Lebanon involves monitoring, proactive and reactive inspection, enforcement and prosecution that are described in the following sections.

2.4.1 Monitoring

Environmental monitoring is essential to understand the status of the natural environment and protect it from any negative anthropogenic activities (Envirotech, 2014). The monitoring system of environmental parameters is progressing slowly in Lebanon through implementation of various programs. For example, the Air Quality Monitoring Network (AQMN), as per Article 5 of Law 78/2018, includes 26 distributed all over

Figure 2-3 Publications of MoE's Programs and Achievements

Lebanon. Data from these stations can be accessed free of charge from MoE. Unfortunately, operation of this network has been halted in 2019 for budgetary reasons *(See Chapter 4 - Air Quality)*.

It is therefore imperative that the national environmental monitoring system be bolstered and capabilities of enforcement at MoE and other institutions strengthened (GoL/MoE, 2013) to provide periodic and accurate data on environmental indicators for the purpose of research and development, policymaking and development planning. These can be also used to accurately determine the country's EPI and COED.

2.4.2 Proactive and Reactive Inspection

Environmental inspections, proactive and reactive, are critical to investigate compliance with the legislation and standards set by the GoL. However, due to limited resources, such inspection is often limited to the reactive type. In order to overcome this limitation, outsourcing has been tested under the UNDP Institutional Strengthening to the MoE Project, whereby the Young Men's Christian Association– Lebanon (YMCA) supported the MoE in monitoring and inspecting activities in protecting ecosystems and controlling sources of pollution under the "Environmental Watchdogs" initiative. The initiative aimed at:

- Monitoring and reporting on the situation of established nature reserves in Lebanon.
- Checking the status of ecosystem in natural sites under the protection of MoE.
- Auditing of hunting exams.
- Monitoring and reporting the situation of licensed quarries.
- Inspecting compliance of classified industrial establishments with environmental regulations.
- Ensuring the adequate application of healthcare waste treatment process.
- Monitoring and reporting on the implementation of Environmental Management Plans for developmental projects.

Throughout the project's implementation period between March 2013 and December 2017, a total of 1,238 inspection visits, distributed based on different inspection categories, were carried out by the YMCA team who completed inspection reports in template forms as requested by MoE. At the end of their mission, the YMCA team made recommendations based on the challenges encountered to improve the inspection process. This included better coordination between relevant ministries and authorities, rapid response to complaints and regular follow-ups.

2.4.3 Enforcement and Prosecution

Controlling environmental crimes through punishing the perpetrators would ensure effective implementation and enforcement of environmental laws and regulations, thus limiting environmental degradation and its associated impacts. The ability of the GoL to undertake this has been improved through the adoption of legislation on environmental prosecutors (Law 251/2014) and environmental police (Decree 3989/2016) (refer to Section 2.1.3.1). To further activate the implementation of this legislation, a roundtable meeting was held by MoE in 2016 with judicial authorities and was attended by the President of the Higher Judicial Council, President of the State Litigation Authority, representatives of the Designated Attorney at the Court of Cassation, President of the State Council, Director General of the MoJ, in addition to the designated environment prosecutors and investigative judges. The outcomes of this meeting were ratified by the Minister of Environment and President of the Higher Judicial Council and its recommendations can be found in Box 2-12.

Box 2-12 Outcomes of Roundtable Meeting between the Minister of Environment and Judicial Authorities in 2016

Nine recommendations were made during this meeting as follows:

- Raising environmental rights to the level of a constitutional right.
- Ensuring the shared responsibilities between the executive and the judiciary authorities in protecting the environment.
- Granting NGOs the right to initiate public rights lawsuits on environmental issues and the right to claim compensation to be used to finance their activities.
- Securing the specialization of public prosecutors in environmental affairs by virtue of Law 251/2014.
- Increasing the number of environmental court experts after undergoing an examination determined by the MoE in cooperation with the Higher Judicial Council.
- Continuous training of environmental court experts.
- Preparing a protocol for sampling and adopting an official form for laboratory analysis.
- Allocating an amount in the MOE budget to pay expert fees and laboratory analysis.
- Establishing a mechanism to implement the provisions of Article 5 of Law 251/2014.

2.5 Environmental Research and Development

The development and improvement of scientific research has been key to the continuous growth and development of societies and social and economic sectors. Although Lebanon has a dynamic research community represented by various public and private entities, financial support from the government is generally limited, especially for public institutions. Over the years, the Lebanese Government has allocated time and money to conferences that present environmental crises and propose solutions, but practical steps remain absent. The following sections present the activities of public and private institutions have been the backbone of environmental research and development in Lebanon.

2.5.1 Government Bodies and Affiliated Institutions

2.5.1.1 National Council for Scientific Research

Established by Law dated 14/9/1962, the CNRS is a public institution directly linked to the PCM to assist in science policy-making and has financial and administrative independence. Its main objectives are to promote scientific research programs. Through its advisory function, the CNRS formulates scientific guidelines of policies, makes recommendations to the government and undertakes inventories related to private and public research activities and projects. Its executive function consists of the implementation of the National Science Policy. Between 2010 and 2016, CNRS has disbursed research funding to centers, programs and universities through its Grant Research Program. In 2016, out of 82 accepted project proposals, 20 were environmental sciences projects. The council encompasses four specialized research centers: National Center for Marine Sciences (NCMS), National Center for Geophysics, National Center for Remote Sensing and Lebanese Atomic Energy Commission.

CNRS publishes twice a year the Lebanese Science Journal that accepts submissions from all over the world, particularly from the Middle East and the North Africa. This journal is accessible for free to the public at http://lsj.cnrs.edu.lb/current-issue. CNRS uses Early Warning Systems through specific sensors and satellite images that could monitor and track earthquakes, movement of tectonic plates, measurement of snow accumulations, evaporation, landslides, torrents and the prediction of forest fires and floods. In addition, CNRS undertook the assessment of the status of bathing water quality along the main Lebanese beaches for the years 2019 and 2020 *(Refer to Chapter 3 - Water Resources).*

2.5.1.2 Industrial Research Institute

The Industrial Research Institute (IRI) is a Lebanese non-profit, non-commercial and public utility organization founded in 1956 through Decree 10059/1955 and linked to MOI by virtue of Law 642/1997. IRI has financial and administrative autonomy to conduct research and studies for the establishment of new industries and support existing ones in Lebanon. It ensures reliable testing and analysis, grants certifications of quality or conformity with standards, provides consulting services for the industrial sector and maintains tight cooperation with national and international organizations. IRI assists the committees of the Lebanese Standards Institution (LIBNOR) in updating and issuing Lebanese technical standards. IRI has 162 qualified experts and employees working out of its head office and 14 laboratories. Three research and development centers are associated with IRI and are the Lebanese Cleaner Production Center, the Euro-Lebanese Center for Industrial Modernization and the Centre for Innovation and Technology.

2.5.1.3 Lebanese Agricultural Research Institute

The Lebanese Agricultural Research Institute (LARI) is a governmental organization established through Decree 16766/1957 and its amendments under the tutelage of the Minister of Agriculture.

It was reorganized in 1964 as an administratively and financially autonomous public institution. LARI is headquartered in Tel Amara (Beka'a) and has ten research stations distributed throughout the country. With 500 employees including 25 researchers holding a doctorate degree and 120 departments and laboratories, LARI conducts research on plant, soil, animal, environmental and food sciences, and economics. LARI also provides extension services to farmers on soil fertility and water use management, control of plant pest and disease, crop rotation and other topics.

LARI offers analytical services on soil, plant, water, feed, fertilizers and pesticides, as well as analytical quality control of food and the production and distribution of basic seeds and selected ruminants. In addition, LARI collects and provides agrometeorological data through their 80 interconnected meteorological stations. Since March 2015, LARI has been working on an informative mobile application called "LARI-LEB", which works as an Early Warning System for weather forecasting, pest and disease outbreaks, forest fires, drought, irrigation management, natural disasters and climate change. As of 2019, there were 78,219 users of LARI-LEB (LARI, 2019). The institute provides free climatic data covering the various Lebanese regions through an email request to lari@lari.gov.lb.

2.5.1.4 Lebanese Center for Energy Conservation

Established in 2002 through Global Environment Facility (GEF) funding, the Lebanese Center for Energy Conservation (LCEC) aims at addressing energy issues, setting national strategies and action plans, implementing national projects and monitoring their quality, and greening the energy sector. In 2011, LCEC became an NGO affiliated with the MoEW. Based on the energy efficiency and renewable energy initiatives of the 2010 Policy Paper for the Electricity Sector, LCEC developed the first and second National Energy Efficiency Action Plan (2011-2015 and 2016-2020). LCEC also provides technical support and capacity building to relevant stakeholders under the National Energy Efficiency and Renewable Energy Action (NEEREA), a financing mechanism created by the Central Bank of Lebanon (BDL) to finance green energy projects in Lebanon. The LCEC team includes an executive board supported by a consulting council with 19 members including engineers, consultants, environmental experts, economists and coordinators.

2.5.2 Other Research and Educational Institutions

2.5.2.1 Tripoli Environment and Development Observatory/Urban Community of Fayhaa

The Tripoli Environment and Development Observatory (TEDO) was established by virtue of Decree 1095/1999 and was formally incorporated in 2006 into the Urban Community of Fayhaa, which is the municipality union, through CoM Decision 18 dated 9/12/2004 to help manage environmental issues while promoting sustainable development in Tripoli, El Mina, Beddawi and, recently, Kalamoun. TEDO also aims to ensure the dissemination of information through an advanced database. There are seven full-time employees at TEDO including two working at the observatory's air pollution laboratory that was created in 2000. The laboratory is equipped to measure exhaust emissions from diesel and gasoline cars, industrial pollutants including car paint and furniture and various air pollutants. In addition, TEDO staff are trained on the Geographic Information System and have in turn trained employees of the municipalities. TEDO has implemented and monitored various projects such as the Gouv'Airnance project *(refer to Chapter 4 – Air Quality)*. TEDO has also developed Al-Fayhaa Sustainable Development Strategy (2011-2020) that aims to improve the quality of life of citizens. TEDO regularly collects data on weather, potable water quality and solid waste generation rates. However, due to the small number of employees working at the observatory, data analysis often fails to be processed and updated for the development of new reports.

2.5.2.2 Private Universities and Research Centers

Environmental studies have been integrated into the Lebanese education system for decades. At the university level, courses are offered on various topics including environmental engineering, science or policies. Lebanon's public and private universities have provided a multitude of majors, diplomas and programs in the field of environment. These include the American University of Beirut (1866), Université Saint-Joseph (1875), Lebanese American University (1924), University of Balamand (1937), Université Saint-Esprit de Kaslik (1950), Lebanese University (1951), the Beirut Arab University (1960), Notre Dame University (1987) and the American University of Technology (1998). Moreover, the majority of these universities have created at their premises specialized environmental research centers such as the Nature Conservation Centre at the American University of Beirut, the Environmental Research Center, Eastern Mediterranean Area at Université Saint Joseph, the Institute of the Environment at the University of Balamand and the Research Center for Environment and Development at Beirut Arab University aiming at protecting the environment through conducting applied research and studies, capacity building and awareness raising. In addition, Majal, an urban academic observatory was established by the académie libanaise des beaux-arts. Universities in Lebanon have signed many national and international cooperation agreements and have collaborated regularly with MoE. - See Annex 4 for a full list of environmental degrees offered by universities in Lebanon and Annex 5 for a full list of environment research centers and institutes at universities in Lebanon as of December 2020.

2.6 Environmental Information and Data

Transparency and the public's right to access information are essential for sustainable natural resource management and effective pollution control. According to the Lebanon country report produced by the European Neighborhood and Partnership Instrument "Towards a Shared Environmental System", appropriate information sharing processes and systems in Lebanon are still lacking. Data collection and research projects are influenced by the information available in the country and the agendas of specific institutions. Although public institutions, academic and research centers and donor-funded projects generate a substantial amount of environmental data, this data often remains unpublished resulting in duplication of efforts and leading to redundancies in research efforts (European Environment Agency, 2012). Moreover, the relation between the academic sector and policy makers is weak, reducing the impact of research and access to information on the country's development (American University of Beirut, 2015). As a positive step in the last few years, sector strategies, such as the National Water Sector Strategy, Air Quality Management Strategy, and ISWM Strategy have focused on data monitoring and management as a prerequisite for proper planning.

The right to access environmental information had been regulated in Lebanon within an existing legal framework. The Environmental Protection Law 444/2002 addressed Environmental Information Systems in Article 14, which states that any person interested in environmental management and sustainable development has the right to gain access to the environmental information system, based on the rules and the exceptions imposed by this law. For example, EIA studies can be obtained by submitting a letter to MoE. In addition, MoE have started the process to publish the executive summaries of all the studies received on their website but has been delayed due to technical difficulties. More recently, Decree 6940/2020, relating to the implementing provisions of the Law 28/2017 on the right to access information, was adopted, allowing any person to receive documents and information from various administrations. In response, public institutions started assigning focal points for this purpose. The MoE has already assigned four employees: two focal points to provide information to the public and two additional acting focal points. Nevertheless, the effectiveness of this law and the success with which the public has managed to access public information since its adoption has not been fully demonstrated yet. In addition, and despite the massive amount of data on environmental issues that has been amassed in the last decade, a comprehensive national database on environmental monitoring is still lacking.

2.6.1 Data Availability, Sources and Access

Table 2-1 presents the status of data availability, sources and access of the different sectors described in the various chapters of this SOER.

Table 2-1 Data Availability, Sources and Access

Chapter	Available Data	Sources of Data	Access to Data
Chapter 2: Environmental Governance	• Proceedings of the Parliamentary Committee for Environment. • All environmental laws, decrees, MoE decisions and circulars are collected by MoE. • MoE archives all SEAs, EIAs and EAs submitted in line with the safeguard decrees. • Court rulings on environmental issues are required by law to be sent to MoE but no national database on environmental cases. • Council for Development and Reconstruction (CDR) prepares annual progress reports of its work with a summary of developments of main sectors including physical infrastructure (electricity, post and telecommunications and urban transportation), social infrastructure (public health, social and economic development, land use and environment), basic services (potable water supply, wastewater and solid waste) and productive sectors (agriculture and irrigation).	• Lebanese Parliament, CDR, MoE. • National reports such as VNR. • Academic literature.	• Minutes of some PCE meetings available online. • All legal documents available on MoE website. • SEAs usually published online and subject to feedback. • EIAs may be officially requested from MoE. • Court rulings can be obtained through legal experts. • CDR annual reports available online.
Chapter 3: Water Resources	• Historical data only available on river flows. • Partial information on location of springs and their flows. • Sporadic data on water quality in rivers, reservoirs and water tankers. • Limited information on ground water levels and quality. • Incomplete and fragmented data on location of public and private wells and unavailable for well pumping volumes and depths. • Sporadic data on domestic water quality. • Partially available data on water and wastewater networks and locations and capacity of WWTPs. • Limited data on non-revenue water and wastewater effluent. • Limited and estimated (not measured) domestic and agriculture water demand and non-existent for industrial WD. • Limited and sporadic health statistics on the number, type, and prevalence of water borne diseases. • Incomplete and fragmented information on location and volumes of irrigation ponds. • Unavailable data on evapotranspiration and water quality in wetlands.	• Public institutions such as MoEW, RWE, Litani River Authority, MoA, LARI, Green Plan, CNRS, MoPH, MoPT, and municipalities • International organizations (UNICEF and WHO) • National strategies, publications and reports • Academic literature	• Difficult to obtain or require official request from public institution, time consuming, if provided. • Some data can be found in reports available online but limited to summary statistics with no time series data. • Historical data on precipitation and temperature available for purchase.
Chapter 4: Air Quality	• Historical data from MoE AQMN (2013 until 2019) on $PM_{2.5}$, PM_{10}, NO_2, SO_2, O_3 and CO depending on location of the monitoring station, in addition to air quality monitoring data from TEDO stations. • Sporadic air quality measurements done for EIA and EA studies. • Sporadic measurements of various pollutants as part of academic studies and university research. Not temporally continuous nor spatially homogeneous. • No available data on indoor air quality except in sparse academic research studies.	• MoE, TEDO • National strategy and online reports • Academic literature	• Data from AQMN available to the public. • EIAs can be requested through an official letter to MoE. • EAs are considered confidential and data not generally shared. • Data from academic research available but sometimes require payment.

Chapter	Available Data	Sources of Data	Access to Data
Chapter 5: Ecosystems	• Scattered information available on marine and terrestrial species, dependent on the interest of individual researchers. • Prevalent information on non-indigenous species. • No list of total number of species, population status and dynamics of marine mammals, chondrichthyans and reptiles. • Historical information on phytoplankton and zooplankton collected by the NCMS-NCSR for decades. • Historical data on catch/effort of commercial fish species collected by MoA since 2013. • Available information on protected and sensitive areas including proposed ones. • Available data on surface area of coastal zone and habitat types. • Bathymetric maps developed by Lebanese Army, NCMS-NCSR and under oil and gas activities and specific projects by academic institutions. • Available marine water quality mainly through NCMS-NCSR. • No marine meteorological data (i.e. currents, waves, etc.). • Minimal information is collected on deep sea environments. • No data on energy flows in ecosystems, food chains and webs.	• Public institutions such as MoE, municipalities, NCMS-NCSR and Lebanese Army • International and national NGOs and independent experts • Technical national and regional reports • Academic literature • Academic institutions and research centers	• Published materials easily accessed. • No national repository to stay updated of the latest publications. Unpublished data at public institutions need official requests. • Academic institutions and research centers may provide "unpublished" data upon request.
Chapter 6: Land Resources/ Chapter 7: Haphazard Urbanization	• National Physical Master Plan for the Lebanese Territories prepared by CDR in 2004 developed a national geodatabase (known as a spatial database) using ArcGIS software based on high-definition satellites but requires updating (Box 2-13). • Data and maps available on natural hazards, soil types, land use and ownership, infrastructure and services. • Data available on geographic distribution of refugees and displaced. • Data not available on urban expansion and violations mainly on natural areas, a quarries survey, soil quality, and coverage of Master Plans of all governorates and districts.	• Private and public administrations including CDR, MoE, MoPWT, CNRS and Lebanese Army • Existing reports, studies and plans	• Published reports and research generally available to the public. • No easy access to data on land resources and haphazard urbanization especially from public administrations
Chapter 8: Solid Waste Management	• Systematic and historical data on municipal solid waste generation rates generally available with fair accuracy. No accurate weighing done at any stage of the MSW management process. • No monitoring data on the performance of most of the waste processing facilities. • No estimation of the activity of the informal sector. • No conclusive information (on generation, management or disposal) for most special waste streams.	• Public authorities (MoE, CDR, OMSAR, MoEW, municipalities) • Private sector (consultants and contractors) • International organizations and local NGOs (UNDP, United Nations Industrial Development Organization, EU, Arc-en-Ciel) • Academic research	• Data on solid waste generation and management in Lebanon not easily accessible to the public and scattered in different locations. • No unique physical or virtual location where the bulk of waste related data and studies is stored • MoE website includes some reports related to solid waste and dump sites conducted by MoE. • If requested officially from public institutions, data has to be requested in hard copies with an excessively long processing time.

Chapter	Available Data	Sources of Data	Access to Data
Chapter 9: Climate Change and Energy	• Data on greenhouse emissions available covering the period up to 2015. • Climate change publications and submissions. • Data available on Electricité du Liban and other public electricity infrastructure as well as fuel consumption. • No reliable and consistent data available on most private generators. • No reliable data on the location of renewable energy projects.	• Public institutions including MoE, MoEW, Electricité du Liban, Central Administration of Statistics (CAS) • UNDP publications • Academic literature	• Data is generally accessible to the public as most reports are published online or can be directly obtained from key stakeholders. • Academic publications in peer-reviewed journals are available though some require payment to access.
Chapter 10: Chemical Management	• Estimates of the prevalence of POPs and ODS available. • Limited data available on actual prevalence of hazardous chemicals and geographic distribution. • Sporadic data on chemical emissions from industries and agriculture available through project reports and environmental audits. • Data on industries available but does not always include unregistered establishments. • Sporadic data through individual research and some projects but no comprehensive studies on chemical pollution in various environmental media. • No continuous environmental monitoring and biomonitoring data available. • Few studies on health impacts and socio-economic costs of exposure to particular hazardous chemicals.	• Private and public administrations including MoE, MoI and MoA. • International organizations including UNDP, UNEP, UNHCR and local NGOs • Academic literature	• Data in national reports (such as submittals to Stockholm Convention, Montreal Protocol, etc.) available online. • Data on industries can be officially requested but may not be provided from public institutions due to confidentiality issues. • Academic publications and reports by international organizations are generally accessible. • Research articles found in journals and some require payment to obtain.

Box 2-13 Update of the National Physical Master Plan for the Lebanese Territories
CDR stated in its Progress Report of 2017 its intention to initiate the update of the National Physical Master Plan for the Lebanese Territories in collaboration with the DGUP. This project will include updates of the databases of the national Geographical Information Systems and the National Land Use Map based on high-definition satellites images. The work will be done with technical support from the National Center for Remote Sensing of the CNRS. However, no clear timeline has been set for this activity.

2.6.2 Other Data Available at Public Institutions

2.6.2.1 Ministry of Environment

MoE publishes all relevant laws, decrees, decisions and circulars on its website (www.moe.gov.lb), which also includes all reports, publications, releases and information prepared by MoE. These documents are regularly updated and could be easily downloaded by the public. Moreover, information and data could be requested through an official letter submitted to the Ministry.

2.6.2.2 Central Administration of Statistics

The CAS is a public administration established in 1979 under the CoM whose activities and institutional organization are governed by Decrees 1793/1979 and 2728/1980. CAS staff provide research services and statistical studies through collecting and processing of social and economic data at the national level. Moreover, CAS supervises statistical data collection and analysis undertaken by ministries and public administrations and supports in improving the methodologies used. In line with the United Nations Fundamental Principles of Official Statistics and the EU Statistics Code of Practice, CAS produces information on the various topics including demographic, social, economic and environmental. Their website (www.cas.gov.lb) contains updated results of CAS surveys and yearbooks, international statistical reports and publications from international organizations and electronic publications and reports. All these resources are freely accessible.

2.6.2.3 Council for Development and Reconstruction

Established in 1977, CDR's main objective was for reconstruction and development of Lebanon after the civil war. Its role has since developed to encompass various activities including planning, financing and supervision of infrastructure projects and rehabilitation of public institutions. The CDR is linked directly to the CoM through the Prime Minister and enjoys extended jurisdiction. The official website of CDR (www.cdr.gov.lb) presents annual progress reports of its work and reports and studies prepared by CDR including environmental assessments. Moreover, a list of Lebanese consulting offices is qualified at CDR to conduct environmental studies and is available for entities seeking environmental services in Lebanon.

2.7 Access to Environmental Funding

International and local funding agencies active in Lebanon, as well as some important funded projects, are described in the following sections.

2.7.1 International Funding

In response to the country's commitment to environmental issues (refer to Section 2.2.2), the international community has been continuously funding environmental projects in Lebanon. In addition to United Nations organizations, examples of these donors include the World Bank, GEF, EU, Italian Agency for Development Cooperation, Agence Française de Développement, German International Cooperation, Kingdom of the Netherlands, United States Agency for International Development, Arab Fund for Economic and Social Development, Islamic Development Bank and Kuwait Fund for Arab Economic Development. The GEF has supported Lebanon in reporting on various international environmental conventions, such as the UN Convention to Combat Desertification, the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change and the Stockholm Convention on Persistent Organic Pollutants and is currently funding several projects in the country. GEF operates through various implementing agencies including the World Bank, UNDP, UNEP, Food and Agriculture Organization and United Nations Industrial Development Organization. Several development banks provide investment funding for environmental projects in Lebanon, including the European Investment Bank and the European Bank for Reconstruction and Development. In an effort to consolidate this international cooperation and avoid the financial crisis back in 2018, the GoL prepared its Capital Investment Plan and presented it to donors and financing agencies requesting technical and financial support (Box 2-14). Lack of reforms requested by the international community has so far prevented the country from receiving this support and implementation of the plan.

Box 2-14 Lebanon's Capital Investment Plan of 2018

In 2018, the GoL developed its Capital Investment Plan that outlines three phases of implementation of 269 projects needed for developing Lebanon's physical infrastructure (Atallah S. et al., 2019). The targeted sectors include transport, water and irrigation, wastewater, electricity, solid waste, cultural heritage and infrastructure networks for industrial areas. The plan was presented that year at the Conference for Economic Development and Reform through Enterprises in Paris to seek funding, where countries pledged $11 billion in grants and loans for the first two phases of this plan. However, these pledges were conditional on serious reforms that should be accomplished by the GoL. Since the financial crisis in 2019, the conference has become a trust contract between the international community and the GoL with even stricter conditions for unlocking funding, including agreeing on a reform package with the International Monetary Fund (L'Orient-Le Jour, 2020).

2.7.2 Central Bank of Lebanon Mechanisms

In 2012, BDL developed the NEEREA as a green financing mechanism to promote sustainable energy projects and provide long-term loans for all energy efficiency and renewable energy projects and green certified buildings in Lebanon. The loan has a ceiling of US$ 20 million and is offered at an interest rate of 2.5% for a period that should not exceed 14 years, including a grace period of 6 months to 4 years. The loans were being provided through local commercial banks reaching directly the end user (LCEC, 2020).

Through LEPAP, the MoE joined forces with BDL to assist industries in Lebanon in setting up an environmental compliance process in line with national regulations and standards. Launched in 2014, LEPAP provides free technical support for industrial enterprises to evaluate their environmental status and propose measures to improve their environmental performance. The latter could be implemented through a loan with close to zero interest rate supported by BDL for a seven-year period that includes a two-year grace period. Available funding to LEPAP is €2.3 million from the Italian Agency for Development Cooperation for the technical support component, which is implemented by UNDP, and US$ 15 million for the investment component from the International Bank for Reconstruction and Development (BDL, 2016).

Following NEEREA and in cooperation with the LCEC, BDL launched in 2015 a national financing mechanism called the Lebanese Environmental Action that provide, through local commercial banks, environmental loans to implement environmental projects in Lebanon (MoET, 2020). These loans are in partnership with the EU, UNDP, MoEW–LCEC, MoE, Lebanese Banks and other institutions such as the European Investment Bank, Agence Française de Développement, and the World Bank. Subject to eligibility criteria, types of projects covered by this mechanism are recycling, organic farming, ecotourism, sustainable landscaping and agriculture, green roofs and walls, reclaimed stones cladding, roof tiling, wastewater treatment and rainwater collection (BDL, 2016). The future of all these mechanisms has become unclear due to the current banking and financial crisis.

2.7.3 The Planned National Fund for Environment

Pursuant to Law 444/2002 (Articles 8, 9, 10 and 11), a National Fund for the Environment (NFE) is to be established in Lebanon. The NFE would be a financially and administratively independent body under the tutelage of the MoE and have various responsibilities including contributing to funding environmental monitoring and supervision activities. The budget of the NFE would come from the national budget, environmental fees, grants from international organizations, and fines, indemnities and settlements related to environmental crimes. However, the creation of the NFE is subject to the issuance of a decree by the CoM upon the proposition of the Minister of Environment and the Minister of Finance, which has not yet been done.

2.8 Advocacy and Public Participation

Advocacy is about influencing people, policies, decisions and systems in order to achieve change. Environmental advocacy involves sharing important and simplified scientific information with the general public (Giardina, 2018). Lebanon is characterized by a civil society that is highly active in the field of environmental protection and is continuously growing. While some question their real impact on the ground, they have successfully raised public awareness on various topics including sustainable development, air and water pollution, land degradation, wastewater and solid waste management, renewable energy and climate change. Their involvement in analyzing and proposing solutions to environmental problems has in some cases pushed the government to adopt legislation for safeguarding the environment. In certain settings, they fill gaps left by the authorities due to lack of funding, such as in reforestation and recycling activities.

Public participation in decision making is one of the underlying principles highlighted in the Environmental Protection Law 444/2002 (Article 19). Public hearings, meetings and consultations are forms of participatory approaches that are described in the context of SEA and EIA studies and are required by Decree 8213/2012 and Decree 8633/2012, respectively. During the early stages of both studies, public hearings and consultations should be held to inform and obtain feedback from local communities, NGOs and other stakeholders on the proposed project or program. Since adoption of the decrees, these forums have served as a useful tool for local advocacy groups to obtain information about developments in their region and exert pressure on the government and project developers. Given the consultative nature of these meetings, stakeholders can only influence decision-making rather than participate in it.

2.8.1 Civil Society, NGOs/Coalitions and Foundations

According to MoE records, there are more than 816 NGOs in Lebanon with environmental objectives that are registered at MoIM. Each NGO is experienced to address various environmental issues and is active in specific fields, such as reforestation and forest fire prevention (Association for Forest Development and Conservation (AFDC), Jouzour Lebanon, Lebanon Reforestation Initiative), biodiversity conservation (Spéléo Club du Liban, Society for the Protection of Nature in Lebanon, Animal Encounter, Amwaj of the Environment, T.E.R.R.E Liban, Bahr Loubnan, Beeatoona, Jibal, Greenpeace MENA), ecotourism (Vamos Todos, Lebanon Mountain Trail), land resources and protected area designation and management (Al Shouf Cedars Society, Friends of Horsh Ehden, Association for the Protection of Jabal Moussa), solid waste management and recycling (arcenciel, L'Ecoute, Terre Liban, Live Love Recycle, Recycle Lebanon, Waste Management Coalition), energy and climate change (The Lebanese Association for Energy Saving & for Environment-ALMEE, Lebanese Foundation for Renewable Energy), energy conservation and green building (Lebanon Green Building Council) and many other NGOs and foundations hosting various platforms (Lebanon Clean and Green Environment Website, Green Opportunities Website), positively affecting the environment and advocating for its protection. These also include foundations such as the Ibrahim AbdEl Al Foundation for Sustainable Development specialized in water and energy, and the Rene Moawad Foundation working on rural and socioeconomic development.

2.8.2 Schools and Clubs

Environmental education has gained traction in Lebanon over the last decade with various initiatives launched by the public sector and civil society. The crucial role of environmental clubs in schools and the importance of integrating international knowledge and expertise into the community was emphasized during the 2016 Annual Conference of Lebanese Catholic Schools, which also highlighted important role of the MoE and the MEHE (Mekhael, E., & Karameh, J., 2018). Although generally not undertaken under one overall framework, various activities have brought environmental education in schools to the forefront, with the aim of mainstreaming it in public and private schools throughout the country. Examples of these initiatives include:

- In 2012, AFDC and the Center for Educational Research and Development affiliated with MEHE, under the supervision of the MoE with funding from Hanns Seidel Foundation, developed the "National Strategy for Environmental Education in Lebanon" (Figure 2-4).

Figure 2-4 National Strategy for Environmental Education, 2012

- In 2018, in collaboration with the MEHE and with support from USAID through BALADI CAP Program, AFDC developed a paperless policy to advance the national case for paper use and paper waste reduction at schools to be approved through ministerial decrees and circulars. Accordingly, the following was undertaken:
  - Identifying steps to reduce paper consumption in the education sector in Lebanon.
  - Drafting decisions and recommendations that support implementation of this policy.
  - Implementing a national workshop to present and discuss the draft policy and put forward recommendations and proposals that can be implemented.
  - Implementing workshops targeting school principals, teachers, health and environmental counselors and supervisors.
- In 2019, a memorandum of understanding was signed between the MoE and the Center for Educational Research and Development. It aimed at launching an environmental education awareness program that includes several topics for all workers in the education sector, as well as students and their families, to motivate them to become effective actors in the field of the environment.
- The e-Eco Solutions environmental consultancy firm, with support from MEHE, MoE and the Global Coalition of Green Schools in Lebanon, developed the Green Schools Certification Program, which aims to help school students become environmentally responsible citizens and contribute to green communities. Around 100 public and private schools in Lebanon and 22 organizations participated in this program that assesses their level of commitment based on 6 categories: recycling, green spaces, energy efficiency, water efficiency, health and safety, and education for sustainability.
- The International School Award, a global accreditation scheme, was applied by 23 Lebanese public and private schools. This program includes inter-curriculum activities that tackle environmental, health and social issues.
- The International Initiative Zero Waste ACT aims at reducing solid waste disposal and diverting the waste stream away from landfills. It was implemented in 91 Lebanese schools, universities and organizations.
- The United Nations Educational, Scientific and Cultural Organization's Education for Sustainable Development was included into the activities of the Associated Schools Project Network that covers 66 Lebanese schools.
- The Lebanon Organization for Green Schools was established in 2016 to support educating younger generations to protect Lebanon's environment. It is currently working with local schools to integrate environmental awareness for students in the Lebanese curriculum and provide training for teachers (The Switchers, 2019).
- The Teacher's Guidebook on Climate Change for Schools in Lebanon was developed by MoE and UNDP in 2015 which aims at supporting teachers and students to build the knowledge and skills which help them face climate change (MoE/UNDP, 2015).
- The "Up Cycling for Hope" Project, which closed in 2017, aimed to raise youth awareness

of waste management issues through an art-focused project implemented in 7 public schools in Beirut, targeting 1,233 Lebanese and refugee students between the ages of 7 and 12. The project funded by UNHCR and implemented by Red Oak Foundation.

2.8.3 Media

With an increased interest in environmental matters in Lebanon, the frequency of media coverage of this topic has markedly increased. Some outlets now feature weekly and daily pieces on environmental issues. Traditional and social media have provided a myriad of tools for public participation and expression. These include newspapers, magazines, televised debates and documentaries, radio interviews, Facebook groups and pages, Twitter and websites including The Daily Star, Al Akhbar, Environment and Development Magazine, Beyond Magazine, Executive Magazine, Green Area, Middle East Eye, Legal Agenda, Ghadi news, and many more. National and international environment days and clean-up, recycling and reforestation campaigns are covered on TV and radio stations and in newspapers. Public seminars, booklets and brochures are all tools used to disseminate information and discuss environmental issues. In 2014, the MoE and the Ministry of Information signed a memorandum of cooperation to face environmental challenges and activate the role of media to focus not only on conveying news but on critically analyzing and spreading awareness of major environmental challenges in Lebanon (MoE, 2017). More recently, MTV's "Sar El Wa2et" or "It's about time", in partnership with the American University of Beirut's Nature Conservation Center, created the Environment Academy that aims to "publicize and expand on a process for co-creating solutions with the residents of rural and urban areas at the front lines of our common environmental problems".

2.8.4 Other Influencers

Other influencers include the Chamber of Commerce, Industry and Agriculture of Beirut and Mount Lebanon, which has an Energy and Environment Committee, and the Association of the Lebanese Industrialists that has an Environment Committee, and a Sustainable Development and Energy Committee. At the syndicate level, the Order of Engineers and Architects and the Beirut Bar Association both have dedicated environmental committees. Collectively, these committees contribute to mainstreaming the environment into the various sectors of the economy.

The past decade has witnessed an increase in public protests and campaigns on various issues and grievances, and protecting the environment has been at the forefront, with campaigns such as Save the Bisri Valley, The Civil Campaign to Protect the Dalieh of Raouche and most prominently the waste crisis protests of 2015. These are believed to have been precursors to the mass protests that engulfed the country at the start of the financial crisis in 2019 (Yee and Saad, 2019).

2.9 Incentivizing Environmental Protection

The GoL has incentivized environmental protection through different mechanisms as described in the sections below.

2.9.1 Environmental Compliance Certificate

Decree 8471/2012 for the Environmental Compliance for Establishments (Refer to Section 2.2.3.1) aims to regulate all activities that may result in pollution and environmental degradation. Establishments in specific categories will be required to apply for an environmental compliance certificate every three years as part of a construction or operation permit. As per this decree, the Environment Compliance Certificate will be a tool for integrated pollution control and management and will define all the interlinked requirements to protect human health and the environment and will complement the compliance action plan developed under the conducted environmental audit. An Environmental Compliance Committee was formed within the Urban Environment Service at MoE to technically support and follow up this mechanism (MoE, 2013). LEPAP has supported the preparation of some of the application decisions for this decree. This environmental compliance mechanism was set for industrial enterprises through the provision of free of charge technical assistance and soft loans with close to 0% interest rates for the implementation of pollution abatement interventions as well as supporting MoE's monitoring and enforcement capabilities (Refer to Section 2.7.2).

2.9.2 Climate Change Certificate

The Lebanon Climate Act (LCA) aims at improving economic growth in the country through addressing climate change challenges and making societies more valuable. Through LCA, a network of companies and institutions involved in combatting climate change was established. LCA also supported the private sector and businesses to get involved in the climate change community and contribute sustainably and successfully to mitigating and adapting to climate change. The engaged companies would need to reduce their environmental and carbon footprint, increase low-carbon investments, deploy cleaner energy and build more sustainable businesses and communities to tackle climate change. The LCA initiative is led by the Green Mind, in partnership with UNDP and BDL, and has undertaken three business knowledge platforms. MoE Decision 99/1 for 2013 provides that the commercial, institutional and industrial enterprises from the private sector have to report their greenhouse gas emissions and related activity data to the MoE. They are then awarded with a Climate Change Certificate signed by the Minister (MoE/UNDP, 2020).

2.9.3 Economic Incentives for Environmental Protection

In addition to the soft loans granted through BDL's green financing mechanisms (Refer to Section 2.7.2), the GoL issued Decree 167/2017, an application decree to Article 20 of Law 444, that offers economic incentives for activities contributing to environmental protection and sustainability. This includes tax credits for environment industries. It also allowed for tax credits for expenditures on sustainable environmental protection activities and customs duty abatement on importing goods to be used to avoid, reduce or eliminate pollution or to treat, recycle or reuse waste. The necessary application decisions for this Decree were issued in 2017 by MoE through Decision 1281/1, in 2020 by the MoF Decision 18/1 and in early 2021 by the MoF through Decision 35/1.

2.10 Moving from Legislation and Planning to Enforcement and Implementation

The previous sections provided an overview of selected institutions, laws and regulations, policies, strategies, plans and programs, monitoring, inspection and enforcement, research and development, information and data, access to funding, advocacy and public participation and incentives for environmental protection that constitute and govern the environmental sector in Lebanon. All those components have witnessed significant progress over the last decade, with the adoption of key legislation and increased public awareness on the importance of environmental issues. However, some of these legislations took up to a decade to be enacted, a challenge that still faces new laws, decrees and decisions. The main reasons behind these delays are political instability and lack of clear deadlines for review and enactment of draft legal texts (Moussallem, 2017).

Although it is essential to enact environmental laws and regulations, enforcement remains a critical requirement. This report shows that despite improvements in the legal framework, enforcement and implementation have been lacking and is the main detriment to sound environmental governance in the country, which is highly reliant on political will. In this respect, the appointment of full-time public prosecutors, investigative judges and police officers specialized in environmental matters will improve enforcement, but this will take time to ensure proper transfer of knowledge to these appointees. Activating Law 664/2005 by creating an Ombudsman, an independent mediator, would also have a positive impact on the government's environmental performance by supporting the public in dealing with government bureaucracy and providing assistance in dispute resolution. In addition, systematically allocating human resources and funds will be a key step for Lebanon to safeguard its environment and show real political drive. Initiatives that have successfully supported the enabling environment for sustainable development at the national policy level in Lebanon is UNDP's Institutional Strengthening to the Ministry of Environment Project that ran between 2010 and 2020. Another is the EU-funded program StREG at MoE (Box 2-15).

Box 2-15 Support to Reforms: Environmental Governance

StREG aimed to improve the environmental performance of the Lebanese public sector through reforms to environmental governance on the legal, administrative, financial and technical levels. This program was approved by the CoM as per Decree 9189/2012 with a total budget of €8 million (EU grant) over a period of six years. StREG creates effective capacity at MoE to plan and execute environmental policy, enforce environmental laws and mainstream environmental issues in key line ministries. The technical assistance component of StREG was implemented over a period of 46 months from March 2014 till December 2017, with a budget of €4,689,060. The goal of the project was to create solid foundations for environmental governance. Major achievements of the project include: (1) open communication and coordination among staff members, creating a sense of buy-in and ownership of the project outputs; (2) capacity building and knowledge transfer trainings; (3) upgrading of the administrative system by introducing automation in the hunting permitting process; (4) creating a framework of applicable laws, taxation and regulations; (5) developing environmental standards and emission limits to reinforce monitoring and limit environmental degradation; (6) introducing the concept of sanction, implemented through environmental police, upon environmental violations. StREG proposed legal texts, green taxation, standards and emission limits. The StREG publications can be found at www.stregmoe.gov.lb. These include technical documents (Automation and Administrative Capacity, Environmental Fiscal Instruments, Training Documents, Environmental Policy Documents, Protected Areas, Quarries and Solid Waste Management) and legal documents (Environmental Policy, Air Quality, Protected Areas, Quarries, Solid Waste Management and Water and Wastewater Treatment). Hence, this program focused on the foundations of the governance to achieve positive and durable impacts in the long term (GoL/MoE/GFA/EU, 2017).

Long term policymaking and implementation has been made virtually impossible as a result of political turmoil locally and in the region, compounded by several crises that the country has endured, most prominently those related to the influx of Syrian displaced at the beginning of the decade to the financial meltdown, Covid-19 pandemic and Beirut Explosion at its end. However, instead of being perceived as impediments, these events should serve as proof of the country's need to reinforce its resilience and improve its sustainable development practices so that future crises and challenges can be better faced.

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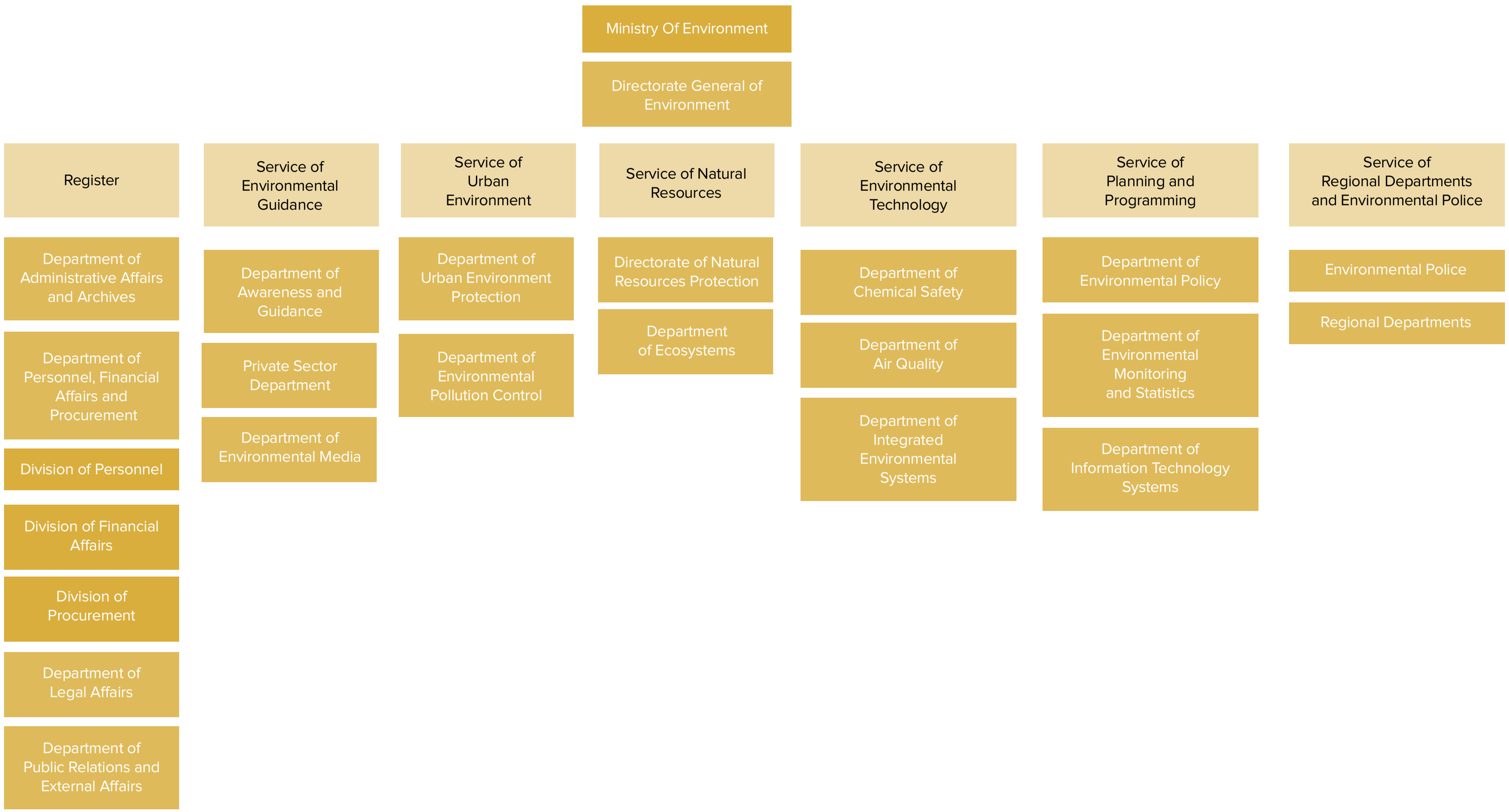
Cited Legislations related to Environmental Governance

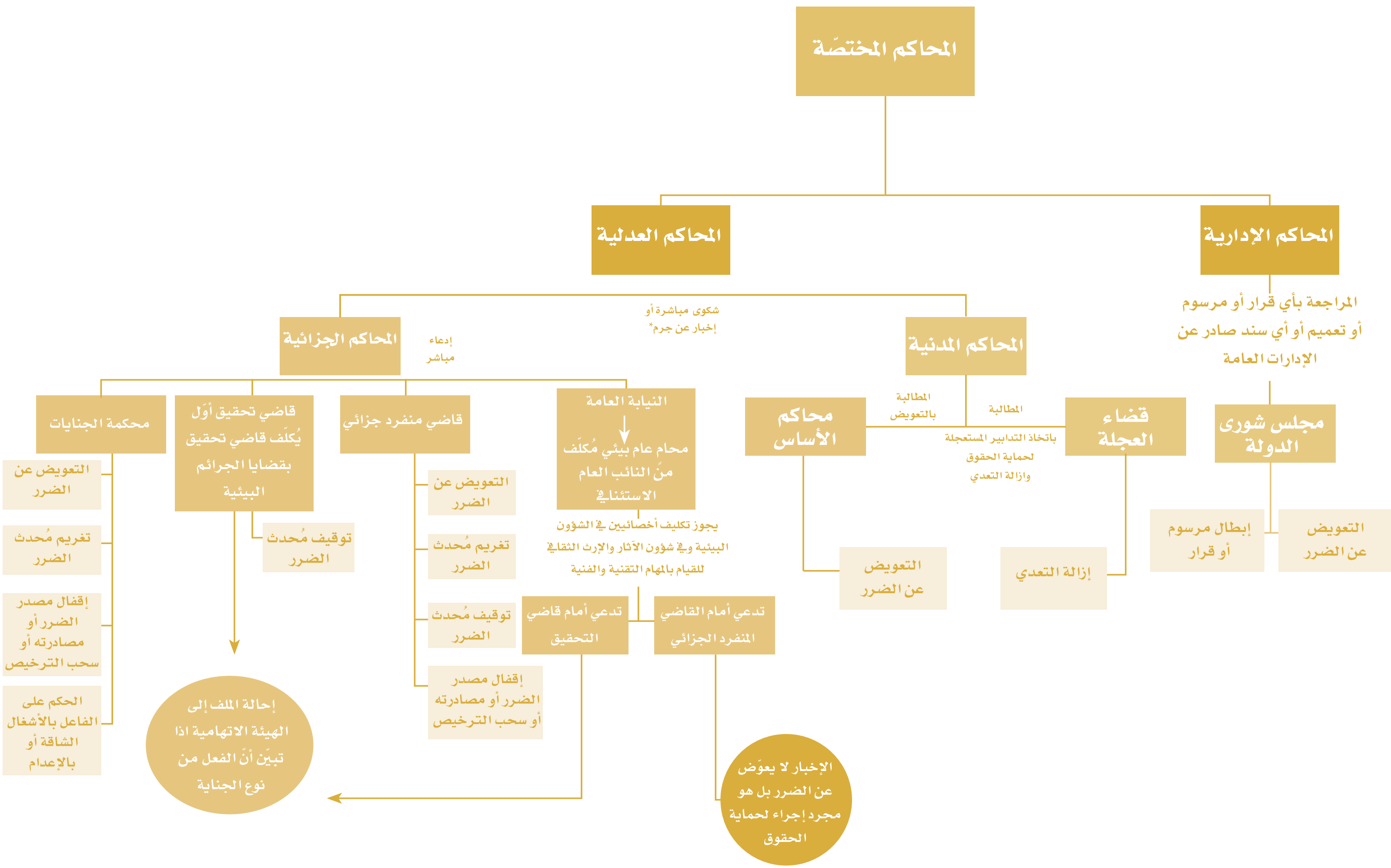
نوع النص	الرقم	التاريخ	عنوان النص
قانون	١٩٢	٢٠٢٠/١٠/١٦	يرمي الى تعديل القانون رقم ٧٧ تاريخ ٢٠١٨/٤/١٣ «قانون المياه »
قانون	١٣٩	٢٠١٩/٧/٩	تسوية مخالفات البناء الحاصلة خلال الفترة من تاريخ ١٩٧١/٩/١٣ولغاية تاريخ ٢٠١٨/١٢/٣١ ضمناً
قانون	١٣٠	٢٠١٩/٤/٣٠	قانون المناطق المحمية
قانون	٨٠	٢٠١٨/١٠/١٠	الإدارة المتكاملة للنفايات الصلبة
قانون	٧٧	٢٠١٨/٤/١٣	قانون المياه
قانون	٧٨	٢٠١٨/٤/١٣	قانون حماية نوعية الهواء
قانون	٢٨	٢٠١٧/٢/١٠	الحق في الوصول الى المعلومات
قانون	٥٤	٢٠١٥/١١/٢٤	تمديد العمل بأحكام القانون رقم ٢٠١٤/٢٨٨ (إضافة فقرة الى المادة السابعة من القانون رقم ٤٦٢ تاريخ ٢٠٠٢/٩/٢ - تنظيم قطاع الكهرباء)
قانون	٢٨٨	٢٠١٤/٤/٣٠	إضافة فقرة الى المادة السابعة من القانون رقم ٤٦٢ تاريخ ٢٠٠٢/٠٩/٠٢ (تنظيم قطاع الكهرباء)
قانون	٢٥١	٢٠١٤/٤/١٥	تخصيص محامين عامين متفرغين وقضاة تحقيق لشؤون البيئة
قانون	١٣٢	٢٠١٠/٨/٢٤	قانون الموارد البترولية في المياه البحرية
قانون	٦٩٠	٢٠٠٥/٨/٢٦	تحديد مهام وزارة البيئة وتنظيمها
قانون	٦٦٤	٢٠٠٥/٢/٤	وسيط الجمهورية
قانون	٤٤٤	٢٠٠٢/٧/٢٩	قانون حماية البيئة
قانون	٦٦٧	١٩٧٩/١٢/٢٩	تعديل القانون رقم ٢١٦ تاريخ ١٩٩٣/٠٤/٠٢ المتعلق باحداث وزارة البيئة
قانون	٦٤٢	١٩٩٧/٦/٢	احداث وزارة الصناعة
قانون	٢١٦	١٩٩٣/٤/٢	احداث وزارة البيئة
قانون	٦٩٤٠	١٩٦٢/٩/١٤	إنشاء مجلس وطني للبحوث العلمية
مرسوم		٢٠٢٠/٩/٨	تحديد دقائق تطبيق القانون رقم ٢٨ تاريخ ٢٠١٧/٢/١٠ (الحق في الوصول الى المعلومات)
مرسوم	٥٦٠٥	٢٠١٩/٩/١١	يرمي الى فرز النفايات المنزلية الصلبة من المصدر
مرسوم	٥٦٠٥	٢٠١٩/٩/١١	تحديد أصول إدارة النفايات الخطرة
مرسوم	١١٧٧	٢٠١٧/٧/٣١	تعديل بعض مواد المرسوم ١٠٢٨٩ تاريخ ٢٠١٣/٤/٣٠ المتعلق بالأنظمة والقواعد المتعلقة بالأنشطة البترولية تطبيقا للقانون رقم ١٣٢ تاريخ ٢٠١٠/٨/٢٤ (الموارد البترولية في المياه البحرية)
مرسوم	١٦٧	٢٠١٧/٢/١٧	تحديد دقائق تطبيق المادة ٢٠ من قانون حماية البيئة رقم ٤٤٤ تاريخ ٢٠٠٢/٧/٢٩
مرسوم	٣٩٨٩	٢٠١٦/٨/٢٥	انشاء ضابطة بيئية وتحديد عدد اعضائها وتنظيم عملها
مرسوم	١٠٢٨٩	٢٠١٣/٤/٣٠	الأنظمة والقواعد المتعلقة بالأنشطة البترولية تطبيقاً للقانون رقم ١٣٢ تاريخ ٢٠١٠/٨/٢٤ (الموارد البترولية في المياه البحرية)
مرسوم	٩١٨٩	٢٠١٢/١٠/٢٩	إبرام اتفاقية مشروع «دعم الإصلاحات - الإدارة البيئية»الموقعة مع الإتحاد الإوروبي ممثلا بالمفوضية الأوروبية
مرسوم	٨٦٣٣	٢٠١٢/٨/٧	اصول تقييم الاثر البيئي
مرسوم	٨٤٧١	٢٠١٢/٦/٤	الالتزام البيئي للمنشآت
مرسوم	٨٢١٣	٢٠١٢/٥/٢٤	التقييم البيئي الإستراتيجي لمشاريع السياسات والخطط والبرامج في القطاع العام
مرسوم	٨١٥٧	٢٠١٢/٥/١٨	تأليف المجلس الوطني للبيئة وتحديد مهامه وتنظيمه
مرسوم	٧٩٦٨	٢٠١٢/٤/٧	هيئة ادارة قطاع البترول
مرسوم	٢٢٧٥	٢٠٠٩/٦/١٥	تنظيم الوحدات التابعة لوزارة البيئة وتحديد مهامها وملاكها وشروط التعيين الخاصة في بعض وظائفها
مرسوم	٨٨٠٣	٢٠٠٢/١٠/٤	تنظيم المقالع والكسارات
مرسوم	١٠٩٥	١٩٩٩/٨/١٢	قبول هبة لصالح وزارة البيئة من الاتحاد الاوروبي
مرسوم	٢٧٢٨	١٩٨٠/٢/٢٨	تنظيم ادارة الاحصاء المركزي وتحديد ملاكها والشروط الخاصة للتعيين في وظائف هذا الملاك وسلسلة رتبها ورواتبها وتحديد التعويضات وشروط التصنيف
مرسوم	١٧٩٣	١٩٧٩/٢/٢٢	انشاء ادارة الاحصاء المركزي
مرسوم اشتراعي	١١٨	١٩٧٧/٦/٣٠	قانون البلديات
مرسوم	١٠٠٥٩	١٩٥٥/٨/١٧	اعتبار معهد البحوث الصناعية من الجمعيات ذات المنفعة العامة

عنوان النص	التاريخ	الرقم	نوع النص
آلية الاستفادة من التخفيض الضريبي المرتبط بالمحافظة على البيئة	٢٠٢١/١/٢٨	٣٥/١	قرار وزارة المالية
تحديد إجراءات واصول تطبيق الفصل الاول (منشآت تخزين النفايات الخطرة) من الباب الثالث من مرسوم تحديد أصول إدارة النفايات الخطرة (رقم ٥٦٠٦ تاريخ ٢٠١٩/٩/١١)	٢٠٢٠/١/٢١	٥٩/١	قرار وزارة البيئة
اعتماد نماذج تصاريح للمكلفين الذين يستفيدون من التخفيض الضريبي استناداً الى المرسوم رقم ١٦٧ تاريخ ٢٠١٧/٢/١٧	٢٠٢٠/١/١٣	١٨/١	قرار وزارة المالية
عرض وزارة البيئة مسودة سياسة الادارة المتكاملة لقطاع محافر الرمل والأتربة والمقالع والكسارات	٢٠١٩/٣/٢١	٤٥	قرار مجلس الوزراء
تحديد اجراءات واصول تطبيق الفصل الثاني (الناقل وموجباته) من الباب الثاني من مرسوم تحديد اصول ادارة النفايات الخطرة (رقم ٥٦٠٦ تاريخ ٢٠١٩/٩/١١)	٢٠١٩/١٢/٢٤	٩٩٩	قرار وزارة البيئة
تحديد اجراءات واصول تطبيق الفصل الاول (المواد وموجباته) من الباب الثاني من مرسوم تحديد اصول ادارة النفايات الخطرة (رقم ٥٦٠٦ تاريخ ٢٠١٩/٠٩/١١)	٢٠١٩/١٢/٢١	٩٩٨	قرار وزارة البيئة
تأليف لجنة تنسيق شؤون قطاع النفايات الصلبة وتحديد طريقة عملها	٢٠١٩/٣/٥	١٠٨	قرار وزارة البيئة
تعديل القرار رقم ١/١٢ تاريخ ٢٠١٩/٢/٢٠ (القاضي بتأليف لجنة بمتابعة ملف تلوث نهر الليطاني)	٢٠١٩/٣/٢٨	٤٥	قرار وزارة الصناعة
تعميم الى جميع الإدارات العامة والمؤسسات العامة والبلديات وإتحادات البلديات والمجالس والهيئات بشأن التعاون مع وحدة إدارة مخاطر الكوارث والحد منها لدى رئاسة مجلس الوزراء	٢٠١٩/١/٢٢	٣	تعميم مجلس الوزراء
تحديد آلية الاستفادة من التخفيض الضريبي للاشخاص الذين يقومون بنشاطات تحافظ على البيئة	٢٠١٧/١٢/٢٦	١٢٨١	قرار وزارة البيئة
عمل الدوائر الاقليمية لوزارة البيئة في المحافظات اللبنانية	٢٠١٦/٩/٢٨	١٥/١	تعميم وزارة البيئة
انشاء لجنة لدى رئاسة مجلس الوزراء لتنسيق عمليات مواجهة الكوارث والازمات الوطنية	٢٠١٣/٢/١٨	٤١	قرار رئاسة مجلس الوزراء
مبادئ توجيهية عن كيفية تقديم معلومات عن إنبعاثات الغازات الدفيئة من قبل الشركات والمؤسسات الصناعية والتجارية للحصول على إفادة تصريح	٢٠١٣/٤/١١	٩٩/١	قرار وزارة البيئة

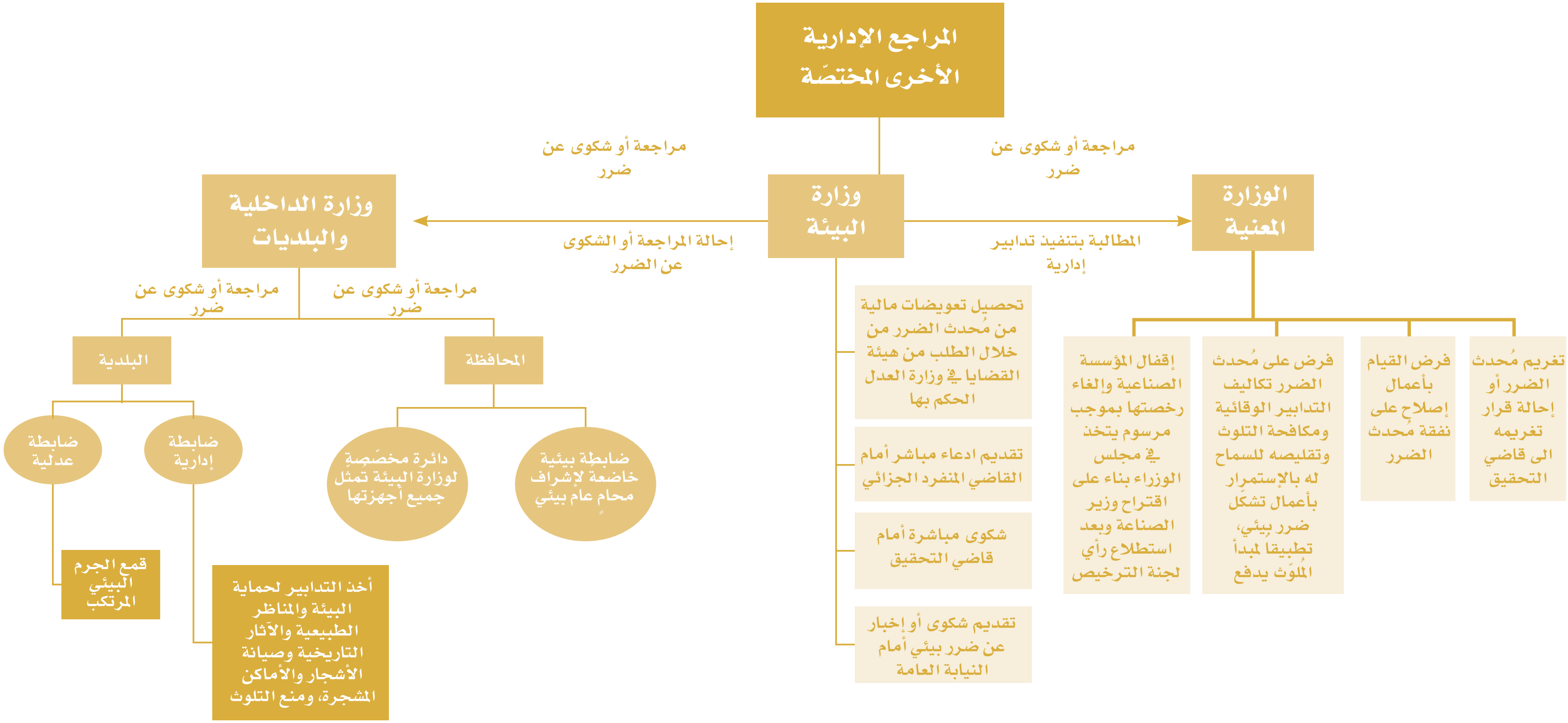
Annex 1 Organizational Structure of the Ministry of Environment



Annex 2 Legal Avenues for Protecting Environmental Victims



× ويمكن لشاهد الضرر أن يقوم بالإخبار عن الضرر البيئي أمام النيابة العامة.



× ويمكن لشاهد الضرر أن يقوم بإعلام وزارة البيئة عن الضرر البيئي الذي لحظه.

Annex 3 List of Environmental Conventions, Treaties and Protocols Signed & Ratified by the GoL

Year	Name of Convention, Treaty & Protocol	Status[1]	Law/Decree
2016	Kigali Agreement (Amendment to Montreal Protocol)	Ratification	Law 119/2019
2015	Paris Agreement on Climate Change	Ratification	Law 115/2019
2013	Minamata Convention on Mercury	Ratification	Law 2/2017
2010	Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity	Ratification	Law 3/2017
2008	Integrated Coastal Zone Management Protocol/ Barcelona Convention	Ratification	Decree Law 639/2014
2006	Cartagena Protocol on Biosafety	Adhesion	Law 31/2008
2005	Kyoto Protocol to the United Nations Framework Convention on Climate Change aiming to fight Global Warming	Adhesion	Law 738/2006
2004	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	Adhesion	Law 728/2006
2004	Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic-ACCOBAMS	Adhesion	Law 571/2004
2002	Protocol Concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea	Ratification	Decree Law 618/2017
2002	Agreement on the Conservation of African-Eurasian Migratory Water Birds (AEWA)	Adhesion	Law 412/2002
2008	Amendments to Barcelona Convention	Adhesion	Law 34/2008
2001	Stockholm Convention on Persistent Organic pollutants for adoption by the conference of plenipotentiaries	Signature: 22/5/2001 Accession	Law 432/2002
1999	Beijing Amendment of Montreal Protocol	Adhesion	Law 758/2006
1999	Convention on Wetlands of International Importance especially as Waterfowl Habitat-Ramsar	Adhesion	Law 23/1999
1997	Protocol of 1997 to amend the International Convention for the Prevention of Pollution from Ships of 2 November 1973, as modified by the Protocol of 17 February 1978	Ratification	Law 116/2019
1995	Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD)	Ratification	Law 127/2019
1994	United Nations Convention to Combat Desertification-Paris	Ratification	Law 469/1995
1994	The Ban Amendment / Basel Convention	Ratification	Law 29/2015
1992	United Nations Framework Convention on Climate Change-Rio de Janeiro	Ratification	Law 359/1994
1992	Convention on Biological Diversity-Rio de Janeiro	Ratification	Law 360/1994
1992	Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer-Copenhagen	Adhesion	Law 120/1999
1990	Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer-London	Adhesion	Law 253/1993
1989	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal-Basel	Ratification	Law 387/1994
1987	Montreal Protocol on Substances that deplete the Ozone Layer-Montreal	Adhesion	Law 253/1993
1986	Convention on Early Notification of a Nuclear Accident-Vienna	Ratification	Law 566/1996

Year	Name of Convention, Treaty & Protocol	Status[1]	Law/Decree
1986	Convention on Assistance in Case of a Nuclear Accident-Vienna	Ratification	Law 575/1996
1985	Vienna Convention for the Protection of the Ozone Layer-Vienna	Adhesion	Law 253/1993
1982	Protocol Concerning Mediterranean Specially Protected Areas-Geneva	Adhesion	Law 292/1994
1982	Convention of the Sea (Mont –Diego Bay) – Jamaica	Adhesion	Law 295/1994
1980	Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources-Athens	Adhesion	Law 292/1994
1979	Convention on the Conservation of Wild Animals (CMS)	Ratification	Decree Law 3320/2018
1976	Convention on the Prohibition of Military or any other hostile use of Environmental Modification Techniques-Geneva	Signature: 18/5/1977	NA
1976	Protocol Concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency-Barcelona	Signature: 16/2/1976 Accession	Decree Law 126/1977
1976	Convention for the Protection of the Mediterranean Sea against Pollution-Barcelona	Signature: 16/2/1976 Accession	Decree Law 126/1977
1976	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft-Barcelona	Signature: 16/2/1976 Accession	Decree Law 126/1977
1975	Convention on International Trade of Endangered Species (CITES)	Ratification	Decree Law 233/2012
1973	International Convention for the Prevention of Pollution from Ships-London	Adhesion	Law 13/1983
1972	UNESCO Convention on the Protection of Cultural & Natural Heritage	Adhesion	Law 19/1990
1972	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.-London-Mexico city-Moscow-Washington	Signature: 15/5/1973	NA
1971	Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Seabed and the Ocean floor and in the Subsoil-London-Moscow-Washington	Ratification	Decree 9133/1974
1969	International Convention relating to Intervention on the High Seas in cases of Oil Pollution Casualties-Brussels	Ratification	Decree 9226/1974
1969	International Convention on Civil Liability for Oil Pollution Damage-Brussels	Ratification	Law 28/1973
1963	Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and in Underwater	Ratification	Law 59/1964
1963	Convention on Civil Liability for Nuclear Damage-Vienna	Adhesion	Law 565/1996
1954	International Convention for the Prevention of Pollution of the Sea by Oil-London	Adhesion	Law 68/1966

[1] Signature of a treaty is an act by which the State expresses its interest to the treaty and its intention to become a Party. Treaty signature is not binding. Accession is the usual method by which a State, which has not taken part in the negotiations, signed the treaty and is subsequently consent to be bound by its terms. Ratification is an act by which the State expresses its definitive consent to be bound by the treaty. It must then respect the provisions of the treaty and implement it by a Law within the statutory allowed period. The date corresponds to the date of publication in the Official Gazette in Lebanon. Adhesion is the usual method by which a State, which has not taken part in the negotiations and has not signed the treaty, subsequently adheres to the treaty by law and is consent to be bound by its terms.

Annex 4 Environmental Degrees Offered by Universities in Lebanon

University	Major	Degree	Faculty
American University of Beirut (AUB)	Ecosystem Management	Master of Science	Faculty of Agricultural and Food Sciences
	Environmental Policy Planning	Master of Science	Faculty of Arts and Sciences
	Environmental and Water Resources Engineering	Master of Engineering; PhD	Faculty of Engineering and Architecture
	Environmental Technology	Master of Science	Faculty of Engineering and Architecture
	Urban Design	Master of Urban Design	Faculty of Engineering and Architecture
	Urban Planning and Policy	Master of Urban Planning and Policy	Faculty of Engineering and Architecture
	Environmental Health	Bachelor of Science, Master of Science	Faculty of Health Sciences
	Environmental Sciences	Master of Science	Interfaculty
Université Saint Joseph (USJ)	Civil, Water and Environmental Engineering	PhD	Ecole supérieure d'ingénieurs de Beyrouth
	Eau et Environnement	Ingénieur Civil	Ecole supérieure d'ingénieurs de Beyrouth
	Énergies renouvelables	Master	Ecole supérieure d'ingénieurs de Beyrouth
	Oil and Gas: Exploration, Production and Management	Master	Ecole supérieure d'ingénieurs de Beyrouth
	Sciences de l'Eau	Master	Ecole supérieure d'ingénieurs de Beyrouth
	Environnement et Aménagement du Territoire	Licence, Master Recherche et Doctorat	Faculté des lettres et des sciences humaines
	Sciences et Gestion de l'Environnement	Master	Faculté des sciences
Lebanese American University (LAU)	Civil and Environmental Engineering	Master of Science	School of Engineering
University of Balamand (UoB)	Urbanisme	Master	Académie Libanaise des Beaux-Arts (ALBA)
	Aménagement du Paysage	Master	ALBA
	Environmental Sciences	Bachelor of Science and Master of Science	Faculty of Art and Sciences
	Chemical Engineering	Bachelor of Science, Bachelor of Engineering and Master of Science in Chemical Engineering	Faculty of Engineering
	Public Health and Development Sciences	Bachelor of Science	Faculty of Health Sciences
Université Saint-Esprit Kaslik (USEK)	Environmental Technologies	Master of Science	Faculty of Arts and Sciences
	Environmental Risks and Waste Treatment	Master of Science in Chemistry	Faculty of Arts and Sciences

University	Major	Degree	Faculty
Lebanese University (LU)	Environmental Engineering & Natural Resources	Bachelor	Faculty of Agronomy
	Building & Urbanism	Master in Engineering	Faculty of Engineering
	Hydrosciences	Research Master	Faculty of Engineering
	Industrial Control	Research Master	Faculty of Engineering
	Renewable Energy	Research Master	Faculty of Engineering
	Health and Environment	Bachelor and Research Master	Faculty of Public Health
	Environmental and life Sciences	Master 1	Faculty of Sciences
	Environmental Geosciences	Professional or Research Master 2	Faculty of Sciences
	Expertise and Treatment in Environment	Professional and Research Master	Faculty of Sciences
	Management and Conservation of Natural Resources (Biodiversity)	Professional Master 2	Faculty of Sciences
	Phyto-ecology	Professional Master 2	Faculty of Sciences
	Marine Biology and Ecology	Research Master 2	Faculty of Sciences
	Petroleum Geosciences	Research Master 2	Faculty of Sciences
Beirut Arab University (BAU)	Urban Design and Planning	Master of Science, PhD	Faculty of Architecture - Design & Built Environment
	Environmental Science	Bachelor of Science, Master of Science, PhD	Faculty of Sciences
Notre Dame University (NDU)	Urban Design/Sustainable Architecture	Master of Architecture	Faculty of Architecture, Art & Design
	Environmental Science	Bachelor of Science	Faculty of Natural and Applied Sciences
	Geographic Information System	Bachelor of Science	Faculty of Natural and Applied Sciences
	Industrial Chemistry	Master of Science	Faculty of Natural and Applied Sciences
American University of Technology (AUT)	Environmental Health	Bachelor of Science	Faculty of Applied Sciences
	Water Resources and Geo-Environmental Sciences	Bachelor of Science	Faculty of Applied Sciences

Annex 5 Environment Research Centers and Institutes at Universities in Lebanon

Center	University	Research Area
Aerosol Research Lab	AUB	• Research on aerosol dynamics, chemistry, combustion, computational fluid dynamics, instrumentation, and controls • Study research: tobacco smoke, urban and indoor air pollution and its sources, and atmospheric particle dynamics and fundamental problems in aerosol transport phenomena
Atmospheric and Analytical Laboratory	AUB	Research on atmospheric chemistry, chemical analysis of waterpipe and electronic nicotine delivery system (ENDS) content and smoke, medicinal analytical chemistry, inhalable and atmospheric aerosols
Balamand Earthquake Engineering Center	UoB	• Earthquake research, real time data collection and analysis, study and investigate the seismic faults characteristics and movements, perform earthquake hazard, risk and damage assessment, seismic resistance • Two Divisions related to Seismology/Geo-Physical Laboratory Division and the Structural/Geotechnical Laboratory Division • Earthquake Disaster Research and Public Awareness Program including a Disaster Management Research Division and Public Earthquake awareness Campaign Division
Center for Research and Analysis	USJ	Industrial tests, inspections, and appraisals; continuous technical training courses; practical lessons
Center for Engineering and Environmental Studies	UoB	• Develop links between the UoB, the public and the job market • Design solutions, ideas, advice, and research for several projects in order to develop the students' learning experience and translate it into practice
Center for Research on Sustainable Development (CROSD)	NDU	• Investigate sustainability concepts and special attention to regional challenges such as water, energy, and the environment • Proper optimization and implementation of integrated resource management through developing strategies and training
Environmental Engineering Research Center	AUB	Investigation on chemical, physical and biological contaminants associated with Potable water, surface and groundwater, seawater, municipal wastewaters, industrial effluents, sludge/slurries, leachate, compost, sediments, etc.
Environment and Sustainable Development Unit	AUB	Research and development on rural community development, local food systems and sustainable agriculture
Environmental Research Center, Eastern Mediterranean Area	USJ	• Fundamental and applied research • Environmental and sustainable development sciences in the Mediterranean region • Geographic sciences • Develop the methodological approach (structuralist, systemic, analytical, multiscalar and modelling)
Institute of the Environment	UoB	• Scientific research, loss of biodiversity, marine resources and coastal management, failure of food supplies, sustainable development and mismanagement of natural resources • Promote effective decision-making in sustainable development and empower the Lebanese community to make sound decisions on environmental issues • Marine Resources and Coastal Zone Management Program(MRCZMP), Biodiversity Program, Environmental Communication Program, Future Programs (Waste Management and Renewable Energy)
Issam Fares Institute	AUB	• Informing policy-making processes which gives rise to environment climate change policies • Exploring state of the art research methodologies and new ways for research dissemination • Attracting talented scholars and practitioners for the emerging policy needs in Lebanon and the Arab world
Jouzour Loubnan Laboratory	USJ	• Biodiversity Conservation Initiative • Restoring degraded ecosystems and conserving threatened species • Raise awareness on the importance of forests and biodiversity • Involve local communities in the protection and management of planted forests.
Laboratories for the Environment, Agriculture, and Food	AUB	• Analytical testing and training services covering various sectors including water, soil, wastewater, compost, food and agro-food products (raw, processed, canned, etc.), non-edible oil analysis, food chemistry and microbiology. • Consultancy services and sampling. • Routine and non-routine international inter-lab analysis comparison program also known as Proficiency Testing programs

Center	University	Research Area
Laboratory for Cartography	USJ	• Conservation and consultation of cartographic material on Lebanon and the Middle East • Teaching cartography and GIS • Research unit for teachers and students
MAJAL: Academic Observatory for Construction and Reconstruction in Lebanon	ALBA	• Improve the knowledge, facilitate research and encourage public debate concerning Urban planning and construction • Collect, analyze and disseminate data, give technical assistance: expert missions, counseling, monitoring, educating and training, etc. and favor research
Nature Conservation Center (NCC)	AUB	Address nature conservation through leverage the expertise and experience of AUB faculties, research staff, and volunteers to tackle the region's most pressing environmental challenges
Nature Conservation Center for sustainable futures (IBSAR)	AUB	Biotechnology research, identification, characterization, and monitoring of biodiversity, landscape conservation, developing economic opportunities for the sustainable use of biodiversity
Regional Center for Water and Environment	USJ	Water resources and management, Snow cover, Rainfall-Runoff modeling, Karst sources and Climate change
Remote Sensing Laboratory	USJ	• Processing and analysis of satellite images, modeling and GIS • Training in environment and spatial planning • Teaching and receiving students and interns • Provision of technical assistance for research projects and partnership with Lebanese (CNRS) or foreign universities or research organizations • Contribution to creation of observatory on snow by participating in the International Observatory on Biodiversity (O-Life)
Water Energy and Environment Research Center	NDU	• Water energy resources management • Investigate the state of environment in Lebanon and the MENA region following many aspects • Develop appropriate strategies and provide training for the proper optimization and integrated management of water and energy
Water Resources Center	AUB	Database for water resources studies

SECTION II

STATE OF THE ENVIRONMENT

3 Water Resources

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Abbreviations and Acronyms

BMLWE	Beirut Mount Lebanon Water Establishment
BOD	Biological Oxygen Demand
BWE	Bekaa Water Establishment
CDR	Council of Development and Reconstruction
CEDRE	Conférence Économique pour le Développement, par les Réformes et avec les Entreprises
CFU	Colony Forming Unit
CIP	Capital Investment Program
CNRS	National Council for Scientific Research
COD	Chemical Oxygen Demand
CoM	Council of Ministers
DAI	Development Alternatives Incorporated
DO	Dissolved Oxygen
EIA	Environmental Impact Assessment
EU	European Union
GBA	Greater Beirut Area
GDP	Gross Domestic Product
GoL	Government of Lebanon
HABs	Harmful Algal Blooms
IDRC	International Development Research Centre
IHIS	Integrated Hydrometric Information System
LEPAP	Lebanon Environmental Pollution Abatement Project
LRA	Litani River Authority
LRB	Litani River Basin
LWP	Lebanon Water Project
MCM	Million Cubic Meter
MAR	Managed Aquifer Recharge
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoI	Ministry of Industry
NAP	National Action Plan
NCMS	National Center for Marine Sciences
NLWE	North Lebanon Water Establishment
NRW	Non-revenue Water
NSWS	National Strategy for the Wastewater Sector
NWSS	National Water Sector Strategy
PAH	Polycyclic Aromatic Hydrocarbon
PPP	Public Private Partnership
RO	Reverse Osmosis
RWE	Regional Water Establishment
SCP	Sustainable Consumption and Production
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SLWE	South Lebanon Water Establishment
SOER	State of the Environment Report
SWI	Saltwater Intrusion
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
UFW	Unaccounted-for-water
ULB	Upper Litani Basin
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund

UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
WASH	Water, Sanitation and Hygiene
WB	World Bank
WEF	Water-Energy-Food
WHO	World Health Organization
WWTP	Wastewater Treatment Plant

3. Water Resources

The provision of clean water and sanitation lies at the core of the 2030 Sustainable Development Goals (SDGs) adopted unanimously by the United Nations member states in 2015. As Lebanon charts its way forward, attempting to spur economic growth, special attention needs to be placed to ensure that its water resources are sustainably managed and preserved. Lebanon's expenditure on the water and wastewater sector over the past 30 years, around US$ 4 billion, has been insufficient to meet growing water demands and wastewater generation (Gharios and Farajalla, 2020). The level of expenditure as a fraction of the Gross Domestic Product (GDP) has been estimated at around 0.5%, which is below the World Bank (WB) defined ratio of 0.8% of GDP (World Bank, 2010; Yepes, 2008). As a result, water pollution is rampant, water conservation remains largely a slogan, chronic water shortages persist, access to safe and improved water resources remains low, unconventional water sources continue to be untapped and institutions remain in need of financial and technical support. The WB has estimated that the cost of inaction in the water sector reached 2.8% of the national GDP (World Bank, 2010). This chapter provides an overview of the available water resources and describes their current status and the pressures they face. The chapter concludes by discussing a set of opportunities that the sector can harness to ensure a more sustainable future to all.

3.1 Driving Forces

The main driving forces affecting the Lebanese water resources in terms of quantity and quality are population growth, urbanization, economic growth and climate change.

3.1.1 Population Growth

Population growth and internal migration are the main driving forces modulating the demands on the available water resources across the country. The population of Lebanon is estimated to have exceeded 4.84 million people back in 2018 (CAS/ILO, 2019). Population growth rates have been reported to range between 1 and 2.5% per year. In the final draft 2020 National Water Sector Strategy (NWSS) the Ministry of Energy and Water (MoEW) has assumed that population growth for the period between 2020 and 2035 will be 1.5% for rural areas and 0.75% for urban areas, with the exception of districts under the jurisdiction of the South Lebanon Water Establishment (SLWE) that were projected to grow at a rate of 2% per year (MoEW, 2019c).

When it comes to assessing demands on the national water resources, it is also important to include the demands generated from the refugees, displaced and informal settlements. As of October 2017, the Government of Lebanon (GoL) estimated that the country was hosting 1.5 million Syrians, who have fled conflict in Syria, along with 34,000 Palestinian refugees and displaced from Syria, 35,000 Lebanese returnees and a pre-existing population of more than 277,985 Palestinian refugees in Lebanon (MoE/EU/UNDP, 2016a; UNHCR/UNICEF/WFP, 2019). Currently, refugees and displaced constitute around 30% of the Lebanese population, representing the world's highest number of refugees and displaced per inhabitant. It is estimated that the influx of refugees and displaced increased the national water demand by 8 to 12% and the wastewater generation rate by 8 to14% (MoE/EU/UNDP, 2016a).

3.1.2 Urbanization

Lebanon is a highly urbanized country with more than 87% of its population living in urban areas and 64% living in large urban agglomerations (Beirut and its suburbs, Tripoli, Sidon, Zahle and Tyre) (UN-Habitat, 2011). In the last fifty years, rates of urbanization have increased dramatically, primarily due to rural exodus, suburbanization, war displacements and the influx of refugees and displaced (CDR, 2016). Future projections of urbanization have predicted that urban areas will continue to increase and will cover 884 km^2 of the country by 2030 (CDR, 2004). Given the fast and unplanned urban sprawl in the country, urbanization is a major point and non-point source of water pollution *(Refer to Chapter 7 – Haphazard Urbanization)*. Moreover, the rapid urban growth has added a significant strain on the existing outdated drainage infrastructure, many of which operate as combined wastewater systems. This has led to the increased incidence of urban flooding during storm events. Meanwhile, domestic water demands in many cities have continued to outpace investments in water delivery and wastewater collection networks.

3.1.3 Economic Growth

Over the past 20 years, Lebanon's economy has been very volatile. While the country witnessed a period of moderate economic growth between 2006 and 2010 (9.2% GDP growth), that growth stagnated between 2010 and 2017, with an average GDP growth of 1.3%. Since then, the economy has started to contract, experiencing a decline of 6.7% in 2019 (World Bank Group, 2021). In October of 2020, the WB predicted that the real GDP growth of the country will decline by around 19.2% by the end of that year followed by a further decline of 13.2% in 2021 (World Bank, 2020).

In 2018, the GoL had put together an ambitious national economic plan that prioritized growth across the different economic sector both in terms of GDP and job market (Figure 3-1). The plan projected that the annual GDP growth in the industrial sector will be between 4.6 and 14.8% per year, while the agricultural sector was expected to grow annually between 4.5 and 7.5%. These growth rates far exceed the projected population growth rate. As such, the growth in the water demands from these two sectors was envisaged to eclipse any growth in the domestic demand sector.

Following the economic crisis of 2019, the Council of Minsters (CoM) approved a financial recovery plan that attempted to limit the contraction in the economy (Ministry of Finance, 2020) through the provision of revenue enhancing measures aimed at helping restart the different economic sectors. The impacts of these measures on the economy remain questionable given the deepening political and economic crisis in the country. As such, projected changes in the sectoral water demands are associated with large uncertainties.

Agriculture, like most other countries worldwide, is the largest water consumer across all economic sectors. It is estimated that the sector will continue to increase its share of the total water demand from 55% in 2010 up to 62% by 2020 (MoEW/MoE/CAS, 2012). While this percentage is expected to decrease slightly to reach 58% of the total demands by 2030, the net irrigation demands are expected to keep on increasing and reach 1,050 million cubic meters (MCM)/year. This increase is a result of several planned large-scale irrigation projects that are expected to increase the irrigated areas up to 60,000 ha by 2035 (MoEW/MoE/CAS, 2012). Without proper water management, the agricultural demands will conflict with domestic, industrial, and touristic demands as water scarcity in Lebanon becomes more severe.

3.1.4 Climate Change

Projected climate change in Lebanon is expected to negatively impact its water resources and increase water shortages. Quantifying climatic trends in the Lebanese hydrological system is challenging and associated with high uncertainties given the lack of long time series, the natural inter-annual variability inherent to the system (Telesca et al., 2014) and the difficulty of separating natural climate related changes from anthropogenic disturbances. Shaban (2009) reported that between 1965 and 2005, snow cover and precipitation witnessed a 12 to 16% drop. The average time that dense snow covered

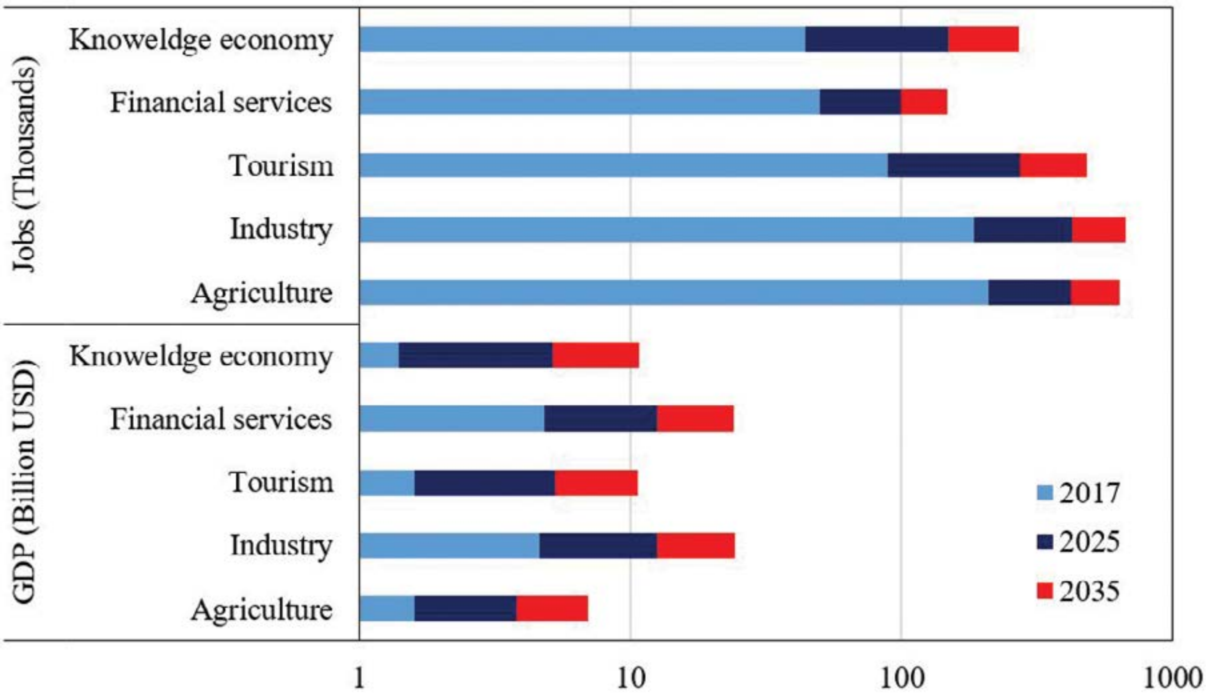

Figure 3-1 Projected Economic Growth by Sector between 2017 and 2035
Source: Ministry of Economics, 2018

the mountains was found to have decreased from 110 to less than 90 days/year (Shaban, 2009). As a result of these changes, the average discharge rate of Lebanese rivers was reported to have dropped by 23% between 1965 and 2005, while the average discharge from springs dropped by 52% over the same period (Shaban, 2009). Groundwater levels were also reported to have fallen by 5 to 13 m (Shaban, 2011). According to the Lebanon's third national communication to the United Nations Framework Convention on Climate Change (UNFCCC), climate projections predict that by mid-century (2046-2065) temperatures are expected to increase by 1.2°C to 1.7°C (according to the moderate and worst-case scenario, respectively) and up to 3.2°C by 2100, compared to the baseline period of 1986-2005. Precipitation is projected to drop by 4 to 11% under the moderate and worst-case scenario, respectively. The report also estimated a reduction of 40 to 70% in snow cover, while snow residence time was expected to decrease from 110 days down to 45 days (MoE/UNDP/GEF, 2016b). A recent study conducted at Université Saint-Joseph (Baaklini, 2018) highlighted the impact of climate change on the temporal distribution of water resources in the country. The study found that in the 1960s and 1970s, 30% of the snowmelt used to be available as water supply after April; how ever, this percentage has dropped to reach 18%. These changes will surely have dramatic effects on Lebanon's hydrological cycle. *More detailed information on the impacts of climate change on the water resources are presented in Chapter 9 - Climate Change and Energy.*

3.2 Current Situation

Lebanon's available renewable water resources have dropped below the 1,000 m^3/capita/year threshold that defines water stress. In 2010, the MoEW estimated that the total renewable resources per capita per year was 926 m^3 and predicted that it will continue to fall reaching 839 m^3 by 2015 (MoEW, 2012). Since then, population growth, climate change, and the influx of refugees and displaced have further strained the available resources and as a result, the total renewable resources per capita has reached 700 m^3/capita/year (IFI, 2014). In addition to the challenges associated with ensuring that the water sources are effectively managed to meet the demands of the different sectors, pollution levels in many of these freshwater systems have made them either unable to meet their designated uses or requiring expensive treatment prior to use.

On March 9, 2012, the GoL officially adopted its NWSS through CoM Resolution 2. This was followed six months later by the adoption of the National Strategy for the Wastewater Sector (NSWS) through CoM Resolution 35 dated 17/10/2012. The 2010 NWSS defined several environmental initiatives and identified the major environmental concerns associated with its implementation (Refer to Box 3-1 on 2010 NWSS Environmental Initiatives). Despite the adopted strategy, the MoEW and the water utilities have assumed a largely reactive role over the past 8 years. Their focus has centered on ensuring the supply of water for the domestic sector, with less attention placed on wastewater collection and treatment, irrigation improvements and servicing the agricultural sector, or on building capacities needed to sustainably manage water supplies. As such, many challenges face the water sector, including outdated and insufficient infrastructure, poorly managed water utilities, high rates of non-revenue water (NRW), limited water storage, poor irrigation efficiency and mounting pressures on ground and surface water supplies (USAID, 2017). In the face of these challenges, the MoEW updated its 2010 NWSS, which is currently awaiting adoption. The update aims to revise the strategy to reflect the implementation of the legal and regulatory framework reforms set in the Water Code (Law 77/2018) amended by Law 192/2020, develop sectoral monitoring mechanisms and programs and revise the proposed infrastructure projects throughout the country to improve service provision and reduce costs. It also proposes an overhaul in the adopted tariff system, whereby consumption-based tariffs are to be introduced, new tariff structure for sanitation services are proposed and the tariff structure for irrigation is revisited. Furthermore, the proposed update intends to enhance the private sector involvement in the sector. Equally important, the final draft 2020 NWSS focuses on improving reporting and monitoring within the sector and on the need to build capacities at MoEW and the four Regional Water Establishments (RWEs). Finally, implementing the updated NWSS will enhance stakeholder engagement in the decision-making process through the update of its Strategic Environmental and Social Assessment.

Box 3-1 2010 NWSS Environmental Initiatives

1. Improve/refine climate change knowledge, and particularly its implications on the water sector and its vulnerability (i.e. refinement of models and figures)
   - Collect, analyze and develop trends for climatic data (precipitation and temperature) covering all of Lebanon, to compare with historic data and detect possible deviations
   - Establish a unified database to include all water monitoring data and maintain it regularly to ensure that it is up to date
   - Develop and implement long-term monitoring programs for rivers, springs and snow cover
   - Update periodically water usage scenarios and associated water management options
2. Improve water quality and the protection of recharge zones
   - Review and upgrade water quality standards
   - Take actions to protect against contaminants found in drinking water
   - Design and implement a comprehensive integrated surface and groundwater quality monitoring network
   - Develop and implement a concept for protecting recharge zones
   - Centralize data and ensure communications with the consumers
   - Design and implement an integrated monitoring system for irrigation water quality
3. Develop flood mitigation arrangements
   - Establish flood plain zoning
   - Develop an integrated flood management plan
   - Assess the potential use of flood water for groundwater recharge
   - Support initiatives aiming at combating desertification
4. Improve wastewater treatment and effluent quality
   - Review and update wastewater treatment and effluent standards
   - Review and adopt draft standards for wastewater reuse in agriculture and sludge reuse
   - Implement wastewater effluent monitoring systems
5. Evaluate environmental consequences of the proposed NWSS (Strategic Environmental Assessment (SEA)) to ensure that they are fully inclusive and taken into account at the earliest stage of decision-making on par with economic and social considerations

3.2.1 Water Resources Availability

The most recent national water balance was conducted by the MoEW and UNDP (2014) using data collected over 4 hydrological years between 2008 and 2012. The study reported that precipitation per year ranges between 6,015 and 9,365 MCM, including snow. The report also stated that annual groundwater recharge varied between 4,116 and 6,651 MCM/year, which correspond to around 55% of the total precipitation. However, the final draft 2020 NWSS is still based on the water balance that was reported in the 2010 NWSS (MoEW, 2012). The latter adopted the figures of the FAO 2008 Aquastat country profile report, which based its numbers on a longer time series (30 years average), as compared to the 4 hydrological years relied upon in the MoEW and UNDP study. Table 3-1 summarizes the available annual water resources as adopted by the final draft 2020 NWSS and compares it to the values previously reported in the MoEW and UNDP hydrological assessment. Significant differences exist between the two studies, particularly with regards to their estimates of evapotranspiration and groundwater recharge. The 2010 NWSS estimated evapotranspiration at 50% of the precipitation without a clear scientific basis, while the MoEW and UNDP study calculated it according to the Turc (1961) method and estimated it to range between 16 and 26%. This in turn affects the groundwater recharge component in the water balance estimation.

Table 3-1 Annual Water Balance

Source	Amount (MCM)	
	MoEW/UNDP (2014)	Final Draft 2020 NWSS
Precipitation (including snow)	9,365 - 6,015	8,600
Evapotranspiration	1,475 - 1,563	4,500
Surface runoff (excluding spring discharge)	3,807 - 2,151	2,900[1]
Groundwater to sea	400	1,200[2]
Groundwater recharge	4,116 - 6,651	

[1] Includes losses as rivers to neighbors (700 MCM) and renewable surface water (2,200MCM)

[2] Includes losses to groundwater (700 MCM) and renewable groundwater resource (500 MCM)

Discrepancies between the two sources is to a large extent a direct result of the absence of a unified properly curated database of long-term high quality meteorological and hydrological datasets at the national level, which necessitates the dependence on different studies with varying assumptions. The final draft 2020 NWSS acknowledges that a complete and inclusive long term annual average water balance is still missing for Lebanon and prioritizes the need to further refine the estimates on evapotranspiration and the quantity of groundwater flowing to neighboring countries or to the sea through submarine springs. In addition, the plan foresees the need to incorporate the new information collected on the contribution of snow cover into the annual water balance (Refer to Section 3.2 for details about the final draft 2020 NWSS). Currently, there are 136 meteorological stations and 138 hydrometric stations across

Lebanon (maps can be found in Annex 1). These stations are operated by the Lebanese Meteorological Service, the Litani River Authority (LRA) and the Lebanese Agricultural Research Institute. Unfortunately, these stations are not connected through an Integrated Hydrometric Information System (IHIS). The final draft 2020 NWSS envisions the implementation of an IHIS system and estimates its cost at around US$ 6 million, assuming that 113 meteorological stations and 135 hydrometric stations will be added to the existing ones in an effort to reach an average density of 1 station per 50 km^2.

3.2.1.1 Rivers

The total length of rivers and streams in Lebanon is 730 km. There are 40 rivers in the country, of which 16 are defined as perennial and the rest as seasonal (Figure 3-2) (FAO, 2016; MoEW/UNDP, 2014).

The hydrographic system in the country can be divided into five major regions as described below (FAO, 2016):

- The Litani River Basin (LRB): It drains large parts of the eastern and southern sections of the country. The basin is the largest catchment in the country (2,180 km^2), draining 20% of the total area of Lebanon. The average annual water flowing in the Litani River is estimated to be 475 MCM but the river experiences large inter-annual variations.
- El Assi Basin in the northeast: This comprises the watershed of El Assi River that flows from Lebanon into the Syrian Arab Republic and discharges in the Mediterranean Sea in Turkey.
- The Hasbani Basin in the southeast: The Hasbani River is one of the tributaries that forms the Jor-

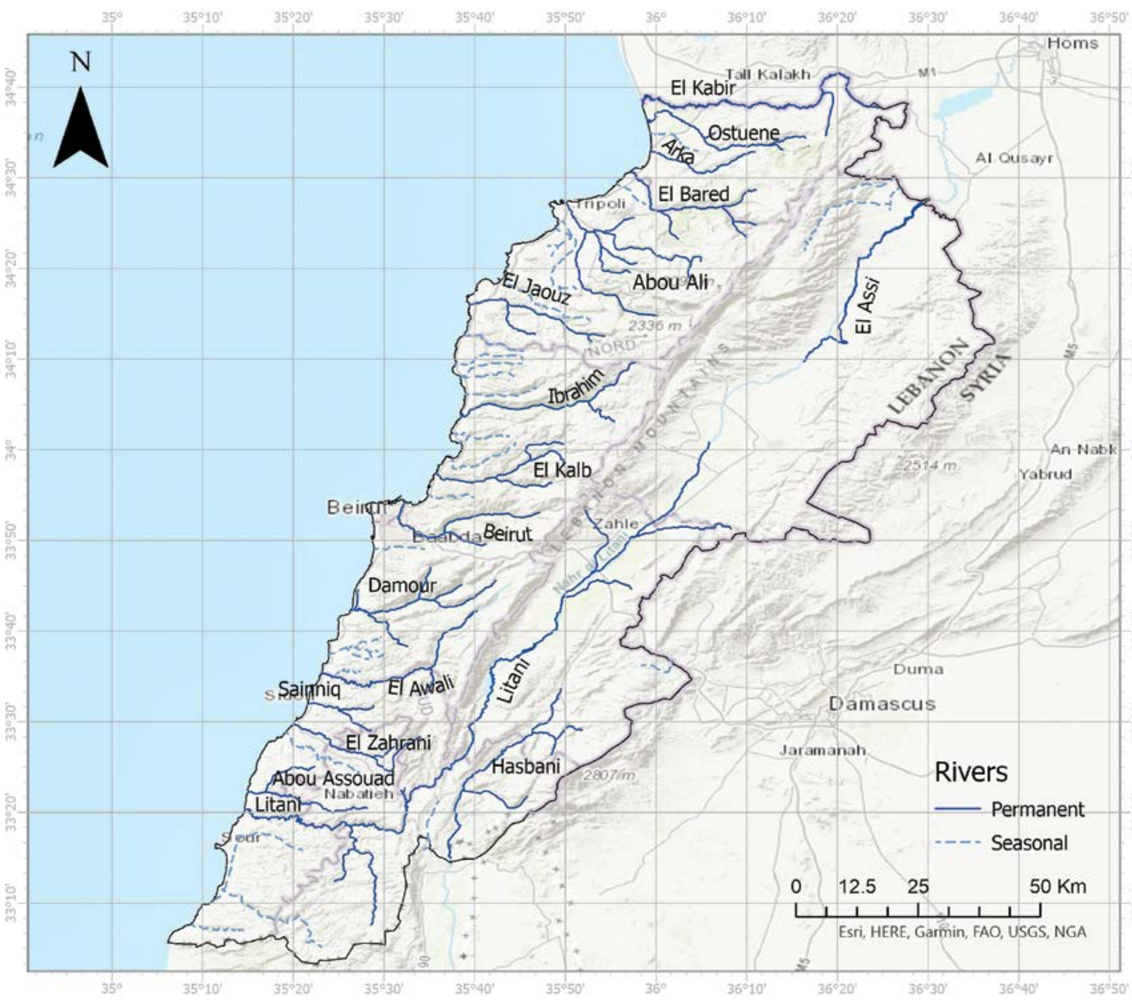

Figure 3-2 The total length of rivers and streams in Lebanon is 730 km. There are 40 rivers in the country, of which 16 are defined as perennial and the rest as seasonal (FAO, 2016; MoEW/UNDP, 2014).

dan River, which discharges in the Dead Sea.

- The major coastal river basins: These include the basins that form the coastal rivers of Lebanon. Some of the most important coastal rivers in Lebanon, include El Kabir, Ostuene, El Bared, Abou Ali, El Jaouz, Ibrahim, El Kalb, Beirut, Damour, El Awali, El Zahrani and Abou Assouad rivers.
- Minor and isolated sub-catchments that drain wadis and flow between major river systems.

All rivers in Lebanon are replenished annually by local precipitation events, which tend to be restricted to around 90 to 100 days between October and April, and to snowmelt. River flows tend to be seasonal with significant inter-annual variability. The average total annual river flow is estimated to range between 2,151 and 3,900 MCM, 75% of which occurs between January and May (Comair, 2010). Currently, the monitoring of river flows across Lebanon is implemented by the LRA, which operates 66 fixed monitoring stations distributed across the rivers of Lebanon (ECODIT, 2015). Yet, several stations are obsolete and the LRA needs capacity building, financial resources, and manpower to effectively manage the gauging network and upgrade it (ECODIT, 2015). Table 3-2 presents the estimated annual average volumes for the major Lebanese rivers and some smaller rivers that are used for drinking water and irrigation purposes by the country's four RWEs.

Table 3-2 Flow Data of Perennial and Other Main Rivers Used for Drinking and Irrigation

River (Perennial (P)/ Seasonal (S))	Watershed Area (km^2)	Average Annual Volume (MCM) (2013-1990)	Summer Volume Percentage (%) (Jul-Oct)	Gauging Station
Main rivers used for drinking and irrigation as reported by the final draft 2020 NWSS				
El Kabir (P)	297	470	7.0	Before discharge
Ostuene (P)	164	47[a]	-	-
Arka (S)	172	57	16.9	Hakour
El Bared (P)	282	163	13.5	Before discharge
Abou Ali (P)	491	245	8.7	Abou Samra
El Jaouz (P)	193	50	0.2	Before discharge
Ibrahim (P)	310	378	3.5	Before discharge
Damour (P)	311	179	1.9	Before discharge
El Awali (P)	301	397	25.6	Saida
El Zahrani (P)	156	38	16.0	-
Izziye (S)	154	6	8.0	-
Litani (upper) (P)	1,288	223	2.4	Joub Jannine
Litani (lower) (P)	2,090	243	1.3	Before discharge
Hasbani (P)	582	145	11.0	-
Sainniq (S)	140	17	12.0	-
Total	**2,600 MCM/yr**			
Other major perennial rivers*				
El Kalb		154[1] – 189[2]		
Beirut		48[1] – 82[2]		
El Assi		11[1]-8.7[2]		
Wazzani (part of Hasbani)		2.3[1]		

Source: MoEW, 2019c;* MoE/UNDP/ECODIT, 2011

[1] for the years 2005-2009

[2] for the years 1971-1975

3.2.1.2 Water Storage

Up until 2010, Lebanon only had two large dams, the Qaraoun Dam on the Litani River and the Chabrouh Dam that captures runoff and water from the Laban Spring. Their respective static storage capacity is estimated at around 220 MCM and 9 MCM, respectively. Currently, only 30 MCM are being utilized from the Qaraoun Dam for water supply and irrigation projects and the rest is used to generate hydropower. Over the past 10 years, the MoEW started the implementation of a plan that aims to augment water supply through the construction of dams and lakes (Table 3-3). The newly established Ballout (Matn caza) (0.5 MCM) and Qaysamani (Baabda caza) (1 MCM) lakes in Mount Lebanon provide potable and irrigation water to nearby villages, while the Yammouneh lake (Baalbek caza) (1.45 MCM) supplies water for irrigation, as does the rehabilitated Kouachra lake (Akkar caza) (0.4 MCM) in the north. Currently, several dams are under construction including the Janneh (Jbeil caza), Beqaata (Keserwan and Matn caza), and Bisri (Chouf and Jezzine cazas) dams under the jurisdiction of the Beirut Mount Lebanon Water Establishment (BMLWE), the Mseilha (Batroun caza) and Balaa (Batroun caza) dams under the jurisdiction of the North Lebanon Water Establishment (NLWE), and the first phase of the Assi dam (Hermel caza) under the jurisdiction of the Bekaa Water Establishment (BWE). Once these dams are completed, the static storage capacity at the national level will reach 409 MCM, compared to the current total of 232.5 MCM (MoEW, 2019c).

Table 3-3 Dams and Lakes Existing and Under Construction

Dam	Static Storage (MCM)	Dynamic Storage (MCM/year)	Status	Usage
BMLWE				
Ballout Lake (Matn caza)	0.5	0.5	Operational	Potable / Irrigation
Bisri Dam (Chouf and Jezzine cazas)	125.0	125.0	Under Construction	Potable / Irrigation / Hydropower
Boqaata Dam (Keserwan and Matn caza)	6.0	12.0	Under Construction	Potable
Chabrouh Dam (Keserwan caza)	9.0	11.0	Operational	Potable / Irrigation
Janneh Dam (Jbeil caza)	38.0	95.0	Under Construction	Potable / Irrigation / Hydropower
Qaysamani Lake (Baabda caza)	1.0	1.0	Operational	Potable
Total BMLWE	179.5	244.5	-	-
BWE				
Assi Dam - Phase I (Hermel caza)	63.0	63.0	Under Construction	Irrigation
Yammouneh Lake (Baalbek caza)	1.45	1.45	Operational	Irrigation
Total SLWE	1.45	64.45	-	-
NLWE				
Balaa Dam (Batroun caza)	1.2	2.2	Under Construction	Potable
Brissa Dam (Danniyeh caza)	0.8	0.8	Needs repair	Irrigation
Kouachra Lake (Akkar caza)	0.4	0.4	Operational	Irrigation
Mseilha Dam (Batroun caza)	6.0	12.0	Under Construction	Potable / Irrigation
Total NLWE	8.4	15.4	-	-
LRA				
Qaraoun Dam (West Bekaa caza)	220.0	300.0	Operational	Potable / Irrigation/ Hydropower
Total capacity	409.0	624.0	-	-

Source: MoEW, 2019c

3.2.1.3 Springs

Most of the water used to secure domestic supply in Lebanon comes from captured spring sources. The exact number of springs in Lebanon remains uncertain. More than 5,000 springs have been reported and displayed on the topographic maps of Lebanon; yet only 409 of these have flow data. Currently, only nine springs are instrumented and their flow and quality monitored on a regular basis (MoEW/UNDP, 2014). Given the lack of instrumentation on most springs, it is impossible to accurately quantify their yield. The MoEW estimates that the total annual yield exceeds 1,200 MCM, with less than 200 MCM available during the dry summer period. The MoEW also reports that the RWE are tapping around 90% of the springs falling under their jurisdictions and thus sees little value in further optimizing extraction (Table 3-4) (MoEW, 2019c).

The yields and the water quality of springs are sensitive to climatic change, modifications to land use and land cover in their sheds, and to pumping activities. As a result, many small springs have been experiencing progressive dryness, while many others have been polluted and require treatment before use. Recently, the United Nations Children's Fund (UNICEF), through a KfW fund and upon the request of the MoEW, has started rehabilitating the catchment works of 22 springs[1] in order to reduce leaks and protect the tapped water from pollution. The rehabilitation and construction works were completed in May 2020 (MoEW, 2019b). A detailed assessment of the Jeita Spring (Keserwan caza) has been undertaken with support from the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) study and its findings are presented in Box 3-2.

Table 3-4 Total Average Annual Yield and Volume Extracted from Springs by RWE

RWE	Average Yield (Mm^3/year)	Average Volume Extracted (Mm^3/year)	Number of Springs	Names of Springs
BMLWE	457.9	72.2	22	Aamatour, Aassal, Abou Laban, Ain El Delbe, Ain Baradaa, Ain el Sfayat, Afqa; Barouk, Chaghour Hammana, Daychounieh, El Ayoun, El Madiq, El Mamboukh, El Qaa, Fouar Antelias, Jamajem spring, Jeita, Jouaizat, Laban, Safa, Roueiss, Raayan
BWE	354.5	231.7	28	Aarouba & Al Hariq, Ain Daher, Ain el Hajar, Ain El Haour, Ain Zarka, Ana, Anjar, Berdaouni, Chamsine, Chtaura, Ech Chaghour, El Kharbe & El Wardeh, El Khreizat, El loulouj, Es Saalouk, Fekha, Laboue, Lezzabe, Maabour, Naba Bir Ez Zhour, Nabi Sbat, Ouadi el Delem, Ouyoun Orghosh, Oyoun Obeid, Ras Baalbek, Ras el Ain, Yahfoufa- Ain Es Sikeh, Yammouneh, Zahleh old spring
NLWE	237.4	72.35	37	Abou Halka, Ain Boulos, Ain Daher, Ain el Abdeen, Ain el Bire, Ain el Jrab, Ain el Tine, Arbaiin, Dalle an Ghouaouit, El Ghar, El Hab, el Jaouz (Qobayat), EL Karem, El Qadi, Es Sabaa, Es Sekkar, Fraidis, Hamde, Houe, Iskandar, Keftine, Kseim, Mar Challita, Mar Sarkis, Mar Semaan, Naassah, Nabaa el Bire, Nabaa el Breissa, Nabaa Ez Zahlan, Oyoun Es Samak; Qadisha, Rachaiine, Rahoue, Ras el Ain, Safa, Sir, Zahle
SLWE	56.5	36.8	9	Aalman, Ain el Tine, Ain Rkeiz, Ghalle, Hasbani, Qbay, Rachidiye, Ras el Ain, Tasseh

Note: Data on yield and volume extracted for many springs was missing.
Source: Adapted from MoEW, 2019c

[1] Beirut Mount Lebanon (Afqa, Ain el Delbe, El Ayoun), Bekaa (Ain Zarka), North Lebanon (Ain Daher, Dalle an Ghouaouit, El Hab, El Qadi, Es Sekkar, Kseim, Mar Sarkis, Oyoun Es Samak, Qadisha, Rachaiine), South Lebanon (Ain el Tine, Ain Rkeiz, Qbay, Rachidiye (5 springs)).

Box 3-2 Jeita Spring

The Jeita Spring is located in the El Kalb River Valley, northeast of Beirut, at an elevation of 60 m above mean sea level, 4 km upstream from the outlet of the El Kalb River to the Mediterranean Sea. The spring has a water discharge of 80-290 MCM/year and delivers around 70% of the drinking water supply of Beirut. The spring emerges from the Jurassic limestone aquifer, which is highly karstified. As a result, the spring is characterized with pathways that allow for the rapid infiltration of water and contaminants. The steep topography results in extremely high groundwater flow velocities and to the immediate transfer of any pollutant from the watershed to the spring. In 2014, the spring was the subject of a detailed study conducted through the Federal Institute for Geosciences and Natural Resources. The study aimed to provide a comprehensive understanding of the hydrogeology of the spring and focused on the needed management and mitigation measures to reduce pollution risks. Several tracer tests used to define the groundwater contribution zone for the spring were conducted. The study showed that the Jeita watershed was considerably different than previously thought and was largely controlled by the geological structures. The study-delineated groundwater catchment was found to extend over 405.6 km^2, its northern boundary stretching as far as Tannourine (up to 42 km away) and covering more than 50% of the Upper Cretaceous plateau in the Lebanon mountain range. The study also showed that the Jeita spring received up to 46% of its water from an infiltration zone high in the Upper Ibrahim River Valley. This finding raised some concerns regarding the planned Janna Dam on Ibrahim River and its potential impact on the Jeita Spring (El Kalb River). To verify these findings, the MoEW recently commissioned a detailed geologic and hydrogeologic study to delineate the basins of Jeita (El Kalb River), Antelias (Antelias River) and Maddiq (Ibrahim River).

Based on the delineated watershed, the BGR study conducted a groundwater vulnerability assessment. The vulnerability maps were used to identify groundwater protection zones that should have strict restrictions on the allowed land uses. In an effort to provide an early warning system to the water treatment plant in Dbayeh, the project also set up a comprehensive monitoring system to measure discharge and the water quality from four major springs in the project area, namely the Jeita, Kashkoush, Assal and Labbane springs (El Kalb River), using multiparameter probes. The system was connected to the Dbaye water treatment plant via telemetric data transfer in order to provide an early warning system and allow the plant to switch to another source of supply.

The project also assessed the potential of the Jeita Spring within the different water resource options available for the BMLE and proposed to increase its use efficiency. The project highlighted the need to improve the old conveyance system between the Jeita Spring and the Dbayeh treatment plant in order to increase the usable water volume and to improve water use efficiency. The BGR project is a model of integrated river basin management and it is hoped that its approach is replicated across the country (BGR, 2014 & BGR, 2015).

All project outputs can be found at the following link:

https://www.bgr.bund.de/EN/Themen/Wasser/Projekte/abgeschlossen/TZ/Libanon/jeita_fb_en.html

3.2.1.4 Groundwater

Lebanon has two main aquifers, namely the Kesrouane Jurassic (J4) and the Sannine-Maameltain (C4-C5) (Map can be found in Annex 2). Both are largely composed of karstic carbonate rocks and cover around 5,600 km^2 of the Lebanese territory (MoEW/UNDP, 2014). Groundwater resources in Lebanon play a vital role in supplying water to all economic sectors. It is estimated that over 50% of the irrigation water volume comes from wells and boreholes, while 80% of the potable water supplied comes from groundwater sources (MoE/UNDP/ECODIT, 2011). The exact number of wells operating in Lebanon and their annual yields is not known.

The final draft 2020 NWSS reported the existence of 1,325 public wells, of which only 943 were operational. Of these public wells, around 46% tap into undefined aquifers, while 33% tap into the Sannine-Maameltain (C4-C5) and 9% tap into the Kesrouane Jurassic (J4) aquifer. Withdrawal from these wells was estimated at 270 MCM per year (MoEW, 2019c). The MoEW/UNDP study (2014) identified 841 public wells in the country, out of which 44 wells were abandoned and 68 were non-operational. The total groundwater extraction rates by the RWEs were estimated, while the number of installed piezometers and flowmeters was recorded (Table 3-5). The data shows that the SLWE is the most dependent on groundwater; its annual extraction alone represents more than 45% of the total annual national groundwater extraction volume.

In addition to the public wells, Lebanon has a large number of private wells. The number of licensed private wells that are registered with the MoEW was estimated at 20,537 up until 2012, with 61% of those located within the BMLWE jurisdictions, the remaining almost equally distributed among the NLWE (15%), the BWE (12%), and the SLWE (12%). The number of illegal private wells was initially estimated by the MoEW in the 2010 NWSS to be around 22,000 (MoEW, 2012). This estimate was later revised and increased to range between 55,000 and 60,000 wells in the MoEW/UNDP study (2014). In the final draft 2020 NWSS, the MoEW estimates that the total public and private withdrawal from the aquifers was around 700 MCM/year and recommended that the maximum allowable withdrawal should not exceed 500 MCM/year (MoEW, 2019c).

It should be noted that most coastal and many intensively cultivated groundwater basins show significant deficiencies in their water balance. In some basins, such as the North Lebanon Cretaceous Basin, water deficits can exceed 150 MCM per year in dry years. Over-exploitation has resulted in a drop in the groundwater level in most of the interior groundwater-basins that are not in direct contact with the sea. Levels have fallen by 27 m in the Sir ed Dannieh – Ain Yaacoub Basin and by 20 m in the Litani area in the Southern Bekaa Neogene-Quaternary Basin (MoEW/UNDP, 2014). A recent study monitoring the groundwater depths from 8 monitoring wells

Table 3-5 Public Wells in Lebanon

RWE	Total Number of Wells Surveyed	Total Extraction Rate (m^3/day)	Total Extraction Rate (MCM/ year)	Total Extraction Rate Based on 2010 NWSS* (MCM/year)	Total Number of Piezometers Installed	Total Number of Flow Meters
BMLWE	218	193,642	71	89	38	37
BWE	209	90,422	33	53	42	59
SLWE	277	309,128	113	71	7	160
NLWE	137	88,383	32	54	25	31
Total	841	681,576	249	267	112	287

Source: MoEW/UNDP, 2014; *MoEW, 2012

installed for the LRA showed a decreasing trend in their water levels between 2012 and 2016, such as the ICARDA Terbol well that showed a drop in excess of 30 m over these 4 years (Farajalla et al., 2018). While equally stressed, most of the coastal aquifers did not experience a drop in their water levels due to the intrusion of saltwater into these aquifers as a result of over pumping. As a result, the quality of their water has significantly deteriorated with many being abandoned due to their high salinities (Refer to Section 3.2.2.2). Annex 3 maps the stressed aquifers across Lebanon based on the groundwater budget reported in the MoEW/UNDP study (2014).

3.2.1.5 Wetlands

Wetlands are an important ecosystem and water reservoir. There are seven identified wetlands in Lebanon that cover a total area of 16 km^2 (Shaban, 2013). They include the three coastal wetlands of Palm Islands, Deir El-Nouriyeh-Cliffs of Ras Ech-Chekkaa and Tyre Beach, along with the four inner wetlands of Ayoun Orghosh, Aamiq, Chamsine/Anjar and Aiha (Table 3-6). Of the seven wetlands, only four (Palm Islands, Deir El-Nouriyeh-Cliffs of Ras Ech-Chekkaa, Tyre Beach and Aamiq wetlands) are currently included in the RAMSAR List of Wetlands of International Importance (Shaban et al., 2017) and only two are protected, namely the Palm Islands (Law 121/1992) and Tyre Beach (Law 708/1998), along with its extension, the Abbassieyh Beach (Law 170/2020). Lebanon's wetlands have been subjected to natural and anthropogenic stresses, including changing climatic conditions, notably a reduction in the water allocation needed to maintain their water-saturated terrain (Hassan, 2015; Shaban, 2014).

Table 3-6 Identified Wetlands in Lebanon

Name	Area (km^2)	Description
Palm islands	4.10	3 islands almost covered by saline water among the karstic ponds (Tripoli caza; North Lebanon)
Cliffs of Ras Ech-Chakkaa	0.85	Jointed cliffs (~ 200 m) of carbonate rocks adjacent to the sea (Batroun caza; North Lebanon)
Tyre coast	3.80	Elongated watercourse from artesian springs running to the coast (Tyre caza; South Lebanon)
Abbassiyeh beach	0.54	An extension to the Tyre coast (Tyre caza; South Lebanon)
Ayoun Orghosh	0.47	Surface water in a depressed land mainly filled by snow melt (Baalbek caza; Baalbek-Hermel)
Ammiq	2.80	Several natural ponds of freshwater in the carbonate rocks (West Bekaa caza; Bekaa)
Chamsine/Anjar	0.85	Watercourses from Chamsine and Anjar springs (Zahle caza, Bekaa)
Aaiha	3.20	Lowlands where water seeps from neighboring mountain chains (Rachaya caza, Bekaa)

Source: Shaban, 2013

3.2.2 Water Quality

The uncontrolled discharge of point and non-point sources of pollution continue to degrade the water quality of the Lebanese rivers, springs, wetlands and aquifers. Many of these systems receive pollutant loads that are orders of magnitudes higher than their carrying capacities. As such, many systems are impaired and their ecosystem functions are disrupted. Without a long-term time-series dataset on the evolution of water quality in these systems, the assessment of their current state and the rate of their degradation or recovery is difficult to quantify and is associated with large uncertainties. Many of these assessments are often based on studies for which the number of samples collected are limited both spatially and temporally.

3.2.2.1 Rivers and Springs

The extent of water impairments in river systems varies widely by season, across rivers, as well as within a specific river. While the main sources of pollution are largely common (domestic wastewater and solid waste; point sources from industrial, healthcare, touristic and classified establishments, quarries; and non-point agricultural runoff), their relative contribution is river-specific and tightly associated with the dominant land uses within each watershed. Temporally, riverine pollution levels are most extreme during the dry summer period, when dilution is lowest; yet pollution loading to the receiving environments tends to be highest during the wet season when water flows and thus fluxes are highest. Since the publishing of the SOER 2010 (MoE/UNDP/ECODIT, 2011), several studies have attempted to characterize and better quantify the pollution status in 11 rivers[2] across Lebanon (Annex 4).

Microbiological impairment has been documented in all assessed rivers, highlighting that the discharge of untreated domestic wastewater remains the principal source of freshwater pollution at the national level. In a recent study of the microbiological diversity at the outlet of Ibrahim River, fecal coliform levels were found to vary between 0.6×103 and 2.4×103 Colony Forming Unit (CFU)/100 ml (El Najjar et al., 2020). High bacterial contamination was also reported for the Damour and Beirut rivers, with fecal and total coliform levels consistently found to be too numerous to count across all sampling sites (El-Nakib et al., 2020). In the Upper Litani Basin (ULB), the total and fecal coliform concentrations in the river were found to exceed 300,000 CFU/100 ml and salmonella was detected during the dry season (Haydar et al., 2014; IDRC, 2007). Similarly, elevated levels of bacterial contamination were reported in the Lower Litani Basin (IDRC, 2007; Nehme and Haidar, 2018). The state of the Litani River and Qaraoun Reservoir are further described in Box 3-3.

Box 3-3 Litani River Basin and the Qaraoun Reservoir

The ULB and the Qaraoun Reservoir are two of the most significant and well-studied freshwater systems in Lebanon. Yet, their role in water supply is compromised by poor water management and high pollution levels. Back in 2010, it was estimated that 45.4 MCM of untreated municipal wastewater were discharged annually into the ULB, with a BOD load of 15,533 tons/year (UNDP/MoE/ELARD, 2011). Future projections estimate that by 2030, the volume of wastewater will reach 62.9 MCM and the BOD load will reach 21,575 tons. These high loads are a result of treating less than 4 % of the total generated domestic effluent (Arif and Doumani, 2013) and the discharge of 3.7 MCM per year of industrial wastewater generated from about 294 industrial establishments in the ULB (UNDP/MoE/ELARD, 2011). The agricultural sector is also an important source of pollution in the Litani Basin. Application rates of many pesticides, and to a lesser extent, herbicides, are reported to be twice the recommended rates. Meanwhile, fertilizers are over applied by up to 3 times, especially for cash crops and stone fruits, with more than 90% of farmers not engaged in regular soil analysis before fertilization (UNDP/MoE/ELARD, 2011). The poor water quality of the Litani and Qaraoun Reservoir has compromised their abilities to meet their designated uses with the exception of hydropower generation. Swimming and fishing are currently prohibited. Similarly, irrigation is not recommended especially for vegetables. Potable use is also impaired given the expensive and advanced treatment needs prior to use. The cost assessment of water resource degradation in the LRB was estimated at US$ 227 million/year, which corresponded to 0.5% of the national GDP in 2012. Additionally, the costs associated with the health bill resulting from the burden of waterborne diseases is high (US$ 49 million/year in 2012) (Arif and Doumani, 2013).

The Qaraoun Reservoir has recently become a posterchild of surface water pollution in Lebanon, particularly due to the prolific algal blooms that dominate the lake for the better part of the summer and fall seasons. Since 2004, the reservoir has consistently been observed to be in a hypereutrophic state, with low phytoplankton biodiversity and regular blooms of toxic cyanobacteria (Fadel et al., 2014). A recent assessment of water quality predictions based on historical remote sensing data concluded that eutrophication in the lake appears to have been a persistent problem for the past three decades; yet there is evidence that its summer water quality has seen a significant deterioration post-2005 (Deutsch and Alameddine, 2019). During the summer season, toxic cyanobacterial species dominate and bloom. These blooms were first reported in 2009 by Atoui et al. (2013), who reported that *Microcystis* and *Aphanizomenon* represented the major cyanobacterial genus present in the lake between May and December. Several subsequent studies continued to track high cyanobacterial content in the lake (Fadel et al., 2015; Fadel et al., 2014; Slim et al., 2014; Deutsch, 2017; Deutsch et al., 2020). Increases in water temperature along with high nutrient loading are hypothesized to be the main drivers behind the Harmful Algal Blooms (HABs) (Deutsch, 2017; Fadel et al., 2014; Fadel and Slim, 2018; Slim et al., 2014). A recent study assessed future climate change implications of the eutrophic status of the lake and predicted further promotion of HAB events as a result of increased ambient temperatures (Fadel et al., 2019). In an effort to control HABs in the lake, the LRA through the technical and financial support of the Dutch government have recently implemented a reservoir-scale algal bloom control and monitoring system that uses ultrasound treatment to suppress HAB events in the hypereutrophic reservoir. The system is composed of 10

[2] Orontes, El-Kabir, Bared, Arka, Abou Ali, Ibrahim, Antelias, Beirut, Damour, Awali, and Litani rivers

solar-powered ultrasound emitting buoys. Initial results from the field (American University of Beirut (AUB)-led study in collaboration with LRA) has shown that these units have had a low efficacy in reducing algal blooms. As a result of the excessive algae, water transparency in the lake during the summer is low and is reported to range between 0.5 and 2.5m (Fadel et al., 2015). Surface water temperatures on the lake range between 7.0 and 30.9oC, with vertical temperature stratification apparent from May to September (Deutsch et al., 2020). During stratification, the lake bottom dissolved oxygen concentrations get progressively depleted and many parts of the lake dip into prolonged hypoxia (Deutsch, 2017; Fadel and Slim, 2018). Trace metal pollution has also been reported in the reservoir and attributed to loading from industrial effluent and urban and agricultural runoff in the watershed (Korfali et al., 2006; Korfali and Jurdi, 2011). Metal concentrations showed a deterioration in the sediment quality between 2005 and 2013. The potential impact of trace metal pollution on lake fish remains poorly assessed. In 2005 and as part of the Basin Management Advisory Services (BAMAS) project (2006) study, fish tissue analysis showed that while chromium levels in the sampled fish were below the Food and Drug Administration levels, cadmium and lead levels exceeded them (Fadel et al., 2014).

Over the years, several projects and studies have assessed the state of the Litani and Qaraoun Reservoir and proposed management plans aimed towards improving water use and their quality. The latest studies and plans were the United States Agency for International Development (USAID) funded Litani River Basin Management Support Program (LRBMS, 2012) and the GoL /MoE funded Business Plan for Combating Pollution of the Qaraoun Lake in coordination with UNDP (UNDP/MoE/ELARD, 2011). Accordingly, the roadmap for Combating Pollution of the Lake Qaraoun and the Litani River was issued in 2013. The Roadmap identified five areas of action. These included managing 1) governance; 2) non-hazardous solid waste, 3) domestic wastewater, 4) industrial effluents and wastes, and 5) agricultural pollution. Based on the suggestion of the Ministry of Environment (MoE), the CoM approved the establishment of a committee to oversee the execution of the roadmap (CoM Decision 32 of 09/05/2014). The committee includes representatives from the MoE, MoEW, Ministry of Industry (MoI), Ministry of Agriculture (MoA), Ministry of Public Health (MoPH), Ministry of Interior and Municipalities (MoIM), Council for Development and Reconstruction (CDR), BWE, LRA (committee secretariat), National Council for Scientific Research (CNRS) and the heads of the largest municipalities. Since its establishment in 2014, the committee has been convening regularly and reporting to the CoM every 6 months, as mandated. The roadmap was later transformed by deputies from the Bekaa into a law that was issued on October 27, 2016 (Law 63). The law allocated the needed provisions for the implementation of the action items identified in the roadmap after expanding the scope of work to include the Lower Litani Basin. After more than six years from the creation of the committee, the implementation of the roadmap has been slow due to several sectoral specific impediments that are summarized below, along with the overarching challenges associated with the high numbers of Syrian displaced in the basin (Moussallem, 2018a).

Main constraints based on action areas:

Non-hazardous solid waste and domestic sanitation:

- Low speed of implementation, namely as a result of the limited procurement capacity (affected among others by the changes facing human resources management in the public sector), administration of expropriation procedures and the volatile security situation in selected areas.
- Inability of operators of treatment facilities to recover their operation and maintenance costs.
- Lack of information related to the performance of the treatment facilities.

Industrial pollution:

- Lack of a detailed and comprehensive database regarding the licensed and non-licensed establishments (industries; other classified establishments; health care centers; quarries and sand pits; touristic establishments) that is shared across the different actors.
- Limited application of Law 251/2014 related to the designation of environmental prosecutors and investigative judges.
- Limited local expertise in the area of industrial pollution control.

Agricultural pollution:

- Insufficient capacities in the administrations concerned, particularly at the MoA, to provide effective extension services to farmers.
- Slow application of the NWSS regarding recharging groundwater, monitoring the flow and quality of surface and groundwater as well as promoting the reuse of treated wastewater in irrigation, which would reduce farmers' reliance on polluted river water and/or illegally tapping on groundwater.
- Limited extent of delineated, surveyed/demarcated and zoned areas, along with the rules of partitioning and annexation, as well as the exceptional construction permits granted by municipalities based on MoIM memos, which has lead to the urbanization of many agricultural areas *(Refer to Chapter 7 – Haphazard Urbanization).*

Moving forward, the existing roadmap will need to be augmented by measures that aim to restore the Litani's hydrological integrity, while also implementing an integrated sustainable water and sediment quality monitoring program (Moussallem, 2018b).

The open discharge of wastewater has also caused high biological oxygen demand (BOD) and depressed dissolved oxygen (DO) levels, particularly during the dry season. For example, the DO levels in the Litani River, along with its tributary the Berdawni, were found to consistently dip below 3 mg/L during the summer season (Baydoun et al., 2016; Saadeh et al., 2012). BOD levels in the main stem of the Litani were reported to vary between 5 and 29 mg/L (Haydar et al., 2014). In Beirut River, the mean BOD level was found to be 11.3 mg/L, with concentrations reaching 100 mg/L in the dry season. Measured DO levels in Damour River were reported to vary between 4 and 7 mg/L (Massoud, 2012), while its mean level in Ibrahim River was reported to be 7.6 mg/L (El Najjar et al., 2019).

Nutrient levels also tend to be high due to the discharge of both point and non-point sources. Phosphate levels in the Litani and its tributaries were found to exceed 5 mg/L on several occasions (Abou-Hamdan et al., 2014; Saadeh et al., 2012). Reported levels in the Beirut and Ibrahim rivers tend to be significantly lower (0.45 and 0.048 mg/L respectively) (El-Nakib et al., 2020; El Najjar et al., 2019). Concerning nitrates, their mean levels in the Ghouzaiel were reported to exceed 15 mg/L across all stations below its source (Abou-Hamdan et al., 2014), while nitrates in the Berdaouni were above the 45 ppm (10mg/l) LIBNOR standard set for drinking water. Levels in the lower reaches of the Damour River varied between 2 and 10 mg/L (Massoud, 2012), while their mean level in the Beirut River was 2.3 mg/L (El-Nakib et al., 2020). Ibrahim River had the lowest level of nitrates with a mean 0.82 mg/L (El Najjar et al., 2019). Source-apportionment of nutrient pollution loading into the Lebanese rivers is still largely descriptive. Only one study on the Beirut River implemented a source apportionment methodology and was able to show that the contribution of point sources, largely from sewage discharge, was the main cause of water quality impairment (El-Nakib et al., 2020).

Knowledge of riverine pollution by heavy metals and micropollutants across Lebanon is still limited and based on a few sporadic studies. Heavy metal concentrations in the ULB were found to be largely below detection level (Haydar et al., 2014). In El Kabir River, the concentrations of Copper, Zinc, Strontium, Chromium and Nickel were all above the world average concentrations (Thomas et al., 2005). Pollution by pesticides and polycyclic aromatic hydrocarbons (PAHs) has been reported in the El Kabir, Abou Ali and Litani rivers *(Refer to Chapter 10 - Chemical Management for details)*.

3.2.2.2 Groundwater

Groundwater quality in Lebanon has deteriorated both as a result of over-abstraction and anthropogenic pollution. Saltwater intrusion (SWI) is a critical and widespread problem affecting a large stretch of the aquifers along the Lebanese coastline. Coastal aquifers identified to be vulnerable to SWI include: the North Lebanon Cretaceous, the Jabal Terbol Miocene, the Batroun-Jounie Cretaceous, the Jounieh Miocene, the Hadath-Hazmieh Cretaceous and the general Neogene-Quaternary aquifers (MoEW/UNDP, 2014). Several studies have been conducted over the past 20 years to monitor and assess SWI along the Lebanese coast. One of the most comprehensive was the International Development Research Centre (IDRC) - funded study conducted by the AUB (IDRC, 2017), which assessed the status of SWI of aquifers in Tripoli, Jal el Dib, Beirut and Zahrani. Table 3-7 summarizes the status of coastal aquifers experiencing SWI. As can be seen, the salinity levels in many sampled wells exceeded the 500 mg/L LIBNOR standard set for drinking water.

Another common groundwater pollutant that is responsible for the impairment of many wells is nitrates. Nitrate pollution is largely attributed to agricultural sources and to a lesser extent to sewage seepage. Nitrate pollution has serious health implications, as it can lead to methemoglobinemia and potentially to increased cancer risks. Elevated nitrate levels in the groundwater were reported across most monitored wells in the Bekaa plain, rendering them unfit for potable or irrigation purposes (Amacha and Baydoun, 2018). In the Litani basin, the Lucy wells (in El Sultan Yaacoub and El Khiyara) were found to have alarming levels of nitrates that exceeded the LIBNOR standard set for drinking water (Saadeh et al., 2012), while in the region of Terbol (central Bekaa) only 1 of the 21 sampled wells was found to be suitable for

Table 3-7 Saltwater Intrusion along Coastal Aquifers

Region	Saltwater Intrusion Status in Sampled Wells	Studies
Beirut	- Median chloride levels increased up to 4,453 mg/L in 2014 - Out of 170 wells sampled between 2012 and 2013, only 14% were categorized as fresh or slightly saline	Alameddine et al., 2018; Rachid et al., 2017
Choueifat, Jiyeh and Rmeileh	- Most wells had salinities in excess of 2 deciSiemens/m - In 2014, salinity levels in the area between Naameh and Rmeileh were found to have doubled or tripled as compared to their levels in 1989 - Freshwater/seawater interface intruded > 2 km inland	Fayssal and Slim, 2015; Khadra and Stuyfzand, 2018
Jal el Dib	- 90% of wells experienced SWI year-round - Total Dissolved Solids (TDS) levels: 222 - 4,400 ppm	IDRC, 2017
Tripoli	- TDS levels: 209 - 3,460 mg/L - Freshwater/seawater interface expected to move by 103 m further inland over the next 25 years as compared to its current location in 2018	El-Fadel et al., 2014; El-Hoz et al., 2014; Kalaoun et al., 2018
Zahrani	- The plain appears to be in the early stages of SWI	El-Fadel et al., 2018; IDRC, 2017

drinking water purposes (Darwish et al., 2011). Similar to the situation in the Bekaa, wells in the Akkar plain also suffer from elevated nitrate concentrations (Baroudi et al., 2012). Nitrate pollution in urbanized areas tends to be less severe.

Karstic aquifers, which are the most common and important groundwater aquifers in the country, are particularly vulnerable to bacterial pollution, partly due to their large pore spaces that provide minimal soil filtration (Appleyard, 2003). Microbiological contamination of the groundwater has been documented across Lebanon. In urban areas, it is predominantly a direct result of wastewater leakage from faulty sewer systems or the occasional use of septic tanks in suburban areas. Contamination by total and fecal coliforms was reported in 100% and in 83% of the samples collected from 29 wells that were monitored in the Jal El Dib area between 2012 and 2013, respectively (IDRC, 2017). In Tripoli, groundwater samples collected between 2006 and 2007 showed that while total coliforms were detected in almost all samples irrespective of season, fecal coliform contamination was significantly higher towards the end of the prolonged dry period (El-Fadel et al., 2014). In the Borj-Abou Haydar and Nweiri areas in Beirut, 6 out of 9 domestic wells tested positive for gram-negative bacteria and coliform, while 2 also tested positive for the Salmonella and Shigella species (Nawas and Al Koussa, 2017). Inland wells are also negatively affected by microbiological pollution. In the Bekaa, high levels of fecal coliform were reported in most of the monitored wells in the ULB, with levels reaching 400 CFU/100 ml (Amacha and Baydoun, 2018).

Studies that have assessed groundwater pollution by heavy metals and emerging micropollutants are very limited. Data on heavy metal pollution of groundwater across Lebanon is largely scarce; yet none have reported levels that exceed the United States Environmental Protection Agency and World Health Organization (WHO) standards set for drinking water (Amacha and Baydoun, 2018). Similarly, the prevalence of groundwater pollution by PAH and pesticides is limited to a few studies that were conducted in North Lebanon). Recently, groundwater pollution by polychlorinated biphenyls (PCBs) was documented on sites utilized by the Electricité du Liban. Of particular concern was a well in the Bauchrieh area that may have been used to dump up to 0.5 tons of PCBs (MoE, 2016) *(Refer to Chapter 10 - Chemical Management for details).*

3.2.2.3 Water Quality at the Household

Water quality at households is compromised by the fact that over half of all water supply networks in the country have surpassed their designed useful life (MoEW, 2012). The intermittent supply of water also has a serious negative effect on water quality due to the potential suction of non-potable water by negative pressures, biofilm detachment and microbial re-growth (Ayoub and Malaeb, 2006). A national assessment of water quality at the household level conducted jointly by UNICEF and the WHO found E. coli contamination in 53% of all water samples collected from the distribution points of permanent residential households (WHO and UNICEF, 2016). The results showed significant differences between governorates, with Beirut and Mount Lebanon having the worst water quality. Furthermore, around 95% of all samples collected at the household level had unacceptably low levels (<0.2 mg/L) of residual chlorine, which poses serious health risks if the water is to be used for drinking purposes. Based on that study, it was estimated that 64% of the population in Lebanon does not have access to a safely managed drinking water service (GoL/UN, 2018). In a study conducted jointly between UNICEF and the BWE, NLWE and SLWE, water quality within these RWEs was assessed between 2013 and 2020. The results documented bacterial contamination across the three regions, with higher contamination levels during the summer months in the NLWE and SLWE (UNICEF, 2021).

The dependence of residents on water delivered by water tankers and private bottling companies is widespread across Lebanon. While the MoPH regulates the bottled water sector, many unregulated companies still operate. A study conducted by Semerjian (2011) assessed the quality of 32 different domestic bottled water brands and concluded that while all samples were free of fecal coliforms, around 20% tested positive for total coliforms. In contrast, the WHO/UNICEF (2016) national assessment revealed that 47% of the samples collected from bottled water exhibited E. coli contamination. The water tanker sector in Lebanon has gained prominence over the past 10 years; but it remains poorly regulated and lacks monitoring. As a result, the quality of the water delivered by tanker trucks was the most polluted of all water sources that were sampled in the WHO/UNICEF (2016) study, with more than 45% of all collected samples exhibiting E. coli levels above 100 CFU/100 ml. A more localized study was conducted by Constantine et al. (2017), who monitored the quality of the water from 33 groundwater wells used to fill water tankers delivering water to Beirut between 2013 and 2014. The study found that around one third of all samples were contaminated with fecal coliform and that the tanks used to transport the water were a significant source of bacterial contamination.

3.2.2.4 Coastal Marine Water

Large sections of the Lebanese coastal zone are negatively impacted by pollution due to the discharge of untreated wastewater (domestic and industrial), the uncontrolled disposal of solid waste, agricultural runoff and reduced flushing capabilities resulting from poorly designed land reclamation projects. The coastline experiences a high rate of anthropogenic pollution given that around 70% of the Lebanese population lives along the coastline. It is estimated that the Lebanese coastal waters receive around 65% of the total domestic wastewater generated through at least 53 outfalls distributed along the coastline (Abboud-Abi Saab and Hassoun, 2017; Merhaby et al., 2020). In addition, the Lebanese coastal zone hosts major industrial, touristic and other economic activities (Kazour et al., 2019). The Lebanese coastal waters are also affected by the pollutant loads that are transported through rivers from various inland sources (El-Nakib et al., 2020; Geara-Matta et al., 2010; Houri and El Jeblawi, 2007). A study conducted by Saab and Hassoun (2017) reported high nutrient concentrations and the predominance of eutrophic conditions near sewer outfalls located between Beirut and Batroun. The study highlighted the presence of harmful toxic blooms near perturbed sites. Trace metal contamination was found to be significant at Beirut Port but moderately localized at Tripoli Port (Merhaby et al., 2018). High levels of persistent organic pollutants were also reported in the Abou Ali estuary, Chekka and Jounieh Bay, Beirut Port and Jiyeh Port *(Refer to Chapter 10 - Chemical Management for details)* (Merhaby et al., 2020). Meanwhile, the discharge of untreated leachate from coastal dumps has depressed oxygen levels and increased the loads of aromatic organic compounds and microplastics. As part of the framework of the CANA-CNRS-L project, a national survey and sampling program was conducted between 2011 and 2014 that identified six pollution hotspots (Table 3-8). The program also reported the presence of chemical toxicity in Selaata and Antelias, whereas eutrophication was identified at all sites except for Anfeh (CNRS, 2014).

Table 3-8 Summary of Main Sources of Pollution at Selected Sites along the Lebanese Coastline

Site	Source of Pollution			Indicators
	Domestic Wastewater	Industrial Wastewater	Freshwater (Rivers)	
Anfeh (control site)				
Selaata		✓	✓	Phosphates
Ibrahim River			✓	Nitrates
Antelias	✓	✓	✓	Nitrates, Phosphates, FC, FS
Ramlet-el-Bayda	✓			Phosphates, FC, FS
Saida	✓			FC, FS

FC: Fecal coliforms, FS: Fecal streptococci
Source: CNRS, 2014

3.2.2.5 Bathing Water

The National Center for Marine Sciences (NCMS) operates a coastal seawater monitoring program that evaluates bathing water quality and identifies coastal sources of pollution. The center issues its assessment of the status of bathing water quality along the main Lebanese beaches once a year. These reports are published online to inform citizens of the status of their beaches (Figure 3-3).

Figure 3-3 2020 Report on the Status of Lebanese Bathing Water Quality Report
Source: NCMS-CNRS, 2019

Table 3-9 summarizes the bacterial contamination at 31 beaches for the years 2019 and 2020. The results show high bacteriological contamination (from untreated wastewater and/or the presence of dumpsites) in selected locations. The beaches with good bacteriological water quality included those in Batroun, Byblos, Bouar, Jounieh, Damour, Rmeileh, Tyre and Naqoura. The assessment also reported the detection of chemical pollution at three beaches, namely Herri, Selaata, and Antelias.

Table 3-9 Bacteriological Quality of 31 Monitored Beaches in 2019 and 2020

Location	Fecal Coliforms (CFU/100ml)[1]		Fecal Streptococci (FS) (CFU/100ml)[2]	
	2019	2020	2019	2020
Akkar-near Klayat Airport	633	540	267	296
Sandy Private Beach of El Menieh	29	24	49	67
Tipoli-El Mina Abdel Wahab Island	780	580	360	628
Tripoli-Public Beach	409	525	810	1,344
Tripoli- Next to Sports City	33	31	141	150
Anfeh-Deir Al Natour	116	162	187	248
Heri-Sandy Beach of Heri	195	170	234	152
Selaata-near a Chemical Industry	19	27	94	120
Batroun Hima and NCMS	22	24	19	40
Amsheet	-	1	-	214
Byblos-Pebbles Beach	65	35	59	55
Byblos-Sandy Beach	116	101	93	96
Fidar-under Fidar Bridge	195	188	195	200
Okaibi-Near Input of Ibrahim River	195	173	130	138
Bouar-Rocky Public Beach	-	58	-	180
Tabarja/Safra-Rock Beach	126	106	112	145
Jounnieh-Maameltin Beach	53	53	82	150
Jounieh-Sandy Public Beach	-	157	-	296
Dbayeh-Sandy Beach	5,000	10,230	5,000	5,600
Antelias-Near Antelias River	20,000	20,000	36,000	32,000
Beirut-Near New Fishery Port	124	116	142	105
Beirut-New Lighthouse	10,000	3,000	10,000	3,200
Beirut-Ramlet El Bayda Beach	10,000	10,000	10,000	10,000
Damour-Sandy Beach	89	73	42	88
Jiyeh-Private Sandy Beach	-	140	-	181
Rmeileh- Private Sandy Beach	-	9	-	47
Awali-Near Awali River	70	68	250	170
Saida-Public Beach	494	496	480	398
Sarafand-Semi-Public Beach	480	425	450	415
Sour-Sour Hima Beach	49	33	63	56
Naqoura-near Fishery Port	21	12	14	38

[1] MoE standards for fecal coliform in bathing water is 100 FCU/100ml (MoE Decision 52/1 of 1996): Red>standards; Green< standards

[2] WHO standards for FS: Green (very good)=1-200 CFU/100ml; Yellow (caution-critical)=201-500 FCU/100ml, Red (dangerous-highly polluted)>500 FCU/100ml (WHO, 2003)

Source: NCMS-CNRS, 2019

3.2.3 Water Demand

With the absence of reliable primary data on water consumption generated from water meters, water demand at the national level is still estimated based on assumptions related to population, per capita domestic and non-domestic water consumption, network efficiency, total irrigated area and irrigation consumption. The 2010 NWSS adopted moderate water consumption figures of 180 L/capita/day in urban and 160 L/capita/day in rural settings and estimated that the annual water demand was around 1,473 MCM per year. In the final draft 2020 NWSS, the water consumption rates were revised and decreased to 125 L/capita/day for both urban and rural areas. Nevertheless, recent evidence from several pilot communities fitted with water meters have shown that the rate ranges between 300-400 L/capita/day (MoEW, 2019c). These numbers agree with the findings of Hijazi et al. (2012), who reported an average daily water consumption of 255 L/capita/day in Tripoli's new residential "Dam & Farz" area. The final draft 2020 NWSS recognizes these differences and attributes the elevated consumption rates to the fact that consumers were still paying a flat rate, regardless of the volume consumed and thus had no incentive to conserve water.

In the final draft 2020 NWSS, the term 'water demand' was replaced with 'water needs' and the strategy forecasts that the 'water needs' will remain flat between 2020 and 2035. On the other hand, the new strategy estimates that the non-domestic consumption will amount to 20% of the domestic needs (i.e. an additional 25 L/capita/day). Physical losses from the system were assumed to be 50 L/capita/day). As such, the total 'water need' per capita, including industrial demands and network losses, was considered to be 200 L/capita/day. Total irrigated areas were estimated at 105,000 ha with an average annual water requirement of 8,400 m³/ha.

Table 3-10 shows the annual demand estimates for the years 2010 and 2020 assuming a resident population of 4.4 and 4.8 million, respectively. The adopted reduced daily water consumption rates in the final draft 2020 NWSS resulted in a marked reduction of the annual water demand from 1,473 MCM for 2010 to around 1,232 MCM in 2020, despite population growth and an increase in irrigated areas. This reduction is obviously due to decreased domestic and non-domestic demand estimates and improved network efficiency. It remains to be seen if these new estimates are closer to reality or not.

Table 3-10 Estimates of Annual Water Demand Based on 2010 and Final Draft 2020 NWSS Plans (in MCM)

Sector	NWSS 2010	Final Draft 2020 NWSS
	Year 2010	Year 2020
Domestic	505	
Industrial	152	350
Tourism	6	
Agriculture	810	882
Total demand	1,473	1,232
Assumptions		
Population	4.43	4.8*
Per capita consumption (L/d)	180	125
Network efficiency %	52	80
Irrigated area (ha)	90,000	105,000
Irrigation consumption (m^3/ha)	9,000	8,400
Industry demand (% of domestic)	30	20% of the domestic
Tourism demand (400 L/capita/day)	400	

* CAS/ILO, 2019

When comparing the estimated water demands of both the 2010 NWSS and the final draft 2020 NWSS, to the 2,700 MCM per year of net exploitable water available in Lebanon, shortages are not expected. Yet, in reality, chronic water supply shortages are faced across the country. This discrepancy between demand and supply is best perceived by comparing the amount of water supplied to a community with its actual demands. Table 3-11 presents the balance between the water supplied and the water needs by RWE for the years 2020 and 2035, as calculated in the final draft 2020 NWSS. These deficits are a result of both unexploited resources, supply inefficiencies and weak demand management.

Table 3-11 Current and Future Domestic Water Balances by Water Establishment

RWE	Volume Produced (MCM/year)*	Water Balance (MCM/year)**	
	2018	2020	2035
BMLWE	171	-44.52	-9.58
BWE	68	-8.68	-2.37
NLWE	106	-14.68	-27.17
SLWE	113	-19.87	-120.10
Total	458	-87.75	-159.21

* MoEW, 2019a; ** MoEW, 2019c

As can be seen, deficits range between as high as 44.5 MCM/year within the areas served by the BM-LWE to 8.7 MCM/year for the areas served by the BWE. The water deficit in the BMLWE is expected to contract in 2035, while it will deteriorate further for the NLWE and more significantly for the SLWE. The future improvement in the BMLWE is a result of the Awali Conveyor water supply augmentation project (details in Section 3.4.1). As a direct result of these chronic water deficits at the RWE level, customers suffer from water supply rationing. Currently, water supply services are provided on average for only nine hours per day but can reach three hours per day in the dry season. Many locations experience even lower water delivery rates, especially in the summer. As a result, households spend three times as much on sourcing water from private suppliers as they pay for their network water (Alameddine et al., 2018).

There is a need to augment existing water supplies, while at the same time improving water network efficiency and promoting water conservation measures that can reduce the demand down to the 'water needs' level with special consideration for water supplies destined to 'essential services', such as healthcare facilities, schools and public safety institutions. As part of the future plans that the MoEW has set to rectify this situation, the final draft 2020 NWSS proposes a prioritized list of new water sources for each water distribution district (Refer to Section 3.4.1). Yet, the implementation of any of these projects will depend on securing the necessary funds for construction, enhancing the cost recovery mechanism for operation and maintenance, engaging the private sector through public private partnerships (PPPs), social acceptability and mustering the needed political will to move these projects forward.

Household connections to the water system at the national level are estimated to be around 79%, which is slightly higher than the average for the Middle East and North Africa region (75%) (USAID, 2017). Water metering is relatively new in Lebanon and efforts are being made in order to increase their installation. In 2018, the number of deployed water meters was estimated to be around 280,000, more than 66% installed in the BMLWE serviced areas. Currently, water meters have been installed for around 31 to 45% of the subscribers within the BMLWE, BWE, and NLWE service areas. No reliable data exists on water metering within the SLWE. Billing remains largely based on charging a flat rate. As such, subscribers often complain about paying for water they never receive. The BWE currently charges only 10% of its metered subscribers based on their consumption rates, while the NLWE only charges based on actual consumption rates for large consumers. Although implementation of pilot water metering has proven to be successful (MoEW, 2019a), billing based on consumption remains an unresolved issue at the national level, particularly with regards to agreeing on a tariff structure that promotes conservation, while ensuring that it is progressive and assures equity and social justice.

Table 3-12 provides a general overview of the status of the RWEs in 2018, clearly showing the wide gap between the total population residing within the service area of each RWE and the population officially supplied by the establishment. This gap can be explained by the reliance of many households on private legal/illegal wells and on unlicensed connections to the network. The table also highlights the high unaccounted-for-water (UFW), which ranged between 30 and 55%. UFW includes water lost through both illegal/unknown connections and leakages in the network. Decreasing UFW is critical for the RWEs and should be given particular attention. In addition to leak detection and repair, transforming illegal connections into legal ones and introducing a metered delivery system are imperative to allow the RWEs to both reduce technical losses and to shore up their precarious financial status. Working on improving the distribution networks, as well as leak detection and repair, will help increase the available volume of water reaching the final users but will not add any revenue for the RWE in the absence of smart metering.

network (MoEW, 2012), with the majority of these networks discharging untreated wastewater into rivers and coastal areas. It is estimated that more than 53 wastewater outfalls exist along the Lebanese coastline line (MoE/UNDP/ECODIT, 2011). Regions that are not covered by wastewater networks still depend on cesspits that tend to pose a high pollution risk to groundwater due to seepage.

A major reason for the low rate of wastewater treatment in Lebanon is the lack of connectivity between the existing sewage networks and the operational treatment plants. It is thought that less than 30% of the population has a sewage connection that actually reached any of the operational treatment plants (GoL/UN, 2018). Given this situation, the discharge of untreated domestic and industrial wastewater is rampant across the country and is known to be a major source of water quality impairment for the country's coastal, freshwater and groundwater resources (See Section 3.2.2). In an effort to remedy this problem, Lebanon has proposed the construction of new wastewater treatment plants across the country and to continue with expanding the reach of the collection network, as part of its national strategy for the sector (refer to Section 3.4.2.2 for more details).

Table 3-12 Overview of RWEs in 2018

Description	BMLWE	BWE	NLWE	SLWE
Number of villages	533	250	457	385
Est. population of the service area	2,907,000	750,000	1,716,000	1,200,000
Number of subscribers/customers 2018	592,835	86,761	124,793	176,000
Est. population supplied	2,667,758	390,425	561,569	792,000
Est. population tapping water from unknown origin (%)	8	48	67	34
Number of actual employees	782	403	637	236
Estimated length of the network (km)	9,000	4,384	1,839	5,000
Estimated unaccounted for water (%)	40 - 30	48	46	55
Number of deployed water meters	185,960	38,400	56,266	NR
Estimated collection rate (%)	79	32	63	51

Note: Unaccounted for water % reported as per verbal communication from the RWEs. NR: Not reported
Source: MoEW, 2019a

3.2.4 Wastewater Generation

The MoEW published in 2012 the NSWS to complement the 2010 NWSS. According to the wastewater strategy, Lebanon produced in 2010 around 310 MCM of wastewater, of which 250 MCM were domestic and 60 MCM were industrial. Of the total generated wastewater, it was estimated that only 8% underwent treatment, although around 60% of the population was connected to a sewage collection

3.3 Key Actors, Laws and Regulations

This section describes key regulations and policies related to the water and wastewater sector in Lebanon. All laws and regulations pertaining to water resources in Lebanon are listed at the end of this chapter. In addition, an analysis of environmental legislation related to water and environment is presented in the State of the Environmental Legislation Development and Application System in Lebanon report (EU/UoB/MoE/ELARD, 2005). To review environmental jurisprudence cases related to water, wastewater and sea water please refer to MoJ/MoE/UNDP (2010).

3.3.1 Legal and Institutional Framework for Water and Wastewater

Although the MoEW, RWEs and LRA are the main governmental authorities responsible for management of the water sector as established by Law 221/2000, a significant number of actors are also involved. The Water Code, promulgated by Law 77/2018, has recently been amended by Law 192/2020. The amendment represents a substantial effort towards modernizing the legal, financial, and institutional aspects of the water sector. Article 7 of the law defined the MoEW as the entity responsible for managing public water assets. Article 17 gave the MoEW the responsibility of developing a general master plan for the sector that is based on an integrated water resources management approach that aims towards achieving sustainable management of water resources in Lebanon. The law states that the master plan should be developed in coordination with a set of ministries, including that of the Environment, Agriculture, Public Works and Transport, and Industry and then approved by the CoM. Article 56 of the law assigned the RWEs with the role of providing the necessary services for water use. Furthermore, Articles 14 and 15 stipulated the establishment of the National Water Council at the Prime Minister's Office that will be headed by the Prime Minister. The two articles also defined the roles of the council. Recently, an appeal was launched by several parliamentarians to the Constitutional Council to revoke these two articles as they conflict with the constitutional role of the Minister of Energy and Water and the CoM (Constitutional Council Decision 6/2020). The Constitutional Council deliberated on the issue and decided to revoke Clauses 1 and 5 under Article 15. The removal of these two clauses ensures that the role of the National Water Council remains only consultative in nature (Constitutional Council Decision 8/2020).

Some of the most important elements of Law 192/2020 include: 1) putting into effect the water register that allows public authorities to establish an inventory of water resources; 2) establishing the National Water Council; 3) enforcing a water masterplan; 4) defining the legal status of water basins; 5) developing basin management plans following an integrated approach; 6) outlining the founding principles of the legal conventions related to the water sector; 7) identifying the institutional, environmental, economic, and financial requirements, including tariffs and financial compensation in case of water pollution; and 8) proposing new tools to manage the water sector, including the legal possibilities for a PPP, as well as public-public partnerships with municipalities.

However, until the implementation decrees of Law 192/2020 are issued, the crowded institutional framework and policy environment will continue to negatively affect the management of water resources in the country. Table 3-13 lists the main governmental entities that are involved in the water and wastewater sector and summarizes their major responsibilities.

Table 3-13 Responsibilities of National Authorities in the Water Sector

	Responsibility	MoEW	RWE	LRA	MoE	MoPH	MoA	MoI	MoIM	CDR
Policy Making	- Definition of sector policy, institutional roles and structures - Enactment of legislation and regulation - Development of investment and subsidy policy	X[1]								
Planning and Implementation	- Establishment of long-term consolidated public plans for the utilization and distribution of water resources, and the preparation of the masterplan for water and wastewater [1]	X[1]		X[2]	X[3]					
	- Water rationalization	X[1]	X[1]	X[2]			X[4]			
	- Evaluation of infrastructure and investment requirement	X[1]	X[1]	X[2]			X[4]			X[9]
	- Designing, building, operating, and maintaining the potable and irrigation water transmission and distribution networks along with sewage treatment plants and collection networks	X	X[1]	X[2]			X[4]		X	
	- Seeking funding and managing the execution of plans and investment programs	X	X	X[2]			X[4]			X[9]
	- Environmental safeguarding for plans, programs, studies, and activities (SEAs, EIAs,/IEEs, EAs)				X[5]					
	- Implementation of groundwater artificial recharge	X[1]	X[1]	X[2]						
	- Allocation of resources across regions, e.g., water reuse	X	X	X[2]	X		X[4]			
	- Regulating water extraction	X[1]					X[4]			
	- Identification and promotion of water conservation campaigns	X	X	X[2]	X		X[4]			
Regulation and Enforcement	- Issuance and enforcement of regulations and standards for water resources protection, cost recovery, service quality, water quality, and consumer relation	X[1]		X[7]	X[8]	X[6]		X	X	
	- Licensing wells and all water extractions from groundwater, rivers, and public water resources	X[1]								
	- Tutelage and oversight of all public institutions working in the sector according to Law 2000/221 and the laws governing these institutions	X[1]								
	- Ensuring compliance of drinking water with local and international standards					X[6]				
Operation and Distribution	- Enhancing the operational performance of RWEs and monitoring their performance according to approved benchmarks - Setting the standards and benchmarks the RWE's will need to abide by in their design and operation of water supply, irrigation and wastewater systems	X[1]								
	- Ensuring the quantity and quality of the supplied water - Recommending tariffs on water and wastewater		X	X						
	- Maintenance and renewal of infrastructure		X	X						X[9]

	Responsibility	MoEW	RWE	LRA	MoE	MoPH	MoA	MoI	MoIM	CDR
Control and Monitoring	- Conducting continuous hydrological, geological, and hydro-geological research, studies, data gathering and mapping pertaining to the water sector	X[1]	X[1]	X[2]						
	- Implementing service quality and contingency planning	X[1]	X[1]	X[2]						
	- Monitoring the quality of water resources and set relevant quality standards	X[1]		X[7]						
	- Monitoring drinking water quality		X			X[1]				

[1] Law 221/2000 and its amendments (Laws 241/2000 and 337/2001)
[2] The LRA is responsible to manage the LRB and expected to (1) plan and operate all potable, irrigation and hydro-electrical schemes associated with the Litani River, (2) measure all surface flows throughout the country, and (3) establish and operate hydroelectric power plants on the Litani River. Article 7 of Law 221/2000 affirmed that irrigation water schemes tied to the Litani River is under the control of the LRA.
[3] Law 444/2002: MoE reviews the SEA of any plan or program for the sector, including the NWSS, to ensure that related environmental issues are considered. The SEA shall be used as a decision-making tool for issuing any plan and shall facilitate the preparation of the Environmental Impact Assessments (EIAs) for specific components of the plan.
[4] Legislative-Decree 31 (dated 18/01/1955) and its amendments: MoA regulates the distribution of irrigation water and ways to use it and monitors the implementation of these regulations. MoA maintains some influence over small-scale irrigation projects including hill lakes and sustainable water management projects through the Green Plan.
[5] Environmental considerations safeguarded by the MoE via Decree 8213/2012: SEA of policy, plan and program proposals in the public sector, Decree 8471/2012: Environmental compliance of establishments, and Decree 8633/2012: Fundamentals of EIA
[6] MoPH monitors drinking water to ensure compliance with local and international standards. The ministry monitors the incidence of waterborne diseases and publishes related epidemiological data. Article 35 of Decree 8377/1961 on the organization of the MoPH stipulates that the Sanitary Engineering Service is responsible for … (ii) proposing the technical specifications and conditions to be met for the construction of public and private sewers and drinking water network construction projects.
[7] The LRA has been coordinating with the MoE and MoI to close, relocate, or enforce the installation of small-scale package treatment plants on polluting facilities close to the Litani River. The LRA has also established a water quality monitoring program that assesses the water quality of the Litani River and Qaraoun reservoir.
[8] MoE has set standards for water quality suitable for aquatic life and for swimming (Decision 52/1 dated 29/07/1996) and for wastewater discharged into sewers and surface waters (Decision 8/1 dated 30/1/2001). In 2016, MoE's policing role was finally instituted by Decree 3989 (dated 25/08/2016), which established the Environmental Police. The EIA Decree 8633/ 2012 considers springs, riverbanks, waterways, watersheds, maritime public domain, as sensitive areas and requires an environmental assessment study for projects that may have an impact on such areas, which requires MoE approval.
[9] CDR was established in 1977 (Legislative-Decree 5/1977) and is responsible for securing funding for projects (including water and wastewater), managing construction of facilities and infrastructures, supervising the execution of plans and contributing to the rehabilitation of public institutions.
Source: Kerkezian and Farhat, 2016

3.3.2 Multilateral Environmental Agreements

Lebanon is a signatory to several multilateral environmental agreements related to the water sector that include:

- The Convention for the Protection of the Mediterranean Sea against Pollution-Barcelona (ratified in 1977)
- The International Convention for the Prevention of Pollution from Ships-London (ratified in 1983)
- The Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources-Athens (ratified in 1994)
- The Convention on Wetlands of International Importance-RAMSAR (ratified in 1999)

3.3.3 Policy Formulation and Development

For decades, the development of the water sector in Lebanon has been hampered by the absence of an official public policy governing the sector. Law 221/2000 and its derivatives were the first clear policy initiatives addressing the institutional setup of the sector. However, the impact of this law has not been fully realized (MoE/UNDP/ECODIT, 2011). The adoption of the NWSS and the NSWS in 2012 by the CoM followed by the promulgation of the Water Code in 2018 (Law 77/2018 amended by Law 192/2020) were expected to improve the situation by reducing overlap and inefficiencies within the sector. However, both local and regional challenges over the past 10 years have shifted the focus of the MoEW from implementing its strategy to emergency response. Furthermore, the current economic crisis and the political tensions threaten to delay any progress in this sector. Moreover, without a serious effort towards real reform in the country's governance and rebuilding the lost trust between the public institutions and the Lebanese citizen, the execution of the NWSS will be jeopardized (Farajalla et al., 2015).

In 2015, a SEA was developed for the 2010 NWSS. The SEA identified 12 key environmental, social and economic issues likely to be affected by the proposed water and wastewater projects identified under the NWSS (Table 3-14). Priority recommendations were also presented to integrate the SEA findings in the updated NWSS (Plan Bleu/MoEW, 2015). A new SEA is planned for the final draft 2020 NWSS that will be developed based on the 2015 SEA and the 12 defined issues (Table 3-14). The final draft 2020 NWSS includes new recommendations beyond what was analyzed in the 2015 NWSS SEA (MoEW, 2019b). Adding a key issue related to reduction of greenhouse gas emissions in the water sector in the SEA update would be in line with Lebanon's commitments to climate change mitigation *(Refer to Chapter 9 on Climate Change and Energy)*.

Table 3-14. Key SEA Issues Associated with the NWSS

SEA Key Issues	Water		Wastewater
	Production	Distribution	
Climate Change Adaptation	✓		
Effects on Ecology and Ecosystems	✓		✓
Effects on Marine Environment and Coastal Waters	✓		✓
Effects on Underground Water and Karst	✓	✓	✓
Water-Energy Nexus	✓	✓	
Man-Made Water Bodies and Buffers	✓		
Catastrophic Failure and Emergency Planning	✓		✓
Water-Poverty Nexus		✓	
Treated Sewage Effluent and Sludge Reuse		✓	✓
Construction and Excavation Waste	✓	✓	✓
Operation and Maintenance	✓	✓	✓
Transboundary Waters	✓		

Source: Plan Bleu/MoEW, 2015

At a more local level, and as per Box 3-3 on the LRB and the Qaraoun Reservoir, a business plan for combating pollution of the Upper Litani watershed was published in 2011, and a similar one for the Lower Litani Watershed in 2020. Moreover, and in response to the Barcelona Convention and the 1980 Protocol for the Protection of the Mediterranean Sea from Land-based Pollution, a second National Action Plan (NAP) was developed by the MoE in 2016 in coordination with all relevant stakeholders. Some of the main elements of the NAP included upgrading the existing wastewater treatment plants (WWTPs) to secondary treatment, rehabilitating and expanding the sewer networks, and providing the necessary training and capacity building programs for the concerned ministries and institutions.

With regards to industrial wastewater, in 2013, a Policy Paper and Action Plan targeting Industrial Wastewater Management and Compliance was developed by the MoE and CDR and with financial support from the Government of Germany. The action plan identified 4 main steps: (1) setting compliance deadlines for priority industries and existing establishments that are considered as pollution hotspot; (2) strengthening the environmental requirements of the permitting system for new industrial establishments; (3) moving from end-of-pipe treatment to cleaner production, and (4) promoting environmental monitoring and enforcement. In addition, the European Investment Bank in 2018 funded the Industrial Wastewater Assessment in Al Ghadir to establish a baseline assessment of the industrial and non-classified establishments within the Ghadir River watershed area and to develop an industrial pollution abatement program for the watershed (EIB/MoE/Enviroplan/Ecocentra, 2018).

3.4 Selected Responses to Water Issues

In an effort to respond to the mounting challenges faced in the water sector, the GoL has initiated and proposed several projects that aim to increase water availability and improve system efficiency, protect water resources, and improve service delivery. The final draft 2020 NWSS provides a detailed summary of most of these projects. Moving forward, the involvement of the private sector in the execution of these projects is needed to counterbalance the expected contraction in public spending over the near future. As can be seen in Box 3-4, the projected costs associated with no action far exceed those associated with the identified selected responses.

Box 3-4 The Cost of No Action versus Investment in the Sector

In this exercise, the costs of implementing some of the priority projects of the NWSS to the cost of extending the status quo are compared. The Cost of Environmental Degradation Report estimates the annual loss from the status quo, i.e. the failure to implement any improvements in the water sector, to be 1.1% of GDP. This estimate includes costs associated with water-borne diseases from unimproved water, sanitation and hygiene (0.2% of GDP) and of degradation in water resource quality (0.2% of GDP) and quantity (0.7% of GDP). In this calculation, it is assumed that the share of unaccounted for water in Lebanon is 40%. An additional environmental loss resulting partly from poor wastewater management is the degradation in marine ecosystems, estimated at 0.1% of GDP (MoE/UNDP, 2019). Meanwhile, the final draft 2020 NWSS identifies a number of priority projects to implement in the next five years on water, wastewater, irrigation, dams and hill lakes, as well as set of policies and steps to enhance governance, monitoring and management in the water sector, including surface and ground water resources. In the comparison between priority interventions as set by the national strategy and the status quo, projects that directly address the costs included in the Cost of Environmental Degradation Report were included. These are priority infrastructural projects to improve water provision (US$ 1,269 million) and wastewater treatment (US$ 1,424.6), initiatives to enhance governance (US$ 12.9 million) and improve surface (US$ 15 million) and ground water management (US$ 8.5 million) over the next five years. Implementing these projects will limit the losses from environmental degradation and improve public health. Assuming that the projects are rolled out over a 5-year period and that losses are averted gradually as the projects are rolled, the following will likely occur:

1. Enhancement of wastewater treatment
   - Eliminates costs related to water-borne diseases
   - Halves losses to marine biodiversity
2. Design of the enhancement and infrastructural improvement projects for water provision and distribution
   - Reduce non-revenue water from the current level of waste to 25%, leading to a proportional mitigation in costs associated with quantity degradation
3. Proposed upgrade, treatment and management projects
   - Improve the quality of water so that the annual loss of deteriorated water quality is also averted

Since the cost of economic degradation is linked to the degree of economic activity (GDP), the 10-year macroeconomic impact of implementing these projects depends on future trends in GDP. Two scenarios were considered:

1. A conservative scenario of an average annual growth rate of GDP of 2% over the next decade
2. A more optimistic scenario of an average annual growth rate of GDP of 3% over the next decade

In the more conservative scenario, implementing these priority projects would lead to net economic savings in the decade between 2020 and 2030, as long as operating costs of the infrastructural projects is below 4.7% of the project costs. In the more optimistic scenario, the projects will lead to net economic savings with operating costs of up to 7.4%.

3.4.1 Increasing Available Water Resources and Improving System Efficiency

After the end of the Civil War, the GoL launched a long-overdue plan to rehabilitate and upgrade the existing water infrastructure. However, these efforts were unable to meet the growth in demand, particularly with the influx of displaced and refugees, and thus chronic water shortages remain a way of life (GoL, 2018). In the 2010 NWSS, the MoEW proposed a comprehensive plan for the sector targeting transmission, distribution and supply. Several of these projects were completed, some remain at different levels of execution, while many are still not implemented. In the final draft 2020 NWSS, the MoEW embarked on reevaluating the previously proposed projects based on current needs and generated a new list of projects (Table 3-15).

The 2010 NWSS had proposed around 40 dams and hill lakes with various storage capacities. Of those, four new dams and lakes were constructed over the past ten years. Six new dams are currently under construction (refer to Section 3.2.1.2). In the final draft 2020 NWSS, all unexecuted dams from the 2010 NWSS were reassessed following a detailed water balance study conducted at the water district level, which led to reducing the number of proposed dams from around 26 dams down to 16. These dams were also assigned a priority score to reflect the urgency of their implementation (Table 3-16) (MoEW, 2019d). It is worth noting that there has been a public outcry recently against the construction of dams, with those questioning their viability and adverse impacts on the environment, the financial position of the country, as well as health and safety concerns. Many of these concerns should be properly addressed in the required EIA studies and related ecological compensation or offset plans that should be prepared before commencing construction works.

Table 3-15 Summary of Proposed Transmission Lines, Distribution Networks, Wells, Reservoir, and Pumping Stations under the Final Draft 2020 NWSS

Water Establishment	Transmission Lines (km)	Distribution Network (km)	Number of Reservoirs	Number of Wells	Number of Pumping Stations	Proposed Priority [1]
BMLWE	268	1,956	46	13	5	Priority 1
	115	665	67	18	11	Priority 2
	18	190	2	9	0	Priority 3
BWE	19,407	38,360	20	19	3	Priority 1
	11,083	243,634	9	26	1	Priority 2
NLWE	456	1,055	168	107	14	Priority 1
SLWE	535	1,926	170	9	40	Priority 1
	70	0	0	3	0	Priority 2

[1] Priority 1: urgent projects to be implemented as soon as can be, Priority 2: projects that are required but could be delayed, Priority 3: projects that would be required in the future
Source: MoEW, 2019d

Table 3-16 Proposed Dams under the Final Draft 2020 NWSS

Dam	Priority	Static storage (MCM) - Dynamic Storage (MCM/year)	Use
BMLWE			
Ain Dara - Azounieh Dam	3	4.1-5	Potable
Damour Dam	2	42-106	Potable/Irrigation
Maaser Chouf Dam	3	2.2-2.2	Potable
BWE			
Assi Phase I Dam[1]	1	63-63	Potable/Irrigation
Assi Phase II Dam	2	37-15	Potable/Irrigation
Massa Dam	3	8-8	Potable/Irrigation
Younine Dam	3	5.8-5.8	Potable/Irrigation
NLWE			
Atolbe Dam	3	0.7-0.7	Potable
Dar Baachtar Dam	3	7-7	Potable/Irrigation
El Bared Dam	1	37-90	Potable
Noura el Tahta Dam	3	35-50	Irrigation
Qarqaf Dam	3	20-25	Irrigation
Rahwe Dam[2]	3	2.2+2[2]-3.5	Potable/Irrigation
SLWE			
Choumariye Dam	3	28-28	Potable/Irrigation
Ibl es Saqi Dam	2	50-50	Potable/Irrigation
Khardali Dam	3	120-120	Potable/Irrigation

[1] Already under construction the proposed priority includes completion of execution works and supervision of works
[2] Providing additional storage capacity
Source: MoEW, 2019c

Over the past 10 years, one of the most important water supply initiatives in Lebanon was the Greater Beirut Water Supply Project, which has been under consideration since the 1970s. The project aims to reduce the water deficit in the Greater Beirut Area (GBA) through securing new sustainable potable water sources from the Awali and Litani rivers. Phase I of the project is the Awali-Beirut Water Conveyor that is expected to supply the GBA with 250,000 m^3/day. The project includes the construction of two water tunnel conveyors with a combined length of 24 km, two twin transmission pipelines of a combined length of 10.3 km, three regional reservoirs with a 100,000 m^3 cumulative capacity, and the Wardanieh water treatment plant (capacity of 250,000 m3/day) (World Bank, 2018). Phase II of the project envisions the construction of the Bisri dam and connecting it to the conveyance tunnel to provide an additional 125 MCM of water to the GBA during the dry season. While the works of Phase I have progressed, work on Phase II has been halted by the WB in response to civil society campaigns opposing the project (Box 3-5).

Box 3-5 Bisri Dam

The proposed Bisri Dam is planned on the Bisri River, around 15 km east of the Mediterranean coastline. The location is around 35 km south of Beirut, immediately upstream of the village of Bisri, at an elevation of 395 m above sea level, extending about 4 km upstream of the dam axis before forking northwards along El-Barouk River and southwards along Wadi Bhannine. At maximum water level, the dam will inundate around 4.34 km^2 of land (CDR, 2014). The construction of Bisri dam was first envisioned in the 1950s. Since then, several prefeasibility studies were undertaken up until the early 1980s. In 1995, a feasibility study and site investigations were finalized. The construction of the dam became an integral part of the 2010 NWSS. The project aims to store 125 MCM of water, which will be used to secure the demands of around 1.6 million residents in the GBA during the summer season. The reservoir is designed to fill up naturally from the flow of the Bisri River during the rainy season. The water will then be carried to the GBA by gravity through a 26 km underground tunnel. Before distribution, the conveyed water will be treated at the Wardanieh water treatment plant. The expected construction period of the dam was estimated at around 5 years; however, construction works have not started yet. The project was originally funded through a US$ 474 million WB loan, an Islamic Development Bank loan (US$ 128 million) and by the GoL (US$ 15 million). The WB approved the project loan on September 2014, following the conditional endorsement of the ESIA by the MoE (CDR, 2014), and accordingly an ecological offset study was undertaken in consultation with stakeholders and completed in 2020. The Bisri Dam project has received fierce opposition by some experts, civil society, and lately some political parties. Opposition focused on several assertions, including 1) the biased dismissal of potential alternatives (e.g. expanding the conveyance capacity of the El Kaleb River/Jeita to Beirut system, increasing exploitation of groundwater resources and reducing non-revenue water[1]), 2) the safety risks associated with the seismicity of the area, 3) the poor suitability of the site to effectively store water given its karstic nature, 4) the failure to understand and account for the potential impacts of climate change on the operations of the dam, 5) the dismissal of the health risks associated with the quality of the procured water[2], 6) the irreversible environmental and cultural damages that the project will have on the study area, 7) the focus of MoEW on supply management rather than on demand management, 8) the lack of transparency in the tendering of works and political nepotism, and 9) the negative impacts that the additional loans will have on the ballooning public deficits. It is perhaps accurate to assume that the strong opposition to the Bisri Dam is partly due to a general shift in the public's opinion with regards to the soundness and effectiveness of previously executed dams in the country (e.g. the inability of the Brisa dam in North Lebanon to store water and the developments of cracks in the Msailha Dam in 2019-2020) and an overall loss of trust in the country's government institutions. Aside from the ongoing debate on the technical, social, environmental, and fiscal worthiness of the Bisri Dam, it should be made clear that opting for a "do nothing scenario" from the supply side in the GBA will be associated with significant socio-economic costs that are associated with an intensifying SWI problem along the coastline and increasing the dependence of the population on often informal, unimproved, expensive, and/or unsafe water resources (Rachid et al., 2021).

The future of the project is currently uncertain as on the 5th of September 2020, the WB notified the GoL that the funds for the Water Supply Augmentation Project (Bisri Dam Project) have been cancelled following the non-completion of prerequisite tasks to the commencement of construction works.

3.4.2 Protecting Water Resources

In the last ten years, responses for the protection of water resources in Lebanon in terms of quantity and quality included water conservation and wastewater treatment projects that were implemented throughout the Lebanese territory.

3.4.2.1 Water Conservation

Several initiatives have been implemented in Lebanon to demonstrate the feasibility of alternative options of water supply such as collecting rainwater and using it for domestic or agriculture purposes. At the household-level, ACTED, as part of the Water Access and Development Consortium and with support from the European Union (EU) MADAD project, introduced and implemented a rainwater harvesting pilot program in 2018 in Berqayel-Akkar. The program aimed to provide a simple yet effective, feasible, and decentralized solution to address the water needs of the most vulnerable families in Berqayel. The system consisted of transferring rooftop rainwater directly to a nearby reservoir, which would then provide water to households. By the end of 2018, 35 rainwater harvesting systems had been installed, benefitting over 100 families in Akkar. According to ACTED, these projects reduced expenditure on water by as much as US$ 100 per month per household in the target areas (ACTED, 2020). Rainwater harvesting projects have also been implemented to supply water for the agriculture sector. These projects consist of collecting rainwater falling on agricultural greenhouses, the construction of hill lakes or earth lakes, and diverting runoff to fields. Such activities were predicted to increase agricultural revenues by US$ 4 million per year and secure water availability during the dry season (MoE/URC/GEF, 2012). A pilot project that aims to harvest rainwater from the tops of agricultural greenhouses was implemented by the MoE in collaboration with UNDP and from which a set of national guidelines to promote greenhouse rainwater harvesting was published. Furthermore, since the initiation of the Green Plan in the 1964, hundreds of hill lakes in several localities in Lebanon have been constructed to harvest rainwater (MoE/URC/GEF, 2012). Eight new hill lakes in the governorates of Akkar, Baalbek-Hermel, and the Bekaa are in the process of being constructed, while other are being rehabilitated, through the "Programme d'Appui à la Résilience Sociale, aux Infrastructures, à la Forêt et à l'Agriculture au Liban" project funded by the French Development Agency. The total volume of these hill lakes is expected to be around 282,000 m^3.

[1] The technical and economic feasibility of these alternatives will need further in-depth analysis.

[2] There is a public misconception that water from the Qaraoun Dam will be stored in the Bisri Dam. In reality, part of the water stored behind the Qaroaun Dam will reach the Awali-Joun Reservoir after getting mixed with water from the Ain Zarqa Spring and springs in the Jezzine caza. The Awali-Joun Reservoir will also receive the water to be stored behind the Bisri Dam. The mixed water from both sources in the reservoir will be sent to the GBA through a tunnel that connects the Awali-Joun Reservoir to the Wardaniyeh water treatment plant.

3.4.2.2 Wastewater Treatment

The open discharge of untreated wastewater continues to degrade water quality and thus compromise both the state of the environment and human health. Although Lebanon has launched several water pollution prevention and reduction projects over the years- including plans to upgrade existing WWTPs, rehabilitate and/or install sewer networks and collectors, and construct new WWTPs- the implementation of most of these projects has been slow and hindered by procurement, expropriation, operational, financial, judicial and political constraints. In Lebanon, there are currently 78 WWTPs that are distributed amongst the four RWEs, with the majority of these plants located within the SLWE and the NLWE service areas. Most of these plants are small in scale and were built by non-governmental organizations through international funding. Unfortunately, data on the performance of these plants is largely lacking, particularly for the small-scale treatment units. As for the large scale coastal WWTPs, with the exception of Al Ghadir plant, all were designed and constructed to provide secondary treatment; however, they currently only operate as preliminary treatment facilities.

Currently, eleven new WWTPs are under construction and are expected to provide an additional capacity of 128,256 m^3/day. Moreover, the MoEW has proposed in the final draft 2020 NWSS the construction of an additional 181 WWTPs across the country, with a total additional capacity of 892,769 m^3/day. Table 3-17 provides a comprehensive summary of the status of all existing, under-construction and planned WWTPs in Lebanon by RWEs. Meanwhile, Annex 5 provides a summary of the WWTPs with a design capacity greater than 10,000 m^3/day. The summary is based on the RWE, their operational status and their treatment technology. If all plants are constructed and operated, then the total national capacity will reach 673.7 MCM/year, which is more than twice the current estimated wastewater generation rate in the country (310 MCM/year). This additional capacity will ensure that these plants are able to handle the projected growth in volumes during their projected service years. Ultimately, the proper operation of these WWTPs will be largely contingent on the ability to fund their running costs and to staff them with qualified personnel. The difficulties faced by the operators of the Zahle treatment plant due to the lack of an efficient cost recovery system has hin-

Table 3-17 Status of WWTPs in Lebanon across Water Establishments

Stage	Process	RWEs														
		BMLWE			BWE			NLWE			SLWE			Total		
		E	UC	P	E	UC	P	E	UC	P	E	UC	P	E	UC	P
PRI	PT	1												1		
SEC	AS	1		1	1		6	1	1	2	1		1	4	1	10
	AT										1			1		
	TF				1		1			10				1		11
	TF&AS	2												2		
	MMBR	1												1		
	BF			1												1
	MB			1												1
	RBC									1						1
TER	AS + NR				1				1					1	1	
	AS + UV	1												1		
Others	RB	12	2	27	7	2	17	20	3	72	20	2	19	59	9	135
	Wetland									13	2			2		13
Unknown			5	1		1	3			1		3	5		9	
Total		18	2	35	11	2	25	24	5	98	25	2	23	78	11	181
Grand Total		55			38			127			50			270		
Total Capacity (m^3/day)														**1,845,690[1]**		

E: Existing, UC: Under Construction, P: Planned, PRI: Primary; SEC: Secondary; TER: Tertiary,
PT: Preliminary Treatment, AS: Activated Sludge, AT: Aeration Tank, TF: Trickling Filter,
MMBR: Moving Bed Biofilm Reactor, BF: Biofilters, MB: Membrane Bioreactor,
RBC: Rotating Biological Contractors, NR: Nitrogen Removal, RB: Reed Bed
[1]of the 1,845,690 m^3/day total capacity, only 824,664 m^3/day are operational; 128,257 m^3/day are under construction and the rest are planned

dered the provision of appropriate skilled personnel, human capacity, as well as equipment and other operating costs. These difficulties provide a glimpse of the challenges that lie ahead, which is also associated with the absence of a wastewater tariff scheme. The 2010 NWSS identified policies and targets for the introduction of new wastewater tariffs to recover operation and maintenance costs by 2014 and 2021, respectively. In fact, the new wastewater tariff was planned to be introduced initially in 2011 (25% of the water supply tariff) to pilot areas (MoEW, 2012). However, this scheme was not adopted. Moreover, the final draft 2020 NWSS proposed the adoption of wastewater fees through the introduction of an additional fee that will be proportional to the water consumed by a household. The plan also recommended establishing a wastewater fee for all households that are not subscribed to the WEs (MoEW, 2019a).

In addition to domestic wastewater, Lebanon suffers from the discharge of untreated industrial wastewater into the environment. Industrial wastewater is estimated to account for around 20% of the total amount of wastewater generated in the country (MoE/MoI/UNEP, 2015). While the country has around 133 designated industrial zones, none of these zones has been designed or equipped with the needed infrastructure to properly manage the generated industrial wastewater and comply with the national standards (Mawla, 2016). Moreover, many industries are located outside of these zones, which renders managing industrial wastewater more difficult. In the past 10 years, several efforts have been initiated to reduce the sources of industrial pollution both by guiding and supporting the industrial sector technically and financially to comply with emission limit values (MoE Dec 8/1/2001) (Table 3-18). Several of these initiatives have also worked towards establishing a comprehensive database on the industrial sector.

Table 3-18 List of Implemented Initiatives (Projects and Plans) Targeting Industrial Pollution

Type	Initiative	Description
TA/I	Lebanon Environmental Pollution Abatement Project (LEPAP) (2014-ongoing)	- A joint initiative between the MoE, the WB, Banque du Liban, the Italian Agency for Cooperation Development and UNDP in coordination with the Ministries of Finance and Industry, CDR, Association of Banks in Lebanon, Association of Lebanese Industrialists and Federation of Chambers of Commerce, Industry and Agriculture - Set up a mechanism to finance the abatement of industrial pollution in targeted industrial enterprises and to provide necessary technical assistance for ensuring the implementation and the sustainability of these interventions - As of September 2020, more than 8 industries have benefited from the soft loans (with a disbursement exceeding US$ 11 million) and 69 benefited from technical assistance out of which 8 implemented their projects under LEPAP financing, 17 implemented their projects through other financing resources and 6 are currently finalizing their technical assessments and financial applications and will be moving to implementation in the coming few months (either through LEPAP financing or their own resources).
TA/I	Local Development Programme along LRB (2018-ongoing)	- EU-funded Programme implemented by the Economic and Social Fund for Development - Supports small and medium sized industries in the LRB to become environmentally compliant by providing subsidized loans and technical assistance (European Commission, 2017; UNDP, 2020)
TA/I	WELI Project (2017- 2019)	- Funded by USAID as part of the Lebanon Water Project and implemented by DAI in partnership with the Association of Lebanese Industrialists - Provided technical assistance and equipment to the marble and granite industry that resulted in water conservation measures, wastewater volume reduction and wastewater quality improvements

Type	Initiative	Description
TA	Lebanese Cleaner Production Center (2002-ongoing)	- Originally supported by the European Commission-LIFE Programme, United Nations Industrial Development Organization (UNIDO), the Austrian Government and MoE, international funding ceased by 2013 - Aims to reduce the negative environmental impacts of industrial production, mainly by encouraging sustainable and continuous application of cleaner production by the industrial sector - Targeted the agro-food and canning, dairy, paper & cardboard, plastic production & recycling, olive oil milling, and textiles sectors
TA	SwitchMed I-Med TEST-II project (2015 – 2017)	- Financed by the EU and implemented by the IRI under the technical oversight of UNIDO in partnership with the MoI, the MoE, and in collaboration with other stakeholders - Demonstrated the business case of industrial resource efficiency by using the UNIDO TEST Methodology on 8 assisted industries. The identified resource efficiency measures were able to reduce the volume and improve the quality of the generated wastewater through Chemical Oxygen Demand (COD) and BOD reductions - Developed a roadmap to upscale the implementation of industrial resource efficiency in Lebanon and conducted capacity building to 78 professionals from environmental consultancy companies, government institutions and industries on resource efficiency
TA	SwitchMed II -Med TEST-III project (2019 – on-going)	- Funded by the EU and implemented by UNIDO in partnership with the MoI and MoE and in collaboration with other stakeholders - Aims to upscale the adoption of industrial resource efficiency in Lebanon by developing a monitoring system at the industrial zone level for assessing resource efficiency indicators - Mainstream the concept of resource efficiency and cleaner production in relevant environmental legislation and develop guidelines on safe management of chemicals in industry
Plan	Sustainable Consumption and Production (SCP) Action Plan for the Industrial Sector (2015-ongoing)	- Developed by MoE in partnership with MoI with support from UN Environment as part of the of SWITCH-Med I program funded by the EU - Objectives: (1) adopt Best Available Techniques to promote SCP in the industrial sector, (2) introduce SCP approaches related to the industrial sector in the policy and institutional frameworks, and (3) educate and raise the awareness of consumers on SCP in the industrial sector (MoE/MoI/UNEP, 2015)
Data-base	Industrial Statistics (2013)	- Established a scheme and database to record industrial information such as permits, type, contact information, geographic coordinates and ownership - Applied a classification system to industrial activities (Mawla, 2016)

TA: Technical Assistance, I: Investment

3.4.3 Improving Service Delivery: Public Private Partnerships

In 2017, Lebanon ratified Law 48/2017 for Regulating Public-Private Partnerships. The passage of the law is expected to encourage PPPs in various sectors including water and wastewater (USAID, 2018). PPPs are expected to attract funding for projects identified in the final draft 2020 NWSS, while helping the financial sustainability of the RWEs. Up until now, the active participation of the private sector in water and wastewater delivery has been slow. Most PPPs are small in scale and are limited to service contracts that are awarded to private small-medium enterprises that are contracted to provide specific tasks, such as operating and maintaining pumping stations and WWTPs. Other PPPs have been in the form of short-term contracts to provide technical and human resource support to the RWEs, which lack these resources (EU/MoEW, 2017). Long before the ratification of Law 48/2017, two elaborate PPPs had been implemented in the water sector. In 2003, the Tripoli Water office (now part of the NLWE) launched the first PPP, a service and management contract for drinking water services in the urban area of Tripoli that spanned 4 years. The project involved first the construction of the needed infrastructure (enlargement of the water treatment plant of Bahsass, extension of the secondary and tertiary network of Tripoli), as well as providing institutional support to the establishment. During the contract duration, the relationship between Tripoli Water office and the private company (Ondeo) was strenuous, largely due to the absence of a clear legal framework to govern the PPP. As a result, the contract was not renewed. In 2007, the SLWE awarded a 3-year contract to a private company to operate the financial and accounting systems of the establishment. The SLWE was supported by the Lebanon Water Policy Project financed by USAID in the preparation of the contract. While these two PPPs can be considered as successes, the Awali conveyor PPP failed, due primarily to differences in the interpretations of the legal framework needed for issuing a build operate transfer (BOT) contract (EU/MoEW, 2017).

Following the passing of the PPP Law, the GoL developed a Capital Investment Program (CIP) that was unveiled at the CEDRE conference in Paris in April 2018. The CIP aims to address the challenges facing the water and wastewater sector in Lebanon through facilitating PPPs with a focus on infrastructure development and rehabilitation. It is estimated that the total cost of the first phase of the CIP will exceed US$ 10.8 billion, of which 35% are expected to come from private investment. During the conference that was organized by the Higher Council for Privatization in Beirut in March 2018, the CIP proposed three water sector projects (dams with associated water treatment plants, transmission lines and reservoirs) and five wastewater sector projects (wastewater treatment plants with collection and conveyance systems) as potential PPP opportunities (HCP, 2018).

3.5 Emerging Issues and Outlook

Anthropogenic pollution of the surface and groundwater resources in Lebanon and their mismanagement are threatening their long-term sustainability. Moving forward, there is a pressing need to adopt a path that aims to protect these water resources by avoiding polluting activities and regulating their use, exploring the potential of new unconventional resources, as well as decreasing demand. Future management of water and wastewater will need to be approached from an integrated river basin management perspective that focuses on finding synergies and identifying critical paths within a basin. This approach also allows for reinforcing the link between effective water management and socio-economic decisions that are made in the basin, thus emphasizing the benefits of protection and conservation as compared to investments in expensive water treatment options or non-conventional water sources. Moreover, WHO has recommended the implementation of water safety plans as an effective means of ensuring the safety and acceptability of a drinking-water supply. These plans are risk-based assessments of water quality from catchment to consumer. Their implementation is being piloted in Lebanon with UNICEF support but will need to become a more widely adopted strategy for water protection. The recent BGR project (Refer to Box 3-2) is a good example of such an approach and should be considered as an important starting point that needs to be replicated at the national level, even though the project questions the validity of defining river basins solely based on surface water flow. Nevertheless, the weakest link of adopting such an approach will remain in how these findings and recommendations can be translated into actual enforceable policies that regulate land use and manage water and natural resources within the basins across spatial scales and between the different hierarchies of authority and jurisdictions. Hence, it is important to ensure that the Qaraoun Lake Committee, which was established in 2014 (See Box 3-3) to mitigate water pollution in the ULRB, succeeds in its mandate, while its shortcomings and the main impediments are properly identified, studied and resolved.

3.5.1 Alternative Water Resource and Augmentation Options

The following sections present alternative and efficient water supply options including managed aquifer recharge, rainwater and dew harvesting, desalination and wastewater reuse that are essential components of the holistic and sustainable water management needed in Lebanon.

3.5.1.1 Managed Aquifer Recharge

Managed aquifer recharge (MAR) is an effective approach that can reduce water stress when implemented at a suitable site (Dillon et al., 2014). Both the 2010 NWSS and its final draft 2020 update have identified MAR as an integral measure towards increasing groundwater resources. It has been estimated that MAR can potentially provide between 100 to 200 MCM from natural sources and an additional 100 MCM from reclaimed wastewater. In addition to providing an alternative approach for water storage and subsequent recovery, MAR can retard the progression of SWI if implemented at specific coastal aquifers (MoEW/UNDP, 2014). Studies assessing the potential of MAR in the largely karstic Lebanese aquifers are still limited and not fully developed. Moreover, MAR in karstic and highly fractured aquifers, which dominate in Lebanon, is challenging due to their complex hydrodynamics. In 2014, a national assessment of MAR suitability was conducted (MoEW/UNDP, 2014). The study identified 12 groundwater basins as suitable for MAR activities based on aquifer water stress, storage capacity and depth to the water table. Twenty-two sites in these basins were selected as suitable for recharge with natural water from springs and streams. The study also identified another 10 sites as suitable for recharge with treated wastewater (Figure 3-4). A multi-criteria decision analysis framework for ranking MAR sites was more recently proposed by Rolf (2017).

Furthermore, several feasibly studies have been conducted for specific locations (BTD, 2016a, b, c; GIZ, 2015). Currently, no fully functioning MAR project has been successfully implemented in Lebanon, while the policies needed to regulate it have yet to be written and approved (Khadra and Stuyfzand, 2020). More recently, the Dutch government funded a pilot project in the Bekaa. The project has drilled an exploration well in Khirbet Qanafâr (West Bekaa caza) to quantify MAR potential in the Miocene conglomerates (Khadra and Stuyfzand, 2020). Yet, the project faces opposition from the LRA that insists on ensuring that none of the generated runoff in the upper Litani basin is diverted away from the Qaraoun Dam.

3.5.1.2 Rainwater and Dew Harvesting

In the MoE's Technology Needs Assessment for Climate Change study, rainwater harvesting was identified as a promising adaption technology for Lebanon (MoE/URC/GEF, 2012). Rainwater harvesting includes the construction of hill or earth lakes, collecting runoff in urban areas, as well as collecting rainwater from roofs. Rainwater harvesting projects for both domestic and agriculture supply are being implemented in several regions (Refer to Section 3.4.2.1). In an effort to increase the adoption of these projects, national guidelines for domestic rainwater harvesting systems were published in 2016 (MoEW/UNDP, 2016). The guidelines provide detailed technical and commercial information needed for the implementation of rainwater harvesting systems in domestic settings in both rural and urban localities (MoEW/UNDP, 2016). Moreover, guidelines for rainwater harvesting systems in the agriculture sector were defined in 2016 (MoE/UNDP, 2016). The full realization of the potential of rainwater harvesting is limited by a low agricultural water tariff, the irregular distribution of rainfall, inadequate urban planning, poor storm water collection infrastructure, and a lack of awareness on rainwater harvesting (MoE/URC/GEF, 2012).

Dew harvesting presents another promising adaptation measure for augmenting water resources. An experimental campaign recently measured dew yields at 6 sites across Lebanon (Tomaszkiewicz et al., 2017). The results showed that dew harvesting was best suited for high elevation areas that run parallel to the coast. These areas benefit from maritime influences, orographic lift and reduced atmospheric pressure. In these locations, dew events occurred around 50% of the time and the yield averaged 0.11 mm/day during the dry season. Meanwhile, dew harvesting in the urban environment was poor, with dew events occurring at a frequency of 18% and producing yields of 0.06 mm/day. Similarly, dew yields were low in two inland sites located in the Bekaa Valley.

3.5.1.3 Desalination

Fast urbanization and population growth along several coastal aquifers have put these systems under the threat of SWI, particularly in the GBA (refer to Section 3.2.2.2). With chronic shortages in the public water and increased salinization of the aquifer, there has been a proliferation in the use of brackish Reverse Osmosis (RO) units, particularly in Beirut (Alameddine et al., 2018). Between 1995 and 2009, several brackish water RO desalination units with capacities ranging from 90 to 1,893 m^3/day

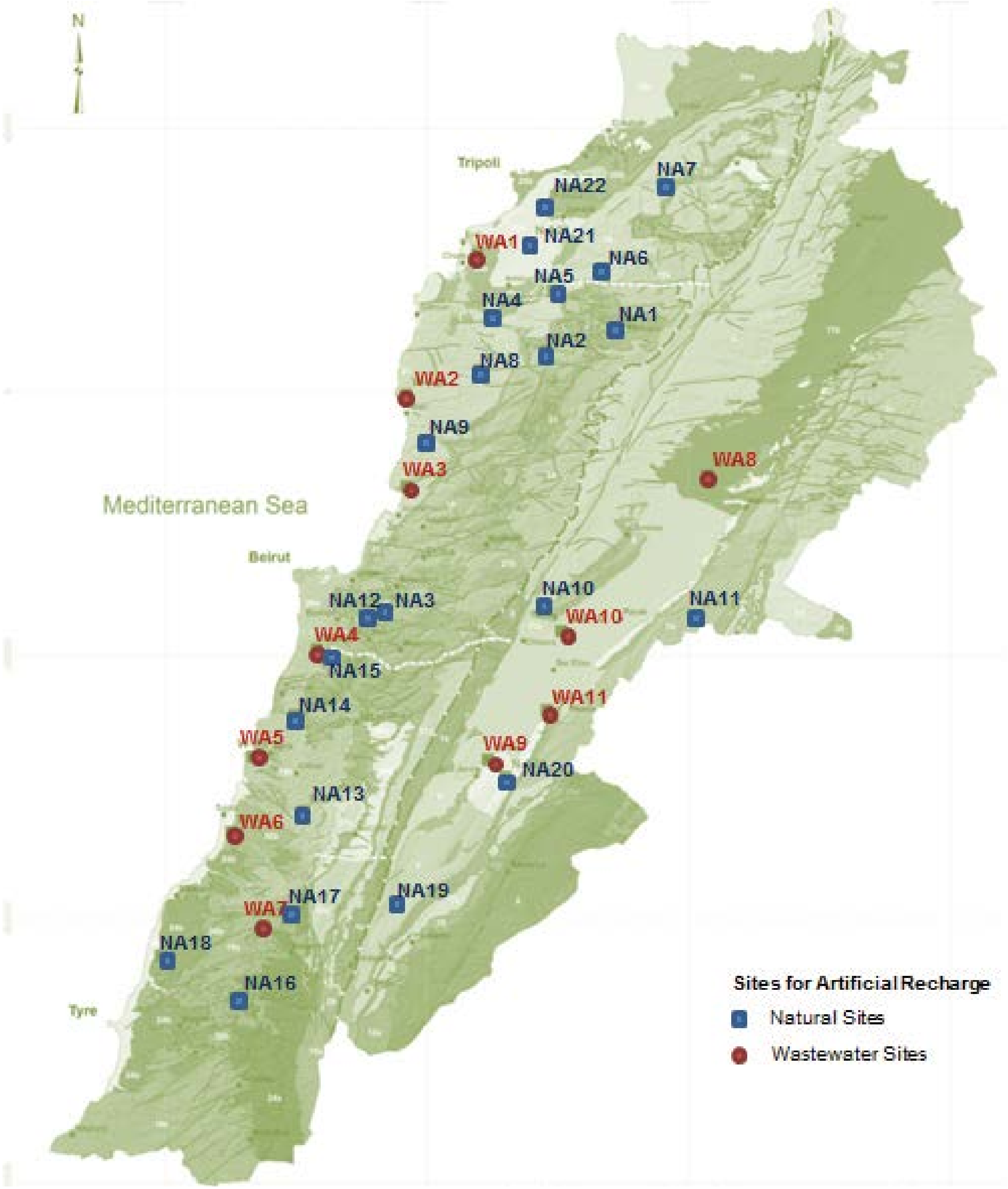

Figure 3-4 Map of the Proposed MAR Locations across the Country as well as the Type of Water Recommended for the Recharge by Site
Source: MoEW/UNDP, 2014

were installed in Beirut, mostly to supply fresh water for industries, municipalities and tourist facilities (FICHTNER, 2011). More recently, there has been a proliferation in small-scale RO units for residential use. Unfortunately, the absence of governmental regulation or oversight on their use and minimum efficiency has resulted in the installation of units that have poor conversion efficiencies. A recent study, by Hamdan (2019), documented that most of the installed units had a shortened serviceable life, low recovery rate (<60%) and weak social confidence in the quality of their produced water. As a result, their increased market penetration is leading to 1) over-pumping and the accentuation of SWI; 2) increasing the volume of wastewater generated in the city as most operators opt to dispose of the brine in the sewer system; and 3) increasing demands on the limited national electricity supply. While these brackish RO units are helping many residents to meet their short-term needs by allowing them to make use of their brackish groundwater, their proliferation is restricted to affluent areas and their negative impacts on the overall quality of the aquifer is typical of the tragedy of the commons.

On the other hand, the adoption of a centralized seawater RO desalination to supply part of the domestic water needs of the GBA has often been considered as an alternative water supply option in EIAs but never studied in depth. Recent successes of large-scale seawater RO desalination plants along the eastern Mediterranean have broken the taboo that desalination is only a viable technology for water poor but fossil-fuel rich countries; yet desalination is not part of the final draft 2020 NWSS. In January 2019, the United Nations Educational, Scientifi and Cultural Organization's Science des Membranes Appliquée à l'Environnement met with BMLWE to discuss the prospect of installing a desalination plant for the Establishment. The feasibility mission is expected to provide BMLWE with a study on the methods and means available for the implementation of desalination projects (UNESCO, 2020). Opting for a centralized seawater RO plant can ensure the provision of a continuous safe water supply to GBA residents and reduce dependence on inter-basin transfers that are prone to climatic variabilities and increased demands in the basins themselves. Nevertheless, the implementation of large-scale desalination requires a large investment for its establishments and is associated with high energy needs and operating costs. As such, it currently seems to be only feasible through a PPP such as the BOT or Build Own Operate options (Saidy, 2016). When considering such options, renewable energy should also be considered to reduce costs and improve environmental sustainability.

3.5.1.4 Wastewater Reuse

In the 2010 NWSS, the MoEW set a target to increase the reuse of treated wastewater from 0% in 2010 to 20% in 2015 and then to 50% by 2020. The strategy estimated that up to 150 MCM/year of treated wastewater could be used for irrigation by 2020, while another 100 MCM could be used for MAR (MoEW, 2012; MoEW/UNDP, 2014). Unfortunately, these goals were never realized. Currently, only one pilot wastewater reuse project is being implemented at the Ablah WWTP in the Bekaa region. The project is funded by the EU through a climate change adaptation and best agricultural practices project. The reuse system has replaced groundwater with treated wastewater for the irrigation of 20 hectares of table grapes.

Several obstacles hinder the wide adoption of wastewater reuse. These include the delays in the execution of WWTP projects, the lack of an adopted national standard for the reuse of treated wastewater effluent and sludge, inadequate capacities and absence of extension services at the involved ministries and water establishments, as well as the lack of needed infrastructure to transport the water from the plant to its intended use location. In 2010, FAO developed the Lebanese Guidelines on Sewage Sludge Use in Agriculture and the Lebanese Wastewater Reuse Guidelines; yet none have been officially endorsed (MoEW, 2019b). With the upcoming implementation of the Water Code, several decrees should be adopted or revised, including the decree on the reuse of treated wastewater (MoEW, 2019a). Recently, the International Water Management Institute, through the Rewater MENA project, has started a national baseline assessment on reuse potential. The project also aims to update and validate the reuse quality standards in association with the LIBNOR committee and to implement two local reuse plans (MoEW, 2019b). In the meantime, CDR is undertaking a study on sludge management, specifically in the Bekaa region. The study is funded by the WB in partnership with the MoE and MoEW. This study should also be undertaken for all areas of Lebanon to develop a strategy for sludge treatment and reuse or disposal prior to operation of the planned WWTPs in the draft final 2020 NWSS.

3.5.2 Demand Management

Demand management is key towards ensuring efficiency, sustainability, equity and long-term water security. Demand management encompasses both direct interventions through regulation and technology, as well as indirect actions brought about through market mechanisms, financial incentives, awareness raising, and public education (El-Fadel and Maroun, 2003). Existing water demand management in Lebanon is still weak and government investment has so far focused disproportionately on source augmentation. There is a pressing need for adopting water-related legislation that defines the general guidelines for the rational utilization of water resources (e.g. proper water use and conservation, water resources protection, water pricing, etc.). As such, the MoEW ought to issue executive decrees based on the Water Code and its latest amendment that clearly address the different aspects of demand management.

Yet, the effectiveness of these much-needed water-related legislative measures will remain highly dependent on the overall institutional framework and the presence of appropriate enforcement mechanisms. As such, the role of the Lebanese Center for Water Conservation and Management within the MoEW needs to be better defined and empowered to promote policies that aim to develop and implement water conservation initiatives in the sector. Through this center, the MoEW would need to implement programs that promote the use of low water-use devices and technologies and bar the import/use of inefficient appliances. Ensuring efficiency in the industrial sector is equally important. For example, as per Section3.4.2.2, the WB funded LEPAP project and the USAID funded WELI project administered through the LWP program have both worked towards the implementation of sustainable water consumption practices and the adoption of water-saving technologies in the industrial sector. In fact, the LWP program has provided financial incentives to promote the concept of water conservation and water efficiency among high water use industries such as marble industries, as well as agro-food producers (Social Impact Inc., 2018). The program supported these industries to install WWTPs to treat and reuse their generated wastewater and reduce their dependence on freshwater supply.

The impact of adopting technical interventions aimed at reducing water use probably remains highest in the agriculture sector. Existing efforts by the MoA to reduce losses during the conveyance of irrigation water through canal lining or the use of pipes, as well as improving surface irrigation through land leveling or its replacement by sprinkler or micro-irrigation (drip, micro-sprinkling, sub-irrigation, deficit irrigation systems) techniques need to be doubled (El-Fadel and Maroun, 2003). Results from the LWP have shown 40 to 60% savings in irrigation water following the installation of modern irrigation systems (Social Impact Inc., 2018). In addition to these interventions, there is a need to adopt a more holistic vision to agriculture and to slowly shift towards the water-energy-food (WEF) nexus that accounts for the high interdependency and the interrelatedness between these three sectors. The adoption of the nexus in Lebanon is complex, as the country faces water and energy shortages and imports more than 80% of its food needs, while agriculture consumes nearly 60% of its available freshwater resources. A policy paper by the Issam Fares Institute examined the structure of the different state actors in Lebanon and looked at their policies with regards to favoring the WEF nexus approach (Farajalla et al., 2016). The study revealed that while an integrated system of coordination among state actors exists, a closer look at these institutions showed deficiencies in coordination within and between institutions starting from the high vacancy rates in the ministries, complicated bureaucratic procedures, and the lack of a common methodology for setting strategies. As a result, the creation of an inter-sectoral coordinating body was recommended. Its role will be to monitor the entire WEF nexus modelling process and evaluate the outcomes with regard to appropriate decision making concerning the allocation of resources and the required trade-offs needed between the various development priorities of different stakeholders (Stephan et al., 2018). In order to ensure the transparency of the inter-sectoral decision-making process, there is a need to develop quantitative tools and models that provide a clear understanding of the interconnectedness of the nexus and that identify the trade-offs and the potential synergies involved across multiple actors and sectors. These tools and models can serve in assessing policy coherence, testing the potential of various policy mechanisms, identifying current and future challenges, offering solutions pertaining to resource planning, and implementing specific technologies and infrastructure at a large scale (Stephan et al., 2018). In 2016, an optimization model was developed at the scale of Lebanon, for optimal resource allocation towards sustainable water and food security under nutritional, socio-economic, agricultural, environmental and natural resources constraints (Mortada et al., 2018). A similar quantitative WEF nexus assessment framework was also developed by Karnib (2017).

Demand management also needs the adoption and implementation of technical interventions to reduce unaccounted-for water and other forms of water loss. Over the past decade, significant technological advances have occurred with regards to sensing, telemetry, modeling and data analytics that allow for the efficient implementation of leak detection and repair programs, the identification of illegal connections and flagging of inadequate system pressure. Most of the RWEs have started integrating these technologies in several pilot project areas through internationally funded programs such as the EU Regional Trust Fund MADAD project. However, more resources and political and community support still need to be deployed to increase the subscription rates, which remain extremely low in selected areas.

Moreover, changing the existing water billing system to one based on consumption rates is much needed to incentivize water conservation. Lebanon lacks a national water tariff strategy. Each RWE has its own tariffing system. However, as mentioned in Section 3.2.3, billing is still largely based on charging a flat rate. Moreover, the existing tariff and billing system have shown their failure to sustain the RWE, most of which operate under growing financial deficits, largely due the high percentage of NRW as a result of low subscription rates and high network losses. Revising the water tariffs is expected to increase public awareness of the value of water, as well as promote water conservation and deter water misuse, provided that the tariffs are assigned equitably. The role that the RWEs have on the successful implementation of a new tariff system is monumental.

3.5.3 Environmental Monitoring

The establishment of an integrated monitoring system is the cornerstone for the successful implementation of effective water resources management. Decisions taken in the absence of adequate spatio-temporal monitoring data will lack transparency and accountability and may often misrepresent system uncertainties. In Lebanon, the lack of an integrated monitoring system remains one of the major hurdles impeding the fulfillment of the goals set out by SDG6 on water and sanitation. The final draft 2020 NWSS recognizes this limitation and proposes an overhaul of the existing hydrometric networks. It identifies the need to instrument the major aquifers in order to better quantify surface-groundwater interactions and the changes in water level. The updated strategy also states that most public operating wells will need to have their flows and water level continuously monitored, which is essential not only for human health by ensuring water availability but for maintenance of natural ecosystems. Similarly, continuous monitoring of flows is planned for all springs with a flow rate above 80 l/sec. The strategy foresees that these projects will be implemented with the assistance of the RWEs and the Department of River Flow Monitoring at the MoEW.

Regarding rivers, the updated strategy plans to expand the existing hydrometric network to cover a larger number of stream segments. It plans to have 135 additional hydrometric stations at different locations within various catchment areas. The strategy also underscores the need to improve meteorological data collection. As such, it plans to add 113 stations to the existing ones. It also envisions the installation of snow monitoring stations in the mountainous regions above 1,500 m to better assess snow contribution to river flows and to track the impacts of climate change on snow hydrology (MoEW, 2019b). The updated strategy foresees that the execution of the hydrometric monitoring will start by 2022, while the expansion of the hydrometric stations is set to start in mid-2023. The strategy foresees that the execution of these projects will result in having a sensor density of 50/km^2 (MoEW, 2019b).

In addition to the planned monitoring of the hydrological system, the updated NWSS plans to overhaul the existing domestic water quality monitoring program to replace it with one that includes regular sampling at the outlet of the RWE tanks, within the distribution network, as well as at the consumer's tap. The plan defines a set of parameters that will be measured based on those listed in the LIBNOR 161:1999 standard set for drinking water and proposes a sampling frequency that ranges from continuous/daily for some parameters e.g. (pH, turbidity, chlorine residue) up to annual for others (e.g. heavy metals). It should be noted that a draft update to the LIBNOR standard was prepared in 2016 (LIBNOR 161:2016); but it is yet to be approved, owing to limitations in equipment and human resource at certified laboratories. It is hoped that the RWEs will be able to replicate the WHO/UNICEF national water quality study (WHO and UNICEF, 2016) on a routine basis.

Unfortunately, the strategy does not include a well-defined ambient water quality monitoring plan both for the groundwater and surface water systems. This oversight will curtail any serious effort to identify pollution hotspots, track pollution sources, determine pollution loads, quantify pollution sources and sinks, track the effectiveness of mitigation measures and identify the ability of water bodies to meet their designated use(s). The effective use of ambient water quality data to make transparent decisions and actions is constrained by the absence of clear and relevant ambient environmental water quality standards. Currently, water quality measurements are evaluated with regards to the LIBNOR potable water quality standards or to the standards defined in the MoE Decision 52/1 of 1996 for bathing water and aquatic life and MoE Decision 8/1 of 2001 for discharge limit values. While these standards are helpful and provide a general idea on the status of the water body, there is a need to update these standards and to move away from a one size fits all approach and to embrace instead a new system of standards that is based on a tiered approach that is linked to the designated use for each water system.

3.5.4 Institutional Building

The water and wastewater sector is in dire need of institutional and capacity building. With regards to environmental protection, both the MoEW and the RWE staff require training on the operationalization and implementation of environmental safeguards *(Refer to Chapter 2 – Environmental Governance)* to limit the pollution of water resources and minimize the impact of implementation of water and wastewater projects on the environment. This needs to happen in tandem with the MoE's efforts to mainstream environmental considerations and enhance MoE's management of the environmental safeguards, particularly with regards to environmental compliance monitoring.

Furthermore, both the MoEW and RWEs are in urgent need to hire new permanent staff with adequate and relevant educational and technical backgrounds, along with supporting the existing workforce by sufficient technical assistance and capacity building. Many of the RWEs currently suffer from limited capacities and are severely understaffed. It has been estimated that the permanent staff in most RWEs total around a quarter of the required staff as defined by the RWE's organizational decree, with many vacancies in the technical and planning departments (MoEW, 2019a). While the RWEs are expected to function with financial and administrative autonomy, they have been amassing debts due to the low percentage of customer-metered connections, the low percentage of billing and collection (as low as 30% in certain regions), and high NRW (estimated at around 40%-50% nationwide) (El-Amine, 2016; USAID, 2017, MoEW, 2019a). These deficiencies have been the focus of capacity building and support programs by several international donors, including: (1) the Implementation of Technical Tools for Water Management Project and the Support Programme for Infrastructure Strategies and Alternative Financing (EU-funded); (2) Water Sector Reform Assistance Project (GIZ-funded); (3) Lebanon Water Policy Program, Lebanon Water and Wastewater Sector Support and LWP (USAID-funded); and (4) several other support programs financed by the WB and the Swiss Development Agency and other financing agencies (MoEW, 2019a). While these projects have brought about some improvement in the capacities of the RWEs in terms of the increase in the number of metered connections and the improvements in leakage detection and repair, much still needs to be done. The final draft 2020 NWSS recognizes these challenges and highlights the need to strengthen the management structure at the RWEs by recommending the recruitment of qualified staff and by reviewing the organizational decrees of the RWEs. These changes were made in an effort to further develop the capacities of these establishments on different levels including improving current management of water service, increasing the quality of the supplied water, enhancing customer relations, developing irrigation-related activities and implementing structured service monitoring and enhanced reporting (MoEW, 2019a). It should be noted that Law 77/2018 has permitted the private sector to participate in these various activities and its involvement may help improve certain functions at the RWEs, particularly when it comes to customer relations, customer database management, communication, billing and water meter reading.

3.5.5 Stewardship and Stakeholder Engagement

In general, there is an absence in the sense of citizen stewardship in Lebanon across all sectors, including water. As a result, water is rarely treated as a common good and citizen groups seldom work together to plan and manage their water resources in a sustainable and equitable manner. Some reasons for this lack of stewardship include the 1) relatively young environmental grassroot movements, 2) low public knowledge concerning water management and water use efficiency, 3) lack of stakeholder engagement by the state when it comes to water management and centralized and top-down public decision making in the water and wastewater sector, 4) marginalization of women, youth, and rural communities in the decision making process, 5) failure to think at the watershed level and to account for the nexus concept, 6) limited enforcement of the polluter pays principle enshrined in Law 444/2002 and failure to introduce equitable consumption-based water tariffs, and 7) lack of accountability of unsustainable practices by private companies. As such, there is a need for capacity building to help the public and private sectors along with civil society better understand their own water uses and impacts of their polluting activities within the catchment context. It is also essential for these three entities to share responsibilities and have a voice when it comes to ensuring proper water governance, water use sustainability and access to safe water. For this to happen, there is a need for well-planned and designed awareness campaigns targeting all three entities. The recent public opposition towards several mega water projects in the country are both a sign that the government needs to more genuinely engage the public early on and go beyond the EIA requirements and that there is a vibrant and more vocal grassroot community that is asking for a seat at the table. Over the past five years, USAID, through the LWP, has been promoting stewardship in water conservation, reuse and treatment by working with industries, farmers and business enterprises. Such individual initiatives and successes at the level of small and medium-sized enterprises should be built upon to embed the water stewardship concept into future national water and wastewater sectoral plans.

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قوانين الاتفاقيات الدولية

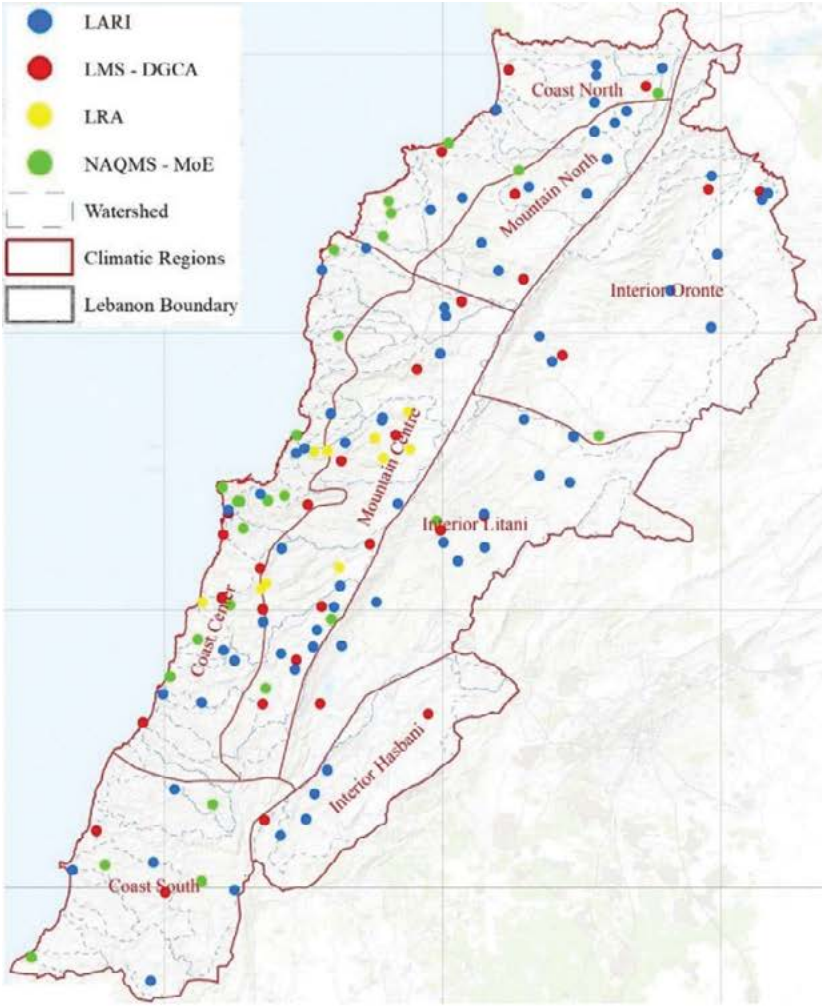
نوع النص	الرقم	التاريخ	عنوان النص
قانون	٢٣	١٩٩٩/٢/٢٣	الاجازة للحكومة الانضمام الى اتفاقية بشأن الاراضي الرطبة ذات الاهمية الدولية وخاصة بوصفها مآلف للطيور المائية
قانون	٢٩٢	١٩٩٤/٢/٢٢	الاجازة للحكومة الانضمام الى بروتوكولين ملحقين باتفاقية حماية البحر المتوسط الموقعة في برشلونه بتاريخ ١٩٧٦/٢/١٦
قانون	١٣	١٩٨٣/٥/٢٨	الإجازة للحكومة الانضمام إلى الاتفاقية الدولية لتفادي تلويث مياه البحر بالمحروقات السائلة
مرسوم إشتراعي	١٢٦	١٩٧٧/٦./٣٠	اجازة انضمام لبنان الى الاتفاقية المتعلقة بحماية البحرالابيض المتوسط من التلوث والبروتوكولين الملحقين بها

القوانين والأنظمة

نوع النص	الرقم	التاريخ	عنوان النص
قانون	١٩٢	٢٠٢٠/١٠/١٦	تعديل القانون رقم ٧٧ "قانون المياه"
قانون	٧٧	٢٠١٨/٤/١٣	قانون المياه
قانون	٤١٥	٢٠٠٢/٦/٥	إتفاقية قرض بين لبنان والصندوق الكويتي للتنمية بشأن مشروع نقل مياه الليطاني إلى الجنوب اللبناني لأغراض الري والشرب
قانون	٣٣٧	٢٠٠١/١٢/١٤	تعديل القانون رقم ٢٠٠٠/٢٢١ المصحح بالقانون رقم ٢٠٠٠/٢٤١ (تنظيم قطاع المياه)
قانون	٢٤١	٢٠٠٠/٨/٧	تعديل القانون ٢٢١
قانون	٢٢١	٢٠٠٠/٥/٢٩	تنظيم قطاع المياه
قانون	-	١٩٥٤/٨/١٤	إنشاء مصلحة خاصة تدعى المصلحة الوطنية لنهر الليطاني
قانون	١٤٤/س	١٩٢٥/٦/١٠	الأملاك العمومية
مرسوم	٣٩٨٩	٢٠١٦/٨/٢٥	انشاء ضابطة بيئية وتحديد عدد اعضائها وتنظيم عملها
مرسوم	٨٦٣٣	٢٠١٢/٨/٧	اصول تقييم الاثر البيئي
مرسوم	٨٤٧١	٢٠١٢/٧/٤	الالتزام البيئي للمنشآت
مرسوم	٨٢١٣	٢٠١٢/٥/٢٤	التقييم البيئي الاستراتيجي لمشاريع السياسات والخطط والبرامج في القطاع العام
مرسوم	١٦٤٥٤	٢٠٠٦/٢/٢٧	إدراج بند تحكيمي في العقود المتعلقة بمشروع نقل مياه نهر الليطاني إلى الجنوب اللبناني لأغراض الري والشرب (منسوب ٨٠٠ متر)
مرسوم	٩٦١٣	١٩٩٦/١٢/١٣	إضافة مهام إلى المصلحة الوطنية لنهر الليطاني
مرسوم إشتراعي	٥	١٩٧٧/١/٣١	إنشاء مجلس الإنماء والإعمار
مرسوم	٧٤٣٢	١٩٧٤/٣/١٦	دمج مصلحة ري القاسمية ورأس العين بالمصلحة الوطنية لنهر الليطاني
مرسوم	١٤٥٢٢	١٩٧٠/٥/١٦	توزيع مياه نهر الليطاني والمياه الاخرى المتوفرة من مختلف مصادر
مرسوم	٨٣٧٧	١٩٦١/١٢/٣٠	تنظيم وزارة الصحة
مرسوم إشتراعي	٣١	١٩٥٥/١/١٨	تحديد مهام وزارة الزراعة
قرارالحكومة اللبنانية	٣٥	٢٠١٢/١٠/١٧	عرض وزارة الطاقة والمياه لإستراتيجية قطاع الصرف الصحي

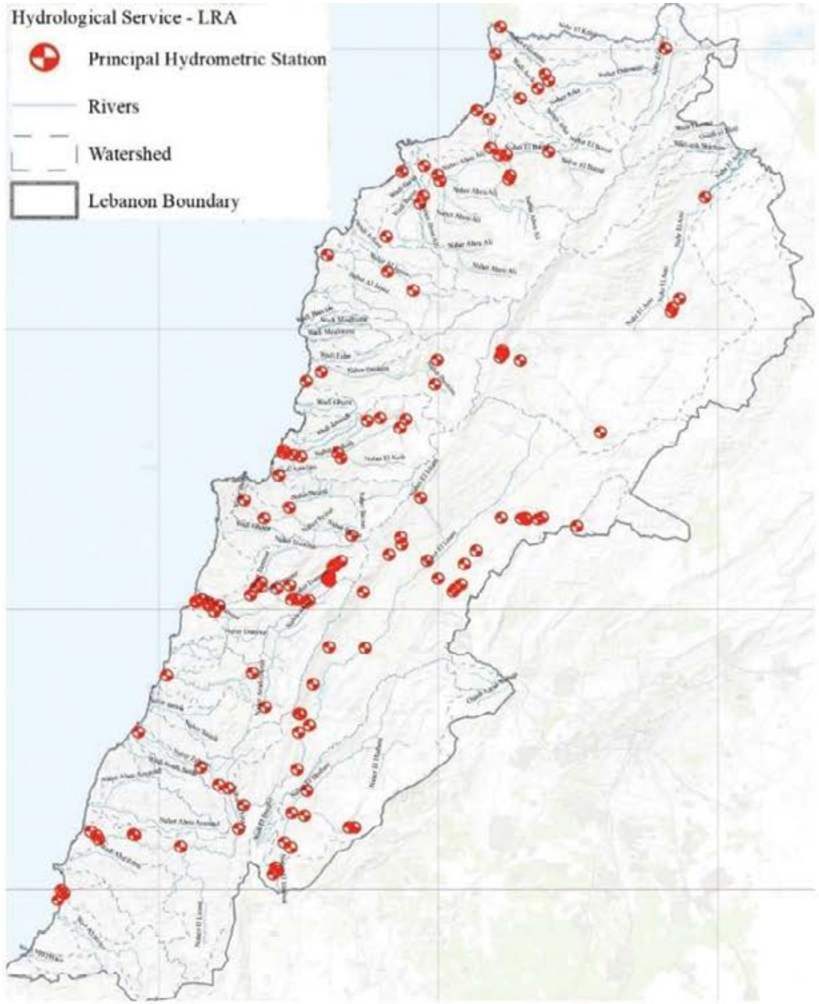
نوع النص	الرقم	التاريخ	عنوان النص
قرارالحكومة اللبنانية	٢	٢٠١٢/٣/٩	عرض وزارة الطاقة والمياه للإستراتيجية الوطنية لقطاع المياه NWSS
قرار وزارة البيئة	١/٨	٢٠٠١/١/٣٠	المواصفات والمعايير المتعلقة بملوثات الهواء والنفايات السائلة المتولدة عن المؤسسات المصنفة ومحطات معالجة المياه المبتذلة
قرار وزارة البيئة	١/٥٢	١٩٩٦/٧/٢٩	تحديد المواصفات والنسب الخاصة للحد من تلوث الهواء والمياه والتربة
مرسوم	١٤٥٢٢	١٩٧٠/٥/١٦	توزيع مياه نهر الليطاني والمياه الاخرى المتوفرة من مختلف مصادر
مرسوم	٨٣٧٧	١٩٦١/١٢/٣٠	تنظيم وزارة الصحة
مرسوم إشتراعي	٣١	١٩٥٥/١/١٨	تحديد مهام وزارة الزراعة
قرارالحكومة اللبنانية	٣٥	٢٠١٢/١٠/١٧	اعتماد الإستراتيجية الوطنية لقطاع الصرف الصحي
قرارالحكومة اللبنانية	٢	٢٠١٢/٣/٩	اعتماد الإستراتيجية الوطنية لقطاع المياه
قرار وزارة البيئة	١/٨	٢٠٠١/١/٣٠	المواصفات والمعايير المتعلقة بملوثات الهواء والنفايات السائلة المتولدة عن المؤسسات المصنفة ومحطات معالجة المياه المبتذلة
قرار وزارة البيئة	١/٥٢	١٩٩٦/٧/٢٩	تحديد المواصفات والنسب الخاصة للحد من تلوث الهواء والمياه والتربة

Annex 1: Distribution of Meteorological and Hydrometric Stations across Lebanon



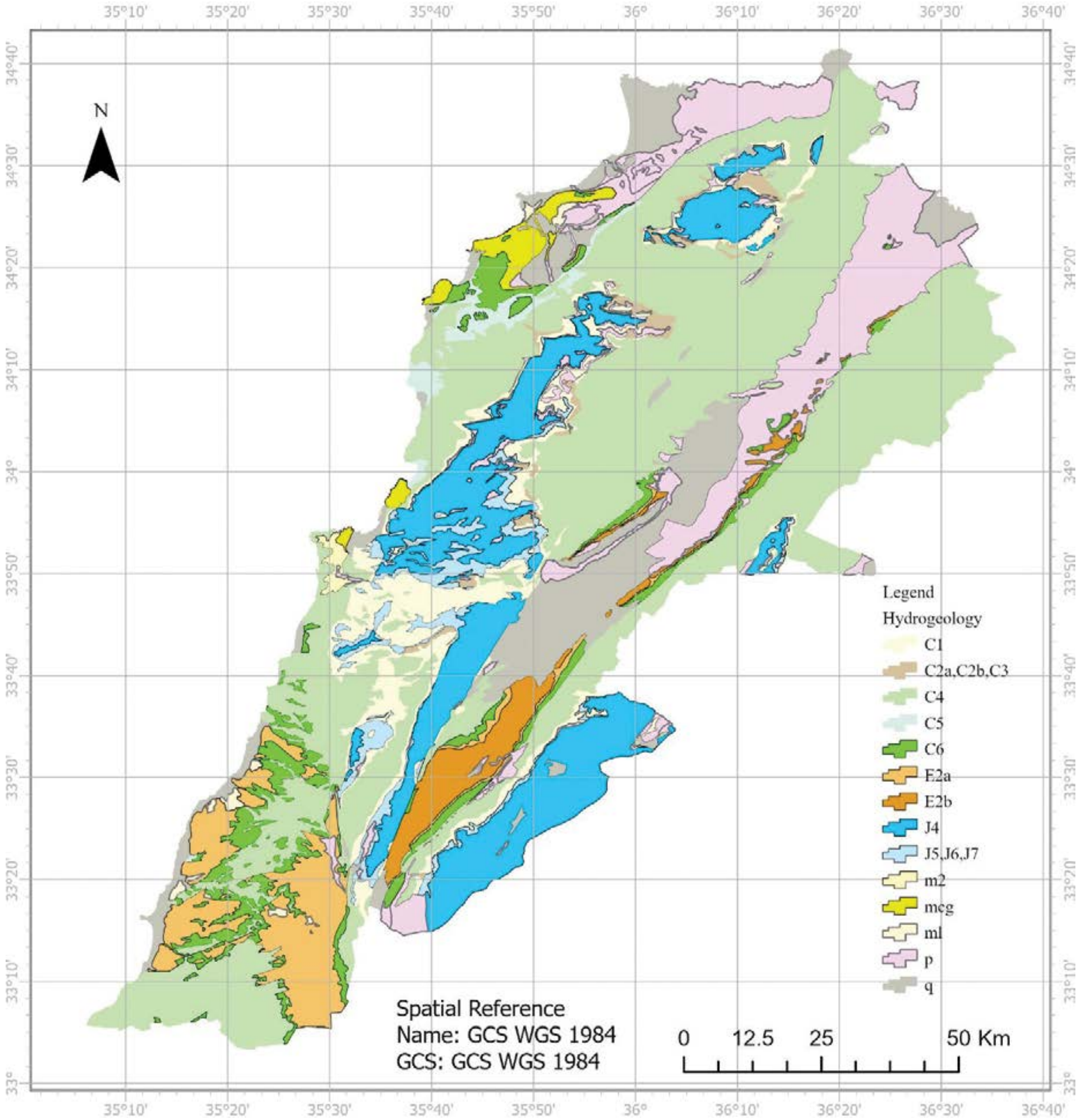
Meteorological Stations of Public Institutions

Source: 2020 NWSS Volume III

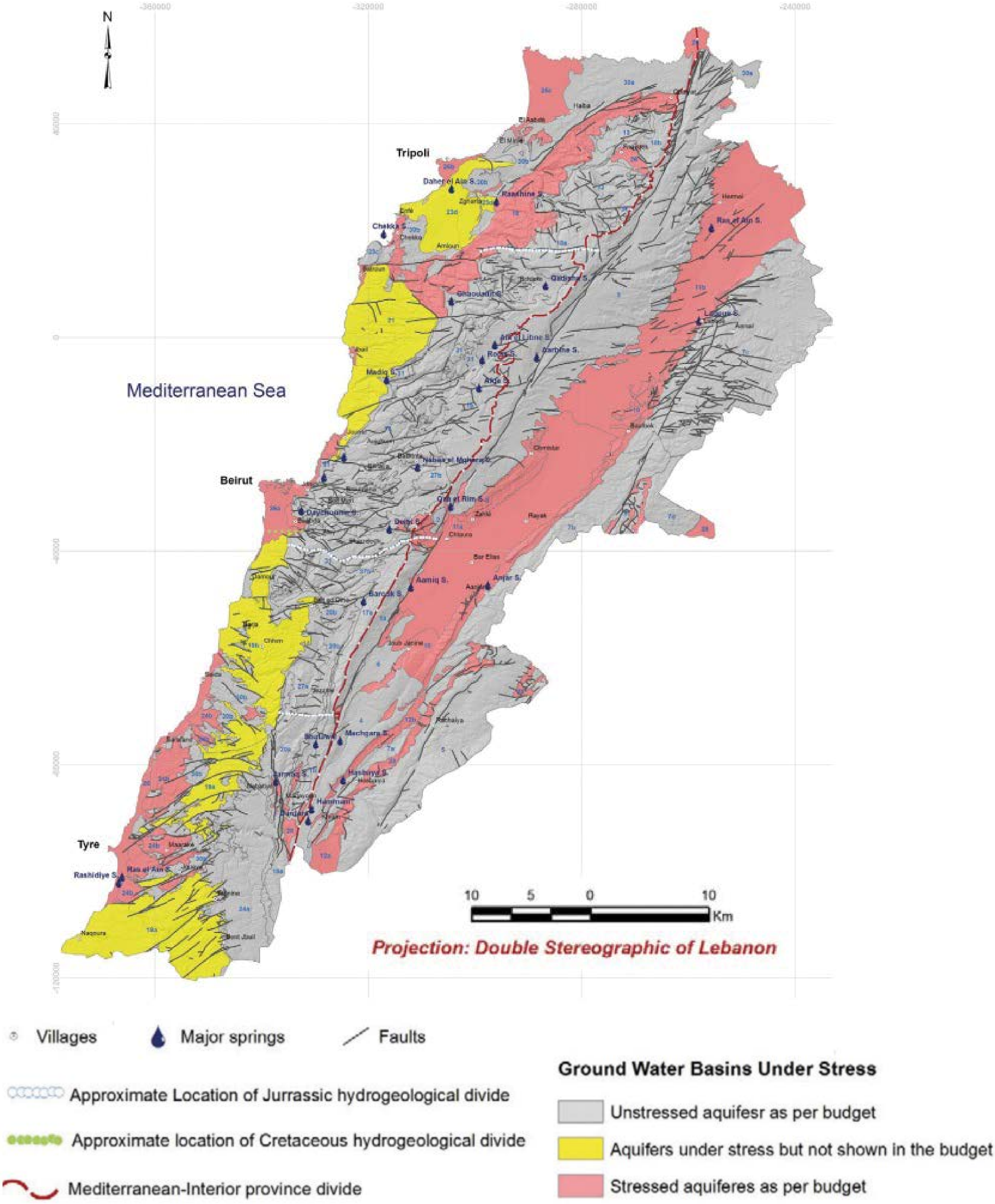


Hydrometric Stations of the Lebanese Hydrometric Service at the LRA

Annex 2: Hydrogeology of Lebanon



Annex 3: Map Showing the Location of Stressed Aquifers across Lebanon



Source: MoEW/UNDP, 2014

Annex 4: Recent Studies that Attempted to Assess River Water Quality across Lebanon

River basin	Sampling period (# samples)	Physical	Micro-biological	BOD/COD/TOC	Nutrients	Heavy Metals	Micro-pollutants	Study
Litani	2004 (3)	✓	✓	✓	✓			(Houri and El Jeblawi, 2007)
	2010-2011 (44)	✓		✓	✓			(Abou-Hamdan et al., 2014)
	2013-2014 (27)	✓		✓	✓			(Baydoun et al., 2016)
	2006-2011 (NR)	✓		✓	✓			(Saadeh et al., 2012)
	2010-2011 (24)	✓	✓	✓	✓	✓		(Haydar et al., 2014)
	2012-2014 (18)	✓	✓	✓	✓	✓		(Nehme and Haidar, 2018; Nehme et al., 2013)
Abou Ali	2015-2017 (30)						✓	(Jabali, 2017; Jabali et al., 2020)
	2004 (3)	✓	✓	✓	✓			(Houri and El Jeblawi, 2007)
	2010-2011 (60)	✓	✓	✓	✓	✓		(Daou et al., 2018)
Ibrahim	2004 (3)	✓	✓	✓	✓			(Houri and El Jeblawi, 2007)
	2016 –2017 (285)	✓			✓			(El Najjar et al., 2019)
	2016 –2017 (12 +3*)		✓					(El Najjar et al., 2020)
	2010-2011 (60)	✓	✓	✓	✓	✓		(Daou et al., 2018)
Damour	2004 (3)	✓	✓	✓	✓			(Houri and El Jeblawi, 2007)
	2005 - 2009	✓	✓	✓	✓			(Massoud, 2012)
	2010-2011 (60)	✓	✓	✓	✓	✓		(Daou et al., 2018)
El Awali	2004 (3)	✓	✓	✓	✓			(Houri and El Jeblawi, 2007)
Beirut	2016 - 2017 (82)	✓	✓	✓	✓			(El-Nakib et al., 2020)
El Kabir	2001 (39)*					✓	✓	(Thomas et al., 2005)
	2004 (3)	✓	✓	✓	✓			(Houri and El Jeblawi, 2007)
El Bared	2004 (3)	✓	✓	✓	✓			(Houri and El Jeblawi, 2007)
Antelias	2004 (3)	✓	✓	✓	✓			(Houri and El Jeblawi, 2007)
Arka	2014 (56)	✓	✓	✓	✓			(Daou et al., 2016)
El Assi	2010-2011 (60)	✓	✓	✓	✓	✓		(Daou et al., 2018)

*: Sediment samples

Annex 5: List of WWTPs with Design Capacity > 10,000 m³/day

RWEa	Caza	WWTP Name	Capacity(m³/day)	Process
Existing				
BMLWE	Baabda	Al Ghadir	306,430	PT
BMLWE	Chouf	Nabi Younes	38,000	AS
BMLWE	Jbeil	Jbayl	10,000	AS
BWE	Baalbek	Iaat	20,300	AS
BWE	West Bekaa	Joub Janine	10,000	AS
BWE	Zahle	Zahle	40,000	AS
NLWE	Tripoli	Tripoli	256,000	AS
SLWE	Nabatieh	Charqiye	20,400	AS
SLWE	Sidon	Sidon	50,000	PT
SLWE	Tyre	Chabriha	55,000	AS
Under Construction				
BWE	Zahle	Majdel Anjar/El Marj	45,000	RB
NLWE	Akkar	El Aabde	39,010	RB
SLWE	Marjaayoun	El Khiam	16,000	RB
Proposed				
BMLWE	Aley	Bchtfine	10,200	Unknown
BMLWE	Baabda	El Halaliyeh	17400	RB
BMLWE	Baabda	El-Kneisse	13,900	RB
BMLWE	Chouf	Chourit	13,000	RB
BMLWE	Chouf	Sirjbal	10,780	BF
BMLWE	Matn	Burj Hammoud	325,000	MBBR
BMLWE	Kaserwan	Ghazir/Adma	48,000	RB
BMLWE	Kaserwan	Makhada	42,000	RB
BWE	Baalbek	Chaat	11,893	RB
BWE	Baalbek	Tamnine	50,000	AS
BWE	Baalbek	Ras Baalbek	17,296	RB
NLWE	Akkar	Jebrayel	17,275	RB
NLWE	Minieh-Danniyeh	Bakhaoun	15,680	AS
SLWE	Bint Jbeil	Froun	10,000	RB
SLWE	Bint Jbeil	Ouadi Houjair	26,093	RB
SLWE	Bint Jbeil	Salhani	11,000	RB

Source: MoEW, 2019c
PT=Primary Treatment; AS= Activated Sludge; MBBR= Moving Bed Biofilm Reactor

4 Air Quality

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Abbreviations and Acronyms

AQMN	Air Quality Monitoring Network
AUB	American University of Beirut
BaP	Benzo[a]pyrene
BRT	Bus Rapid Transit
CFC	Chlorofluorocarbon
CH_4	Methane
CO	Carbon Monoxide
CO_2eq	Carbon Dioxide Equivalent
CVD	Cardiovascular Disease
EC	Elemental Carbon
EDL	Electricité du Liban
ETS	Environmental Tobacco Smoke
EU	European Union
GBA	Greater Beirut Area
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GoL	Government of Lebanon
HCFC	Hydrochlorofluorocarbon
HCl	Hydrogen Chloride
HFC	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
LUR	Land Use Regression
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoI	Ministry of Industry
MoIM	Ministry of Interior and Municipalities
MoPH	Ministry of Public Health
MoPWT	Ministry of Public Works and Transport
NMHC	Non-Methane Hydrocarbon
NMVOC	Non-Methane Volatile Organic Carbon
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
O&M	Operation and Maintenance
O_3	Ozone
OC	Organic Carbon
ODS	Ozone Depleting Substance
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCDD/F	Polychlorinated dibenzo-dioxin and furan
PM_{10}	Particulate Matter (diameter less than 10 micrometers)
$PM_{2.5}$	Particulate Matter (diameter less than 2.5 micrometers)
POP	Persistent Organic Pollutant
PPAH	Particle-bound Polyaromatic Hydrocarbons
SELDAS	Strengthening the Environmental Legislation Development and Application System in Lebanon
SO_2	Sulfur Dioxide
SOx	Sulfur Oxide
SWM	Solid Waste Management
SWMS	Standalone Weather Monitoring Station
TEDO	Tripoli Environment and Development Observatory
UCF	Urban Community of Al Fayhaa
UNDP	United Nations Development Programme

UNEP	United Nations Environment Programme
UoB	University of Balamand
USJ	Saint Joseph University
VOC	Volatile Organic Compound
WHO	World Health Organization

4. Air Quality

Degradation of air quality is considered one of the major environmental risks affecting public health in Lebanon. Main contributors to air pollution in the country include anthropogenic sources, such as the transport, energy and industrial sectors, and natural sources such as dust storms and forest fires. This chapter describes the driving forces and current situation regarding air quality in Lebanon in the past decade. The legal framework and selected responses are identified to highlight the efforts that have been taken by key stakeholders to monitor and safeguard air quality and the future outlook for the coming decade is described. The chapter tackles main criteria pollutants (nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2) and particulate matter (PM_{10} and $PM_{2.5}$), polycyclic aromatic hydrocarbons (PAHs), volatile organic carbons (VOCs), indoor air pollutants and pollutants addressed in multilateral environmental agreements to which Lebanon is committed.

4.1 Driving Forces

Lebanon's National Strategy for Air Quality Management 2015-2030 identified the on-road transport sector as the main source of carbon monoxide (CO), non-methane volatile organic carbon (NMVOC) and nitrogen oxides (NOx) emissions and power plants as the main source of SO_2 and PM_{10}, and $PM_{2.5}$ emissions (MoE, 2017). Source apportionment studies and national reports have also concluded that the main anthropogenic sources of air pollution in Lebanon are traffic, diesel generators, power plants and industries. For the aforementioned sources, emission calculations conducted by the authors of this chapter, using activity data sourced from Lebanon's Third Biennial Update Report to the UNFCCC (MoE/UNDP/GEF, 2019), showed a significant increase in the concentrations of pollutants like NMVOC, NOx, $PM_{2.5}$ and PM_{10} (Figure 4-1). Similarly, the report showed a 194% increase in emission of greenhouse gases (GHG) as carbon dioxide equivalent (CO_2eq) between 1994 and 2015. Natural phenomena include dust storms and forest fires.

The following represents an overview of the available data that shed light on the effect of the major driving forces on air quality in Lebanon.

4.1.1 Road Transport

Per capita emissions due to road transport in Lebanon are higher than those for many countries in the region (Waked and Afif, 2012). The road network in the country spans around 21,705 km (World Bank, 2017) and in 2015, the vehicle fleet totaled around 1.73 million, of which private passenger cars make up 86%, private trucks 7% and motorcycles 3.5%. In the period spanning between 2005 and 2015, the number of light duty vehicles jumped from 0.79 to 1.49 million, whereas the average fleet age increased from 13 to 19 years, and diesel-powered vehicles increased from 7 to 12%. Consequently, light duty vehicle emissions increased from 4,045 to 7,180 Gg for CO_2, 40.0 to 57.4 for CO, 2.6 to 4.6 Gg for NOx, 1.81 to 3.27 Gg for SO_2 and 0.55 to 0.75 Gg for $PM_{2.5}$ (Baayoun et al., 2019). In addition to fleet age, high emission rates are associated with high ownership rate, low vehicle occupancy, lack of environmental controls, high rate of congestion and frequent stops

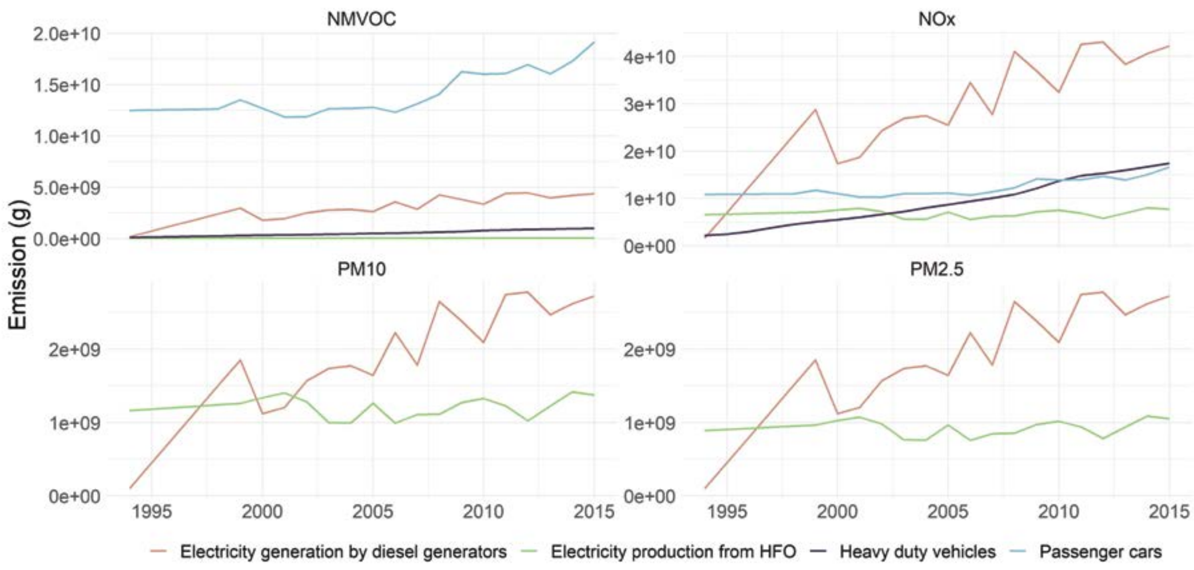

Figure 4-1 Yearly Emissions of NMVOC, NOx, $PM_{2.5}$ and PM_{10}
Note: Data was calculated using European Monitoring and Evaluation Programme 2019 emission factors.
Source: Activity data for each sector is extracted from MOE/UNDP, 2019)

at short time intervals (MoE/URC/GEF, 2012; IPTEC 2016). A 2014 study estimated that a 5% increase in traffic resulted from the Syrian crisis, exacerbating conditions on already congested streets. This traffic increase is estimated at 15% in Greater Beirut Area (GBA) and up to 50% in the cities where the displaced reside. It also led to an increase in emissions of NOx (+10%), CO (+17%) and PM (+3%) (UNDP, 2015). Further increases in the number of Syrian displaced since 2014 are expected to have worsened the situation in dense urban areas where the concentrations of these pollutants are already above standards.

Sources affecting pollution distribution over Beirut city were assessed using a Land Use Regression (LUR) model. LUR was developed to predict NOx, NO_2 and O_3 concentrations across GBA and to develop ambient air pollution concentration maps (Figure 4-2). NOx, NO_2 and O_3 were monitored over a year using passive air quality samplers. The annual average concentrations of NOx, NO_2 and O_3 in the study area were 89.7, 36.0 and 26.9 ppb, respectively. Traffic related predictors were found to have a strong predictive role across all LUR models (El Khoury, 2019).

Calculated emission factors of the roads in Beirut were comparable to values reported for heavy-duty vehicles (Baalbaki et al., 2013). In fact, global inventories (such as ACCMIP, EDGAR, MACC-ity) underestimate the emissions by up to a factor of 10 for the transportation sector (Salameh et al., 2016). Measurements of non-methane hydrocarbons (NMHCs) in suburban Beirut revealed that the levels observed exceeded by a factor of two in total volume the levels found in northern mid-latitude megacities (Paris and Los Angeles), especially for the unburned fossil fuel fraction, and were mainly attributed to strong local emissions and local atmospheric dynamics (Salameh et al., 2015). Fossil-fuel combustion was found to be a major contributor to the organic and elemental carbon $PM_{2.5}$ composition (Waked et al., 2014). Measurement of $PM_{2.5}$ concentrations along Hamra street in the summer of 2018 showed that the levels during weekdays are 53% higher than what was measured on Sundays. This increase is mainly due to traffic and other emission sources (Saliba and coworkers, 2020 in preparation).

4.1.2 Energy Production

Electricity supply by the public utility Electricité du Liban (EDL) is insufficient to meet the country's growing demand that peaks at about 3,562 MW. The utility supplied only 47% of this demand in 2018 (about 1,670 MW) from its 2,334 MW of available (installed and rented) generation capacity. Aside from installed capacity, this energy deficit is driven by 16% technical losses, 21% non-technical losses and the additional power demand for the Syrian displaced,

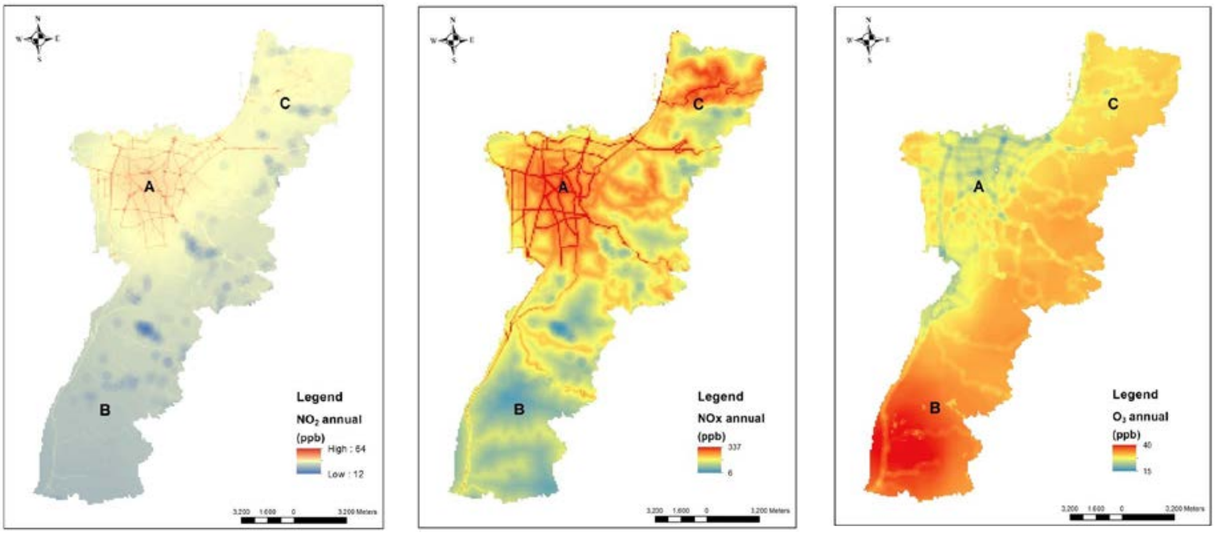

Figure 4-2 LUR Model Results for NO2, NOx, and O3
Source: El Khoury, 2019

The contribution of traffic to PM measurements was assessed in several publications (Daher et al., 2013; Baalbaki et al., 2013; Baalbaki et al.; 2018). In comparison to other road emission factors reported in different cities around the world, the emission factors computed on freeways and inner roads in Lebanon were 278% higher than the emission factor that was reported in one of the major freeways in California.

whose consumption has been estimated at around 500 MW. The balance of demand is partially satisfied by diesel-fired private generators connected to a low-voltage distribution network. About 85% of households rely on these private generators (MoE/UNDP/GEF, 2019; Mobarek, 2019; MoEW, 2019).

It is estimated that private generators produce 80% of EDL's energy output deficit (MoE, 2019). Nevertheless, compared to EDL, private generators emitted in 2010 about 6.3 times more CO, 2.2 times more $PM_{2.5}$, 1.5 times more PM_{10} and a comparable amount of NOx (analysis of Waked et al., 2012 results). Based on a 2017 survey, the number of diesel generators in Beirut was estimated at 9,369, consuming around 747 metric tons of diesel fuel daily (Al Aawar et al., in preparation).

In addition, the established LUR model over Beirut city mentioned in Section 4.1.1 indicated that the role that local point sources, such as diesel generators, had on ambient air quality levels was also evident in the final model structures (El Khoury, 2019). Other than traffic emissions, levels of $PM_{2.5}$ in Hamra street during weekdays in the summer of 2018 were higher than what was measured on Sundays, attributed to additional emission sources such as diesel generators, construction and other city activities (Saliba and coworkers, 2020 in preparation).

The deteriorating service provided by EDL between 1994 and 2015 has led to an increase of 2,500% in total fuel consumption by the installed diesel generators (MoE/UNDP/GEF, 2019) and made the diesel generator sector a stable business, with a consistent coverage area of 1,172 m^2/generator in Beirut since 2010 (Shihadeh et al., 2013). As the content of emissions released by the combustion of diesel oil used in private generators depends on the emission factors of the used diesel fuel and its chemical composition, fuel consumption data in 2018 was used along with the emission factors for the main pollutants presented in Table 4-1 to estimate the amount of emissions from these generators.

Table 4-1 Emissions of Private Diesel Generators in 2018.

Pollutant	Emission Factor (g/kg)	Emissions (1,000 ton)
CO	15	33.97
NOx	25.28	57.25
SOx	3.68	8.33
PM	1.28	2.90
TA	TA	TA

Source: ESMAP, 2020

The simulations showed that, all else being equal, the stack location on the rooftops versus the street levels and the wind speed of 4 m/s versus 1 m/s significantly reduced ground $PM_{2.5}$ concentrations.

The contribution of diesel generators to toxic air was demonstrated through several studies including the measurement of ambient particle-bound polyaromatic hydrocarbons (PPAH) concentrations on the balconies of 20 residences in the Hamra area of Beirut between 2010 and 2012. Results showed that the use of diesel generators for only 3 hours per day accounted for an approximately 40% increase of airborne PPAH in the studied area (Shihadeh et al., 2013). Areas in which diesel generators operate for longer than 3 hours/day can be expected to have proportionally higher ambient concentrations. A recent study at the American University of Beirut (AUB) showed that diesel generators contribute 48% of the total emission of PAHs around AUB (Jaafar et al., 2020 in preparation).

The effect of the EDL power plant in Zouk area was established in terms of PM_{10} contribution to ambient concentrations. EDL power plants using heavy fuel oil are a significant emission source of PM given their high fuel consumption (around 1.18 million tons were used by EDL for this purpose in 2013) (MoE/UNDP/GEF, 2015). According to Salloum et al. (2018), the Zouk power plant steam engines burn heavy fuel oil number 6 that has a density of 3.6704 kg/gal. This translates to 10.2 g/s emitted from the stacks in an ideal case scenario of regular maintenance. Using this data, a computer simulation based on the Air Pollution Model (TAPM) showed power plant stack emission trajectories for a whole year (Figure 4-3) and highlighted differences in annual, seasonal and monthly average PM_{10} concentration in 2014.

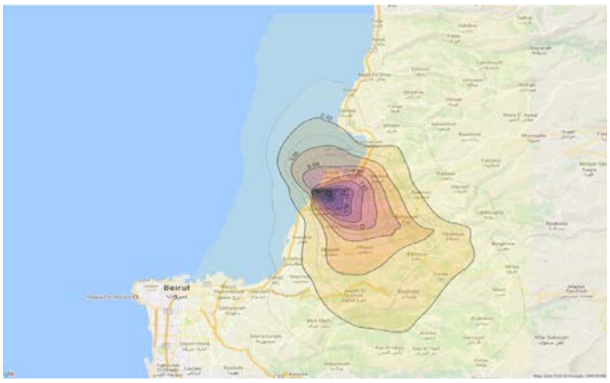

Figure 4-3 Average Annual PM_{10} Concentration in μg/m^3 due to the Zouk Power Plant Stack Emissions in 2014. Source: Salloum et al. 2018

The computer simulation work was done in parallel with three simultaneous field measurements of the carcinogen benzo[a]pyrene (BaP), which were conducted in Zouk Mikael, Zouk Mosbeh and at a background site situated in Beirut (AUB). Results showed BaP concentrations in Zouk Mikael exceeding by 4.5 and 10 times the BaP concentrations in Zouk Mosbeh and AUB, respectively (Figure 4-4).

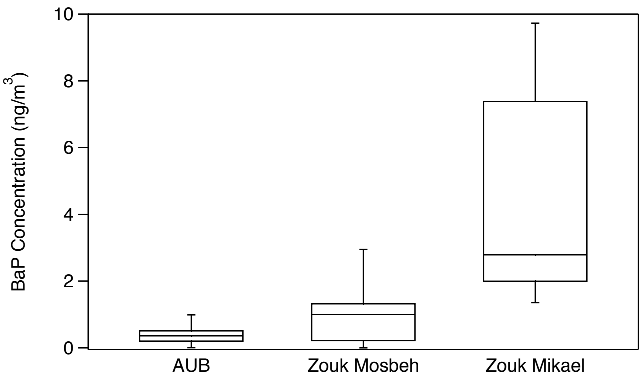

Figure 4-4 Box Plots of BaP Concentrations Measured at AUB, Zouk Mosbeh and Zouk Mikael. Whisker Bottom, Box Bottom, Box Top and Whisker Top Represent 10, 25, 75 and 100 Concentration Percentiles
Source: Baalbaki et al., 2018

In February 2020, Lebanon drilled the first deep water oil and gas exploration well (Offshore Technology, 2020). Being a significant emission source, the energy sector is likely to have a higher contribution to overall air pollution emission rates if Lebanon's ambition in fossil fuel extraction is reached.

4.1.3 Industry

Industrial processes and product use accounted for 9.5% of the emissions of GHGs in 2015. Cement factories in Chekaa and Sibline are estimated to contribute more than 99% of the emissions of the industry sector (MoE/UNDP/GEF, 2019). As an example, the primary emissions in the manufacture of Portland cement are PM, NOx, SO_2, CO and CO_2. Depending on the process, as well as the nature and quality of material burned in the kiln, lower quantities of pollutants such as VOC, ammonia (NH_3), chlorine, hydrogen chloride (HCl) and hazardous organic pollutants may also be emitted (EPA, 1994).

A 2011 study published the results of a monitoring campaign that spanned from 2002 to 2004 at five locations in and around the cement industry zone situated in Northern Lebanon in and around the town of Chekka. The results show that during the dry season, the levels of PM and SO_2 in the ambient surroundings experience high rates of exceedance. Numerical modeling confirmed that the industrial plants' smokestacks account for around 10 to 20% of the measured levels of SO_2 and PM_{10}. The rest is attributed to secondary sources at the mills, quarries and the private power plants operating within the industrial compounds (Karam and Tabbara, 2011).

Another study in 2012 developed a temporally-resolved and spatially-distributed emission inventory for Lebanon to provide quantitative information for air pollution studies as well as for use as input to air quality models. Among other findings, the study reported that the spatial allocation of emissions shows that the city of Beirut and its suburbs encounter a large fraction of the emissions from the on-road transport sector while urban areas such as Zouk Mikael, Jieh, Chekka and Selaata are mostly affected by emissions originating from the industrial and energy production sectors (Waked et al., 2012).

Industrial related air pollution is reportedly associated with several health impacts. A 2017 publication studied the health impact of airborne particulate matter in Northern Lebanon through the assessment of the mutagenicity and genotoxicity of $PM_{2.5}$ collected at industrial (Zakroun) and rural background sites (Kaftoun) of the Koura Caza. The mean $PM_{2.5}$ concentrations in Zakroun (industrial site) and Kaftoun (rural site) were 36.5 and 22.8 μg/m³, respectively (compared to daily and annual World Health Organization (WHO) guidelines of 25 and 10 μg/m³, respectively). Particles collected under industrial influence showed dose-response higher mutagenicity and genotoxicity compared to the rural one due to higher concentrations of PAH, dioxins and furans (Melki, 2017). In addition, a statistically significant increase in respiratory health complaints among children (5-15 years old) in Northern Lebanon was associated with the proximity of residence to cement and fertilizer plants in industrialized districts (Kobrossi et al., 2010). *Additional information about industries in Lebanon and their distribution can be found in Chapter 10 – Chemical Management.*

4.1.4 Other Driving Forces

Uncontrolled waste burning is believed to largely contribute to air pollution worldwide and is the method use to dispose of around 40% of the world's generated waste (Wiedinmyer et al., 2014). Environmental protection agencies have warned against these practices and shared a wealth of information with the public to emphasize the associated health risks (CIB, 2014; DEP, 2016; DNR, 2016; EPD, 2015; IDEM, 2016). In some developing countries, proper waste management practices are absent, which results in increased open waste burning activities both in residential areas and at dump sites. Waste burning is known to emit a wide variety of atmospheric pollutants including, but not restricted to, GHGs, SO_2, NOx, VOCs, PM, PAHs, HCl, hydrogen cyanide, persistent organic pollutants (POPs) such as hexachlorobenzene, polychlorinated biphenyls (PCBs), polychlorinated dibenzodioxins and polychlorinated dibenzofurans (PCDD/Fs), and heavy metals such as Mercury (Hg), Arsenic (As) and Lead (Pb) (Akagi et al., 2011; Estrellan & Iino, 2010; Lemieux et al., 2000; Lemieux et al., 2004; Park et al., 2013; Solorzano-Ochoa et al., 2012; Wiedinmyer & Friedli, 2007).

Open waste burning is prohibited in Lebanon and is addressed in Law 80/2018, which states that solid waste management (SWM) should occur in a way that prevents contamination of air and harm to public health (Article 7). However, this practice has always been common in rural areas of the country. A 2017 study by the Ministry of Environment (MoE) and the United Nations Development Programme (UNDP) revealed that a high rate of waste dumpsites undergoing open burning (35%) was encountered in South Lebanon. Significant burning practices were also identified in the Baalbek-Hermel Governorate compared to non-evident and decreasing practices in Beirut/Mount Lebanon and Akkar/North Lebanon areas, respectively (MoE/UNDP, 2017). In addition, farmers and villagers tend to burn tree pruning, leaves, crop residue and mostly organic household waste in their backyards. This practice has, since July 2015, expanded to urban areas especially in Beirut and Mount Lebanon, in response to the SWM crisis *(refer to Chapter 8 – Solid Waste for details)*. Burning waste among highly dense residential areas leads to the deterioration of air quality and has significant public health implications with ambient concentrations of PM_{10}, $PM_{2.5}$, particle and gas phase PAHs and PCDD/Fs showing alarming levels (Baalbaki et al., 2016).

Of the natural phenomena, Lebanon is subject to seasonal dust storms in the fall and spring seasons originating from the Arabian and Saharan Deserts. Dust storms are often loaded with high levels of PM_{10} and $PM_{2.5}$ that are rich in crustal elements and long-range transported secondary inorganic aerosols. Additionally, seasonal forest fires, caused mainly by natural drought and the accumulation of flammable material due to forest mismanagement, are the main sources of smoke plumes charged with fine particles rich in carbon (VOCs, PAHs and inorganic elements such as potassium). During the October 2019 break out of forest fires in Lebanon, more than 120 forest fires were recorded in a period of two days (IFI, 2019a). Approximately 95% of the forest fires in the Mediterranean region are related to human impact (negligence, arson, etc.) (EEA, 2019). Only a small portion of open vegetation fires is caused by natural phenomena such as lightning (Koppman et al., 2005). The major products of biomass burning are CO_2 and water vapor. However, a large number of particulates (including black carbon) and trace gases are produced, including the products of incomplete combustion (CO and NMVOCs) and nitrogen and sulfur species, which indirectly influence the tropospheric ozone (O_3 budget) (Koppmann et al., 2005). These arise partly from nitrogen and sulfur contained in vegetation and organic matter in surface soils. Additionally, emissions can arise from the re-volatilization of substances that have been deposited (Hegg et al., 1987, 1990). Although important, the contribution of biogenic sources to ambient air pollution is still minimal (Waked et al., 2012).

4.2 Current Situation

The sections below present ambient air quality monitoring data that has been collected in the last decade in Lebanon. Emissions of global importance that the country has committed to reducing or eliminating are also discussed.

4.2.1 Ambient Air Quality

The levels of various air pollutants in Lebanon have been reported intermittently through the national air quality monitoring network (AQMN) that was installed and operated by MoE and by researchers, through stations operated by their respective universities (e.g. AUB, Saint Joseph University (USJ), University of Balamand (UoB)) and short to medium term air quality measurement campaigns using portable instruments. Studies have shown that levels of gas pollutants, PMs and their chemical contents, and VOCs exceed the WHO recommended limits for yearly averages. The following summarizes the studies that have reported outdoor levels of main criteria air pollutants along with other gas pollutants.

4.2.1.1 Main Criteria Pollutants

The WHO Air Quality Guidelines provide threshold limits for key air pollutants, also referred to as the main criteria pollutants, that have proven to be associated with health risks. The recommended exposure levels for PM_{10}, $PM_{2.5}$, O_3, NO_2 and SO_2 by WHO, as well as the national standards set by MoE, are shown in Table 4-2, noting that the national standards require updating (refer to Section 4.5.1). By reducing key pollutant concentrations to guideline levels, air pollution health risks are reduced. For example, by reducing PM_{10} pollution from 70 to 20 µg/m_3, air pollution-related deaths can be reduced by around 15% (WHO, 2021).

Table 4-2 Key Pollutant WHO Guidelines and National Standards

Key Pollutant	WHO Guideline (µg/m³)*	National Standard based on MoE Decision 52/1 of 1996 (µg/m³)
PM_{10}	50 (24-hour mean) 20 (annual mean)	80 (24-hour mean)
$PM_{2.5}$	25(24-hour mean) 10 (annual mean)	NA
O_3	100 (8-hour mean)	150 (1-hour mean) 100 (8-hour mean)
NO_2	200 (1-hour mean) 40 (annual mean)	200 (1-hour mean) 150 (24-hour mean) 100 (annual mean)
SO_2	500(10-minute mean) 20 (24-hour mean)	350 (1-hour mean) 120 (24-hour mean) 80 (annual mean)

*Source: WHO, 2006

Annual mean levels of O_3, NO, NO_2 and SO_2 for the year 2005-2006 in a Beirut urban site were 31, 36, 40 and 11 µg/m³, respectively (Farah et al., 2014) with no exceedance of the means recommended by WHO. O_3 and NO_2 showed similar concentrations in 2017 as reported by the MoE monitoring network. As shown in Figure 4-5, monthly average concentrations as collected by the AQMN, between June and December 2017 (the only continuous published record available) in urban and background locations across Lebanon, were between 12-123 µg/m³ for O_3, 9-79 µg/m³ for NO_2, 0-24 µg/m³ for SO2, 7-50 µg/m³ for $PM_{2.5}$ and 13-59 µg/m³ for PM_{10}.

A study conducted in 2018 used the AQMN data of 2014, as well as data from a long-term monitoring campaign, to assess the Weather Research and Forecast/Polyphemus air quality modelling system used to simulate air quality over one national domain over Lebanon and one city-scale domain over Beirut for key gas pollutants. At the time (i.e. before Phase 2 of the AQMN - more information regarding the installation phases are provided in Section 4.4.2), the AQMN consisted of five stations, four of which were used in the study, namely two urban stations in Beirut (one at the Beirut Pine Forest and the other at the Lebanese University campus in Hadath), an urban station in Zahle, and a suburban station in Baalbek. The long-term monitoring campaign was conducted simultaneously by USJ at an urban location within the capital at the Beirut Pine Forest, and at a suburban location outside Beirut namely the USJ campus in Mansourieh (Abdallah et al., 2018). The results of this study in terms of the statistical evaluation of the model compared to measurements are presented in the following subsections.

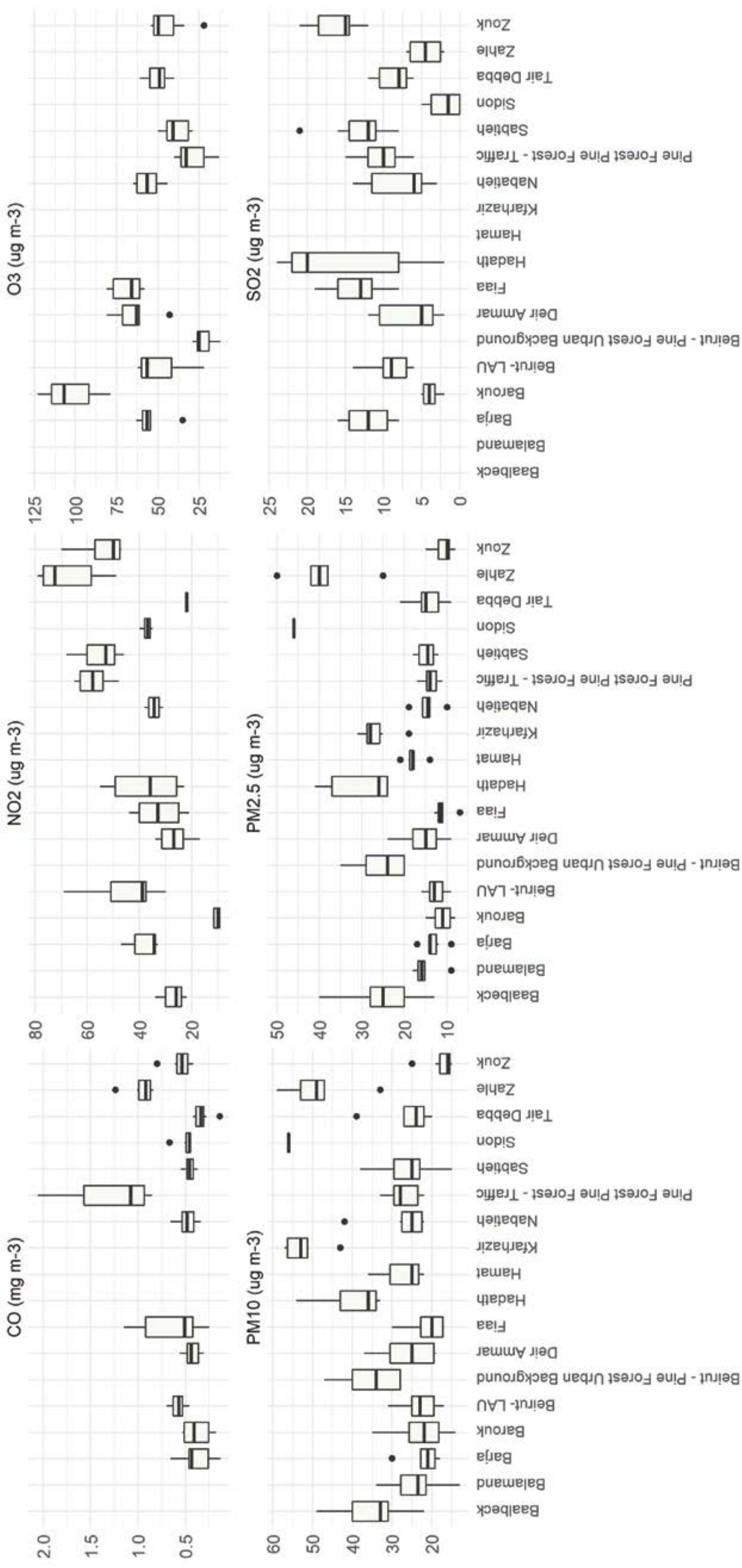

Figure 4-5 AQMN Monthly Means for the Period Spanning June to December 2017
Source: Data extracted from available National Air Quality Monitoring Reports

Nitrogen Dioxide

Combustion of fossil fuels for heating, power generation and motor vehicles (internal combustion engines) are the major sources of anthropogenic emissions of NOx into the atmosphere. Other contributors of atmospheric NO_2 are certain non-combustion industrial processes, such as the manufacture of nitric acid, the use of explosives and welding (WHO, 2000).

The results for the Lebanon simulation by Abdallah et al. (2018) showed a modelled annual mean and an observed annual mean concetrations of 34.7 μg/m^3 and 41.3 μg/m^3, respectively (compared to a WHO annual guideline of 40 μg/m^3). As for the Beirut simulation, the reported modelled annual average was 30.6 μg/m^3 while the observed value was 48.3 μg/m^3 (Figure 4-6). These concentrations are mainly attributed to the transport sector, which is a major contributor of NO_2. In fact, Lelieveld et al. (2015) indicated a 20-30% increase of NO_2 total column over Lebanon in 2014 compared to 2013. This increase is in line with another study which estimated a 20% increase in emissions in Lebanon between 2011 and 2014 as a result of population growth resulting mainly from the Syrian crisis (MoE/EU/UNDP, 2014) (refer to Section 4.1.1).

In addition, the same modelling study indicated that NO_2 observed annual averages ranging between 45 μg/m^3 and 56.7 μg/m^3 are above the WHO recommended value of 40 μg/m^3 limit. With the exception of the Baalbek station, NO_2 exceedances were reported in all stations of the MoE operated AQMN (Abdallah et al., 2018). In line with the AQMN data and other previous studies such as Afif et al. (2009) and Badaro-Saliba et al. (2014), the modelled data of Abdallah et al. (2018) also showed exceedance in NO_2.

Ozone

Ozone is a secondary pollutant formed by photochemical reactions in the presence of sunlight and precursor pollutants such as NOx and VOCs, as well as methane (CH_4) and CO. These ozone precursor emissions originate mainly from anthropogenic activities. In the vicinity of the anthropogenic source of pollution, NOx depletes ozone, leading to lower levels of this pollutant in urban areas. Downwind, at a distance from the source, however, NOx emissions lead to ozone formation (WHO, 2008).

At the time of the Abdallah et al. (2018) study, only two stations of the AQMN were equipped with O_3 analyzers. The first is the urban station of Beirut, the second is the sub-urban station of Baalbek, which is outside the domain of the Beirut simulation. This study revealed that, compared to the observations, the model performs well with respect to the used performance criteria (Figure 4-7). In addition, the WHO limit (100 μg/m^3 for eight consecutive hours) is exceeded in the Baalbek measurements. This limit is also exceeded according to the model in the regions that are distant from anthropogenic sources of pollution, especially over the mountainous areas of Mount Lebanon (between Beirut and Zahle), as well as in regions near the domain boundary limits to the south (Abdallah et al., 2018).

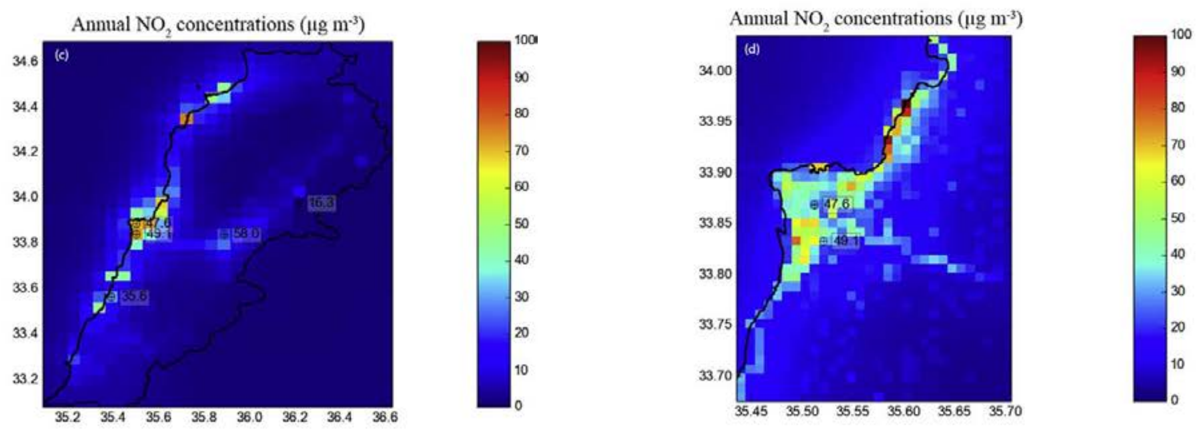

Figure 4-6 Mean Modelled Annual NO_2 Concentration Maps over Lebanon (Left) and Beirut (Right). Source: Abdallah et al., 2018

Sulfur Dioxide

Sulfur dioxide is a major air pollutant in many parts of the world and is derived from the combustion of sulfur-containing fossil fuels used for domestic heating purposes or from poorly controlled combustion in industrial installations (WHO, 2000). In the study of Abdallah et al. (2018), the average

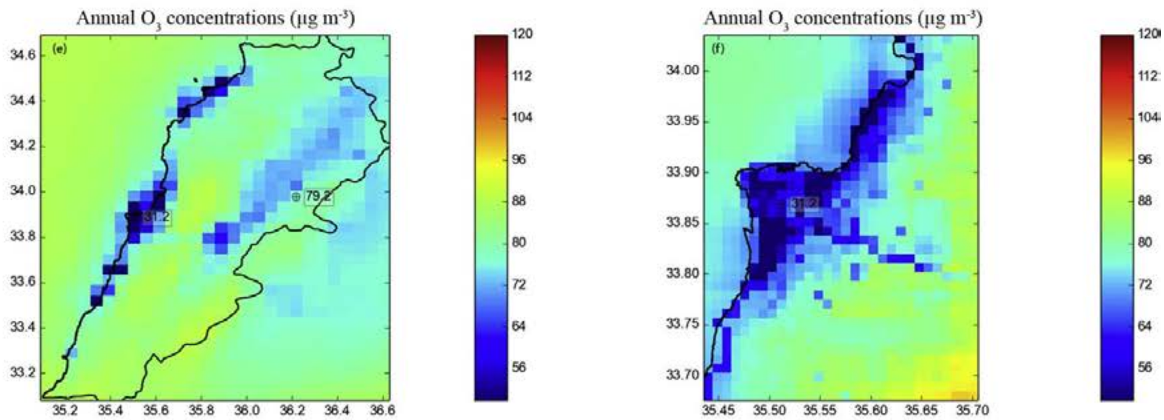

Figure 4-7 Mean Modelled Annual O_3 Concentration Maps over Lebanon (Left) and Beirut (Right)
Source: Abdallah et al., 2018

modelled annual concentration of SO_2 for the Lebanon simulation is 28.3 μg/m^3 while the average observed annual concentration is 10.5 μg/m^3, which is relatively low compared to the WHO daily guideline and to the national annual standard for SO_2 (20 μg/m^3 and 80 μg/m^3, respectively, noting that there are no annual WHO guidelines for SO_2). The poor correlations between modelled and observed concentrations could be explained by an overestimation of the emissions and/or the uncertainties in the reproduction of local winds governing the transport and dispersion of the high concentrations emitted from the major sources. This is observed near Saida, where the mean measured SO_2 concentration is 4.6 μg/m^3 while the modelled one is 28.8 μg/m^3, the variation most likely attributed to the dispersion of nearby point sources with high emissions, such as the power plants (Figure 4-8).

Particulate Matter

For $PM_{2.5}$, the WHO annual limit is 10 μg/m^3. This limit is considered very strict compared to other legislations such as the European Union (EU) Directive 2008/50/EC on ambient air quality and cleaner air for Europe, which allows a limit of 25 μg/m^3 (EU, 2008). The 2014 $PM_{2.5}$ averages from the MoE-operated AQMN exceeded not only the WHO limits but also the EU limit. In addition, the Abdallah et

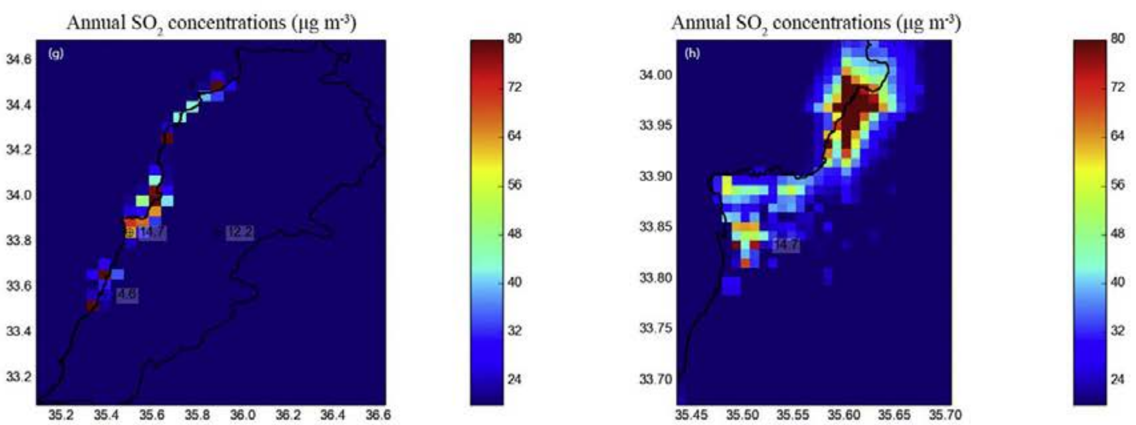

Figure 4-8 Mean Modelled Annual SO_2 Concentration Maps (over Lebanon (Left) and Beirut (Right)
Source: Abdallah et al., 2018

al. (2018) model results suggest that the air quality throughout the whole country exceeds the EU limit (Figure 4-9).

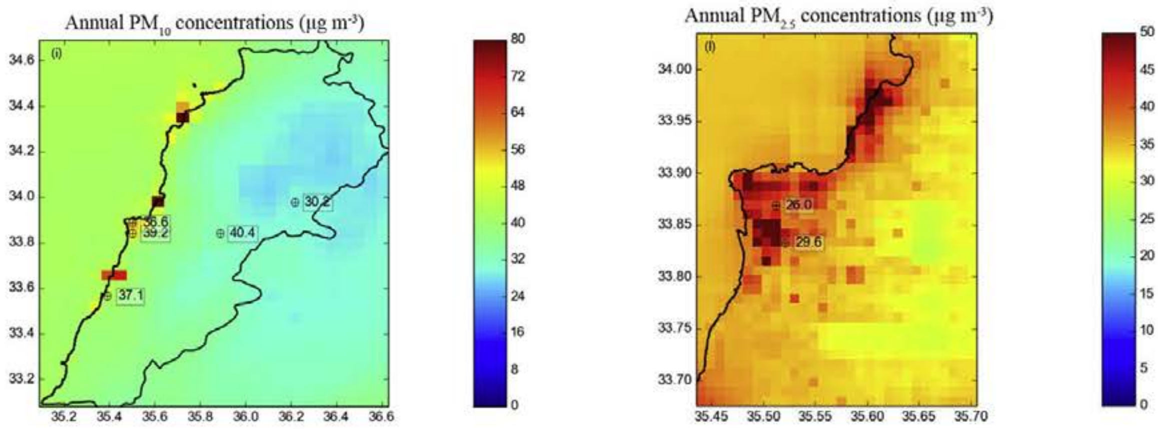

Figure 4-9 Mean Modelled Annual $PM_{2.5}$ Concentration Maps over Lebanon (Left) and Beirut (Right)
Source: Abdallah et al., 2018

In addition, PM mass concentrations measured between 2003 and 2010 at various sites in Beirut varied between 19.7 and 521.2 $\mu g/m^3$ for PM_{10} and 8.4 and 72.2 $\mu g/m^3$ for $PM_{2.5}$, in some cases exceeding the WHO standards by up to 26 times for PM_{10} and 7 times for $PM_{2.5}$. PM averages were shown to be season dependent with higher values in the fall and summer as a result of the increase of dust storm activities and low precipitation, respectively (Saliba et al., 2010, Massoud et al., 2011, Farah et al. 2018).

Observed PM mass concentrations in Lebanon are subject to dusty PMs originating from the Sahara Desert of North Africa, as well as the Arabian Desert of the Arabian Peninsula. Aerosols from dust events in the Arabian Desert migrate westward through the urban atmospheres of Saudi Arabia, Jordan and eastern Lebanon before joining with the indigenous Beirut PM above the city. This air mixture showed an increase, over non-dust episodes, in particle volume distribution and an increase in average mass concentration by 48.5% and 14.6% for the coarse and fine fractions, respectively (Jaafar et al, 2014). Even the content of these particles is subject to chemical variations. In addition to crustal elements, dust-rich episodes have been shown to exhibit an increase in secondary ions in PM_{10} and $PM_{2.5}$ like nitrates and sulfates (Saliba & Chamseddin, 2012 Jaafar et al, 2014 Daher et al., 2013). Chemical variations have also been associated with increased inflammation precursors in PMs (Lovett, 2018).

The effect of traffic density on PM levels is significant. In fact, PMs collected at the Jal El Dib freeway showed mass levels that were 1.3 to 2.6 times greater than the masses measured at a reference urban background location like AUB. The particle counts measured along the Jal El Dib freeway at the roadside site were at least 20% higher than those off the road sites. The average increase in PM count on the road relative to AUB amounts to 42%, 43% and 26% in the morning, afternoon and evening, respectively, with particle sizes ranging predominantly between 0.425 and 0.675 µm with a prevalent peak at 0.475 µm (Baalbaki et al., 2013).

Although PM concentrations are significantly affected by seasonal dust events, the toxicity of PMs in terms of PAH, heavy metals, Organic Carbon (OC) and Elemental Carbon (EC) content is mostly associated with local anthropogenic loads such as traffic activity, energy generation and waste burning. This highlights the need to study the sources of air pollution and their contributions to the pollution load. To do so, more measurement equipment need to be installed to provide continuous monitoring.

4.2.1.2 Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons are formed mainly as a result of pyrolytic processes, particularly from the incomplete combustion of organic materials during industrial and other anthropogenic activities, including processing of crude oil and coal, combustion of natural gas, combustion of refuse, vehicle traffic, cooking and tobacco smoking, as well as from natural processes such as carbonization (WHO, 2000). Like other volatile and semi-volatile pollutants, PAHs adsorb on suspended particles in the air (Błaszczyk et al., 2017). Traffic-related emissions have been found to be the main outdoor source of indoor PAH concentration in urban and suburban areas. In fact, motor vehicle emissions account for approximately 46–90% of the mass of individual PAHs in ambient air particles in urban areas, whereas domestic heating can account for a lower percentage of PAHs in outdoor air (WHO, 2010).

In Lebanon, EC and PAHs present in the PMs collected at the Jal El Dib freeway were, respectively, 5 and 3.7 times greater than a diesel-impacted freeway in Southern California, and when compared gram-for-gram, PM levels on the Jal El Dib freeway contained up to 7 times higher amounts of BaP than what was measured at the I110 California freeway. In the vicinity of the freeway, PM bound OC levels exceeded those at the background site by up to 7 times (Daher et al., 2013).

Measurements of ambient levels of PAH at three coastal locations at AUB, Zouk Mikael and Dora showed average levels of 36.3 ng/m^3, 25.08 ng/m^3 and 91.88 ng/m^3 in winter and 13.15 ng/m^3, 27.65 ng/m^3 and 69.43 ng/m^3 in summer, respectively. High PAH levels in winter in AUB and Dora are attributed to several factors including the higher frequency of temperature inversions, increased usage of PAH emitting sources, such as domestic heating, and slower PAH photo-degradation reactions. In the vicinity of the power plant site in Zouk Mikael, a 300% increase in BaP in the summer (3.32 ng/m^3) is likely due to a greater need for electricity during the hot season. The annual average BaP concentrations of 2.07 ng/m^3 and 2.9 ng/m^3 at Zouk Mikael and Dora, respectively, exceeded the EU air quality standard of 1 ng/m^3. These concentrations are 60%-99% higher than many cities around the world (Figure 4-10) (Baalbaki et al., 2018).

Higher and alarming levels of PAHs were also observed during open waste burning episodes in a residential area located east of Beirut between October and December 2015. Associated with PAHs are high levels of PM (PM_{10}, $PM_{2.5}$), gaseous and particle-bound PAHs, as well as PCDD/Fs. During waste burning, the total concentration of 16 measured PAHs averaged at 55 ± 19 ng/m^3 compared to a concentration of 24.1 ng/m^3 measured on the “no-burning” day (Figure 4-11). In one incident, the sum of the 16 PAHs was 76.7 ng/m^3; a 218% increase over the “no-burning” day (Baalbaki et. al., 2016).

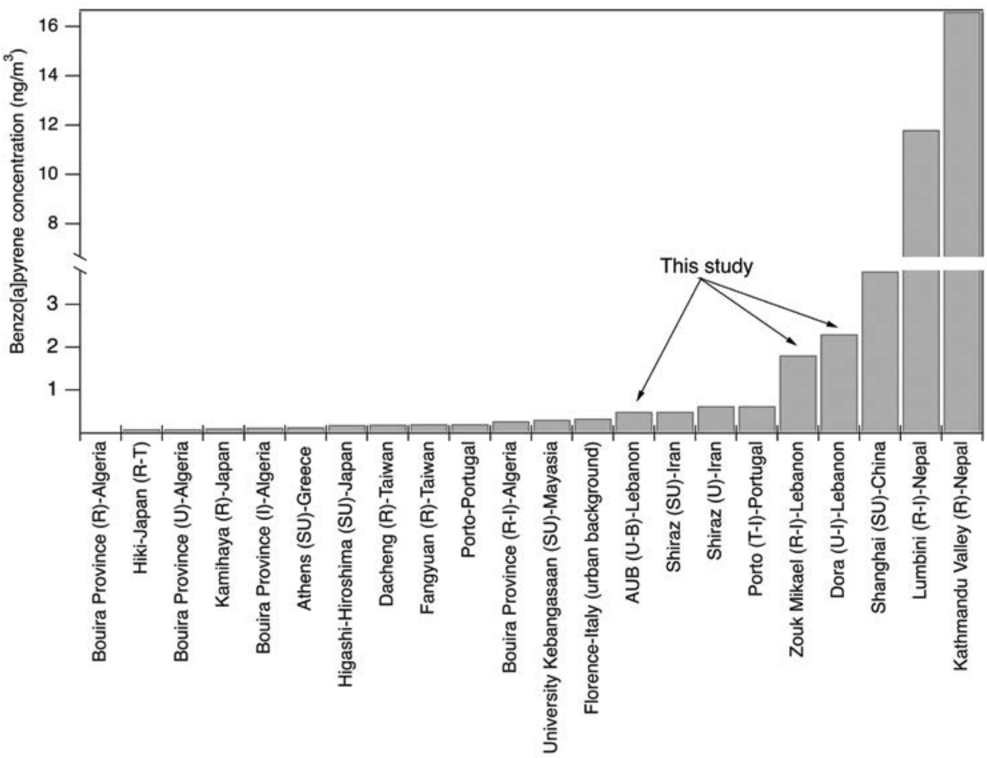

Figure 4-10 BaP Concentrations (ng/m^3) Measured in Lebanon (This study) and Other Cities
Source: Baalbaki et. al., 2016, referred to in the graph by ‘This study”

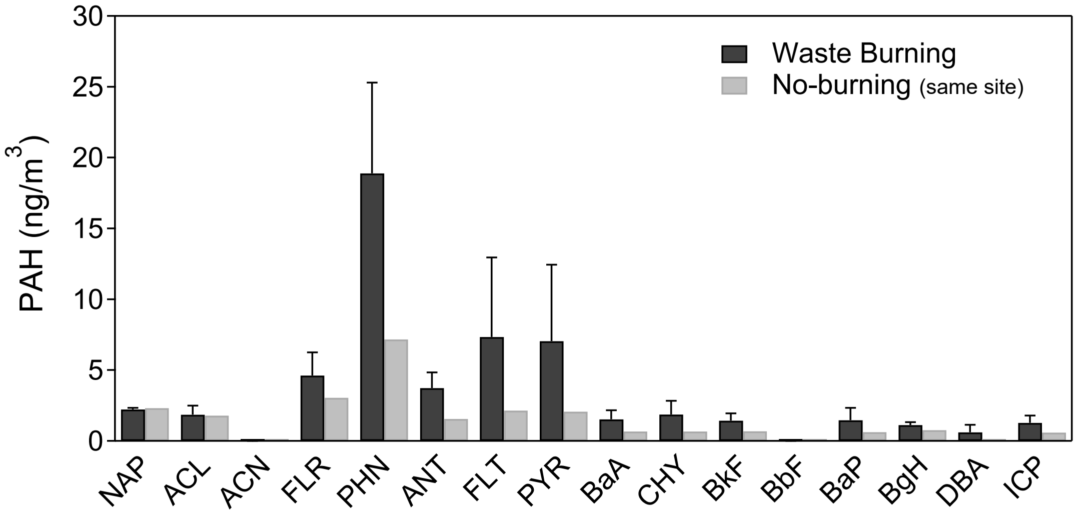

Figure 4-11 Levels of 16 PAHs during Waste Burning and "No-Burning" Days in Beirut, Oct-Dec 2015
Note: Error Bars Represent the Standard Deviation Of 3 Samples. NAP (Naphthalene), ACL (Acenaphtylene), ACN (Acenaphtene), FLR (Fluorene), PHN (Phenanthrene), ANT (Anthracene), FLT (Fluoranthene), PYR (Pyrene), BaA (benzo[a] anthracene), CHY (Chrysene), BkF(Benzo[k]fluoranthene), BbF (Benzo[b]fluoranthene), BaP (Benzo[a]pyrene), BgH (Benzo[g,h,i]perylene), DBA (Dibenz[a,h]anthracene) and ICP (Indeno[1,2,3-cd]pyrene).
Source: Baalbaki et. al., 2016

4.2.1.3 Volatile Organic Compounds

Some VOCs, mainly NMHCs, are the main classes of organic pollutants and the main O_3 precursors in the atmosphere, which can markedly affect the atmospheric photochemical chemistry and human health. Sources of NMHCs in urban air are usually dominated by anthropogenic activities including vehicular emissions, liquefied petroleum gas leakage and solvent usage (Guo et al., 2012).

NMHCs were measured in a study conducted by Salameh et al. (2016) at a suburban site in Beirut during two field campaigns in the summer of 2011 and winter of 2012. The study indicated that gasoline evaporation contribution, mainly from traffic and the episodic point source, was found to be a large contributor to NMHC ambient concentrations. In addition, the measured average concentrations of NMHCs showed a seasonal variation whereby concentrations were found to be higher in summer. On the other hand, regardless of the season, major compounds such as toluene, isopentane, butane, m,p-xylenes, propane and ethylene were the most abundant forms of NMHCs in Beirut's urban area during both seasons, representing almost 50% of the measured average (Salameh et al., 2015).

4.2.1.4 Health Impact and Economic Cost

According to WHO, there is a close and quantitative relation between exposure to high concentrations of PM_{10} and $PM_{2.5}$ and increased mortality and morbidity, both daily and over time. Serious health effects from air pollution are associated with exposure to PM, O_3, NO_2 and SO_2. Associated health risks of PM exposure include acute lower respiratory infections, cardiovascular disease, chronic obstructive pulmonary disease and lung cancer. Excessive O_3 in the air can cause breathing problems, trigger asthma, reduce lung function and cause lung disease. In fact, O_3 is a major factor in asthma morbidity and mortality globally. As for NO_2, epidemiological studies have shown that symptoms of bronchitis in asthmatic children increase in association with long-term exposure, as is reduced lung function growth. Health effects from SO_2 air pollution include respiratory system diseases, reduced lung function and eye irritation. Inflammation of the respiratory tract is also a health risk associated with SO_2 exposure, causing coughing, mucus secretion, aggravation of asthma and chronic bronchitis. It also makes people more prone to respiratory tract infections (WHO, 2021).

Assessment of exposure to PAHs is important due to their widespread presence in the environment and their toxicological characteristics, particularly to vulnerable populations such as children (Błaszczyk et al., 2017). In fact, epidemiological studies show a significant relation between exposure to PAHs and asthma development and respiratory function in children. In addition, PAH exposure in adults can be linked to respiratory functions, exacerbation of asthma and increased morbidity or mortality from obstructive lung diseases (Lar et al., 2020). As for

VOC, health impacts include eye, nose and throat irritation, shortness of breath, headaches, fatigue, nausea and dizziness. Moreover, higher concentrations may cause irritation of the lungs, as well as damage to the liver, kidney or central nervous system (USEPA, 2021).

Greater effect is predicted for developing countries with high air pollution concentrations, missing infrastructure for an environmental regulatory entity and a growing need for urban and industrial development (Briggs, 2003). Total global deaths attributable to ambient airborne fine particulate matter ($PM_{2.5}$) were 4.2 million in 2015, when ambient $PM_{2.5}$ was the fifth-ranking mortality risk factor (Cohen et al., 2017). In 2012, outdoor air pollution accounted for a global total of approximately 7 million premature deaths annually, of which 80% are from cardiovascular disease (CVD) (WHO, 2014). Children have higher respiration rates and inhale proportionally more pollutants, and so are especially vulnerable in polluted urban environments. In fact, in 2016, over half a million children under five years died from air pollution related causes worldwide (WHO, 2016). CVD deaths have increased rapidly in low- and middle-income countries recently, as have levels of $PM_{2.5}$ (IHME, 2016; Cohen et al. 2017).

In Lebanon, a recent evaluation of a Lebanese community cohort from the GBA revealed worsening of the cardiovascular profile over the past years (Isma'eel et al., 2018). Other studies showed that air pollution exposure was associated with hypertension in a dose-effect relationship (Salameh et al., 2018) and that living near busy highways and close to local diesel generators was significantly associated with CVD (Nasser et al., 2015). Furthermore, an association between daily ambient airborne particulate matter (PM_{10} and $PM_{2.5}$) concentrations and respiratory and cardiovascular emergency hospital admissions in the city of Beirut was established (Nakhleh et al. 2015). The average cumulative cancer risk in Beirut exceeded the US EPA acceptable level (10−6) by 40-fold in the summer and 30-fold in the winter (Dhaini et al., 2017).

As mentioned previously, burning waste among highly dense residential areas leads to the deterioration of the air quality especially from emissions of PM_{10} and $PM_{2.5}$ with spikes reaching up to 1,126 and 665 µg/m^3, respectively. This translated to an increase of short term (2 years) incremental cancer risk to 65 cases per million people solely due to inhalation of PCDD/Fs. Particle-bound metals have also shown a strong increase during waste burning days but levels remain below alarming thresholds (Baalbaki et al., 2016).

Box 4-1 presents the implications of the August 4 Beirut Port Explosion on air quality within the city.

Box 4-1 Explosion of Beirut's Port Implications for Air Quality
Around 6 pm on August 4, 2020, a large amount of ammonium nitrate exploded in the port of Beirut. A substantial chemical release of NOx occurred with risks of cascading release of other hazardous substances that may have been stored in facilities impacted by the explosion. The Aerosol Research Lab at AUB reported that air quality indicators showed a sharp rise between 6 and 7 pm on August 4 and returned to pre-explosion levels shortly after. The plume has been carried downwind and scattered into the atmosphere to below detectable limits, while larger dust particles will have settled on the ground in areas downwind of the port and some can be re-suspended in the air (UNDAC, 2020).

Human activities are the largest determinants of ambient air quality, which depends on pollutant emission transport, transformation, mixing and removal from the atmosphere. The combination of the different pathways is not a linear relationship and is mostly accounted for by complex computer modeling coupled with satellite imaging and ground monitoring. Pollutant levels recommended by the WHO are based on an extensive body of scientific evidence relating to air pollution and its health consequences. In particular, the air quality guidelines for the main criteria pollutants (Table 4-2) are developed to support actions to achieve air quality that protects the well-being of people in different countries. Box 4-2 presents the cost of air pollution in Lebanon and shows how enacting reforms in the energy and transport sector in Lebanon can reduce the economic burden and mortality rates that are linked to air pollution in GBA.

Box 4-2 Cost of Ambient Air Pollution and Savings from Sector Reforms in GBA

Cost of degradation: The rapid cost of environmental degradation study conducted in 2018 by UNDP (MoE/UNDP, 2019) used an exposure-based approach with annual average $PM_{2.5}$ concentration of 36 ug/m^3 derived from AQMN stations measurements. Several epidemiological studies revealed strong correlations between long-term exposure to $PM_{2.5}$ and premature mortality. The population exposed was assumed to be the urban population with more than 100,000 and special areas such as Chekka, where the cement industry is a large emitter of PM, and was estimated to be around 3.5 million. The Value of Statistical Life as derived from OECD (2015) and adjusted to 2018 prices is used for premature death. The GDP/capita/year in 2018 is used per Disability-Adjusted Life Year (DALY) lost, which is a health metric equivalent to 1 lost year of healthy life. Mortalities and morbidities caused by air pollution were estimated at 33.04 deaths and 263 DALY per 100,000. **The cost of degradation in 2018 was then estimated to be US$ 0.84 billion for premature mortalities and around US$ 0.1 billion for morbidities for a total of US$ 0.95 billion (1.7% of the GDP).**

Savings from sector reforms in the Greater Beirut Area: An estimation of the economic losses due to mitigatable $PM_{2.5}$ emissions emanating from the transport and energy sectors in the GBA was conducted by Salti and co-authors. It assumes an annual average exposure of 32 µg/m^3 of 2.2 million residents in the GBA. Based on ongoing work by the authors on sources apportionment, the contribution of the energy and transport sectors to $PM_{2.5}$ pollution in GBA was assumed to be 30% (due to private power generation) and 50%, respectively. The economic losses due to mitigatable $PM_{2.5}$ emissions were estimated by considering the effect of sector reforms. For the energy sector, the 24/7 supply of electricity to GBA would then reduce $PM_{2.5}$ levels by 30% and, for the transport sector, a newer vehicle fleet would decrease vehicle fleet emissions by an average of 50%. These yields projected reductions in $PM_{2.5}$ by 9.3 and 8 µg/m^3 for energy and transportation sector reforms, respectively. Using dose response functions similar to the ones used in the cost of environmental degradation study, these reductions would translate in a reduction of attributable cases of death from air pollution from 11,233 to 2,604 cases per year in GBA alone. Therefore, as compared to the do-nothing scenario, reforms in the energy and transport sector would "save" 8,629 lives per year in the GBA and would represent economic savings of around US$ 1.2 billion.

4.2.2 Indoor Air Quality

Built environments such as buildings, apartments and offices affect occupants' health in many ways depending on the type of ventilation and air exchange between the indoor and outdoor environment (Hood, 2005; Fisk, 1999; Zheg et al., 2011). Household air pollution (HAP) mainly affects women and children due to the nature of activities performed indoors, such as cooking and other domestic practices and accounts for 60% of premature deaths. Additionally, HAP contributes to 50% of child pneumonia, the single biggest killer of children under 5 years of age worldwide (Prüss-ustün et al., 2016; WHO, 2016). In 2016, around 3.8 million premature deaths were attributed to HAP. Almost all of the burden was recorded in low- to middle-income countries (WHO, 2021). Studies performed in the Middle East have linked gender-specific practices such as smoking and grilled/barbecued food to exposure to PAH, mainly pyrene, naphthalene, phenanthrene and fluorene. The results suggest that urinary-PAH is more detected in men than in women due to smoking habits (Hoseini et al., 2018).

Several organizations and government agencies have identified commonly encountered indoor pollutants with sources of emission and established guidelines for exposure limits and associated health effects. These include mold, benzene, CO, formaldehyde, naphthalene, NO_2, PAH, radon, trichloroethylene and tetrachloroethylene. Although exposure to combined indoor air pollutants exists, there are no guidelines for co-exposure. Instead, reducing PM, which has biological, chemical and physical properties, may be effective to reduce exposure effects to multiple pollutants (WHO, 2010; WHO, 2009).

Environmental tobacco smoke (ETS) is a major source of PM pollution, emitting concentrations up to 10-fold those emitted from diesel engines (Invernizzi et al., 2004). PM in ETS leads to immunological and lung function impairment, pulmonary diseases and aggravation of cardiovascular and respiratory conditions (EPA, 1996). In Lebanon, smoking cigarettes, cigars and water pipes is excessive in both public and private areas (MoE/UNDP/ECODIT, 2011). According to the needs assessment mission for the implementation of the WHO Framework Convention on Tobacco Control conducted in April 2016, 38.5% of the Lebanese population smoke cigarettes and 22.4% smoke water pipes. In addition, 98.6% of children aged between 13 and 15 years are exposed to second-hand smoke at home. A study conducted in 2010 found secondhand smoke levels in 28 public Lebanese places to be in the "hazardous" range (WHO FCTC, 2016). According to a study conducted by Salti et al. (2014), tobacco trade in Lebanon led to a total social cost of $326.7 million, equivalent to 1.1% of the gross domestic product (GDP) in 2008.

4.2.3 Pollutants Addressed in Multilateral Environmental Agreements

Lebanon is a signatory of several international treaties like the United Nations Framework Convention on Climate Change (UNFCCC), the Stockholm Convention on POPs, and the Vienna Convention and the Montreal Protocol for the Protection of the Ozone Layer (refer to Section 4.3.1). The Government of Lebanon (GoL) has therefore pledged to contribute to stabilizing GHG concentrations in the atmosphere, protecting human health and the environment from POPs and protecting the ozone layer from damage by ozone depleting substances (ODS), including

Chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), halons and methyl bromide.

4.2.3.1 Greenhouse Gases

The Intergovernmental Panel on Climate Change (IPCC) defines radiative forcing as a measure of the ability of a given climatic factor to absorb and radiate back energy into space. The forcing value for each factor is calculated for the time period between 1750 and the present day. Climatic factors with "positive forcing" warm while the "negative forcing" cool the Earth's surface (NOAA, 2021a). In 2015, it was reported that the positive forcing of the earth increased since 1990 by 37%. This increase is mainly due to the continuous increase in CO_2 in the atmosphere, accounting to around 80% of the total increase in radiative forcing. Other contributors to the positive forcing of the earth's surface include CH_4, nitrous oxide (N_2O), O_3 and black carbon (NOAA, 2021b).

Lebanon ratified the UNFCCC in 1994, the Kyoto Protocol in 2006 and the Paris Agreement in 2019 and has since submitted several reports on the status of GHG emissions in the country. The latest inventory of GHG emissions compiled in Lebanon's Third Biennial Update Report covers the years 1994-2015 based on the 2006 IPCC Guidelines. National emissions of CH_4 and N_2O were converted to CO_2eq using the IPCC Fifth Assessment Report's Global Warming Potential values based on the effects of greenhouse gases over a 100-year time horizon. During the reporting period, a threefold increase in GHG emissions took place such that in 2015, Lebanon emitted 27,107 Gg CO_2eq (as total emissions) with the most significant GHG being CO_2, primarily produced from the burning of fossil fuels. The main contributor to GHG emissions were the electricity production and transport sectors with 85% of GHG emissions, followed by industrial processes (8%). CO_2 removals from forestry and land use change amounted to -3,311 Gg CO_2, bringing Lebanon's net emissions to 23,796 Gg CO_2eq (MoE/UNDP/GEF, 2019).

A comprehensive discussion of the status of GHG emissions in Lebanon and associated responses and recommendations is found in Chapter 9 - Climate Change and Energy.

4.2.3.2 Unintentionally Released POPs

POPs are halogenated organic carbon-based chemicals pertaining to a class of endocrine disruptors. They are highly lipophilic and bioaccumulative, residing in lipid-containing tissues for several years before being excreted by the body. These toxicants bio-magnify and have been associated with different types of cancer (Alharbi, et al., 2018), metabolic syndrome (Dusanov et al., 2018), cardiovascular problems (Ljunggrenet al., 2014 and Lind, 2014), hypertension (Alharbi, et al., 2018), decrements in cognitive functions (Jacobson et al., 1990), immune suppression (Schwacke et al., 2012) and other health complications.

Due to the danger POPs pose on humans and the environment, the Stockholm Convention was held in 2001 by the United Nations Environment Programme (UNEP) to work towards eliminating the production and use of POPs. Lebanon ratified the Stockholm Convention in 2002. The chemicals originally enlisted under POPs were called the 12 dirty dozen and of interest are dioxins (PCDD) and furans (PCDF), which can be released into the atmosphere during waste incineration, metal production, heat and power generation, production of mineral products, transport, open burning processes, and use of chemicals and consumer goods. The total estimated annual PCDD/PCDF emissions in Lebanon between 2004 and 2014 are 469 g TEQ to air, 929 to residues, 23 to water and 80 to products (MOE/UNEP/GEF, 2017).

Chapter 10 – Chemical Management provides detailed information on POPs prevalence in Lebanon, along with national responses and future outlook.

4.2.3.3 Ozone Depleting Substances

ODS are pollutants that are long-lived and can remain in the atmosphere from 20 to 120 years or more. Unlike most chemicals released into the atmosphere at the earth's surface, ODS are not "washed" back to earth by rain or destroyed by other chemicals. As such, pollutant transport mechanisms can drift them to the stratosphere layer where they interact with ozone. The reaction of ozone with ODS leads to the reduction of ozone and consequently the ability of the stratosphere to absorb the ultraviolet radiation before reaching the troposphere. Ultraviolet radiation can have detrimental effects on the ecosystem including both humans and the environment. ODS have been commonly used in refrigerants in commercial, home and vehicle air conditioners and refrigerators, foam blowing agents, components in electrical equipment, industrial solvents, solvents for cleaning (including dry cleaning), aerosol spray propellants and fumigants. They are mainly composed of CFCs, HCFCs, hydrobromofluorocarbons (HBFCs), halons, methyl bromide, carbon tetrachloride and methyl chloroform.

Lebanon ratified the Montreal Protocol and its amendments that call for a phase out of ODS, which led to a drastic decrease in their consumption. This trend is projected to continue over the coming years. Lebanon also ratified in 2020 the Kigali amendment to the Montreal Protocol which aims for the phase-down of hydrofluorocarbons (HFCs), ODS substitutes that have high global warming potential, by cutting their production and consumption *(Refer to Chapter 10 – Chemical Management for more details on their phase out schedules).*

4.3 Legal Framework and Key Stakeholders

4.3.1 Multilateral Environmental Agreements

The GoL has acceded to and ratified several multilateral environmental agreements related to improving air quality, mitigating climate change and protecting the ozone layer (Table 4-3).

4.3.2 Legislation, Policy and Strategies

The last decade has witnessed several important milestones related to the adoption of legislation and the strategy for the air quality sector. These are presented in the sections below.

4.3.2.1 Legislation

A discussion of the major regulatory texts governing air quality management in Lebanon is included below. In addition, a comprehensive list of laws and regulations pertaining to air quality management in Lebanon is provided at the end of this chapter.

The Air Quality Protection Law

After 13 years since its preparation in the framework of the Strengthening the Environmental Legislation

Table 4-3 Multilateral Environmental Agreements related to Air Quality

Conventions	Status	Main Goals
Climate Change		
United Nations Framework Convention on Climate Change	Ratification by Law 359/1994	Framework to stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.
Kyoto Protocol	Ratification by Law 738/2006	Protocol to the UNFCCC to reduce GHG emissions to levels that would prevent interference with the climate system.
Paris Agreement	Ratification by Law 115/2019	Agreement within the UNFCCC to keep the increase in global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the increase to 1.5°C, which would substantially reduce the risks and impacts of climate change.
Ozone Layer		
Vienna Convention for the Protection of the Ozone Layer	Adhesion by Law 253/1993	To protect ozone layer damage by ODS including CFCs, HCFCs, halons and methyl bromide.
Montreal Protocol on Substances that Deplete the Ozone Layer and its amendments London Amendment	Adhesion by Law 253/1993	Protocol to Vienna Convention to phase out the production and consumption of substances believed to be responsible for ozone depletion.
Copenhagen Amendment	Adhesion by Law 120/1999	
Beijing Amendment	Adhesion by Law 758/2006	
The Kigali Amendment to the Montreal Protocol	Ratification by Law 119/2019	To phase out the use of HFCs, which if fully implemented, would avoid up to 0.4°C increase in global temperature by the end of the century.
POPs		
Stockholm Convention on Persistent Organic Pollutants	Accession by Law 432/2002	To protect human health and the environment from POPs, including dioxins and furans (by-products of combustion activities).
Others		
WHO Framework Convention on Tobacco Control	Ratification by Law 657/2005	To combat the tobacco epidemic and its industry marketing and protect present and future generations from the devastating consequences of tobacco consumption and ETS.
Minamata Convention on Mercury	Ratification by Law 2/2017	To protect human health and the environment from the adverse effects of mercury.

Development and Application System in Lebanon (SELDAS) project (EU/UOB/MOE/ELARD, 2005), the draft law on the protection of air quality was finally adopted in 2018 (Law 78). Comprising of 34 articles, the law aims at preventing and mitigating ambient air pollution from fixed and mobile sources, through: monitoring air pollutants (through the National Program for Ambient Air Quality Monitoring, National Network for Ambient Air Quality Monitoring, National Emission Inventory and National Report on Ambient Air Quality), assessment of their levels in the Lebanese atmosphere, setting limit values and thresholds of ambient air pollutants (including CO, NOx, O_3, Particles, SO_2, NMVOC and Pb) and emission limit values of fixed and mobile sources, and prevention, and control and surveillance of ambient air pollution resulting from human activities (MoE, 2017).

Ambient Air Quality Standards and Air Emission Limit Values

Safe ambient air exposure limits are specified in MoE Decision 52/1 of 1996 whereas the national emission limit values for air emissions from industrial facilities are specified in MoE Decision 8/1 of 2001. This decision also provides emission limit values for power plants with capacities between 100 MW and 300 MW. However, to date, there are no emission standards for large power plants (>300 MW). Despite being outdated, these standards continue to be used to determine regulatory compliance in several contexts. It is worth noting that updates have been prepared for these regulations but have not been officially adopted yet.

In 2013, the MoE issued Circular 11/1 specifying the acceptable emission limits and air pollutant levels from the operations of diesel generators with capacity higher than 0.25 MW. In addition to emission limit values, this circular also specifies monitoring requirements of air pollutants and other conditions such as the minimal length of the exhaust stack. In spite of these efforts, compliance by the diesel generator owners remained limited due to lack of monitoring capacity within the MoE and local authorities and the political infighting within the government over the electricity plan's implementation, which resulted in delaying the government's response to the energy crisis in the country and continued dependence on the informal sector (WB, 2020).

Tax Incentives

Several tax incentives have been introduced in the second half of the decade, aiming at curbing pollution and reducing air emissions. For example, Article 55 of Law 79/2018 (2018 National Budget Law) provided that eco-friendly cars, including hybrid and electric vehicles (EV), will have reduced customs duties and excise taxes when entering the Lebanese market. In addition, Decree 167/2017 (application of Article 20 of the Environmental Protection Law 444/2002) grants tax credits on various activities aimed at protecting the environment and reduces customs tariffs on environmentally-friendly goods *(Refer to Chapter 2 - Environmental Governance for additional information).*

Tobacco Control

The National Program for Tobacco Control (NPTC) was established in 2009 in Lebanon as a result of the GoL signing the WHO Framework Convention on Tobacco Control in 2005. The program was developed in parallel with the constitution of a national committee to develop a strategic plan to prevent tobacco consumption that encompasses the laws and regulations to be passed in Lebanon in this regard. The efforts exerted in collaboration with the civil society lobbies resulted in the introduction of Law 174/2011 on Tobacco Control and Regulation of Tobacco Product Manufacturing, Packaging and Advertising. Article 5 of this Law states that "smoking or lighting a tobacco product or using such products are forbidden in all indoor places, workplaces and public transport" (MoPH, 2021).

Other Legislation

With regards to reducing air pollution from the transport sector, the GoL issued in 2012 Law 243, the "New Traffic Law", whereby Article 89 made the installation of catalytic converters mandatory in all gasoline vehicles. In addition, under this law, vehicles older than eight years cannot be imported to Lebanon (MoE, 2017).

Finally, the Integrated Solid Waste Management Law 80/2018 asserted that solid waste should be managed from its source of origin to final disposal sites in an environmentally suitable manner that does not increase social and economic burdens and that prevents contamination of air and harm to public health.

4.3.2.2 Policy and Strategies

In 2020, the National Strategy for Air Quality Management 2015-2030 was adopted in Lebanon through Decree 6212. This strategy builds on the vision that 'every citizen has the right to enjoy clean air' to set several long-term goals that need to be adopted by the GoL to reach the vision by 2030. Each of the goals was coupled with a set of outputs, activities, indicators and an indication of the different stakeholders involved in the implementation of each activity, information designed to be used as a framework for monitoring the progress towards the 2030 vision. An overview of the strategic goals defined in the strategy, along with each goal's outputs are presented in Table 4-4 (MoE, 2017).

Table 4-4 Strategic Goals and Outputs Adopted in the National Air Quality Strategy 2015-2030

Goal 1	Strengthening the Legal and Institutional Framework
Output 1.1	Adopting the Draft Law for the Protection of Air Quality
Output 1.2	Updating the National Ambient Air Quality Standards based on the Assessment of Air Quality throughout the Territory
Output 1.3	Strengthening MoE Air Quality Department and Other Concerned Groups
Output 1.4	Developing Local Air Quality Planning
Output 1.5	Developing Measures/Plans in Case of High Pollution levels
Goal 2	**Improving Air Quality Assessment throughout the Territory**
Output 2.1	Establishing, Operating and Maintaining (including the required Quality Assurance/Quality Control) the Air Quality Monitoring Infrastructure
Output 2.2	Establishing a Methodology for the Analysis, Assessment and Reporting of the Ambient Air Quality Data for MoE and Affiliated Monitoring Systems
Output 2.3	Updating, Improving and Reviewing Existing Initial Emission Inventories Conducted by MoE and other Stakeholders
Output 2.4	Developing and Updating Regularly a National Integrated Assessment and Modelling System
Output 2.5	Producing and Disseminating the National Fire Weather Index with the Use of Local Networks/Stations and Start Evaluating the Performance of Existing Wildfire Danger Warning Systems.
Goal 3	**Solving Air Quality Problems due to Stationary Sources in Degraded Airsheds**
Output 3.1	Adopting Proposed Emission Standards for Key Stationary Sources in line with Best Avail-able Techniques Levels
Output 3.2	Developing Procedures for Enforcing Regulations for Self-Monitoring, Reporting and Third-Party Verification in Key Sectors
Output 3.3	Developing the Environmental Licensing Mechanism for Emissions of Air Pollutants
Goal 4	**Solving Air Quality Problems from Mobile Sources**
Output 4.1	Strengthening the Inspection Capabilities of Mobile Sources at National Level
Output 4.2	Implementing, Monitoring and Enforcing Regulations for Fuel Quality
Output 4.3	Improving Air Quality from Air and Maritime Transport
Goal 5	**Mainstreaming Air Quality Management in Priority Sectors**
Output 5.1	Ensuring Synergies with National Climate Change Policies and Plans
Output 5.2	Developing an SEA for the Lebanese Land Transport Strategy
Output 5.3	Integrating Air Quality in the Energy Sector
Output 5.4	Integrating Air Quality in the Industrial Sector
Output 5.5	Integrating Air Quality in the Solid Waste Management Sector
Output 5.6	Integrating Air Quality in the Agriculture/Forestry Sector
Goal 6	**Communication and Outreach on Air Quality**
Output 6.1	Providing Data and Regular Reports on Air Quality from all Monitoring Sites and Modelling Results to the Public
Output 6.2	Linking the On-going Activities at the MoE and the Universities

Beside the National Strategy for Air Quality Management 2015-2030, there are several other cross-sectoral national policies and strategies of direct relevance to and influence on air quality. These include for the transport sector the 2001 Draft Transport Policy and the 2016 Draft Land Transport Strategy, and for the electricity sector the 2010 Policy Paper for the Electricity Sector and its update of 2019, the 2016-2020 National Energy Efficiency Action Plan and the 2016-2020 National Renewable Energy Action Plan *(Refer to Chapter 9 – Climate Change and Energy for details).* They also include the Integrated Vision for The Lebanese Industrial Sector 2025 and the Draft Integrated Solid Waste Management Strategy for Lebanon *(Refer to Chapter 8 –Solid Waste).* A comprehensive list and description can be found in Lebanon's National Strategy for Air Quality Management 2015-2030 (MoE, 2017).

4.3.3 Key Actors and Stakeholders

Key actors and stakeholders in air quality management are ministries (most notably the ministries of Environment, Public Health, Energy and Water, Public Works and Transport, Interior and Municipalities, and industry), local authorities, universities and research centers. An overview of the roles of the governmental stakeholders is provided in Table 4-5.In addition to these key stakeholders, several academic institutions including universities conduct sporadic/continuous air quality monitoring projects, as well as studies, in an effort to identify sources and causes of surrounding air pollution *(refer to Chapter 2 - Environmental Governance)*. Universities have also contributed to the development and implementation of the National Strategy for Air Quality Management in Lebanon 2015-2030.

Table 4-5 Key Actors and Stakeholders in Air Quality Management

Responsibilities	MoE[1]	MoPH	MoEW	MoIM	MoPWT	MoI	UCF
Developing strategies, plans, programs, projects, activities and studies for safeguarding air quality, including through interventions in the power and transport sectors	X		X[4]		X[7]		
Establishing guidelines and regulations regarding indoor air quality and tobacco control in indoor spaces		X[3]					
Identification of sources, causes, methods and places of surrounding air pollution	X						
Installation and operation of power plants (through EDL)			X[4]				
Planning and implementation of oil and gas activities (through Lebanese Petroleum Administration (LPA))	X[2]		X[5]				
Proposing and enforcing traffic laws and regulations				X[6]			
Issuance, renewal and canceling of industrial permits based on environmental, health and safety criteria						X[8]	
Enforcement of ambient air quality and emission discharge standards, through environmental impact assessment and auditing	X						
Monitoring of ambient air quality	X						X[9]

* MoPH: Ministry of Public Health; MoEW: Ministry of Energy and Water; MoIM: Ministry of Interior and Municipalities; MoPWT: Ministry of Public Works and Transport; MoI: Ministry of Industry; UCF: Urban Community of Al Fayhaa.

1 Law 690/2005: Regulating the MoE and defining its tasks and competencies

2 Law 132/2010: Offshore Petroleum Resources Law.

3 Law 657/2005: Ratification of WHO Framework Convention on Tobacco Control. This law resulted in establishing the National Program for Tobacco Control

4 Law 20/1966: Establishment of MoEW, later reorganized by virtue of Law 247 of 2000; Law 462/2002: Organization of the Electricity Sector

5 Decree 7968/2012: Establishing the LPA

6 Law 243/2012: New Traffic Law

7 Decree 2872/1959: Organization of MoPWT

8 Law 642/1997: Establishment of MoI; Decree 8018/2002 which determines the procedures and conditions for the authorization of establishment of industries

9 CoM Decision 18 dated 9/12/2004 for including Tripoli Environment and Development Observatory (TEDO) under UCF

4.4 Selected Responses

In the last decade, Lebanon made some significant legal and institutional strides to reduce air pollution and safeguard public health. It has also faced some major setbacks. The sections below present selected responses that were developed in response to the need for a more detailed, coherent and updated legal framework and spatially and temporally adequate monitoring.

4.4.1 A Better Legal Framework and Strategic Vision

The MoE was supported by several internationally funded projects in developing a holistic framework for tackling air pollution. The EU funded projects (SELDAS and Support to Reforms – Environmental Governance) were instrumental in providing technical assistance for preparing the Air Quality Protection Law adopted by Law 78/2018 and the National Strategy for Air Quality Management adopted by Decree 6212/2020, respectively. Through the Strategy, Lebanon committed to protecting ambient air quality through the adoption of long-term goals requiring the assessment of CO, NOx, NH_3, PM, SO_2, tropospheric ozone, black carbon, fluorinated gases and CH_4, as well as GHG emissions. The Strategy highlights the need for improved wildfire risk reduction in Lebanon as a means to prevent large forest fires and avoid or mitigate the associated health and environmental impacts (refer to Section 4.3.2.2).

By setting emission standards, roles and responsibilities and penalties on polluters, implementation of Law 78/2018 will contribute to the reduction of emissions and improvement of air quality throughout Lebanon. Moreover, Decree 167/2017 will encourage industries and individuals to shift to environmentally friendly activities as a result of tax incentives. With Article 55 of Law 79/2018 (2018 National Budget Law), Lebanon has abolished 100% of taxes on electric vehicles and 80% of taxes on hybrid vehicles aiming to increase the use of fuel-efficient and hybrid vehicles.

The GoL also committed to provide protection from exposure to tobacco smoke in all indoor public places through the enactment of Law 174/2011. The provisions of this law included: (1) a ban on smoking in all indoor public spaces, (2) a ban on advertisements, promotion and sponsorship and (3) larger text warnings with the possibility of pictorial warnings. Lebanon implemented this law within the five-year deadline with a strong public awareness and enforcement campaign. The law was relatively strictly enforced for about three months. After that, enforcement faded due to strong lobbying, particularly of the restaurants where water pipes are offered. The Ministry of Tourism also stopped its enforcement claiming that tourism was negatively affected, despite efforts by the activist groups to counter these claims with scientific data. Although the current situation of smoke-free places remains much better than prior to the law, a lot of ground has been lost as a result of lack of political will (Nakkash et al., 2018).

Concerning GHG emissions and as part of its Paris Agreement commitments, Lebanon published its Nationally Determined Contribution to set a long-term strategy to reduce national GHG emissions and to mobilize international financing for implementation. Lebanon has set targets to reduce its emissions by 15% as an unconditional target and 30% as a conditional target. The targets were increased respectively to 20% and 31% in the 2020 Nationally Determined Contribution update *(Refer to Chapter 9 – Climate Change and Energy)*.

4.4.2 The National Air Quality Monitoring Network

Under the framework of the project Environmental Resources Monitoring in Lebanon funded by the Ministry of Foreign Affairs of the Government of Greece, the MoE in Lebanon, the UNEP-Regional Office for West Asia and UNDP launched in 2013 Phase 1 of the AQMN. Five stations were installed and deployed, and online analyzers were connected to a supervisory control and Data Acquisition System (DAS) located at the MoE. The project also launched “Camil the Chameleon”, the Mascot of the Air Quality Index, which was updated daily on the website of the MoE (Figure 4-12).

Figure 4-12 The Daily Air Quality Index "Camil the Chameleon"

Phase 2 of the AQMN was launched in 2017 with the support of the EU and covered the installation of ten additional stations to monitor criteria pollutants, in addition to eight standalone weather monitoring stations (SWMS), three PM stations and one calibration laboratory. Those were also directly connected to the DAS at the MoE. The locations of Phase 1 and Phase 2 AQMN stations along with the PM and weather stations can be found in Figure 4-13.

Table 4-6 provides a list of all the AQMN stations, their locations and parameters monitored in each.

Figure 4-13
Distribution of AQMN Stations

Table 4-6 AQMS, PM, Calibration Laboratory and Weather Stations across Lebanon

Station	Location/Host	Caza	Governorate	Parameters Monitored
Air Quality Monitoring Stations				
Phase 1				
AQMS 01	Hadath/Lebanese University	Baabda	Mount Lebanon	NO_2, SO_2, PM_{10}, $PM_{2.5}$
AQMS 02	Pine Forest - Background/Beirut Municipality	Beirut	Beirut	NO_2, O_3, PM_{10}, $PM_{2.5}$
AQMS 03	Zahle Public Garden/Zahle Municipality	Zahle	Bekaa	NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$
AQMS 04	Saida/Rafic Hariri High School	Saida	South Lebanon	NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$
AQMS 05	Mohamad Makki Military Barracks/Ministry of Defense	Baalbek	Baalbek - Hermel	NO_2, PM_{10}, O_3, $PM_{2.5}$
Phase 2				
AQMS 06	Tair Debba/Tair Debba Municipality	Tyre	South Lebanon	NO_2, CO, SO_2, O_3, PM_{10}, $PM_{2.5}$
AQMS 07	Chouf/Barouk Reserve	Chouf	Mount Lebanon	NO_2, CO, SO_2, O_3, PM_{10}, $PM_{2.5}$
AQMS 08	Nabatieh - Asdak Parc/Nabatieh Municipality + Awkaf	Nabatieh	Nabatieh	NO_2, CO, SO_2, O_3, PM_{10}, $PM_{2.5}$
AQMS 09	Deir Amar/Deir Ammar Municipality	Minieh - Danniyeh	North Lebanon	NO_2, CO, SO_2, O_3, PM_{10}, $PM_{2.5}$
AQMS 10	Kaslik/Holy Spirit University of Kaslik - Faculty of Agriculture	Keserwan	Keserwan-Ftouh - Jbeil	NO_2, CO, SO_2, O_3, PM_{10}, $PM_{2.5}$
AQMS 11	Fiaa/Fiaa Municipality	Koura	North Lebanon	NO_2, CO, SO_2, O_3, PM_{10}, $PM_{2.5}$
AQMS 12	Beirut/Lebanese American University	Beirut	Beirut	NO_2, CO, SO_2, O_3, PM_{10}, $PM_{2.5}$
AQMS 13	Sabtieh/Middle East University	Metn	Mount Lebanon	NO_2, CO, SO_2, O_3, PM_{10}, $PM_{2.5}$
AQMS 14	Pine Forest - Main entrance Tayouneh side/Beirut Municipality	Beirut	Beirut	NO_2, CO, SO_2, O_3, PM_{10}, $PM_{2.5}$
AQMS 15	Barja/Iman High School	Chouf	Mount Lebanon	NO_2, CO, SO_2, O_3, PM_{10}, $PM_{2.5}$
PM Stations				
PM1	Hamat/Military Base	Batroun	North Lebanon	PM_{10}, $PM_{2.5}$
PM2	Kalhat/UoB	Koura	North Lebanon	
PM3	Kfarhazir/Kfarhazir Municipality	Koura	North Lebanon	
Calibration Laboratory				
Calibration Laboratory	Hadath/Industrial Research Institute	Baabda	Mount Lebanon	N/A
Standalone Weather Monitoring Stations				
SWMS 01	Andkit Ecolodge/AFDC	Akkar	Akkar	Temperature, precipitation, wind speed
SWMS 02	Btormaz/Btormaz Municipality	Minieh-Danniyeh	Akkar	
SWMS 03	Bentael/Bentael Reserve Committee Headquarter	Jbeil	Keserwan-Ftouh - Jbeil	
SWMS 04	Bsalim/Daher El Bachek Public Hospital	Matn	Mount Lebanon	
SWMS 05	Dmit Ecolodge/AFDC	Chouf	Mount Lebanon	
SWMS 06	Bkassine/Bkassine Firefighters Center	Jezzine	South Lebanon	
SWMS 07	Wadi Al Houjeir/Kabrikha Municipality	Marjaayoun	Nabatieh	
SWMS 08	Naqoura/Naqoura Public School	Tyre	South Lebanon	

Unfortunately, on 9 July 2019, the MoE announced that the monitoring stations were to be shut down due to lack of sufficient funds to operate them. Box 4-3 presents a description of the network installation process and operation, as well as data treatment and reporting procedures.

Box 4-3 AQMN Installation Process and Operation Procedures

Installation Phase of the Network: The choice of the locations where the stations were installed was based on a scientific study, taking into consideration several parameters and factors such as the surrounding environment, security of the place and type of the area (e.g. urban, rural, etc.). The following summarizes the steps reaching the installation of the stations:

1. Direct contact with each host, who differs from one region to another.
2. Site inspections by MoE and the Operation and Maintenance (O&M) team to check the suitability of each location.
3. Memorandum of Understanding between the MoE and each host (Table 4-6).
4. Installation of stations by O&M team in selected locations under the supervision of the Air Quality Department at MoE and the supporting project team.

Operation Phase and Administration of the Network: The administration of the network requires close coordination between the Air Quality Department and the company responsible for O&M of the network (which is contracted by the MoE or the project supporting the MoE). On a daily basis, the Air Quality Department performs remote checks to make sure that the stations are working properly. If anything suspicious is detected (for example one station is not properly transmitting the data), the Department gets in touch with the O&M team who performs an emergency visit and checks the station. In addition to the emergency visits, the O&M team is responsible to make routine visits to all the stations each month, in order to check the functionality of the analyzers and take necessary actions whenever needed (for example replacement of spare parts). In addition, all analyzers of the network are calibrated at the Calibration Laboratory located at the Industrial Research Institute in Hadath to ensure generation of good quality data. The tasks of the O&M team are clearly mentioned in detail in the O&M contract.

Treatment of the Data: The data measured through the stations is treated following a delicate scientific protocol of data validation before being published or used in scientific and academic research. A data validation guideline was prepared by the Air Quality Department with supervision and close collaboration with national and international experts, taking into consideration best practices in data validation. It was issued officially under MoE Circular 19/1 of 2019.

National Monthly Reports of Ambient Air Quality Data: According to Article 7 (Clause 1) of Law 78/2018, the MoE is responsible to publish monthly national reports with the air quality data measured through the network. The report shall contain validated data and be published on the Ministry's website. So far, 6 reports have been published (June 2017 to December 2017- Phase 1 and 2), 12 reports have been prepared awaiting publication following internal approval (Year 2018 - Phase 1) and 12 reports are in their final phase of preparation awaiting data validation to be completed (Year 2018 – Phase 2).

The data collected from the AQMN is used by researchers and experts working in the field in order to assess the current situation on air quality in the country and propose management measures to protect it. In addition, this data helps conduct dispersion modeling to identify major sources of air pollution and to develop models that predict future pollutant emissions. Environmental practitioners also find this data valuable as it can be used during environmental impact assessment of proposed projects to set baseline conditions on air quality for modeling of expected emissions and future comparison once the project has been implemented.

In addition to the AQMN, TEDO/UCF has implemented the Gouv'Airnance Project (2012-2015), funded by the EU and administered by the UNEP and UNDP, to set up an air quality monitoring network with three stations in the northern cities of Tripoli, Beddawi and Al Mina. These stations monitor several parameters including total PM, NOx, CO and CO_2. However, due to lack of resources, only the station in Tripoli is currently operational and data analysis often fails to be processed and updated for the development of new reports. TEDO/UCF has been communicating with MoE to start sharing its monitoring data with the Ministry.

There are other air quality and meteorological monitoring efforts across Lebanon. For example, the Faculty of Engineering and Architecture at AUB runs an air quality observatory at their campus in Beirut which continuously monitors airborne particulate matter (PM_{10} and $PM_{2.5}$) as well as meteorological parameters (temperature, humidity, wind speed, wind direction) and posts real time hourly measurements online. The Meteorological Department of the Beirut Rafic Hariri International Airport collects continuous meteorological data with the purpose of observing weather and elaborating weather forecasts at several locations: Koubayat (Akkar Caza), Al Abdeh (Akkar Caza), Tripoli (Tripoli Caza), Cedars (Bcharre Caza), Kartaba (Jbeil Caza), Beirut Airport (Baabda Caza), Beirut Golf (Baabda Caza), Bayssour (Aley Caza), Haouch El Oumara (Zahle Caza), Rayak Amara (Zahle Caza) and Dahr El Baydar (Zahle Caza). A related weather report is posted daily on the airport website. Their Climatology Division archives and analyzes all measured data and prepares related climate reports. In addition, AUB, USJ and UoB own several instruments for the measurement of airborne pollution which are deployed from time to time in short to medium term monitoring campaigns used for research purposes.

4.4.3 Pollution Prevention and Emission Control

The GoL has demonstrated a strong commitment to tackle industrial pollution through improvements to the environmental legal framework including a combination of regulations that were introduced by the MoE over the last ten years. One of these was establishment of the environmental compliance certification system through Decree 8471/2012, which requires establishments to conduct an external environmental audit and implement its recommendations. The audit includes information about air emission data and existing air quality control measures. The audit also defines technical specifications for the required pollution abatement equipment including air pollution control technologies. Through its application, MoE aims to regulate industrial activities that may cause environmental, including air quality, degradation, scale up pollution abatement in the industrial sector and facilitate the transition of industries towards environmental compliance (World Bank, 2014). To support this effort, since 2013, the Lebanon Environmental Pollution Abatement Project (LEPAP) provides free technical assistance to industrial enterprises in order to assess their environmental conditions and propose actions to improve their overall environmental performance in line with the national regulations. The project also provides soft loans through commercial banks to support these industries in implementing the recommended pollution reduction actions including air quality management measures.

4.5 Recommendations and Future Outlook

Adoption of the Air Quality Protection Law and the National Air Quality Management Strategy has been a milestone achievement for the sector. To solicit public support for advocating the government to finance its activities, periodic evaluations of the progress towards the goals set in the strategy and using the strategy's proposed monitoring and evaluation framework should be undertaken and disseminated widely. The sections that follow highlight some sectoral recommendations for better air quality in the coming decade.

4.5.1 Enforcing Legislation and Updating Standards

Although the number of studies addressing the source apportionment question in Lebanon is modest, all conclusions converge into considering road transport, local point sources, such as diesel generators, and larger scale power generation plants and industries, as the main contributors to outdoor air pollution. Hence, attempts to decrease ambient pollutant levels are needed to enforce existing regulations such as the Air Quality Protection Law (Law 78/2018) through development of application decrees and decisions and missing standards or to update existing ones in relation to these specific emission sources. For example, to date, there are no emission standards for large power plants (above 300 MW). Ambient air quality standards are currently outdated and need to be modernized, as are emission standards that date back to 2001. These standards should also take into consideration available laboratory testing capabilities to ensure that regular monitoring is feasible. As for efforts on tobacco control, reactivating Law 174/2011 that bans smoking in indoor places in the hospitality sector should be reactivated and stringently enforced with no exceptions.

4.5.2 Developing a Comprehensive Emission Inventory and Predictive Models

In addition to completing and implementing the legislation framework, it is important to highlight the need for a systematic and sustainable way to compile a current comprehensive baseline coupled with continuous and spatially distributed monitoring of air quality parameters. Also needed is a periodically updated inventory of emission sources to assist in achieving Goals 2 to 4 of the National Air Quality Management Strategy (Improving air quality assessment throughout the territory, Solving air quality problems due to stationary sources in degraded air sheds, Solving air quality problems from mobile sources). A proposed process, in line with the overall scheme of the National Strategy, is described as follows:

- MoE to reactivate the AQMN consisting of the collection of a standardized baseline of criteria pollutants as part of a national effort by providing the necessary funding. This is highly needed as the available air quality data remains segmented, intermittent and relying on the interests of researchers. This renders the data difficult to use as a monitoring tool for the success of the various efforts put forth to reduce air pollution.
- Other government bodies such as the MoEW, MoIM, MoI and MoPWT feeding activity data to the MoE in order to create a comprehensive database for all emission sources in the country.
- Improving the technical capacity of MoE Air Quality Department and associated Climate Change Division and providing them with the appropriate technological tools to regularly update the national emission inventory.

Air quality management planning should rely on the most up to date information and scientific research. For this purpose, the Air Quality Department at MoE can also cooperate closely with academic institutions, as well as public and private scientific research centers. The proposed integrated approach that includes a monitoring network, an updated emission inventory and an air dispersion modeling tool enables MoE to enact and evaluate policies based on evidence.

By sharing the data publicly, the civil society and local authorities will be able to play an active role in advocating for a stronger commitment from the GoL in improving air quality. Building awareness and capacity to address air quality would help catalyze actions towards providing clean air solutions.

The absence of real time air quality monitoring data due to the current problems facing the operation of the AQMN highlights the challenges that are usually faced by developing countries such as Lebanon. Air quality monitoring, which is usually based on in situ ground stations, is an expensive method that yields data too sparse to accurately assess the exposure effects of air pollution. Findings from several studies incorporated in this chapter (Waked et al., 2013; Waked et al., 2015; Abdallah et al., 2018; Al Aawar et al., in review; Salloum et al., 2018; El Khoury, 2019) seem to confirm that one way to compensate for the high cost associated with ground monitoring is to promote initiatives that have addressed air quality by developing a comprehensive emission inventory coupled with predictive models that estimate gridded parameters of ambient air and investigate what-if scenarios to assess mitigation strategies. Using this approach, in association with reactivating the existing AQMN that has already been installed throughout the country, would provide a comprehensive overview of the sector and drive policy decisions and effective interventions.

Another strategy adopted in other countries, based on the use of low-cost air quality measurement devices, is community involvement in indoor and ambient air monitoring in the places where they live, work or attend school. Besides collecting data for air quality experts, it raises awareness in the general public and reinforces personal behaviors that help avoid or reduce exposure to harmful pollution.

In addition, a local air quality management plan should be put in place in areas with known point sources of pollution, such as the area around Chekka where large industrial facilities are in close proximity to residential areas.

4.5.3 Modernizing the Vehicle Fleet

A key approach to reducing transport-related emissions is to decrease the fleet age and promote hybrid vehicles beyond the currently enacted regulation. Towards that end, the Nationally Appropriate Mitigation Action in Lebanon's Private Road Transport Sector (adopted by Council of Ministers Decision 14 dated 12/10/2017) incorporates plans to completely eradicate vehicles older than 15 years by 2030 (MoE, 2017). It is important to mention that current laws allow the import of vehicles as old as 8 years. This means that old vehicles removed from the fleet today could be replaced by vehicles which would be 17 years old by 2030 (2 years older than the target set by the NAMA). Furthermore, most emission standards are updated approximately every 2 years, rendering most older vehicles obsolete regarding their pollution technology. Therefore, it is important to close this loophole by decreasing the permissible age at import to allow for more sustainable vehicles while retaining their value before getting scrapped.

As mentioned earlier, the GoL approved the reduction of road-usage and excise taxes to 20% for hybrid vehicles and 0% for electric vehicles through the National Budget Law 79/2018. This step can be complemented with value added tax exemptions for spare parts of hybrid vehicles, in addition to preferential loans (Irani & Chalak, 2015). Authorized dealers also need to agree with manufacturers on the business model for the technology, such as end-user paying a monthly premium in exchange for providing timely replacements, as part of a subscription model (Saad & Mansour, 2018). Additionally, the country needs to resolve its power crisis and start planning a charging infrastructure required to sustain electric vehicles.

4.5.4 Promoting Public Transit

The absence of a proper, reliable and attractive public transport system has shaped the habits of the Lebanese people whereby most of the population rely on private cars for their mobility needs. This results in traffic congestions, thus magnifying GHG emissions in the country. The infamous traffic jams on the northern, southern and eastern highways connecting the country to the capital Beirut are considered a significant urban planning and development problem for the country. In the absence of an adopted national transport strategy, the only viable solution is to provide mass transit services on main routes, such as the proposed Bus Rapid Transit (BRT). The environmental impact assessment study of the BRT project indicates that the project will improve air quality in the area. In fact, the study compared emissions from two scenarios: 1) operation of the BRT system and 2) current public transport system in the absence of the BRT system. The results showed that the shift to a mass transit system will reduce annual CO, NOx, SO_2 and PM_{10} emissions in the project area in 2023 by 1,232 tons per year, 642 tons per year, 35 tons per year and 36 tons per year, respectively, as well as GHG emissions in Lebanon by 590 Gg/year of CO_2eq (World Bank, 2018).

4.5.5 Investing in Renewable Energy and Energy Efficiency Measures

Knowing that the sources of most of Lebanon's GHG and much of its air pollutant emissions is the energy sector, investing in renewable energy can significantly reduce these emissions. Although Lebanon has ample renewable energy resources that may be utilized to achieve these reductions, including both solar and wind potential, to date there has been limited investment in large-scale renewable energy in the country. For example, a procurement process for a 50-100 MW wind farm was initiated in 2013; however this process has faced delays and is yet to be implemented. Investments in decentralized renewable energy power generation such as the Small Decentralized Renewable Energy Power Generation Project should thus be encouraged in the country in an effort to reduce GHG emissions (UNDP, 2017). In addition, implementation of energy efficiency measures across all sectors is needed to reduce energy consumption, and thus resulting emissions *(Refer to Chapter 9 – Climate Change and Energy for details*).

4.5.6 Managing Pollution Sources

Power: Assuming the de facto situation of electric energy supply undercutting demand persists, enforcing standards and incentives on imported diesel generators, their assembly and their operation inside the country could help reduce their overall emissions. Some suggested actions are:

- Linking customs on the imported generators and filters to their efficiency by linking the cost to NOx emissions.
- Raising awareness in industries on solar energy as an alternative solution for self-generation purposes taking into consideration the environmental requirements.
- Enforcing local standards for diesel generators after conducting technical studies in collaboration with LIBNOR.
- Optimizing the EDL power outage schedule to have the minimum heat maps and hotspots in the different regions and investigating the opportunity of installing gas generators instead of diesel generators in some regions.

Industry: Given the profile of the Lebanese industrial sector, substantial reduction in emissions of air pollutants would emanate firstly from employing measures for energy efficiency as combustion is the source of most of the emitted pollutants. Furthermore, employing recent industry standard emission mitigation measures for related processes is required. For the cement industry, it is recommended that clean fuel is used in the burners and, where applicable, updating shaker, reverse air and cartridge units to pulse jet filters would serve to reduce fugitive emissions. Using electrostatic precipitators, in addition to fabric filters, would further reduce PM emissions. Making sure that absorbing reagents are present in kiln filter cakes is necessary for efficient SO_2 capture.

Solid Waste: Lebanon has a recurring issue in achieving evidence informed strategic planning in SWM. To support improved decision-making in SWM, a range of digital assessment tools and methods have been developed (Marshall et al., 2013; Zurbrügg et al., 2014). Following the best practices in developing countries, it is suggested that a tool that is contextually relevant to Lebanon could provide sound data to inform decision making to propose a procedure that would eliminate waste burning. *A comprehensive assessment and recommendations for the sector can be found in Chapter 8 – Solid Waste.*

Forest fires: There is an urgent need for Lebanon to implement its National Strategy for Forest Fire Management with priority given to implementing risk modification activities such as forest management, increased ground monitoring during the dry season and proper law enforcement. It is also important that related legislations are supported by needed decrees and laws to enforce the implementation of the strategy. In parallel, it is recommended that the government invest in appropriate equipment for use in responding to forest fires. In case of fire, it is suggested that awareness material is disseminated widely to guide people on how to protect themselves from exposure and approaching fires. A set of recommendations developed by WHO can be used for this purpose (WHO, 2020).

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قوانين الاتفاقيات الدولية

نوع النص	الرقم	التاريخ	عنوان النص
قانون	١١٩	٢٠١٩/٣/٢٩	الموافقة للحكومة بالانضمام الى تعديلات كيغالي-روندا المتعلقة ببروتوكول مونتريال حول حماية طبقة الاوزون من المواد المستنفزة لها
قانون	١١٥	٢٠١٩/٣/٢٩	الموافقة على إبرام اتفاق باريس الملحق باتفاقية الأمم المتحدة الإطارية بشأن تغيّر المناخ
قانون	٢	٢٠١٧/٢/٣	الموافقة على ابرام انضمام لبنان الى اتفاقية ميناماتا بشأن الزئبق
قانون	٧٥٨	٢٠٠٦/١١/١١	الانضمام الى تعديلات بيجين المتعلقة ببروتوكول مونتريال حول حماية طبقة الأوزون من المواد المستنفذة لها
قانون	٧٣٨	٢٠٠٦/٥/١٥	الإجازة للحكومة الانضمام إلى بروتوكول كيوتو الملحق باتفاقية الأمم المتحدة الاطارية بشأن تغير المناخ المحررة في كيوتو
قانون	٦٥٧	٢٠٠٥/٢/٤	الاجازة للحكومة الانضمام الى اتفاقية منظمة الصحة العالمية الاطارية بشأن مكافحة التبغ
قانون	٤٣٢	٢٠٠٢/٧/٢٩	الاجازة للحكومة الانضمام الى اتفاقية ستوكهولم للملوثات العضوية الثابتة
قانون	١٢٠	١٩٩٩/١٠/٢٥	الاجازة للحكومة الانضمام الى تعديلات كوبنهاغن المتعلقة ببروتوكول مونتريال حول حماية طبقة الأوزون من المواد المستنفدة لها
قانون	٣٥٩	١٩٩٤/٨/١١	التصديق على اتفاقية الامم المتحدة الاطارية بشأن تغير المناخ
قانون	٢٥٣	١٩٩٣/٧/٢٢	الإجازة للحكومة الانضمام إلى معاهدتين متعلقتين بطبقة الأوزون

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قانون	٧٩	٢٠١٨/٤/١٨	الموازنة العامة والموازنات الملحقة لعام ٢٠١٨
قانون	٧٨	٢٠١٨/٤/١٣	قانون حماية نوعية الهواء
قانون	٢٤٣	٢٠١٢/١٠/٢٢	قانون السير الجديد
قانون	١٧٤	٢٠١١/٨/٢٩	الحد من التدخين وتنظيم صنع وتغليف ودعاية منتجات التبغ
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قانون	٦٩٠	٢٠٠٥/٨/٢٦	تحديد مهام وزارة البيئة وتنظيمها
قانون	٤٤٤	٢٠٠٢/٧/٢٩	قانون حماية البيئة
قانون	٤٦٢	٢٠٠٢/٩/٢	قانون تنظيم قطاع الكهرباء
قانون	٢٤٧	٢٠٠٠/٨/٧	دمج والغاء وانشاء وزارات ومجالس
قانون	٦٤٢	١٩٩٧/٦/٢	احداث وزارة الصناعة
قانون	٢٠	١٩٦٦/٣/٢٩	انشاء وزارة الموارد المائية والكهربائية
مرسوم	٦٢١٢	٢٠٢٠/٣/٢٧	إقرار الاستراتيجية الوطنية لإدارة نوعية الهواء المحيط (٢٠١٥-٢٠٣٠) وملحقها التعديلي
مرسوم	١٦٧	٢٠١٧/٢/١٧	تحديد دقائق تطبيق المادة ٢٠ من قانون حماية البيئة رقم ٤٤٤ تاريخ ٢٠٠٢/٧/٢٩
مرسوم	٧٩٦٨	٢٠١٢/٤/٧	هيئة ادارة قطاع البترول
مرسوم	٨٤٧١	٢٠١٢/٧/٤	الالتزام البيئي للمنشآت
مرسوم	٨٠١٨	٢٠٠٢/٦/١٢	تحديد اصول واجراءات وشروط الترخيص بانشاء المؤسسات الصناعية واستثمارها
مرسوم	٢٨٧٢	١٩٥٩/١٢/١٦	تنظيم وزارة الاشغال العامة والنقل
قرار مجلس الوزراء	١٤	٢٠١٧/١٠/١٢	الموافقة على إجراءي التخفيف المتعلقين بقطاع النفيات المنزلية الصلبة وقطاع النقل البري الخاص من اجل تسجيل إجراءات التخفيف الملائمة وطنياً لمكافحة تغير المناخ في السجل الرسمي لدى الأمانة العامة لاتفاقية الأمم المتحدة الإطارية بشأن تغير المناخ بهدف تنفيذ الإجراءات من قبل الجهات المعنية
قرار مجلس الوزراء	٥٢	٢٠٠٩/٥/١٣	اقرار الاستراتيجية الوطنية لإدارة حرائق الغابات
قرار وزارة البيئة	١/٨	٢٠٠١/١/٣٠	المواصفات والمعايير المتعلقة بملوّثات الهواء والنفايات السائلة المتولدة عن المؤسسات المصنفة ومحطات معالجة المياه المبتذلة
قرار وزارة البيئة	١/٥٢	١٩٩٦/٧/٢٩	تحديد الواصفات والنسب الخاصة للحد من التلوث الهواء والمياه والتربة
تعميم وزارة البيئة	١/١٩	٢٠١٩/١٢/٦	المتعلق بدليل تنقيح وتدقيق بيانات الشبكة الوطنية لرصد نوعية الهواء المحيط
تعميم وزارة البيئة	١/١٠	٢٠١٣/٦/٢٩	المتعلق بمراقبة تشغيل واستثمار المولدات الكهربائية

5 Ecosystems

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Abbreviations and Acronyms

ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
AFDC	Association for Forest, Development and Conservation
APAC	A Protected Areas Committee
APJM	Association for the Protection of Jabal Moussa
ARs	Artificial Reefs
AREC	Advancing Research, Enabling Communities
AUB	American University of Beirut
CBD	Convention on Biological Diversity
CC	Climate Change
CEPF	Critical Ecosystem Partnership Fund
CHM	Clearing House Mechanism
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNRS	Centre National de la Recherche Scientifique
CNTPL	Cooperative of Native Tree Producers of Lebanon
CoM	Council of Ministers
CSO	Civil Society Organization
CZ	Coastal Zone
DFW	Directorate of Fisheries and Wildlife
DRM	Disaster Risk Management
EIA	Environmental Impact Assessment
ELCA	East Levantine Canyon Area
ERML	Environmental Resource Monitoring in Lebanon
ESCWA	United Nations Economic and Social commission for Western Asia
EU	European Union
FAO	Food and Agriculture Organization
FLOUCA	Fish Landing Operational Utility for Catch Assessment
FLRM	Forest Landscape Restoration Mechanism
FON	Friends of Nature
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFCM	General Fisheries Commission for the Mediterranean
GIS	Geographic Information System
GMO	Genetically Modified Organism
GoL	Government of Lebanon
HCH	Higher Council for Hunting
IBA	Important Bird Area
ICARDA	International Center for Agricultural Research in the Dry Areas
ICZM	Integrated Coastal Zone Management
IoE	Institute of Environment
IPA	Important Plant Area
ISF	Internal Security Forces
IUCN	International Union for Conservation of Nature and Natural Resources
KBA	Key Biodiversity Area
LARI	Lebanese Agricultural Research Institute
LDN	Land Degradation Neutrality
LRI	Lebanon Reforestation Initiative
LSGC	Laboratory for Seed Germination and Conservation
LW	Lebanese Wildlife
MCR	Marine and Coastal Resources Programme
MoA	Ministry of Agriculture
MoD	Ministry of Defense
MoE	Ministry of Environment

MoEW	Ministry of Energy and Water
MoF	Ministry of Finance
MoIM	Ministry of Interior and Municipalities
MoPWT	Ministry of Public Works and Transport
MPA	Marine Protected Area
MPD	Maritime Public Domain
NA	National Action
NARP	National Afforestation/Reforestation Program
NBSAP	National Biodiversity Strategy and Action plan
NCE	National Council for Environment
NFP	National Forest Program
NCMS	National Center for Marine Sciences
NEF	National Environmental Fund
NGO	Non-Governmental Organization
NIS	Non-Indigenous Species
NR	National Report
NRP	National Reforestation Plan
NT	National Target
ROWA	Regional Office for West Asia
O-LiFE	Observatoire Libano-Français de l'Environnement
PA	Protected Area
PGRFA	Plant Genetic Resources for Food and Agriculture
PINR	Palm Island Nature Reserve
PSSF	Purse Seine Sardine Fisheries
PSU	Practical Salinity Unit
SALMA	Smart Adaptation of Forest Landscape in Mountain Areas
SAP BIO	Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean Region
SBR	Shouf Biosphere Reserve
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SGP	Small Grant Programme
SLMQ	Sustainable Land Management in the Qaraoun Catchment
SLR	Sea Level Rise
SPA/RAC	Specially Protected Areas Regional Activity Centre
SPNL	Society for the Protection of Nature Lebanon
SST	Sea Surface Temperature
STIP	Science Technology and Innovation Policy
TCNR	Tyre Coast Nature Reserve
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCWA	United Nations Economic and Social commission for Western Asia
UNFCCC	United Nations Framework Convention on Climate Change
UoB	University of Balamand
UNOPS	United Nations Office for Project Services
USJ	Saint Joseph University
WWTP	Wastewater Treatment Plant

5. Ecosystems

5.1 An Ecological Overview of Lebanon

Lebanon forms part of the Mediterranean Basin Biodiversity hotspot which is recognized for its biodiversity richness (CEPF, 2018). Major biodiversity richness determinants include the geographic location of Lebanon by a water body - the Mediterranean associated with its particular topographic features. In addition, the rising of the Lebanese mountains by tectonic activity and the forces that allowed their lifting to the attained heights in the upper snow range, the two mountain chains with an internal high plain, the scathing and the wrinkling of the mountain slopes, and the breaking of mountain faces by deep valleys compose a unique combination of extensive potentials to host life (Figure 5-1). These major topographic features outline the main natural systems created by structural and altitudinal variations. As for the minor topographic features from river valleys to different grades of inclinations and orientations of mountain slopes, as well as different compositions of surface water systems from river courses to streams, boggy lands, and wetlands, these induce different measures of local variations. As a result, Lebanon exhibits extensive diversity in bioclimatic conditions inspiring elevated richness in ecosystem, habitat and microhabitat variation, thus expanding the potential for a broad range of biological elements to exist and a number of endemics to typify its land (MoA/UNEP/GEF, 1996; Asmar, 2011; MoE/GEF/UNDP, 2019).

Figure 5-1 High Mountain Landscape of Aqoura
Photo Credit: Myrna Semaan

5.1.1 Lebanon's Unique Biodiversity

On a global scale, Lebanon is considered a unique land due to its species richness in relation to its surface area. Lebanon occupies only 0.007% of the world's land surface area, while it hosts 1.11% of the world's plant species (Tohme & Tohme, 2014) and 2.63% of the reptile, bird and mammal species. Accordingly, Lebanon observes one of the highest densities of floral diversity in the Mediterranean basin, which is one of the most biologically diverse regions in the world and the third among the world's hotspots in both plant diversity and endemism (Box 5-1). The 'Biological Diversity of Lebanon' report (1996) remains the most recent compilation of the Lebanese biodiversity; it ascribed to Lebanon a biodiversity mass of 9,119 known taxa comprising 4,633 floral taxa and 4,486 faunal taxa. Around 8.5% of the terrestrial flora are broad endemics and 3.5% are strict endemics of Lebanon (MoA/UNEP/GEF, 1996; MoE/UNEP/GEF, 2016). More recent taxonomic research and reviews have recognized many new records of known species observed for the first time in Lebanon, and described some species new to science; checklists of biodiversity of the reserves and nature sites are better defining the distribution of the biodiversity in support of a future update to the national inventory. The conservation status of 227 plant, 15 mammal, 28 bird, and 7 reptile species of Lebanon is now defined on the International Union for Conservation of Nature (IUCN) Red List (MoE/GEF/UNDP, 2019). In addition, the Shouf Biosphere Reserve (SBR) is recognized on the IUCN Green List.

Box 5-1 The Mediterranean Basin Biodiversity Hotspot

This hotspot is the largest of the world's five Mediterranean-climate regions, and the second largest hotspot in the world (area of 2x106 km^2). Its significance to biodiversity is recognized in its floral richness where about 30,000 plant species thrive, making it the third richest in the world (Myers et al., 2000). Adding to this richness is the level of endemism whereby about 43% of the plant species (13,000 species) are endemic to the hotspot. Moreover, 1,110 Key Biodiversity Areas (KBA) were identified making 19.5% of the total area of the hotspot. Around half of them (512 KBA) contain marine or coastal regions expressing the importance of the coastal zones. About half of the KBAs (435 KBAs) also exist in 17 biodiversity conservation corridors (CEPF, 2018).

5.1.2 Major Ecosystems

The topography of Lebanon and the presence of mountain chains that pinnacle at 2,500-3,083 m a.s.l. dictate bioclimatic zones that correspond with respective ecosystems largely influenced by distribution of temperature and humidity. These climatic influencers (temperature and humidity) are subject to altitudinal variation, thus inducing altitudinal segregation of ecosystems and biodiversity (MoA/UNEP/GEF, 1996; Stephan et al., 2016; Stephan and Issa, 2017b).

The major ecosystems of Lebanon include (MoA/UNEP/GEF, 1996; Asmar, 2011):

- The terrestrial ecosystem.
- The mountainous ecosystems are classified as lower mountain ecosystem associated with the thermo-Mediterranean vegetation series, the middle mountain ecosystem that features the EU-Mediterranean vegetation series, the upper mountain ecosystem integrating the supra-Mediterranean vegetation series, the high mountain ecosystem where coniferous forests thrive, the subalpine ecosystem on the very high slopes of nearly 2,000-2,500 m a.s.l., and the alpine system of high rate of endemism on the very high peaks of Mount Lebanon at 2,700 m and above.
- The river valley ecosystems are highly distinctive subject to their own characterizing features.
- The aquatic ecosystems such as rivers, streams, springs, boggy lands and wetlands encompass high diversity.
- The semi-arid and arid ecosystems are determinants of the inlands of Northern Bekaa in their natural extension toward the desertic internal plains of Syria.
- The coastal and marine ecosystems:
    - The coastal ecosystems are majorly defined between sandy shore ecosystems and rocky shore ecosystems (Figure 5-2). Island and archipelago systems have particular significance as they present special combinations of terrestrial and marine habitats.
    - The marine ecosystem, which is typical of the East Mediterranean.

The National Council for Scientific Research (CNRS) and the “Observatoire Libano-Français de L’Environnement (O-LiFE)” based therein have identified and mapped ecosystems and habitat types based on standardized criteria (MoE/UNEP/GEF, 2016).

Figure 5-2 Ghosta Overlooking Jounieh Bay
Photo Credit: Myrna Semaan

5.1.2.1 Forests

Forest cover of Lebanon was assessed several times using different methodologies and was consistently reported to be above 13% of the total area of the country (FAO, 2020). Naturally regenerated forests occupy 142,930 ha (FAO, 2020), whereas dense forest cover reaches 79,200 ha (Faour and Abdallah, 2018). Other wooded lands cover around 10% of the national territory; when these are considered, natural ecosystems embedding forest tree species are estimated to cover around 24% of the total area of Lebanon (FAO, 2020). The largest areas of forests dominated or characterized by single tree species include the oak forests of *Quercus coccifera* and the pine forests of *Pinus brutia* on the lower and middle mountain zones, whereas cedar forests of *Cedrus libani* and Juniper forests of *Juniperus excelsa* define the high mountain landscape. As last assessed, 57% of the forest cover is formed of broadleaved species, while coniferous species contribute 32% of the cover and the remainder is formed of mixed conifer/broadleaf forests (Asmar, 2011). The Lebanon Reforestation Initiative (LRI) is working on Land Cover Land Use mapping that will provide a more recent assessment of the forest cover considering land reclamation, forest fires and other degradation factors on one side, and the expanding reforestation projects and forest management initiatives on the other side.

5.1.2.2 Riparian Vegetation and Wetlands

The riparian systems of Lebanon exhibit considerable diversity (MoA/UNEP/GEF, 1996; MoE/UNEP/GEF, 2016; MoE/GEF/UNDP, 2019). Lebanon is rich in river courses of varying topographic features allowing for a wide range of flowing water velocities. These conditions influence the structure of the riverbanks, thus the habitats offered for riparian species.

Platanus orientalis (Oriental Plane tree) aligns most riverbanks and bases of valleys in Lebanon beautifying the landscape and adding a particular character to water basins especially in autumn. Beside the rivers and their tributaries, many streams flow over slopes and in narrow courses. Some of these streams are ephemeral and dry up after the surge of snow water, while others persist to varying times throughout the summer. *Salix* species are strongly associated with running streams. Small springs are also found in the countryside creating boggy land in their vicinity, however, their annual lifetime varies greatly. Small ponds of rainwater accumulation also provide life for some riparian species (Figure 5-3). In addition, small springs and ponds offer appropriate habitats for *Juncus* and *Cyperus* species.

Figure 5-3 Near Eastern Fire Salamander *(Salamandra infraimmaculata)*
Photo credit: Lebanese Wildlife

As for wetlands, several sites have suffered drainage in earlier decades for various purposes mostly reclamation for agriculture. This resulted in a significant loss of these habitats and systems in Lebanon. Aammiq and Anjar wetlands are valuable habitats for aquatic fauna and flora, and vital for migratory birds (MoA/UNEP/GEF, 1996). The conservation and management of these wetlands are supported by several Non-Governmental Organizations (NGOs), such as, A Rocha, SBR and the Society for the Protection of Nature in Lebanon (SPNL).

5.1.3 Other Habitats and Natural Areas of Importance

One of the most significant natural areas is the line of summits that lie in the subalpine to alpine natural systems between an altitude of 2,500 m and above. The climatic conditions in these areas are quite severe in winter experiencing the lowest range of temperatures, heavy winds, frosty days and snow cover. During summer, weather conditions are also aggressive with intense winds and a broad difference in temperatures between the day and night. These expanses host a good part of Lebanon's endemics, many of which have restricted ranges (Figure 5-4) (MoE/UNEP/GEF, 2016; MoE/GEF/UNDP, 2019). These habitats are the most threatened by climate change (CC). In fact, in the past few years, the snow cover was not as usually expected for the heights of Lebanon and the temperature range that they usually experience has also increased (AFDC, 2019).

The valley ecosystems are also important due to the uniqueness of their bioclimatic features. They host a diversity of special habitats and microhabitats, such as floodplains, canyons and cliffs. The Adonis/Nahr Ibrahim valley is one of the river valleys that is attracting much attention in recent years, such as the O-LiFE project. The river outlet to the summits of its heights preserves representatives of about 70% of the flora of Lebanon as well as unique plant associations and their transitions over altitudinal stratifications (Haber and Semaan-Haber, 2013) (Figure 5-4).

Figure 5-4 The Site-Restricted Endemic *Cyclamen libanoticum* in Jabal Moussa Biosphere Reserve
Photo Credit: FON-CEPF Project

5.2 Driving Forces

5.2.1 Terrestrial Ecosystems

The nature of Lebanon has endured extensive phases of anthropogenic exploitation partly for human existence and livelihood, and partly to supply the interest of neighboring countries and civilizations for wood products. After the early exploitations, land reclamation for agriculture expanded with the increase in human population. In the more recent past, land reclamation for construction and urbanization took its toll on the natural capital of the country aggravated by the intense rural to urban migration.

5.2.1.1 Degradation Forces at the Ecosystem Level

Each of Lebanon's ecosystems has been subjected to a series of anthropogenic pressures. These pressures are either localized or shared across systems.

A. Mountain Systems

The mountainous systems of the Western Mount Lebanon slopes have been gravely impacted by urban expansion that reclaimed large expanses of forest landscape, such as in Matn region. Lack of proper urban planning was assessed to induce major pressures on Lebanon's biodiversity (AFDC, 2019). Moreover, forests are under the effect of variable need and dependence on charcoal and firewood. In recent years, the economic crisis is forcing more people, particularly of the vulnerable and poor communities, to rely on forest wood for heating especially with the increase in gasoline price (Chalak, 2016).

B. Subalpine and Alpine Systems

Parts of Lebanon's summit line are losing precious habitats to quarrying and land reclamation for large projects, though some of the latter did not materialize such as on the mountains of Sannine, Kneisseh and Makmel (AFDC et al., 2019). Overgrazing is another intense threat on these heights, which attract herdsmen from lower altitudes to the summer grazing grounds (Chalak, 2016). Under the UNDP-MoE Sustainable Land Management in the Qaraoun Catchment (SLMQ) project, an assessment was undertaken of small ruminants grazing behavior and the spatiotemporal pattern of grazing livestock movements within the three districts of Rachaya, Zahle, and West Bekaa. The assessment found that several types of leisure activities are invading the heights. These activities include skiing, various forms of snow sports and off-road activities using all-terrain vehicles to drive through previously inaccessible terrain.

C. Valley Ecosystems

Some dams are planned to be constructed in river valleys, such as Adonis/Nahr Ibrahim (Figure 5-5) and Bisri valleys. As such the running water will be transformed to stagnant water stored in dam lakes overlaying riparian and natural habitats and forests, which will modify the valley features such as floodplains and water courses (AFDC et al., 2019).

D. Quarries

Quarries were never subjected to site selection criteria that consider protection of natural system, bio diversity, geological features and underground water systems; even though the masterplan for quarries developed in 2002 required a scientific treatment of quarries. Unorganized quarrying caused the loss of important habitats, transformed landscapes permanently and diffused degradation pressures over massive surrounding areas (Figure 5-6). Most of the quarries are located in forests and scrubland ecosystems, which are rich in faunal and floral diversity. Quarries induce fragmentation of forests and natural systems, accelerate soil erosion, and destroy arable lands (AFDC et al., 2019). Between 1996 and 2005, the number of quarries gradually increased from 711 to 1278, and the excavated areas doubled in size from 2,875 to 5,283 ha (AFDC et al., 2019). Quarries active between 1989 and 2005 destroyed 738 ha of grassland, 676 ha of arable land and 137 ha of forests. Recently, the number of quarries has jumped over 1,800 sites; 710 sites have become abandoned. Mapping of the existing quarries in 2018 revealed that illegal quarries have spread outside the sites designated by

Figure 5-5 The Aromatic Species *Viola odorata* found in Nahr Ibrahim Valley
Photo Credit: Myrna Semaan

Figure 5-6 The Sand Quarry of Mayrouba
Photo Credit: Myrna Semaan

the national plan (MoE/GEF/UNDP, 2019). Previously concentrated on Western Mount Lebanon, relocating quarries to Anti-Lebanon and banning quarrying to the advantage of import are some of the reiterated alternatives; however, most of these initiatives failed due to lack of feasibility (AFDC, 2019).

E. Forest Degradation by Insect Infestation

Forest degradation reduces the vigor of trees and increases their vulnerability to infestation.

- The web-spinning sawfly *Cephalcia tannourinensis* was first reported to infest cedars, in 1997. A new outbreak occurred in Tannourine Forest in summer 2013. Pertinent legislation prohibits the utilization of chemical pesticides in the reserves, thus integrated pest management and use of endemic bio-control agents was encouraged (AFDC, 2019).
- The scale insect pest, *Dactylopius opuntiae*, was first encountered in 2012 in Nabatiyeh region. In 2014, it caused heavy infestation of the cactus *Opuntia ficus-indica* in many regions of Lebanon and proved highly damaging. It consumes its host to the extent that infested cacti plants collapse into skeletons of fiber nets. Its predator *Cryptolaemus montrouzieri* was discovered in 2015; the difference between the population sizes and reproduction capacity of predator and prey favored the infestation (Moussa et al., 2017).
- The stone pine forests (*Pinus pinea*) in several Lebanese regions, such as Matn and Jezzine, suffered an abrupt and intense decrease in production of pinecones with symptoms of conelet dryness since 2011. This reduction in production led to economic losses for many farmers. *Leptoglossus occidentalis* was found to infest pine conelets; exotic *Tomicus destruens* was also found to populate the stone pine trees. However, symptoms cannot be solely attributed to the presence of these invasive species, as many insects are accused of the decline in the yield of *Pinus pinea* and the reduction in farmers' income (AFDC et al., 2019).
- The pine processionary moth *Thaumetopoea pityocampa* attacks forests of *Pinus brutia*, broadly spread yet highly manifested in Keserwan and Akkar forests; its caterpillars defoliate trees and weaken their growth (AFDC, 2019).
- *Lymantria dispar, Eriogaster philippsi* and *Thaumetopoea sp.* were also recorded on *Quercus calliprinos* and *Q. infectoria* from a large sample of oak forests. These species are considered current and potential defoliators of oak in Lebanon (Démolin and Nemer, 1999).

5.2.1.2 Overexploitation of Resources

A. Overgrazing

Poor management of grazing practices has led to the loss of forest cover in various areas in Lebanon, particularly in the middle and the high mountain areas. If grazing was properly managed, it could benefit forests by reducing flammable biomass and rejuvenating the forest soil (AFDC et al., 2019).

B. Overexploitation

Four main factors affect terrestrial ecosystems: uncontrolled hunting, overharvesting of wild edible plants, overgrazing (MoE/UNEP/GEF, 2016), and overexploitation of forest resources (AFDC et al., 2019). Hunting in Lebanon was an uncontrolled practice for many years; however, in the past three years, the hunting law was implemented with the leading efforts and follow up of the Ministry of Environment (MoE) and its close coordination with the Ministry of Interior and Municipalities (MoIM), in order to enforce the law. However, the diversity of techniques used in hunting and the widespread hunting territory do not facilitate effective control (refer to Section 5.4.2.5). Non-timber Forest Products including wild edible plants are over harvested, aggravated by poverty and economic crisis. The uncontrolled grazing and lack of awareness are supported by the inexistent land use management and the lack of rangeland management (MoE/UNEP/GEF, 2016). Overexploitation of forest resources for wood and charcoal production affects mostly juniper and oak trees; however, if exploitation was managed properly, it may provide forest ecosystems with a positive impact to reduce fires and rejuvenate patches (AFDC et al., 2019). Land degradation mapping and assessment was undertaken by UNDP in the districts of Zahleh, Rachaya, and West Bekaa under the SLMQ Project. World Overview of Conservation Approaches and Technologies methodology was utilized to document degradation in the three sectors of agriculture, forests and rangelands in the three districts. This internationally adopted approach has been tailored to the Lebanese context and applied therein for the first time.

5.2.1.3 Exotic Invasive Species

Ecologically, it is feared that alien species may grow invasive, overtake natural habitats and induce biodiversity loss. Several invasive species were identified in the past decade in Lebanon. The biodiversity team at the Saint Joseph University (USJ) surveyed the Tyre Coast Nature Reserve (TCNR) in 2015 to discover that the non-native agronomic weed Camphorweed (*Heterotheca subaxillaris*) had invaded the dune habitats in high frequency. The team exercised manual control on species occurrence and propagation. The species control was then adopted by the reserve management (Bou Dagher Kharrat et al., 2015).

The invasive plant species *Ailanthus altissima* has attained broad distribution from the coast to the middle mountains. A recent study reveals that its distribution is favored by degradation and disturbance, yet it does not erode biodiversity (Trad, 2018).

5.2.1.4 Pollution

Several sources of pollution drive adverse impacts on natural systems and biodiversity including discharge of untreated municipal and industrial wastewater, uncontrolled dumping of municipal, and livestock solid waste, production of agro-chemicals such as pesticides and fertilizers and improper discharge of rubble as well as air pollution (MoE/UNEP/GEF, 2016; AFDC, 2019). The 'Biodiversity for Food and Agriculture' national report (Chalak, 2016) also defined intensive agriculture and industrialization as sources of pollution resulting in high organic and heavy metal pollution of soils and ecosystems *(refer to Chapter 10 – Chemical Management)*. Furthermore, Lebanon's fresh and marine water bodies are currently facing major pollution problems that are increasing at an alarming pace, severely threatening native flora and fauna.

5.2.1.5 Climate Change

Climate change is exerting high pressures on the biodiversity of Lebanon as the prevalent Mediterranean climatic conditions markedly divert toward drought with warmer and longer summers and lower precipitation in winter.

A. Forest Fires

Forest fires have caused the fragmentation, loss and degradation of sizable hectares of forested land affecting ecosystem services as well as local community's livelihood. The worst fires that Lebanon witnessed to date took place in autumn 2019. In 2009, Lebanon endorsed the National Strategy for Forest Fire Management; however, limited steps were undertaken to reduce fire risks (AFDC, 2019). Wildfire data analysis was initiated in 2013 with the concerted efforts of the MoE and the Institute of Environment at the University of Balamand (IoE- UoB); consequently, a yearly report is published on the occurrence of wildfires and burnt areas (Figure 5-7). Based on the MoE database, Lebanon lost 837.96 ha, 206.52 ha, 1851.93 ha, and 1870.54 ha of vegetation cover (forests and other wooded lands) during the years 2012, 2013, 2014, and 2016 respectively. Forest fires are the major cause of soil degradation, especially in the areas that have been consecutively exposed to fires, which limits their chances for forest regeneration (AFDC et al., 2019). Burnt areas reveal high regeneration density one year after fire eruption, whereas, 4-5 years after a fire, they exhibit lower regeneration density. Lebanon's National Strategy for Forest Fire Management has recommended reforestation in areas where regeneration is not possible (EL Halabi et al., 2014). Based on risk assessment, fire risk increases in vegetated areas close to agriculture

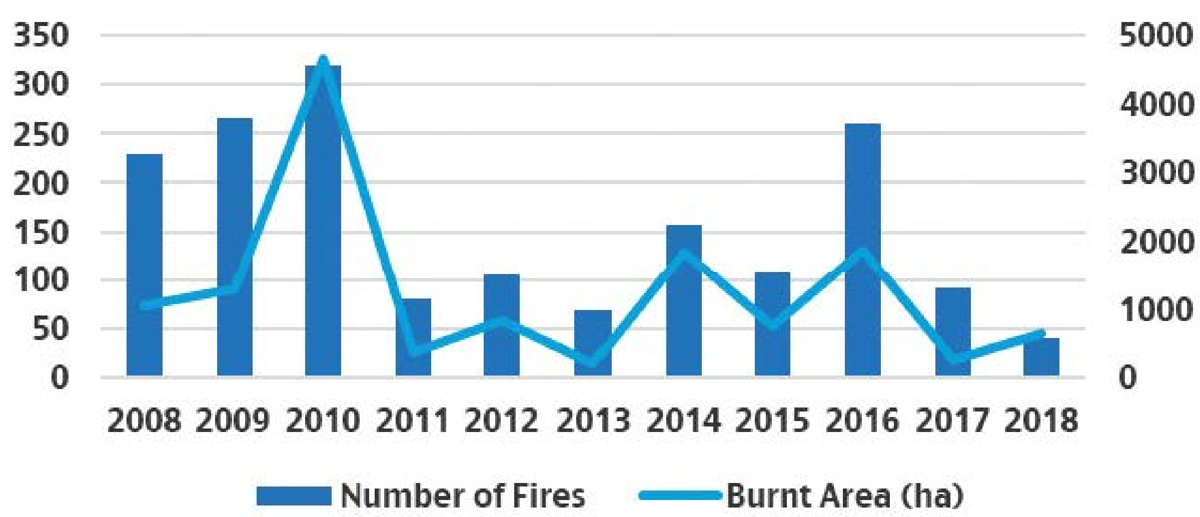

Figure 5-7 Wildfires in Lebanon from 2008 to 2018

Source: Data derived from the annual report on "State of Lebanon's Wildfires" 2008 to 2018 (Mitri, G., 2019; Mitri, G.,2018; MoE/UoB, 2017; MoE/UoB, 2016a; MoE/UoB, 2016b; MoE/UoB, 2016c; MoE/UoB, 2015a; MoE/UoB, 2015b; MoE/UoB, 2015c; MoE/UoB, 2014; MoE/UoB, 2013).

and urban areas (Mitri et al., 2012). Armed conflict areas are also associated with increased vulnerability to fires due to changes in vegetation cover (Mitri et al., 2011). Change in land use, such as land conversions, land abandonment, and fuel accumulation led by the socio-economic changes, also increases the risk of fire occurrence (Mitri et al., 2016). Assessment of public perception of the socioeconomic impact of fires showed high inclination to associate impact with prevalence of wood resources, public health problems and high recovery costs (Mitri et al., 2018). The "State of Lebanon's Wildfires" annual report highlights the technical needs of Lebanon's National Strategy for Forest Fire Management, for unifying fire data, and for the improvement of understanding wildfire problems in Lebanon. The level and distribution of risk to wildfires are evaluated on national scale (Annex 1).

Regarding responses to forest fires, the Sustainable Natural Resource Management Platform (SuNar) of the CNRS presents an early warning system. The open access web-application, the FireLab, also supports the management of wildfires and early responses (Mitri et al., 2014). The Disaster Risk Management (DRM) Unit at the Presidency of the Council of Ministers in cooperation with the CNRS, the Civil Defense and the MoIM coordinate efforts to better respond to and manage forest fires. The DRM Unit also coordinates with municipalities during extreme weather conditions. In addition, reports on forest fire predictions are regularly released and reported daily during the forest fire season.

B. Other Climate Change Impacts

The Mediterranean climate is expected to deviate to more frequent and intense drought conditions and higher temperatures (IPCC, 2014). It is estimated that the drought period in Lebanon will commence 15 days to 1 month earlier than usual, and the drought period will become 9 days longer in 2040, and 18 days longer in 2090; the subarid–arid zones especially in northern Bekaa and the South will endure the sharpest effects (AFDC, 2019).

Generally, CC influences a shift in niche distribution and habitat conditions. Species surviving in the high-altitude zone of Lebanon are expected to be the most affected by bioclimatic shifts (Tolba and Saab, 2009). In addition, species of restricted habitat ranges especially endemic species are also the most vulnerable to these shifts (AFDC, 2019). Marginal mammals may disappear due to habitat loss such as the otter (Lutra lutra) in Ammiq wetlands; reptile and amphibian species will be also affected. However, drought-resistant species, such as the rodent family and its predators, will be able to establish themselves better (MoE/GEF/UNDP, 2009). The forests stressed by fragmentation, pest outbreak, forest fires and inappropriate practices will be the most affected by CC (AFDC, 2019). Forest species may change their distribution and geographical ranges by migrating to other habitats that provide their growth needs (AFDC et al., 2019). Vulnerable species include *Juniperus excelsa, Cedrus libani, Abies cilicica, Quercus cerris var. pseudo-cerris, Fraxinus ornus* (Figure 5-8), and *Ostrya carpinifolia* (AFDC, 2019). *Juniperus drupacea* may become endangered requiring conservation measures (Walas et al., 2019).

Figure 5-8 *Fraxinus ornus* in bloom at JMBR
Photo credit: Myrna Semaan

CC is also expected to increase forest fires, and outbreaks of pests, diseases, and invasive species (AFDC, 2019). The decrease of the cold periods required for flowering and seed germination, advancement in the flowering period, prolongation of the growth season, deficient winter hardening and decrease in snow and other winter damages are also considered impacting factors. In addition, freshwater systems are affected by climatic fluctuations and increased temperatures exceeding 40°C promoted blooms of cyanobacteria (*Microcystis aeruginosa* and *Aphanizomenon ovalisporum*) at the expense of the highly diverse original microflora of the Qaraoun lake (Figure 5-9) (Slim et al., 2014). Yet, CC adaptation nationally remains constrained by insufficient funding (MoE/UNEP/GEF, 2016).

Figure 5-9 The Qaraoun Dam Lake
Photo Credit: Myrna Semaan

5.2.1.6 Syrian Crisis

The Government of Lebanon estimates that the Syrian crisis caused an influx of 1.5 million displaced (UNHCR, 2020), whose presence augmented pressures on urban areas, as well as nature sites where some of the displaced settled in informal tented settlements. The displacement crisis was assessed to induce major pressures on Lebanon's biodiversity (MoE/UNDP/EU, 2014; AFDC, 2019).

5.2.1.7 Lack of Data

Many aspects of biodiversity suffer insufficient to total lack of information, which precludes the devising of appropriate measures for biodiversity management. The intrinsic value of the biodiversity of Lebanon is not appreciated and rarely addressed (MoE/UNEP/GEF, 2016); its socio-economic and cultural values are yet to be fully appreciated (Figure 5-10). Regarding ecosystem services, they are captured in only a couple of studies. Showcasing the SBR, an assessment of its ecosystem services highlighted an average annual economic value of US$ 19 million for monetized services and concluded that each investment of US$ 1 in the reserve would return US$ 19 worth of public benefits (MoEW/ECODIT, 2015).

Figure 5-10 Sheltopusik or the European legless lizard *(Pseudopus apodus)*
Photo Credit: Lebanese Wildlife

5.2.2 Coastal and Marine Ecosystems

In the last decades, an increase in human and natural pressures has jeopardized the ecological and socio-economic integrity of coastal areas globally. In particular, the Lebanese Coastal Zone (CZ) is under increasing pressure from urban sprawl and privatization of the Maritime Public Domain (MPD) for tourism and private use to the creation of landfills in coastal waters, all leading to the destruction of coastal habitats. Additional stresses to the marine ecosystems include CC, erosion and sea-filling, pollution, solid waste dumpsites, wastewater discharges and many industries amongst others (MoE/UNEP/UNDP, 2013b; MoE/UNEP/GEF, 2016a). The cumulative effects are putting the CZ and its natural resources in jeopardy that will most likely affect food security for current and future generations (if not already affected).

5.2.2.1 Changes in Landcover/Land Use

The Lebanese CZ, as most Mediterranean countries, has undergone drastic land use changes, from natural to bio-cultural (linked to traditional activities such as agriculture and fisheries) to urban environments. According to the "Situational analysis of the current land use of the CZ, particularly in terms of socio-economic activities" (MoE/UNEP/UNDP, 2013b; Mitri et al., 2020), the major types of change recorded in land cover/land use between 1998 and 2010 on the CZ of Lebanon in terms of area in hectares and in decreasing order are (Figure 5-11):

- Changes from grassland to artificial land.
- Changes from forest to artificial land.
- Changes from agricultural to artificial land.
- Changes from sea to artificial land.

Uncontrolled Urbanization and Construction of Infrastructure

Urban development on the Lebanese CZ is entirely related to the centralization of economic and commercial activities in this strategic location. This is

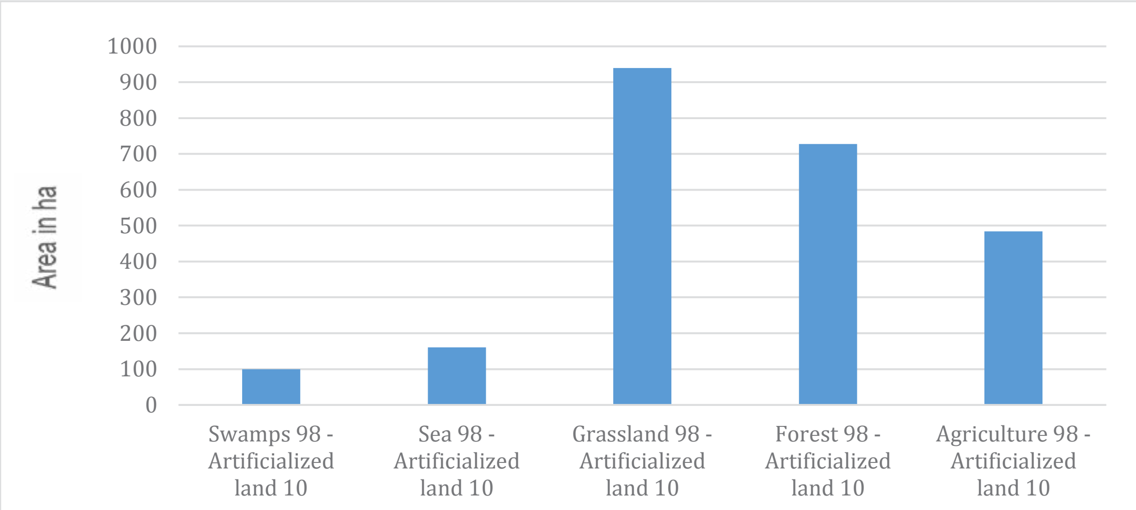

Figure 5-11 Extent of Artificialization on the CZ between 1998 and 2010
Source: MoE/UNEP/UNDP, 2013b

clearly represented by uncontrolled urban expansion with the corresponding construction of infrastructure.

Urban sprawl is initially a result of demographic growth and rural population migration towards the cities (MoE/UNEP/UNDP, 2013b). Moreover, weak law enforcement had greatly increased chaotic artificialization of the CZ.

Another cause for the intensive urban development along the coast is the growing tourism sector that is mainly based on activities within urban structures such as beach resorts, hotels, restaurants and country clubs (Figure 5-12). This traditional trend of Lebanese tourism has a destructive impact on the environment. The unregulated construction of coastal resorts and the violation of the MPD have resulted in coastal privatization, beach erosion, and land and ecosystem degradation.

Figure 5-12 Artificialization on the CZ near Tripoli
Photo Credit: Manale Abou Dagher, 2020

Vermetid platforms (refer to Section 5.3.2.4 for information) are severely degraded in several areas along the Lebanese coast as in Tabarja and El Mina regions, and other Vermetid reefs such as the abundant platforms from Batroun to Jbeil and in Ras Beirut and Saadiyat are under high risk of disappearance (Figure 5-13). If disturbed, the natural recovery of Dendropoma spp. populations is very unlikely because of the low recruitment rates even from adjacent healthy reefs (Milazzo et al., 2017). In fact, Dendropoma spp. show a peculiar reproduction characterized by low connectivity and dispersal range as snails brood their young and the hatchlings crawl only a short distance before becoming sessile individuals (Milazzo et al., 2017; Badreddine et al., 2019).

Figure 5-13 Vermetid Platform - Amchit
Photo Credit: Jina Talj, 2016

Furthermore, coastal towns that used to persist on agriculture (Akkar, Damour - Chouf, Ras El Ainand Naqoura - Tyre) are converting their lands into residential properties due to increased revenues leading to the loss of this important sector. This increases the risks of continued urban encroachment on remaining agricultural lands as can be seen in many coastal regions (Akkar and Damour Plains, lands between Saida and Tyre, and between Ghaziyeh and Naqoura - Tyre). Most of these changes are irreversible, transforming the natural and agricultural areas into built-up properties (MoE/UNEP/UNDP, 2013b).

Additional susceptible, decreasing natural features are the coastal woodlands that are today restricted to only few areas including the slopes of Ras El Shaqaa, El Kelb, Damour and Awally River valleys. Such decrease is mostly due to urbanization, in addition to other agricultural practices like overgrazing and industrial activities like charcoal production (MoE/UNEP/UNDP, 2013b).

In order to remedy violations, the Directorate General of Land and Maritime Transport of the Ministry of Public Works and Transport (MoPWT) produced in 2012 a report detailing occupation (legal and illegal) of the MPD. It showed that there were around 1,068 transgressions (over 5 million m^2 of sea-filling excluding the sea-filling in the area of Downtown Beirut, Debayeh Marina and military settlements) where only 20% of the shore is accessible by public (MoPWT, 2012).

A proposition of settlement of "Illegal Occupancy of Public Maritime Property" was put forward under Law 64/2017 and Law 132/2019; however, these laws tackle only the financial aspect of this issue in view of "funding the state's depleted treasury". In addition, imposed fines are considered to be very low. Both laws also put deadlines for violators to settle their violations or else the state will expropriate illegally built properties, but no expropriation was recorded to date *(Refer to Chapter 6 - Land Resources)*.

5.2.2.2 Exploitation of Natural Resources

A. Marine Fishing

The fisheries sector in Lebanon is artisanal and traditional with outdated regulations dating back to 1929 (Decision 2775/1929). With no seasonality or size limits of fish caught, fishermen heavily exploit available resources and exert tremendous pressure on marine ecosystems (Figure 5-14; Majdalani, 2005; Nader et al., 2020). Nevertheless, the Directorate of Fisheries and Wildlife at the Ministry of Agriculture (DFW-MoA) has significantly reduced the use of many destructive fishing practices like dynamite fishing, trawling nets, fishing of marine turtles, cetaceans and monk seals, and the use of small mesh sizes (Nader, 2011; MoE/UNEP/UNDP, 2013a; Nader et al., 2020).

Figure 5-14 Diversity of Commercial Fish Species
Photo Credit: Shadi El Indary, 2015

B. Uncontrolled Recreational Activities

Seashore destinations witness the largest mass of tourism. They are often frequented by visitors during the summer season (mainly May-September) resulting in uncontrolled recreational activities, including unregulated recreational fishing, scuba-diving, jet-skiing and boating that are located on the various coastal marinas and sea fronts along the entire Lebanese coast (MoE/UNEP/UNDP 2013a).

Furthermore, sensitive ecosystems such as sandy beaches and coastal wetlands are attractive to tourists, developers, and local residents. Increasing numbers of tourists of natural, well-conserved sites such as the Palm Island Nature Reserve (PINR) (Figure 5-15) and the Tyre Coast Nature Reserve (TCNR) consti-

Figure 5-15 Sandy Beaches and Unique Vegetation at the PINR
Source: IMAC Project, 2009

tutes a major concern. The disturbances caused by visitors include trampling, noise and littering, damaging turtle nests, the unique insular vegetation, the unique freshwater vegetation, and the special plants that stabilize sand dunes at the reserves (MoE/UNEP/UNDP, 2013a).

Another main concern is the disturbance of vermetid platforms (Figure 5-16) across the Lebanese coast (Badreddine et al., 2018; Badreddine et al., 2019) by the tourism sector.

Figure 5-16 Vermetid Platforms
Photo Credit: Manal Nader, 2014

Beaches considered as tourist destinations or located near touristic areas include stretches from Tripoli to Qalamoun, Jbeil to Amshit, Rmeileh, Jiyeh, Damour and Ras-El-Dine-El-Bahr-Tyre. The main roads connecting those areas host many restaurants, nightclubs and coffee shops that are sources of impact through noise, solid and liquid waste, and lights at night (MoE/UNEP/UNDP 2013a). Night lights lead to a considerable decrease in the potential of marine turtles nesting on sandy beaches and pollution debilitates marine organisms and reduces survival capacity. In the marine environment, main problems are also caused by water activities such as over-frequentation by divers, jet skis and recreational boats. The special underwater habitats of the marine springs of Chekka and underwater caves along the coast are especially affected by such activities (SPA/RAC-UNEP/MAP, 2018a).

5.2.2.3 Erosion and Sea-filling

A study conducted by the Marine and Coastal Resources Program at the IoE-UoB (MCR-IoE-UoB) comparing historical aerial photographs of 1962 and a satellite image of 2010 by using photo-interpretation based on Geographic Information System (GIS) (Figure 5-17) (Mitri et al, 2020) showed that sand and pebble beaches have retreated due to extensive erosion while more than 8 km^2 of land were added along the Lebanese shores by sea-filling. These changes are attributed mainly to illegal activities like sand extraction and chaotic coastal development due to the inability of the Government to enforce applicable laws especially during and after the civil war (1975-1990) (Abou Dagher et al., 2013; Mitri et al, 2020) and beyond.

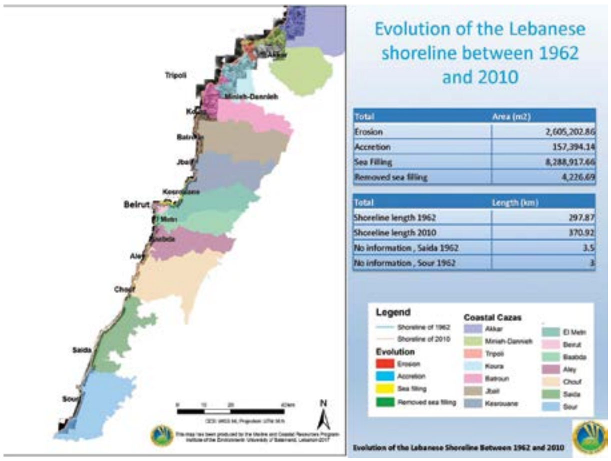

Figure 5-17 Evolution Map of the Lebanese Coast between 1962 and 2010
Source: MCR/IOE/UOB, 2010

Furthermore, the CZ and beaches in Lebanon are experiencing low sediment supply due to new dams being built along rivers and to the diversion of the majority of coastal rivers for potable water and irrigation (Section 5.2.1.1). This will likely result in extensive disturbance in the sediment intake of beaches leading to disequilibrium in coastal dynamics and further erosion, in addition to disruption to food webs (MoE/UNEP/GEF, 2016c; Mitri et al., 2020).

Negative impacts on marine and coastal productivity are expected from artificialization of the coast and the building of dams due to the interdependency between the CZ and organic and sediment loading from rivers. The interactions of freshwater input loaded with sediments and organic nutrients and the productivity of marine resources and coastal erosion are poorly studied in the country requiring a more profound assessment of these interactions (El Khoury et al. 2020).

5.2.2.4 Pollution

Seawater pollution is a chronic issue in Lebanon. It is mostly due to lack of enforcement of environmental laws, absence of sufficient functional wastewater treatment plants (WWTP) and various anthropogenic activities, all leading to land based and sea-based sources of pollution. The National Center for Marine Sciences of the National Council for Scientific Research (NCMS-CNRS) is monitoring the physical, chemical and biological parameters of coastal waters on monthly basis (www.cnrs.edu.lb) and the data is being used in scientific publications and technical reports.

A. Land-based Sources of Pollution

River discharges are considered as the major land-based source of pollution affecting the marine and coastal environment of Lebanon (Houri & El-Jeblawi, 2007). Most urban/domestic, industrial and agricultural effluents coupled with lack of infrastructure and proper management find their way to waterways and eventually to coastal waters. In addition, solid waste dumping in rivers and valleys, considered as additional sources of land-based pollution, aggravate the situation since they are transported by surface water into the CZ during the rainy season (Arif & Doumani, 2014; Abbas et al., 2017; Ghadban et al., 2017).

Urban/domestic pollution: The CZ hosts about 70% of Lebanon's population who, along with thousands of tourists each year, generate about 65% of the total sewage load of Lebanon (Figure 5-18). The load is directly discharged into coastal waters. Untreated sewage forms one of the main types of urban pollution since some WWTPs have not been completed yet while many completed ones are either operating below design capacity or at preliminary levels of treatment *(refer to Chapter 3 – Water Resources for more information)*. According to the Strategic Environmental Assessment (SEA) for the "National Water Sector Strategy for Lebanon", if all planned and exiting coastal and major inland WWTPs are properly operational, pollution loads into the Mediterranean Sea would be reduced by up to 80% (MoEW/ECODIT, 2015). In addition to untreated wastewater, coastal waters are also affected by large seafront dumpsites as the successive Government policies still rely on landfills as the preferred solid waste disposal method (Romboli et al., 2018). In total, 940 open dumpsites are found in Lebanon with several located on the shoreline especially in Tripoli, Bourj Hammoud (Matn), Costa Brava (Baabda), Saida and Tyre leading to low coastal water quality. Solid waste dumped daily in these sites is mainly comingled, therefore aggravating the problem of seawater pollution through leachates potentially containing heavy metals, high level of coliforms, organic compounds and other hazardous wastes (Fakhri et al., 2012; El Khoury et al., 2020).

Figure 5-18 Urban Sprawl
Photo Credit: Arab News PK, 2020

In addition, open dumping and burning of solid waste outside landfills is a widespread phenomenon outside Beirut and most of Mount Lebanon. This is caused by the lack of implementation of a solid waste management programme, due in part to the strong public opposition to proposed landfill sites and to the installation of incinerators, and on the other part to financial shortages. Tonnes of solid wastes are dumped in the natural environment every year including household waste, bulky items, as well as medical, industrial, agricultural and slaughterhouse wastes (Arif & Doumani, 2014; Abbas et al., 2017; Boswall, 2019).

Industrial effluent: The majority of industries in Lebanon are spread across the country mainly outside "industrial zones" and inside residential areas including towns and cities. Effective zoning regulations for industries are either lacking or are not adequately enforced (Figure 5-19). Most industries continue to discharge their effluents into the municipal wastewater system (if existent) or directly into the environment with no prior treatment (MoEW/ECODIT, 2015). The overwhelming presence of heavy industries along the coast for faster transportation and fewer costs towards their destination markets is resulting in additional pollution of coastal waters.

Several coastal sites have been recorded to suffer from industrial wastewater discharges (Arif & Doumani, 2014; Abbas et al., 2017; Fakhri et al., 2018). Near industrial sites, high levels of heavy metals such as Arsenic, Lead, Zinc and Chromium that are

Figure 5-19 Industrial Activity and Urban Areas along the Coastal Zone
Photo Credit: Shadi El Indary, 2014

known to be toxic to ecosystems and biota are detected in coastal waters (MoE/UNDP/ECODIT, 2011; MoE/UNEP/UNDP, 2013b; Fallah et al., 2016) *(refer to Chapter 10 – Chemical Management)*. Sources of industrial wastewater discharged into public sewers and streams that reach the sea vary from phosphogypsum slurry to olive mill wastewater during the olive pressing season. In addition, cooling water that may carry pollutants is directly discharged through the sewage systems in nearby rivers or coastal waters causing poisoning of both humans and aquatic organisms. Furthermore, the high temperature of cooling water creates thermal pollution around its outfalls disturbing the surrounding marine environment.

Agricultural run-off: Agriculture on the Lebanese coast is mainly concentrated in Akkar and Damour agricultural plains, although some farming practices can be found on a smaller scale in several other locations. Agricultural practices are mostly traditional and unsustainable, with disregard to impacts on natural resources especially soil and water. Pollution generated by this sector results from the uncontrolled use of chemicals such as fertilizers, pesticides and livestock farming. Such pollution can infiltrate very easily into aquifers and/or reach surface waters through run-off from agricultural fields, eventually entering coastal waters threatening sensitive coastal ecosystems (MoE/UNEP/UNDP, 2013b; MoEW/ECODIT, 2015; Slim & Fadel, 2019). In addition, waste generated from livestock produce organic pollution causing eutrophication of coastal waters and intoxication of marine organisms (MoE/UNEP/UNDP, 2013a).

Air pollution: The dense population along the CZ coupled with intensive economic activity are resulting in high levels of air pollution. In Beirut and its suburbs, the level of pollutants reached “smog” levels that can be easily seen by the naked eye. Anthropogenic emissions are increasing rapidly over the CZ of Lebanon due to industrialized areas, the absence of an efficient public transport system, dense traffic, the use of community generators to overcome electricity shortages, and high population densities (Waked et al., 2013; Mrad-Nakhlé et al., 2015). Such emissions will be carried into coastal waters through precipitation, surface runoff and diffusion.

Visual and noise pollution: Coastal pollution also includes noise coming from the main coastal highway that parallels the shoreline, in addition to visual pollution caused by the chaotic construction of tourism complexes and residences that lack cohesive aesthetic parameters and conceal the sea view (MoE/UNEP/UNDP, 2013a). Lights from urban development on shorelines also disturb the life cycle of certain species like marine turtles.

B. Sea Based Sources of Pollution

The United Nations Environment Programme (UNEP) Regional Seas Programme states that the discharge of solid and liquid waste, including oily engine waste, from vessels, the use of antifouling chemicals and ballast waters from day-to-day shipping operations have a severe impact on the marine environment because such pollution is steady, continuous and occurs everywhere. Moreover, even low levels of contamination can kill larvae and cause disease. Oil spills kill birds, marine mammals and fish, particularly near coasts, and coagulated oil destroys coastal habitats (MoE/UNEP/UNDP, 2013a).

Most of Lebanon’s primary energy consists of imported hydrocarbon fuels, which are only supplied by sea tankers. Fuel transportation can impact marine and coastal waters through spillage of hydrocarbon fuels from vessels especially from fuel tankers. No information exists in the country to quantify this type of pollution and determine its environmental impact (MoE/UNEP/UNDP, 2013a). However, shipping or commercial harbors on the Lebanese coast, where loading and unloading terminals for oil and other products are located, form major pollution hotspots. These are the ports of: Tripoli-Mina, Chekka, Selaata, Jounieh, Zouk Mosbeh, Bourj Hammoud, Beirut, Saida and Tyre (Figure 5-24; MoE/UNEP/UNDP, 2013a).

5.2.2.5 Climate Change

The impacts of CC on the marine environment include, but are not limited to, more intense storms, intensified storm surges, higher sea surface temperature (SST), an increase in water acidity (ocean acidification) due to the absorption of CO2 emissions (MoE/UNDP/GEF, 2015), sea level rise (SLR), non-indigenous species (NIS) and ocean deoxygenation. Erosion risks will increase due to changes in sediment flow causing beach erosion/regression (Paice & Chambers, 2016; MoE/UNDP/GEF, 2015). The impacts on biodiversity will be mainly negative while in some rare cases it will be positive, depending on the ability of the species to adapt to the new changes:

- SST: Community composition and interactions between species of organisms ranging from phytoplankton to marine mammals, will be deeply altered due to increase of SST. It will affect certain characteristic species such as the *Dendropoma* genus and the coralline algae *Neogoniolithon brassica-florida* considered essential for building vermetid platforms and therefore affecting the stability of such vulnerable habitats (Badreddine et al., 2019). In addition, increasing water temperature will allow the thermophilic NIS to have an advantage over indigenous species pushing them to deeper waters in certain cases and competing for shared resources (Otero, et al., 2013; Vogiatzakis et al., 2016). Furthermore, changes in precipitation patterns due to climatic variations will negatively impact the flow of surface freshwater flowing into the sea, therefore inducing complex changes in the water exchange and nutrient flow. This leads to modifications in species behavior like alteration of the life cycles of species, symbiotic associations, desynchronization between periods of reproduction, dispersal, and migration (MoE/UNEP/GEF, 2016b; Ouba et al, 2016).
- SLR: An increasing depth due to SLR diminishes the amount of light received for the growth of fragile seagrass meadows and other algal species while certain sessile organisms (e.g. barnacles, mussels) will experience high rates of mortality. Declines or losses in species will negatively impact the whole intertidal community of rocky shores and the services they provide. Moreover, SLR will cause the flooding of estuaries and change their physical and chemical characteristics affecting the structure of this fragile natural habitat (Michel, & Pandya, 2010; Abdul Maulud et al., 2018). SLR may threaten the habitats of the Monk seal (*Monacchus monacchus*, listed on the IUCN Red List as an endangered species) with the potential of caves flooding especially during storms due to wave action. Turtle nesting grounds will become unsuitable due to flooding threatening the viability of this fragile species (Neelmani et al., 2019). Furthermore, SLR will also submerge vermetid platforms leading to their gradual disappearance and in turn expose the coast to amplified erosion processes and coastal floods due to both storm surges and heavy rains. The few remaining natural coastal habitats will vanish threatening the species depending on such platforms for survival (MoE/UNDP/GEF, 2011).
- NIS: NISs have drastically affected certain indigenous species populations by occupying the habitats of native species and competing for existing resources (SPA/RAC-UNEP/MAP, 2018a & b). Marine habitats including Marine Protected Areas (MPAs) are facing a migration of NIS. The possibility of establishing viable populations will negatively affect the stability of sensitive coastal ecosystems and population structures (FAO, 2015; Abboud-Abi Saab & Hassoun, 2017). In addition, species like the Silver-cheeked toadfish (*Lagocephalus sceleratus*) can affect human health by causing intoxication and fatalities due to the ingestion of Tetrodotoxin(Khalaf et al., 2014; Boustany et al., 2015); the stings of Striped catfish (*Plotosus lineatus*) causes extreme pain and requires hospitalization; as well the venomous spines of the common lionfish (*Pterois miles*) causes intense pain, edema and erythema (Nader & El Indary, 2011; Nader et al., 2012; SPA/RAC-UNEP/MAP, 2018b). Among the main threatening species are also toxic microalgae and the nomad jellyfish (*Rhopilema nomadica*) that may affect the quality of bathing waters and impact coastal tourism (Abboud-Abi Saab & Hassoun, 2017; Bitar et al., 2017; Nader et al., 2012, MoE/UNEP/GEF, 2016c; SPA/RAC-UNEP/MAP, 2018b). Nevertheless, and in some cases, NIS introduction has created a lucrative parallel industry for Levantine fisheries, in particular for species like the Kuruma prawn (*Marsupenaeus japonicas*), Goldband goatfish (*Upeneus moluccensis*), Por's goatfish (*Upeneus pori*), Blue Crab (*Portunus pelagicus*) and Marbled spinefoot (*Siganus rivulatus*) (MoE/UNEP/GEF, 2016).
- Ocean acidification: This is expected to decrease the net calcification and abundance of rocky intertidal and reef-associated species especially the characteristic species building the vermetid platforms (*Dendropoma sp., Vermetus sp.* and *Neogoniolithon brassica-florida*) by softening of their shells (Badreddine et al., 2019). Ocean acidification will also threaten coastal habitats several of which function as nursery and spawning grounds for marine species, therefore lowering the viability and recruitment of juveniles (FAO, 2015; MoE/UNEP/GEF, 2016b; IUCN, 2017).

- Ocean deoxygenation: Ocean deoxygenation leads to increase in disease incidence among species, deterioration of spawning grounds and reduction in the survival rate and growth of marine organisms. Coastal water pollution may induce bloom-forming species of phytoplankton causing extensive red tides, which may lead to oxygen deficiency in bottom waters (Abboud-Abi Saab & Hassoun, 2017). Such impact will create disequilibrium in ecosystems, deteriorate spawning grounds, and reduce the survival rate and growth of different marine species (FAO, 2015; Abboud-Abi Saab & Hassoun, 2017). Thus, it will negatively affect fish stocks and the fisheries sector, and by association food security. Furthermore, it will negatively impact species richness lowering the attractiveness of the natural habitats and therefore affect the scuba diving sector (FAO, 2015; MoE/UNEP/GEF, 2016b).

5.2.2.6 Syrian Crisis

The increase of generated volume of wastewater in 2014 as a result of influx of Syrian displaced was estimated to be between 8% and 12%. Given the lack of accurate data, it is difficult to determine the fate of this incremental wastewater. As mentioned in Section 5.2.2.4, the release of untreated wastewater in water bodies have can include negative effects on fish and wildlife populations, oxygen depletion, beach closures and other restrictions on recreational water use, and restrictions on fish and shellfish harvesting and consumption (MoE/UNDP, 2019).

5.3 Current Situation

5.3.1 Terrestrial Ecosystems

The most recent complete compilation of the biodiversity of Lebanon remains the 'Biological Diversity of Lebanon' report prepared in 1996 by the MoA through UNEP funding (MoA/UNEP/GEF, 1996). Since then, research has focused on assessing elements of this diversity from species to ecosystems.

5.3.1.1 The Flora of Lebanon

About 2,600 terrestrial plant species make up the flora of Lebanon revealing a high rate (12%) of endemism including 8.5% broad endemics (Lebanon, Syria, and Palestine) and 3.5% narrow endemics to Lebanon (MoE/GEF/UNDP, 2009). A remarkable high number of rare and threatened species exists in the high mountain summits due to the isolation effect of these peaks (MoE/GEF/UNDP, 2009; CEPF, 2018). Yazbek et al. (2011) estimated 2,790 species of vascular plants, and Tohme and Tohme (2014) presented 2,597 photographed taxa, while the extensive bibliographic review of Bou Dagher Kharrat (personal communication) amassed 3,111 taxa including subspecies, varieties and forms. Checklists, field surveys and research are leading to new records and species and continuously updating the status of the country's flora, thus explaining the discrepancies in the observed final count.

A. Lebanon Trees and Forests

Forest cover expands over more than 13% of Lebanon's total area; 142,930 ha are naturally regenerated forests and 350 ha are planted forests, while other woodlands comprise 170,160 ha (FAO, 2020). Of the forest areas, 79,200 ha are formed of dense canopy according to the latest Land Cover/Land Use map generated with data from 2013 (Faour and Abdallah, 2018). According to the Food and Agriculture Organization (FAO; 2005), coniferous forests occupy 44,879 ha (Figure 5-20), while broadleaf forests reach 78,887 ha and mixed forests amount to 15,610 ha. The highest concentrations of forests are found in North Lebanon (30%) and Mount Lebanon (37%) (MoA, 2003). The largest proportion of forest cover thrives under stable non-stressful conditions, as do grasslands (FAO, 2020). Annual reforestation is estimated to have covered 2,430 ha between 2015 and 2020; this trend is expected to strongly increase in the coming years. Volume estimations of species reveal that pines occupy 2.86 million m^3, oaks reach 1.33 million m^3, junipers 1.2 million m^3, and cedar 0.31 million m^3 (FAO, 2020).

A.1 Conifers

Threats to conifers include the potential loss of genetic diversity, which can be avoided by reinforcing in-situ conservation of conifer species and forests of Lebanon. This will strengthen their adaptability and promote better natural regeneration, enhancing the response of the species to the coming environmental challenges (Bou Dagher Kharrat et al., 2018).

A.1.1 Juniper Landscape

Juniperus drupacea (The Syrian juniper)

Extant *Juniperus drupacea* stands of Lebanon occupy limited geographical areas that are subject to intense fragmentation, reduction in area and density and alarming level of dieback. Adopting Jabal Moussa Biosphere Reserve as investigation terrain inferred that optimum conditions for *Juniperus drupacea* growth are at middle altitudes, at western expositions with low slope and in relatively open forests (Douaihy et al., 2017). Exploration of the species across its national distribution range is yet to be developed. In a broader exploration (Greece, Turkey, Syria and Lebanon), CC featured as a source of threat to its future survival; accordingly, conservation strategies to preserve its genetic and morphological diversity are highly advised (Walas et al., 2019). *Juniperus* species distribution is mapped in Annex 2.

Juniperus excelsa

Research concluded that *Juniperus excelsa* is subject to intense degradation pressures across its populations inflicted by a diversity of anthropogenic activities. Several indicators assert a status of threat to species continuity: species density does not exceed 257 trees per hectare, species regeneration is low, and seed fertility reaches 40% at its utmost (Douaihy et al., 2013b). Further endangerment is inflicted by an acari Eriophyoid parasite infesting the seeds of the species (Douaihy et al., 2013a). The high genetic diversity of the species is comforting; moreover, two genetic pools were distinguished with the higher altitude populations of Aarsal and Jourd El Njass distinctive from the rest (Douaihy et al., 2011; Douaihy et al., 2013b). This information is fundamental to future actions from strategies to implementations targeting the species.

Juniperus polycarpos

Juniperus polycarpos trees were discovered in Wadi El Njass through DNA sequencing; Lebanon may have been a refugium during the Pleistocene ice age (Adams et al., 2014).

A.1.2 Cedar Landscape

A regional approach to management of *Cedrus libani* ecosystem generated bio-indicators, where the most significant negative indicator species are the thermo-Mediterranean elements and the most significant positive indicator plants are supra - and Mountain-Mediterranean elements. It also reasserts the significance of high elevations at determining the distribution of the Lebanon cedar (Özkan et al., 2013).

A.1.3 Fir Landscape

The scientific advancement related to *Abies cilicica subsp*. cilicica is the confirmed segregation of the populations of Lebanon from those of East Taurus by genetic and morphological evidence. The differentiation is probably attributed to the effect of genetic isolation exacerbated by subsequent anthropogenic pressures on species distribution and outreach (Sękiewicz et al., 2015). At the national level, fragmentation has negatively affected the level of genetic diversity, which exposes the remnant populations to genetic drift and erosion (Sękiewicz et al., 2015). Accordingly, every Abies tree existing today in the mountains of Lebanon counts (Figure 5-20).

Figure 5-20 *Abies cilicica* and *Cedrus libani* Conifers of Horsh Ehden Nature Reserve
Source: FON-CEPF Project

A.2 Flowering Trees

A.2.1 Oak Trees and Landscape

Rediscovery of an endemic oak: One oak species reiterated in floristic literature on Lebanon is identified as *Quercus pinnatifida* Gmelin, however this species name is not accepted anymore. Taxonomic investigation corrected the identification as *Quercus kotschyana O. Schwarz* endemic to Lebanon (Stephan et Teeny, 2017).

Oak species distribution: Oak species of Lebanon are concluded to be strongly influenced by climatic conditions with temperature and precipitation constituting major driving forces for distribution (Annex 3). Substrate has a minor influence on oaks except *Quercus ithaburensis* Decne confined to volcanic soils (Stephan et al., 2016).

New plant association with the Oak of basaltic landscape: *Quercus ithaburensis* forests have been confirmed as a new alliance in Lebanon (*Quercion ithaburensi*). Several plant associations were characterized leading to the identification of novelties (Stephan et al., 2019).

A.2.2 Wild Almonds and Prunes

Research in the Bekaa affirms that the wild almond species (Figure 5-21) are still an important and rich

Figure 5-21 Wild Almond in Bloom
Photo Credit: Myrna Semaan

component of the natural flora of Lebanon; however, it alerts to their genetic erosion and dangerous species decline (Chalak et al., 2014; Chalak and Hamadeh, 2015). *Prunus kotschyi, P. microcarpa,* and *P. monticola* were not found in the natural habitats indicated in earlier literature (Annex 4).
Wild almond species still have a diversity of uses by rural communities including reforestation, rootstock sources, honey production, food, essential oil production and energy sources.

Prunus species exhibit high morphological diversity revealing high level of heterozygosity. While safe genetically, the species are exposed to a variety of anthropogenic threats; wildfires and overgrazing constitute the main threats particularly in northern Bekaa, urban sprawl is more prevalent in North Lebanon, and integration in agriculture through grafting is also eroding the wild trees. Survival of the wild almonds is challenged with serious endangerment already pushing some species to extinction. The highly needed protection of the different species in their wild habitats calls for national actions.

A.2.3 Sorbus and Cotoneaster

Two new records are added to the flora of Lebanon; *Sorbus persica* and *Cotoneaster morulus* were newly discovered in the Horsh Ehden Nature Reserve (Dönmez et al., 2018).

B. Floral Families

A baseline record of the orchids of Lebanon has amassed 86 taxa in Lebanon (Haber and Semaan-Haber, 2009). Recently, the species *Platanthera holmboei* was reported in the Akkar region. Diversification in *Ophrys apifera* reveal the occurrence of five taxa newly recorded in Lebanon (*Ophrys apifera var. chlorantha, var. aurita, var. purpurea, var. purpurea f. alba* and *var. flavescens*) (Addam et al., 2015). Another variety was newly described as well: *Ophrys apifera var. libanotica* (K. Addam & M. Bou-Hamdan, 2015). New subspecies were also discovered and described including *Neotinea tridentate var. libanotica* (K. Addam & M. Bou-Hamdan, 2014), and *Ophrys omegaifera ssp. gharifensis* (Addam et al., 2013). New line of orchid research infers the significant reproductive success of *Orchis galilaea* in Lebanon especially that this is a rare regional endemic species of Lebanon, Jordan and Palestine (Machaka-Houri et al., 2012). An orchid micro-reserve was started in 2013 pioneering a milestone in private micro-reserves with the engagement of the industry, Lafarge-Holcim. It constitutes the first orchid reserve in the MENA region (Semaan, 2016).

C. Ecosystems

C.1 Mount Hermon

Mount Hermon is recognized as a Key Biodiversity Area (KBA) known for its rich biodiversity. A recent exploration of the vascular plant species reported 221 phanerogams collected therein during 2011-2014 at altitudes of 1,100 to 2,800 m. Twenty-four of the collected species were endemics (Lebanon and Syria), and 115 taxa were recorded for the first time in this mountain ecosystem (Arnold et al., 2015).

C.2 Riparian Systems

Studies showcasing the riparian habitats of the river valley of Nahr Ibrahim revealed the effect of bioclimatic conditions (temperature, humidity), topography and geomorphology, type of bedrock, the presence of alluvial soils and the variability of the water flow regime on richness of biodiversity, species types and canopy cover by riparian species. A study by Stephan and Issa (2017b) also reveals that river channel deviation is the most significant disturbance factor affecting riparian habitat quality. The studies corroborate the significance of ecological gradients related to altitude, slope, distance from riverbed, and number of dry months at influencing the distribution and structure of riparian arborescent flora (Stephan and Issa, 2017 a) (Annex 5). The implications of these findings are highly indicative to any conservation or sustainable use strategy.

5.3.1.2 Terrestrial Fauna of Lebanon

Species diversity of the fauna of Lebanon is estimated to exceed 20,000 species (MoE, 2011; Azar, personal communication) with 46% of this diversity thriving in terrestrial habitats.

A. Mammals of Lebanon

Fifty-nine known species of terrestrial mammals were compiled in 2011 (MoE/UNDP/ECODIT, 2011). The global status of the species based on the IUCN Red List indicate a least concern level of threat to all species occurring in Lebanon, with the exception of the near threatened Striped Hyena (*Hyaena hyaena*) and the vulnerable Marbled Polecat (*Vormela peregusna*). The status of the mammals remains as previously assessed with 36.54% of the existing mammals rare, 1.92 % near threatened, 7.7 % vulnerable, and 1.92 % close to extinction (MoE/UNDP/ECODIT, 2011). In 2013, the mammalian species, Iranian vole (*Microtus irani*, order Rondentia) was reported for the first time in Lebanon; its discovery in Tripoli is based on a study of cytochrome b sequences (Kryštufek et al., 2013). From field observations, the populations of the wild boar are manifesting a noticeable increase deduced by the frequent and abundant signs of their presence in several reserves. The squirrel, which was previously reported as close to extinction, is becoming more frequently observed in several reserves; whether their populations increased under protection cannot be asserted. More sightings of wolves are indicated by shepherds, and a breeding record is confirmed in one of the reserves; however, the status of vulnerability of the species cannot be modified solely by field observations. The status of the only two mammalian taxa endemic to Lebanon (*Nyctalus noctula lebanoticus* and *Myotis myotis macrocephalus*) has not been studied.

B. Insects of Lebanon

An estimated 842 insect species are known to exist in Lebanon (MoA/UNEP/GEF, 1996). However, learned estimation of specialists assesses the number of species to range between 14,000 and 18,000 species (Azar, D. personal communication.). The past 10 years marked an enhanced interest in the exploration of this biological category. An entomological expedition conducted between 2015-2018 by the Hungarian Natural History Museum and collaborating partners in Lebanon gathered 104 known species of class Insecta, 52 known species of Coleoptera, and 30 of Lepidoptera; several species new to science were also described from Order Coleoptera (Figure 5-22) (Novak, 2017; Bálint et al., 2016; Háva & Németh, 2016; Németh, et al., 2019; Szenasi, Nemer, & Németh, 2019; Markus & Németh, 2016; Bezdek, 2018; Németh, 2019; Kostal, 2018).

Figure 5-22 Different Species of Coleoptera; (Left) *Prionychus ottoi* sp. nov. (holotype); (Right) *Hymenalia ehdenica* sp. nov. (holotype)
Source: Novak, 2017

C. Paleontological Arthropods

This section will provide insight into another biodiversity richness that is proving valuable and significant to comprehend evolutionary trends in the biodiversity of arthropods, which is the study of paleontological arthropods. These species have long been extinct; however, examples of the species are captured in amber. Research on Lebanese amber from 1999 to 2020 has led to the discovery of 105 taxa of arthropods and 1 taxon of green algae; 73 of those taxa present new genera and species first time recorded to science, another 21 taxa are new species. A good part of the chosen nomenclature bears honorary reference to Lebanon in the genus or species epithets (Arillo et al., 2019; Shcherbakov and Azar, 2019; Azar et al., 2019; Wichard et Azar, 2017; Legalov et al., 2017; Kirejtshuk et al., 2016; Krogmann et al., 2016; Angelini et al., 2016; Choufani et al., 2015; Kirejtshuk et al., 2015; Choufani et al., 2014; Kovalev et al., 2013; Azevedo et Azar, 2012; Azar et al., 2011; Szwedo et al., 2011).

D. Birds of Lebanon

A total of 405 species of birds were recorded in Lebanon until the end of January 2021; new bird sightings are reported in Annex 6. 285 species (70.4%) are passage migrants, winter visitors, or both; 69 species (17.0%) are vagrants; 73 species (18.0%) are summer breeders, and 65 species (16.0%) are breeding residents; it is to be noted that some species fall into more than one category (Ramadan-Jaradi et al., 2020). Of the remaining species, four observe uncertain status; two have originated from escapes; three were introduced; and two had disappeared from Lebanon around 70 to 120 years ago but reappeared recently as vagrants. The IUCN Red List status of threat indicates that 1 species of the birds of Lebanon is Critically Endangered, 4 are Endangered, 13 are Vulnerable, and 24 are Near Threatened; Annex 7 presents details on the globally threatened birds species of Lebanon. Due to previously uncontrolled hunting and other threats, successive decline in the common species was rated at 14% in 1999, 18% in 2003, and 19.8% in 2008 (MoE/UNDP/ECODIT, 2011); this trend is expected to reverse with the highly improved enforcement and implementation of the hunting law since 2017, and with the marked increase in protected areas as well.

E. Herptile Species

A 2017 reassessment of reptiles revealed an inventory of 63 known species (UETZ, 2017) adding 8 species to the previous records, which were 42 reptile species in 1996 (MoA/UNEP/GEF, 1996), then 44 species (Hraoui-Bloquet et al., 2002), to 55 reported species in 2011 (MoE/UNDP/ECODIT, 2011). The continuously growing number of identified species is mostly related to enhanced exploration of habitats and new areas. Lebanon's nature is privileged with three endemic species; they survive in restricted habitats in the high altitudes of Mount Lebanon, Anti-Lebanon and Hermon (Hraoui-Bloquet personal communication) (Figure 5-23). The inventory of amphibian species of Lebanon remains with 7 identified known species, 5 of which are frogs (MoE/UNDP/

Figure 5-23 Lebanon Mountain Viper
(Montivipera bornmuelleri)
Photo Credit: Lebanese Wildlife

ECODIT, 2011). Globally, two of Lebanon's amphibian species and 17 of its reptile species are considered threatened.

The past ten years witnessed a trend of reduced rainfall and elevated summer temperatures with more prevalence of hot days. This inflicted the drying up of aquatic habitats early in the season, particularly the shallow waters and boggy water habitats, thus increasing pressures on amphibian species. Pollution of water sources and habitat destruction and loss exacerbate the threat to the herptiles. A positive and encouraging impact is generated by the increase in the number of nature reserves and the protected surface areas. Dr. Hraoui-Bloquet (personal communication) regrets that Lebanon has lost one of the most important biotypes for herptiles in particular, as well as fauna and flora. These are the sandy beaches south of Beirut till Naqoura, which preserve a natural significance totally different from those of the northern sandy beaches; the habitats are different such that species frequency is lower northward.

5.3.1.3 Freshwater Biodiversity

The total freshwater fauna and flora species count is 987 species (Al-Zein, 2001), of which 656 are known freshwater invertebrates that include 61 species of worms, 41 species of mollusks, 60 species of crustaceans, and 494 species of insects (MoA/UNEP/GEF, 1996). The contribution of freshwater biodiversity to the total biodiversity is evaluated at 16% of the total fauna and 6% of the total floral species of Lebanon; it is also estimated that 5% percent of the country's freshwater fauna are threatened, including the Globally Near Threatened Otter *Lutra lutra*, and 1.3% are endemic (MoA/UNEP/GEF, 1996), Freshwater ecosystems suffer high disturbance from a variety of threats including pollution and land reclamation for construction or agriculture (Chalak, 2016; AFDC, 2019).

A. Freshwater Fish

Freshwater fish compound 25 species; their conservation status indicates one species vulnerable, three endangered and two critically endangered. The only endemic freshwater fish to Lebanon, *Phoxinellus libani*, was considered extinct in 1996 (MoA/UNEP/GEF, 1996); subsequent observations confirmed its presence in Yammouneh Lake, Litani River and Qaraoun Lake, encouraging the possibility of its occurrence at other sites as well (Al Zein, 2001). Unfortunately, its sites of re-occurrence are highly threatened; the Yammouneh Lake was subject to works, and the Litani River and Qaraoun Lake are highly polluted (Yazbek et al., 2019). Generally, overfishing is recognized to have caused the extermination of some fish species from certain rivers (MoE/GEF/UNDP, 2009). On the other hand, aquaculture has been developed on some rivers introducing species for harvesting (Al Zein, 1997). The aquaculture industry has grown significantly in recent years, mostly associated with tourism.

B. Mollusks

Mollusks have attracted more research in recent years. A survey of the rivers of Lebanon affirmed the presence of *Pseudobithynia hamicensis, P. kathrini, P. levantica, P. badiella, P. saulcyi,* and *P. amiqensis* particularly in rivers Abou Ali, Orontes and Litani (Glöer et al., 2012). Another survey of limnic and terrestrial mollusks collected 17 freshwater and 33 land gastropod species as well as 6 small clams; 11 new records of mollusks were also reported for first occurrence in Lebanon (Bößneck, 2011).

5.3.1.4 Genetic and Agro-Biodiversity

A. Agro-Biodiversity

'Biodiversity for food and agriculture' is recognized to be the biological basis of food security that supports directly or indirectly people's livelihoods. The new Agriculture Strategy of Lebanon for the years 2015-2019 aims to promote the sustainable management of natural and genetic resources, which would combat CC impacts, land degradation, overgrazing, unsuitable cropping patterns, overuse, and overexploitation. Many components of the strategy are dedicated to the enhancement of conservation and sustainable utilization of agro-biodiversity and genetic resources. Concrete measures have been taken to stop biopiracy; MoA issued a decision to organize the use and the exportation of oregano and sage (Decision1/176 dated 6/3/2012).

B. Genetic Resources

Lebanon developed its "National Strategy for Conservation and Management of Plant Genetic Resources for Food and Agriculture (PGRFA) for 2015-2035" (TCP/SNO/3401 FAO project). The strategy aims at promoting and ensuring the rationalized management of PGRFA from conservation to sustainable use including seed delivery in a continuum approach. It calls for aligning the PGRFA relevant activities with other long-term national development plans e.g. National Biodiversity Strategy and Action plan (NBSAP), and Aichi global biodiversity targets. It also calls to the adequate implementation of the IT-PGRFA and promotes the access to plant genetic resources and the benefit sharing that may arise from their use. Lebanon has updated its global plan of action (GPA2) and developed its national information sharing mechanism for the conservation and sustainable utilization of plant genetic resources. Significant efforts were conducted to conserve the genetic resources of the cultivated crops and their wild relatives at the national gene bank, which is holding 1,380 accessions of cereals, pulses, vegetables and fruit trees. Forest genetic variability has also been studied for few forest species. At the level of the state of use by community, the Lebanese people generally make good usage of the various genetic resources for culinary purposes, as well as fishing, hunting, honey making, charcoal, recreation and eco-tourism. Besides ornamental, medicinal, wild edible, forest and forage plants, more than 80 species for food and agriculture are currently cultivated and utilized in the country (Chalak, 2016).

C. Genetically Modified Organisms (GMOs) in Lebanon

GMOs constitute a potential threat to Lebanon's biodiversity. Since July 2005, a National Biosafety framework based on the provisions set in the Cartagena Protocol on Biosafety is implemented. This was supported by MoA through the issuance in 2006 of the Sanitary and Phytosanitary Measures (Law 778) that bans the import of genetically modified seeds and seedlings that might lead to the introduction of new diseases and toxins to Lebanon (Chalak, 2015). Lebanon acceded in 2008 to the Protocol of Cartagena (Biosafety Protocol) regulating the transboundary movement, import, export and use of GMOs. Guided by the Cartagena Protocol, the MoE prepared a draft decree to regulate the import of GMOs based on case-by-case risk assessment. The decree draft is still pending the endorsement of CoM (MoE/GEF/UNDP, 2019). The implementation of the protocol has been defined as National Target #3 under the 6th National Report to the Convention on Biological Diversity (CBD), with 2030 set as the due date for its mechanism to become operational (MoE/GEF/UNDP, 2019). Practically, Lebanon has so far banned the imports of seeds and seedlings; however, there are no national regulations regarding other types of GMO products. The risk of the accidental contamination of the human food chain through GMO products that were only intended for animals exists. This matter calls for the adoption of regulatory measures for the handling of all sources of GMOs reaching Lebanon (Sakr et al., 2014).

5.3.2 Coastal and Marine Ecosystems

According to literature, the Lebanese coastline extends over 220 km from Arida in the north to Ras Al-Naqoura in the south (Badreddine et al., 2018). However, and based on GIS calculations of a 2010 Quickbird panchromatic imagery (0.6 m) and a 1962 aerial photography (0.5 m) using a photo-interpretation method, the length of the shoreline was calculated at 297.87 km in 1962 and 370.92 km in 2010, respectively (MCR-IoE-UoOB, unpublished; Mitri et al, 2020). The coastline is mainly characterized by three bays, 12 prominent headlands and several river deltas.

5.3.2.1 Physical Environment of the Lebanese Coastal Zone

A. Fresh Water Resources

The average annual precipitation is reported to be between 8.6 billion m^3 and 9.7 billion m^3, of which 1 billion m^3 is due to snow (MoEW/UNDP, 2014; Fayad et al., 2017). Lebanon has 2,000 springs and 17 main perennial rivers of which 15 rivers flow into coastal waters supplying sediment and nutrient uploads especially during floods, and therefore contribute tremendously to the productivity of coastal marine resources (MoE/UNDP/ECODIT, 2011). These rivers are not allowed to flood naturally, and most of the surface freshwater is captured and used for anthropogenic needs. It is currently estimated that the available renewable freshwater resources for an average rainy year in the Country is around 4,100 MCM (Sorour Al Housseiny, 2016). Furthermore, over 50% of irrigation water comes from underground wells and boreholes. It has to be noted that aquifers in Lebanon are being over-exploited to the extent that wells are drying up or their salinity is increasing (MoE/UNDP/ECODIT, 2011; MoEW/ECODIT, 2015; Fayad et al., 2017).

B. Coastal Habitats

Lebanese shorelines are a combination of sandy beaches (~20%) and rocky shores (~80%). For soft and hard substrata, several coastal habitat types are encountered along the coast where species are spread between supra-littoral, mid-littoral, infra-littoral and circa-littoral habitats. In addition to sandy and pebble beaches, rocky shores are formed of vermetid platforms, rocky off-shore islands (i.e. PINR – El Mina, El Zire – Saida, etc.), sandstone and limestone cliffs (i.e. Jbeil, Ras Al Shakaa and Ras El Bayada), coastal sand dunes (i.e. unstabilized: Tyre, stabilized: Airport), and coastal caves (i.e. Beirut, Amchit and Ras Al Shakaa), (Figure 5-24).

Figure 5-24 Main Coastal Sites in Lebanon
Source: Prepared by MCR-IoE-UoB, 2020

Marine habitats in Lebanon are not well defined or mapped for fauna and flora associations. Regional Activity Centre for Specially Protected Areas (SPA/RAC) and the United Nations Environment Program/Mediterranean Action Plan (UNEP/MAP) (2018a) described more than 20 benthic biocenosis of hard substrata for the littoral rock, infra-littoral rock and upper circa-littoral rock. The habitats were divided between hard and soft substrata for marine divisions using the «Handbook for interpreting types of marine habitat for the selection of sites to be included in the national inventories of natural sites of conservation interest» (UNEP-MAP–RAC/SPA, 2015). They concluded that certain characteristics of Lebanon's benthic habitats are peculiar creating difficulties for the use of the Mediterranean habitat/biocenosis classifications (SPA/RAC-UNEP/MAP, 2018a). Among these limitations:

- The scarcity of research on marine habitats.
- The specificity and difference of certain habitats from to the rest of Mediterranean.
- The relative homogeneity of the infralittoral fauna and flora (late summer thermocline at 40-50 m depth).
- The influence of some lessepsians species on habitats.
- The very pronounced seasonal changes in flora composition.

C. Continental Shelf

The continental shelf stretches from 0 m from the shore to depth ranging between 100-200 m. It is relatively wide in the north between Enfeh and Akkar (18Km) and south between Ras Beirut and Naqoura (7 Km). Between Beirut and Enfeh, the shelf is extremely narrow (less than 3 Km) where the margin exhibits its steepest slope, with the water depth dropping from 100 to 1,500 m in less than 5 km (Figure 5-25; MoE/UNEP/GEF a, 2016; El Khoury et al., 2020; Bariche & Fricke, 2020).

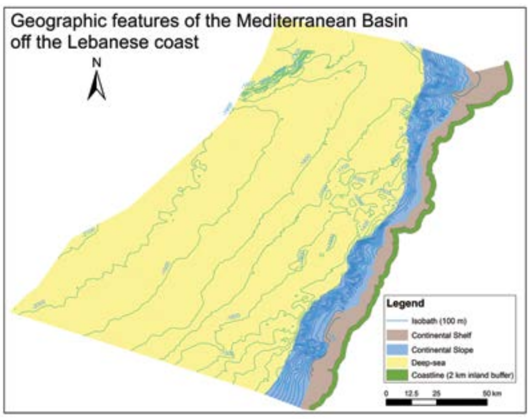

Figure 5-25 Geographic Feature of the Sea Basin Off the Coast of Lebanon
Source: El Khoury et al., 2020

D. Sea Water Properties, Waves, Currents and Tides

Lebanese waters are characterized by the succession of two annual thermal phases: cold phase in winter and warm phase in summer separated by two short inter-seasonal periods in spring and autumn. Sea surface waters are relatively well-mixed during the cold season and more stratified throughout the rest of the year. SST averages vary from a minimum of 17 °C in February to a maximum of 30°C in August. Such characteristics benefit the CZ of Lebanon as in winter the sea warms up the air masses due to higher SST compared to the ambient air temperature. In summer, it is the opposite where SST is lower than the ambient air temperature, and therefore the sea contributes to the cooling of air masses (Abboud Abi Saab et al., 2013).

As for surface water salinity, it fluctuated between 38.5 Practical Salinity Unit (PSU) in winter and 39.7 PSU in summer at offshore stations with greater fluctuations in near shores with an annual average salinity of 38.91 PSU (Kouyoumjian and Hamze, 2012; Ouba et al., 2016; Hassoun et al., 2019).

Tidal activity on the Lebanese coast is weak and similar to the Mediterranean averages that range between 30 to 40 cm (Kabbara, 2005; Awad and Darwich, 2009; Lakkis, 2011 a & b). Water levels on Lebanese shorelines fluctuate mostly due to wind-generated waves.

Regarding waves and currents, they are poorly researched and the only sporadic publications available can be summarized as follows:

- The dominant wind in Lebanon blows from the South-West for the majority of the year. Given the few protected bays, the coast is directly exposed to waves and coastal storms. Waves along the coast are characterized by weak amplitude and a short wavelength. Long term time series data for waves are absent and records show a large discrepancy between studies and regions. Buoys deployed off the coast of Beirut during 12 months in 2003 showed a maximum average monthly wave height of 1.41 m while no information is available for the near-shore environment for depth ranging between 10 to 20 m (Aoun et al., 2013). Data recorded by the Tripoli Environment and Development Observatory between 2012 and 2017 showed that the highest waves in Tripoli were around 1.1 m recorded mainly in winter during storms (El Khoury et al., 2020). On the other hand, the strongest winds are recorded from November to March, especially during heavy winter storms generating waves up to a maximum height of 9 m in Beirut and 1.8 m in Tripoli (Kabbara, 2005).
- Off-shore currents follow a North-Eastern direction in line with the general counter-clockwise gyre of the Eastern Mediterranean. The general East Current reaches Lebanon with a relatively weak speed recorded around 1 knot during strong Western winds (NG-IA, 2017; El Khoury et al., 2020) while localized eddy currents form near the shore and follow a clockwise direction. These eddy currents create a southerly movement of sand along relatively closed coastal areas often causing constant accumulation of sand at the entrances of harbors (Issa et al., 2016; Fakhri et al., 2018).

E. Sedimentary Processes

Sediment and organic loads flowing with river floods are essential for beach sand replenishment and biological productivity of coastal environments. The principal sources of coastal sediments found on Lebanese beaches are the adjacent river watersheds, calcium carbonates coming from shells, and other minerals coming from the Nile River in Egypt (Emery and George, 1963). El Kareh (1981) revealed in his study that the sedimentary influence of the Nile ends in Tyre in South Lebanon. This sand though may be transported northward by marine currents generated by the prevailing south-eastern winds that predominate for most of the year, especially in the summer. Furthermore, as surface fresh waters are limited due to anthropogenic usages and by the building of new dams along rivers and in valleys, the CZ and beaches in Lebanon are facing continuous decrease in sediment and organic loads (Abou Dagher et al., 2013; Mitri et al., 2020). This is expected to increase erosion rates and lower biological productivity reducing the overall resilience of the CZ.

5.3.2.2 Coastal and Deep-Sea Sensitive Sites

Although there are no remaining pristine or singular habitats in Lebanon, distinctive habitats are still considered of high significance due to their richness and importance such as Coralligenous assemblages, Vermetid platforms, Deep-sea canyons and Cystoseira forests (Badreddine et al., 2018; SPA/RAC-UNEP/MAP, 2018a; Aguilar et al., 2018). Therefore, preserving these sites is highly recommended.

A. Coastal Sensitive Sites

A few coastal areas have preserved their natural biotopes and beauty. Within this context, several coastal nature reserves and Ramsar sites were declared by law. Furthermore, additional coastal habitats have also been identified with great ecological and cultural value and require legal protection.

A.1 Marine Protected Areas

The Lebanese MoE already declared three coastal sites as protected (map in Figure 5-24 earlier):

- PINR: Established under Law 121/1992, PINR consists of three small islands, the Palm Island, Sanani and Ramkin, located 5.5 km off the coast of Tripoli-North Lebanon (Figure 5-26). The Palm Island is the largest with a rocky shoreline from the northwest to the south and a sandy shoreline from the north to the east. It includes coastal sand dunes, and its sandy beach is classified as a nesting site for marine turtles and bird species. The other two islands, Sanani and Ramkin, are smaller and their shorelines are mostly rocky. The PINR is open for the public only during the summer season based on the decision of its Management Committee.
- TCNR: Established under Law 708/1992 and located in South Lebanon, TCNR is a coastal & marine site which includes sensitive and threatened habitats: coastal sand dunes and freshwater ponds with reed beds. The TCNR is open for the public only during the summer season based on the decision of its Management Committee.
- Abassieh Coast Nature Reserve: Located in South Lebanon, it was recently declared as an MPA under Law 170/2019. It includes coastal sand dunes and a nesting site for marine turtles.

Figure 5-26 Palm Island Nature Reserve
Photo Credit: Sabine Saba, 2015

In addition, the "Lebanon's Marine Protected Area Strategy" proposed a list of MPAs to support the conservation and management of important marine habitats and species in Lebanon (MoE/IUCN, 2012). For each site, key habitats were assessed and described, such as: permanent or transient aggregations of fish species; turtle nesting areas; areas supporting high diversity; areas supporting species with limited abundance/distribution; areas that are preferred habitats for vulnerable species; and areas that contain a variety of habitat types in close proximity to one another.

This Strategy sets out how the policy related to the marine environment fits within the Government's wider policy framework and what can be achieved by creating the network, (MoE/IUCN, 2012). Sites recommended are (refer to map in Figure 5-24 earlier):

- Naqoura
- Sidon rocks
- Raoucheh cliffs and caves
- Beirut Port Outer Platform
- Byblos
- Medfoun Rocky Area
- Batroun Phoenician Wall
- Ras El Chekaa Cliffs
- Enfeh Peninsula

In addition, the strategy proposed five estuaries (Litani, Awally, Damour, Nahr Ibrahim and Arida) and four deep-water sites (Beirut Escarpment, St. Georges Canyon, Jounieh Canyon, and Tyre Canyons) to be declared as MPAs. Within this context, the MoE developed several draft laws to declare new coastal sites as MPAs. (Annex 10; SPA/RAC–UNEP/MAP, 2018c).

A.2 Coastal Ecologically and Culturally Sensitive Sites

Within the project entitled "Environmental Resources Monitoring in Lebanon (ERML)" the geographical, biological, cultural features in addition to other parameters such as potential stresses and conservation status were considered for the classification of the most coastal sensitive sites (MoE/UNEP/UNDP, 2013a). The CBD and United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Centre criteria were adopted for the evaluation and ranking of coastal sites as high, medium or low priority and immediate protection of high priority sites was recommended (Figure 5-27).

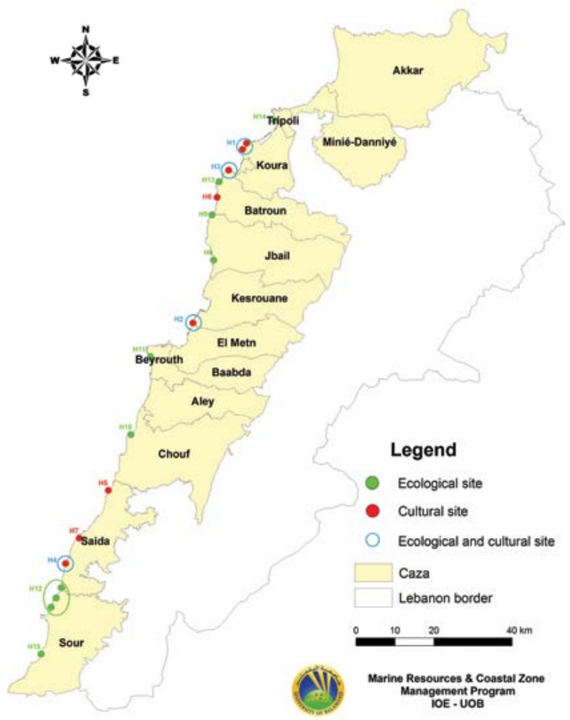

Figure 5-27 Ecological and Cultural High Priority Sites Map
Source: MoE/UNEP/UNDP, 2013a

Table 5-1 represents the high priority sites that were identified by the ERML, such that the existing protected Nature Reserves, Natural Sites and Himas are discussed in Section 5.5.1.4.

A.3 Ramsar Sites

Since the entry of the Ramsar Convention into force in the country on 16 August 1999, Lebanon has designated four sites as Wetlands of International Importance (Ramsar Sites) covering a total surface area of 1,075 hectares. Among the declared Ramsar sites, three are coastal: PINR, TCNR that are already declared as MPAs, and Ras el Chaqaa, which, as mentioned earlier, is in the final stages for being declared as MPA (Figure 5 -24 earlier; Ramsar site number 979 declared on April 16, 1999) with the fourth one being the Ammiq wetland in the Bekaa Valley.

A.4 Important Birds Areas (IBA)

Of the 15 Important Bird Areas (IBA) declared in Lebanon, only one, the PINR, is a coastal site (refer to map in Figure 5-24 earlier; MoE/UNDP/GEF, 2014) (Annex 14).

B. Deep Sea Sensitive Sites

The narrow continental shelf of Lebanese waters is crossed by canyon systems ranging from 50 to more than 1,600 m depth and connecting the CZ to the deep-sea. Given their importance in ecosystem equilibrium, their role should be highlighted and

Table 5-1 ERML High Priority Sites

Code	Name	Type
H1	Ras Enfeh	Ecological and cultural
	Salinas, wall promenade and our lady of Natour monastery	
H2	Nahr el Kelb historical site and estuary	Ecological and cultural
H3	Promontory cape and cliffs of Ras Chaqaa + Saydet El Nouriyeh Monastery	Ecological and cultural
H4	Aadloun beach and caves	Ecological and cultural
H5	The sea castle of Saida and underwater city + Sea façade + old harbour	Cultural
H6	Historical centre and fishing harbour of Batroun	Cultural
H7	Ancient tell of Sarafand	Cultural
H8	Beaches in the south and north of Jbeil (Jbeil-Amshit)	Ecological
H9	Medfoun rocky area	Ecological
H10	Damour river estuary	Ecological
H11	Sandy beach of Ramlet el -Baida in Beirut	Ecological
H12	Qasmieh estuary	Ecological
	Mhayleeb beach	
	North Tyre beach (Ras-El Dine-El-Bahr)	
H13	Selaata terraces	Ecological
H14	Terraces of Al Mina	Ecological
H15	Mansouri beach	Ecological

action taken to provide these canyon systems with legal protection, especially with the novel oil and gas sector.

Canyons

Submarine canyons are nutrient "super highways" where mixing rates could reach 1,000 times the rates measured in the open ocean. Water movement associated with canyons enhances local primary productivity and the functioning of the benthic and pelagic ecosystem. Due to the importance of the role of canyons, a workshop was organized by the CBD in Malaga, Spain in 2014. Objectives were to define Ecologically and Biologically Significant Areas for the Mediterranean where Lebanon suggested the establishment of one for the East Mediterranean under the title of East Levantine Canyon Area (ELCA) (UNEP/CBD/EBSA/WS, 2014; Figure 5-28).

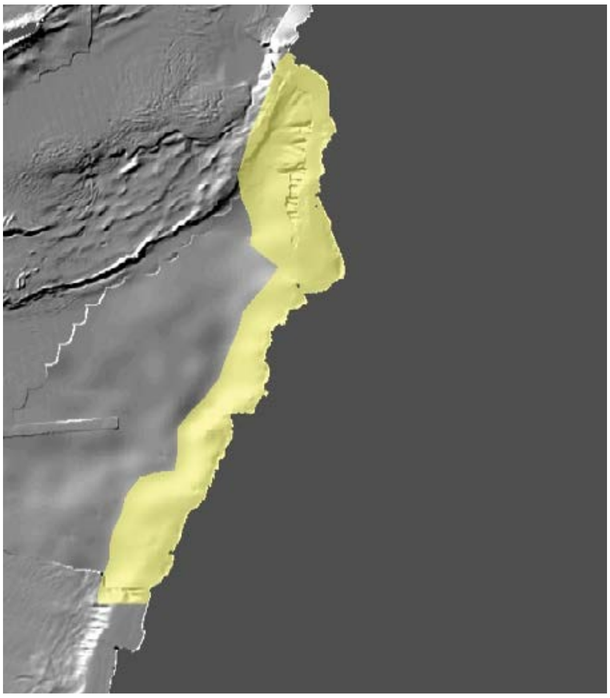

Figure 5-28 Proposed East Levantine Canyons Area (Yellow)
Source: UNEP/CBD/EBSA/WS, 2014

Inside Lebanon's territorial waters, this area represents about 1,240 km². In addition, the Oceana - MedNet (2011) described several specific features of significance amongst many others of the Levantine area further justifying the importance of the ELCA, and are:

- Several hydrothermal vents
- Submarine freshwater springs
- Particular habitats: Rhodolith/Maerl beds, bathyal muds, sandy bottom
- Species of ecological and commercial value

Upon the request of the MoE, a deep-sea expedition funded by the MAVA Foundation was undertaken in 2016 as part of the "The Deep-Sea Lebanon Project". This project is the result of a partnership between Oceana, IUCN and UNEP/MAP - Specially Protected Areas Regional Activity Centre (SPA/RAC), on behalf of the MoE with the support of the CNRS, the General Fisheries Commission for the Mediterranean (GFCM) and the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS). Through this expedition, the following five canyons were surveyed: Beirut Escarpment (Ouzai), Saint Georges Canyon, Jounieh Canyon, Sayniq (Saida) Canyon, and Chekka-Batroun Canyon (Figure 5-29).

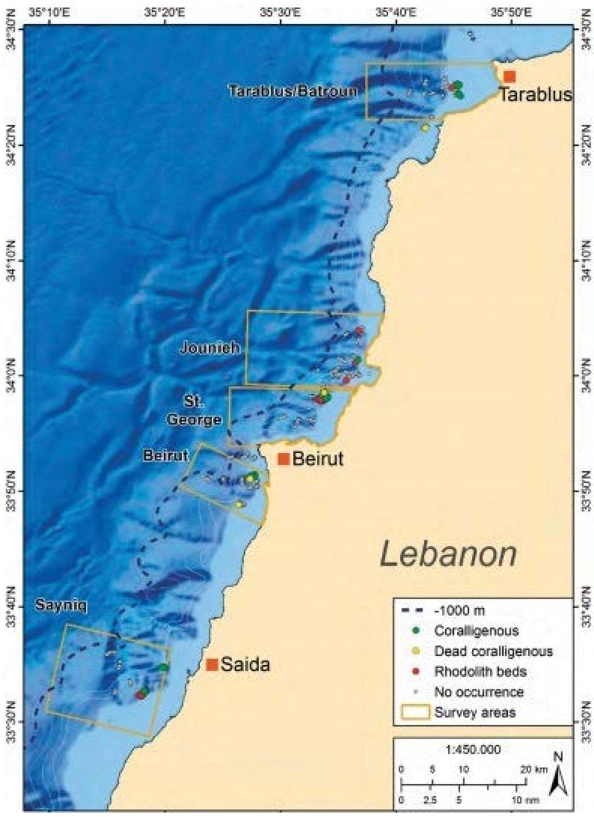

Figure 5-29 Surveyed Canyons by OCEANA
Source: Aguilar et al., 2018

The expedition documented more than 600 species, including new records for the Mediterranean Sea. It confirmed the presence of "a superb belt of coralligenous gardens discovered at 80-meter depth, beautiful corals, and a huge variety of sponges." The long-nosed skate (*Dipturus oxyrinchus*) was seen for the first time in the Levantine Sea, and observations of lantern shark (*Etmopterus pusillus*) marked the first record of this species in the Mediterranean (Aguilar et al., 2018).

5.3.2.3 Biodiversity of the Lebanese Coast

Lebanese waters constitute less than one percent of the world's ocean surface but hold an impressive 6 percent of global marine species (Quignard & Tomasini, 2000; MoE/UNEP/GEF, 2016a). Several types of marine biotopes including rocky, sandy, sludgy, coastal, neritic and oceanic can be found, where biocenosis developed according to the prevalent geological, physical and chemical conditions (Lteif, 2015; MoE/UNEP/GEF, 2016c; Aguilar et al., 2018; El Khoury et al., 2020). One of the most characteristic habitats of the Lebanese CZ are the threatened vermetid platforms (RAC/SPA - UNEP/MAP, 2014; Badreddine et al., 2018).

A positive development in the past decade is the surge in scientific investigations of the CZ where several initiatives were launched by academic and research institutions to close existing gaps in Lebanese biodiversity research (MoE/UNEP/GEF, 2016c).

No national list of species exists for Lebanese marine biodiversity. Producing and regularly updating one is a necessity especially given the large number of new NIS, both fauna and flora, recorded on a yearly basis. Nevertheless, gathering information from a multitude of publications allows reporting the following:

- Phytoplankton: 385 species (Lakkis, 2013; Lakkis, 2018).
- Zooplankton: 783 species have been identified, 220 of those being Microzooplankton and 563 Macrozooplankton (MoE/UNEP/GEF, 2016c).
- Macrophytes: 243 including 29 non-native species (SPA/RAC-UNEP/MAP, 2018a).
- Zoobenthos: 1,072 marine invertebrates recorded, 156 of which are exotic. Mollusks account for 371 species, including 30 gastropods and 18 alien bivalves (Bitar, 2014). Benthic communities contain an extremely diverse assemblage of species groups like Sponges, Cnidaria, Nemerta, Polychaetes, Sipunculiens, Molluscs, Brachiopoda, Crustacea, Echinoderma, and Asidies (SPA/RAC-UNEP/MAP, 2018a). (MoE/UNEP/GEF, 2016c).
- Ichtyofauna: 367 species comprising 39 Chondrichthyes (Figure 5-30; Bariche & Fricke, 2020).
- Marine mammals: A total of 7 species are recorded in Lebanese waters: Short-beaked common dolphin (*Delphinus delphis*), Common bottlenose dolphin (*Tursiops truncatus*), fin whale (*Balaenoptera physalus*), Cuvier's beaked whale (*Ziphius cavirostris*), Risso's dolphin (*Grampus griseus*), Striped dolphin (*Stenella coeruleoalba*), and the Mediterranean monk seal (*Monachus monachus*) (Figure 5-31; Kouyoumjian & Hamze, 2012; SPA/RAC- UNEP/MAP, 2018; SPA/RAC-UNEP/MAP, 2020a). In winter 2019-2020, Orcas (*Orcinus orca*) were observed and documented along the Lebanese coast and one was found washed dead on the southern shores of Lebanon. Cross-checking the individuals' distinctive markings behind their dorsal fin and the white patch above the eye in international datasets allowed the identification of at least one individual (SN113) while experts are still working on identifying the washed dead individual as its body was in a state of decay (Lewis, 2016).

Figure 5-30 Fish Diversity
Photo Credit: Manal Nader, 2020

Figure 5-31 Mediterranean Monk Seal *(Monachus monachus)* in Front of Beirut-Raouche
Photo Credit: Operation Big Blue, 2013

- Marine herpetofauna: Marine herpetofauna in Lebanon totals four species, the most common are the Loggerhead turtle (*Caretta caretta*) and the Green sea turtle (*Chelonia mydas*) that regularly nest along some of the few remaining Lebanese sandy beaches with annual nesting numbers being speculated due to sporadic monitoring initiatives. On the other hand, rare records exist for the other two species, the Leatherback turtle (*Dermochelys coriacea*) and Olive ridley sea turtle (*Lepidochelys olivacea*) (RAC/SPA-UNEP/MAP, 2018a; SPA/RAC-UNEP/MAP, 2020b&c).

- Marine ornithofauna: A total of 404 bird species have been reported in Lebanon (Ramadan-Jaradi & Itani, 2019). Of those, 86 species including 35 foreshore species, 18 coastal, 6 maritime, and 27 species with different affinities were documented in the northern part of Lebanon (Ramadan-Jaradi, 2017).

In addition, the MoE in Lebanon produced the National Biodiversity Monitoring Plan in 2017 in collaboration with the SPA/RAC-UNEP/MAP. This was carried-out through expert meetings. The plan includes a list of species with heritage value and interest for conservation that deserve to be protected. Each species is presented by its conservation status, geographical distribution, habitat, and threats with some recorded observations. This plan adopted a habitat classification based on geo-morphological features that makes it possible to compare results of surveys from different studies, independently of the season. The classification aims at providing a standard nomenclature for describing and mapping marine habitats, mainly in areas where very little is known about the benthic environment (SPA/RAC-UNEP/MAP, 2018a).

5.3.2.4 Vermetid Platforms

Vermetid platforms are organogenous formations basically built up by the association of *Dendropoma* species (gastropod), *Vermetus triquetrus* and the crustose coralline algae *Neogoniolithon brassica-florida*. These platforms are very fragile habitats and their optimum environmental conditions are in the intertidal or immediate subtidal zone, which interacts with the surrounding physical and chemical changing factors (Figure 5-13; Badreddine et al., 2019). Vermetid platforms are considered biogenic intertidal or shallow subtidal reefs that provide key ecosystem functions and services. More specifically, they protect shorelines from wave erosion, act as carbon sinks and function as nursery grounds and refuge habitats from predators for many diverse assemblages of species, including many invertebrates and fish of commercial interest (Badreddine et al., 2019).

This habitat was extensively studied in the past decade allowing the understanding of the status of vermetid reefs along the Lebanese coastline (Badreddine et al., 2019). Results highlighted that this habitat is very fragile to disturbance where the reef building species *Vermetus triquetrus* and *Dendropoma anguliferum* were hardly found alive and in low densities. This raises concerns about the survival of such reefs in the Levantine Basin (Badreddine et al., 2019) and the loss of its services on overall coastal biodiversity.

According to the latest available information, Lebanon has lost approximately 34% of the surface of its vermetid platforms between 1962 and 2010 (from 2,482,656 m^2 in 1962 to 1,670,152 m^2 in 2010) mainly due to sea-filling and chaotic construction activities along its coast (MCR-IoE-UoB, within a Masters Thesis project presented in January 2018; unpublished). This loss is expected to increase due to continuing destruction of the Lebanese coast by urban development and to the impacts of CC, more specifically SLR.

5.3.2.5 Non-Indigenous Species

NIS can be either introduced directly by people (for example through aquaculture or the aquarium industry) or accidentally by fouling and ballast water from ships or allowed passage by human actions. The opening of the Suez Canal established a direct, major route of invasion for Indo-Pacific fauna and flora into the Mediterranean and is considered by far as the main source of NIS in Lebanese waters. Lebanon's location at a short distance to this major point of entry (Suez Canal), coupled with the wide diversity of marine habitats, has facilitated the fast encountering of NIS in its waters and their subsequent establishment (Figure 5-32). The Marine Mediterranean Invasive Alien Species online database (http://mamias.org/; www.eea.europa.eu) reports a total of 215 marine NIS from Lebanon (SPA/RAC-UNEP/MAP, 2018b). An increase in NIS in Lebanese coastal waters is expected due to CC.

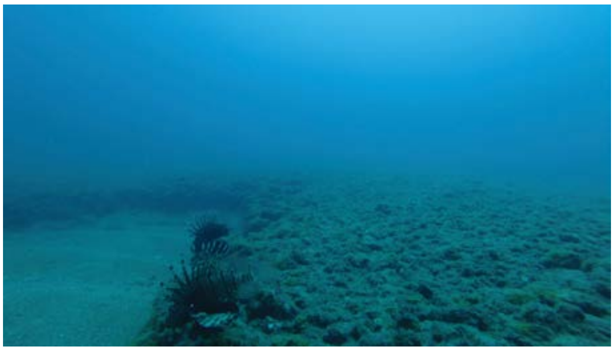

Figure 5-32 Lionfish *(Pterois miles)*
Photo Credit: Manal Nader 2020

5.3.2.6 Artificial Reefs

The Lebanese marine ecosystem has come under an increasing series of diverse and complex stresses (natural and anthropogenic) that have led to serious detrimental changes in its natural environment resulting in habitat destruction and a tremendous decrease in marine biological resources.

One proven positive step towards turning the tide is to create stable and sustainable habitats in the form of Artificial Reefs (AR). ARs support marine life in otherwise extremely stressed, barren and/or unproductive areas where there is a lack of stable marine substrate to support an abundance of sea life. In addition, ARs provide an added value to fisheries, ecotourism and education (Figure 5-33).

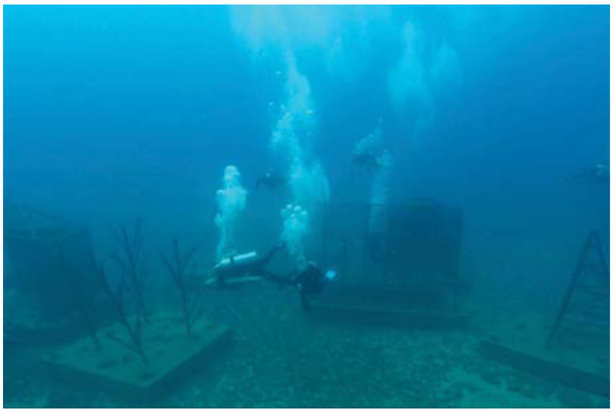

Figure 5-33 Artificial Reef
Photo Credit: C-Club Scuba Diving Center, 2020

In 2005, the UNDP-Lebanon commissioned the study entitled "Economic Assessment to Convert 100 Derelict Buses to Artificial Reefs" that concluded that introducing ARs would potentially boost ecotourism through diverse aquatic activities and the local fishing industry through higher fish yield. Two of the main outcomes of the study were the enhancement of the standard of living of one of the poorer sections of society, the fishing community, and secondly a boost in ecotourism through the provision of new diving sites for divers and marine sport enthusiasts. Within this context, several initiatives to deploy ARs were launched in the past decade (Box 5-2).

Box 5-2 Initiatives to Deploy ARs in the Past Decade

The first initiative to deploy AR in Lebanon was in June 2012, constructed by the Lions & Rotary Clubs, in coordination with the MoE, Ministry of National Defense, MoPWT and in partnership with the MCR-IOE-UOB, using 8 derelict tanks and vans donated by the Lebanese Army in the Abdeh region (North Lebanon). In 2017, five years after the deployment of the reef, a total of 93 species (16 fish species; 38 species of sessile macrofauna, macroalgae and sea-grasses; and 39 in faunal species) were identified during a Masters Thesis research at UOB, further showing the importance of ARs in enhancing marine ecosystems. Colonization has exceeded expectations and the AR is fulfilling its role of providing substrates for the settling of many species therefore enhancing marine biodiversity in the region.

Under the "Protection and sustainable development of maritime resources in Lebanon" (ProMARE) Project implemented by the EU in partnership with the MoE, two projects were awarded for the deployment of ARs in 2018 to MCR-IOE-UOB and the "Friends of Nature" NGO. The ARs were deployed in Jounieh bay and in off-shore Barbara and post deployment studies/activities are being held.

In addition, the "Friends of Al-Zireh Island Association" in collaboration with the municipality of Saida deployed in June 2018 an AR around the island of Al-Zireh, Saida constructed of six old army tanks and four other military vehicles donated by the Lebanese Army. Vehicles were submerged to depths of 14, 17 and 18 meters within an area of about 150 m^2.

5.3.2.7 Socio-economic Sectors on the Lebanese Coast

In Lebanon, 90% of the population resides in urban environments with the highest concentration occupying cities along the coastline that host 70% of the population (MoE/UNDP/GEF, 2011; MoE/UNEP/GEF, 2016a; Ghoussein et al., 2018). The most important economic centers are located in these coastal cities that represent major opportunities in the fields of industry, services, agriculture and fisheries.

A. Fisheries Sector

Lebanese fisheries are artisanal or traditional in nature (Figure 5-34). According to the DFW-MoA, the number of licensed fishing vessels in 2019 was 2,084 boats operating from 44 fishing harbors and landing sites. Living marine resources are managed by the MoA while the MoPWT is in charge of the fishing boat registry (Majdalani, 2005; Sacchi and Dimech, 2011). The majority of Lebanese fishing boats are small (less than 12 m in length) and the main gears used include trammel nets, gill nets, long lines, purse seine nets (lampara) and beach seines (Majdalani, 2005; Sacchi & Dimech, 2011; Nader et al., 2014; Nader et al., 2020). Fishing mostly takes place at an average depth of 50 m, and occasionally at maximum depth of up to 200 m. Moreover, illegal fishing techniques using dynamite and nets with small mesh size are chronic problems that, even though reduced, have not been completely resolved.

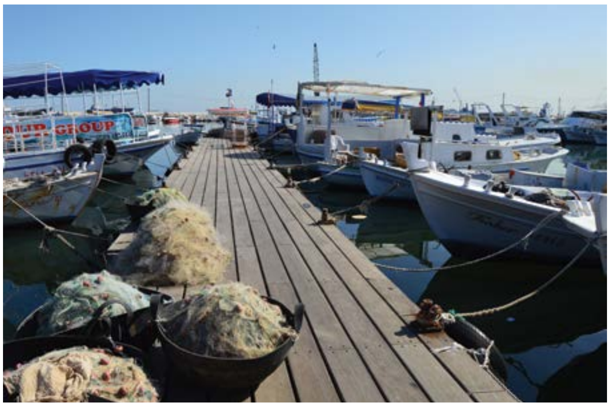

Figure 5-34 Artisanal Fishing Fleet and Fishing Gears
Photo Credit: Sabine Saba, 2015

In the last decade several initiatives were undertaken by the DFW-MoA, the FAO of the United Nations, NCMS-CNRS and other institutions to fill the existing gaps in the fisheries sector and to properly and sustainably manage marine and coastal resources. In 2013, the FAO-EastMed project (www.faoeastmed.org; funded by FAO) in collaboration with the MoA in Lebanon initiated a "Pilot Survey on Fisheries Dependent Data Collection in Lebanon Including Training" to implement a national fisheries dependent data collection programme through the expansion of the MCR-IoE-UoB original Fish Landing Operational Utility for Catch Assessment (FLOUCA) into a national web driven utility named FLOUCA Web. The national data collection system is on-going since 2013 (El Khoury et al., 2020) and catch/effort fisheries data can be requested from the DFW-MoA. In addition, several studies were initiated by several institutions in the country to collect biological parameters and assess fish stocks of commercial importance.

Moreover, a national management plan for the Purse Seine Sardine Fishery (PSSF) was developed based on the Ecosystem Approach to Fisheries for the benefit of the MoA with the financial and technical support of the FAO-EastMed project (www.faoeastmed.org) and in collaboration with the DFW-MoA (Nader et al., 2020). Furthermore, a new draft law was prepared by the MoA taking into consideration the new challenges in fisheries management as well as the new scientific references and benchmarks for the sustainable management of marine resources and the wellbeing of fisher communities. The draft law is currently being revised by different related ministries for commenting and amendments before being raised to the CoM (MOE/UNEP/GEF, 2016c; El Khoury et al., 2020).

Furthermore, a socio-economic study held under the FAO-EastMed Project showed that fishing in Lebanon is a family-based activity. Fishers are part of the poorest segment of society. There is a non-aging fishers' population where the average age of the skipper is 48 years and that of the fishers is 35 years both with a low level of education and comparable to other Mediterranean countries. The annual income per fisher-owner (US$ 7,400) and fisher (US$ 3,000) is 20% and 70% respectively less than the national Gross Domestic Product (GDP) per capita. Furthermore, a fisher earns about 25% less than the minimum wage of the Country (Pinello & Dimech, 2013). The value of this income has since severely deteriorated following the economic crash of 2019.

B. Agricultural Sector

Agricultural lands on the CZ are mainly concentrated in Akkar, Abou Ali Valley in the North, Damour, and the Southern Plain (mainly in Saida and Tyre) in the South (Figure 5-24). Cultivation consists of subtropical crops in the South (i.e. citrus, avocados, bananas, etc.) and vegetables and irrigated crops in the North. The agricultural sector including fisheries contribution to the national GDP is estimated around 6.24% representing 17% of the value of export and relying mainly on individual initiatives (MoE/UNEP/UNDP, 2013c). On the other hand, in the Lebanon Economic Vision (MoET, 2018), the real GDP of this sector was estimated at around 3.1% in 2016. Coastal agriculture faces similar challenges similar to the general agricultural sector in Lebanon with its main issues summarized as follows (MoET, 2018):

- Low productivity and quality: Due to limited modernization/technology adoption (harvest, post-harvest, etc.) and excess use of fertilizers & pesticides (452 kg/hectare, vs. 131 kg/hectare in OECD countries).
- Structural constraints: Small farms (1.4 ha), ineffective cooperative system (~1200 COOPs, 2/3 of which are inactive), dominated by wholesale markets/distributors, etc.
- Insufficient and poorly targeted government support: Limited extension and research services, poor controls on food safety & quality, water usage, limited access to financing.
- Financial unsustainability: Rising land & transportation costs, reliance on subsidies, ad-hoc financial support and the recent economic crisis.

Agriculture in general, and coastal agriculture in particular, plays a minor role in the Lebanese economy even though it constitutes either the sole source of income or an additional source of income for a large portion of individuals (Pinello and Dimech, 2013; CDR, 2016). Coastal plains are threatened with urban sprawl and other economic activities, rendering coastal agriculture very fragile (MoE/UNEP/UNDP, 2013c).

C. Industrial Sector

In Lebanon, 51% of industries are located along the coast surrounding the main cities since the coastal infrastructure offers a better supply of raw materials throughout and prompter export of merchandises (CCIA, 2011; MoE/UNEP/UNDP, 2013c). According to the Lebanon Economic Vision (MoET, 2018), the real GDP of this sector was estimated at around 2.79% in 2016 with the following key challenges that lead to the low competitiveness of the sector:

- High costs of factors of production (high cost of private electricity generation, rising land and labor costs, unfavorable business environment, ineffective transportation network).
- Low quality/standards: Shortage of skilled technical labor, limited application of international standards.
- Challenges aggravated by external market shocks: Reduced regional demand for key products (e.g. generators) and constraints on land transportation due to the Syrian conflict, and more recently the economic crash of 2019.

D. Oil & Gas Sector

Recently, the Ministry of Energy and Water (MoEW) launched the exploration and production activities for offshore petroleum resources in Lebanon under the Offshore Petroleum Resources Law (Law 132/2010). A SEA was conducted for offshore activities in 2012 and updated in 2020 (TOTAL E&P, 2019; El Khoury et al., 2020) (Figure 5-35). An Environmental Impact Assessment (EIA) for Block 4 (located approximately 6 km from the nearest coastline and covers an area of 1,911 km^2 with water depth ranging from 320 m to 1,780 m) was conducted followed by exploration activities. The introduction of this new sector in Lebanon will create new challenges and pressures on the surrounding marine and coastal environments. Through a participatory approach, the intensity of impact of activities, mitigation measures based on international standards, best practices, and Lebanese legislative requirements were proposed to avoid or reduce potential impacts (TOTAL E&P, 2019). On the other hand, the sector can be considered an opportunity to increase knowledge of coastal and deep-water environments through EIAs and other research activities.

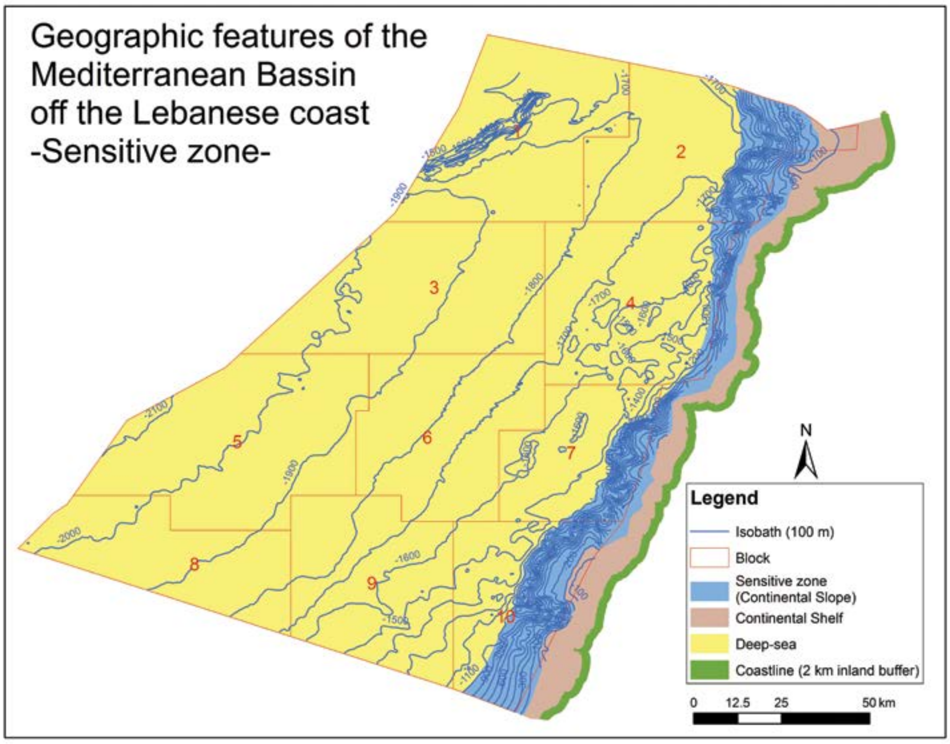

Figure 5-35 Lebanese Exclusive Economic Zone (EEZ) and Oil Exploration Blocks
Source: El Khoury et al., 2020

E. Tourism Sector

Tourism is a main contributor to Lebanon's economy and represents a major source of income and employment. Seventy-one percent of Lebanon's total hotels and resorts are located on the CZ (MoE/UNEP/UNDP, 2013c; Kanbar, 2015). On the social level, this sector directly generated 92,500 jobs in 2013 or 6.7% of total employment (WTTC, 2014). Coastal tourism nevertheless provides both positive and negative effects. Certainly, it offers benefits to local communities, but it also generates adverse impacts on coastal resources (Kanbar, 2015) in the form of pollution, habitat destruction and sea-filling for the construction of resorts and marinas leading to total devastation of coastal habitats.

5.4 Key Stakeholders and Legal Framework

5.4.1 Multilateral Environmental Agreements Related to Biodiversity Ratified by Lebanon

Lebanon has signed and ratified several international conventions and agreements related directly or indirectly to biodiversity protection and conservation, as well as coastal zone and marine ecosystems (Annex 8).

The Nagoya protocol concerning Access and Benefit Sharing was developed in 2010 as a supplementary agreement to the CBD of 1992; it was adopted by the Conference of Parties to the CBD (COP10). Law 3/2017 ratified the protocol. To regulate its implementation, MoE prepared a national law draft under the "Lebanese Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization" and submitted it to the Council of Ministers (CoM).

5.4.2 Policy and Legislation

The Environment Protection Law (Law 444/2002) includes the major principles for the protection of the natural environment and regulations to the requirements and presentation of SEA and EIA. The release and implementation of the SEA Decree (Decree 8213/2012) and EIA Decree (Decree 8633/2012) allowed more specialization of these two important tools to manage impacts of planned projects and strategies on natural resources. The Environmental Compliance for Establishments Decree (Decree 8471/2012) supports the above two at regulating activities that may cause harmful pollution and environmental degradation induced by existing classified establishments. An important advancement and critical milestone attained in 2014 was Law 251, which permitted the appointment of environmental prosecutors and judges in different governorates to look into environmental crimes and lawsuits *(Refer to Chapter 2 - Environmental Governance for more details).*

5.4.2.1 Forest Laws, Regulations and Action Plans

A. Forest Laws

Originally, two laws under the mandate of the MoA governed actions on forests. The Forest Code of 1949 addressed basic forest management, as well as monitoring of forest-based activities. Law 85/1991 and its amendment Law 558/1996 targeted forest protection, banning a number of activities inside forests (camping, pruning and logging, grazing and hunting) and within a protection radius of 500 m. Law 195/2000 allowed the criminalization of illegal actions stating fines between 500,000 to 2,000,000 LBP or imprisonment between 3 months to 3 years. In collaboration with the UNFAO, the MoA is updating the forest law of Lebanon, and increasing the brackets of fines on illegal actions with the aim of enhancing forest and natural resources management in line with biodiversity conservation and the millennium Sustainable Development Goal (SDGs) (MoE/GEF/UNDP, 2019). On a parallel front and to closely support the targets of the MoA, the SLMQ project is developing the charter related to rangeland laws to be included in the updated version of the forest law.

B. Forest Fire Laws

The National Strategy for Forest Fire Management, prepared jointly by the MoE, the Association for Forests, Development and Conservation (AFDC), MoIM, MoA, Lebanese Army and Directorate General of Civil Defense, was endorsed by CoM in Decision 52 of 13/5/2009. Then, Law 92/2010 banned the felling of burnt trees and all land uses inside burnt forests to prevent acts of arson and the intentional burning of forests for development of land. *The Forest Fires Management, Prevention and Control and Damaged Forests Assessment and Rehabilitation* Project (LRF-14 OSRO/LEB/703/UNJ: 2009-2010) researched forest fires and provided measures and processes to support efficient firefighting and the prevention of future fires, in addition to rehabilitation of fire damaged forests.

The MoE drafted a forest fire law that addresses several objectives: combating forest fires, engendering ecological benefit of forests, soil preservation, protection of green cover, stopping land degradation, and the effects of drought and CC. The proposed law awaits CoM approval; it calls for the creation of a high committee for forest fire management formed of main stakeholders: MoA, MoE, MoIM, the Ministry of Defense (MoD), the Ministry of Foreign Affairs, the Ministry of Finance (MoF), and MoPWT. It also defines the role of associated administrations, such as municipalities and local authorities, and collaboration with NGOs, universities and research centers.

5.4.2.2 Reforestation

The Forest Code of 1949 offered the MoA the responsibility of reforestation. In the 1960s and early 1970s, Lebanon engaged in a large-scale reforestation program. Seed sources and plant material were mixed between native and exotic species; foreign *Pinus nigra* patches are still found in the countryside. When MoA lost its plant nurseries, reforestation plant material came from neighboring countries. Later, MoA re-established several tree nurseries (Decree 5246/1994 and its amendments); and in 1995, MoA banned all imports of cedar seeds and seedlings (Decision 108/1 of 1995) but not other species. In the framework of Law 326/2001, the Government of Lebanon (GoL) financed the implementation of a National Reforestation Plan (NRP); NRP implementation was mandated to MoE for the first time. In 2012, the GoL launched the National Afforestation/Reforestation Program (NARP), also known as 40 Million Trees reforestation program (Refer to Section 5.5.1.1).

5.4.2.3 Protected Areas System

Conservation of nature sites under classification of nature reserve started in 1992 culminating years of field and community work conducted by the Friends of Nature (FON) NGO; with FON legislative proposals, the first two nature reserves were ratified by Law 121/1992 creating a legal precedence. To facilitate reserve management, the law designated the establishment of a managing committee formed of representatives of key stakeholders: municipalities, local NGOs, conservationists and scientists. When the MoE strengthened its capacity, it leveraged nature conservation to new dimensions. Article 23 of Law 690/2005 gave MoE the mandate to establish protected areas (PA) along with designation criteria, and to propose necessary laws and regulations for PA management.

Recently, Law 130/2019 was issued to improve nature conservation processes and procedures; it classifies PA into 4 categories: nature reserves, nature sites, hima and natural parks; it also outlines management and financial processes and procedures. Importantly, Law 130 strengthens reserve management through considering nature reserve committees legal entities with financial and administrative independence; it has also defined the reserve entrance fees *(refer to Chapter 6 – Land Resources for more information)*. Law 130 has set advancement at the level of creating nature reserves on private lands with providing the necessary regulations. In addition, this law allows local authorities to declare a local area under their mandate as a hima. In addition, the CoM issued Decision 42 of 20/10/2017 to form a ministerial committee authorized by the Prime Minister to study the request of MoE for the development of a master plan to protect Lebanon mountain summits and organize the development of the coastal area including agriculture lands (AFDC, 2019); in follow up, CoM Decision 50 of 5/9/2019 approved the MoE request and entrusted CDR to develop a master plan to protect mountain peaks and natural areas, and regulate the exploitation of beaches, green areas and agricultural lands.

Besides, Law 127/2019 authorized the Government of Lebanon to join the Protocol concerning the Specially Protected Areas and Biodiversity in the Mediterranean under the Barcelona convention; it is an amendment of the Protocol, which was ratified by virtue of Law 292 dated 22/2/1994. Also based on the suggestion of the MoE, Decision 14 of 18/6/2016 of the CoM authorized the Minister of Environment to sign the statute of the Arab Union for PAs.

5.4.2.4 Protection and Conservation of Freshwater Ecosystems

Lack of legislation addressing freshwater ecosystems is staggering when compared to the significance and value of these systems. Large projects and establishments on watercourses are subject to EIA in accordance with Decree 8633/2012. However, with the lack of pertinent legislation that regulate and manage these systems, it is difficult to tie these controls to well defined restrictions allowing more room for subjectivity. Regular cleaning of watercourses mandated by MoEW does not take into consideration the ecological value of the freshwater system and its biodiversity. There is an imperative need to conduct a national review of all activities on freshwater ecosystems and to produce the appropriate legislations to properly address these particular ecosystems of high ecological and biodiversity value. A water quality control system is also highly needed to maintain appropriate habitat for the freshwater biodiversity (AFDC, 2019).

5.4.2.5 Protection and Conservation of Flora and Fauna

As mentioned earlier, threats to biodiversity and conservation, at least from new projects and activities, are controlled indirectly through the assessment of the environmental impacts of these projects. Other legislative tools are described in the following sections.

A. Biodiversity Conservation

Lebanon has embarked on the theme of nature and biodiversity conservation since 1992 with the creation of the first reserves. Lebanon then participated in the global milestone for nature conservation the CBD held in 1992 having already declared two nature reserves. Lebanon joined the global strategy for conservation with the signing of the CBD ratified through Law 360/1994. Law 130 ratified in 2019 will also provide support to biodiversity conservation and the creation of PA. Lebanon also updated its NBSAP, which was endorsed by CoM in its Decision 62 dated 4/4/2018.

B. Genetic Resources

The MoA established the "National Committee on Plant Genetic Resources for Food and Agriculture". In 2014, the "National Strategy for the Conservation and Management of Plant Genetic Resources for Food and Agriculture" was developed. In 2015, Lebanese Agricultural Research Institute (LARI) finalized a draft for the "Management of Plant Genetic Resources for Food and Agriculture". On another front, the MoA with FAO developed in 2014 through the framework of the TCP/LEB/3302 Seeds and Seedlings Policy project, a draft law targeting the organization of seed and seedling production. Moreover, the novel varieties are protected in the country by the TRIPS Patent Law (Law 240/2000) (Chalak, 2015).

C. Biodiversity Harvest

The MoA is accompanying Lebanon's strategy for biodiversity conservation through its mandate, whereby the Ministry produced a number of decisions to prohibit, limit or regulate wild harvest, such as:

- Decision 108/1 of 1995 regulating the introduction of cedar seeds and seedlings.
- Decision 340/1 of 1996 regulating the export of the aromatic and medicinal plants oregano and sage.
- Decision 125/1 of 1999 regulating fishing of Wales, Monk seals, and their derivatives.
- Decision 179 of 2012 readdressed regulating the collection of the two wild plant species sage (*Salvia fruticose*) and oregano (*Origanum syriacum*). Harvest regulation is tied to a permit that indicates the specific period allowed for collection of these herbaceous wild plants. Permits are issued based on applications (GEF/UNDP/LARI, 1999-2005 Project).

Lebanon ratified the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); MoA is requiring a CITES permit for the import and export of species that are included in Appendix 1 and 2 of the Convention. Lebanon researchers and reputable foreign establishments are abiding by the regulations of CITES convention. However, illegal collectors are still visiting Lebanon to poach its rich biodiversity without control. It is imperative that law enforcement bodies be engaged and educated on the importance of implementation of CITES and its binding clauses.

D. Animal Protection

Law 47/2017 addresses Animal Protection and Welfare; it endorses the relevant international agreements and recommendations, more specifically CITES and the World Organization for Animal Health.

E. Hunting

Law 580/2004 entrusted the MoE with the organization of the hunting sector. MoE prepared the necessary legal texts foreseen under this law and ensured their adoption in 2012 and continued setting the foundations for its effective implementation through capacity building of law enforcement agencies, as well as, achieving the full automation of the hunting permit process in coordination with the Higher Council for Hunting (HCH). In 2017, MoE announced the opening of the first hunting season, and has continued since to annually set seasonal limits and to coordinate with the Internal Security Forces (ISF) and MoIM to ensure law enforcement. In 2019, Lebanon signed the Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS), thus complementing the national and global efforts for the protection of migratory birds. Details of the strategies and steps undertaken by the MoE are presented in Box 5-3.

Box 5-3 Engagement of the MoE in Organizing the Hunting Sector

In 2004, Hunting Law 580 was ratified to organize hunting activity in Lebanon. Its objective is to protect fauna and wildlife, recognize their heritage value, and advocate measures to ensure sustainability, partly to comply with the EU "Birds Directive". Some of its important clauses are:

- Endemic, rare and threatened species are excluded from hunting.
- Hunting and trapping of internationally threatened bird species and all species during spring migration and nesting seasons are prohibited.
- Hunting of all resident and migratory birds and terrestrial mammals is prohibited except for the species designated as game.
- The collection of eggs and nestlings from nests is prohibited.
- The tools of hunting are restricted, and some popular means became explicitly illegal such as the use of sticky bars, bird voices recordings, nocturnal attractions, and others.

Law 580 referred to the MoE the mandate of law implementation and organization of hunting. It dictated the establishment of the HCH under MoE tutelage and outlined the clauses for obtaining a hunting permit (mandatory insurance, hunting exam, etc.). Decree 3304/2018 assigned the latest HCH and appointed its members.

In 2012, the MoE worked on passing the necessary legislations to activate implementation of the Hunting Law. Accordingly, the following organizational decisions were issued after consultation with the HCH:

- Procedures for selecting and defining the hunting clubs to be accredited by MoE to run the hunting tests (MoE Decision 71/1 of 2012).
- Procedures to grant nature reserve rangers the authorization to control hunting violations in the surroundings of the nature reserves and to issue fines to violators (MoE Decision 199/1 of 2012)
- Procedures and conditions of the hunting test (MoE Decision 212/1 of 2012).
- Procedures for private land owners/investors and municipalities to submit a request to MoE to prohibit hunting on their lands (MoE Decision 236/1 of 2012).
- Procedures for obtaining hunting licenses (MoE Decision 245/1 of 2012).

In addition, the following complementing decisions were issued by the Minister of Finance based on the proposal of the Minister of Environment and the HCH:

- Defining the design and details of the hunting stamp (MoF Decision 900/1 of 2012).
- Defining the hunting license fee (MoF Decision 901/1 of 2012).

Furthermore, hunting insurance was regulated through Decree 11987/2014 based on the proposals of both the Minister of Environment and the Minister of Economy and Trade; the insurance covers damages that may be inflicted on a third party due to hunting practices. Complementing decrees that fill the gaps and ensure better understanding and interpretation of hunting activities are also being issued. MoE Decision 798/1 of 2018 banned the hunting of foxes, hyenas and wolves throughout the year.

Regarding the hunting permit process, it was originally performed manually whereby the applicants submitted forms to the MoE for approval. During the same year however, in 2017, the MoE developed, with the support of international organizations, a software for conducting the hunting test by the accredited hunting clubs. In 2018, a whole automation system was put in place to receive applications for hunting permits and the respective permit issuance by the ministry.

Capacity building to support proper enforcement of the hunting law was also undertaken. The MoE has conducted awareness and training programs over many consecutive years; the programs were supported by international organizations and coordinated with the ISF and MoA. The ISF, forest guards of MoA, and nature reserve guards in all the Lebanese governorates were targeted in the capacity building program. As part of awareness dissemination, the MoE, in collaboration with other partners, produced bird field guides and the hunting test manual that addresses the new hunting law (MoE/UNDP/GEF, 2013).

To support regular implementation of the hunting law, the MoE has issued in recent years annual decisions that announce the beginning and closure of the bird hunting season, define the species permitted for hunting, and alert the police to follow up on proper implementation (Decision 449/1 on 1/6/2017; Decision 723/1 on 28/8/2018; Decision 275/1 dated 25/4/2019; Decision 135/1 dated 15/9/2020). For the enhancement of law enforcement, the MoE is constantly sending official letters to the ISF and MoIM, which are responsible for hunting law enforcement, to urge them to control hunting violations and issue fines; in addition, the MoE is regularly filing lawsuits against hunting violators. The MoE has updated the hunting law to assign to the municipal police and the environmental police the role of enforcement of this law; the draft was submitted to the CoM for review.

In 2020, the ISF succeeded at ensuring the protection of two very important bird migration hotspots in North Lebanon (Mount Terbol and Daraya/El-Ayacha) against illegal hunting; the two hotspots are known for the mass killing of migratory birds (mainly raptors, white storks, cranes and pelicans). ISF daily surveillance for 160 days in the spring and autumn seasons resulted in thousands of migratory soaring birds crossing Lebanon safely (Owaygen, 2020). The UN Convention on the Conservation of Migratory Species (CMS) reported the achievement on its website, particularly that Lebanon is a signatory of the convention.

NGOs are also supporting hunting law enforcement. SPNL, in partnership with CABS (Committee Against Bird Slaughter), are undertaking rescue missions targeting the identification and documentation of violations. SPNL has defined Responsible Hunting Areas in the aim to restrict hunting activities to these areas, which would allow better law enforcement in the countryside with the assistance of municipalities. This proposal still requires official adoption by relevant ministries and the accompanying legislation to put it into action. From another side, SPNL and other NGOs have conducted awareness and training programs on the hunting law targeting local communities and trainees.

The framework to control hunting has, as stated above, advanced markedly in recent years. However, numerous challenges are still compromising efficient implementation on a national scale; these include, but are not limited to, inaccessibility of all sites to police, ineffective law enforcement infrastructure, diversified methods of hunting, social and economic crisis, and other.

5.4.2.6 Protection of CZ and Marine Ecosystems

Law 444/2002 for environmental protection stipulates in Articles 29 to 34 the necessity to protect marine habitats and resources by forbidding activities harming and/or polluting marine activities and creatures. Nevertheless, it does not specify what constitutes harmful activities. The law tackles CZ issues by considering the following:

- Plans and issues/problems of shore protection
- Actions to deal with marine pollution
- Wetland protection including their ecological systems
- Banning the "drainage, flooding or burning in Lebanese territorial waters of any material that can directly or indirectly impact human health and marine natural resources, or that can negatively affect seawater quality".

In addition, specific national laws tackle special coastal ecosystems such as wetlands/estuaries, marine habitats, dunes, coastal forests, coastal landscapes and protected areas, whereas other legal instruments ensure the conservation and protection of coastal and marine biological resources, such as Decree 8633/2012 on the requirement for an EIA before implementation of any project, particularly those located within the CZ. An exhaustive list of all applied laws, decrees and ministerial decisions related to the CZ and marine ecosystems can be found in the cited legislation at end of this chapter.

5.4.3 Key Actors and Stakeholders

An exhaustive list of stakeholders was developed in 2016 as part of the "Activity for the Revision/ Updating of the NBSAP and Preparation of the 5th National Report to the CBD" and included nearly all public institutions, private sector entities, cooperatives, NGOs, associations, universities and research institutions (MoE/UNEP/GEF, 2016c (MoE/ UNEP/UNDP, 2013b). In addition to public institutions with mandates on the maritime domain (Table 5-2), main stakeholders include:

- NCMS
- NGOs
- Nature Reserve Management Committees
- Academic institutions and research centers
- Beirut Bar Association
- Order of Engineers and Architects
- Cooperatives and syndicates of related owners/ workers
- Union of Hotel Owners in Lebanon
- Association of Lebanese Industrialists
- Environmental consulting firms
- Local inhabitants.

Table 5-2 Role of National Institutions in Terrestrial and Marine Ecosystems

Role \ Institution		MoA[1]	Ministry of Culture[2]	MoE[3]	MoEW[4]	Ministry of Industry[5]	MoIM[6]	Ministry of Public Health[7]	MoPWT[8]	Ministry of Tourism[9]	Municip-alities[10]	CDR[11]	Ports Authorities[12]	Lebanese Petroleum Agency[13]
Standards and Legislations		X		X		X		X						
Planning		X			X				X		X	X		X
Urban planning and zoning				X		X	X		X		X	X		
Law enforcement		X					X		X	X	X			
Issuing permits				X		X	X	X	X	X	X			
Awareness and guidance		X		X						X	X			X
Management and conservation	Water resources management				X							X		
	Ports and marine transportation								X				X	X
	Cultural heritage													
	Biodiversity and marine environment protection	X		X							X			X
	Wastewater discharge			X	X	X	X		X		X	X		
	Solid waste management			X			X		X		X	X		
	Forests	X		X							X			
	Maritime public domain						X		X		X			
	Fisheries	X					X		X		X			
	Coastal resorts			X			X	X	X	X	X			
Project financing and execution			X	X	X	X	X		X	X	X	X	X	X
Sampling &/or monitoring				X	X	X	X	X			X			

1. Decree 1983/97 and Decree 1994/5246 (MoA mandates)
2. Laws 1993/215 and 2000/247 (The structure of the Ministry of Culture) Law 2008/35 (re-organization)
3. Law 1993/216, Law 2005/690 (Amendment of the organization of the MoE), Decree 2009/2275 (Law 2005-690 application decree)
4. Law 66/20 and Law 2000/247 (Regulations and duties of the Ministry of Energy and Water)
5. Decree 1998/13173 (Regulation of the Ministry of Industry)
6. Decree 1968/9791 (The decree regulating the control of the Lebanese shore)
7. Decree 1961/8377 (Organization of the Ministry of Public Health)
8. Decree 1959/2872 (Organization of the MOPWT); Decree 1968/9791 (The decree regulating the control of the Lebanese shore)
9. Decree 1975/10339 (The structure of the Ministry of Tourism); Decree 1955/9449 (Creation of the Touristic Brigade)
10. Legislative Decree 1977/118 (Law on municipalities)
11. Decree 1977/5 (Establishment of the Council of Development and Reconstruction)
12. Ministerial decision of the Minister of PWT 1/31 of 1966 (Approval of the Lebanese Ports Regulations); Decree 1968/9791 (The decree regulating the control of the Lebanese shore)
13. Decree 2012/7968 (Creation of the Lebanese Petroleum Agency)
14. Decree-law 1983/69. (Creation of The Higher Council for Urban Planning)
15. Decree 1968/791 (The decree regulating the control of the Lebanese shore); Decision of the High Commissioner n299° LR, 1936 (Regulation of surface of plane water); Decree 1994/5509 (Rules and regulations concerning liquid oil derived products, containers, storages, and distribution of liquid fuels); Ministerial decision 88/T (Minister of Transportation) dated 1997/07/03 and 33/T dated 1998/03/10 (fixing the fare of reception and transportation of ship wastes in Beirut Harbor and Tripoli-Saida Harbors and in other harbors)

5.5 Selected Responses

This section describes the responses directly related to ecosystems. Nonetheless, the decade review reveals valuable responses from significant initiatives that are indirectly related to ecosystems, such as, quarry rehabilitation *(See Chapter 6 - Land Resources)* and solid waste dump rehabilitation *(See Chapter 8 - Solid Waste).*

5.5.1 Terrestrial Ecosystems

5.5.1.1 Restoration and Conservation

A. Reforestation

Recently, reforestation has been provided special attention globally due to its significance at mitigating climate change, sequestering CO_2 and reducing the carbon footprint. Lebanon has engaged at improving its reforestation strategy and implementation to accompany the global trend. *Efforts undertaken in reforestation and conservation of forests in Lebanon are presented in detail in Chapter 6 - Land Resources.*

B. Fire Prevention

Fire prevention measures on national level were estimated at a certain point to have improved and built the capacity of Lebanon to fight fires and stop their advancement; however, the fire outbreaks that spread all over the country in one day in October 2019 revealed the inability of Lebanon to efficiently and effectively extinguish forest fires. The firefighting brigades relentlessly avail immense efforts, supported by the Lebanese Army and the local communities; their essential work needs to be strengthened on the ground by equipment and technology. The Sustainable Natural Resource Management Platform (SuNar) of the CNRS and the Firelab application help predict fire risk based on daily weather forecasts and potential fire risk maps (MoE/UNEP/GEF, 2019). The DRM Unit, the CNRS, the Civil Defense and the MoIM collaborate closely to prevent and control fires outbreaks. The project “Towards a better assessment and management of wildfire risk in the Wildland-Urban Interface in Lebanon: Gaining from the US experience” funded by USAID and directed by IoE-UoB highlights the regions of high risk, where preventive measures and intensive monitoring should be applied. In addition, some protected areas have initiated their own protective and preventive measures; at SBR and Horsh Ehden Nature Reserve for example, water ponds were established to help extinguish fires quickly.

5.5.1.2 Improving Conservation Management in Protected Areas

Six of the long-established reserves benefit from management plans, whereas the remaining 12 reserves still need to develop their management strategies and action plans (Annex 9). SBR presents the most advanced example of PA management providing important lessons to learn from and apply at other sites. SBR has developed an integrated interconnected administrative management system linking the entrances, guides, visitors and management staff together. The SBR outreach and visibility program is considered advanced, frequently appearing in the media. The ecotourism programme is diverse and aims to create income to the local community whether in guesthouses or visitors of restaurants or food and artisanal products.

The Jabal Moussa Biosphere Reserve (JMBR) executed a 5-year management plan that will benefit from an update in 2020 with a focus on species conservation. Funded by the Critical Ecosystem Partnership Fund (CEPF) grant, FON and USJ are conducting field and lab research on the site-restricted endemics to promote conservation (Figure 5-37), reduction of threats and propagation of the species. Similar to JMBR, Horsh Ehden Nature Reserve is part of the field and lab research on site-restricted endemics conducted by FON and USJ to help recognize the status of the species and protect them better in a tailored management plan that enhances conservation. Supported by a CEPF grant, the plan will be finalized by the end of 2021. Jaj Cedar Reserve will also gain a management plan focused on conservation of its endemics through the same CEPF grant.

Figure 5-37 *Salvia peyronii* the Treasured Site-restricted Endemic of JMBR
Photo Credit: FON-CEPF Project

5.5.1.3 Protecting and Conserving Freshwater Resources

A treatment of freshwater KBAs of the Mediterranean Basin hotspot validated the following KBAs for Lebanon: Litani River with 2 trigger species and Aamiq marshes as a focal area, Nahr al Kabir with 3 trigger species, and Upper Assi with 6 trigger species. The Litani River KBA was highlighted to also qualify as a freshwater Alliance for Zero Extension site due to the presence of the fish, Tylognathus festai, in the Aamiq marsh; the other trigger species include Oxynoemacheilus leontinae (Lebanese Loach), which is restricted to the Litani and northern Jordan drainages, and the endangered mussel, Potomida littoralis, which is declining across its highly fragmented range at an alarming rate. Conservation actions undertaken by A Rocha at Aamiq marsh were recommended for replication across the region to prevent extinction of many freshwater species; reducing water abstraction for irrigation and conversion to less water demanding crops helped maintain more water for the marshland to stay wet all year round. Improved management of water resources is needed to face the major threats of water shortage and drought. Ex situ conservation of T. festai until its natural habitat becomes more sustainable was emphasized (Darwall et al., 2014).

The installation and regulation of wastewater treatment plants can help reduce one of the many threats facing freshwater systems. Formal water reuse quality standards are needed. An initiative was undertaken to clean up and eliminate sources of degradation on the highly polluted Litani River. The initiative led to the discovery of the pollution of the Qaraoun dam lake with poisonous cyanobacteria, making the cleaning process expensive and long-term. Industrial waste in the river has been partially controlled. The SLMQ project is currently setting the guidelines for riparian rehabilitation.

5.5.1.4 Protecting and Conserving Flora and Fauna

A. In-situ Conservation

Nature and biodiversity conservation in Lebanon present a variety of in-situ conservation modules from nature reserves to biosphere reserves, micro-reserves, heritage sites and Himas. While the MoE provides the framework and guidance, NGOs and other stakeholders actively inspire and advocate conservation at grassroots level and progress it towards adoption. In fact, the first two nature reserves of Lebanon were created at grassroots level through community engagement prior to conservation by legislation. After its establishment in 1993, the MoE elaborated the framework for conservation and advanced the legislations. More recently, Law 130/2019 defined four categories for PA: *nature reserves, natural parks* which define vast rural territory of exceptional natural and cultural heritage and low habitation, *natural sites and monuments* which correspond to areas of highly important features that deserve protection on basis of rarity, representativeness and beauty, and *Himas*.

Eighteen nature reserves are officially established in Lebanon to date (Annex 9). They encompass more than 2.5% of Lebanon's land (MoE/GEF/UNDP, 2019). Each of the reserves has well defined objectives, area, buffer zones, permitted activities, penalty fees, and the committee responsible for its management. Twelve other sites are in the pipeline to become nature reserves (Annex 10). Besides nature reserves, there are 19 natural sites protected by the MoE through ministerial decrees or decisions (Annex 11). Twenty-five Himas are officially established by SPNL on municipal land through municipal decisions declared in collaboration with municipalities and local authorities (SPNL, 2019) (Annex 12).

The number of other types of protected areas has also increased; some with national designation including 17 protected forests (Annex 13), 16 protected natural sites/landscapes, and some with international designation including 3 biosphere reserves (measuring 414 km^2, almost 4% of the territory), 4 Ramsar sites, 5 World Heritage Sites, and 6 IBAs. Some of the sites and nature reserves have acquired one or more international designations.

Another form of conservation is the establishment of natural parks; 5 areas of Lebanon were previously nominated, some had advanced their status by creating and endorsing their charters, for example 'Charte Du Haut-Matn' in 2013, and 'Charte Du Jezzine' (AFDC et al., 2019). The recent conservation Law 130/2019 recognized natural parks as a distinct PA category and facilitated the process of their declaration; decrees proposed by both the Minister of Environment and the Minister of Interior and Municipalities would change the status of charts to natural parks.

Currently, each nature reserve is governed by A Protected Area Committee (APAC) appointed by the MoE and oversees a reserve management team. MoE has continuously provided support to the APAC through capacity building, resource mobilization and funding orientation, management directives and exposure. On the financial front, funding to support reserve management and operational cost is currently dependent on visitor contributions and ecotourism activities, contributions from other sources, project implementations, and other non-definitive sources. Law 130/2019 supports better governance and financial securities for the management of the reserves with dedicated frameworks (AFDC, 2019).

In addition to protected areas, several projects have been implemented to support in situ conservation, as well as sustainable use of agro-biodiversity, including:

- Mainstreaming Biodiversity Management into Medicinal and Aromatic Plants Production Processes in Lebanon Project (GEF/UNDP/LARI, 2009-2013): The project integrated conservation objectives into the gathering, processing and marketing of globally significant Medicinal and Aromatic Plants (MAPs); it also introduced a sustainable management regime for supporting both the establishment of community-based MAP small business enterprises for the benefit of local people, and value-added production systems.
- Agroforestry for Sustainable Agriculture (Friends of Nature, 2017-2019): The project trained over 400 farmers nationally to integrate biodiversity on farmland to enhance productivity of healthier crops in sustainable agricultural system.
- SLMQ: Forests and rangelands and arable lands that are currently weakly managed and poorly funded within the three districts of Zahle, Rachaya and West Bekaa will benefit from comprehensive land use plans that will promote sustainable land use, increase natural productivity and land management efficiency, as well as enhance livelihoods and financial security.

From another angle, the increase in biodiversity studies and field surveys, as well as public awareness and capacity building of communities, supports better protection and conservation of flora and fauna. Similarly, the national and global redlisting of species, and attention to threatened species are improving biodiversity conservation practices (MoE/GEF/UNDP, 2019).

B. Key Biodiversity Areas

Fifteen sites have been designated as IBAs in Lebanon; 5 are located within nature reserves, 6 are protected by NGOs, and 4 do not have any protection (AFDC et al., 2019). In addition, 20 Important Plant Areas (IPAs) were initially recognized in Lebanon in 2010; they encompass 80% of Lebanon's floral diversity within a very small total area.

Global efforts to standardize measures for recognition of the significance of nature sites agreed in 2016 to the employment of KBA while following a specified methodology for their identification. In response, Lebanon re-evaluated its sites applying KBA criteria. Accordingly, 26 KBAs were identified (Figure 5-38) (AFDC, 2019). A total of 11 IPA-KBA sites are prioritized for protection; some are properly man-

No.	Name
1	Mount Makmel
2	Hermel Plain
3	Arsal-Ras Baalbeck Plateau
4	Ammiq
5	Mount Hermon
6	Menjez
7	Akkar-Danniyeh Mountains-Hermel Plateau
8	Palm Islands
9	Bcharre-Ehden-Qadisha Valley
10	Ras Chekka
11	Tannourine-Hadeth Jebbe
12	Jbeil Coast
13	Nahr Ibrahim Valley
14	Nahr El-Kalb Valley
15	Mount Sannine and Mount Kneisse
16	Mount Barouk
17	Nahr Ed-Damour
18	Beirut-Jiyeh Coast
19	Tyr-Naqoura Coast
20	Jabal Rihane
21	Nahr Beirut Valley
22	Sarada
23	Ehmej-Jaj
24	Nahr el Awwali Valley
25	Afqa Plateau
26	Mount Mneitre

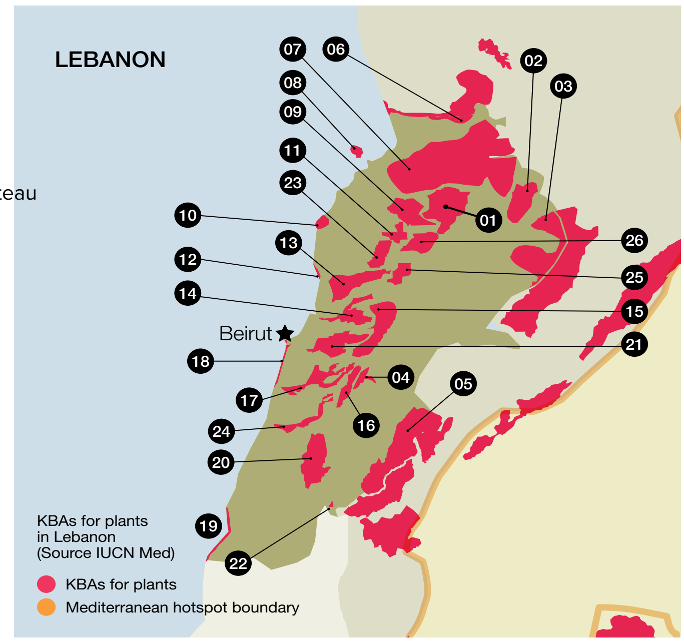

Figure 5-38 Map Showing the KBAs of Lebanon
Source: Valderrábano et al., 2018

aged and protected, while most require protection measures especially that they are subject to major threats (MoE/UNEP/GEF, 2016). The list of IPAs, IBAs and KBAs of Lebanon is presented in Annex 14.

C. Hima

Himas are known to be the oldest form of nature conservation and management, dated back almost 5,000 years ago in ancient Egypt. The Hima practice became an existing management tool in the Arab region almost 1,500 years ago. Since 2004, SPNL worked relentlessly to revive this trend of traditional landscape management in collaboration with local authorities in many parts of the country such as Kfarzabad IBA. The goal is to combine traditional practices with the latest conservation strategies in order to attain sustainable resource use, as well as conservation of biodiversity and avifauna, with education, research, recreation and expansion of economic opportunities (AFDC, 2019; AFDC et al., 2019). Law 130/2019 for PAs ratified Hima as a conservation category.

D. Biodiversity Management

Concrete actions were undertaken to ensure biodiversity management in Lebanon including reforestation and restoration initiatives and plans, adoption and implementation of the SEA and EIA decrees, implementation of the hunting law and mainstreaming conservation of migratory soaring birds, mainstreaming the sustainable management of marine and coastal ecosystems, mainstreaming biodiversity management into medicinal and aromatic plants production processes, managing fire risks, redlisting, and others. Yet, the main threats to Lebanon's biodiversity are still as diverse and intense, including habitat loss, fragmentation and destruction; unsustainable exploitation of natural resources, pollution, invasive species, introduction of new improved varieties (agro-biodiversity), climate change and lack of documented data. To address these threats, land management plans should be developed and enforced (MoE/UNDP/GEF, 2015) *(refer to Chapter 7 – Haphazard Urbanization).*

E. Forest Management

The National Report on Land Degradation Neutrality (LDN) studied land cover/land use change from 2000 to 2010 and uncovered a loss of 1,783 ha of forest cover and 1,201 ha of grasslands in that period. This report ties the commitment of the GoL to reach LDN by 2030 to the accomplishment of several targets including the implementation of sustainable forest management practices and the restoration of forest landscapes (UNCCD/MoA/LDN, 2018). The National Greenhouse Gas Inventory Report attributes land degradation and over-exploitation to the absence of land management, whereby about 84% of the Lebanese territory does not have adequate master plans (MoE/UNDP/GEF, 2015). Similarly, Lebanon's Third Biennial Update Report to the UNFCCC still stresses the absence of sustainable forest management, the poor land management with lack of enforcement of zoning decrees, and the lack of implementation of the National Land Use Master Plan associated with the need for regional master plans (MoE/UNDP/GEF, 2019). The SLMQ project is supporting the reaching of national targets through the development of the national forest management guidelines, rangeland management guidelines, as well as the riparian rehabilitation guidelines.

Figure 5-39 *Fritillaria acmopetala*
Photo Credit: Myrna Semaan

5.5.1.5 Ex-situ Conservation – Seed Banks

A. Lebanese Agricultural Research Institute

In the past 16 years, LARI had collaborated with the Millennium Seed Bank of the Royal Botanic Gardens, Kew, in the United Kingdom for seed collection in Lebanon. The National Seed Bank was established in 2013; it now preserves 1,376 accessions from 877 species representing 31.4% of the Lebanese flora in ex-situ conservation in seed banks. The accessions belong to 82 families, and comprise wild edible, medicinal, aromatic, wild relatives of cultivated crops, wild forages, wild fruit trees, endemic species and landraces. The collection includes seeds from 11 species and 5 intraspecific species that are endemic to Lebanon, and 22 species endemic to the Mediterranean region. Under project Crop Wild Relative, 450 seeds from 10 wild crops were also collected in 2015. Currently, the seed bank is developing a forest seed center to help produce certified seeds to ensure the propagation of native species and reforestation with native plant material (LARI, 2020). Similarly, under project SLMQ, a seedbank for major rangeland species (mainly Fabaceae and Poaceae) was collected from the project implementation area including the three districts of Zahle, Rachaya and West Bekaa; the project also established a rangeland species propagation unit.

B. International Center for Agricultural Research in the Dry Areas (ICARDA)

Following the war in Syria, ICARDA transferred its offices from Syria to Lebanon to continue its activity in the Middle East. ICARDA works on research techniques in forage legume and crop range species. In Lebanon, it has constructed special capacity for the regeneration of wild crops having more than 200 cages for isolation (CGIAR Genebank Platform, 2020).

C. Advancing Research, Enabling Communities Center (AREC) of the AUB

AUB established a seed bank at its AREC Center in the Bekaa valley; AREC is a 100-hectar land dedicated for teaching, research facilities and experimental field work. The seed bank received from ICARDA in June 2004 more than 18,000 seed samples of cereal, legume and their wild relatives recuperated from ICARDA seed bank, of which 2,500 accessions previously collected in Lebanon (Chalak, 2015). The seed bank includes a laboratory, a cold room for short-to-medium term storage, kept at a constant 0°C, and another freezer for long-term storage at -20°C. The rooms of around 18 m^2 each are specially designed for safe storage with two compressors for each room. A range of laboratory equipment is also available. The crop production and protection division oversee the seed bank activities, which were halted after ICARDA moved their accessions to their quarters.

D. Laboratory for Seed Germination and Conservation (LSGC) of Jouzour Loubnan

In 2009, 'Jouzour Loubnan' NGO developed the LSGC at the USJ. The lab is dedicated to propagating native Lebanese plants in the aim of their employment in the restoration of the forest ecosystems of Lebanon (Jouzour Loubnan, 2020). Advanced germination protocols are available online through www.Lebanon-flora.org website. In 2015, the laboratory was expanded to host a seed bank equipped with the required facilities to support seed conservation from desiccation room to the final conservation room and growth chambers. 'Jouzour Loubnan' seed bank currently conserves more than 26 million seeds belonging to 100 different taxa. The available collection includes endemic flora and tree species utilized for ecosystem restoration (Saint Joseph University, 2020).

5.5.1.6 Social and Economic Investment in Terrestrial Biodiversity

A. School Orientated Programmes

Lebanon witnessed a strong orientation toward engaging schools and students to learn about biodiversity and conservation. Protected area committees developed initiatives for the nature reserves, and environmental NGOs created a diversity of activities; examples of both sources are presented respectively.

A.1 APJM - Association for the Protection of Jabal Moussa

The APJM provides guided hiking tours for students and citizens to experience the beautiful nature and biodiversity of the reserve. APJM also has designed a series of outdoor education activities on site. APJM's two children books feature the Rock Hyrax (Tabsoun) as the main character; 'Tabsoun' is employed in the presentations and animations on the biosphere reserve raising children awareness to the value of nature and biodiversity. APJM provides opportunities for school students to volunteer in different activities, such as planting, seed collection, and other.

A.2 SBR – Shouf Biosphere Reserve

The SBR offers hiking trails for students and citizens to enjoy and learn about the reserve's biodiversity. SBR implemented the programme 'Educational Sustainable Development' that included educational workshops and an educational rally for 500 students. Also, 1,280 students from public and private schools were coached on importance of biomass management in the reduction of forest fires. In addition, SBR organized the Jabalna festival with the participation of over 200 children.

A.3 AFDC – Association for Forest, Development and Conservation

Among its different projects on environmental education and children and youth awareness, AFDC developed the character “Sanjoub” along with theater plays dedicated for children awareness on the protection of forests from fire. Its “Awareness on Wheels” project raised awareness on solid waste management through a mobile unit that toured schools. Additionally, AFDC is the national coordinator of the GLOBE programme aiming to learn more about physical Earth. AFDC also offers awareness and training workshops and has produced a number of awareness publications.

A.4 FON – Friends of Nature

Connecting Children with Biodiversity’ programme of FON is dedicated to sensitizing children to embrace biodiversity with pleasurable hands-on experiences and tailored field learning that adopt observation, self-expression, and inquisitive thinking to create enjoyable long-lasting bonding with nature and a sense of responsibility for conservation. Since 2014, over 2,000 students followed the programme jointly with their teachers.

A.5 GreenHand

GreenHand’s mobile botanical garden toured schools to provide an on-look on the floral diversity. The vehicle is equipped with a series of educational plant specimens that convey a multitude of concepts.

A.6 LRI – Lebanon Reforestation Initiative

LRI implemented the Youth Environmental Awareness programme in 2017, aiming to boost awareness, protection and conservation of the environment. The programme promotes youth personal development through practical environmental projects and activities. Additionally, LRI offers orientation and awareness sessions concerning forest conservation, reforestation, insects, climate change, forest fires, and other. LRI also conducts planting activities with students.

A.7 SPNL – Society for the Protection of Nature Lebanon

The SPNL developed the Hima School (School with No Walls-SNOW) in the Hima programme; it aims to enhance children’s capacities on biodiversity and natural resources conservation. The Homat Al-Hima, the Souk Hima and the Hima Farm programmes also engage local communities and their children in a diversity of activities.

B. Youth Engagement

The engagement of youth in conservation and nature protection activities has prospered significantly and promoted the creation of new youth-led NGOs, for example:

B.1 The Lebanese Wildlife

Initially started as a youth initiative in September 2018, Lebanese Wildlife (LW) received its registration as an environmental conservation NGO in 2020. The main focus of the LW is the rescue of wild animals of all sorts; LW treats injured or orphaned local wildlife and returns them back to their natural habitat upon full recovery. Since its start, LW has rescued more than 400 animals from mammals, reptiles, birds and amphibians; more than half have been successfully treated and released, while several are still under treatment. However, some perished before receiving appropriate care, and some had to be euthanized due to the severity of their injuries. The most frequently observed cause of admission were gunshot wounds (157 cases). Beside wildlife rehabilitation, the NGO generates public awareness on wildlife aiming at changing attitudes and behaviors through campaigns, trainings and activities; LW also conducts research to fill gaps in local data for appropriate development of conservation management plans (Lebanese Wildlife, personal communication, 2020).

B.2 Wolves of Lebanon

The initiative Wolves of Lebanon was commenced in 2009 through hiking trips to various areas in Lebanon. The vision of the association is to build a conscious Lebanese community. They are currently developing five main courses to educate mountain guiders, wilderness instructors, search and rescuers (Wolves of Lebanon, personal communication, 2020).

C. Investment in Lebanon Biodiversity and Ecosystems

Lebanon biodiversity has attracted a remarkable increase of investment in the past decade. Since 2004, about 7,503,447 USD in international funds were allocated to biodiversity projects implemented through the MoE. Other institutions including MoA, LARI, CNRS, academic institutions, NGOs, and municipalities have also gained international financing for biodiversity causes. NBSAP helps define the priority needs for biodiversity-related interventions, and facilitates international resource mobilization on national basis accordingly, such that the MoA budget for reforestation is aligned with the NBSAP (MoE/GEF/UNDP, 2019). Global implementing agencies of biodiversity-oriented projects include, but not limited to, UNDP, UNEP, UNESCO, UNIDO, UNFAO and UNESCWA. Green Climate Fund has also funded projects up to 30 million USD through connecting biodiversity conservation with climate change mitigation and adaptation.

In addition to international support, funding for biodiversity and conservation was also secured from national sources, such as the Lebanese Central Treasury; for example, US$ 1,972,133 were contributed to APAC via MoE from 2001 to 2015. Over US$ 16,600,000 of public funding was also allocated to reforestation activities; only 34% was spent by 2014 (MoE/UNEP/GEF, 2016). The 40-Million-Tree reforestation programme has engendered private and public financial support. Rehabilitation plans have also attracted various funding; over US$ 22 million have been invested in the development of rehabilitation plans by SBR, LRI and MADA. Rehabilitation of dumpsites and quarries mobilized similar investments. Research projects on biodiversity, traditional knowledge, biodiversity and sustainable use of resources by local communities also received funding, but the allocated budget is unknown (MoE/GEF/UNDP, 2019).

Two examples of the investment of internationally funded programs are highlighted in Box 5-4 and Box 5-5.

Box 5-4 The Investment of the GEF Small Grants Program in Biodiversity in Lebanon

The GEF Small Grant Programme (SGP)-Lebanon was started in 2005, it is implemented through the United Nations Office for Project Services (UNOPS). The programme supported more than 94 environmental projects granting more than 3,600,000 USD.

GEF-SGP Grants during Different Operational Phases in Lebanon

Operational Phase	Period	Number of Funded Projects	Total Grant Amount (USD)
OP3	2006-2008	21	549,302
OP4	2008-2010	19	700,000
OP5	2012-2015	41	1,749,506
OP6	2016-2018	13	616,380

The SGP projects were implemented in partnership with NGOs, CSOs, governmental bodies and other stakeholders. They aimed to enhance biodiversity conservation and contribute to the SDGs relevant to combating climate change (Goal 13), conservation and sustainable use of the oceans and marine resources (Goal 14), and sustainable land management (Goal 15). Other SDGs addressed by the country programme and grantees include: Approving legislations, strengthening capacity of NGOs, establishing new networks and planning dialogue platforms, enhancing socio economic livelihoods, promoting gender equality and social inclusion, and other. The current SGP-OP7 focuses on conservation, ecotourism, sustainable use of biodiversity, sustainable agriculture and water management, strengthening partnerships and networking, and promoting good governance with CSO-government dialogue platforms on environment.

Distributing accomplishments per focal area reveals that the largest portfolio (40%) centered on biodiversity focal area owing to the effectiveness and operational role of the CSOs, followed by mitigation of climate change (17%), land degradation (17%), capacity development (13%), chemical and waste pollution (6%), and international waters (6%).

Box 5-5 Critical Ecosystem Partnership Fund (CEPF)

CEPF treats its investment in the Mediterranean Basin Biodiversity Hotspot as essential to balance economic development with the needs of natural areas, and to conserve biodiversity and ecosystem services in this vast region where infrastructural development triggered by the tourism industry and urbanization are augmenting threats on populations of species inducing their fragmentation and isolation. The CEPF investment strategy for the Mediterranean Basin addressed integrated coastal zone management, sustainable management of water catchments, improvement of conservation status of priority key biodiversity areas, maintenance of traditional land use practices, and the engagement of civil society to support conservation of plants that are critically endangered or endemic to highly restricted ranges.

Since 2012, CEPF granted around 1.4 million USD for biodiversity relevant projects that satisfy its strategic directions in Lebanon. Nationally, these directions and the investment priorities integrate and engender the attainment of the NBSAP national targets of Lebanon for 2030. They also have positive impact on supporting livelihood and economic activities favorable to biodiversity conservation to enhance communities' well-being.

CEPF funding assisted at enhancing biodiversity conservation and improving management of existing reserves, as well as expanding the protection range through the creation of new nature reserves, nature sites, and himas; more sites for conservation are in process of development using community participatory approach aided by capacity building.

Areas Endorsed for Protection Supported by CEPF-funded Projects.

Site	Objective	Area (ha)
Hima Al Fekha	Community shared resources	5,913
Ehmej micro-reserve	Species conservation – Iris	52
Sarada - Metropolitan Geawargios Haddad Nature Reserve	Species conservation – Iris	100
Anjar micro-reserve	Species conservation – Responsible Hunting practices	40
Qaytouli-Roum	Responsible Hunting practices	300
Baskinta micro-reserve	Species conservation	16
Al Shouf Cedars Nature Reserve	Community local economy-tourism	15,647
Horsh Ehden Nature Reserve	Species conservation & management	1,740
Jabal Moussa Biosphere Reserve	Species conservation & management	6,500
Jaj Cedars Reserve	Management of endemics	20
Total		30,328

The benefiting NGOs and CSOs are thankful for the support of CEFP and the Regional Implementation Team, led by BirdLife International, especially BirdLife Middle East Office whose continuous follow-up and guidance promote enhanced project implementation.

D. Beneficial Use of Biodiversity

The beneficial use of the native flora was the center of few investigations, which provided important insight into this aspect of floral significance, which was rarely treated before.

1. 14 wild shrub species proved of multipurpose use by rural communities on a national level. *Myrtus communis, Rhus coriaria, Asparagus acutifolius, Rubus sp.,* and *Capparis spinosa* ranked at the top of the used shrubs. The direct and indirect economic benefits include food, fodder, and materials to spiritual, religious and cultural use (Baydoun et al., 2020).
2. A showcased study for beneficial use of plant species in the region of the Jabal Moussa Biosphere Reserve counted 130 plant species that are still in use by the local community (Baydoun et al., 2017). (Figure 5-40)
3. Investigation of the traditional use of wild medicinal plants in Mount Hermon area found 124 species still in use by local communities (Baydoun et al., 2015).

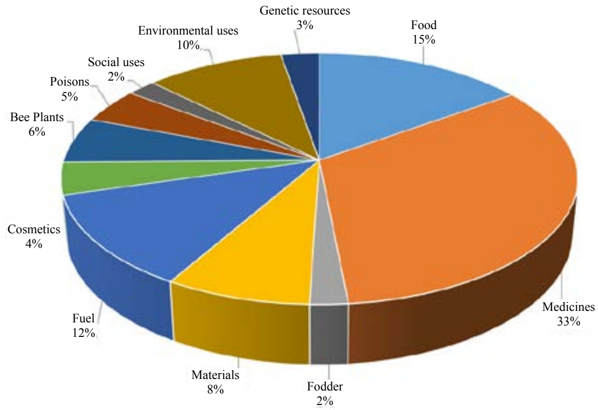

Figure 5-40 Different Use Categories of JMBR Plant Species by Local Community
Source: Baydoun et al., 2017

D.1 Forest Products

Forests can engender economic benefits through wood and non-wood products. One hectare of broadleaved trees is estimated to produce between 2,175 and 14,500 USD. If cedar forests had a 100-year management plan, it is estimated that this plan can produce 362,500 USD; however, there are no management plans for cedar forests in Lebanon. Wood is considered a renewable energy source in comparison to fossil fuel, which contributes to emission of greenhouse gases. According to the National Bioenergy Strategy for Lebanon 2012 (UNDP/CEDRO, 2012), forests of Lebanon possess great potentials. An estimation of fuel wood used for heating in rural areas would spare 425 USD per ton of imported fuel oil. However, investing in forest wood biomass for bioenergy is still considered difficult in Lebanon. Based on the UNFAO comprehensive report of 2016, wood and charcoal have crucial socio-economic and environmental values (AFDC, 2019).

Non-wood products are diverse and include: pine nuts, honey production, aromatic and medicinal plant, carob product, laurel oil, mushrooms and truffles. These products provide important incomes in various rural areas, which generate 80 to 97 million USD of sales annually and provide primary and secondary income for 10,000 to 15,000 households in rural areas (AFDC, 2019).

D.2 Forest Economic Value

The forests of Lebanon contribute 0.5% of the GDP with estimated Total Economic Value of 181,274 million USD representing 587 USD per hectare. This is considered a high value compared to other Mediterranean countries (AFDC, 2019). Accordingly, Lebanon forests have great potential at supporting the sustainable development of poor and marginalized communities.

E. Ecotourism

The past ten years were highly significant at encouraging a fundamental use of natural resources for enjoyment and leisure through nature friendly activities as in ecotourism. The 18 established nature reserves are important assets to orient ecotourism activities to support biodiversity and ecosystem conservation, and to enhance the integral role of the reserves in the development of the rural economy for the benefit of local communities. Economic valuation of nature reserves for ecotourism, decision-making and fund generation constitutes National target 18.10 of NBSAP (MoE/UNEP/GEF, 2016; MoE/GEF/UNDP, 2019). Reflections on some such activities:

- The SBR is the largest reserve in Lebanon encompassing landscape of natural cedar forests and 22 surrounding villages; the villages benefit through services and projects including tourism, agriculture, rehabilitation of terraces, attracting visitations, the selling of local artisanal and food products as well as serve the visitors directly in food and accommodation.
- Horsh Ehden Nature Reserve also implements ecotourism activities such as hiking, guided tours, photography, bird watching, snowshoeing, star gazing, and night walks (Horsh Ehden, personal communication, 2020).
- Lebanon Mountain Trail Association (LMTA) aims to protect Lebanon's natural heritage and improve economic opportunities through the promotion of responsible tourism (LMTA, 2020). LMTA has developed the Lebanon Mountain Trail across the heights of Mount Lebanon; they are contributing to the promotion of the ecotourism in all the regions and villages where the trail passes (MoE/GEF/UNDP, 2019).
- The Hima programme of SPNL encourages ecotourism at the Hima sites and increases resilience of local communities via nature-based income generating activities (MoE/GEF/UNDP, 2019).
- The Association (مجلس البيئة - القبيات) has worked on eco and rural tourism aiming to portray the importance of forests and the crucial resources of Northern Akkar. 14 mountain guides have been provided intensive training on different aspects of the forests in the region especially Qammouaa forest; guesthouses near the forests started hosting tourists and enhancing the economy of Qobayet region (Dr. Antoine Daher, personal communication, 2020).
- Jabal Moussa Biosphere Reserve is showcased in Box 5-6.

Box 5-6 Jabal Moussa Biosphere Reserve Ecotourism

JMBR is nested in the heart of one of the most important valleys on the Mediterranean, the Adonis Valley. In 2009, 'Jabal Moussa' was declared a UNESCO biosphere reserve under the Man and Biosphere program. The reserve extends over an area of 65 km^2 with a core area of 12 km^2. JMBR exhibits an extensive diversity in habitats (aquatic and terrestrial) and microhabitats (Figure 5-41) due to its altitudinal span and highly varied topographic features realizing all orientations; it is designated an IBA, IPA and KBA.

The not-for-profit Association for the Protection of Jabal Moussa (APJM) oversees the conservation and effective threat reduction of the reserve. The ecotourism programme of APJM supports the sustainable development of the local communities, whereby seven villages are dispersed in this natural expanse serving a total population of nearly 8,750 inhabitants. APJM opened 15 trails and created a national media campaign to promote visitation. The year 2019 recorded 30,000 visitors. A total of 30 qualified guides assist in visitor tours; 5 guesthouses and two B&B facilities opened. APJM enhanced the capacity of women in the village to market food products on a large scale with traditional recipes supported by produce from local farmers. Innovative artisanal work constitutes another economic opportunity; 7 women from the village create artisanal pieces specifically for APJM, who had developed their capacity through training, marketing and design. APJM has succeeded at opening 10 market outlets, one of which is at the reserve entrance. The new economic cycle is generating sustainable alternative income to several members of the local community. A cycle of socio-economic interdependence was created, whereby the social relevance is even more impacting than the economic input. Providing new local sources of income may slow down the rural to urban migration, and maintain the local social structure, thus adding another social benefit for the conservation of JMBR.

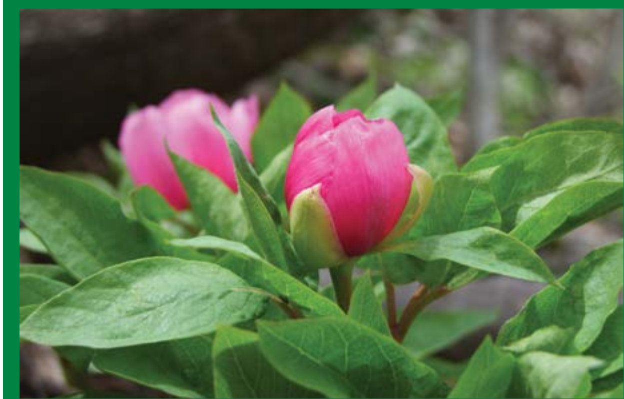

Figure 5-41 The Endemic Paeonia kesrouanensis at JMBR
Photo Credit: FON-CEPF Project

5.5.2 Coastal and Marine Ecosystems

5.5.2.1 Regulatory Framework and Planning

Several national strategies, draft laws and initiatives have been undertaken to respond to marine and coastal ecosystem issues in Lebanon, most prominently the following:

- The sixth National Report to the CBD was submitted by Lebanon in January 2019 with revision of the achievements regarding each NT (developed in the updated NBSAP) and their related actions, in addition to recommendations and main challenges regarding the implementation of NBSAP. The NBSAP was developed in line with the new CBD strategic goals tacking into consideration the 2020 Aichi Biodiversity Targets (MoE/UNEP/GEF, 2016a; MoE/UNEP/GEF, 2019).
- All the laws and international agreements mentioned in this chapter will contribute to SDG 14 “Life below water”. In addition, in the updated NBSAP, NAs were linked with SDGs whereby implementing the NBSAP actions concerning marine and coastal areas, SDG 3 “Good health and well-being”, SDG 11 “Sustainable cities and communities”, SDG 13 “Climate action”, SDG 14 “Life below water” and SDG 15 “Life on land” will be attended to (MoE/UNEP/GEF, 2019).
- Efforts and initiatives at the national level were also made to protect specific coastal and marine areas:
    - Declaration of MPAs by the GoL through the MoE and proposition of others under the National MPA Strategy.
    - Coastal ecologically and culturally sensitive sites: evaluated, ranked and prioritized under the ERML Project.
    - Ramsar sites declared under the Ramsar Convention (three of them are coastal).
    - Canyons (Deep sea sensitive sites).

Other responses such as strategies, draft laws and projects on national level can be found in Annex 15.

5.5.2.2 Opportunities and Funding Programmes

The Lebanese Central Treasury is the main source of national financing. Government funding allocates a share for the MoE and for specific programs and projects from which conservation and biodiversity related actions can be undertaken. For example, the Lebanese Central Treasury provides contribution to the management of protected areas through the MoE budget (MoE/UNEP/GEF, 2016a).

Although Law 444/2002 (Articles 8 to 11) stipulates the creation of a National Environmental Fund (NEF), to date there is no application decree to enact the NEF. In addition, there are several environment revenues (such as entrance fees to nature reserves and hunting permit fees) that are not allocated to serve environmental projects. Instead, they are submitted to the Central Treasury (MoE/UNEP/GEF, 2016a) to become part of the overall Government budget.

This is why the MoE, in addition to other public institutions (MoA, LARI, CNRS, academic institutions, NGOs, and municipalities, etc.), resort to external sources of funding to realize projects of interests related to marine and coastal ecosystems. Funds could be through grants, technical assistance or loans. Some of these potential donors provide funds through other implementing institutions such as the UNDP, ESCWA, UNEP, UNESCO and UNIDO, while others provide direct funds for governments, public sector, private sector, and NGOs (MoE/UNEP/GEF, 2016a).

5.5.2.3 Research

The scientific arm of the GoL is the CNRS. It was established in 1962, covering all scientific disciplines and boasts four specialized research centers of which is the NCMS-CNRS that was established in 1977. The NCMS focuses on the following themes:

- Monitoring of the entire CZ in the framework of a national monthly monitoring programme.
- Biogeochemical measurements and time-series surveys in the context of CC and ocean acidification.
- Detection of the pollution sources on the coastline and assessment of the transfer and bioaccumulation of chemical compounds in the coastal and marine ecosystems.
- Evaluation of the marine species (from plankton to cetaceans) and their habitats, and assessment of the migratory species and their influences on local ecosystems.
- Ichthyological studies and fishery stock evaluation.

In 2006, the International Centre for Advanced Mediterranean Agronomic Studies - Mediterranean Agronomic Institute of Bari from Italy donated a scientific vessel, dubbed CANA-CNRS, to support marine, environmental and geophysical studies and research in Lebanon. Many research activities have been undertaken by CANA since 2006 (http://www.cnrs.edu.lb/english/intl-collaborations/cana/cana).

LARI is a governmental organization supervised by the MoA. It develops "applied and basic scientific research for the development and advancement of the agricultural sector in Lebanon". LARI also undertakes coastal studies for water quality and conducts research related to coastal flora.

In addition, several research projects on marine and coastal ecosystems were implemented by different ministries, and/or national research centers such as (but not limited to):

- The MoE in collaboration with the SPA/RAC in 2020 developed the "National Action Plan for the Conservation of the Coralligenous assemblages in Lebanon".
- The MoE in collaboration with the SPA/RAC in 2020 developed the "Stranding Network for Sea Turtles and Cetaceans & Protocol for Monitoring the Interaction between Marine Litter and Marine Turtles in Lebanon".
- The MoE in collaboration with SPA/RAC in 2018 developed the "National Action Plan on marine species introductions and invasive species in Lebanon".
- The MoE in close coordination with SPA/RAC developed in 2018 a national monitoring programme for marine biodiversity in Lebanon including NIS species, marine turtles, coastal and marine birds, fisheries, cetaceans and habitats.
- The MoE in collaboration with SPA/RAC in 2016 carried out "Ecological characterization through biodiversity field surveys" for three of the proposed coastal MPAs (Batroun, Medfoun and Byblos). The Project funded by the EU and the MedMPA Network Project and executed at regional level by SPA/RAC.
- MoE in collaboration with Oceana, SPA/RAC, IUCN and NCMS implemented in 2016 the project "Towards deep-sea conservation in Lebanon" that was funded by MAVA.
- NCMS-CNRS implemented the project "DNA Identification and Authentication of Mediterranean Fisheries Resources" (2018-2019).
- NCMS-CNRS, in coordination with the "Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area" (ACCOBAMS), conducted a mammalian scientific mission onboard of CANA vessel between 2011 and 2013 and surveyed cetaceans in the Lebanese waters, using the CANA vessel in 2018.
- NCMS-CNRS used the CARLIT methodology in 2018 for the assessment of the distribution and abundance of shallow-water communities (particularly species that need protection) (Badreddine et al. 2018).
- NCMS-CNRS with the support of IUCN will deploy a smart marine buoy in offshore station in front of Beirut. The buoy will monitor environmental trends in the context of CC. The device is of a high-sensitivity, and capable of repeating high-quality measurements over a long time, allowing permanent deployment at sea.
- The NCMS-CNRS regularly monitors water quality along the Lebanese coast in addition to regularly assessing phytoplankton and zooplankton since 1970's.

Interest in the field of environment in Lebanon has been growing over the past two decades especially at the level of research and development. in addition to the public institutions mentioned above, private consultancy firms, academic institutions, and even NGOs are implementing important projects related to coastal ecosystems.

Furthermore, many academic institutions in Lebanon have dedicated courses and/or majors in marine and coastal disciplines in addition to laboratories and research centers concerned with marine and coastal issues:

- AUB in its Department of Biology offers active research in environmental biology, marine and aquatic ecology amongst others. The Department also includes three common research laboratories and a new marine laboratory housing 11 aerated tanks of fish (https://www.aub.edu.lb/fas/biology/Pages/default.aspx).
- The Lebanese American University in its Department of Civil Engineering ensures an environmental laboratory that offers a wide range of equipment for analysis of fresh and marine water quality, environmental impact monitoring, and environmental site investigations amongst others (https://soe.lau.edu.lb/ce/programs/be-civil/).
- The Lebanese University in its Faculty of Sciences offers a Masters of Sciences in Marine Biology and Ecology (https://www.ul.edu.lb/faculte/branches.aspx?facultyId=6).
- The UoB offers several courses related to marine and coastal ecosystems and CZ management for Environmental Sciences students at the Bachelor of Science and Masters of Science majors. In 2004, the University established the IoE, which includes the MCR that addresses issue related to the CZ and its associated resources (http://www.balamand.edu.lb/home/Pages/default.aspx).

5.5.2.4 Technological Perspectives

The CNRS developed in 2006 the Science, Technology and Innovation Policy (STIP) for Lebanon supported by the UNESCO initiative of 2002. The STIP objective was to "enhance and diversify science, technology and innovation input in economic activities resulting in the creation of high-quality jobs and investment opportunities". One of its major themes was the Sustainable Management of Coastal Areas where the main focuses are 1) interaction between physical and biological systems through monitoring, modelling and impact studies; 2) land use planning; and 3) promotion of environmental studies using new technologies and techniques (such as EIA studies, ICZM techniques, GIS and remote sensing technologies). However, after the 2006 war, no major advancement was made towards implementing this policy. The NBSAP NA 15.3 was to update the STIP to include biodiversity as a priority and define the areas where research is needed within the biodiversity sector. However, until 2019 there were no identified measures towards implementing this National Action (MoE/UNEP/GEF, 2019).

Advancement in technological perspectives can be divided into three axes: advanced tools, capacity building of personnel and data sharing.

A. Advanced Tools

Many projects developed technical guidebooks, booklets and other documents to help tackling issues related to coastal and marine ecosystems, such as technical guidelines for rehabilitation and/or restoration of quarries, rangelands and forests, dumpsites and degraded underwater marine environments.

There has been development in many techniques that are being used in the field of coastal and marine ecosystem research such as GIS, remote sensing, Decision Support Systems, modelling, and developed equipment amongst others. An example is the FLOUCA Web utility for catch/effort in the fisheries sector at the MoA to continuously collect data and report on fishing gear, species, quantity, price and size of commercial species from the major fishing ports in Lebanon. This utility was developed under the project "Pilot Survey on Fisheries Dependent Data Collection in Lebanon" implemented in 2013-2014 and funded by FAO in collaboration with, and for the benefit of, the MoA.

B. Capacity Building of Personnel

Many initiatives for capacity building were held for staff at different public institutions concerned with environmental issues such as: awareness on biodiversity for tour operators at the Ministry of Tourism; awareness on the conservation of birds and on the hunting law for the ISF, forest guards and public school educators; and awareness on SEA/EIA, Land Use and Ecosystem Management for the municipal police. In addition, the ISF participated in the development of the PSSF Management plan (MoE/UNEP/GEF, 2019).

C. Data Sharing

Several initiatives were launched to promote data sharing amongst stakeholders, such as:

- Creation of the National Clearing-House Mechanism (CHM) in 2016 by the MoE, a planned web-based platform where stakeholders can share information on biodiversity. The CHM would be linked to the CBD CHM (under the GoL obligation to the CBD; MoE/UNEP/GEF, 2019). This portal is currently being made operational by the MoE through the project "Market Policy and Legislative Development for Mainstreaming Sustainable Management of Marine and Coastal Ecosystems in Lebanon".
- As part of the CHM, initiation of a web-based library for "coastal and marine biodiversity data collection and biodiversity reporting" centralized at the MoE. This Library collected more than 800 documents and was posted on the Lebanese CHM.
- The O-LIFE, part of the CNRS introduced a web-based biodiversity library for the compilation of all works (such as technical reports, theses, books, papers, maps etc.) on biodiversity in Lebanon (including marine and coastal species and ecosystems). This library is not yet accessible for all stakeholders (MoE/UNEP/GEF, 2019).

5.6 Priority Recommendations and Future Outlook

5.6.1 Terrestrial Ecosystems

Milestone achievements took place during the last decade to preserve the terrestrial biodiversity of Lebanon; yet, threats of major consequences are still eroding its natural wealth. The coming decade should reinforce and advance preservation while abating deterioration pressures.

Resilience to Crisis: Forces of degradation on ecosystem and biodiversity are expected to rise in association with the dire socio-economic crisis that Lebanon is currently facing. In situations of crisis, natural resources become the first victim to support livelihood. A crisis strategy is imminently required with pre-emptive measures to avoid the downfall, the loss of precious accomplishments and the momentum of advancing resource preservation.

Forest Fires: Years 2019 and 2020 present alarming records of forest fire frequency, distribution and burnt areas. This is an indicator that the existing infrastructure, human resources and capacity to combat fires are still lagging and not equivalent to the acting pressures. Accordingly, it is recommended to undertake a constructive review of the fire problem over the past decade in order to identify gaps and impediments in the administration, infrastructure, legislation and implementations. Based on the review, a new strategy to combat forest fires must be designed with a futuristic vision employing advanced technologies, and permanently undertaken forensic investigations by equipped and specialized teams; investigation results should be publicly accessible to enhance transparency and evidence compilation. The remarkable community support witnessed at fighting forest fires should also be capitalized on, enhanced and integrated in any future strategy.

Freshwater Ecosystems: Despite Lebanon's wealth of water resources, freshwater ecosystems are not well documented nor envisaged as holistic ecosystems. Watersheds and river valleys are characterizing features of Lebanon's nature; they should be well-studied, appreciated and preserved as complete entities to maintain the essential basis of a good part of Lebanon's biodiversity, and to guide a learned sustainable development approach to these systems and resources.

Preservation of Summits: The development of a master plan to protect Lebanon's mountain summits needs to reach execution, as per CoM Decision 5 of 5/9/2019, in order to further the preservation of Lebanon's distinctive topographic features - its summits, biodiversity (Figure 5-42), water catchments and underground water infiltration; these are all vital for any sustainable development plans.

Figure 5-42 *Allium libani* the Rare Endemic of the Alpine Summits
Source: Ricardus Haber

Ecosystem Services: Lebanon should progress from the current limited initiatives to develop a national ecosystem services chart, which is integral to any sustainable development effort, including a national biodiversity management plan.

Lebanon Biodiversity Record Update: Some records of biodiversity are subject to continuous updating through sequential reporting, such as in forest cover and Plant Genetic Resources for Food and Agriculture. The national record of species (fauna and flora) has not been updated since 1996; it would be advisable to generate a more recent record in the coming decade particularly with the increased research in this field; in light of the new records and generous publications, an update of the national Flora of Lebanon is important.

Fauna Protection: In spite of the improved legislation and law enforcement of bird and animal hunting, especially in recent years, the mechanisms for law enforcement still need to become more effective and efficient on a national scale, and immune to situations of crisis. The massacres revealed on social media are an indicator of failure to attain consistent law enforcement in this regard. Better monitoring and implementation measures need be devised possibly integrating multiple entities from municipalities to NGOs, local communities, creating a more enabling national atmosphere is yet to be achieved as well.

5.6.2 Coastal and Marine Ecosystems

In the past two decades, a large number of projects implemented by public and private institutions, in addition to other factors, have led to major advances in research and knowledge regarding marine and coastal ecosystems. This is clearly reflected in the marked increase in scientific publications in peer reviewed journals and technical reports commissioned by national and international organizations on almost all aspects related to marine ecosystems. This increase in knowledge has led to the production of several strategies and plans for marine ecosystem conservation and fisheries management. Recently, and upon the request of the MoE, IUCN- Regional Office for West Asia (ROWA) commissioned a report entitled "Assess current climate change and to find adaptation measures to fit the situation in the CZ and the marine environment in Lebanon" on the impacts of CC on the Lebanese coastal zone (in progress).

Moreover, the GoL has set a list of priorities for the coastal and marine ecosystems as part of updated NBSAP. This was followed by two main reports/initiatives that described and analysed these priorities: 1) 6th National Report to the CBD produced in 2019 and 2) The first Voluntary National Review in 2018 concerning SDGs.

In order to further ensure the sustainability of the marine and coastal ecosystems, more actions on the institutional, legal and governance and on research level are recommended:

Legal, institutional and governance level:

- Ensure the implementation of the ratified international conventions by issuing applicable laws and decrees and by enforcing them.
- Submit pending draft laws to the CoM and push for the passing of these draft laws by Parliament.
- Endorse, allocate funds and implement national conservation plans and monitoring programmes for biodiversity, climate change, pollution and many other issues.
- Enhance coordinated action according to the expertise of academic and research bodies, national experts, NGOs and other relevant institutions to meet the NAs set in the NBSAP and the objectives of other relevant plans and strategies.

Research level:

- Ensure adequate follow up to scientific studies and projects undertaken in the past regarding the marine environment.
- Direct funds towards filling scientific gaps, mapping of habitats, expanding knowledge of ecosystems and energy flows, and towards launching and sustaining national monitoring programmes for marine biodiversity.
- Produce and regularly update national species lists for all taxa and map coastal and deep-sea habitats.
- Support the GoL in order to meet its obligations in terms of mainstreaming biodiversity into policy frameworks by launching targeted actions to reach set goals.

As it can be seen, a combination of legal and scientific initiatives has been launched in the past few decades to properly and sustainably manage marine and coastal resources while taking into consideration the well-being of coastal communities. By enforcing existing laws/decrees, endorsing other draft laws/strategies/plans and working towards achieving the NTs, the CZ may experience advancements in the protection of its environment from chaotic development and degradation. It is nevertheless crucial to sustain scientific research in order to maintain and build on all the progress that has been made in the field.

Even though the future outlook may appear optimistic, all of the above remains quite challenging when placed against the background of constant political instability in Lebanon and the Middle East. Moreover, the continuing Syrian displaced crisis since 2011 and the new crises (economic crash, political impasse, Covid-19 pandemic and the Beirut Explosion of 4 August 2020) have shifted national priorities, testing both scientists and administrators alike to achieve set goals. Such a chronic, complex situation represents the main obstacle towards fulfilling national targets and objectives.

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Cited Legislation related to Ecosystems

Legislation	Year	Title
Law 130	2019	Law for Protected Areas
Law 78	2018	Protection of Air Quality
Law 77	2018	Water Resources Law
Law 80	2018	Integrated Solid Waste Management Law
Law 28	2017	The Right of Access of Information
Law 243	2012	New Traffic Law
Law 163	2011	Delineation and Declaration of the Maritime Regions of the Republic of Lebanon
Law 132	2010	The Offshore Petroleum Resources
Law 35	2008	Law for the Re-Organization of The Structure of The Ministry of Culture
Law 34	2008	Ratification of the Amendments to Barcelona Convention
Law 690	2005	Law on the Organization of the Ministry of Environment
Law 571	2004	Ratification by the GoL of the Agreement on Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area ACCOBAMS
Law 444	2002	Environmental Protection Law
Law 412	2002	Ratification by the GoL of the African-Eurasian Migratory Water Birds Agreement AEWA
Law 341	2001	Reduction of Air Pollution from Transport Sector and Encouragement on the Use of Less Polluting Fuel
Law 23	1999	Ratification by the GoL of the Ramsar Convention on Wetland of International Importance Specially as Waterfowl Habitat
Law 360	1994	The Convention on Biological Diversity CBD
Law 292	1994	Protection Against Marine Pollution
Law 14	1990	Considering contracts for selling, leasing, and exploitation of the public maritime or municipal domain that are not compliant with applicable rules and regulations as absolutely invalid
Law 19	1990	The UNESCO Convention on the Protection of the Cultural and Natural Heritage
Law 64	1988	Protection of The Environment Against Pollution from Hazardous Waste Disposal and Substances
Law 126	1977	Ratification of the UNEP Barcelona Convention on Mediterranean Sea Protection
High Commissioner's Decision 95/L	1939	Regulating Sponge Fishing
High Commissioner's Decision 70/LR	1937	Coastal Marine Fishing System (Prohibit Coastal Marine Fishing Except for Lebanese Ships)
High Commissioner's Decision 166	1933	Antiquities System
High Commissioner's Decision 2775	1929	Control Coastal Marine Fishing
High Commissioner's Decision 372	1926	Regulations Relating to Navigation, Fishermen and Fishing Boats
High Commissioner's Decision 144/S	1925	Definition of Public Domain

Legislation	Year	Title
High Commissioner's Decision 1104	1921	The Determination of the Coastal Zone Scope and Penalties Related to the Infringement of Fishing Rules
Decree 167	2017	Application of Article 20 of Law 2002/444 (Tax Reduction)
Decree 10289	2013	Petroleum Activity Regulations
Decree 8633	2012	Fundamentals of Environmental Impact Assessment
Decree 8941	2012	Public Transport Incentives
Decree 8213	2012	Strategic Environmental Assessment
Decree 2604	2009	Control of Materials that Depletes of the Ozone Layer
Decree 9765	2003	Control Measures and Penalties Relating to Industrial Establishments
Decree 8442	2002	Standards for Gasoline and Diesel
Decree 12189	1998	Modification of the Master Plan for the Southern Seaside of Byblos
Decree 12841	1998	Organization of Fishing and Leisure Ports, and Regulation of their Use and Conservation
Decree 5645	1994	The Master Plan for the Southern Seaside of Byblos
Decree 3899	1993	Regulation of the Extraction of Sand and Other Materials from the Public Maritime Domain
Decree 2522	1992	Annual Fees for the Temporary Use of the Public Maritime Domain
Decree 34	1985	Canceling Decree 1983/144 Relevant to Settling Violations of the Public Maritime Domain and Regional Water Depths
Decree 138	1983	Specification of the Width of the Regional Waters and Regions where Navigation is Forbidden
Decree 9132	1974	Affiliating the Seabed and Depth of Regional Waters to the Public Maritime Domain
Decree 8327	1974	Rules Relating to Fishing in Rivers, and Relevant Permit Fee
Decree 15649	1970	Regulation of the Extraction of Sand and Other Materials from the Public Maritime Domain and Seabed
Decree 5118	1969	Regulation of Beaches and Pools in the City of Beirut
Decree 9791	1968	Organization of Coastal Monitoring Activities
Decree 11541	1968	Organization of the Body Responsible for Monitoring the Coast Within the Internal Security Forces
Decree 4809	1966	Regulating the Lebanese Coastal Zone
Decree 4810	1966	Regulating the Occupation of the Public Maritime Domain
Decree 17614	1964	The Exploitation of Public Maritime Lands
Decree 17702	1964	Regulating the Coastal Zone of Jounieh
Decree 10121	1962	Allowed Regions and Conditions for Issuing Permits for Extracting Gravel and Sand from the Public Maritime Domain
Decree 11882	1948	Enforcement of the Law Organizing Fishing in Rivers
Decree 2383	1943	Prohibiting the Extraction of Products from Part of Beirut River

Legislation	Year	Title
CoM Decision 9	2000	Organization of Land Public Transport Sector in Lebanon and Proposition of a Reduction in Number of Public Transport Vehicles
PCM Decision 41	2013	Establishment of National Coordination Committee for Responding to Disasters and Crises
MoA Decision 1044/1	2014	General Conditions for the Protection of Whales and Marine Mammals
MoA Decision 1045/1	2014	General conditions for Sharks fishing in Lebanon
MoA Decision 346/1	2010	Regulates and Identifies Fishing Types and Equipment
MoA Decision 93/1	2008	Regulates Scuba Diving
MoEW Decision 14	2005	Establishment of the committee for field emergencies for energy issues and aquatic resources
MoA Decision 88/1	2003	Prohibition of the Use of Beach Seines in Fishing along the Lebanese Coast
MoE Decision 8/1	2001	National Standards for Environmental Quality Related to Air Contaminants and Liquid Waste Emitted from Classified Establishments into Receiving Water Bodies. Amends Decision 1996/1-52
MoA Decision 125/1	1999	Prohibiting Fishing of Whales, Seals and Marine Turtles
MoA Decision 43/1	1999	Restricting the use of Sardine and "Ciaciulu" Mesh to Specific Conditions
MoA Decision 42/1	1999	Organization of Underwater Fishing
MoA Decision 281/1	1998	Prohibiting Sponge Fishing for 5 Years
MoA Decision 291/1	1998	Restricting the Use of Purse Seine Mesh to Specific Conditions
MoA Decision 115/1	1998	Organization of Work at the Institute of Oceanography and Fisheries and Defining the Basis for Cooperation with the National Center for Scientific Research
MoA Decision 385/1	1997	Prohibits Fishing Activities in All Estuaries All Year Round
MoA Decision 397/1	1997	Creation of a Fishing and Hunting Guidance Center at the Institute of Oceanography and Fisheries in Batroun- Northern Lebanon
MoA Decision 398/1	1997	Creation of a Fishing and Fisheries Center at the Institute of Oceanography and Fisheries in Batroun- Northern Lebanon
MoE Decision 52/1	1996	National Ambient Air Quality Standards (NAAQS) Determination of Specifications and Percentages to Reduce Air, Water and Soil Pollution
MoPW and MoIM Decision 7/1	1974	Common Instructions for Coordinating the Stoppage of Contraventions on the Public Maritime Domain
MoA Decision 83/1	1983	Prohibiting Fishing and Hunting of Some Animal Species

Note: Legislations regarding the establishment or mananegemnt of nature reserves are presented in Annex 9.

Annex 1: Overall Wildfire Risk Map of Lebanon

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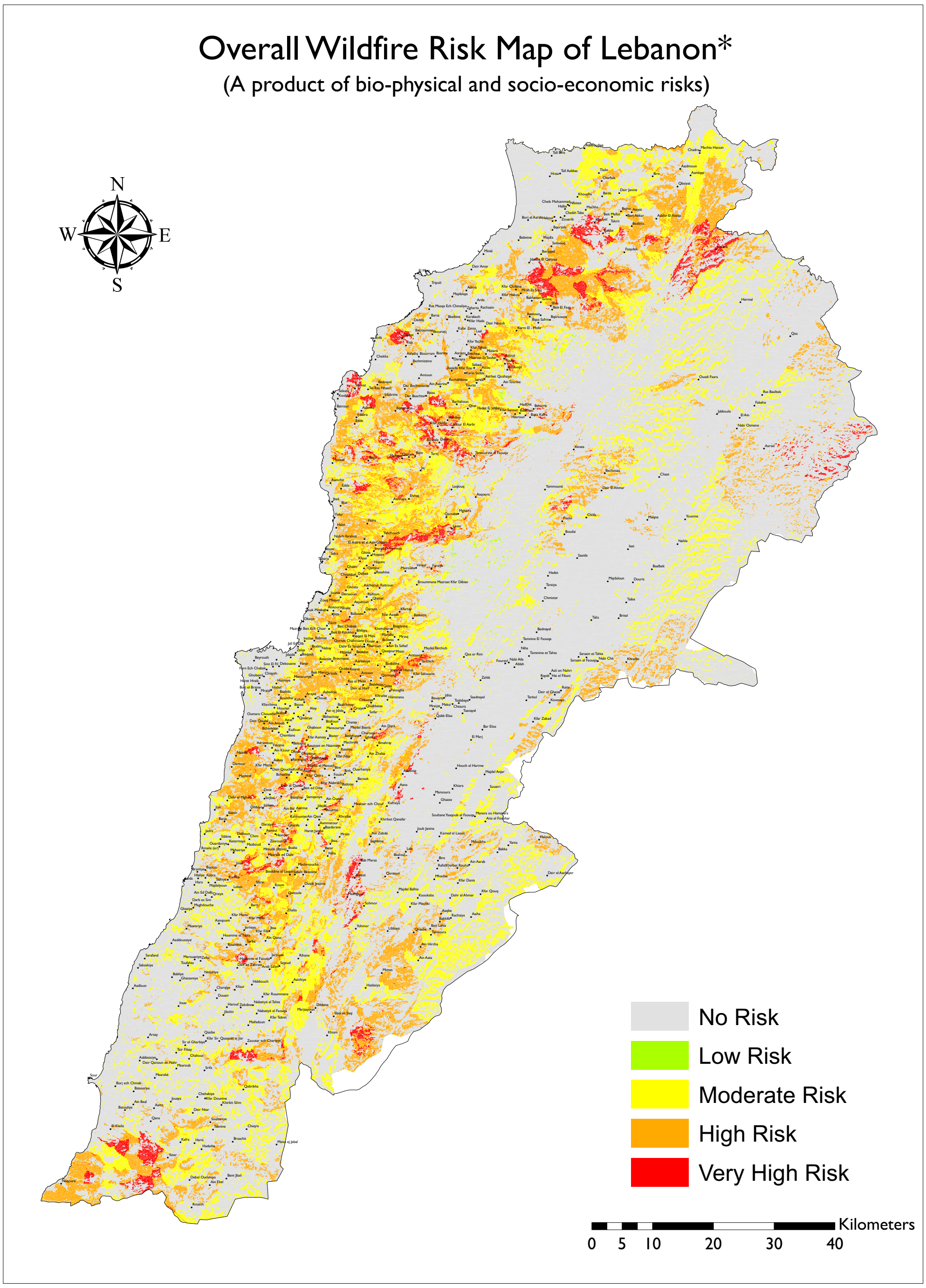
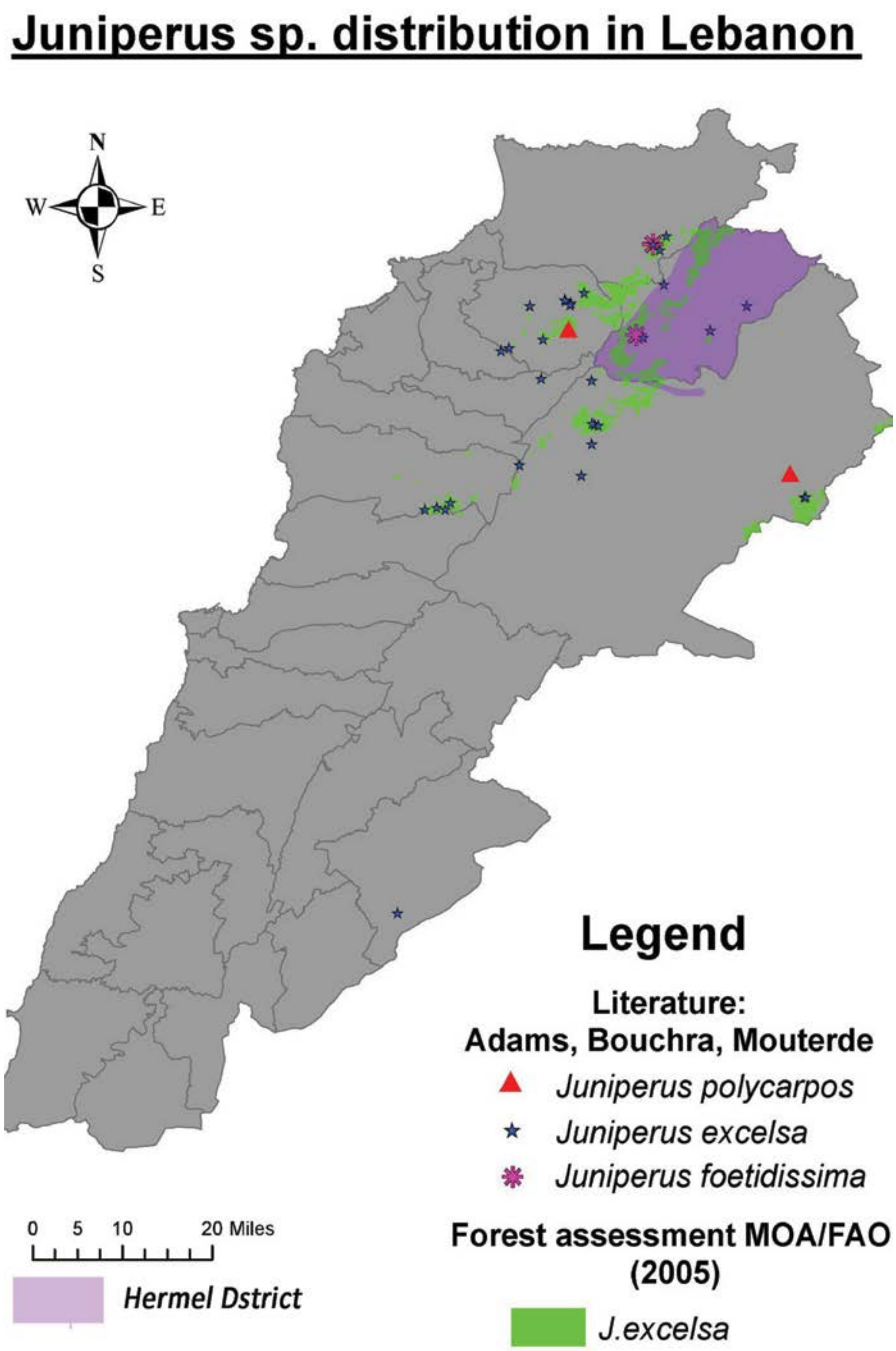
UNIVERSITY OF BALAMAND 1988 - 2013



Annex 2: Juniperus Species Distribution in Lebanon



Juniperus Species Distribution in Lebanon (Bou Dagher Kharrat and Farhat, 2017).

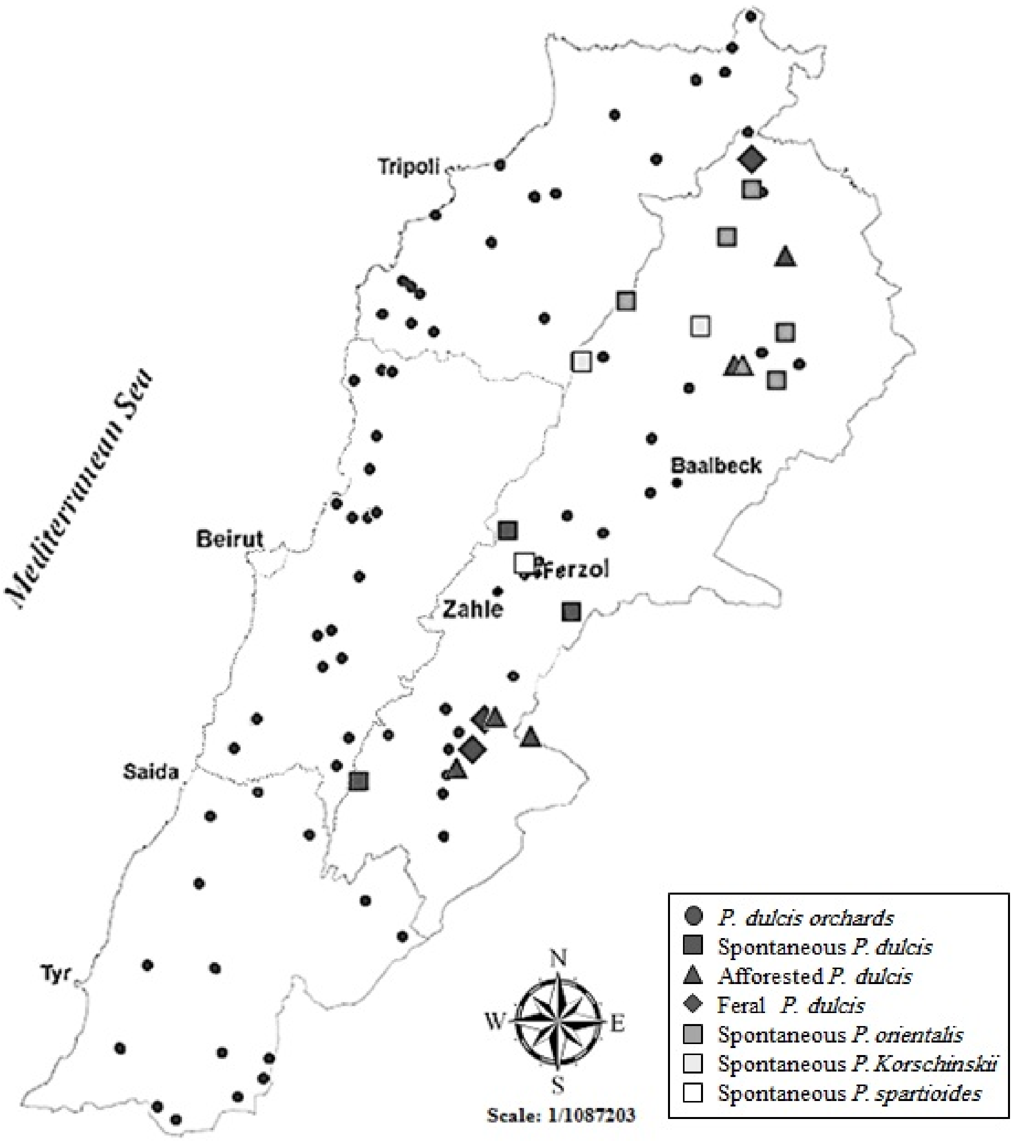
Annex 3: Abiotic Driving Factors Influencing Oak Species Distribution in Lebanon

Species	Determinant Abiotic Factor
Quercus cerris L.	High precipitation ranges and cold, cool, and temperate winter variants
Quercus cedrorum Kotschy	High precipitation ranges and cold and very cold winter variants, high altitude, negatively influenced by temperature,
Quercus kotschyana O. Schwarz	Per-humid, humid and sub-humid bioclimatic zones with cold and very cold winter variant, high altitude, and negatively influenced by temperature
Quercus look Kotschy	Humid and sub-humid bioclimatic zones withcold and very cold winter variant, high altitude, and negatively influenced by temperature
Quercus ithaburensis Decne.	Low altitude and deep volcanic soils, supports drought
Quercus calliprinos Webb	Indifferent due to large plasticity to their bio-geographical range, limited by cold and very cold winter variants
Quercus infectoria Olivier	Indifferent due to large plasticity to their bio-geographical range, limited by aridity

Source: Stephan et al., 2016

Annex 4: Distribution of Wild Almonds in Lebanon

Figures



Distribution of Wild Almonds in Lebanon based on Surveys Conducted in 2013
Source: Chalak and Hamadeh, 2015

Annex 5: Summary of Ecological Relevance of Arborescent Riparian Species

Ecological relevance	Species
Obligate riparian species (phreatophytes)	*Salix acmophylla Boiss. Salix alba* L. and *Platanus orientalis* L.
Facultative riparian species (facultative phreatophytes)	*Salix libani* Bornm., *Ostrya carpinifolia* Scop., *Juglans regia* L., *Crataegus monogyna* Jacq.
Most drought tolerant species	*Salix libani*
Low disturbance species	*Platanus orientalis*
Species of distorted habitats	*Salix acmophylla* and *Salix alba*
Species tolerant to high slopes	*Rhododendron ponticum* var. *brachycarpum, Salix libani* and *Platanus orientalis*
Strictly low-altitude species	*Salix acmophylla* and *Tamarix smyrnensis*
Strictly high-altitude species	*Rhododendron ponticum* and *Salix libani*

Source: Stephan and Issa, 2017b.

Annex 6: Recent Data on Bird Species First Time Sighted in Lebanon

Recent data on bird species first time sighted in Lebanon as well as First Breeding Records Based on Monitoring Work Done by SPNL and Other Hunters, and Other Observations:

Species Name	Common Name of Species	Location	Significance
Pyrrhula pyrrhula	Eurasian Bullfinch	Douar (above Bikfayya); Ehden	New site of occurrence
Marmaronetta angustirostris	Marbled Duck	Qaaroun and Cheikh Zennad, West Bekaa	New site of occurrence
Tetrax tetrax	Little Bustard	Jiyyeh, Saida, Anjar, Tal Znoub	new record of species occurrence (the previous record was in 1958)
Chlamydotis macqueenii	Macqueen's Bustard	Sinay, Nabatiyeh Rachaya Al Fokhar	New record of species occurrence in over 58 years
Merops persicus	Blue-cheeked Beeeater	Tyre	New Record of species occurrence in over 70 years
Oxyura leucocephala	Whiteheaded Duck	Lake of Qaaroun, West Bekaa	First record of the species
Turdus obscurus	Eyebrowed Thrush	Bchaaleh (Batroun, north Lebanon)	First record of the species
Thalasseus bengalensis	Lesser Crested Tern	NA	First record after considered extinct in Lebanon for more than a century
Serinus serinus	European Serin	NA	First breeding record
Burhinus oedicnemus	Eurasian Stone Curlew	NA	First breeding record
Corvus corax	Northern Raven	NA	First breeding record in over four decades
Podiceps cristatus and *Regulus regulus*	Great Crested Grebe and Goldcrest	NA	First breeding record

Source: (Ramdan-Jaradi, et al., 2019) (Ramadan-Jaradi & Serhal, 2014) (Ramadan-Jaradi et al., 2015) (Ramadan-Jaradi, Itani, & Serhal, 2017) (Ramadan-Jaradi, Serhal, & Ramadan-Jaradi, 2016) (Ramadan-Jaradi & Itani, 2018) (Ramdan-Jaradi al., 2017)

Annex 7: Globally Threatened Bird Species of Lebanon

Species Name	Common Name of Species	Status
Vanellus gregarius	Sociable Lapwing	Critically Endangered
Oxyura leucocephala	White-headed Duck	Endangered
Neophron percnopterus	Egyptian Vulture	Endangered
Aquila nipalensis	Steppe Eagle	Endangered
Falco cherrug	Saker Falcon	Endangered
Marmaronetta angustirostris	Marbled Duck	Vulnerable
Aythya ferina	Common Pochard	Vulnerable
Melanitta fusca	Velvet Scoter	Vulnerable
Puffinus yelkouan	Yelkouan Shearwater	Vulnerable
Podiceps auritus	Horned Grebe	Vulnerable
Clanga clanga	Greater Spotted Eagle	Vulnerable
Aquila heliaca	Eastern Imperial Eagle	Vulnerable
Otis tarda	Great Bustard	Vulnerable
Chlamydotis macqueenii	Macqueen’s Bustard	Vulnerable
Rissa tridactyla	Black-legged Kittiwake	Vulnerable
Streptopelia turtur	European Turtle Dove	Vulnerable
Serinus syriacus	Syrian Serin	Vulnerable
Emberiza rustica	Rustic Bunting	Vulnerable

Source: Ramadan-Jaradi et al., 2020 and Ramadan-Jaradi, personal communication

Annex 8: International Agreements, Treaties and Conventions related to Terrestrial and Marine Biodiversity

Convention Title	Year	Signature/Adhesion/Ratification/Accession
Nagoya Protocol concerning Access and Benefit Sharing (ABS)	2010	Ratification: Law 3 dated 3/2/2017
Protocol on Integrated Coastal Zone Management (ICZM) in the Mediterranean (under Barcelona Convention)	2008	Ratification: Decree 639 dated 18/09/2014. Entered into force August 31, 2017
Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic (ACCOBAMS)	2004	Adhesion: Law 571 dated 05/02/2004
Agreement on the Conservation of African-Eurasian Migratory Water Birds (AEWA)	2002	Adhesion: Law 412 dated 13/06/2002
Protocol Concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea	2002	Accession: Decree Law 618 dated 03/11/2017 Entery into force: 03/12/2017
Cartagena Protocol on Biosafety to the CBD	2000	Ratification: Law 31 dated 16/10/2008
Convention on Wetlands of International Importance especially as Waterfowl Habitat – Ramsar	1999	Adhesion: Law 23 dated 01/03/1999
Protocol Concerning Specially Protected Areas and Biodiversity (SPA/BD)	1995	Ratification: Law 127 dated 30/04/2019.
United Nations Convention to Combat Desertification; Paris	1994	Ratification: Law 469 dated 21/12/1994.
Amendment to the Montreal Protocol on Substances that deplete the ozone layer; Copenhagen	1992	Adhesion: Law 120 dated 03/11/1999.
Convention on Biological Diversity; Rio de Janeiro.	1992	Ratification: Law 360 dated 11/08/1994.
Convention on the Law of the Sea (UNCLOS) adopted in Montego Bay (Jamaica)	1982	Adhesion: 22/02/1994, Law 295.
Protocol Concerning Mediterranean SPAs	1982	Adhesion: Law 292 dated 27/12/1994 Entery into force: 26/01/1995.
Convention on the Conservation of Migratory Species of Wild Animals, also known as the Convention on Migratory Species or the Bonn Convention (CMS)	1979	Ratification: Decree 3320 dated 29/6/2018
Convention for the Protection of the Mediterranean Sea against Pollution; Barcelona Convention	1976	Signature: 16/02/1976; Accession: 30/06/1977 by Decree-Law No. 126.
Protocol Concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency; Barcelona	1976	Signature: 16/02/1976; Accession: 30/06/1977 Decree-Law 126
Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft; Barcelona	1976	Signature: 16/2/1976; Accession: 30/06/1977 Decree-Law 126
Convention on International Trade in Endangered Species of Wild Fauna and Flora CITES)	1975	Ratification: Law 233 dated 22/10/2012
International Convention for the Prevention of Pollution from Ships; London	1973	Adhesion: Law 13 dated 24/11/1983
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. London, Mexico City, Moscow, Washington	1972	Signature: 15/05/1973
UNESCO Convention on the Protection of Cultural & Natural Heritage	1972	Adhesion: Law 19 dated 30/10/1990.
Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Seabed and the Ocean floor and in the Subsoil	1971	Ratification: 7/10/1974, Decree 9133
International Convention relating to Intervention on the High Seas in cases of Oil Pollution Casualties	1969	Ratification: 12/10/1974, Decree 9226
Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Underwater	1963	Ratification: 30/12/1964, Law 59/64
International Convention for the Prevention of Pollution of the Sea by Oil	1954	Adhesion: 16/11/1966, Law 68/66

Annex 9: Nature Reserves in Lebanon

Reserve	Caza/ Governorate	Legal Instrument	Creation Date	Approximate Surface Area (ha)	Elevation Zone (meters)	International Desig-nations	Management Plan
Horsh Ehden	Zgharta/ North Lebanon	Law 121	3/9/1992	1,740	1,200 - 1,900	Important Bird Area (IBA)	Yes
Palm Islands	Tripoli/ North Lebanon	Law 121	3/9/1992	417.73 (The three islands with 500m. of surrounding water)	Sea Level	Ramsar Site, Specially Protected Area (SPA), SPA of Mediterranean Importance (SPAMI), IBA	Yes
Karm Chbat	Akkar	MoE Decision 1/14	10/6/1995	520	1,400 - 1,900	None	No
Al Shouf Reserve	Aley and Chouf / Mount Lebanon	Law 532 and its amendment Law 119	7/24/1996 and 7/29/2010	15,647	900 - 2,000	Biosphere Reserve, IBA	Yes
Tyre Coast	Tyre/ South Lebanon	Law 708 and Decree 8044 [1]	11/5/1998	3,889.25 (Land: 176.32, Sand: 6.12, Water: 3,706.81)	Sea Level	Ramsar Site, SPAMI	Yes
Yammouneh	Baalbek/ Baalbek-Hermel	Law 10	2/20/1999	2,100	1,400 - 2,000	None	No
Bentael	Jbeil/ Keserwen Ftouh-Jbeil	Law 11	2/20/1999	75.31	250 – 800	IBA	Yes
Tannourine Cedars	Batroun/ North Lebanon	Law 9	2/20/1999	195.48	1,300 - 1,800	IBA	Yes
Wadi Al Houjeir	Marjaayoun/ Nabatieh	Law 121	7/23/2010	3,595	250 – 400	None	No
Mashaa Chnaniir	Keserwan/ Keserwen Ftouh-Jbeil	Law 122	7/29/2010	27	500 – 530	None	No
Kafra	Bint Jbeil/ Nabatieh	Law 198	11/18/2011	40	~650	None	No
Ramya	Bint Jbeil/ Nabatieh	Law 199	11/18/2011	20	~650	None	No
Debl	Bint Jbeil/ Nabatieh	Law 200	11/18/2011	25	~600	None	No
Beit Leef	Bint Jbeil/ Nabatieh	Law 201	11/18/2011	20	~550	None	No
Jaj Cedars	Jbeil/ Keserwen Ftouh-Jbeil	Law 257	4/15/2014	20	~1,650	None	No
Nmayrieh	Nabatieh	Law 169	8/5/2020	10.2	~300	None	No
Abbasiyeh	Tyre/ South Lebanon	Law 170	8/5/2020	293.10	Sea level	None	No
Mount Hermon	Rachaya and West Bekaa/ Bekaa	Law 202	12/30/2020	1260	1700	None	No

Source: Department of Ecosystems - MoE, 2020

[1] Decree 8044/2012: Management of Tyre's Coast's Natural Reserve

Annex 10: Nature Reserves in the Pipeline

#	Name	Caza/ Governorate	Preparatory Phase	Municipal Council Approval	Submittal to CoM/ Line Ministries	CoM Approval Decision	Approval Decree	Law No.
1	Qammouaa	Akkar	Awaiting approval of related municipalities	-	-	-	-	-
2	Andket	Akkar	Completed	Granted[1]	Submitted	Decision 33 dated 5/9/2019	-	-
3	Dinniyyeh	Minieh-Danniyeh/ North Lebanon	Completed	Granted	Submitted	-	Decree 92 dated 3/7/2014	-
4	Anfeh	Koura/ North Lebanon	Completed	Granted	Ready to be sub-mitted	-	-	-
5	Ras El Chakaa	Batroun/ North Lebanon	Completed	Granted	Submitted	Decision 23 dated 29/8/2019	-	-
6	Batroun	Batroun/ North Lebanon	Awaiting official approval from munic-ipal council	-	-	-	-	-
7	Jbeil Coast	Jbeil/ Keserwen Ftouh-Jbeil	Done	Granted	Ready to be sub-mitted	-	-	-
8	Jounieh Canyon	Keserwen/ Keserwen Ftouh-Jbeil	Awaiting official approval from munic-ipal council	-	-	-	-	-
9	Jabal Rihan	Jezzine/ South Lebanon	Done	Granted	Submitted	-	Decree 17533 dated 11/8/2006	-
10	Zibquine	Tyre/ South Lebanon	Awaiting remaining documents concern-ing land ownerships and maps	-	-	-	-	-
11	Naqoura	Tyre/ South Lebanon	Awaiting official approval from munic-ipal council	-	-	-	-	-
12	Sarada	Marjaayoun/ Nabatieh	Awaiting remaining documents concern-ing land ownerships and maps	-	-	-	-	-

Source: Department of Ecosystems - MoE, 2020

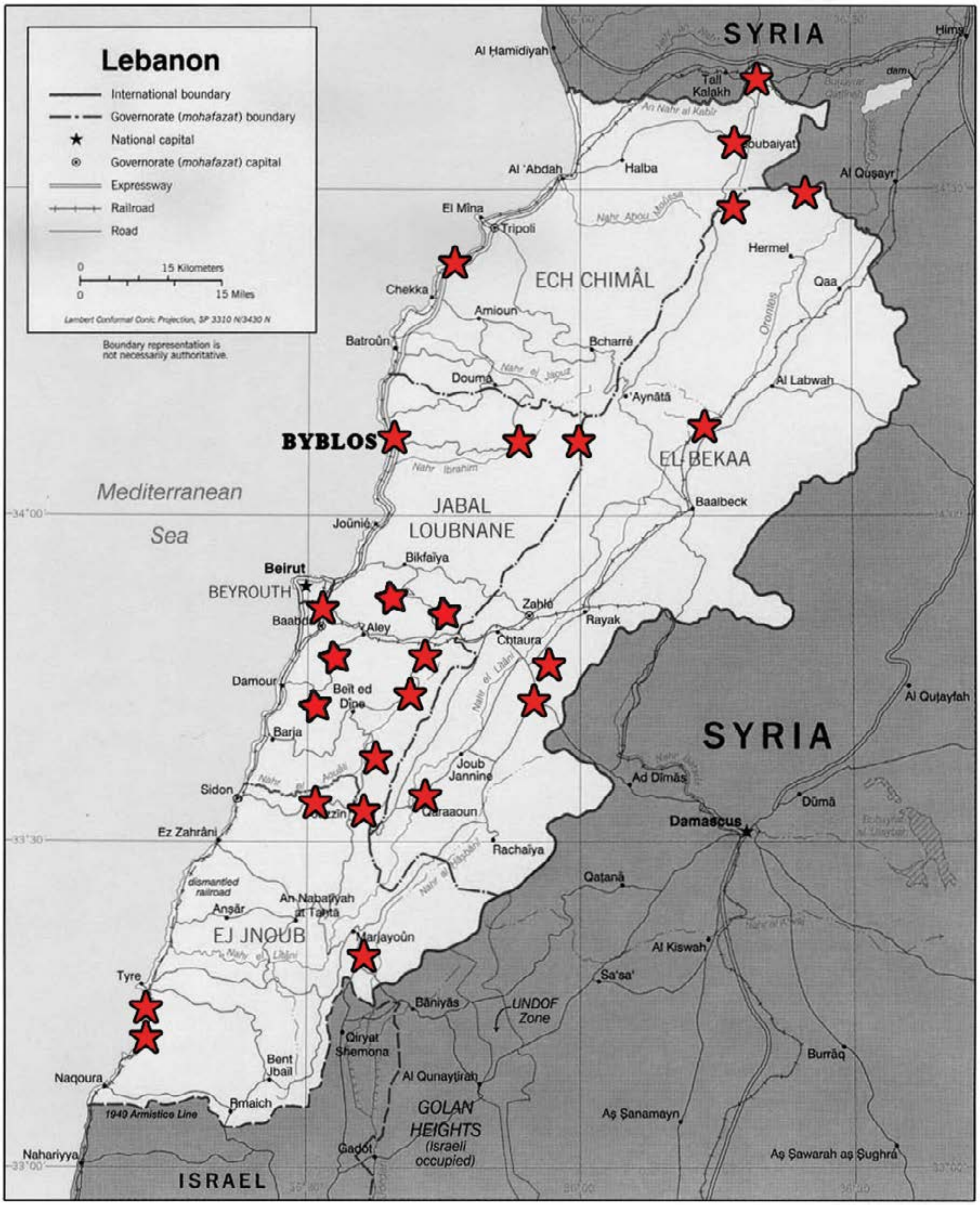
[1] Contested by surrounding municipalities on basis of land ownership

Annex 11: Nature Sites Under the Protection of the MoE

#	Decision/Decree No.	Date	Location	Caza/Governorate
1	Decision 15/1	1995	Faqra Natural Bridge	Keserwen / Keserwan Ftouh-Jbeil
2	Decision 151	1997	Kadisha Valley	Bcharre / North Lebanon
3	Decision 34	1997	Ibrahim River to sea outfall	Jbeil / Keserwan Ftouh-Jbeil
4	Decision 22	1998	Al Jawz River to sea outfall	Batroun / North Lebanon
5	Decision 29	1998	Al Damour River to sea outfall	Chouf / Mount Lebanon
6	Decision 97	1998	Al Kalb River to sea outfall	Keserwen / Keserwan Ftouh-Jbeil
7	Decision 130	1998	Beirut River to sea outfall	Matn, Baabda, Beirut/ Beirut and Mount Lebanon
8	Decision 131	1998	Al Awali River to sea outfall	Saida / South Lebanon
9	Decision 132	1998	Forests between Ain El Hour- Daraya- Debiyé- Bérjin; Sheikh Osman Forest; Deir al Mokhalis surrounding; Ain w Zein Hospital surrounding; Dalboun forest; Al Mal valley; Kafra wells; Ainbal valley sites	Chouf / Mount Lebanon
10	Decision 187	1998	Al Makmel Mountain	Bcharre / North Lebanon
11	Decision 188	1998	Arka River to sea outfall	Akkar
12	Decision 189	1998	Al Assi River to sea outfall	Hermel / Baalbek-Hermel
13	Decision 19	2002	Al Qammoua Area	Akkar
14	Decision 21	2002	Al Qaraqeer Valley	Zgharta / North Lebanon
15	Decision 22	2002	Dalhoun Forest	Chouf / Mount Lebanon
16	Decision 8	2004	Baatara Sinkhole	Batroun/ North Lebanon
17	Decree 7494	2012	Jabal Moussa	Keserwan / Keserwan Ftouh-Jbeil
18	Decree 11949	2014	Kassarat Grotto	Matn / Mount Lebanon
19	Decree 2878 amended by Decree 657	2016 amended in 2017	Ehmej	Jbeil / Keserwan Ftouh-Jbeil

Source: MoE/UNEP/GEF, 2016a; Department of Ecosystems - MoE, 2020

Annex 12: Hima Sites of Lebanon



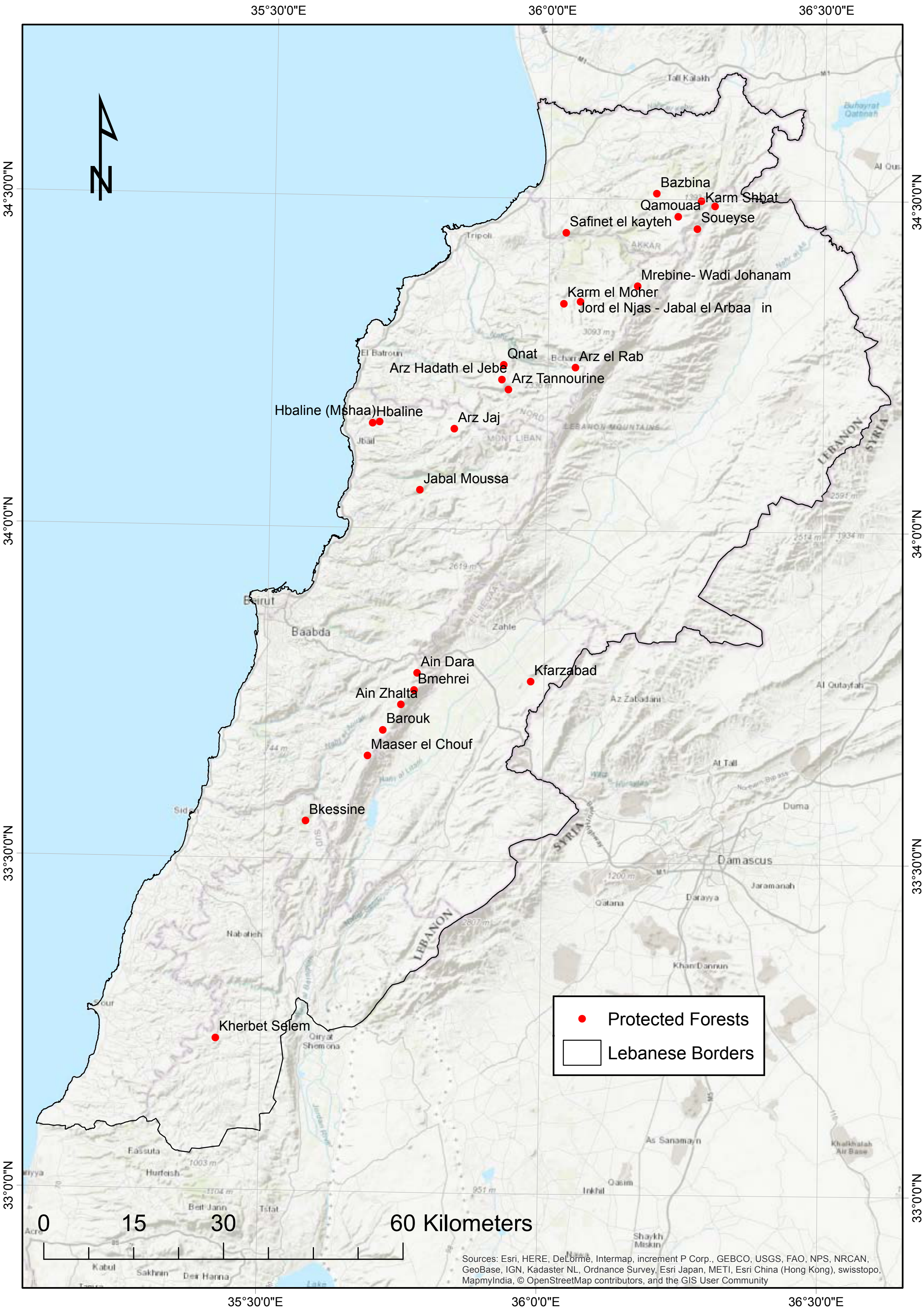
Stars denote the 25 established Himas listed from South to North: South Lebanon: Ebeles-Saqi, Qoleileh and Mansouri, Roum and Qaytouli. Bekaa: AinZebdeh & Kherebet Anafar, Qaroun & Aitanit in West Bekaa, Anjar and KfarZabad wetland in Central Bekaa, West Baalback, Charbein, Jdeidet El-Fakiha in North Bekaa. Mount Lebanon: Jbeil, Tarshish, Aakoura, Kayfoun, Kfar Matta, Ras Al Maten and Hammana. North Lebanon: Maabour Alabiad, Andket, Menjez, Anfeh. Source: SPNL,2019

Annex 13: List of Protected Forests by MoA

List and Distribution Map of Himas and Forests Protected by Ministerial Decisions Issued by the MoA

Decision	Date	Location (Caza)	Predominant Species				
			Cedar	Fir	Juniper	Oak	Other
127/1	1991	- Maaser El Chouf, Barouk, Ain Zhalta (Chouf) - Ain Dara (Aley)	X				
71/1	1992	Kfarzabid (Zahle)	Mixed forest and fruit trees				
152/1	1992	Hbaline (Jbeil)	Mixed forest and fruit trees				
21/1	1992	Kherbet Selem (Bint Jbeil)	Mixed forest and fruit trees				
499/1	14/10/96	- Arz El Rab (Bcharre) - Tannourine/Hadath El Jebbeh (Bcharre) - Jaj (Batroun)	X			X	
587/1	30/12/96	Soueyse (Hermel)	X	X	X		
588/1	30/12/96	Qamouaa (Akkar)	X	X	X		
589/1	30/12/96	Karm Shbat (Akkar)	X	X	X	X	
591/1	30/12/96	Bazbina (Akkar)	X	X	X	X	Pine
592/1	30/12/96	Qnat (Bcharre)	X	X	X	X	Pine
10/1	17/1/97	Safinet el kayteh (Akkar)	X			X	
11/1	17/1/97	Mrebine (Wadi Johannam, Minieh Danniyeh)	X	X	X		
8/1	17/1/97	Ain El Houkaylat/Karm El Mohr (Minieh Danniyeh)	X	X	X	X	
9/1	17/1/97	Jord El Njass/Jabal El Arbaiin (Minieh Danniyeh)	X		X		
174/1	25/3/97	Chbaa, Hbaline (Jbeil)				X	Pine
3/1	8/12/97	Bkessine (Jezzine)					Pine
399/1	18/9/08	Jabal Moussa (Keserwan)			X	X	Pine

Source: MoE/UNDP/ECODIT, 2011



:: REF: MoA - FAO - SALMA PROJECT 2021 ::

Distribution of the Protected Forests by the MoA
Source: Michel Bassil pers. com., Salim Roukoz – SALMA project 2021

Annex 14: IBA, IPA and KBA of Lebanon

#	Important Bird Areas (IBA)	Important Plant Areas (IPA)	Key Biodiversity Areas (KBA)
1	Upper Mountains of Akkar-Donnieh	Qammouaa-Dinnyeh- Jurd Hermel	Akkar-Danniyeh Mountains – Hermel Plateau
2	Horsh Ehden Nature Reserve	Bcharreh-Ehden	Bcharre-Ehden - Qadisha Valley
3	Palm Islands Nature Reserve	Palm Islands	Palm Islands
4	Hima Ebel es-Saqi	Ras Chekka	Ras Chekka
5	Tannourine Cedars Nature Reserve	Tannourine	Tannourine Hadath ej-Jebbe
6	Jabal Moussa Mountain	Wadi Jannah	Nahr Ibrahim Valley
7	Riim / Sannine Mountain	Sannine - Knaisseh	Mount Sannine and Mount Kneisse
8	A-Shouf Cedar Nature Reserve	Shouf	Mount Barouk
9	Aamiq Wetland	Aammiq	Ammiq
10	Semi Deserts of Ras Baalbek	Aarsal	Aarsal – Ras Baalbek Plateaux
11	Beirut River Valley		Nahr Beirut Valleys
12		Hermel Plain	Hermel Plain
13		Menjez	Menjez
14		Mount Makmel	Mount Makmel
15		Jbeil Coast	Jbeil Coast
16		Keserwan	Nahr El-Kalb Valley
17		Beirut – Jiyyeh Coast	Beirut-Jiyeh Coast
18		Nahr Ed-Damour	Nahr Ed-Damour Valleys
19		Rihane	Jabal Rihane
20		Tyre - Naqoura	Tyr-Naqqoura Coast
21		Mount Hermon	Mount Hermon
22	Bentael Nature Reserve		
23	Ramlieh Valley		
24	Lake Qaraoun		
25	Hima Anjar / Kfar Zabad		
26			Ehmej-Jaj
27			Mount Mneitre
28			Afqa Plateau
29			Nahr el-Awwali Valley
30			Sarada

Annex 15: National Strategies/Plans, Draft Laws and Projects Affecting Marine Ecosystems

National Strategies/Plans

Title	Year	Interest for Coastal and Marine Ecosystems	Legal Status
Lebanon National Agriculture Strategy 2020-2025/MoA	2020	The National Agriculture Strategy overall objective is to transform the Lebanese agri-food system in a more resilient, inclusive, competitive, and sustainable agri-food system. Fisheries related action includes: - Increase the total agricultural production capacity (crop, livestock, fisheries) and productivity. - Promote and organize cooperative work and farmers' groups and associations at the level of the value chains (targeting smallholder's producers including fishermen). - Promote sustainable use of natural resources (soil, pastures, forests and fisheries).	Issued and endorsed by the MoA
National Action Plan for the Conservation of the Coralligenous assemblages in Lebanon	2020	The proposed national action plan includes actions/ programs for: - Collection and regular updating of data. - Awareness-raising and education. - The protection and conservation of coralligenous assemblages.	Issued by RAC/SPA in close coordination with MoE
A Stranding Network for Sea Turtles and Cetaceans & A Protocol for Monitoring the Interaction between Marine Litter and Marine Turtles in Lebanon	2020	This report proposes a first national stranding network for sea turtles and cetaceans and a guidelines protocol for monitoring the interaction between marine litter and sea turtles in Lebanon.	Issued by RAC/SPA in close coordination with MoE
Lebanon's 6th National Report to the Convention on Biological Diversity	2019	Including a revision of the achievements regarding each NT (developed in the updated NBSAP) and their related actions in addition to recommendations and main challenges regarding the implementation of NBSAP.	Issued by MoE
Management Plan for the Jounieh proposed Marine Protected Area	2018	Management Plan for the proposed Marine Protected Area.	Proposal issued by MoE
National Monitoring Programme for Marine Biodiversity in Lebanon	2018	Includes two Ecological Objectives: - EO1. Biodiversity related to habitats and species: marine mammals, marine turtles and sea birds. - EO2. Non-Indigenous Species.	Issued by RAC/SPA in close coordination with MoE
Action Plan Concerning Species Introductions and invasive species in Lebanon	2018	The plan includes a data collection and update at national level, dissemination, capacity building for experts and awareness in addition to coordination at national, Mediterranean and international levels.	Issued by RAC/SPA in close coordination with MoE
National Oil Spill Contingency Plan in the Lebanese Waters/ MoEW	2017	The objectives of the NOSCP are in line with the International Maritime Organization (IMO) objectives for a NOSCP.	Issued by the Lebanese Petroleum Administration
Lebanon's National Biodiversity Strategy and Action Plan/ MoE (NBSAP)	2016	Lebanon has submitted the first NBSAP to the CBD in 1998. The updated NBSAP submitted in 2016 including: - Selection of 13 Priority Areas. - Setting of 18 National Targets (NT) with 91 National Actions to insure the implementation of the NTs. - Integration of the new CBD strategic goals. - Integration of the 2020 Aichi Biodiversity Targets.	Endorsed by the CoM on 4 April 2018 (Decision 62).

Title	Year	Interest for Coastal and Marine Ecosystems	Legal Status
Ministry of Agriculture Strategy 2019-2015/MoA	2014	The strategy sets three objectives, eight main courses of action including 30 components and 104 areas of intervention. Fisheries related actions include: - Improve the contribution of agriculture to the economic and social development of the country. - Support investment in the fisheries and aquaculture and improving sustainable management of the sector.	Issued and endorsed by the MoA
Lebanon's Marine Protected Area Strategy	2012	Strategy proposes new MPAs in addition to the two existing sites and sets the MPAs management strategy.	Issued and endorsed by the MoE
Tyre Coast Nature Reserve management plan 2009-2004	2004-2009	Management plan for Tyre Coast Nature Reserve.	Issued and endorsed by the MoE
Palm Islands Nature Reserve Management Plan 2005-2000	2000	Management plan for Palm Islands Nature Reserve.	Issued and endorsed by the MoE

Draft Laws

Draft Law/[1]	Content
ICZM draft law	-26 articles spread over 7 sections. - A clear definition of the CZ. - Articles stipulating the creation a National Council for ICZM. - 6 articles related to sanctions and penalties.
Draft Fishing Law	Prepared by the MoA taking into consideration the new challenges in fisheries management as well as the new scientific references and benchmarks for the sustainable management of marine resources.
Draft NOSCP Decree	Defines requirements for the readiness, response and management of oil spills in the Lebanese Waters.

[1] Draft laws related to the establishment of nature reserves or MPAs are presented in Annex 10.

Projects:

Project Name	Funding and Implementing Bodies	Implementation Period	Main Outputs
Assess current climate change and to find adaptation measures to fit the situation in the CZ and the marine environment in Lebanon	Activity executed by the MCR-IoE-UoB	2020-ongoing	- Assessment of Climate Change Impact on Lebanon Coastal Zone. - Identification of one marine biodiversity hotspot area (site specific adaptation analysis, comprehensive site-specific adaptation plans and prioritized actions). Awareness handbook.
Atlas for Marine and Coastal Birds of Lebanon	Activity executed by Dr. Ghassan Ramadan-Jaradi	2020	Currently under press, the Atlas, aims at raising people awareness about the threats facing these birds, and will inform the conservation experts in the country about the priority areas and keystone species that merit priority attention and protection (including 40 bird species of high concern recorded along the Lebanese shoreline and for a distance of 7 km offshore).
Conservation of Marine Turtles in the Mediterranean Sea	Funded by MAVA Foundation Implemented by SPA/RAC-UNEP/MAP	2019-2020	Conservation of the Marine Turtles in Lebanon. Results of the 2019 monitoring of the Marine Turtles along the Lebanese coast.
Marine Ecosystem Recovery through Artificial Reef	Funded by FAO Implemented by Friends of Nature	2018-ongoing	The Artificial Reef was deployed in Jounieh.
Enhancing socio-ecological climate change resilience of marine and coastal systems in Lebanon – CER Project	Funded by the Royal Norwegian Embassy in Beirut and implemented by IUCN ROWA through the IUCN Lebanon Project Office.	2018 – 2021 Ongoing project	This project aims to reduce the vulnerability of selected coastal towns in Lebanon, which are facing crucial sustainability issues, and improve Marine Protected Areas as Ecosystem-based Mitigation and Adaptation. Project's milestones are: - Milestone 1: Capitalize on effective measures and tools that have previously been tested and proven successful around the Mediterranean. - Milestone 2: Conduct vulnerability assessments and ecosystem mapping to protect and safeguard coastal communities. - Milestone 3: Empower stakeholders on marine management planning and change processes for effective and sustainable management of Marine ecosystems and livelihood security.
Promoting marine biodiversity and improving fishery potential and marine ecotourism activities through the deployment of ARs off the Lebanese coast-AR2020	Funded by FAO Implemented by MCR-IoE-UoB	2018-2021	Artificial Reef deployed in July 2020 in front of Berbara coast.
Deployment of an Artificial Reef around the island of Al-Zireh, Saida.	Friends of Al-Zireh Island Association in collaboration with the municipality of Saida	June 2018	Deployment of six old army tanks and four other military vehicles donated by the Lebanese Army around the island of Al-Zireh, Saida.

Project Name	Funding and Implementing Bodies	Implementation Period	Main Outputs
The implementation of a pilot case study on the Ecosystem Approach to Fisheries (EAF) in Lebanon	Funded by FAO Implemented by MCR-IoE-UoB	2016	- Baseline study for the PSSF. - PSSF Management Plan.
Market policy and legislative Development for mainstreaming sustainable management of marine and coastal ecosystems in Lebanon.	Funded by the GEF, Implemented by the MoE and UNEP and supported by IUCN ROWA as executing agency	2015-2020 Ongoing project	This project aims at creating an enabling integrated framework for sustainable management and conservation of coastal and marine biodiversity and at mainstreaming the priorities of this biodiversity into national plans, and coastal zone management plans, with particular focus on the impact of climate change on marine and coastal biodiversity.
Towards deep-sea conservation in Lebanon project	Funded by MAVA Foundation for Nature and lead by OCEANA in cooperation with IUCN and UNEP/MAP-SPA/RAC as executing partners; the Lebanese MoE as key member of the Steering Committee; and ACCOBAMS, GFCM and CNRS as Supportive Partners.	2015 - 2018	- Increase the surface of MPAs in Lebanon by providing national government and regional bodies with scientific evidence and information collected in the field via at-sea research. - Scientific expedition for data collection; Habitats and species identification; Mapping; Scientific report and pre-selection of MPAs; Communication strategy. - Contribute to reaching Aichi Target 11 by 2020 and strengthen the natural marine biodiversity corridor in the Eastern basin, supported by proper ecosystem-based management measures. - Preliminary management guidelines; Stakeholder workshops and meetings; Management plans; MPA designations follow-up and advocacy.
Evolution of the Lebanese Shoreline between 1962-2016	MCR-IoE-UoB	2015-2016	Maps of Evolution of the Lebanese Shoreline between 1962 and 2016. (National scale and Coastal Cazas scale).
Coastal and Marine Biodiversity Data Collection and Biodiversity Reporting	Activity executed by MCR-IoE-UoB	2015	A comprehensive database of published scientific papers and reports by universities, research centers, public institutions, international agencies and individual researchers (> 900 publications collected).
Sustainable Fisheries Management for Improved Livelihoods of the Coastal Fishing Community in Tyre, South Lebanon.	Funded by Drosos Foundation and implemented by IUCN ROWA and ADR.	2013-2017	Aimed at poverty reduction, sustainable fisheries management, better processing/marketing and supplementary income generation. Main outputs: - Simple and effective monitoring system covering 60% of the fishing activity. - A sustainable fisheries management plan. - An effective local governance system for the fisheries of Tyre. - Supported TCNR with equipment, tools and technical and institutional support.

Project Name	Funding and Implementing Bodies	Implementation Period	Main Outputs
			- Reduced blast fishing in tyre to 89%. - Created income generating activities to fishermen families and reduced fishing pressure. - Secured revolving fund for micro-credit for fishermen and their direct families.
Deployment of the first official AR in Lebanon in the Abdeh region (North Lebanon)	The Lions & Rotary Clubs, in coordination with the MoE, MOD, MoPWT and in partnership with the MCR-IoE-UoB	2012	AR constructed from 8 derelict tanks and vehicles donated by the Lebanese Army.
Environmental Resources Monitoring in Lebanon (ERML)	Implemented by MoE under the management of UNEP in collaboration with UNDP.	2011-2013	- Improved Understanding, Management and Monitoring in the Coastal Zone. - Analysis of the Institutional and Legal Frameworks Related to Management and Monitoring of Coastal and Marine Areas. - Analysis of the Current Land Use and Socio-Economic Activities in the Coastal Zone.
People for Ecosystem-based Governance in Assessing Sustainable development of Ocean and coast (PEGASO)	Funded by the EC through FP7 Implemented by a consortium of 26 Mediterranean and Black Sea institutions including MCR-IoE-UoB from Lebanon.	2010-2014	- Help finding good ICZM solutions at all levels (from local to transboundary). - Assess the readiness/preparedness of Mediterranean countries to implement the ICZM Protocol. - Assess the willingness/readiness to prepare a similar instrument for ICZM in the Black Sea. - Offer solutions for smoother implementation of the ICZM Protocol.
Supporting the conservation and management of important marine habitats and species in Lebanon"	MoE/IUCN	2010-2012	- Lebanon's Marine Protected Area Strategy/ MoE.
Regional Project for the Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of MPAs creation and management-MedMPAnet	Implemented in the framework of the UNEP/MAP-GEF Med-Partnership, with the financial support of EC, AECID and FFEM	2009-2015	- Ecological characterization of sites of interest for conservation in Lebanon (2015). - Synthesis report of the ecological characterization of the marine areas of Nakoura, Tyre and Saida in Lebanon (2015). - Synthesis report of the ecological characterization of the marine areas of Enfeh peninsula, Ras Chekaa and Raoucheh cave in Lebanon (2015).
Integrated Management of East Mediterranean Coastlines (IMAC)	Funded by the EC through SMAPIII. Implemented by MCR-IoE-UoB.	2006-2009	- Status Report for the coast of North Lebanon. - Stakeholder analysis of the main actors in ICM in Lebanon. - Report on "Conflicting Uses of Coastal Resources". - Economic Valuation of the CZ of the Mohafaza of North Lebanon.

Project Name	Funding and Implementing Bodies	Implementation Period	Main Outputs
			- Assessment of the Institutional and Legal Setting. - A strategic action plan for wise use of the coastal resources of the coast of North Lebanon. - Overall awareness raising about the importance of ICM.
Improving Coastal Land Degradation Monitoring in Lebanon and Syria (CoLD)	Funded by EC-Life program Implemented by CTM-ERS/RAC, UNEP/MAP, Priority Action Program/Regional Activity Center (PAP/RAC), Syrian General Organisation for Remote Sensing (GORS) and CNRS	2002-2004	- Production of thematic maps: an overall erosion risk map, a detailed erosion map and the design and implementation of a population GIS. - Assessment and monitoring of degradation causes. - Identification of priority areas. - Drawing up of a "Strategy and Recommendations document.
Coastal Area Management Program of the Mediterranean Action Plan (CAMP-Lebanon)	Implemented within the CAMP of the MAP of UNEP as one of its national projects.	2002-2003	- ICAM National Strategy. - Developing CZ management plans for the target municipalities. - Preparing the first ICAM Law for Lebanon.

6 Land Resources

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Abbreviations and Acronyms

AFDC	Association for Forest Development and Conservation
CDR	Council for Development and Reconstruction
CNRS	National Council for Scientific Research
CNTPL	Cooperative of Native Tree Producers of Lebanon
CoM	Council of Ministers
DAG	Directorate of Geographic Affairs
DGA	Directorate General of Antiquities
DUP	Detailed Urban Plan
ECP	Ecological Compensation Plan
EIA	Environmental Impact Assessment
FDI	Foreign Direct Investment
FLRM	Forest and Land Restoration Mechanism
GEF	Global Environmental Facility
GIS	Geographic Information System
GoL	Government of Lebanon
IUCN	International Union for Conservation of Nature
LDN	Land Degradation Neutrality
LRI	Lebanon Reforestation Initiative
MoA	Ministry of Agriculture
MoC	Ministry of Culture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoF	Ministry of Finance
MoI	Ministry of Industry
MoIM	Ministry of Interior and Municipalities
MoPH	Ministry of Public Health
MoPWT	Ministry of Public Works and Transport
MoT	Ministry of Tourism
MSW	Municipal Solid Waste
NARP	National Afforestation/Reforestation Program
NFP	National Forest Program
NGO	Non-Governmental Organizations
NCQ	National Council for Quarries
NPMPLT	National Physical Master Plan of the Lebanese Territory
NRP	National Reforestation Plan
OMSAR	Office of the Minister of State for Administrative Reform
SEA	Strategic Environmental Assessment
SALMA	Smart Adaptation of Forest Landscape in Mountain Areas
SLM	Sustainable Land Management
SLMQ	Sustainable Land Management in the Qaraoun Catchment Project
SOER	State of the Environment Report
SRLWR	Safeguarding and Restoring Lebanon’s Woodland Resources
UAS	Usable Agricultural Surface
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization

6. Land Resources

Lebanon's size and demography render its land a critical resource with high value (Box 6-1). Pressure on these resources threatens the biodiversity, topsoil, agricultural potential, freshwater, tourism sites, natural monuments and landscapes of the country. In their current state, urban sprawl, agricultural malpractices and quarrying are all contributing to depleting these resources, their impact aggravated by inadequate regulations and weak law enforcement. This chapter details how land resources are currently managed in Lebanon, and what are the actions necessary to improve the situation and adopt a more sustainable approach.

Box 6-1 What are Land Resources?
Land resources include all those features and processes of the land, which can, in some way, be used to fulfill certain human needs (Vink A.P.A., 1975). The FAO adopts the following definition: "The term 'land resources' encompasses the physical, biotic, environmental, infrastructural and socio-economic components of a natural land unit, including surface and near-surface freshwater resources important for management" (FAO, 2021).

6.1 Driving Forces

Driving forces affecting land resources are both natural and anthropogenic. However, the latter are clearly more pronounced and often exacerbate naturally occurring phenomena.

6.1.1 Population Growth

Lebanon's population density is high (about 669 persons/km^2 including displaced and refugees). An estimated 88% live in urban areas and more than half reside in Beirut and its suburbs, also known as the Greater Beirut Area (World Bank, 2020). The highest population density is observed within the coastal zone and the lower mountain areas (up to 500 m). Population density is much lower at higher elevations and in the Bekaa Valley (Figure 6-1).

Lebanon is no exception to the worldwide trend of continuous population migration from rural to urban areas as shown by the exponential growth of peri-urban areas around major cities, as well as between secondary cities and towns. A glaring example is Choueifat, near Beirut airport, where constructed areas significantly increased in the last decade, as can be seen in Figure 6-2.

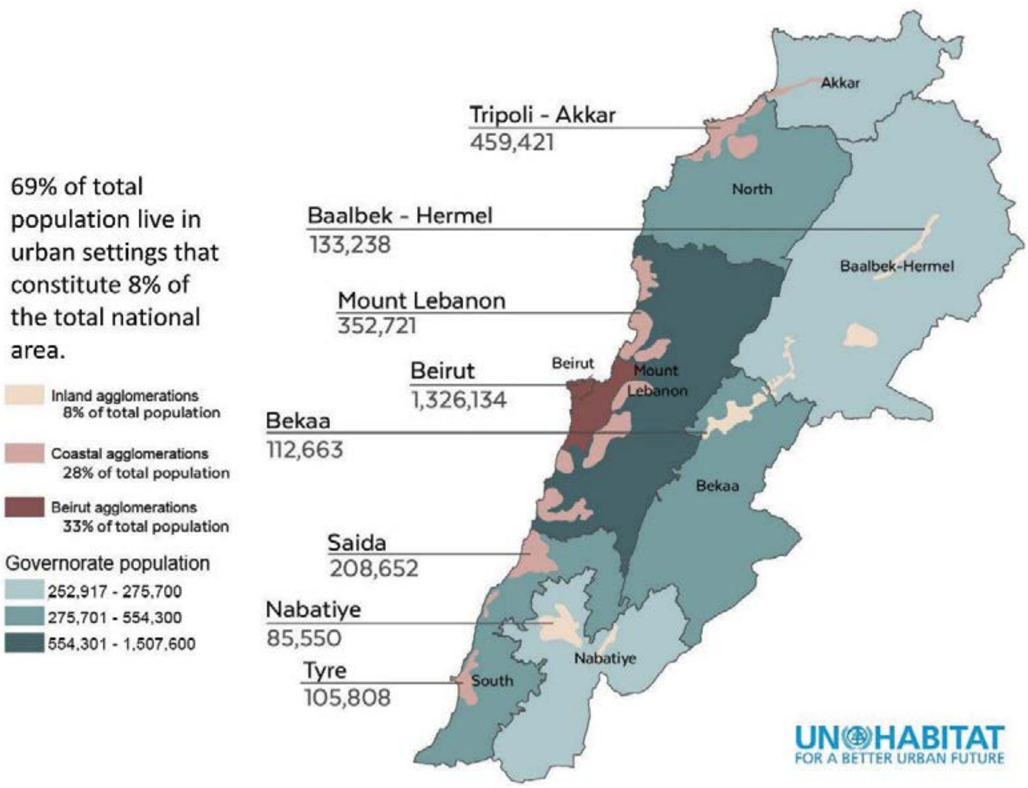


Figure 6-1 Main Urban Agglomerations in Lebanon
Source: UN HABITAT, 2020

Figure 6-2 Built Areas in Choueifat in 2009 and 2020
Source: Google Earth Imagery, 2009 - 2020

Lebanon has not conducted a national census since 1932 and all population estimates are based on surveys and extrapolations. With no recent official census and the influx of displaced in the last decade, population growth in the country has been difficult to estimate. According to the World Bank, Lebanon's resident population in 2018 was 4.8 million, excluding displaced, refugees and migrant workers, who amount to an additional 2 million, for a total resident population of 6.8 million. This is a significant 1.8 million increase compared to 2010, likely attributed to the influx of displaced from Syria and not to natural population growth (World Bank, 2020) (the impact of Syrian displaced is discussed in Chapter 7 - Haphazard Urbanization). The Worldometer anticipates a decline of population in Lebanon by 2040 due to migration (Worldometer, 2020).

6.1.2 Mismanaged Urban Expansion

While population growth is clearly increasing demand for housing, regulation and market dynamics are the main contributors to urban sprawl. After all, there would not be a construction drive if economic actors do not have sufficient funds and incentives to rent, buy or invest in real estate. Cities are consequently growing both vertically and horizontally, at least in the physical dimension. However, the lack of data cannot confirm if the buildings are actually occupied or not. Tall buildings are erected in vacant plots, often used as paid parking areas, or to replace old buildings that are torn down, sometimes illegally. Horizontal growth is occurring at the expense of agricultural fields (e.g. Al Bassatine in Tripoli – Figure 6-3), forested areas (e.g. Metn areas including Beit Mery, Broumana, Baabdat and Bharsaf), and other natural areas of unique environmental significance (e.g. Faytroun in Kesrouan and Fnaideq in Akkar). Such expansion usually occurs concentrically (additional construction on the periphery of existing settlements), in the form of ribbon constructions (concentration of buildings on road and highways sides), or in a leap-frog fashion (the development of a zone separated from pre-existing settlements typically occurring after parcellation of empty land and the connection to the road network). Urban growth is hampering traffic and exerting more stress on roads because of the ever-increasing use of automobiles for transportation. It also necessitates an expansion of public infrastructure, and thus expenditure, which the GoL has long struggled with.

Figure 6-3 Rate of Urban Expansion in Al Bassatine, Tripoli
Source: Google Earth Imagery (2003, 2010 and 2019)

The real estate sector saw record growth in the 2000s with large transactions made for both land purchase and construction. Expats and wealthy citizens from the Gulf represented most of the investors and clients (Azar, 2020). This trend carried on even while the world was facing the Great Recession until the economic slowdown caught up in 2011, with oversupply leading the sector to a standstill. The number of construction permits granted is a good indicator, with about 6 million m2 in 2019 compared to more than 16 million in 2011 (Banque du Liban and Order of Engineers and Architects, retrieved in 2020) (Figure 6-4) *(refer to Chapter 7 - Haphazard Urbanization for analysis of the construction sector and property demand).*

In 2017, Lebanon's road network totaled 21,705 km including international, primary and secondary roads (World Bank, 2017). With an average of 2.077 m of road per m^2 and 4.125 m per inhabitant, this puts it ahead of most countries in the region (Table 6-1). However, two important factors should be noted: the high population density and the primarily mountainous relief that induces the construction of curvy roads and subsequently increases their total length. Thus, the physical impact of roads is clearly more pronounced than on flat plains or plateaus.

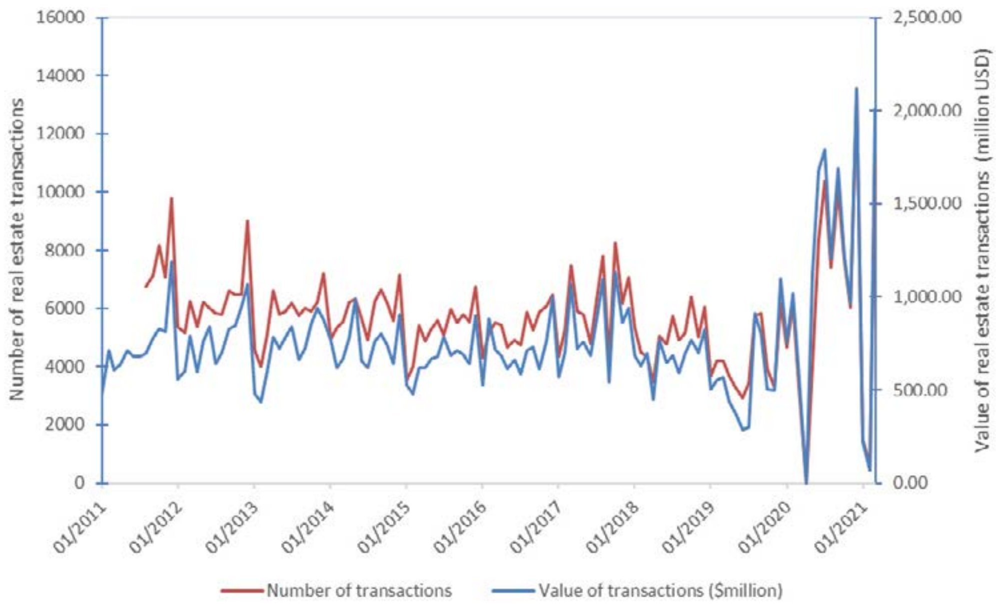


Figure 6-4 Number and Value of Real Estate Transactions
Source: GDLRC/CAS, 2011-2020

Table 6-1 Comparison of Road Networks in Selected Arab Countries.

Country	Total Land Area (km^2)	Population	Total Length of Roads (km)	Average Road Length (m) per Area (m^2)	Average Road Length (m) per Inhabitant
Bahrain	760	1,526,929	4,122	5.424	2.7
Egypt	995,450	106,437,241	65,050	0.065	0.611
Iraq	437,367	39,650,145	59,623	0.136	1.504
Jordan	88,802	10,909,567	7,203	0.081	0.66
Kuwait	17,818	3,032,065	5,749	0.323	1.896
Lebanon	10,452	5,261,372	21,705	2.077	4.125
Qatar	11,586	2,479,995	7,039	0.608	2.838
Saudi Arabia	2,149,690	34,783,757	221,372	0.103	6.364
Syria	185,887	20,384,316	69,873	0.376	3.428
UAE	83,600	9,856,612	4,080	0.049	0.414

Source: CIA World Factbook, 2020

The construction of new roads and highways in mountain areas and over Lebanon's mountain ridges exerts pressure that causes irreversible damage to landscapes, vegetation cover, ecosystems and habitats. Despite the extremely rugged topography, no tunnel project was launched, with new roads built exclusively on surface level. Roads are the starting point of new development (See impact of access roads in Saqi Rechmaya in Figure 6-5), which means controlling their spread would effectively control a non-negligible portion of urban sprawl. Hence the need to ensure that environmental impact assessment (EIA) studies are conducted before implementation of such projects (as required by Decree 8633/2012) to identify potential environmental impacts and propose alternatives or mitigation measures.

pollution and soil infiltration of contaminants. Abandoned quarries also contribute to surface runoff, reduced natural aquifers recharge and accelerated seawater intrusion (el Moujabber et al, 2006) (refer to Section 6.2.4.2). Untreated industrial waste is also a common source of soil pollution. Phosphate fertilizer industries discard elements into the environment without any treatment, contaminating plants, soil and groundwater (Kassir et al., 2012). Many industrial sites are located near residential areas, sometimes merging with them (MoI, 2018). Industries located outside of designated industrial zones are also common *(more details can be found in Chapter 10 – Chemical Management).*

Figure 6-5 Impact of New Access Roads in Saqi Rechmaya Mountain Area
Source: Google Earth Imagery, 2010 and 2019

6.1.3 Agricultural and Industrial Activities

Pollution from agricultural practices, including from heavy and uncontrolled use of fertilizers, negatively affects soil productivity in the long term. Use of fertilizers and pesticides in Lebanon is considered excessive compared to other countries, with an average application of 331 kg/ha for the former and 7 kg/ha for the latter (FAO, 2020). On the coast, increased soil salinity is an additional concern (Table 6-2).

Quarrying and mineral extraction exert remarkable pressure on land. The industry is mainly driven by the real estate sector and operates at the limits of legality, paving the way for topsoil removal, increased air

There is a large number of petrol stations spread across the country, estimated at 3,000 in 2018, with numerous cases of improper use, storage and disposal of hydrocarbons. Improper fluid transfers from one container to another, leaking containers and poor infrastructure such as drainage and pipes all lead to contamination of nearby lands and water resources (Raad et al, 2012). Common traits of these activities are insufficient monitoring and ubiquitous business and political interests. According to the Syndicate of Gas Station Owners, about half of all the petrol stations in Lebanon operate without a license (Alieh, 2018).

Table 6-2 Evolution of Salinity in a Semi-Arid Lebanese Region between 1997 and 2000

Level of Salinity dS/m	Normal <2		Very Slightly Saline 2-4		Slightly Saline		Saline 8-16	
Year of observation	1997	2000	1997	2000	1997	2000	1997	2000
Proportion %	35.3	15.9	23.5	30.1	31.4	39.3	9.8	14.7

Source: El Khatib et al., 1998; Darwish et al., 2005

6.2 Current Situation

6.2.1 Geomorphological Regions

Lebanon's geomorphology has influenced the history and evolution of towns and villages. The country is predominantly mountainous, characterized by a rugged terrain, high mountain peaks and two mountain ranges that trend north-south, separated by a fertile valley (See schematic cross-section in Figure 6-6).

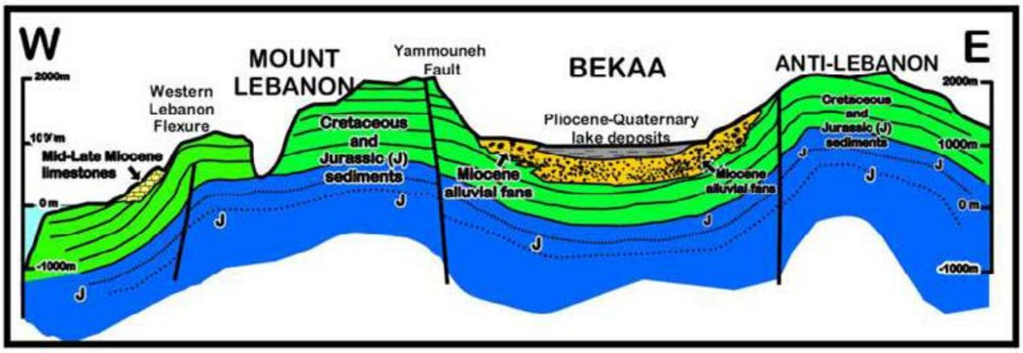


Figure 6-6 Schematic east-west cross section across Northern Lebanon. Source: Walley (1998)

Lebanon is comprised of five distinct geomorphological regions:

- **The Coastal Zone** includes the shoreline and continental shelf, the coastal plain and the foothills of Mount Lebanon rising to 250 meters. It represents 13% of the country's territory. The Lebanese coastline extends about 230 kilometers in length from the northwest border at Aarida to the southwest border at Naqoura. The entire coast is at risk of degradation from naturally occurring events and destructive human activities (Box 6-2).
- **The Mount Lebanon Range** (or chain) includes middle- and high-elevation zones, rising from Akkar in the north and extending south to the hills of Jabal Amel, with the highest peak of Qornet el-Sawda (3,087 meters). It represents 47% of the Lebanese territory and is densely populated on the western side. The mountain range is a vital source of freshwater. Pressure on the mountains directly affects groundwater quality and recharge capacity.
- **The Bekaa Valley** is a fertile land corridor separating the Mount Lebanon and Anti-Lebanon ranges, drained to the north by the Aassi River and to the south by the Litani River. It represents 14% of the Lebanese territory. Most of the agricultural fields are located in this alluvial plain. The Litani River runs through it from north to south. Since the influx of displaced Syrians, the valley saw a surge in informal tented settlements.
- The Anti-Lebanon Range extends across the Lebanese-Syrian border along the eastern part of the country and includes, at its southern terminus, Jabal el Cheikh or Mt. Hermon (2,814 meters), which distributes rainfall and snowmelt into at least three main watersheds across Lebanon, Syria and Palestine. The range represents 19% of the country's territory, such that its natural ecosystems have low biodiversity value and human presence is scarce due to its relatively arid climate. This is due to the rain shadow effect from the Mount Lebanon range, blocking the humid marine winds from reaching the eastern parts of the country and limiting precipitation.
- **South Lebanon** is an elevated plateau that extends a short distance inland from the western shores of South Lebanon to the Mount Hermon foothills in the east. Seasonal streams flowing from east to west into the Mediterranean Sea intersect this region; it represents 7% of the territory. Agricultural fields and human settlements are evenly distributed throughout the region.

Box 6-2 Challenges in Coastal Areas

Due to strong winter storms, the seashore in Lebanon is subject to massive local erosion. This erosion has increased due to sand dredging during the war period (1975-1990) and especially after construction of Egypt's Aswan Dam in the 1970s, which disrupted sediment-load in the Mediterranean, trapping a large amount of sediments behind the dam, thus reducing the volume deposited in the Nile Delta. Dune ecosystems have nearly disappeared, except in the south of Tyre.

Coastal zones, whether natural or agricultural, are permanently exposed to pressure from urban sprawl. Lands located along the seashore are highly prized for their touristic value and hence for the output they can generate through typical real estate operations or tourist and seaside resorts. This pressure also encourages reclamation activities, marina projects for leisure and other maritime public domain violations *(refer to Chapter 7 – Haphazard Urbanization).*

6.2.2 Geology and Soils

Most of Lebanon's geology is formed of sedimentary rocks, mainly Jurassic, Cretaceous and Tertiary karstic limestone with some Cretaceous and Quaternary sandstone and conglomerate. Some volcanic (basalt) rocks may be found and the Akkar and Bekaa Valley strata are more recent. More than two-thirds of the Lebanese territory consist of carbonated rock formations, which make up most of the mountain ranges, rendering them vulnerable to groundwater pollution and natural risks, such as landslides and earthquakes (CAS, 2010). Limestone rocks often take the shape of karst (Figure 6-7; see Map 1 in Annex 1). The country is located in an active tectonic area with complex fault systems characterized by three major faults (Yammouneh, Roum and Serghaya) and bisected by minor faults (MoE/UNDP/ECODIT, 2011).

Such faults are a source of concern for built-up areas. The map showing the location of earthquakes recorded in between 2001 and 2019 is presented in Annex 1 (Map 2). Since 2010, Lebanon experienced 57 earthquakes that were often felt and with a magnitude equal to or above 3.5 on Richter's Scale. The Tyre – Nabatieh region has particularly been active with a clear concentration of seismic activity. The most active years were 2008 and 2014 with respectively 27 and 13 recorded earthquakes (CNRS, 2020), with the strongest recorded in 2012 (5.5 on Richter's scale).

The Lebanese Building Code (Law 646/2004, subsequent Decree 15874/2005 and amendment Decree 617/2007) includes seismic design standards. However, enforcement is almost nonexistent, especially outside major cities and during periods of political instability and increased security risks. In addition, construction is still legally allowed in many high-risk areas.

Figure 6-7 Surface Karst in Faqra (Kesrouane)
Source: Yazigi Atelier, 2014

Lebanon has a long history of interest in the geological substrata for eventual hydrocarbon discoveries (LOGI, 2021, Figure 6-8).

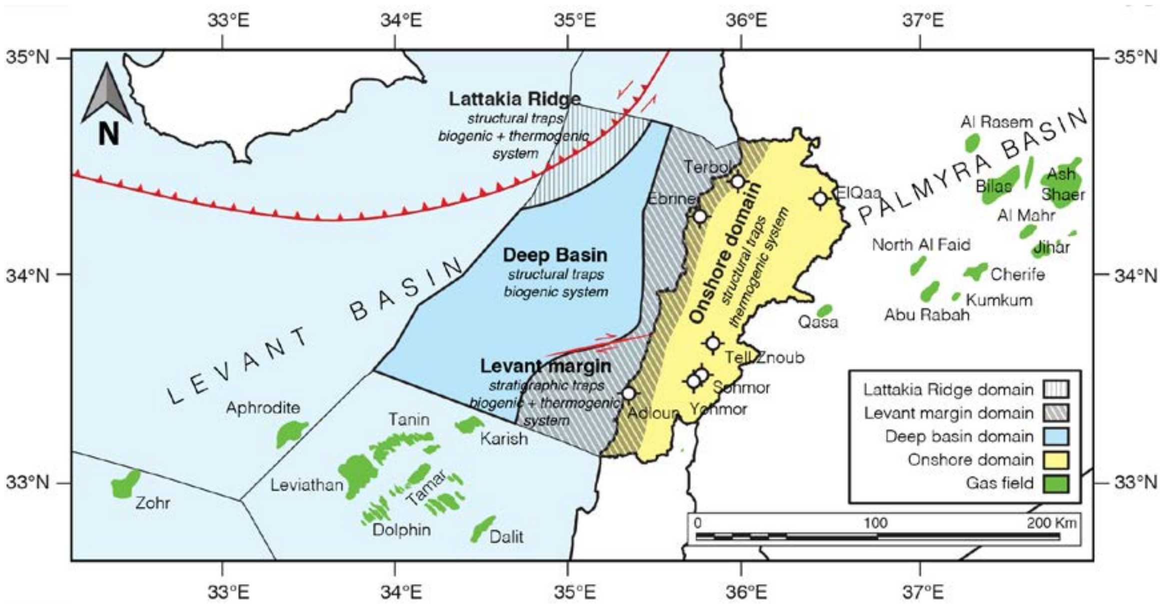


Figure 6-8 The Geological Domains of Lebanon and the Nearby Hydrocarbon Discoveries
Source: Ghalayini, R., et al, 2018

This interest was renewed especially after discoveries of deposits in the eastern Mediterranean basin by Egypt and Syria (Ghalayini, R., et al, 2018, Figure 6-9) and have led to disputes over maritime territory borders.

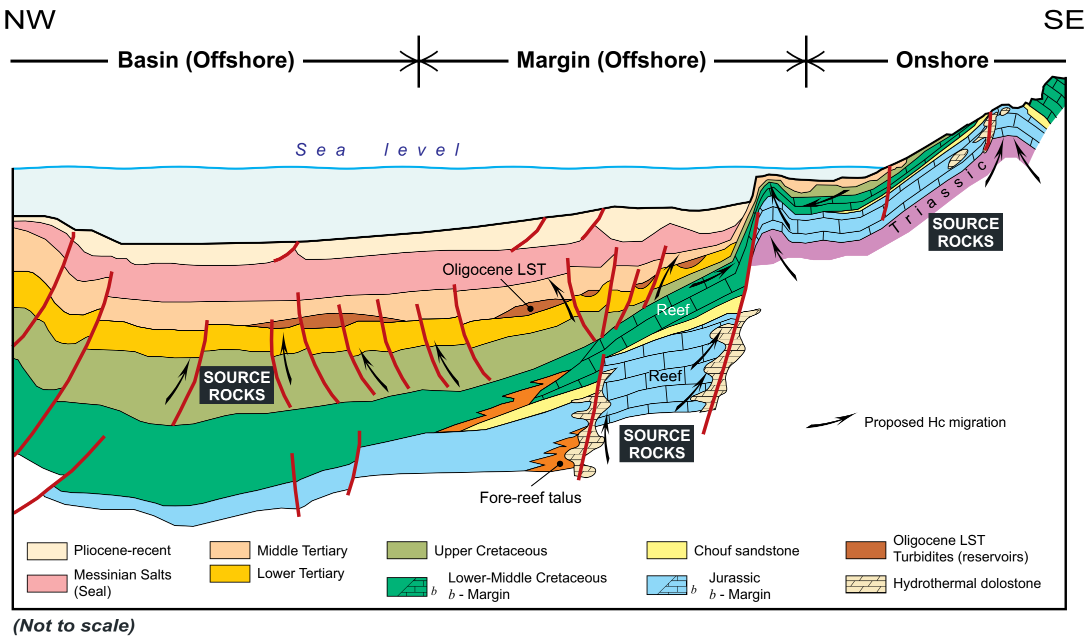


Figure 6-9 Schematic Petroleum System Model for Lebanon, with Possible Plays Offshore, in the Continental Margin and Onshore
Source: Nader, 2011

As for soils, the reference of choice for the subject remains The Soil Map of Lebanon: a booklet published by the Lebanese National Council for Scientific Research (CNRS) in 2006 and divided into 27 sheets containing detailed information on soils of Lebanon, their location and morphology (scale 1:50,000). According to this reference, the most widely occurring soils are the calcareous Terra-Rossa and Rendzinas, located in agricultural plains. Other soil types include sandstone, basalts and similar older volcanic materials. Generally, soils in Lebanon are young and characterized by fragility, poor consistency and shallowness, especially on sloping terrains (MoE/UNDP/ECODIT, 2011). Although natural factors such as wind, rain, and landslides affect soil fertility and may result in soil erosion and even degradation, human activities accelerate it. The main factors that influence this phenomenon are the erodibility of the soil (texture, composition), topography (slope orientation), climate (temperature, frequency of precipitation), surface cover and land use. For example, vegetation cover limits erosion by reducing runoff, slowing down water flow and increasing infiltration. Erosion results in loss of soil productivity and integrity, and the deterioration of water quality. The main anthropogenic causes of erosion remain excavation works, quarrying, poor agricultural practices and deforestation (example in Figure 6-10) (Darwish, 2012). Internal migration has also contributed to this phenomenon, as it leads to abandonment of agricultural terraces, such that the lack of maintenance reduces soil integrity and water retention capacity (Hani, Pagliani and Regato, 2019), and thus productivity.

Figure 6-10 Excavation for Construction Leading to Loss of Topsoil and Erosion in Hrajel, Keserwan
Source: Yazigi Atelier, 2014

6.2.3 Land Cover and Land Use

In 2017, the National Center for Remote Sensing affiliated with the Lebanese CNRS produced the most recent Land Use and Cover (LUC) map for the country (Box 6-3).

Box 6-3 What is Land Cover?
According to FAO, 'Land Cover' is "the physical characteristics of the land, such as grassland or forest" (FAO, 2015). The Coordination of Information on the Environment (CORINE) land cover classification, used by the European Environment Agency and the European Union's Copernicus Land Monitoring Service, has 5 main ("Level 1") land cover categories: artificial surfaces (including urban fabric, industrial and artificial vegetated areas), agricultural areas, forests and semi-natural areas, wetlands, and water bodies. Each category has its own subcategories ("Level 2"), with a total of 15 classes (Kosztra, B., et al., 2017-2019).

A comparison of land cover distribution in 1998, 2005 and 2013 in Lebanon can be found in Figure 6-11. The graph shows that, from 2005 to 2013, agricultural areas slightly increased, while forested land slightly decreased. The most significant changes were the increase of natural terrain with little or no vegetation and the decrease in herbaceous vegetation areas. Detailed spatial distribution maps can be found in Annex 1 (Maps 3 and 4).

6.2.3.1 Forest and Other Wooded Land Resources

Combined, forests and other wooded land (OWL, see definitions in Box 6-4) cover 23% of the country (FAO, 2015).

Box 6-4 Definition of Forests and OWL
"A forest is a land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agriculture or urban use". Areas under reforestation that have not yet reached but are expected to reach a canopy cover of 10% and tree height of 5 m are included, as are temporarily unstocked areas, resulting from human intervention or natural causes, which are expected to regenerate. This definition excludes tree stands in agricultural production systems as well as trees in urban parks and gardens.

OWL is considered as land not classified as "Forest", spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy cover of 5-10%, or trees able to reach these thresholds in situ; or with a combined cover of shrubs, bushes and trees above 10%. It does not include land that is predominantly under agricultural or urban land use."

Source: FAO 2005, 2010

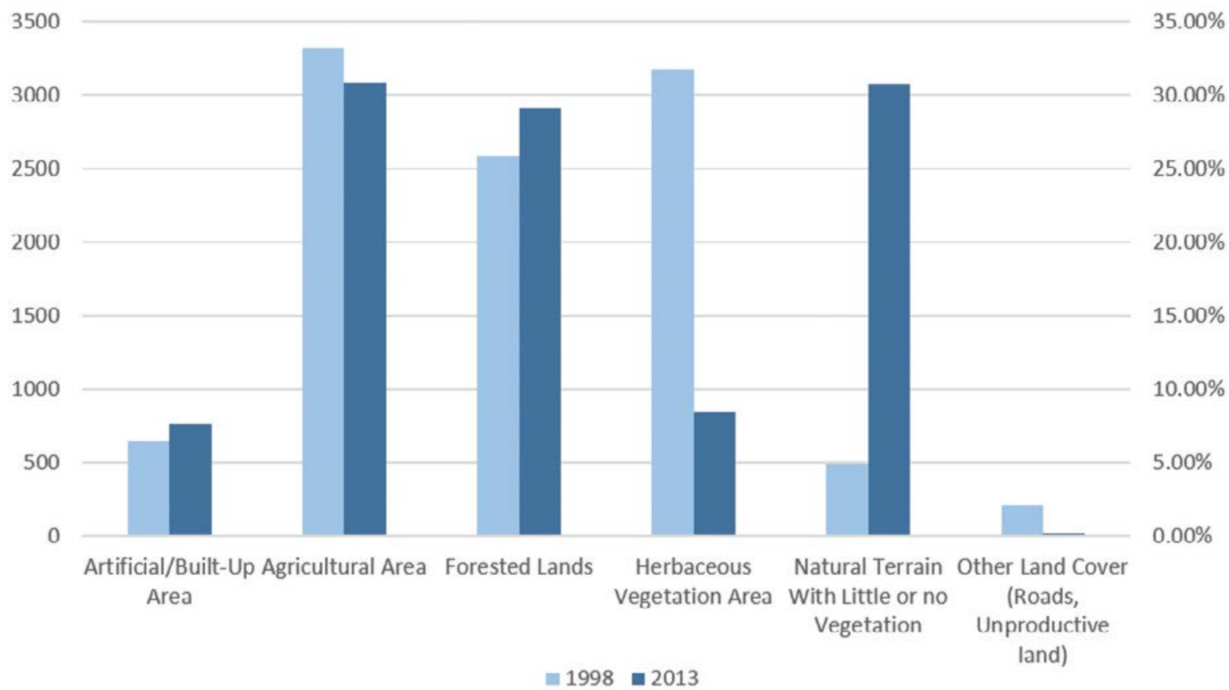


Figure 6-11 Comparison of Land Cover Distribution in 1998 and 2013
Note: Inaccuracies may be present due to differences in land cover classification, data collection, or analysis method between years.
Source: CNRS, 2011-2017

Table 6-3 shows the extent of forests and OWL for years 2000, 2005, 2007, 2010 and 2015. Based on this data, there has been remarkably little change in forest and OWL cover in the last decade, despite widespread and recurring forest fires *(refer to Chapter 5 - Ecosystems)*, as well as extensive logging and construction throughout the country. These may have been offset by intensive reforestation efforts during the same period.

Table 6-3 Evolution of Forests and Other Wooded Lands in Lebanon, 2000-2015

Item	Total Area (km^2)				
Year	2000	2005	2007	2010	2015
Forest	131	136	139	137	137.3
Other Wooded Land	117	106	108	106	106

Source: For 2000, 2005 and 2007: AFDC, 2007; For 2010: FAO, 2010; For 2015: AFDC, 2019

However, data assembled by the CNRS show a total net loss of 38.9 km^2 (comprising all types of forests and OWL) between 2013 and 2017. The same data indicates 4.8 km^2 and 3.2 km^2 of new burnt woodland areas and urban sprawl on forests, respectively (Faour & Abdallah, 2013; Faour & Abdallah, 2018). Forest fires occur mainly between July and October, with the summer peak temperatures and droughts, and are influenced by changing land uses such as the loss of green cover. In October 2019, Lebanon lost 1,214 ha (12.4 km^2) of forest land to the largest fires the country had seen in decades. The Lebanon Reforestation Initiative (LRI) is currently developing a forest cover map using the more recent data for the period 2016-2018, with expected completion in September 2021 *(refer to Chapter 5 – Ecosystems)*.

6.2.3.2 Urban and Built-up Areas

The Lebanese urban planning system has so far not encouraged sustainable development as it has not adequately addressed environmental and social equity issues. In Lebanon, master plans are generally developed at two levels. General master plans lay out the main development principles of the specified zone while detailed master plans go into details such as land use, road network and building ratios (Law 69/1983). While the law stipulates master plans must take into consideration all stakeholders while maintaining a balanced development, including social and environmental aspects, there are no specific legal targets or obligations (Basbous et al., 2018). Nevertheless, Decree 8213/2012, requires conducting a Strategic Environmental Assessment (SEA) for any plan, including an urban master plan, to take environmental issues into account during the preparation phase. Since its adoption, SEA has been applied sporadically and no evaluation has been conducted to estimate its impact on the planning and implementation processes.

The concept of sustainability has increased in popularity and genuine efforts to include it in plans have been observed in recent years. However, most of these initiatives were hampered by obsolete legislation (CDR, 2016). Moreover, even though municipalities have a say in the elaboration of the plan, 1-month timeframe given to object is not sufficient for proper representation of the public's interest. In addition, many municipal councils are not elected by their residents, and thus do not represent them or their interests. Finally, master plans easily become a tool for political or private interests that stand to gain from specific layouts or land use coefficients (Basbous et al., 2018).

In 2018, only 14.4% of the Lebanese territory had a comprehensive master plan developed and issued by decree. Those areas mostly correspond to the main urban agglomerations and their surroundings. Around 4.3% were partially planned while the remaining 81% were unplanned (Legal Agenda, 2018, see Map 5 in Annex 1). While plans are being developed, the Higher Council for Urban Planning (HCUP) issues decisions that allow construction supposedly for up to 3 years until a decree from the Council of Ministers (CoM) ratifies them. In practice, the law is not applied as decrees are not issued within the legal time limit. Despite the decision being invalidated by the 3-year deadline, constructions still go on due to lack of law enforcement. In addition to the adopted master plans, those originating from decisions but not yet ratified by decree cover around 32% of the country's territory (Osman and Antoun, 2017).

Some challenges arise from the consequences of current land governance. Forest lands are often lost to residential projects, even though they fall under regulations specifically meant to limit damage from construction. This occurs when parcels are fragmented between inheritors, dividing the original area into different smaller plots. The newly formed parcels become legitimate for construction given their dimensions, although they had been protected before the fragmentation (AFDC, 2007). Similarly, agricultural parcels can be merged, allowing the construction of large structures. *See analysis of the impact of the lack of urban master plans in Chapter 7 - Haphazard Urbanization.*

The real estate market is, ultimately, what drives new constructions. Demand for property grew exponentially between 2006 and 2014 and Lebanon witnessed record investments in its real estate sector from nationals, expatriates and foreigners. Since then, the economic crisis that unfolded exacerbated the flaws of the real estate sector. Foreign direct investments (FDI) plunged following the Syrian crisis and political tensions. Despite that, real estate still represented 16% of foreign projects, many of which were directed at the reconstruction efforts in Syria and 70% of the FDI in 2018 (IDAL, 2019). Syrians and Saudis remained by far the top investors in real estate with 13% of acquisitions attributed to each. Almost all these transactions occurred either in Beirut (45%) or in Mount Lebanon (47%) (IDAL 2018).

Foreign ownership in Lebanon is regulated by Decree 11614/1969 and its subsequent amendments, most notably Law 296/2001. This law eased the legal limits on foreign ownership of real estate properties in Lebanon and was another important factor behind the Arab capital inflow towards this sector. Statistics on the size and distribution of property and land ownership by foreigners in Lebanon is sketchy. In 2017, at least 80,307 foreign entities (individuals or companies) held no less than 37,686,937 m2 of land property or about 0.362% of the Lebanese territory (Directorate General of Land Registration & Cadaster, 2017).

6.2.3.3 Agricultural Areas

The main agricultural plains in Lebanon are located in Akkar, Bekaa, Hasbaya, Koura, Rachaya, Saida and Tyre. Sources differ as to the exact surface area they cover all over the territory as data collection mapping services might follow different standards and/or classification systems. The 2017 land cover map of the CNRS indicates 3,084 km^2 while the FAO counts 2,580 km^2 of cultivated areas divided between 1,320 km^2 of arable land and 1,260 km^2 of permanent cropland (FAO, 2017). The latter is close to the 1,285 km^2 of permanent cropland estimated by the World Bank (World Bank, 2016). The Copernicus Global Land Cover program shows 1,617.1 km^2 of cropland (Buchhorn et al, 2020).

The agricultural sector represented $1.8 billion and employed around 63,000 workers in 2018, with the top crops being potatoes, tomatoes and cucumbers (IDAL, 2018).

A major obstacle for sustainable agricultural practices remains linked to land tenure. The majority of farmers work on very small parcels: 75% of them operate on less than 1 ha of useful agricultural surface (UAS) and 95% on less than 4 ha, making it difficult to implement comprehensive and unified soil management for a given geographic zone (Darwish, 2015). The shape of the parcel can also be problematic, such as with elongated plots of land, discouraging farmers from cultivating it. Moreover, the proportion of farm operators above 65 years old (23%) surpasses that of younger ones (13% are less than 35 years old and 2% less than 25 years old). In addition, most operators have a low level of education, with 16% being illiterate and 61% not completing the primary level (Table 6-4).

Improving the work of agricultural cooperatives and encouraging the merging of small agricultural parcels could be a solution to these problems. But such

Table 6-4 Distribution of Operators and UAS by Land Area and Operator Age and Education

Description		Percentage of Operators	Percentage of Total UAS
Surface of Agricultural Land	<1ha	75%	20%
	<4ha	95%	51%
	>10ha	2%	30%
Age of Operators	>65	23%	24%
	>35 to <65	54%	64%
	<35	13%	12%
	<25	2%	1%
Education Level	Illiterate	16%	16%
	Primary	61%	60%

Source: Darwish, 2015

actions should be taken with caution, as it could entice construction on merged parcels as they become larger and easier to build on.

6.2.4 Degraded Land

6.2.4.1 Land Degradation and Desertification

Land degradation refers to the general loss of productivity of a given ecosystem, a phenomenon that is accelerating in Lebanon. Factors range from natural such as poor drainage, weak lithology and torrential rainfall to human-induced forest fires, urban sprawl and inappropriate irrigation practices (Francis, 2012). Desertification corresponds to land degradation resulting in arid soils and landscapes (WHO, 2020). The Integration of Lebanon's Land Degradation Targets Within the National Action Program to Combat Desertification published in 2019 classifies 39% of the territory as being very exposed to land degradation (less than or equal to 90 Kg C/m^2). The study estimates that, between 2000 and 2010, the country lost an estimated 2,257 ha of cropland, 1,783 ha of forests and 1,201 ha of grassland. In addition, signs of productivity decline were observed in 13,855 ha of cropland, 5,896 ha of forests and 2,909 ha of grassland. These numbers remain clearly inferior to the amount of land with increased productivity (42,864 ha of cropland, 40,986 ha of forest and 21,461 ha of grassland), but they can, however, be misleading, especially in the case of agricultural areas. This is because land productivity measurements are based on nitrogen concentration in the soils, and so, results can be distorted by excess use of fertilizers. In the case of grasslands, the increase of productivity could be the result of reduced grazing, which could lead to a loss of quality of the rangelands. Constant monitoring of the different areas is necessary to determine the outcome of the variations in land productivity.

The risks associated with land degradation include increased probability of landslides, floods, droughts and a reduced agricultural output. If land degradation reaches desertification, additional health hazards are to be expected from the resulting lack of water. This can lead to a rise of food or water-borne diseases and increase in respiratory diseases from dust and pollution (World Health Organization, 2020).

6.2.4.2 Quarries

Lebanon's quarrying sector is poorly organized, demonstrated by the fact that no official data exists, including an exact number of active quarries. A 2008 study counted 1,278 quarries covering 5,267 ha scattered all over the country (Darwish et al., 2010). Other databases suggest a number closer to 760 quarries while some unofficial studies estimate it as high as 1,800 or even 2,400 (MoE/GEF/UNDP, 2019). These quarries scar the Lebanese landscape, and the vast majority remain unlicensed. Many are abandoned without rehabilitating the damaged area (CNRS-L/AFDC/IUCN/Holcim, 2014).

According to a survey by Atallah (2018), about 56 km^2 of land were exploited for quarrying in 2018, mostly outside of the areas considered suited for such activities as per the 2009 National Physical Master Plan of the Lebanese territory (NPMPLT) (see Map 6 in Annex 1). The Rapid Cost of Environmental Degradation conducted by MoE and the United Nations Development Programme (UNDP) referred to 1,330 active and passive quarrying sites covering 52.6 km^2 (MoE/UNDP, 2019).

The environmental impact related to the operation of quarries can be seen from three perspectives: resource use, ecosystem damage and human toxicity. Minerals are a non-renewable resource available in finite amounts. Quarrying, therefore, irreversibly impacts land resources, as well as ecology, natural landscapes (Figure 6-12) and groundwater resources. Quarries are also a source of pollution for residents living in their vicinity. The large amount of dust particles exposes nearby residents to respiratory illnesses and increase the costs of cleaning for nearby buildings (Hecht et al., 2016). About 62% of quarries are those that have reached the water table, and either emptied the aquifer or polluted it, therefore disrupting the groundwater flow system. It has also affected many springs, especially in the Mayrouba/Wata area in Caza of Keserwan (namely sand quarries). A 2017 study by Jaroudi applied an average of 0.67% of devaluation for all property value in Lebanon due to quarries. The Rapid Cost of Environmental Degradation study of 2018 estimates land degradation from quarrying to amount to between 350 to 770 million USD. Averaged at 560 million USD, it represents 1% of the country's GDP (MoE/UNDP, 2019).

Figure 6-12 Quarry in Ain Dara, Aley (a), Kfarhazir, Koura (b), Maydoun, West Bekaa (c), Jroud Dinniyeh-Akkar (d), and Qabb Elias, Zahle (e)
Photo Credit: IMLEBANON, 2019 (a), Annahar, 2017 (b), IMLEBANON, 2016 (c), Al Ahkbar, 2019 (d), UNDP, 2020 (e)

The accelerated development of quarrying activities started during the reconstruction period following the 1975-1990 Civil War. It was facilitated not only by the rising costs of construction but also by the variety of structures built without any legal authorization. Quarry products are mostly used in new building projects, renovation or restoration of existing buildings, new infrastructure and maintenance of existing infrastructure (Hecht et al., 2016) (Box 6-5). However, quarrying activities were significantly reduced following the severe contraction of the construction sector in 2019 and 2020 (Houssari, 2020).

Box 6-5 Lebanon's Demand for Construction Aggregates

Demand for construction aggregates in 2014 are estimated as follows:

- 3.74 million m^3 of sand
- 7.32 million m^3 of rock

Transporting these amounts require about 3,000 truckloads of 20 m3 of material per day. In terms of aggregate uses, they are as follows:

- 9.06 million m^3 for buildings and 2 million m^3 for roads (in 2014).
- On average, 200-300 tons of aggregates (sand and gravel) are required to build an apartment.
- Roads need 5,000 tons of aggregates per 1 km and highways need 20,000 tons/km.
- To extract 3 Mm^3 of usable materials, a quarry must produce 4 Mm^3, equivalent to about 60-80 ha.
- Total supply of aggregates in 2016 is estimated at 15.01 million m^3.

Source: CDR, 2004 & Hecht et al., 2016

A 2010 study surveyed and reviewed 150 quarries and concluded that most malpractices were related to the following: excavation outside of the authorized area, disregard of the legal steps for the obtaining a quarrying license, excessively high quarry cliffs and avoidance of rehabilitation (MoE/UNDP/ECODIT, 2011). Few of these quarries have "temporary permits" that are continuously renewed and if a permit exists, it is often issued by authorities with no jurisdiction over the sector according to the current decree. They are obtained without going through the steps specified by Decree 8803/2002 and without complying to its conditions (refer to Section 6.3.3 for legal process). Many quarries operate under different labels (Box 6-6) to evade regulation.

Box 6-6 Labels Used for Quarrying Activities to Avoid Licensing Process

- Administrative "extensions" or permits (مهل إدارية)
- Land reclamation or parceling (استصلاح أو إفرازات أراضي)
- Stock transfer (نقل ستوك)
- Transportation of extracted material from communal lands (نقل ناتج في اراضي مشاعية)
- Warehouses - construction materials warehouses (مستودعات – مستودعات مواد بناء)
- Sand washing plants (مغاسل رمول)
- Concrete mixers (مجابل باطون)
- Asphalt mixers (مجابل زفت)
- Stone saws (مناشير صخور)
- Artificial sand mining (استثمار محافر رمل صناعي)
- Crushers (فقّاشات)
- Construction of roads (شقّ طرقات)
- Rehabilitation, leasing, construction and maintenance of internal roads (اعادة تأهيل وتأجير واستثمار وصيانة طرق داخلية)
- Construction permits (رخص بناء)
- Execution of hilly lakes (انشاء و أو استثمار برك جبلية وبرك صخرية)

6.2.4.3 Open Dumps

The most common waste disposal method in Lebanon remains open dumps. A survey conducted in 2016 counted 941 dumpsites compared to 670 in 2011. Those are divided between Municipal Solid Waste (MSW) (Figure 6-13) and Construction and Demolition Waste. This increase is mainly attributed to the sudden surge in population following the influx of Syrian displaced and the closure of the Na'ameh landfill that received an important share of waste from Beirut and Mount Lebanon (UNDP/MoE, 2017). To manage the amount of waste, many municipalities resort to open burning. Waste at more than 150 dumpsites is burnt weekly (Khawaja, 2017). Such practices are considered health hazards due to the emissions of toxic fumes and contamination of soil and groundwater, especially at excavated sites (UNDP/MoE, 2017).

Despite efforts made to identify them, the process of dumpsite rehabilitation in Lebanon has remained slow. For example, a section of the south of Saida waste dump has been turned into a public garden, inaugurated in 2016 (Figure 6-14). While necessary, this case should not be used to encourage the creation of new sanitary landfills along the coastal zone since they could become a major source of pollution and health hazard, especially if they are poorly designed and improperly operated. Nevertheless, existing closed uncontrolled dumps could be rehabilitated and turned into useful reclaimed green areas, while reducing the risk they pose to air and ground water pollution.

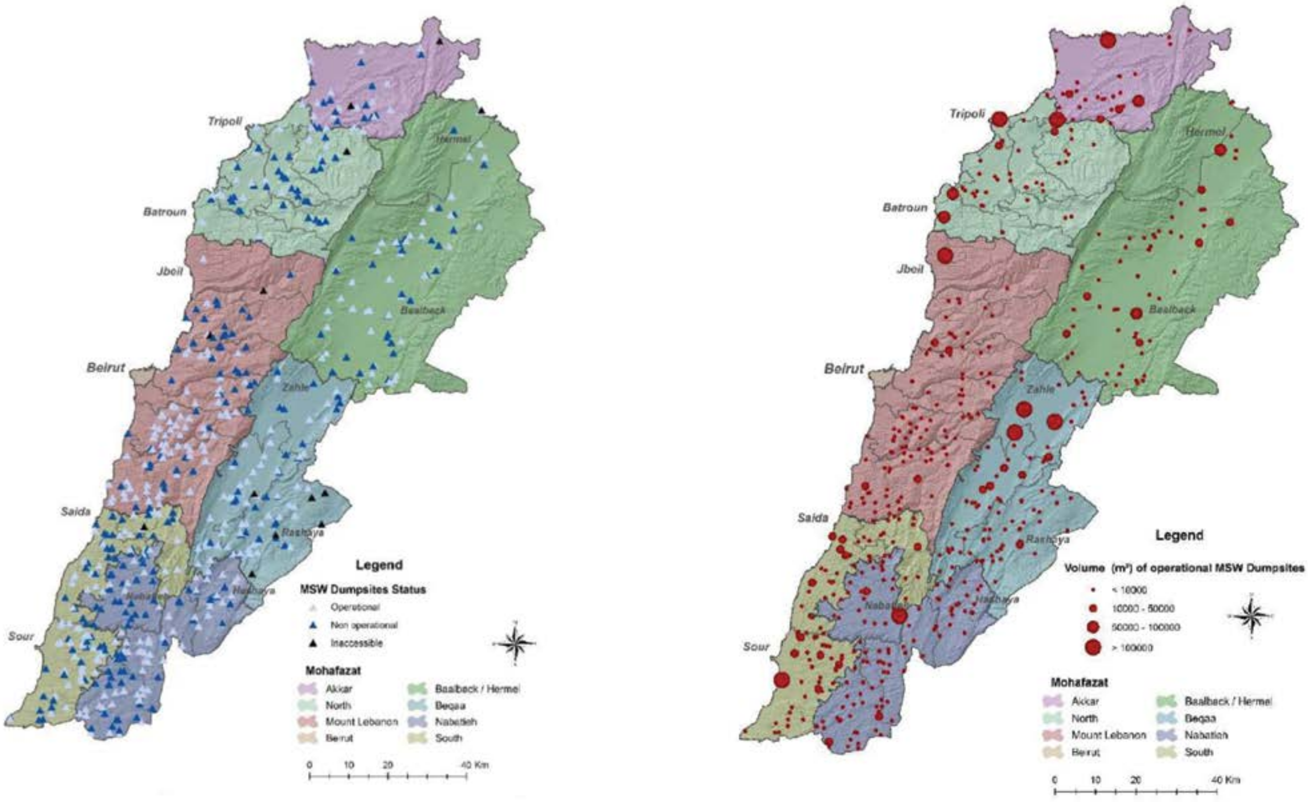


Figure 6-13 Maps Showing the Locations, Status and Volume of MSW Dumpsites in 2016
Source: UNDP/MoE, 2017

Figure 6-14 The New Garden in the Old Saida Dump Site
Source: Google Earth, 2020

6.2.4.4 Land Mines

Many mine fields still need to be cleared in Lebanon to safeguard the community's safety and protect them from injury or death. Victims of land mines include pedestrians, farmers or shepherds, as well as cattle, adding to the socio-economic impact of landmines (LMAC, 2019). Most casualties occur in the South and the North Bekaa.

Since 1975, more than 2,800 injuries and 900 deaths resulting from mines have been reported in Lebanon (Landmine & Cluster Munition Monitor, 2018). In 2017 alone, 8 people were killed by mines and another 28 injured while 2019 witnessed 2 deaths and 13 injuries (Table 6-5). The Lebanon Mine Action Center estimates that 200,000 people are still negatively affected by landmines (LMAC, 2016). Apart from the danger minefields directly pose to people, it voids the potential of otherwise useful land and prevents any type of productive activity or rehabilitation effort.

Table 6-5 Number of Landmines Casualties.

Year	Number of Injured	Number of Deaths	Total Number of Casualties
2008	26	2	28
2009	30	3	33
2010	20	5	25
2011	4	2	6
2012	6	3	9
2013	23	1	24
2014	15	1	16
2015	15	2	17
2016	7	0	7
2017	28	8	36
2018	18	4	22
2019	13	2	15

Source: Landmine & Cluster Munition Monitor (2020) and LMAC (for 2018 and 2019)

A large part of the remaining mines are a legacy of the civil war and Israeli invasions of Lebanon, with the majority located in the south of the country. New mines placed by the Islamic State were found after the combat operations with the Lebanese Armed Forces in 2017 in the northeast near the Syrian border. At the end of 2017, the extent of land mines, cluster munitions and other explosive war remnants covered 37.27 km^2 of confirmed hazardous areas and 21.8 km^2 of suspected hazardous areas and other explosive remnants of war (Landmine & Cluster Munition Monitor, 2018), with new fields being surveyed in the North Bekaa (Table 6-6). Clearance was expected to be completed by 2020, but a lack of operational capacity hindered progress to meet the deadline.

6.2.4.5 Dams

While surface water retention is important to reduce the water supply/demand gap, this causes the loss of lands once the completed dam/lake is filled with water. Although compensation is the least desirable form of mitigation, ecological compensation plans (ECPs) are essential when other measures are not available. ECPs compensate for unavoidable environmental impacts and can include reforestation or land regeneration *(for more information on dams in Lebanon, refer to Chapter 3 – Water Resources).*

6.3 Key Stakeholders and Legal Framework

The following section describes the different institutions and stakeholders that operate within and influence the land resources sector, and the key laws and regulations related to land and the environment. In addition, an analysis of environmental legislation related to land resources is presented in the State of the Environmental Legislation Development and Application System in Lebanon report (EU/UOB/MoE/ELARD, 2005). To review environmental jurisprudence cases related to land resources, please refer to MoJ/MoE/UNDP (2010).

Table 6-6 Cluster Munition and Landmines Contamination (as at end December 2017).

Province	Confirmed Hazardous Areas (cluster munition)	Area (m2)	Suspected Hazardous Areas (cluster munition)	Area (m2)	Confirmed Hazardous Areas (mines)	Area (m2)
Bekaa	74	1,945,384	43	3,937,651	38	1,107,643
Mount Lebanon	35	595,853	48	2,446,903	323	10,562,802
South	250	5,296,398	8	382,489	211	1,493,996
Nabatieh	482	9,320,509	12	23,387	788	6,625,595
North	2	20,000	4	42,653	55	278,315
Total	843	17,178,144	115	6,833,083	1,415	20,068,351

Source: LMAC (2017, 2018).

6.3.1 Institutions Related to Land Management

Land management is directly related to ownership *(see different categories of land tenure and ownership in Lebanon in Box 6-7).*

Box 6-7 Land Tenure Type in Lebanon
According to MoF Decision 3339 (1930) and its amendments (Law 47/1971 and Law 173/2000), land tenure in Lebanon is divided into five main categories:

1. Mulk (الملك): privately owned
2. Amirai (الأميرية): State owned and managed by MoF through the Directorate General of Cadastral Affairs
3. Matrouka mourfika (المتروكة المرفقة): State owned and managed by municipalities or local government bodies
4. Matrouka mahmiya (المتروكة المحمية): Owned by the State or by municipalities and considered a public good; managed by MoF through the Directorate General of Cadastral Affairs
5. Khãliya moubaha (الخالية المباحة): State owned amiria lands that have not been identified nor delineated. Priority is given to the first entity operating the land.

Decision 144 of 1925 defines public properties as goods (lands) of public interest while protecting them from any transaction. The document lists the coast, salt ponds, lakes and water bodies, waterfalls suitable for power generation, streets, roads and railways, and military infrastructure or installations, as examples of public property. Public properties are generally divided between national and municipal properties.

The responsibility of public land management is divided among several ministries. For example, the Ministry of Public Works and Transport (MoPWT) is responsible for the maintenance of primary roads and the railway right-of-way, as well as the public maritime domain, including its ports and marine terminals. The Ministry of Energy and Water (MoEW) is responsible for waterways, underground rivers, springs, rivers and riverbanks (Table 6-7).

Table 6-7 Distribution of Responsibilities Related to Land Management.

Province	MoPWT (DGUP)	MoE	MoA	MoC (DGA)	MoEW	MoIM	CDR	Religious Orders
National land use master planning	X[1]						X[2]	
Protected area management		X[3]	X[4]					
Forest management		X[3]	X[4]					
Urban planning regulations	X[1]							
Public maritime domain (coastal zone)	X[1]							
Protection of cultural heritage				X[5]				X[6]
Protection of rivers and waterways	X[1]	X[3]			X[7]			
Management of religious estates								X[6]
Quarry sector		X[3]			X[7]	X[8]		

DGUP: Directorate General of Urban Planning; MoE: Ministry of Environment; MoA: Ministry of Agriculture; MoC-DGA: Ministry of Culture-Directorate General of Antiquities; CDR: Council for Development and Reconstruction

[1] DGUP is the first authority responsible of developing urban regulations and coordinating urban planning activities (Decree 10490/1997). Urban master plans are prepared and reviewed by the DGUP, then submitted to the associated municipality (which has one month to inquire any objections) before moving to the HCUP for approval and to the CoM for endorsement.
[2] CDR is a public institution established under Legislative-Decree 5/1977. It is in charge of all major infrastructure projects. In 2005, the CDR prepared the NPMPLT that was later approved by the CoM under Decree 2366/2009.
[3] The mandate of the MoE and its organization were defined by Law 690/2005. Its main responsibilities are defining the environmental conditions to protect land use and land resources, as well as reviewing and presenting a position on an EIA and SEA before the approval of any project/plan.
[4] The Department of Forest and Natural Resources under the Directorate of Rural Development and Natural Resources at the MoA manages forested areas. Lebanon has two overlapping forest laws: (1) the Forest Code of 1949 and (2) the Law on Forest Protection, Law 85/1991 amended by Law 558/1996.
[5] Acting under the authority of MoC, the DGA is in charge of implementing regulations related to antiquities (Decision 166/L.R. of 1933 and its amendments), archeological remains, as well as traditional or historical monuments.
[6] Religious orders (Waqf, plural Awqaf) own around 35% (unpublished data) of the Lebanese territory (MoE/UNDP/ECODIT, 2011). The authorities of every religious community recognized in Lebanon have a unit in charge of the management of their estate.
[7] The MoEW is responsible for the water sector under Law 221/2000. It must ensure the protection of water resources and intervene if they are threatened by construction, quarrying or any other activity that may lead to contamination of lakes, rivers and groundwater.
[8] Decree 4082/2000 defines the organization of the MoIM. Municipalities, Unions of Municipalities, Governors and Qaimaqams are all involved in construction and quarries permitting processes under the responsibility of the MoIM.

6.3.2 Conservation Legislation

The first piece of legislation related to conservation in Lebanon is a 1939 law containing a list of natural sites and landmarks of important public interest for their aesthetic or touristic value. Back then, it fell under the authority of the Ministry of National Economy. The text served as the legal basis for the designation of the first protected areas in 1942, when the GoL established eight protected sites pursuant to Decree 434 – see definition of Protected Area in Box 6-8. These protected sites were quite diverse, ranging from urban parks (Horsh Beirut), to springs (Nabaa el Laban), natural sites (Yammouneh Lake and Kfardebian Natural Bridge), forests (Bologna Pine Forest, Mrouj Oak Forest, and the Cedars of Bsharre) and historic monuments (Temple of Baalbeck, Deir el Kalaa).

Box 6-8 What is a Protected Area?
A Protected Area is a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (Dudley and Stolton, 2008).

According to Law 130/2019, Protected Areas are sites characterized by their biological diversity, or by the importance of ecological, geological, geomorphological, anthropological or cultural landscape sites, including wetlands, mountainous areas, forests, woodlands, islands, plains, coasts, territorial waters or any other ecosystem that provide, but is not limited to, the following services:

1. Protection of biological diversity elements, especially those threatened with extinction, rare, distinctive or unique.
2. Recreation of natural wealth of biodiversity.
3. Preservation of ecosystems.
4. Protection of birds and animals, both inhabited and migratory.
5. Preservation of natural landscapes and distinctive natural features.

Law 130/2019 defines four categories of conservation: (1) nature reserves, (2) natural sites, (3) natural park, and (4) hima (For more details on these categories, refer to Section 6.4.2). Additional protected areas such as touristic sites, cultural monuments and forests are declared by various authorities.

The Ministry of Tourism (MoT) issued decisions related to villages or inhabited settlements and specific landmarks (such as Beni Saab (Decision 634/1999) and Jbaa (Decision 266/2004)). The MoC is also involved in the cases of World Heritage Sites, which are classified by the United Nations Educational, Scientific and Cultural Organization (UNESCO). These can include either natural or artificial sites.

The Forest Code (Law 85/1991), amended in 1996 (Law 558), stipulates that all cedar, fir, cypress, oak, juniper and other forests in Lebanon are protected through a decision by the MoA. Based on the amended Forest Code, MoA declared 13 protected forests between 1996 and 1997. Some sites had overlapping decisions, such as Qammouaa (Akkar) for which two decisions were issued, MoA Decision 588/1 for 1996 declaring it a protected forest and MoE Decision 19/1 for 2002 that classified it as a natural protected area. Moreover, in 2008, the MoA declared the protected forest of Jabal Moussa (Decision 399/1 of 2008) before the area was declared a natural site (Decree 7494/2012).

Many of the protected natural sites in Lebanon have also acquired international designations including Important Bird Areas, Ramsar Sites, Special Protected Areas of Mediterranean Importance, UNESCO Biosphere Reserves and World Heritage Sites.

The responsibility and management of the sites is shared among several public institutions and agencies, mainly the MoA and MoE. *For a complete list of protected areas in Lebanon, refer to Chapter 5 - Ecosystems Chapter.*

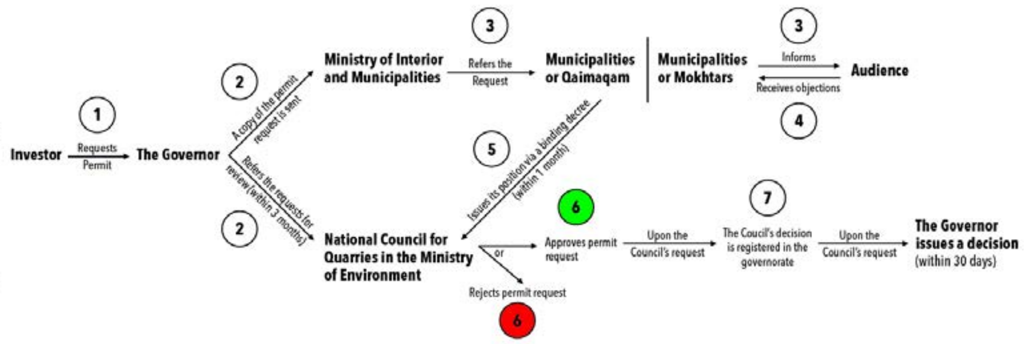


Figure 6-15 Licensing Procedure for Quarries.
Source: Public Works Studio, 2019.
Note: Steps 3, 4 and 5 apply if there is a municipality (or union of municipalities); if the municipality does not exist, then the authority to accept or deny document approval to an operator is relegated to the Qaimaqam.

6.3.3 Quarry Legislation Affecting Land Resources

The legal approval process for quarries involves many parties: the Governor, the MoE (through the National Council for Quarries (NCQ), the MoIM and the municipalities or Qaimaqam) (Figure 6-15).

Decree 8803/2002 and its amendments are the main sources of legislation that define the licensing procedures of quarries and crushers, as well as their operation, management and rehabilitation. The decree also established the NCQ (whose internal system was defined by Decree 9222/2002), which brings together representatives from nine public agencies and is presided by the Minister of Environment. The decree presented the National Master Plan for Quarries, originally identifying four regions: (1) Aarsal in Baalbek, (2) Tfail and Ain El Jaouz in Baalbek, (3) Yanta and Aita El Fokhar in Rachaiya and (4) Qousaya and Deir El Ghazal in Zahle. All these regions are located in the Anti-Lebanon Mountain Range and cover about 163 km^2 (MoE/UNDP/ECODIT, 2011). Those were later expanded through Decree 1735/2009 adding 12 new areas and expanding the total quarry areas to 237 km^2. The decree requires quarry contractors to rehabilitate the site at the owner's expense through terracing and replanting after closure. It also brings local municipalities into the licensing process, imposes fines for non-compliance and requires owners to present a bank guarantee to ensure rehabilitation of the quarry. In 2017, the MoE and the Minister of Finance (MoF) issued joint Decision 179/1 that defines the procedure for confiscating these bank guarantees by the MoE.

MoE issued several decisions related to the quarry sector as described below:

- Decision 48/1 of 2009 defines the licensing mechanism for the rehabilitation of crushers.
- Decisions 52/1 to 57/1 of 2011 define the licensing conditions and documents required for the various type of quarries and crushers (stone, friable gravel, sand, rock and mosaic gravel) *(Refer to the Cited Legislation at the end of this chapter).*
- Decision 190/1 of 2018 defines the licensing conditions and documents required for the exploitations of "small quarries", defined as sites limited to an extraction of 40 m^3 per day of material whose sale is forbidden.

After submitting the required documents, the quarry owner and/or operator can obtain a quarry license extending up to five years. The NCQ meets periodically to review, approve and/or reject license applications. Since the latest amendment to Decree 8803/2002 and amendments (Decree 1735/2009), a ministerial committee was appointed with almost every government formation to organize and/or better coordinate the quarrying sector. However, only two resulted in concrete proposals. The first one was the draft master plan for quarries transferred to the CoM in 2013; this plan was never discussed or approved by the CoM due to the government resignation, and the second one, following the Integrated Management of the Quarries and Crushers Sector Policy Brief (approved by CoM Decision 45 dated 21/3/2019), was the draft master plan elaborated by the MoE in September 2019 approved by the CoM Decision 1 dated 17/09/2019 without the suggested map (refer to Section 6.4.4 for more details).

In 2020, the CoM issued Decree 6569 based on Budget Law 144/2019 for the Department of Geographic Affairs (DAG) of the Lebanese Armed Forces to survey and document all existing active and inactive rock or sand quarries and extraction sites. The decree also forms an inter-ministerial committee to supervise and facilitate these operations. It is headed by the Director of Geographic Affairs and made up of various members from the DAG, MoF, MoIM and MoE. Moreover, it defines the fees to be collected from the owners and investors including the cost of environmental degradation, the cost of rehabilitation of degraded site, additional fees to MoF in case the exploited area exceeds the surface initially paid for, penalty fees for late due payment, as well as for working without acquiring the needed license, or violating the terms of the obtained one.

6.4 Selected Responses to Land Issues

The most significant responses to land issues in the last decade have been undertaken by public administration bodies in partnership with international organizations and NGOs. The following sections describe selected responses related to sustainable land management (SLM), protected area management and reforestation.

6.4.1 Sustainable Land Management

The SLM approach encompasses all the environmental resources of a given geographic area including soils, forests and water to maintain equilibrium between human exploitation and regeneration of these resources. The MoE has been active in promoting and integrating SLM through projects such as the Sustainable Land Management in the Qaraoun Catchment (Box 6-9) and the Land Degradation Neutrality (LDN) of mountain landscapes in Lebanon project (Box 6-10).

Box 6-9 Sustainable Land Management in the Qaraoun Catchment (2016 – 2021)

Funded by the Global Environment Facility (GEF) and implemented by the UNDP in partnership with the MoE, the Sustainable Land Management in the Qaraoun Catchment project (SLMQ) aims at embedding sustainability considerations in land use planning and development activities in the Bekaa Governorate, as well as reshaping land and natural resource management to alleviate land degradation, maintain existing ecosystem services and improve livelihoods in the target areas. The project's specific objectives are to develop upstream institutional tools to provide the various ministries and administrations with the proper means and mechanisms for promoting sustainable land use as in the best interest of the landowners, farmers and communities. The SLMQ Project provides an example of a planning process whereby a macro-overview of the region is undertaken, culminating in the elaboration of a Master Plan to be approved by a decree, with the main objective to build up a long-term "territorial vision" associated with the priority productive sectors and available resources. The vision was accompanied by the elaboration of a Local Development Action Plan (LDAP) suggesting a list of short-, medium- and long-term actions for sustainable development. This was then followed by the development of Detailed Urban Plans reflecting the provisions of the masterplan, including a zoning plan; as well as building regulations (construction coefficients and building and land use regulations). A SEA was also undertaken to proactively inform the planning process on opportunities and constraints for development, guiding the planning process towards more sustainable solutions by developing an environmentally friendly alternative and also helping to avoid the perception of environmental assessment being a hindrance to development.

Accordingly, this initiative allowed for the combination of analytical and participatory approaches that aim to integrate environmental considerations into planning processes. Consequently, the protection of land resources can become an inherent factor to planning decisions.

Box 6-10 The Land Degradation Neutrality of Mountain Landscapes in Lebanon Project (2019 – 2024)

The LDN of Mountain Landscapes in Lebanon Project aims to rehabilitate degraded land and prevent further degradation in the mountain areas in Lebanon. The project is funded by the GEF and is implemented by UNDP in a partnership with the MoE.

Through this project, rehabilitation practices are being tested for technical and cost effectiveness, and benefits to the agriculture, mountain pastures and forestry sectors, the quarrying sector, and the eco-tourism and outdoor recreation sectors. Prevention will be achieved through comprehensive land use planning and the monitoring for compliance with set conditions and their enforcement.

The project also aims to clarify the roles and enhance capacity particularly at local government level to address biodiversity and key ecosystem goods and services to inform planning and permitting decisions. The institutional and regulatory context will be reviewed and strengthened to reduce degradation of forests, rangelands and agricultural lands.

Finally, the project will develop new financing mechanisms for SLM and forest management based on international best practice and a knowledge management platform to facilitate sustainability, replication and upscaling of the new practices leading to LDN. To pilot the approach, the project will focus on the districts of Akkar and Jbeil and apply comparative remedial methodologies to restore mountain lands to their valuable ecological functions, such as sustainable agricultural productivity, biodiversity habitat and ecosystem services.

6.4.2 Legislation to Reorganize Lebanon's Protected Area System

In 2019, Parliament approved Law 130, which introduced a national categorization system applicable for any new protected area. Its objectives are to: protect biodiversity, especially species that are threatened or unique, restore lost biodiversity, preserve ecosystems, protect bird species and preserve landscapes and distinctive natural features.

Four categories of protected areas were defined in this law, and they are as follows:

- Nature Reserve: A land or marine area that requires protection of its ecosystems and habitats for the preservation of species of particular importance (vulnerable or endangered) or natural features, ecosystems and habitats (Figure 6-16). They are protected by law if located on state or municipal lands or by decree after a proposal from the MoE in the case of privately owned lands. If the nature reserve is established on private property, the owner's consent must be obtained. In case the owner does not agree, the MoE may request the acquisition of the property for environmental public benefit, for which the owner would be compensated. Once declared, the area would be protected for at least 20 years.
- Natural Park: Designation for vast rural lands, partly populated, where the relationship between man and nature over the years has made it a distinguished place for its aesthetic, ecological or cultural value. It enjoys in most cases a high biological diversity and has a natural, cultural heritage and distinct natural features at the national level making it worthy of long-term protection. The natural park includes one or more controlled management areas and a sustainable development area or areas. These three areas may include one or several categories of protected areas or areas nominated to become protected areas. Those are established

Figure 6-16 Karm Chbat Forest
Photo Credit: Wild Adventures, 2016

by decree issued by CoM based on a proposal from the Ministers of Interior and Municipalities and Environment following the request of the concerned municipalities and/or unions of municipalities.

- Natural Landmark Site: An area containing a prominent landmark or feature of natural or cultural importance that should be protected in view of its rarity, representative character or aesthetic qualities. These sites are classified according to a decree based on an MoE proposal.
- Hima: A protected site comprising a natural ecosystem, which has important biodiversity, ecological services and cultural values. The site is characterized by the voluntary protection of its ecosystems, natural habitats and cultural values associated with it by means of a traditional system of natural resource management by local communities based on the typical skills of these locals. The decision for the creation of a Hima falls on the corresponding municipal council(s). In case of areas with no municipalities, the decision is that of the Qaimaqam based on the proposal of the area mukhtar(s). The same entities decide on the management of the Hima.

Although the law defines all four types of protected areas, it only describes the management process for the Nature Reserve. According to this process, each reserve is managed by a committee of volunteers appointed through a decision issued by the Minister of Environment and valid for 3 years. Each committee has administrative and financial autonomy and proposes a management plan for the reserve. The MoE allocates the reserve's budget and approves its management plan. The MoE may give permission for activities within the reserves based on proposals from its management committee, accompanied by the MoE approved EIA or IEE. Revenue generated from entry tickets and other activities in the protected area is managed directly by the volunteers' committee for maintenance and preservation of the reserve.

6.4.3 Reforestation Efforts

Now more than ever, reforestation is globally provided special attention derived from its significance at mitigating climate change by sequestering CO_2 and reducing a country's carbon footprint. Lebanon has engaged at improving its reforestation strategy and implementation to accompany the global trend. The MoE and MoA have both developed reforestation programs that are introduced below.

6.4.3.1 The National Reforestation Plan of the MoE

In 2000, the MoE developed the National Reforestation Plan (NRP), a 10-year plan for the rehabilitation of degraded forestland through reforestation using native forest trees. NRP addressed forest genetic resources through the selection of forest species serving ecological requirements and socioeconomic needs. In its first phase (2000-2004), 300 ha were reforested with native species at a density of 800 plants/ha. The second phase (2005) entailed the reforestation of another 300 ha; however, limiting challenges were deterring, amongst were the 2006 war, landmines and lack of financial resources.

A technical follow up was ensured in 2009-2014, through the 'Safeguarding and Restoring Lebanon's Woodland Resources' (SRLWR) Project funded by the Global Environment Facility (GEF) through UNDP and implemented by MoE. The project objective was to create an enabling environment and building capacity for sustainable land management. SRLWR resulted in 1) a management framework and capacities for safeguarding and restoration of degraded forest areas, 2) a set of innovative technologies and instruments for the rehabilitation of forests and woodlands, and their subsequent sustainable management, as well as appropriate policies and practices, and 3) monitoring, learning, and adaptive feedback on sustainable land management (MoE/GEF/UNDP; 2009-2014).

6.4.3.2 The 40 Million Trees Program of the MoA

Strategy Definition

On 13 December 2012, the GoL launched the 40 Million Trees Program, or the NARP. The program aims to plant 40 million forest trees in 70,000 ha of public lands in order to increase Lebanon's forest cover from 13% to 20% by 2030; it is expected to deliver essential economic, social and environmental impacts as it leads to the expansion of forest functions, the adaptation of ecosystems, forest and agriculture to climate change, the establishment of sites with improved capacity production, and the strengthening of the public private partnership as a good governance image (AFDC, 2019). With the support of the President of the CoM, MoA established an inter-ministerial committee to oversee program development and implementation. In 2013, with the support of FAO, MoA developed the Roadmap 2030: A Practical Guide to 7% increase the Forest Cover in Lebanon.

The MoA also developed a strategy for 2015-2019 aiming to increase the forest cover by 5% by 2019, and to establish forest and rangeland areas for the application of sustainable management plans (AFDC, 2019). This strategy defines among the facing challenges the assurance of sustainable management and use of natural resources to respond to impacts of climate change, land degradation, overgrazing, unsuitable crop pattern, overexploitation of forest resources and fisheries. Although the strategy does not include indicators for monitoring and evaluation, it provides a source of verification for the targets concerning the enhancement of the agriculture sector's performance and productivity (AFDC et al., 2019). On the other hand, the strategy integrates with the ecosystem restoration concept of National Target number 9 of NBSAP 2016, which supports primarily the renewal and restoration of ecosystems under degradation pressures from various forms of damage and exploitation, such as quarries and fires (MoE/UNEP/GEF, 2016).

In addition, MoA launched in June 2015 the National Forest Program (NFP), which is the main instrument of the national forest policy for the decade 2015-2025. The NFP identifies the government's interventions in the forest sector and beyond it, aiming at sustainably managing the Lebanese Forest Resources, while defining the coordination and cooperation mechanisms among all public and private sectors.

Implementation Through Reforestation and Restoration Projects

Many projects were developed to support the realization of the 40 Million Trees program; they mostly included a direct reforestation or restoration component and capacity building or developmental and technical component. Some are elaborated on below (also refer to Annex 3).

- The ongoing SLMQ project aims at restoring 300 ha of forests in the districts of Zahle, Rachaya and West Bekaa. The first round focused on restoration of 114 ha in Rachaya district and the riparian corridor from Ammiq to Kfarzabad. It also helped identify priority areas to support forest connectivity and reverse land degradation. It also developed tools for sustainable forest management.
- In 2017, the PARSIFAL project funded by the French Development Agency and managed by CDR started the process for reforestation of 800 ha of land in Bekaa and Akkar governorates.
- In 2016, The Smart Adaptation of Forest Landscapes in Mountain Areas (SALMA) funded by GEF and implemented by FAO and MoA, aimed to restore 1,000 ha of forests and sustainably manage another 1,000 ha. It also supports the development of innovative integrated forest management practices and forest restoration techniques. It established a participatory approach to conducting reforestation/afforestation and forest management plans.
- In 2016, the National Center for Forest Seeds is a project established with FAO and MoA and nested at LARI aiming to build the capacities of specialized and technical cadres and empower them with high level expertise to ensure seed quality, trace seed origin, and improve seed storing processes.
- In 2015, FAO supported MoA with a Technical Cooperation Programme TCP to strengthen the coordination of NARP, field level reforestation oversight, management and reporting capacity by developing training curriculum and providing training to the Rural Development and Natural Resources Directorate engineers and forest guards. It also helped develop a mechanism to strengthen financial resources mobilization from private sector and diaspora.
- In 2014, the Agriculture and Rural Development Program, funded by the EU and implemented by MoA, fostered forestation and reforestation. It assisted MoA at elaborating a Pilot Master Plan for Reforestation aiming to support the on-going reforestation process, reinforce the technical foundations and facilitating decision-making tools for programming, organize, implement and manage forestation and reforestation projects in line with the "40 Million Trees" program. It also planned a grant scheme to encourage participatory reforestry actions fostering cooperation with NGOs and municipalities; 6 NGOs and 14 municipalities signed grant contracts to provide direct and tangible benefits in the areas mostly affected by degradation/desertification and deforestation, and addressing more specifically the vulnerable communities. The direct planting of 112 ha, establishing the scientific and technical governance model of good practices, and supporting participation of stakeholders defined the expected outcomes of these grants.
- Launched by FAO in June 2014, the Forest Landscape Restoration Mechanism (FLRM) project aimed at supporting national actions for better forest and natural landscape restoration, advising sustainable mechanisms for financing restoration needs, and enhancing legislative framework that govern natural landscapes. In the first phase (2016-2018), FLRM implemented model landscape restoration activities, supported LRI to conduct restoration work in areas vulnerable to climate change, and developed the foundations

for a National Forest Fund. The second phase (2018-2020) promoted the legal and institutional establishment of the National Forest Fund, and revising and amending the national forest law, disseminating technical knowhow, as well as applying specific rangeland management plans to 1,000 ha of rangeland.

Implementing Bodies

A range of stakeholders from specialized NGOs to local NGOs, Civil Society Organizations (CSOs) and communities were involved in the implementation of reforestation and restoration activities on the ground. Pertinent activities of some of the main NGOs are herewith highlight (AFDC et al., 2019; MoE/GEF/UNDP, 2019; AFDC, 2019).

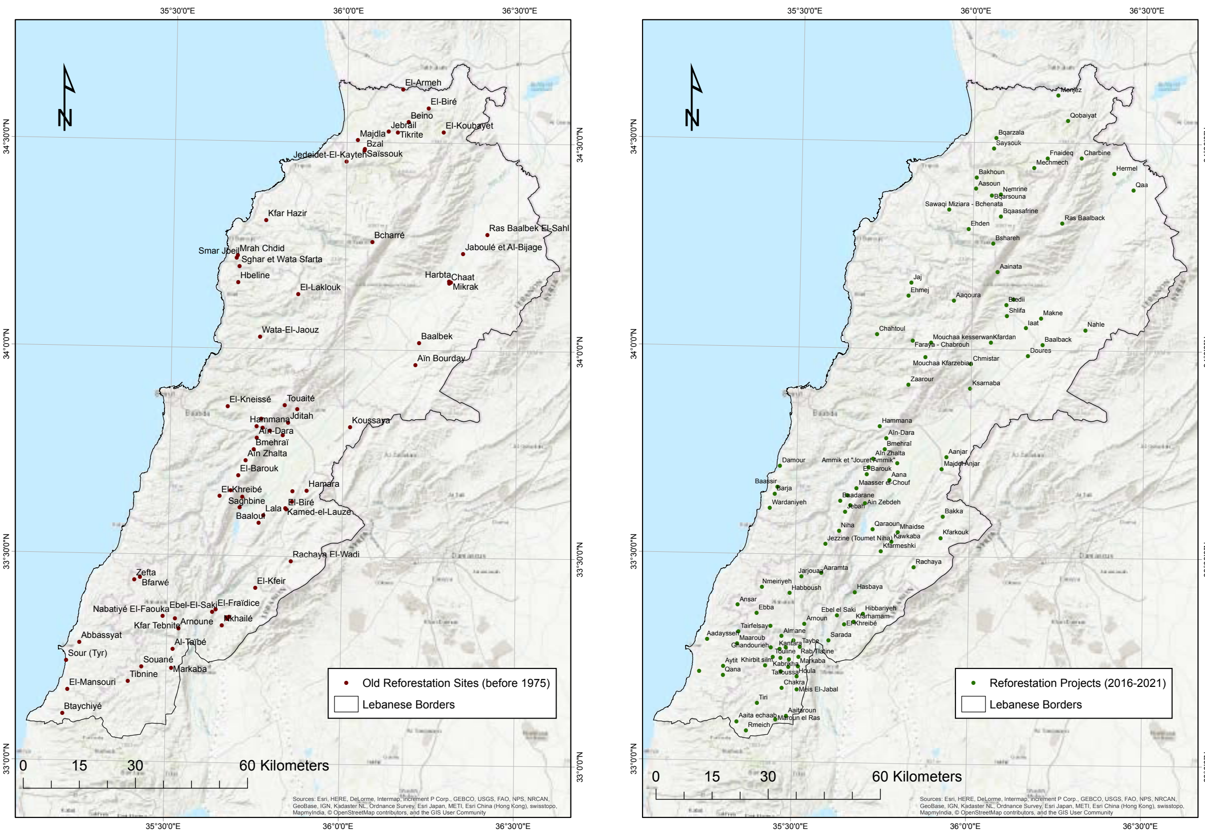
- AFDC has undertaken a holistic forest restoration approach since 2009; it ensures a full cycle of reforestation, from site assessment to seedling production, planting and post monitoring and seed replacement.
- Jouzour Loubnan undertook reforestation initiatives in many parts of the country especially the semi-arid mountainous regions. It also introduced the individual fencing technique and developed germination techniques in the Laboratory for Seed Germination and Conservation at USJ.
- LRI has planted more than 500 ha of public land to expand Lebanon's forests through a community-based approach and public-private partnerships. Three major corridors were selected to work on for forest connectivity: the north corridor Ehden to Ehmej, the Shouf corridor and the Rachaya corridor. LRI also introduced international forestry expertise, improved reforestation techniques and developed protocols for best practices.
- The 'Comité des Amis de la Forêt de Cèdres' focuses its integrated environmental activities in the Bcharre region. It has planted 110,000 cedar trees over an area of 438 ha and established water reservoirs for sapling irrigation.

It is also important to recognize the significant contributions of the many local and regional NGOs at endorsing, implementing and monitoring the reforestation initiatives.

Figure 6-17 presents the maps that were developed by the MoA-FAO project SALMA. The maps incorporate the major reforestation projects while further data compilation from other stakeholders and local initiatives will be included in this work in progress through the life of the project to later present the final map.

Reforestation Nurseries and Practices

In the past, reforestation was limited to the utilization of mainly 3 native tree species. In 2011, IUCN in partnership with AFDC and the University of Cordoba developed a handbook on forest nurseries for the production of native species. Thereafter, transition from traditional seedling production techniques in plastic polybags to customized scientific approaches allowed the germination of more than 50 forest species. The LRI project, in collaboration with the American University of Beirut (AUB) Nature Conservation Center, produced guidelines for the management of native nurseries, elaborating on the best practices in production of seedlings. In addition, LRI contributed to the enhancement of production practices in almost 10 native tree nurseries all over Lebanon and aided the nurseries in the development of the Cooperative of Native Tree Producers of Lebanon (CNTPL). CNTPL includes 19 nursery managers representing the 10 native nurseries; it is so far the only cooperative with the production capacity of 400,000 high quality seedlings for reforestation actions at international standards across the country. In 2014 and in collaboration with LRI, CNTPL provided capacity building on best practices and guidelines to the MoA nurseries (AFDC, 2019).



a- Distribution of old reforestation sites executed by the Green Plan (1960-1975)

b- Major reforestations executed between 2016 to 2021

Figure 6-17 Reforestation Sites in Lebanon between 1960-1975 and 2016-2021

6.4.4 Quarry Policy, the 2019 Draft Quarrying Masterplan and Quarry Rehabilitation

The MoE issued in March 2019 the Integrated Management of the Quarries and Crushers Sector Policy Brief (approved by CoM Decision 45 dated 21/3/2019). The policy highlights the present situation of the quarries and crushers sector in Lebanon through addressing 7 sections: 1) The Guiding principles, 2) Procedural aspect, 3) Financial and Economic aspects, 4) Institutional aspect, 5) Legal and Control aspects, 6) Planning aspect, 7) Educational and Awareness aspects (more details on these can be found in Section 6.5.3). The policy also mandates the MoE to prepare a draft master plan for the sector, taking into account all of the developments since the latest master plan decree in 2009. Once completed, it would be reviewed by the NCQ before approval by the CoM. This draft master plan was submitted by the MoE in September 2019 and approved by CoM Decision 1 dated 17/09/2019. However, the approval of the suggested map was postponed till next meeting, which did not take place due to the government resignation following the economic crash, street protests and political turmoil that began in October 2019. The master plan was formulated based on a set of 33 criteria (see Box 6-11). It also plans to allow the imports of raw materials that were previously prohibited. However, this master plan has not been fully approved.

Box 6-11 Methodology of the Quarrying Master Plan
The master plan developed by the MoE takes into consideration the NPMPLT and other legal texts. Below are the criteria that were entered into GIS to produce the map attached to the draft decree amending Decree 8803/2002 and its amendments (the map is yet to be approved and adopted).

	Criteria	Distance in meters	
		Sands	Gravels and Rocks
Based on decree 2009/2366 (NPMPLT):			
1	Urban Areas	No	
2	Rural Areas - Woodlands	Prohibited	
3	Rural Areas – Rivers Borders	500	500
4	Rural Areas – Beach Borders	500	500
5	Rural Areas – Populated Towns Borders	500	500
6	Natural Areas – Mountain Peaks	No	
7	Natural Areas – Cedar Corridors	No	
8	Natural Areas - Ecological Continuity - Woodlands	No	
9	Natural Areas - Ecological Continuity - Populated Towns Borders	500	500
10	Natural Areas - Ecological Continuity - Beach Borders	500	500
11	Landscape Areas (Parks)	No	
12	Classified Archaeological Sites	No	
13	Classified Natural Sites	No	
Based on decisions issued by the MoE and other legal texts requiring a buffer zone near specific sites:			
14	Other Protected Sites	1,000	2,000
15	Beach Area	1,000	1,000
16	Main Rivers	500	500
17	Secondary Rivers (detailed data not available)	100	100
18	Winter Streams (detailed data not available)	25	25
19	Main Springs	1,000	1,000
20	Seasonal Springs (detailed data not available)	100	100
21	Hydrogeological Sensitivity	_	_
22	Classified Archaeological Sites	1,500	3,500
23	Unclassified Archaeological Sites (detailed data not available)	1,000	2,000
24	Places of Worship (detailed data not available)	500	2,000
25	Hospitals (detailed data not available)	1,500	3,500
26	Schools and Universities (detailed data not available)	1,500	3,500
27	Residential Complex (min. 5 houses)	1,000	2,5001
28	Residential Complex (less than 5 houses) (detailed data not availa-ble)	300	1,000
29	Highways and International Roads (detailed data not available)	300	500
30	Main Roads (detailed data not available)	100	250
31	Other Registered Roads (detailed data not available)	25	25
32	Industrial Zones (detailed data not available)	250	1,000
33	International Borders	500	500

As per Section 2 of the Quarry Policy, rehabilitation is key for the integrated management of quarries and crushers. Within this context, LRI led restoration efforts on the quarries of Qlaiaa (Marjaayoun Caza) and Mrusti (Shouf Caza). The organization also developed rehabilitation plans for quarries in Aita El Fokhar Mdoukha (Rachaya Caza), and Maqne (Baalbek Caza), and partly implemented them in the first two locations. Those plans aim at implementing a sustainable redevelopment of the lands in an ecologically, socially and financially acceptable manner. The cost of quarry rehabilitation in Lebanon is presented in Box 6-12.

Box 6-12 Cost of Quarries Rehabilitation

A 2016 study estimates an average cost of $2.23 million and $102,700 for a rock and sand quarry rehabilitation, respectively. In total, this would amount to approximately $1.3 billion for rehabilitation of all quarries in the country (Hecht et al., 2016). This cost decreases to around $700 million if an outlier quarry, Abu Mizan-Metn, is not included. Overall, the study concludes that rehabilitation is economically feasible in densely populated areas with high property values (mostly in Mount Lebanon and Saida). MoE/UNDP (2019) estimated that the cost for the rehabilitation of 1,330 quarries covering 56.2 km^2 ranges from US$ 381.9 million to US$ 612.2 million. The average cost would be comprised between US$ 6.6 and US$ 15 per m^2 (MoE/UNDP, 2019). In a presentation by the MoE in 2019 regarding the draft amendment of Decree 8803/2002, a total cost of 3.7 billion USD was estimated for the rehabilitation of degraded lands (MoE, 2019).

6.5 Emerging Issues and Policy Outlook

The trend in construction of roads, housing, and commercial developments, as well as in sea reclamation projects such as marinas, sports and recreational facilities during the last decade had been progressing at an alarmingly unsustainable rate. These projects have caused irreversible damage to natural resources and landscapes. Urban development projects have long increased in both number and size for their attractive returns on investment. Modern and appropriately targeted regulation is necessary to improve public resource management and curb construction and speculative investment. The following sections highlight priority investments and actions needed in the coming period for improving the management of land resources in Lebanon.

6.5.1 Updating and Implementing the NPMPLT

The CoM endorsed the NPMPLT in June 2009 (Decree 2366). The Master Plan presents a holistic vision for the country to organize the territory and the direction it should take regarding urban planning and harmonizing land uses in Lebanon while protecting the natural and cultural resource base. The Master Plan is a reference document for every public administration, including the DGUP, to consult when making decisions related to urban development, the provision of public services, and environmental heritage conservation. To date, it is the only document with such an extensive and comprehensive strategic territorial development at the national scale. It is important to note that the NPMPLT elaborated guidelines and recommendations within a strategy envisioning development until around 2030. However, these guidelines were not extended to regional and local scales, which highlighted the absence of a binding legal framework for local actors who involved in the development of detailed urban plans. The more delayed is the implementation of these guidelines, the less relevant they become, until they are obsolete. Most of the NPMPLT data is already outdated and recent events, most notably the Syrian displaced crisis and the economic crash, now have to be taken into consideration. In its Progress Report of 2017, CDR presented its plan to update the NPMPLT in collaboration with the General Directorate of Urban Planning. However, to this date, this update has not been initiated (CDR, 2018).

6.5.2 Adopting the Mountain Law and Preparing a Master Plan for Environmentally Sensitive Areas

Mountains are a significant part of the Lebanese national territory, being the dominant topographical feature and a strategic freshwater reservoir. The NPMPLT explicitly classifies the high mountain (above 1,900 m altitude) and cedar corridor (between 1,500 and 1,900 m) as areas that must be strongly safeguarded for their environmental value and agricultural potential.

While construction in high mountain is sparse compared to coastal areas, all mountain and high plateaus are still exposed to urbanization, quarrying and asphalting. Such activities inevitably lead to increased groundwater pollution and destruction of landscape and biodiversity habitats. Makmel Mountain (in North Lebanon) and a portion of Mount Hermon ("Jabal el Cheikh", Rachaya) remain the only ones classified as a Natural Site (MoE Decision 187/1 for 1998) and Nature Reserve (Law 202/2020), respectively. To effectively protect mountains, elaborated regulation applicable to all areas should be prepared, adopted and enforced above a certain height. This would include Aaqoura-Jbeil, Akkar, Barouk-Shouf, Kneisseh-Baabda, Sannine-Metn and Tannourine-Batroun. In this regard, in 2004, the CDR prepared a draft law for Protection of High Mountains Areas. Moreover, in 2017, the LANE-Lebanese

Advocacy Network for the Environment launched their first campaign, A.R.D.E. ("Advocacy to Reconcile Development with the Environment") to convince concerned authorities to update the NPMPLT, lobby to issue an updated draft law protecting high mountains and raise awareness about the importance of sustainable land use (see Map 7 in Annex 1).

More recently, in 2019, the CoM approved, through Decision 50 dated 5/9/2019, a request initially made by MoE in 2012 to develop a "Master Plan to protect mountain peaks and natural areas, and regulate the exploitation of the coastal zone, green areas and agricultural lands" and entrusted this responsibility to CDR in coordination with all stakeholders. The main objective of this assignment is to introduce the concept of SLM in the targeted areas and integrate it within territorial planning. However, this initiative has not commenced yet due to lack of funding.

6.5.3 Implementing the Quarries Policy

As elaborated in Section 6.4.4, the quarry regulations were updated in 2019 and 2020. However, the new legislation (CoM Decision 45 dated 21/3/2019, CoM Decision 1 dated 17/9/2019 and Decree 6569/2020) is yet to be fully implemented and the master plan to be fully approved. A brief of all the aspects addressed by the policy brief (CoM Decision 45 dated 21/3/2019) and their implementation status are described below:

- The Guiding Principles of the policy include 1) Commitment to the Government's Policy Statement with respect to working towards reforms and fighting corruption; 2) Adherence to international environmental treaties ratified by Lebanon; 3) Respect of the principles set forth in the applicable laws and regulations; 4) Respect of the authority of the Ministry of Environment and the role of the National Council for Quarries; 5) Stressing on the government's duty to ensuring provision of raw materials for the construction industry in accordance with the most appropriate environmental and economic feasibility; 6) Stressing on the obligation of quarry operators to comply with applicable laws and regulations; 7) Maximizing recycling due to its importance in the conservation of natural resources; 8) Encouraging competitiveness, innovation and entrepreneurship; 9) Intransigence of the government and local administrations in the application of laws and regulations for the sector; and 10) Stressing on the joint responsibility between the executive and judicial authorities in the implementation of the policy.
- Procedural Aspect: The procedure for compiling information should be undertaken in a database shared by government stakeholders to take decisions regarding violations and the obligation to rehabilitate. This database is to be developed as per Decree 6569/2020 and past dues should be collected, mainly: 1) cost of environmental degradation and 2) related punitive claim; 3) cost of rehabilitation and 4) related fines for delay; 5) additional fee dues based on actual volumetric survey and 6) related fines for delay; and 7) punitive claim for work without permit. It is also required that, until completion of the master plan, all administrations shall comply with the provisions of Decree 8803/2002 and its amendments for any new licensing. For non-responsive operators, the MoE would launch the rehabilitation process of quarries where work has been stopped using the funds allocated for that purpose (refer to next aspect). In parallel, a feasibility study for the import of sand, gravel and other materials was to be undertaken (the Investment Development Authority in Lebanon prepared a preliminary one in 2019). In this context, regulations allowing the import of cement are evidently needed.
- Financial and Economic Aspects: The funding of the rehabilitation works referred to earlier shall be provided by the following sources: confiscated bank guarantees and fines incurred by excesses in the extracted quantities; judicial rulings; draft Loi Programme for the rehabilitation of abandoned public quarry sites; and the National Environment Fund upon issuing its application decree in pursuance of Law 444/2002 *(refer to Chapter 2 – Environmental Governance for more information)*. In addition, raising the value of the bank guarantees and reducing the price of imported materials should be considered through various taxes reduction schemes.
- Institutional Aspect: It is recommended to continue with the processing of files by the NCQ while reconsidering its internal regulations to activate it. Additionally, it is proposed to simplify the procedures that follow approvals by the NCQ.
- Legal and Control Aspect: There is a need to finalize the draft law regulating the quarries and crushers sector (prepared with EU support), in addition to the revision of applicable texts as needed. With respect to monitoring and control, the following are needed: (i) regular reporting to MoE, (ii) enforcement of laws and regulations through the environmental prosecutors and inspection judges as well as the environmental

police once recruited *(refer to Chapter 2 – Environmental Governance for more information)*; (iii) implementation of the violations section provided for in Chapter 3 of Decree 8803/2002; and (iv) inciting local administrations to perform their supervisory role and report to the relevant Governor and to the NCQ.

- Planning Aspect: Upon adoption of this policy through CoM Decision 45 dated 21/3/2019, and in parallel with the roll-out of its implementation, the MoE shall prepare a draft master plan for the sector consisting of the necessary modifications to Decree 8803/2002 and its amendments. The Ministry presented the draft master plan to the NCQ and then to the ministerial committee established by virtue of CoM Decision 53 dated 28/2/2019 – Article 4. However, as mentioned in Section 6.4.4, the plan has not been fully adopted yet.
- Educational and Orientation Aspect: The MoE shall prepare and implement an integrated communication program that demonstrates the importance of recycling and rehabilitation of the exploited sites; and the preservation of Lebanon's natural heritage (pine trees, springs, karst, etc.); in addition to a media and advertising campaign to raise awareness on the environmental, health and economic risks associated with illegal exploitations to rectify misconceptions.

In the meantime, authorities must be diligent in their crackdown on illegal quarrying activities to ensure compliance of operating quarries with the regulations and the rehabilitation of abandoned sites. Past dues must be collected and quarry operators should bear the costs of environmental damage, rehabilitation, fees to the MoF and any interest incurred on payment delays. In addition, mechanisms to facilitate the import of quarrying materials should be explored in order to alleviate the local demand for quarrying, all while enhancing price competitiveness.

6.5.4 Applying Land Degradation Neutrality Voluntary Targets

The concept of neutrality involves counterbalancing anticipated losses with measures to achieve equivalent gains. The scale of implementation of LDN, at which neutrality is to be achieved, is the individual land type, within the landscape. To facilitate counterbalancing, LDN introduces a new proactive approach in which management of land degradation is coupled with existing land use planning. LDN promotes a long-term approach in which land use planners consider the likely outcomes of land use and land management decisions, so that anticipated degradation can be counterbalanced by interventions to reverse the impacts of land degradation elsewhere, in order to achieve LDN.

The GoL adopted the following official voluntary targets for 2030:

- Improve Land Productivity and Soil Organic Carbon stock, in forests, croplands and grasslands.
- Improve the mosaic of the landscape, including forests, other wooded lands, grasslands and croplands and limit their conversion to other land covers.
- Enhance the role of forests and trees in urban and rural areas in providing sustainable products and services.

To attain these objectives, the GoL intends to restore forest landscapes through reforestation and afforestation on at least 10,000 hectares and restore at least 1,000 hectares of grasslands in high mountain areas. Approaches include introducing financial incentives and partnerships with local and international organizations, all while promoting sustainable land management and agricultural practices. (AFDC/MoA/MoE/UNCCD/UNEP/UNDP, 2019).

However, it is important to note that the GoL did not take any formal engagement in meeting those targets and it has yet to be adopted through legislation.

6.5.5 Digitizing Land and Property Information and Improving Access

A lot of important information, including plans, infrastructure data and cadastral records, is still recorded and archived only in physical format (paper). It is vital to digitize it first to improve the speed of processing such information. This would also safeguard it against various physical hazards to which paper is vulnerable such as tearing and burning and help unify formats and facilitate information exchange and data manipulation between the different administrations and agencies. Geographic Information System has become widely used for geographic data and should be mainstreamed in the Lebanese administration system, especially at departments responsible for urban planning, water and energy utilities, environmental monitoring, transport and agriculture (See Impact of the Syrian Displaced Crisis on Land Use in the Bekaa region of Lebanon in Box 6-13).

Box 6-13 Impact of the Syrian Displaced Crisis on Land Use in the Bekaa Region of Lebanon

In a country lacking social, economic and environmental stability, the substantial presence of refugee and displaced populations has led to a significant increase in demand on scarce natural resources. It remains crucial to account for the environmental impacts of this dramatic shift in population, specifically on agricultural land and solid waste and water services.

In an attempt to alleviate the adverse impacts of this crisis, and with support from UNDP's Office of Information Management and Technology, UNDP undertook an analysis of land-use change, particularly on irrigated land, between 2010 and 2017, by comparing satellite images to correlate between tented settlements and changed use of the land area, taking two case studies in the Bekaa Region: Marj and Bar Elias areas.

The analysis was done using two geographic information systems software: ArcGIS and QGIS. Story maps were produced using satellite images (one per year from 2011- 2017) provided by UNOSAT, an operational technology-intensive program of the United Nations Institute for Training and Research. The study highlighted the land use changes and potential environmental impacts that had occurred in the case study areas. The analysis concluded that as of 2017, Bar Elias lost 418,897 m^2 of agricultural land to informal settlements, while Marj lost 202,716 m^2, compared to 2011.

For decades, remote sensing and mapping software have been used to uncover and display environmental impacts over time. This powerful tool serves as a vital instrument in visually displaying the long-lasting environmental effects and land use changes over time.

Properly managed databases would help get better performance not only of land and real estate operations, but also for emergency response to crises such as those of the Syrian displaced and the 2019 forest fires. Land Use Information Management System could virtually eliminate the lag between data collection, monitoring and analysis. This would enable decision-makers to have near real-time information and react swiftly to unexpected changes. Further on, it is necessary to improve access to reliable information and geospatial data for the general public as it has been identified as a foundational constraint that impacts evidence-based advocacy and stands in the way of an informed population. Many ministries do not publicly disclose data and reports that are typically available in other countries (World Bank 2016).

A good example for this is the Sustainable Planning Information Management System (SPIMS) Platform which is being used by the SLMQ Project. This platform uses a set of cutting-edge technology modules, a highly interactive, fast loading web-based application that is easily sustainable and accessible by a range of end-users (primarily by public entities) to capture the deviations from approved detailed urban plans, land use trends, and their impacts on natural resources by central and local administrations. In short, the system's main objectives are to:

- Alert central authorities when deviations from land use plans occur;
- Act as a repository of planning related documents (shapefiles, maps, reports, indicators, etc.) allowing informed decision making in planning at the national, regional and local levels;
- Provide access to the public to available and disclosable information encouraging participatory and transparent planning processes.

6.5.6 Consolidating a Distressed Real Estate Market

Most real estate and construction projects in Lebanon came to a halt since the economic and banking crisis of 2019. Given the precariousness of the situation and the devaluation of the national currency, many land or real estate owners were easily tempted to dump their assets to secure funds quickly, mostly for debt repayment. Maintaining ownership of these assets is generally the most common course of action among the Lebanese (more details in Chapter 7 – Haphazard Urbanization). In any case, as damage is kept to a minimum, the general slowdown of the sector should be an occasion for swift reform to redirect the market towards better practices, starting with the elaboration of new master plans.

6.5.7 The Potential Impact of Hydrocarbon Activities

Onshore activities related to oil and gas in Lebanon date back to the period of the French Mandate. In 1926, the French High Commissioner for Lebanon Henry de Jouvencel issued a decision to examine the prospects of oil and mineral exploration. Accordingly, legislation was issued for regulating mining activities including oil and gas exploration and production (Decision 113 of 1933 and Decision 133 of 1936). Since then, various onshore exploration programs were initiated from 1948 to 1967 but were limited to drilling seven exploratory wells: Terbol-Zahleh, el-Qaa-Baalbek, Adloun-Saida, Yohmor-Bekaa, Tell Znoub-Western Bekaa, and Aabrine-Batroun. These exploration activities came to a halt due to the adverse security conditions associated with the Lebanese Civil War (1975-1990).

The recent interest in offshore hydrocarbon potential expanded to onshore areas given the geological continuity of subsurface conditions. The upstream petroleum activities were initiated in early 2013 through a new two-dimensional (2D) seismic acquisition program that extended until 2015 to cover around 500 km2. In addition, an airborne geophysical survey was performed in 2014-2015 covering much of Northern Lebanon and the coast but was hampered by the war in neighboring Syria.

In December 2017, a first draft law was submitted to Parliament with the aim of regulating onshore petroleum activities in Lebanon. To support the ongoing preparation for the development of the upstream hydrocarbon sector on land, the Lebanese Government decided in 2018, to initiate a SEA in compliance with the Lebanese regulations (Decree 8213/2012). A reviewed copy "Draft Onshore Petroleum Resources law" was submitted in March 2019. So far, the SEA process is still on hold, and while the onshore draft law has not been adopted, there are raising concerns on the pollution that might be associated with potential onshore operations, such as the installation of a pipeline and an onshore processing facility (Lebanese Oil and Gas Initiative, 2017). Given that Lebanon has so far failed to elaborate a comprehensive energy policy that sets clear and coherent goals for the country's desired energy mix, additional hydrocarbon extraction plans have yet to be proven worth the risk.

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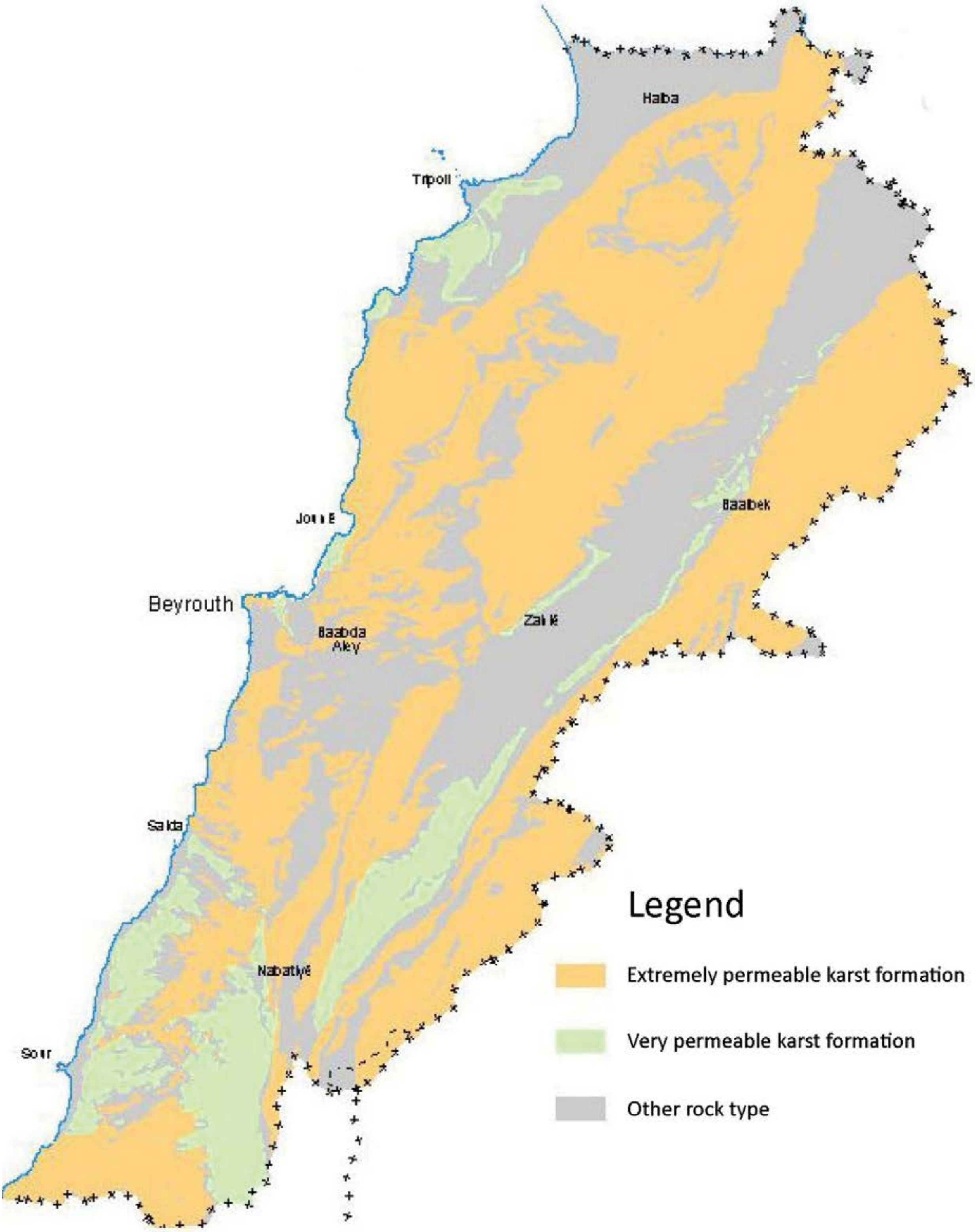
القوانين والأنظمة	التاريخ	عنوان النص
قانون رقم .	١٩٣٩/٧/٨	يختص بحماية المناظر والمواقع الطبيعية في لبنان
قانون رقم .	١٩٤٩/١/٧	قانون الغابات
قانون رقم ٤٧	١٩٧١/٦/٢٤	تعديل المادة ٧ من قانون الملكية العقارية
قانون رقم ٦٩	١٩٨٣/٩/٩	قانون التنظيم المدني
قانون رقم ٨٥	١٩٩١/٩/٧	يرمي الى المحافظة على الثروة الحرجية والاحراج
قانون رقم ٥٥٨	١٩٩٦/٧/٢٤	حماية الغابات
قانون رقم ١٧٣	٢٠٠٠/٢/٤	الموازنة العامة والموازنات الملحقة لعام ٢٠٠٠
قانون رقم ٢٢١	٢٠٠٠/٥/٢٦	تنظيم قطاع المياه
قانون رقم ٢٩٦	٢٠٠١/٤/٣	تعديل بعض مواد القانون المنفذ بالمرسوم رقم ١١٦١٤ تاريخ ١٩٦٩/٠١/٠٤ (اكتساب غير اللبنانيين الحقوق العينية العقارية في لبنان)
قانون رقم ٦٤٦	٢٠٠٤/١٢/١١	تعديل المرسوم الاشتراعي رقم ١٤٨ تاريخ ١٩٨٣/٠٩/١٦ (قانون البناء)
قانون رقم ٦٩٠	٢٠٠٥/٨/٢٦	تحديد مهام وزارة البيئة وتنظيمها
قانون رقم ١٣٠	٢٠١٩/٤/٣٠	قانون المناطق المحمية
قرار المفوض السامي رقم ١٤٤	١٩٢٥/٦/١٠	الاملاك العموميه
قرار المفوض السامي رقم ٣٣٣٩	١٩٣٠/١١/١٢	نظام الملكية العقارية والحقوق العينية غير المنقولة
قرار المفوض السامي رقم ١١٣	١٩٣٣/٨/٩	نظام المناجم
قرار المفوض السامي رقم ١٦٦	١٩٣٣/١١/٧	نظام للاثار القديمة
قرار المفوض السامي رقم ١٣٣	١٩٣٦/٦/٢٣	تحوير القرار عدد ١١٣ ت ٩-٨-١٩٣٣ المتعلق بنظام المناجم
مرسوم-إشتراعي رقم ٥	١٩٧٧/١/٣١	انشاء مجلس الانماء والاعمار
مرسوم رقم ٤٣٤	١٩٤٢/٠٣/٢٨	بتصنيف واخضاع لنصوص قانون ٨ تموز ١٩٣٩ المواقع والمباني الطبيعية في الجمهورية اللبنانية
مرسوم رقم ١١٦١٤	١٩٦٩/١/٤	اكتساب غير اللبنانيين الحقوق العينية العقارية في لبنان
مرسوم رقم ٤٠٨٢	٢٠٠٠/١٠/١٤	تنظيم وزارة الداخلية والبلديات
مرسوم رقم ٨٨٠٣	٢٠٠٢/١٠/٤	تنظيم المقالع والكسارات
مرسوم رقم ٩٢٢٢	٢٠٠٢/١٢/٩	النظام الداخلي للمجلس الوطني للمقالع
مرسوم رقم ١٥٨٧٤	٢٠٠٥/١٢/٥	المرسوم التطبيقي لقانون البناء
مرسوم رقم ١٦٤٥٦	٢٠٠٦/٢/٢٧	تعديل المرسوم رقم ٨٨٠٣ تاريخ ٢٠٠٢/١٠/٤ وتعديلاته (تنظيم المقالع والكسارات)
مرسوم رقم ٦١٧	٢٠٠٧/٨/٨	تعديل المرسوم رقم ١٥٨٧٤ تاريخ ٢٠٠٥/١٢/٥ (المرسوم التطبيقي لقانون البناء)
مرسوم رقم ١٧٣٥	٢٠٠٩/٤/١٤	تعديل المرسوم رقم ٨٨٠٣ تاريخ ٢٠٠٢/١٠/٤ وتعديلاته لا سيما المرسوم رقم ١٦٤٥٦ تاريخ ٢٠٠٦/٢/٢٧ (تنظيم المقالع والكسارات)
مرسوم رقم ٢٣٦٦	٢٠٠٩/٦/٢٠	الخطة الشاملة لترتيب الأراضي اللبنانية
مرسوم رقم ٨٢١٣	٢٠١٢/٥/٢٤	التقييم البيئي الإستراتيجي لمشاريع السياسات والخطط والبرامج في القطاع العام
مرسوم رقم ٦٥٦٩	٢٠٢٠/٧/٣	تحديد دقائق تطبيق المادة ٦١ من قانون موازنة العام ٢٠١٩ المتعلقة بإجراء المسح الميداني للمقالع والكسارات
قرار مجلس الوزراء رقم ٤٥	٢٠١٩/٣/٢١	عرض وزارة البيئة مسودة سياسة الادارة المتكاملة لقطاع محافر الرمل والأتربة والمقالع والكسارات
قرار مجلس الوزراء رقم ٥٠	٢٠١٩/٩/٥	طلب وزارة البيئة الموافقة على تكليف مجلس الإنماء والإعمار اعداد مخطط توجيهي لحماية قمم الجبال والمناطق الطبيعية، وتنظيم استثمار الشواطئ والمساحات الخضراء والأراضي الزراعية في لبنان
قرار مجلس الوزراء رقم ١	٢٠١٩/٩/١٧	الاتفاق على بنود مشروع مرسوم تعديل مرسوم تنظيم المقالع والكسارات كاملة على ان تقر الخرائط المرفقة في الجلسة القادمة
قرار وزيري البيئة والمالية رقم ١٧٩	٢٠١٧/٣/٢	آلية مصادرة الكفالات المصرفية المودعة لدى وزارة البيئة لضمان تنفيذ شروط منح تراخيص إستثمار المقالع والكسارات ومحافر الرمل وتأمين الإعتمادات اللازمة لتنفيذ أعمال إعادة التأهيل
قرار وزارة البيئة رقم ٤٨	٢٠٠٩/٦/١٧	آلية الترخيص لتأهيل مواقع المقالع
قرار وزارة البيئة رقم ٥٢	٢٠١١/١٠/٢٦	تحديد المستندات والشروط العائدة للترخيص ولاستثمار كسارات بحص منفردة (دون مقلع) لزوم مشروع انشائي عام أو خاص خارج الخريطة رقم (١) المرفقة بالمرسوم رقم ٢٠٠٢/٨٨٠٣
قرار وزارة البيئة رقم ٥٣	٢٠١١/١٠/٢٦	تحديد المستندات والشروط العائدة للترخيص ولإستثمار مقالع الحجر التزييني (بلوك) وحجر العمار خارج الخريطة رقم (١) المرفقة بالمرسوم رقم ٢٠٠٢/٨٨٠٣
قرار وزارة البيئة رقم ٥٤	٢٠١١/١٠/٢٦	تحديد المستندات والشروط العائدة للترخيص ولاستثمار مقالع البحص المفتت طبيعياً خارج الخريطة رقم (١) المرفقة بالمرسوم رقم ٢٠٠٢/٨٨٠٣
قرار وزارة البيئة رقم ٥٥	٢٠١١/١٠/٢٦	تحديد المستندات والشروط العائدة للترخيص ولاستثمار محافر الرمل أو الرمل الصناعي خارج الخريطة رقم (١) المرفقة بالمرسوم رقم ٢٠٠٢/٨٨٠٣

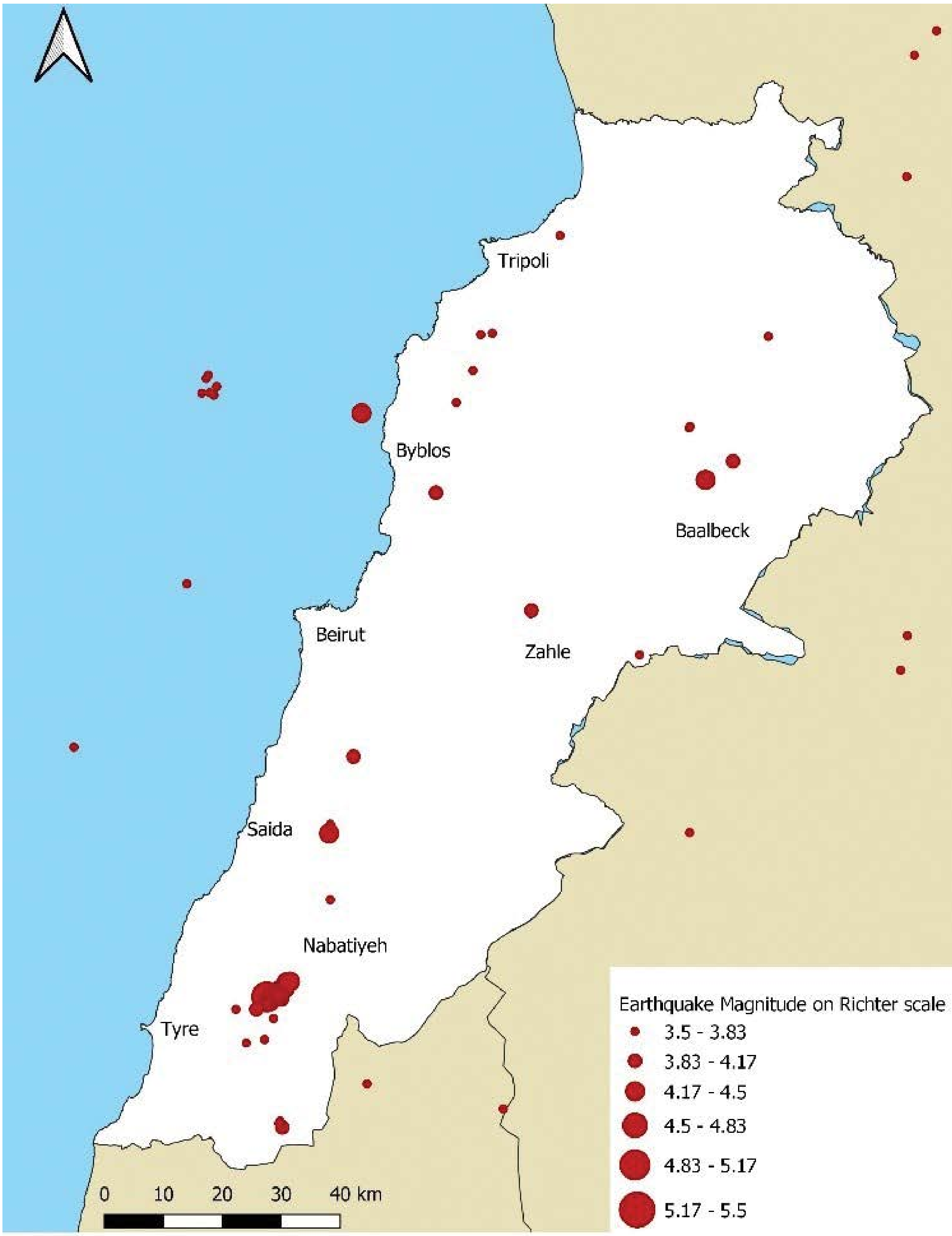
القوانين والأنظمة	التاريخ	عنوان النص
قرار وزارة البيئة رقم ٥٦	٢٠١١/١٠/٢٦	تحديد المستندات والشروط العائدة للترخيص ولاستثمار مقالع الصخور للكسارات والردميات (مقلع وكسارة) خارج الخريطة رقم (١) المرفقة بالمرسوم رقم ٢٠٠٢/٨٨٠٣
قرار وزارة البيئة رقم ٥٧	٢٠١١/١٠/٢٦	تحديد المستندات والشروط العائدة للترخيص ولإستثمار مقالع الصخور والكسارات لصناعة بحص الموزاييك خارج الخريطة رقم (١) المرفقة بالمرسوم رقم ٢٠٠٢/٨٨٠٣
قرار وزارة البيئة رقم ١٩٠	٢٠١٨/٣/٩	تحديد المستندات والشروط العائدة لاستثمار الكسارات صغيرة الحجم في المؤسسات المصنفة

ان القوانين والمراسيم المتعلقة بإحداث محميات طبيعية او مواقع طبيعية موجودة في الفصل الثامن - النظم الطبيعية

Annex 1: Maps



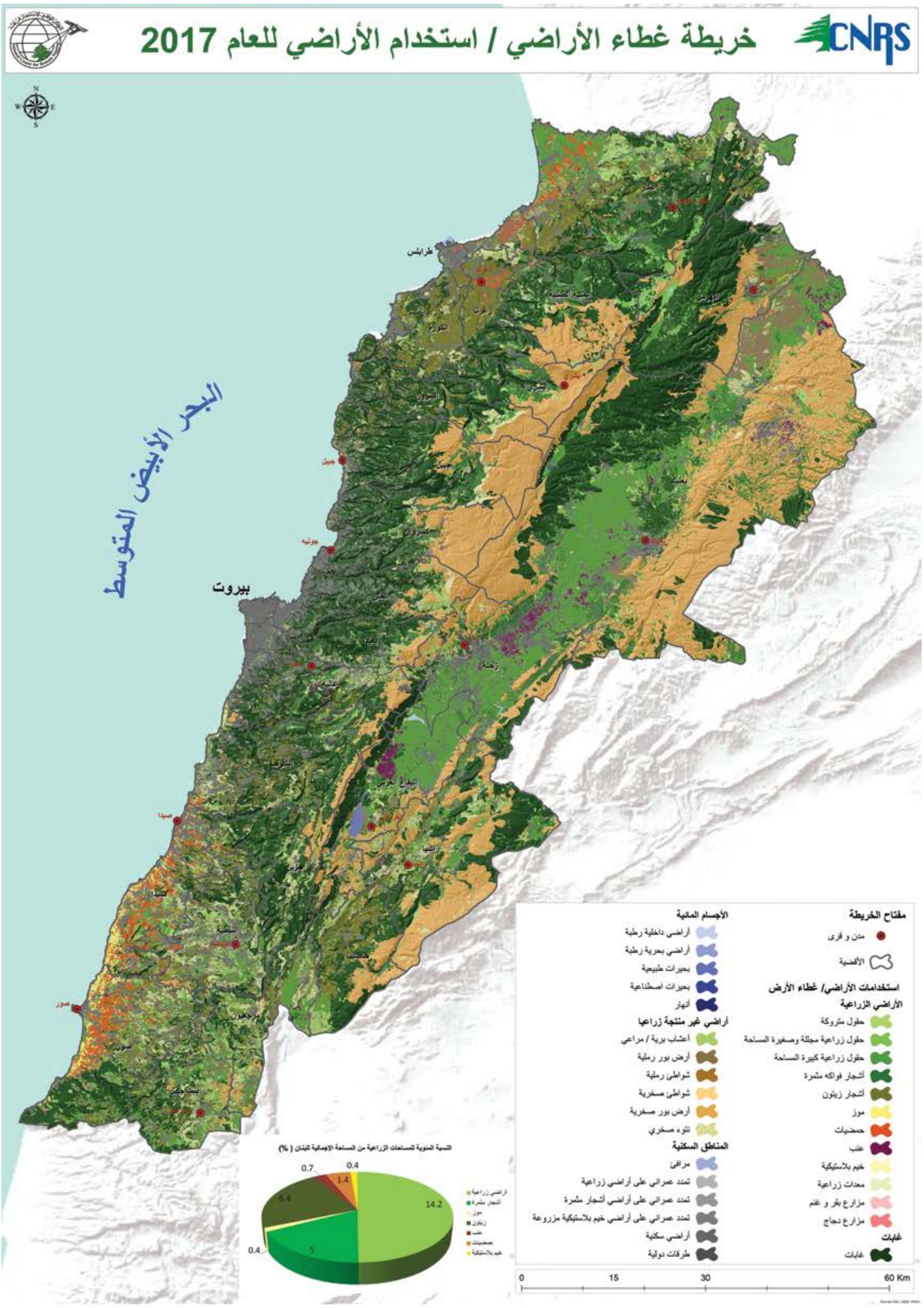
Map 1: Map of Karst Formations
Source: NPMPLT, 2009



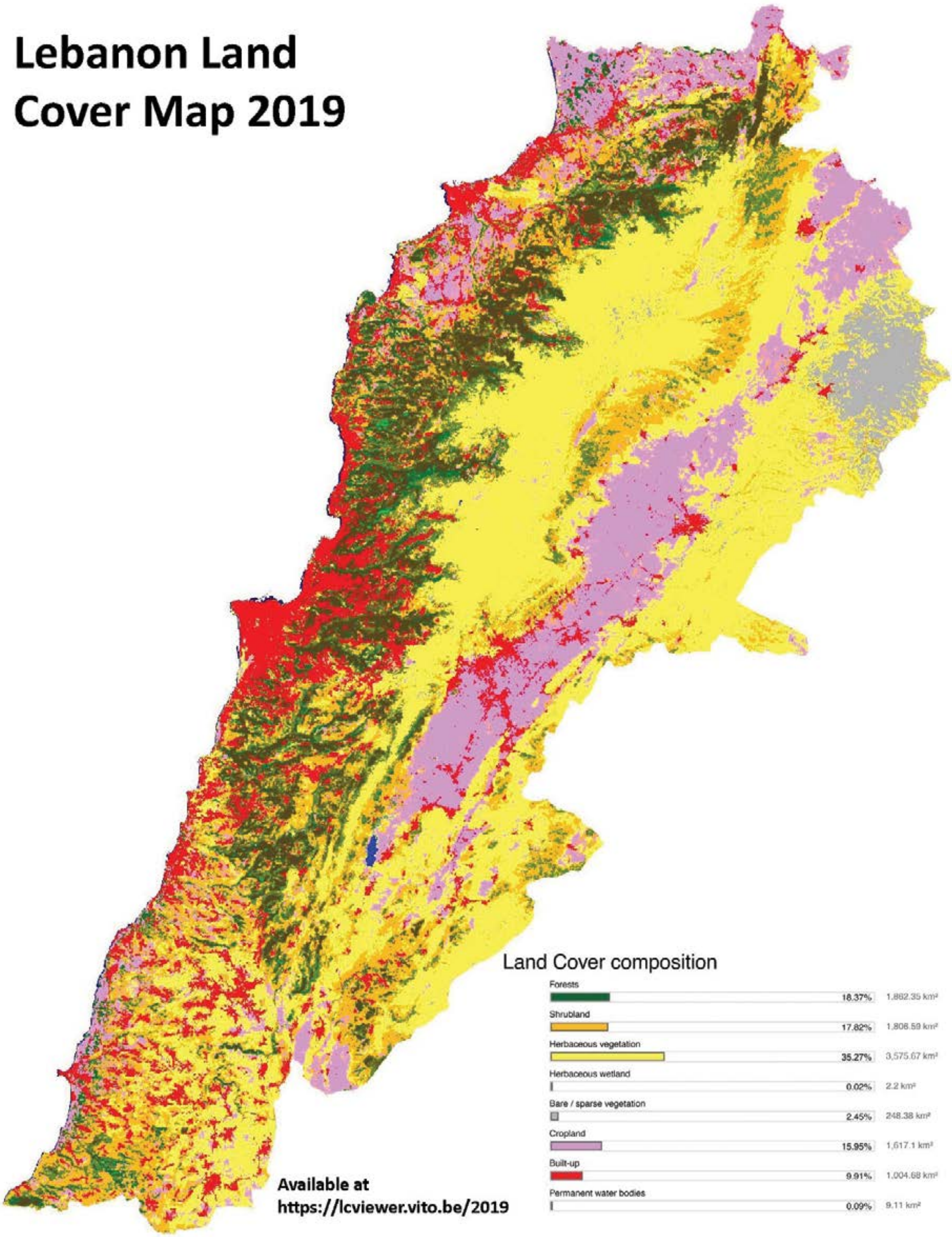
Map of earthquakes from 2001 to 2019 (above a magnitude of 3.5 on Richter scale)

Prepared by author for 2020 SOER. Source: NCSR, 2020.

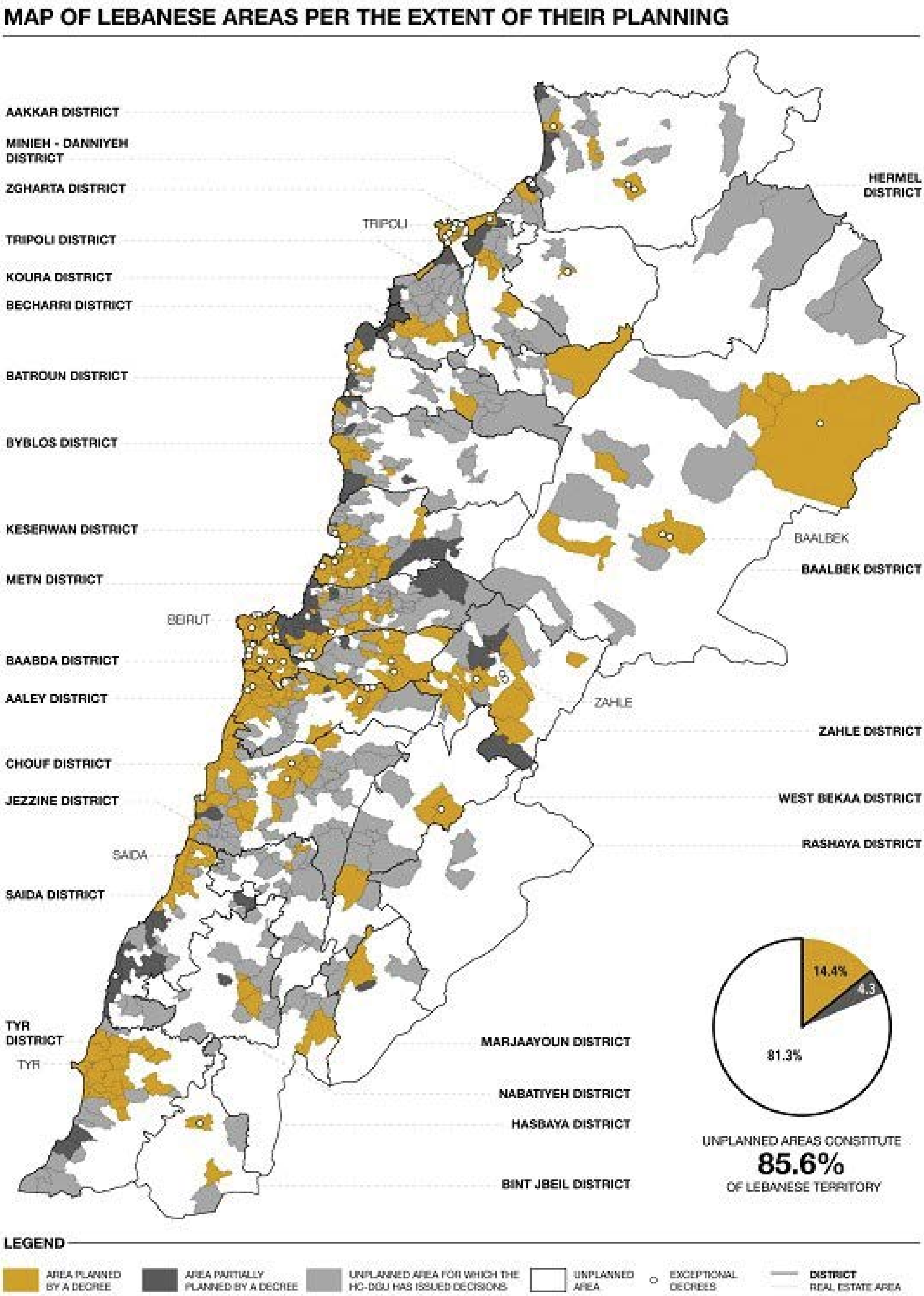
Map 2: Earthquakes recorded above the 3.5 on Richter Scale
Source: CNRS (2001-2019)



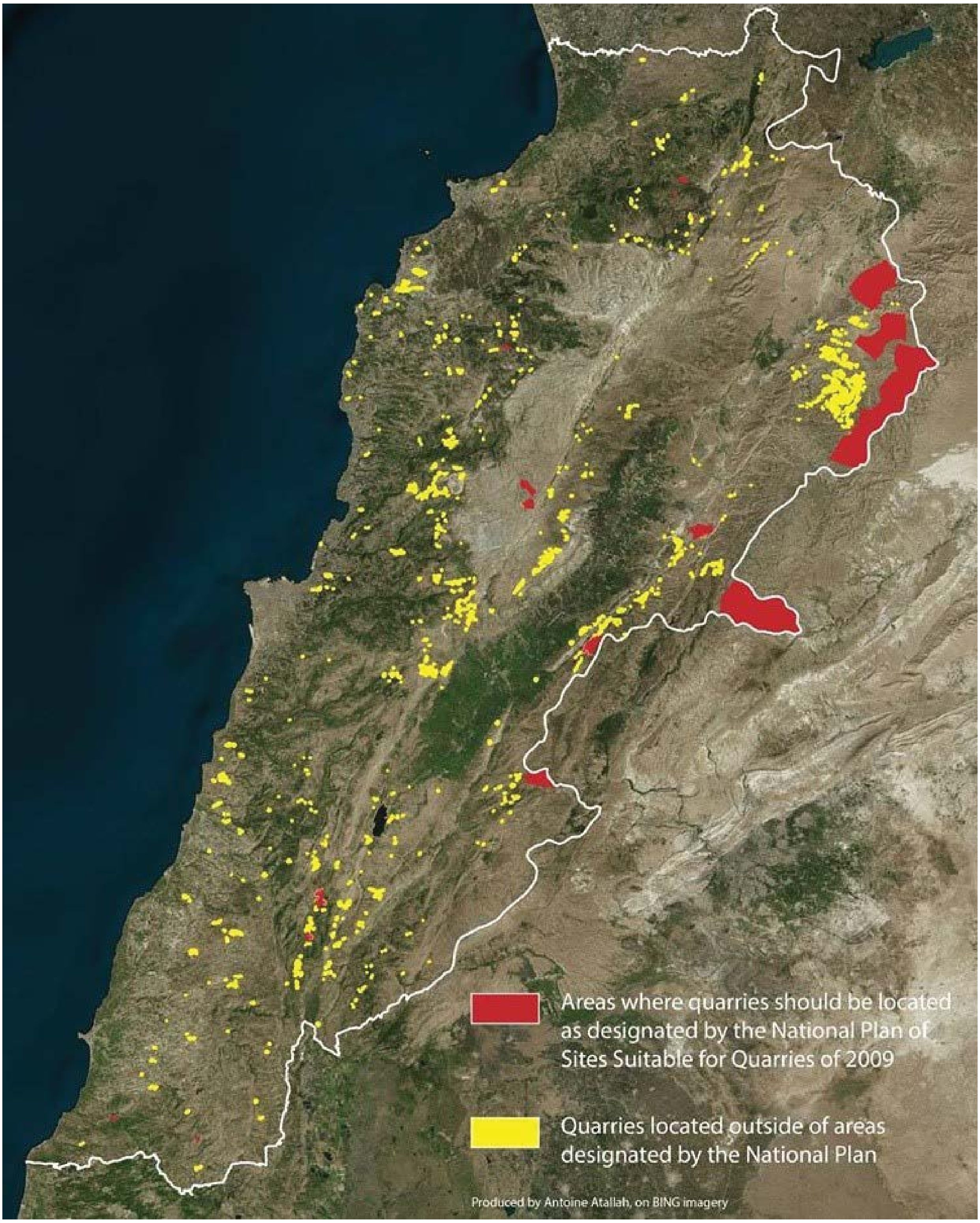
Map 3: Lebanon Land Cover Map 2017
Source: CNRS, 2017



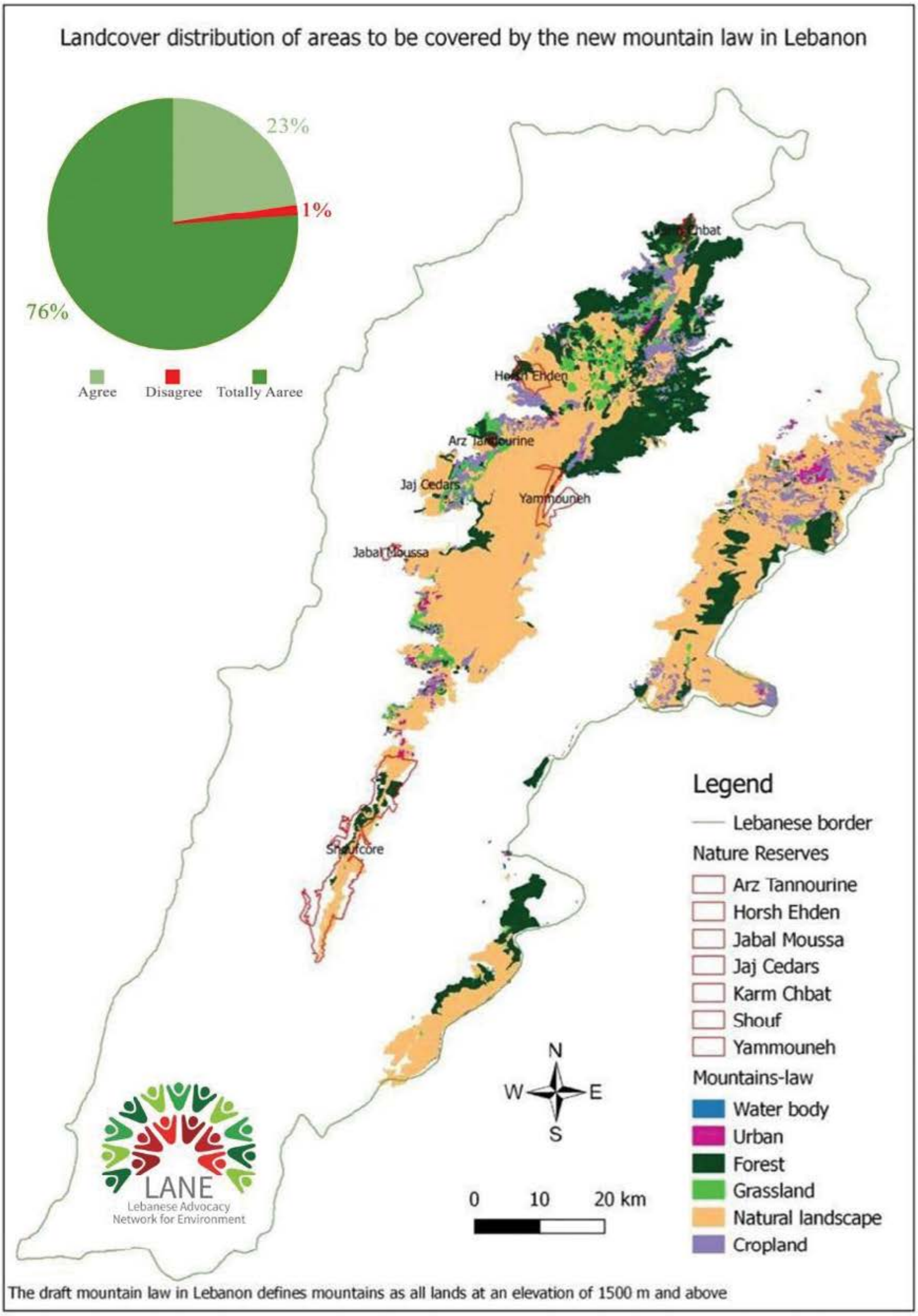
Map 4: Lebanon Land Cover Map 2019
Source: © Copernicus Service Information, 2019



Map 5: Lebanese areas per the Extent of their Planning
Source: Legal Agenda, 2018



Map 6: Location of Quarries and Suitability of Areas
Source: Atallah, Bing Imagery, 2018.



Map 7: Land Classification of Zones above 1,500 m
Source: LANE, 2020

Annex 2: Selected NGOs with Activities Related to Land Resources

NGO Name	Field of Activity	Achievements
Association pour la Protection des Sites et An-ciennes De-meures au Liban, APSAD (esta-blished in 1960)	Promote the protection and restoration of ancient buildings that carry historical and/or unique architectural value. Lobbies for promulgating laws and regulations protecting the architectural heritage	Active since 1962 in the restoration and rehabilitation of traditional Lebanese houses (historical façades), old souks, khans, and old streets (Jbeil, Jounieh, Bikfaya, Zouk Mikhael, Deir El Kamar). Lobbied for protecting a historical building in Sodeco (Beirut) and converting it into a museum Beit Beirut.
Friends of Nature (established in 1972)	Work on the protection of the natural heritage of Lebanon in all its aspects from research to implementation through developing and executing a diversity of tools from conservation of assets and landscape, to reduction of threats, spreading awareness and advocacy, youth and community engagement, ecotourism, and rural development.	Pioneered nature conservation prior to CBD in the creation of the first two nature reserves through com-munity engagement and legislation setting the prece-dence; provided the preambles and documentation for the creation of the Ministry of Environment and supported its continued status as a separate ministry, supported the establishment of many sister NGOs, protected many forests and landscapes from fires, garbage, infestations, logging, quarrying and other threats, established an archetypal artificial reef gar-den for marine ecosystem restoration, and fostering in-situ conservation of endemic plants.
Society for the Protection of Nature in Lebanon – SPNL (established in 1983)	Dedicated to causes that protect species, conserve sites, improve lives, educate the youth, and unite people around the HIMA.	SPNL advocated the establishment of protected areas and the Hima community based conservation approach that has been prevalent in the Arabic region for more than 1500 years. As a member of the World Conservation Union (IUCN), SPNL has helped develop the first biodiversity project in Lebanon, known as the Protected Areas Project. SPNL has established the Environment Information Center (EIC) that serves as a key resource for the provision of environmental information to students, teachers, and researchers in this field.
Friends of the Cedars of Bsharre Committee (established in 1986)	Charged by the MoT to oversee and manage the ancient cedar grove of Bcharre (Arz el Rab, a World Heritage Site). Implement increasingly larger and bolder reforestation activities in the area of Bcharre.	The organization manages its own plant nursery (located in Bcharre) and transplants approximately 12,000-10,000 seedlings per year, mostly cedars, to restore the cedar mantle overlooking Qadisha Valley.
AFDC (established in 1995)	Community-based forest management and conservation including fire prevention. Build awareness and raise capacities in support of national efforts to improve environmental management.	CoM approved a MOU between MoE and AFDC to develop and implement an action plan for forest fire prevention and landscape restoration (Decision 138 dated 2007/10/27). Working in collaboration with the IUCN, AFDC released in May 2009 the long-awaited "Lebanon's National Strategy for Forest Fire Management: Building Partnerships". In 2019, AFDC in collaboration with MoA, MoE, UNCCD, UNEP, UNDP, the LDN Global Mechanism, the GEF and the IUCN published the "Integration of Lebanon's Land Degradation Targets within the National Action Program (NAP) to Combat Desertification".
Mada (established in 2000)	Reinforce the relationship between local communities and their natural environment for the satisfaction of their subsistence needs especially in Aakkar, Donnieh and Hermel	In 2006, Mada defined a pilot zone (about 270 km^2) stretching from Brissa to Qbaiyat, and signed cooperation protocols with the municipalities of Qbaiyat, Hrar, Michmich and Fnaideq to formulate a regional action plan to promote and enhance the natural resources of the area. The organization also conducted studies on flora and avifauna and will soon extend those studies to fauna as well. The proposed national park is today embedded in the NPMPLT (Decree 2366 dated 2009/06/20) along with six other regional parks.

NGO Name	Field of Activity	Achievements
Lebanon Mountain Trail Association, LMTA (established in 2007)	Develop, maintain and promote the Lebanon Mountain Trail, a 440km path that crosses 75 towns and villages; protect the natural, cultural and architectural heritage and landmarks near the trail; enhance economic opportunities by promoting responsible tourism	Prepared and updates a complete set of communication material including brochures and maps; attracts more than 30,000 visitors on the trail every year; organizes an annual thru-walk spanning 30 days; co-sponsored the production of a coffee-table book A Million Steps; organizes training for local guides; lobbies MoT for recognition of local guesthouses and MoE for protection of trail corridor.
Jouzour Loubnan (established in 2008)	Participate in the restoration of Lebanese woodland and promote sustainable forestation in arid regions	Designed and launched 8 consecutive national awareness campaign, planted more than 350,000 native trees in more than 20 areas across Lebanon, created a seed bank lab, and initiated several green programmes for real estate developers, schools, car dealers, companies, etc.
Lebanon Reforestation Initiative (established in 2011)	Preserve and manages forests by supporting local governments and communities.	Projects include the ecological rehabilitation as part of the SLMQ (Bekaa), the FLRM to combat land degradation, as well as various reforestation activities all over the territory (Bakka, Mchaa' Keserwan, Sfireh, Taran, Btormaz, Yammouneh, Dahr El Ahmar, Mdoukha).

Annex 3: Key Reforestation Projects

Project Title	Implementation Date	Activities
Land Degradation Neutrality of Mountain Landscapes in Lebanon (MoE/UNDP/GEF)	2019-2024	The project will rehabilitate and prevent degradation of mountain ecosystems in Akkar and Jbeil districts.
Land Degradation Neutrality of Mountain Landscapes in Lebanon (MoE/UNDP/GEF)	2019-2024	The project will rehabilitate and prevent degradation of mountain ecosystems in Akkar and Jbeil districts.
The "STONE" project (SBR/Istituto Oikos/Italian Agency for Development Cooperation)	2019	30 ha of terraces and traditional farming systems will be restored by the Shouf Biosphere Reserve projecting positive influence on the local economy, biodiversity conservation and ecosystem services
(SBR/Istituto Oikos/Italian Agency for Development Cooperation)	2019	30 ha of terraces and traditional farming systems will be restored by the Shouf Biosphere Reserve projecting positive influence on the local economy, biodiversity conservation and ecosystem services
Sustainable Land Management in the Qaraoun Catchment project (SLMQ) (MoE/UNDP/GEF)	2016-Ongoing	It promotes sustainable management practices for agriculture lands, forests and rangelands and develop national guidelines for the management of forests and rangelands. It will also restore 500 ha of forests and improve the status of 10,000 ha of rangelands.
Smart Adaptation of Forest Landscape in Mountain Areas (SALMA) (MoA/FAO/GEF)	2016-2021	It will result in the restoration of 1000 ha of forests and the sustainable management of another 1000 ha and provide a participatory approach to reforestation/afforestation and forest management.
The Forest and Landscape Restoration Mechanism (FLRM) (MoA/FAO/Republic of Korea and German Republic)	2016-2020	It generated a comprehensive national strategy for rangeland management, promoted national actions for better forest and natural landscape restoration, supported sustainable finance mechanisms for restoration requirements, and improved legal framework to regulate the natural landscapes.
National Forest Seed Center of Lebanon (LARI-MoA/FAO/State of Norway)	2016	It focuses on the requirement for the production of high-quality seedlings to meet the needs of large- scale reforestation and restoration projects.
Safeguarding and Restoring Lebanon's Woodland Resources	2016-2020	It generated a comprehensive national strategy for rangeland management, promoted national actions for better forest and natural landscape restoration, supported sustainable finance mechanisms for restoration requirements, and improved legal framework to regulate the natural landscapes.
The Lebanese Reforestation Initiative (USAID)	2010-Ongoing	A project funded by the United States Agency for International Development (USAID) and implemented by the United States Forest Service (USFS) started in 2010 and developed to an NGO. It has accomplished the reforestation of 2566 ha till 2021 and supported the local network for producing native forest trees and shrubs.

SECTION III

ENVIRONMENTAL PRIORITIES

7 Haphazard Urbanization

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Abbreviations and Acronyms

ADELNORD	Appui au Développement Local dans le Nord du Liban (Support for Local Development in North Lebanon)
CDR	Council for Development and Reconstruction
C&D	Construction and Demolition
CNRS	National Council for Scientific Research
CoM	Council of Ministers
GDLRC	General Directorate of Land Registry and Cadastre
DGUP	Directorate General of Urban Planning
EIA	Environmental Impact Assessment
HCUP	Higher Council of Urban Planning
ITS	Informal Tented Settlements
MAJAL	مجال- مرصد جامعي للإعمار وإعادة الإعمار في لبنان (Academic Urban Observatory for Construction and Reconstruction in Lebanon)
MoE	Ministry of Environment
MoF	Ministry of Finance
MoIM	Ministry of Interior and Municipalities
MoPWT	Ministry of Public Works and Transport
NPMPLT	National Physical Master Plan of the Lebanese Territory
SEA	Strategic Environmental Assessment
SOER	State of the Environment Report
UNDP	United Nations Development Programme

7. Haphazard Urbanization

Urbanization started adding a toll on the environment since the industrialization of the economy and after the demographic transition brought massive land use changes. With the advent of new construction techniques, materials (such as concrete and asphalt) and transportation modes, the rapid development of cities has been, and still is, a major influence on the loss of natural areas, resources and biodiversity. This chapter focuses on the urbanization phenomenon in Lebanon, its effects on the environment and suggested actions to mitigate environmental damage and improve cities to become more sustainable.

7.1 Driving Forces

The weak position of the central government as well as the limited inclusive governance, coupled to the traditional laissez-faire economic policies, are part of the main obstacles for balanced urban growth in Lebanon. The country also deals with the legacy of feudal structures of society and its ramifications on land property, the various quick movement of populations (migration waves, displaced or refugees), destructive events (civil war, Israeli bombardments and disasters) and their aftermath.

Most importantly, the concept of "land" is only defined as that of a commodity and not a public good, given its scarcity in such a small country. Expropriation cases of private lands in Lebanon have only taken place to implement infrastructure projects but never for the sake of conservation, sustainability or public benefit (MoE/UNDP/ECODIT, 2011).

The predominantly mountainous terrain (about 75%) presents another limitation as steep slopes render construction difficult and expensive and adds to the challenge of connecting localities to the infrastructure network, most notably roads. Urban planning laws and regulations, frequently inadequate, are commonly disregarded while urban growth is mainly driven by profit for the construction industry. The observed outcome is continuous environmental damage and poor living conditions in certain areas (Box 7-1). Since the 2019 downturn and the COVID-19 pandemic, much uncertainty prevails on the future evolution of the country as it witnessed a considerable decrease in economic activity and a looming mass emigration.

Box 7-1 Substandard Living Conditions in Poorly Serviced Cities and Suburbs

Haphazard or poorly planned construction, especially around cities, has produced urban communities with substandard infrastructure and living conditions. Selected suburbs around Beirut (e.g., Hay el Sellom, Nab'a) and Tripoli (e.g., Bab al Tabbaneh, Jabal Mohsen) have regressed into slums, or shantytowns, with very modest services and amenities, if any. These areas evolved gradually, over many years, and as result of rural-urban migration. The earliest settlements were individuals seeking work in the ports of Beirut and Tripoli and/or the railway. Over time, these early settlements became denser with new and taller construction, reducing available public space and usually rendering them unhygienic. Furthermore, the majority of buildings in these impoverished suburbs and marginalized slums lack proper septic tanks or sewer connections. Buildings commonly discharge raw sewage on vacant plots, in nearby streams or abandoned water wells.

Many Lebanese cities (Beirut, Tripoli, Saida and Tyre) are densely populated. Buildings are collated to one another, preventing natural ventilation and obstructing the sun. Unhygienic conditions, including odors, may occur especially during summer. The impermeability of ground surfaces creates episodes of localized flooding during precipitations. City dwellers in various cities including Beirut, Tripoli, Baalbeck as well as Zahle experience every year floods in low-lying areas, under bridges and in tunnels, and wherever stormwater networks cannot drain standing water fast enough. Most importantly, Lebanese cities lack public spaces such as gardens, playgrounds, sanitary public beaches, designated sport areas, etc. impacting the population's wellbeing and inclusion.

Excerpt from the 2010 SOER

7.1.1 Inadequate Master Planning

Urban master planning in Lebanon is undertaken at three levels: the national level with the National Physical Master Plan of the Lebanese Territory (NPMPLT), the local level with master plans and the detailed local level with detailed urban plans. Only the last one is legally binding while the other two only give indications on the orientation of urban development.

At the national level, the NPMPLT, elaborated by the Council for Development and Reconstruction (CDR), was adopted in 2009 through Decree 2366. The plan, a high-quality strategic document, aimed to guide all subsequent master plans and future development directions in the country. Despite the high quality of the document, its content remains limited to general guidelines which restrict its application at the local level. Available financial and technical resources were not adequate for authorities (both national and local) to prepare the required master plans and detailed urban plans. Since the work initiated was not extended to regional and local scales, no legal framework binds local actors (those involved in the development of detailed urban plans) to its provisions, which are limited to very broad guidelines. This means that its use was left at the discretion of relevant actors. It is to be noted that the CDR has plans to update the NPMPLT to reflect current conditions, but this activity has not yet commenced. Sustainable development notions have recently gained momentum as more projects claim to follow sustainability principles. However, these initiatives, whether genuine or not, are rarely effective without proper policies to back them (CDR, 2016).

At the local level, 2015 data from the Ministry of Public Works and Transport (MoPWT) shows that 32.2% of the territory is planned (Osman & Antoun, 2017) (planning terminology explained in Box 7-2). This number is in reality closer to 20% as, the 2015 data includes decisions not ratified through decrees during the 3-year period dictated by Law 646/2004 (Article 13), thus creating uncertainty about their current status *(refer to Section 7.2.2).*

Box 7-2 Urban Planning Related Terminology

1. Delineation/demarcation (ترسيم): The delimitation of position and borders of a topographical feature. The General Directorate of Land Registry and Cadastre (GDLRC) in the Ministry of Finance (MoF) has to delineate cadastres to delimitate properties.

2. Surveying (مسح): The recording of an area with including all of its physical features and drawing of a map representing them. The Directorate of Geographic Affairs of the Lebanese Armed Forces is in charge of surveying the whole territory at a 1:20 000 scale for military use. The GDLRC also executes surveying in certain cases.

3. Zoning (تقسيم): Setting specific use or rules of development for a designated space. In Lebanon an area is officially considered "zoned" if it has a detailed urban planned drawn by the DGUP and approved by the Council of Ministers (CoM).

All unplanned areas (manateq ghayr mousannafa) used to follow the same land use coefficients regardless of their location with a built-up area of 25% and a floor-area-ratio of 50% as per the Higher Council for Urban Planning (HCUP) Decision 11 of 2005 (Lamy, 2010). The HCUP rectified this by issuing Decision 22 of 2019 for the conditions to be in line with the NPMPLT (Table 7-1). For areas that are under study (or for which plans are in development), the HCUP issues specific instructions for temporary regulation depending on the case. As master plan preparation can drag on, these instructions remain the reference and may end up permanently regulating the area.

There is a long road ahead to have a proper framework for the development of master plans as many problems are rooted in governance and political glitches in the system. Significant deficiencies remain unresolved at the administrative level such as:

- *Lack of comprehensive land surveys:* According to the World Bank (2017), about 45% of the Lebanese territory still needs to be surveyed. Since the 2000s, the GDLRC at the MoF has been surveying the entire country, particularly the mountain areas. Progress has been slow partly due to bureaucratic procedures and partly to the substandard performance of some topographers (MoE/UNDP/ECODIT, 2011). Some digital services have been available since 2016 on the website of the GDLRC and a Land Administration System Modernization project backed by the World Bank

Table 7-1 Land Use Coefficients in Unplanned Areas according to HCUP (Decision 22/2019)

Zone (corresponding to the NPMPLT classification)	Built-up Area	Floor-Area Ratio	Maximum Height (m)	Building Offset (m)
U	25%	50%	9	3
R	30%	40%	7	4
A-a	15%	30%	7	4
A-b	10%	20%	7	6
N3-a	10%	20%	7	6
N3-b	5%	10%	7	10
N1 & N2	5%	5%	4	10

U: Urban areas; R: Rural areas; A: Agricultural areas; N1: Mountain peaks; N2: Cedar corridor; N3: Natural areas; a: if located less than 300m from settlements of more than 30 buildings; b: if located more than 300m from settlements of more than 30 buildings was launched in 2018 to improve data collection, governance structures and transparency (see Box 7-3).

- *No unified land use classification nor zoning methods at the national level:* Each master plan has its own zoning naming and codes which makes it impossible to elaborate a clear regional view and compare different plans.
- *Lack of updated data:* Most of the data presented by the Central Administration of Statistics related to infrastructure, construction, demographics and vital statistics requires updating. For example, the last census for buildings, dwelling and establishments was published in 2004. Many datasets are irregular, presenting different indicators or layout for each year, and panel data almost non-existent.

Box 7-3 Land Administration System Modernization Project

The 5-year project was launched in 2018 and is funded through a World Bank loan for the amount of US$ 43 million to the MoF and implemented by the GDLRC. It has the following five components:

1. Modernization of the digital Land Registry and Cadastre system. The objective of this component is to implement the integrated ICT solution for Digital Land Registry, Cadastre and State Land Management.

2. National Spatial Data Infrastructure. The objective of this component is to enhance the identification, storage, use, sharing and exchanging of geospatial data and services in Lebanon. This would be achieved by providing access to Land Registry and Cadastre data and other public geospatial datasets through the National Spatial Data Infrastructure.

3. Property Valuation and Taxation. The objective of this component is to establish a mass valuation system and Land Value Map (adjusted by price indices) to increase market transparency, reduce banking sector/mortgage risk as well as enhancing the recurrent property tax.

4. State Land Inventory and Management. The objective of this component is to integrate State Lands into the Land Registry and develop a new State Land Management System.

5. Regulatory and Institutional Development, Capacity Building and Project Management. The objective of this component is to improve the institutional and governance structures of the GDLRC in order to permit the successful implementation of the overall project and to ensure the sustainability of the planned outcomes. It aims at developing modern governance structure for the land administration system and also to provide project management, reporting, fiduciary and safeguards support to the project implementation.

Source: World Bank, 2018

those of the Directorate General for Urban Planning (DGUP) (refer to Section 7.2.1.1), have been hindered by several lobby groups (El-Achkar, 2012).

Another example is the Baalbek consecutive conceived master plans, which contributed to the exacerbation of the “illegal” situation in the city (see Box 7-4).

Box 7-4 Master Planning and Irregularities in Baalbek

For decades, Baalbek has witnessed many violations within the construction sector, creating chaos in city planning. This has led to many confrontations between the residents of Baalbek and security forces as the majority of residents start building construction without obtaining any permit from the relevant authorities.

In 2013, after several failed attempts to address this issue, a directive decree was issued for Baalbek historic core. It highlighted the tourism potential in Baalbek in line with the NPMPLT recommendations through the classification of additional areas next to the castle and its surroundings prepared for expropriation by the Directorate General of Antiquities (DGA). It also encouraged construction in areas characterized by large plots where exploitation ratios increased after being very limited.

Subsequently, in 2015, the Union of Municipalities of Baalbek launched its Strategic Plan for Local Development. The objective of this plan was to study some of the unplanned villages of the union and to reconsider the existing urban master plans for a number of areas including Baalbek city. However, until today, the new master plan has not been adopted, and the amendments that are being made to the classification of areas, as well as the related building regulations, are carried out behind closed doors between the representatives of the region, the assigned engineering office, the municipality, and the Planning Department at the DGUP, without any public participation or consultation. In fact, such a plan requires conducting a consultative Strategic Environmental Assessment (SEA) as per Decree 8213/2012 and submitting it to the Ministry of Environment (MoE) for review. This paved the way to modify the concept of development in Baalbek in line with the vision of the municipality serving the interest of the local political authority, ignoring the residents’ needs, as well as the existing agricultural, historical and social characteristics of its neighborhoods.

In addition, public authorities failed to address the root causes of the problem and resorted to a series of circulars issued by the Ministry of Interior and Municipalities (MoIM) allowing municipalities to grant building permits on rural parcels with an area of 150 m^2 and to add one layer of the same area to an existing building (refer to Section 7.2.3.2 for more details). These decisions, along with the elaborated master plans, likely led to additional illegal construction in the city.

Thus, it is necessary to reconsider the master plan that should emerge from the housing needs taking into account the city’s cultural, archaeological, natural and agricultural heritage leading towards productive economic development.

The process of master planning is vulnerable to political pressure and interference. An example is the Beirut Master Plan, which has remained mostly unchanged since 1954 (except for the Solidere-controlled downtown). Efforts to change it, including

However, even with a master plan drawn and adopted, the limited enforcement of existing regulations, excessive excavations, inappropriate building coefficients disregard for integration with the surrounding environment are all common cases typical of poorly designed plans in Lebanon. They all inevitably lead to increased pressure on the existing infrastructure, the quality of available public services and to the encroachment on agricultural lands. In addition, soft mobility is nonexistent in Lebanon and no serious effort has been made to encourage the development of pedestrian and bike-friendly transportation networks.

7.1.2 A Struggling Real Estate Sector

Since 2011 and until 2019, the real estate sector in Lebanon has considerably slowed down. One reason is the oversupply (Azar, 2018), especially since the main type of construction (luxury residential) is not fit for the majority of the market as demand has trended towards smaller surfaces. The influx of displaced Syrians at the beginning of the crisis brought additional rental transactions estimated at 34 million US$/month, saturating the affordable housing market and encouraging new haphazard constructions (MoE/EU/UNDP, 2014). The economic degradation of the country since the start of the Syrian conflict in 2011 meant that local investors were reluctant to support real estate projects, especially considering the high borrowing rates (details on the impact of the Syrian crisis in Sections 7.1.3 and 7.2.4.2). Additionally, investors from the Gulf became scarce after the fall of oil prices since 2014.

The continuous increase in real estate prices until 2011 had been so significant that many Lebanese working in the country could no longer afford to buy a home without resorting to expensive commercial loans or subsidized loans and exerting additional pressures on the GoL finances, noting that the Central Bank stopped issuing subsidized housing loans in 2018 (Figure 7-1). However, since late 2019, with the increased distrust in local banking institutions, real estate transactions jumped back, although mainly limited to completed buildings (Cornish, 2020) and indebted developers (De Guzman, 2019). Real estate is considered a safe haven for depositors fearing a stranglehold on their bank deposits. The situation remains extremely unpredictable since then, with frequent rushes in specific attractive zones like Kfardebian and its surroundings (Boudisseau, 2021). This meant that, even if transactions jumped back in specific cases, they are far from pre-crisis levels and the construction sector remains lethargic.

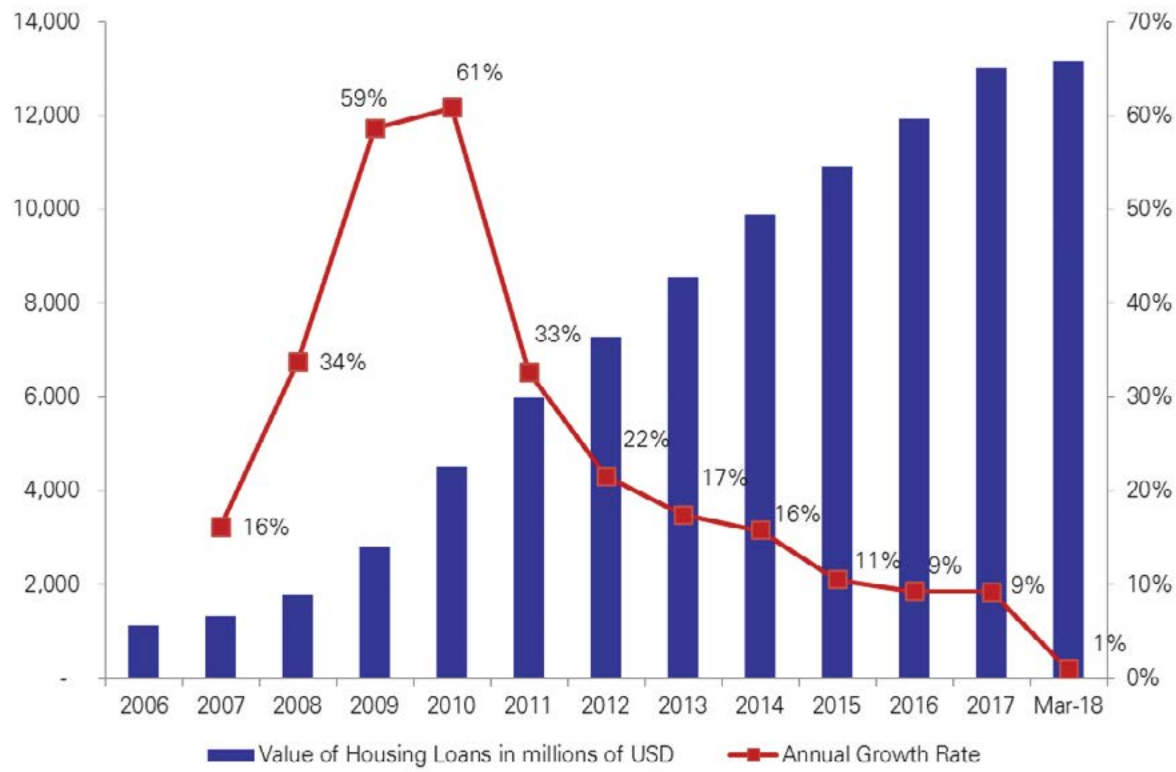


Figure 7-1 Housing Loans Growth 2006-2018
Source: Banque du Liban, 2020

It is important to point out the deficiencies in the Lebanese legislation when it comes to foreign ownership of land and property that remained for years (MoE/UNDP/ECODIT, 2011) still exist and need to be resolved.

To sum up, Lebanon was home to one of the world's most vibrant real estate markets until the recent economic crisis. The sector has traditionally been a catalyst of economic development, despite the lack of sustainable urban planning. As such, overhauling the sector to meet the population's needs in terms of decent and affordable housing and adopting environmental sustainability standards while remaining one of the pillars of the economy is more necessary than ever.

7.1.3 The Impact of the Syrian Crisis

Since the start of the Syrian crisis, the number of displaced soared in Lebanon, with many living in Informal Tented Settlements (ITS), located on or close to agricultural areas and environmentally sensitive areas such as Bekaa and Akkar (See detailed Maps in Annex 1), which exert severe pressures on natural resources including land, biodiversity and water sources. More than 40% of Syrian displaced live in inadequate shelter with minimal infrastructure, such that conditions are worsening over time (UNHCR, 2019 and Fawaz et al., 2014). The majority (69%) is living in urban and peri-urban areas (UNHCR, 2019); the resulting high demand for affordable housing increased the price in the market, making it even less accessible to many.

Observations of settlement patterns indicated a clustering of displaced creating over-dense pseudo-camps in urban areas (Fawaz et al., 2014). No action was taken to properly settle the displaced, as this would be seen as legitimizing their presence in the long term. As most of the displaced do not pay municipal taxes since they reside in informal housing, municipalities became ever more reluctant to upgrade infrastructure and public services. The outcome simply was exacerbated pressure on electricity, water, sewage and waste services, all of which were insufficient even before the crisis. The situation did not improve over time as many displaced moved from conventional housing to ITS after their eviction *(See details in Chapter 6 - Land Resources)*.

7.2 Current Situation

7.2.1 Institutional Framework

Many intervening actors take part in the process of urban planning decisions in Lebanon as illustrated in Figure 7-2.

While Lebanon is a small country and most of the proliferating municipalities (around 1,000) do not have the financial means to sustain themselves, decentralization is key to ensure the development of each region as the large number of municipalities could be an advantage to implement participatory approaches. The main actors in the institutional framework are described in Table 7-2 and in the sections that follow.

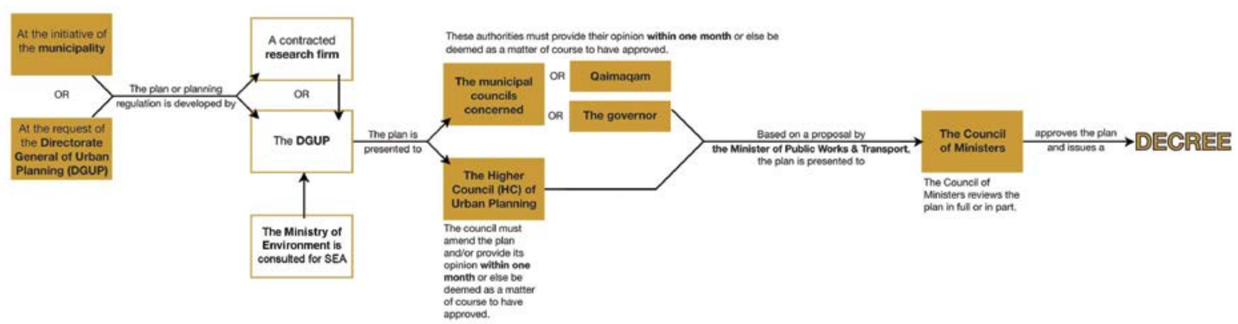


Figure 7-2 Main Stakeholders Involved in Urban Planning
Source: Adapted from Public Works Studio, 2018

Table 7-2 Distribution of Responsibilities Related to Urban Planning

Entity / Responsibility	MoPWT (DGUP)1/	HCUP2/	CDR3/	CoM	MoC (DGA)4/	MoE5/	Munici-palities / Qaimaqam / Gover-nor6/	OEA7/
Master plans	X	X	X8	X			X9	
Strategic Environ-mental Assessment						X		
Construction permits	X	X8					X9	X
Infrastructure	X		X8				X9	
Heritage Buildings	X				X			

1/ Decree 10490/1997: Reorganization of the DGUP and its staffing
2/ Law 69/1983: Urban Planning Code
3/ Law-decree 5/1977: Establishment of the Council for Development and Reconstruction
4/ Law 215/1993: Establishing the Ministry of Culture and Higher Education and Law 247/2000: Merging, canceling, and creating ministries and councils
5/ Decree8213/2012: Strategic Environmental Assessment for Public Policies and Projects
6/ Law-decree 118 dated 30/6/1977: Code of Municipalities
7/ Law 646/2004: Amendment of Law-decree 118/1977: Building Code
8/ For large projects
9/ Qaimaqam if there is no municipality

7.2.1.1 Ministry of Public Works and Transport / DGUP

The DGUP established by Law in 1962 under the MoPWT is in charge of developing and approving master plans throughout the Lebanese territory. These plans include recommendations in addition to the mandatory clauses. The DGUP launches most initiatives related to land development. It also assigns Regional Departments of Urban Planning comprised of architects and civil engineers for each caza to ensure compliance with DGUP and HCUP regulations and instructions, and advise municipalities on planning matters. The DGUP is decreasingly involved in drafting master plans and increasingly negotiating master plans proposed by municipalities (Faour et al., 2016).

Established in 1962, the HCUP is headed by the director of the DGUP who works with members from various ministries and institutions. These include directors of agriculture, environment and industry (each from their respective ministries), interior and municipalities and political and refugee affairs (both from the MoIM), justice (within the Ministry of Justice), roads and buildings (within the MoPWT) in addition to the director of programs at the CDR. Other members include the heads of the Orders of Engineers in Beirut and Tripoli, the Director of the Public Corporation for Housing (within the Ministry of Social Affairs) and three experts in the fields of architecture, environment, planning and sociology. The main role of the HCUP is to review and approve master plans, detailed urban plans, as well as large projects but, in reality, it often deals with municipal or private related cases (usually construction permits) (Lamy, 2010).

7.2.1.2 Ministry of Interior and Municipalities / Municipalities

Under the tutelage of the MoIM, municipalities are local administrations responsible for the day-to-day management of all public works within municipal boundaries (Decree-law 118/1977). Along with the DGUP, municipalities are the only entities that propose detailed master plans (subsequently approved by the HCUP and the CoM). They also actively participate in the construction permitting process (see Section 7.2.3). The directors of interior and municipalities and political and refugee affairs represent the MoIM in the HCUP.

7.2.1.3 Council for Development and Reconstruction

The CDR was created in 1977 by Decree-law 5 and operates independently while directly reporting to the CoM. While it intervenes on various issues, it is the main government entity charged with implementing large infrastructure projects, such as highways and roads, and leads multidisciplinary development plans and projects such as the NPMPLT and the regional plan for Akkar (Appui au Développement Local dans le Nord du Liban - AdelNord). The director of programs represents the CDR in the HCUP.

7.2.1.4 Orders of Engineers and Architects

The Orders of Engineers and Architects (OEA) of Beirut and Tripoli were formed in the 1950s to regularize the professions of engineers and architects. The OEA actively proposes amendments to bylaws and regulations related to urban planning. In 2020, the OEA of Beirut had an estimated 50,000 members while around 11,000 are registered in Tripoli. Architects and civil engineers are allowed to sign each up to 14,000 m^2 of floor plan construction permits per year. The OEA has the authority to reject construction permits if technical standards are not met (details about construction permitting process in Section 7.2.3). The Order also requests the elaboration of a geotechnical report to assess the bearing capacity of the land. The technical unit at the Order is responsible for reviewing the construction drawings including architectural, mechanical, electrical and structural. The heads of the OEA also each have a seat in the HCUP.

7.2.1.5 Other Actors

Besides its representative in the HCUP, the MoE oversees the SEA process for any proposed policy, plan or program including urban master plans in line with Decree 8213/2012. This ensures that environmental issues are integrated within the planning process *(refer to Chapter 2 – Environmental Governance for details on SEA and EIA)*. The Ministry of Energy and Water and MoE are also consulted in certain cases such as the construction of cemeteries due to their potential impact on natural resources. The Ministry of Agriculture, also represented in the HCUP, is in charge of forestry and thus may intervene with forest related matters. Similarly, the Ministry of Industry participates in the creation, development and monitoring of industrial zones.

7.2.2 Extent of Urbanization

As per Section 7.2.1, the DGUP and municipalities are the two entities in Lebanon that propose detailed urban master plans. In order to be implemented, master plans are first approved by the DGUP and the HCUP. However, based on Article 13 of the Building Code (Law 646/2004), planning studies and building conditions in planned and unplanned areas that are approved by an HCUP decision become binding on the authority in charge of granting building permits, provided that a regulatory decree is issued within three years from the date of issuance of the decision. The territorial coverage of the master plans has always been limited. By the end of 2014, there were 568 approved master plans, covering 58% of the country's urban areas. However, most of these are not based on DGUP proposals but rather on municipal initiatives. The number of master plans issued by decree as of 2014 is closer to 238 (Faour et al, 2016).

This context of poor planning (both physical and economical) has paved the way for urban development driven only by market trends and population movements. Besides the expansion of traditional residential constructions, informal settlements have also remained an ignored problem for years. As a consequence of the real estate boom of 2006-2011, the question of high-rise buildings is now more pertinent than ever.

7.2.2.1 Urban Expansion

In line with the global trend, urbanization is increasing in Lebanon (Table 7-3). However, quantitative data vary greatly depending on the source. The first reason is that there is no broad consensus as to what is considered "urban areas". Second, in some land cover classifications, built-up areas are calculated without distinction between urban or rural zones. Third, recent studies rely on remote sensing and satellite images to estimate land cover, but the methods and algorithms of data processing vary depending on the analysis technique and type of data used.

Table 7-3 Urbanization Development in Lebanon between 2010 and 2018

Indicator	2010	2018
Population density (persons/km^2)	484.2	669
Urbanization rate	88.3%	88.6%
Urban population annual growth rate	3%	0.73%

Source: World Bank, 2018

According to the NPMPLT, urban areas in the early 1960s covered approximately 260 km^2 of land reaching 649 km^2 by 1998 (CDR, 2004). The European Union Copernicus Program gives an estimation of approximately 1,004 km^2 in 2019 for Lebanon's built-up area *(refer to Annex 1 in Chapter 6 - Land Resources to see the Map)*. Data analyzed through satellite imagery from 1975 till 2014 shows that the increase of built-up areas was more visible during the first half of the period. Overall, densification has been observed all over the country, except for the high mountains and the arid zones in the Northern Bekaa and Anti-Lebanon range (see evolution of urban areas between 1975 and 2014 in Figure 7-3 and urban morphology in Lebanon in Box 7-5).

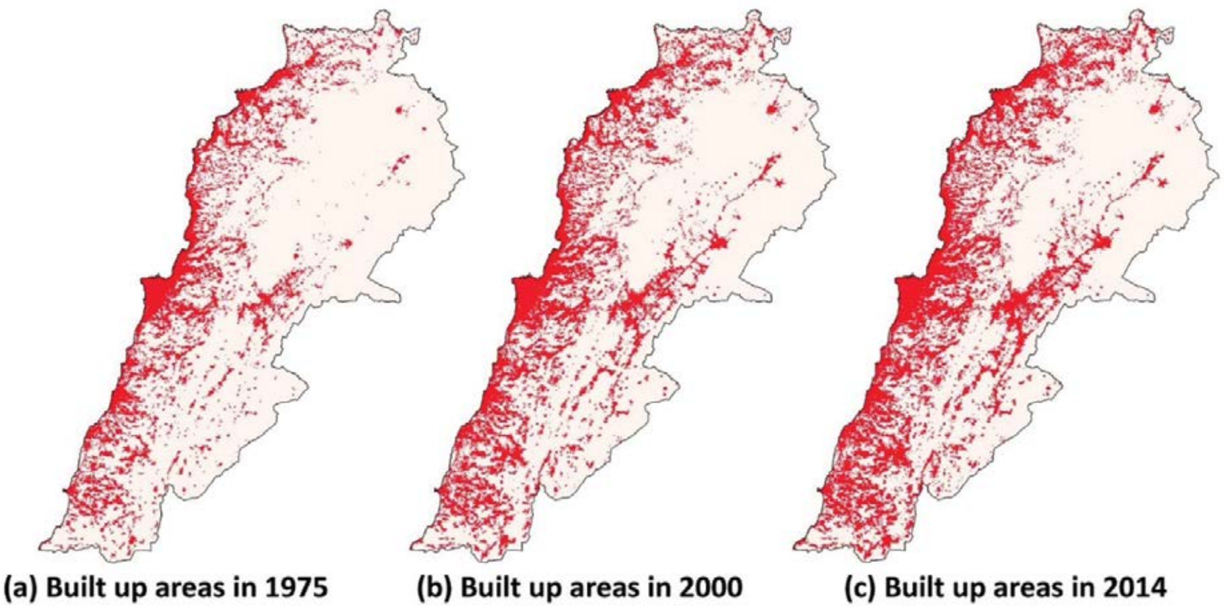


Figure 7-3 Urbanization in Lebanon between 1975, 2000 and 2014
Source: Corbane at al., 2018

Box 7-5 Urban Morphologies Challenges

Current urban planning and building regulations have dramatically failed insofar as producing a coherent urban morphology. The emphasis on building coefficients and floor-area-ratios has resulted in the construction of cluttered buildings that are incongruent and non-aligned. In fact, in Beirut, there is a total laissez-faire in relation to how architects and/or civil engineers decide to position the buildings inside the parcel. Owners may decide to build any distance away from the main road and from the edge of the sidewalk, to optimize the building coefficients. Setbacks have a major issue stemming from the implementation of the building construction code that creates an irregular recess instead of keeping it even. Adjacent buildings in Beirut are therefore disorderly and assume different heights. The building skyline in Beirut is notoriously irregular and tangled. A compounding effect to the urban morphology and skyline is the illegal annexes and implants built during the Civil War (and beyond), most of which constitute enduring eyesores. The same can be said of mountainous areas where construction on excessively steep terrain and ugly facades are a common sight.

Construction is not always concentric. Linear construction in rural areas, also known as ribbon construction, is unsightly and obstructs the view. For example, ribbon construction along many roads stretches in the Bekaa Valley as well as in Akkar has cloaked the natural scenery on both sides of the road. Ribbon construction also voids communities of a city center and a central market where people congregate, and presents formidable challenges for pedestrians on both sides of the road. With time, built-up roads need to be retrofitted with speed bumps and/or traffic lights, as well as road medians and girders for separating opposite traffic lanes, and overpasses for pedestrians –all these measures eventually reduce traffic flow. It should be noted that linear construction is sometimes partially due to the absence of basic infrastructure in villages. Owners therefore choose to build along roads because roads can improve access to water, wastewater and electricity.

Excerpt from the 2010 SOER.

The latest published national land use data was developed by the National Council for Scientific Research (CNRS) and released in 2017 (based on data collected in 2013). Artificialized zones (totaling 767 km^2) are subdivided into the following categories:

1) Urban zones: continuous and discontinuous urban areas, tourist complexes and archeological sites.
2) Non-built artificial zones: quarries, dumpsites, landfills, sea reclaimed lands, construction sites and urban vacant plots.
3) Artificial green zones: sports centers, public parks and other green zones for non-agricultural purposes.
4) Commercial and industrial zones: airports, maritime ports and railway stations.

Other categories, namely forests and agricultural lands also include urbanization data:

- Urban sprawl on cropland
- Urban sprawl on orchards
- Urban sprawl on sparse forests
- Urban sprawl on dense forests
- Urban sprawl on scrubland

From 2005 to 2013, the growth of artificialized areas was noteworthy with an additional 147 km^2 of urban zones, and urban sprawl on agricultural areas almost quadrupled to reach 268 km^2 (Figure 7-4).

Urban areas not only went from covering about 460 km^2 in 2005 to almost 570 km^2 in 2013, but also became much denser: high-density areas increased from 84 to 104 km^2 and mid- density areas from 147 to 313 km^2. On the other hand, low-density areas coverage decreased from 231 to 152 km^2 (Figure 7-5).

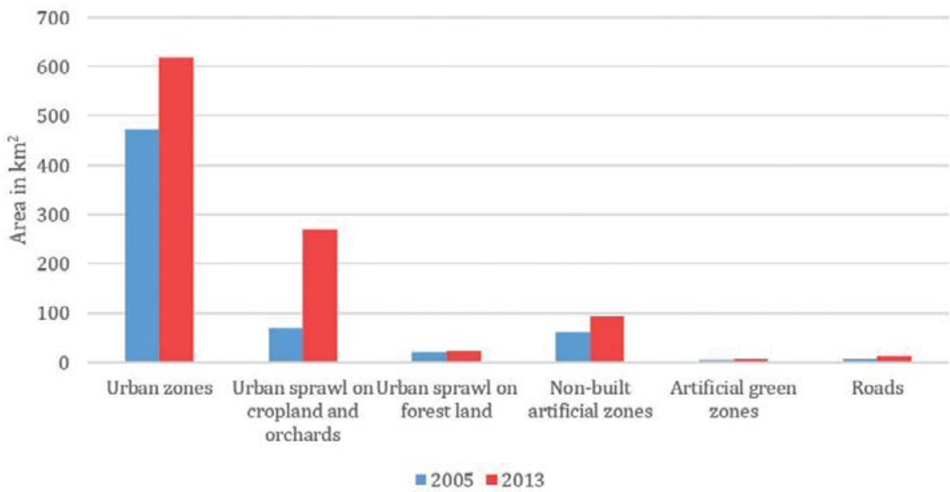


Figure 7-4 Categorization of Artificialized Areas in 2005 and 2013
Source: CNRS, 2011-2017
Note: inaccuracies might be present due to differences in land cover classification, data collection, or analysis method between years.

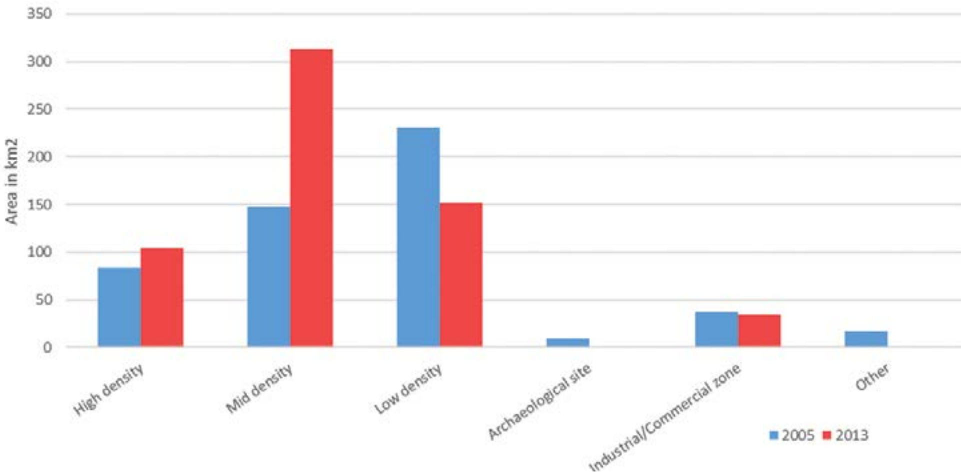


Figure 7-5 Categories of Urban Areas in Lebanon 2005-2013
Source: CNRS, 2011-2017
Note: Inaccuracies might be present due to differences in land cover classification, data collection, or analysis method between years.

A common method for estimating urban growth over time is based on a total floor area approved through construction permits. It shows that not only less and less permits were issued since 2011, but the average surface allowed per permit decreased from around 1,000 m² to approximately 640 m² (Figure 7-6). However, this method lacks accuracy as it excludes informal or illegal activities. Hence, the importance of the exercise undertaken by CNRS between 2013 and 2018. The methodology followed by CNRS was a combination of land use and land cover map along with satellite imageries, where the final statistics showed the loss of 24 km² of natural areas to buildings (Faour and Abdallah, 2018).

Table 7-4 presents the evolution in the number of the total area of issued construction permits in 2018 showing a decrease from 2017 in all governorates. In Beirut, the area of construction permits fell by half to 348,000 m² in 2018 from a year earlier. The drop was the least severe in South Lebanon with the area of construction permits dropping by 6.1% year-on-year to 1.66 million m². This is one of the symptoms of the general economic slowdown that the country was facing at the time. It is likely that activity has stalled even further in the last two years due to the financial crisis.

Table 7-4 Construction Permit Floor Area Allocated in 2018 per Governorate

Governorate	Surface area derived from construction permits in 2018 (m²)	Evolution from 2017
North Lebanon	132,600	- 33.7%
Mount Lebanon	4,550,000	- 25.2%
Beirut	348,000	- 50%
South Lebanon	1,660,000	- 6.1%
Nabatiyeh	1,070,000	- 19.4%
Bekaa	1,150,000	- 23.4%

Source: Data compiled by OEA and published by Banque du Liban

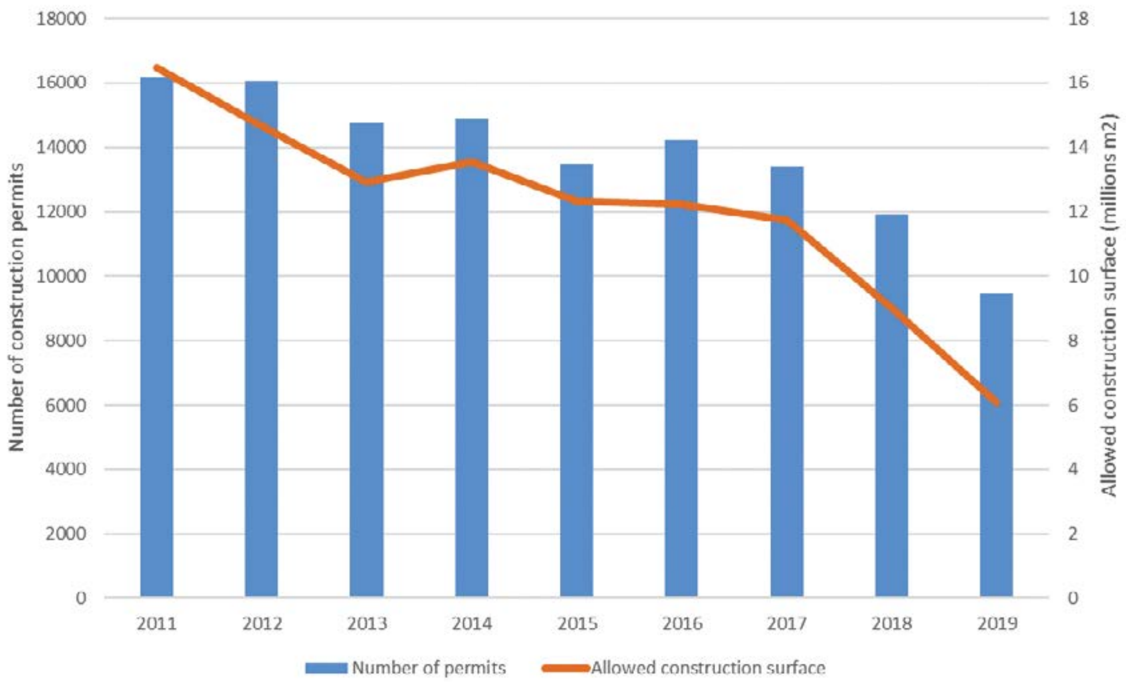


Figure 7-6 Construction Permits Issued and Surface Allowed in m².
Source: Banque du Liban & Order of Engineers and Architects, 2020

Note: In July 2003, the GoL issued Law 522, which separated Akkar from North Lebanon governorate and Baalbek-Hermel from Bekaa governorate. Moreover, in September 2017, Keserwen Ftouh-Jbeil was separated from Mount Lebanon through Law 50, thus totaling to 9 governorates. However, data collection for this table encompassed them in their old administrative boundaries, i.e. 6 governorates. In the next tables, data is presented across 8 governorates (i.e. all 9 except Keserwen Ftouh-Jbeil).

Overall, the governorates that saw the most drastic increase in urban areas from 2005 to 2013 are Mount Lebanon (+31 km^2), South Lebanon (+24 km^2) and Nabatiyeh (+23 km^2). In terms of percentage, urban area increased mostly in South Lebanon (+3%), Mount Lebanon (+2%), Nabatiyeh (+2%) and North (+ 2%) (Table 7-5 and Figure 7-7).

Table 7-5 Urban Growth per Governorate from 1994 to 2013

Governorate	Urban land area in km^2 and as a percentage of the total area					
	1994		2005		2013	
Akkar	20	3%	44	6%	55	7%
North Lebanon	49	4%	89	7%	101	9%
Mount Lebanon	226	11%	281	14%	312	16%
Beirut	21	95%	21	98%	21	98%
South Lebanon	35	4%	68	7%	92	10%
Nabatiyeh	30	3%	76	7%	99	9%
Bekaa	46	3%	67	5%	83	6%
Baalbek-Hermel	45	2%	73	3%	94	3%
Lebanon	**472**	**5%**	**719**	**7%**	**857**	**8%**

Source: Faour et al. 2016

The lack of available information and studies on building categories, spatial distribution and complementary demographics makes it difficult to assert what the main reasons are for some areas developing at a specific point in time. Nevertheless, smooth slopes and easily accessible areas are among the most compelling motives for new developments. The fact that only a small portion of the Lebanese territory is covered by Master Plans and Detailed Urban Plans led to the increase of urban sprawl and to the infringement on agricultural and natural areas. It is also important to note that even when these plans are available, they are rarely updated or properly enforced.

7.2.2.2 Informal Urban Developments

Slums in Lebanon are mostly clustered around cities and in many cases occupy areas comprising important environmental or archaeological heritage (MoE/UNDP/ECODIT, 2011). This phenomenon is most prominent in Tripoli, Beirut, Saida and Tyre.

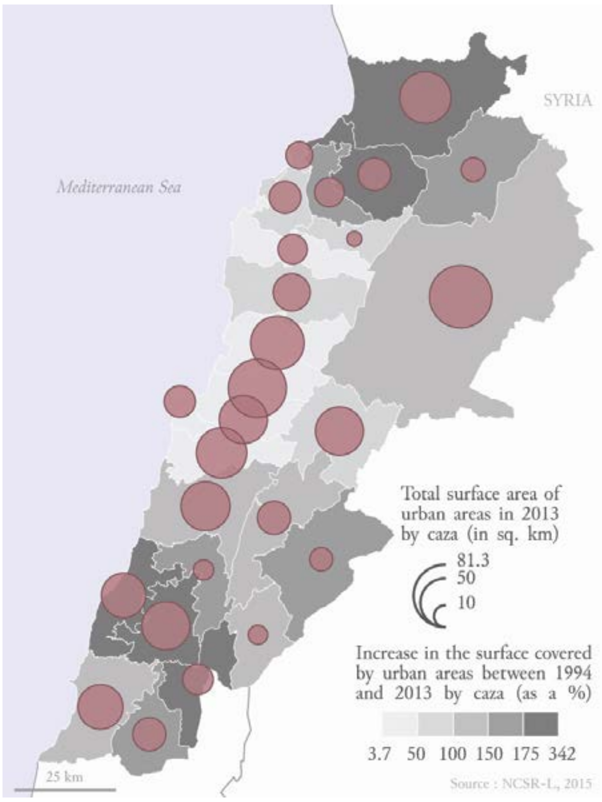


Figure 7-7 Urban Areas in Lebanon by Caza (1994-2013)
Source: Faour et al., 2016

The majority of these slums developed from successive waves of rural migrants, refugees or squatters (such as Qarantina and Bourj Hammoud in the 1920s or the Beirut southern suburb in the 1980s). These resulted in informal settlements with varying degrees of illegality ranging from construction without permits on both public and private land to illegitimate connection to the water network and electricity grid (CDR, 2016). Violations of construction codes (such as the construction of additional stories, no respect of setbacks, etc.), in addition to disregard for health and safety standards are common in informal settlements. Settlements in the Akkar and Bekaa plains are often located in areas exposed to natural hazards, including floods, landslides and earthquakes. When located nearby water bodies (mostly streams), solid waste and wastewater from the nearby settlements are directly discharged into the streams contributing to their pollution (Figure 7-8). In other cases, residents may be exposed to harmful substances from polluted water bodies around which they are located.

There is no strategic slum upgrading program available so far, the closest being the Elyssar project aimed at rebuilding the southern Beirut suburb after the civil war. While the project regularly received funding from

Figure 7-8 Informal Makeshift Constructions on Nahr el Ghadir, Kfarchima
Photo Credit: Yazigi Atelier, 2020

the public budget, it has effectively been on hold since 1997 due to lack of political support (Faour et al, 2016). Political stances and popular pressure have also hindered development of some initiatives such as social housing or resettlement and compensation plans for population displaced by dismantling of informal settlements (CDR, 2016).

7.2.2.3 High-Rise Towers and Large-Scale Real Estate Projects

During the post-2006 real estate frenzy, high-rise towers were mushrooming in Beirut until the real estate market slowed down in the 2010s. The rising demand for property translated into an increase of land prices. The subsequent construction boom fed the appetite for all buildings, often after tearing down old buildings, sometimes illegally. Urban heritage is most at risk in areas prized by developers. The main obstacles to conservation of traditional buildings are mostly related to the economics that makes destruction and replacement of such buildings more lucrative than their conservation. Many old houses are not registered on the Ministry of Culture's list of protected heritage buildings and there are almost no financial incentives for their restoration. Tall structures are concentrated in Beirut (Table 7-6)

Table 7-6 List of 20 Tallest Structures in Lebanon

Building	Municipality (location)	Floors (Overground)	Height (Structural)	Year of Completion	Main Usage
Sama Beirut	Beirut	50	187 m	2016	Residential/ Office
FortyFour Tower	Dekwaneh	45	185 m	2019	Residential/ Office
Sky Gate	Beirut	43	180 m	2014	Residential
Achrafieh 20I30, Bloc A	Beirut	30	155 m	2016	Residential
Platinum Tower	Beirut	34	152 m	2009	Residential
Abdel Wahab 618 Tower 1	Beirut	37	152 m	2017	Residential
Marina Tower	Beirut	27	150 m	2007	Residential
La Citadelle de Beyrouth	Beirut	37	140 m	2018	Residential
Place Pasteur	Beirut	36	140 m	2019	Residential
Ciel et Jardin 1*	Beirut	33	140 m	-	Residential
Ciel et Jardin 2*	Beirut	33	140 m	-	Residential
Les Domes de Sursock	Beirut	28	140 m	2013	Residential
Quasar Tower	Beirut	38	138 m	2018	Residential/ Hotel
Habtoor Grand Hotel	Sin el Fil	30	130 m	2005	Hotel
Bay Tower	Beirut	30	125 m	2011	Residential
Rive Gauche Tower	Beirut	31	122 m	2017	Office
3 Beirut Tower 1	Beirut	32	120 m	2017	Residential
Achrafieh 4748, South Tower	Beirut	30	120 m	2015	Residential
Achrafieh 4748, East Tower	Beirut	30	120 m	2015	Residential
Achrafieh 4748, North Tower	Beirut	30	120 m	2015	Residential

Source: Emporis, 2020

and are eroding its heritage (Figure 7-9), negatively affecting its social and urban fabric. The main neighborhoods with important heritage buildings are Achrafieh, Mar Mikhael and Zokak el Blat. Exploitation ratios are among the highest in these neighborhoods (Bou Aoun et al, 2020).

Figure 7-9 Skyline of Beirut and Suburbs: Distinctly Uneven and Lacks Harmony
Photo Credit: Yazigi Atelier, 2020

Since the adoption of Decree 8633 in 2012, the construction of residential complexes, as well as any building with more than 15 stories, requires submission of an initial environmental examination to MoE to ensure that the environmental impacts of the building have been taken into consideration and that environmental standards are met before a permit is issued.

Following this decree, the HCUP suggested in its Minutes of Meeting 52 dated 26/12/2012 to limit environmental studies to buildings with a total surface area exceeding 10,000 m^2.

The current legislation, including the 'new rent law' of 2014 (and its amendment Laws 64/2017 and 111/2018), made the real estate sector one of the most, if not the most, lucrative in the country and encouraged speculative investments in land and real estate. Contributing factors include the fact that banks prize real estate as guarantee assets for securing loans and the incentives of the financial system. In addition, owners of large projects in Beirut are, at least partly, owned by politicians or people connected to political parties. Thus, the main goal of construction shifted from producing housing and buildings to maximizing capital returns regardless of the impact on the urban environment. Development of such buildings accelerate the gentrification process (Saksouk, 2015).

Another common practice in the sector is the merger of adjacent plots to build skyscrapers (MoE/UNDP/ECODIT, 2011). This is well illustrated by the "grands ensembles" concept introduced in 1971 that allows plots of more than 10,000 m^2 to increase their building coefficients. Owners of small plots were encouraged to sell their land to larger clusters. The "old rent" law fixed all pre-1990 rent rates to protect tenants from any increase. However, it had a perverse effect of encouraging property owners to demolish their property and have a new building constructed in its place (Achkar, 2012).

7.2.3 The Construction Permitting Processes

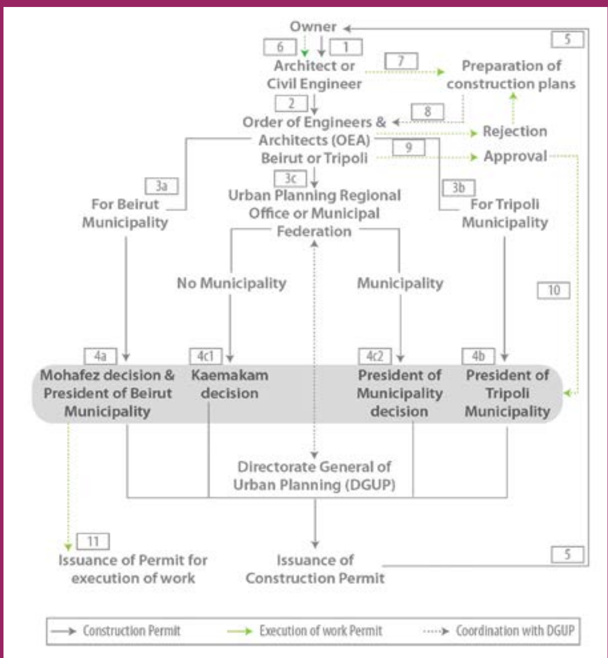
The actors involved in the issuing of construction permits are individual architects or engineers (appointed by project owners to apply for permits), the OEA, the municipalities, governors, and the DGUP (Box 7-6). The permitting process depends on whether the concerned area falls within a municipality or not. If not, then it falls under the jurisdiction of the Qaimaqam or requires input from the governor (in Beirut). These "paths" involving several authorities result in varying processes depending on the region where the development is planned. Nevertheless, there are numerous cases of irregular permit issuance, all facilitated by political and private interests.

Box 7-6 Summary of Typical Steps to Obtain a Construction Permit

1. Owner appoints an architect or a civil engineer
2. Architect or civil engineer applies for a construction permit at the Order of Engineers & Architects (OEA) in Beirut or Tripoli (depending on where the Architect or Civil Engineer is registered).
3. Architect/civil engineer or Owner sends the construction permit to:
   a. the Municipality of Beirut in case the project is located in Beirut
   b. the Municipality of Tripoli in case the project is located in Tripoli
   c. the Urban Planning Regional Office or the Municipal Federation (if the federation has its own urban planning unit) in case the project is located outside Beirut and Tripoli
4. Each one of the above listed authorities then transfers the permit to:
   a. The Beirut Governor who in coordination with the President of Beirut Municipality issues the construction permit
   b. The President of Tripoli Municipality who then issues the construction permit
   c. The Qaemaqam (in case there is no municipality) who then issues the construction permit
   d. The President of the municipality who then issues the construction permit
5. Owner (or his designee) collects the construction permit
6. Owner asks architect/civil engineer to prepare the construction plans in order to obtain the permit of execution of works
7. Architect/civil engineer prepares the construction plans (architectural, civil and electromechanical)

8. Architect/civil engineer presents the construction plans to OEA in Beirut or Tripoli (depending on registry)
9. OEA either approves or rejects the plans. If rejected, the applicant must revise and resubmit the plans
10. The architect/civil engineer or the Owner should present the approved plans to the relevant municipality or Qaimaqam (if there is no municipality) to obtain final approval.

After reporting to the concerned municipality or Qaimaqam, the relevant OEA issues the permit for the execution of works. The figure below summarizes the construction permitting process described above.



7.2.3.1 The Settlement of Illegal Constructions

Lebanon has a long history of illegal constructions, especially on state or municipal lands and the public maritime domain. As an example, Horsh Beirut, the capital's last large public park, has endured a series of documented encroachments and violations (Table 7-7).

Another recent example is the Eden Bay Resort in Beirut, inaugurated in 2018, which prevailed in spite of protests and public opposition to its construction *(Refer to Chapter 2 – Environmental Governance for additional information)*. Numerous opponents denounce the irregularities and infractions that led to construction of the hotel on the Ramlet el Bayda public beach (Figure 7-10).

According to the MoPWT, there are 1,026 to 1,068 infringements of the public maritime domain, most of them dating back to the 1975 to 1990 war. About 73% of those are non-residential constructions on

Table 7-7 Violations of Horsh Beirut

Violator	Area (m^2)	Year	Remarks
Hippodrome	206,972	1920	Rent for 20 years
WWI-WWII cemeteries			
French embassy of Foreign Affairs	5,213	1930	
Imperial British Commission	2,420	1934	
French cemetery	1,063	1952	
Commonwealth war cemeteries	5,264	1964	
Al Maqased cemetery	518	1940	
Martyrs' Mosque and cemetery (Al Shouhada')	1,500	1958	
Al Maqased institutions	4,140	1970	Settled in 1983
Caritative and cultural association (Chamseddine)	26,000	1970	Settled in 1983
Kachaf Al Risala Al islamiya (+ Radio Al Risala)	3,365	1970	Settled in 2017
Pine Residence	35,770	1974	Property of France since 1974 after renting it in 1904 for 50 years
Rawdat Al Chahidayn cemetery	20,000	1975	
Supreme Chiite Council	9,000	1975	
Al Khachekji Mosque	2,810	1981	Settled in 1983 (owned by Al Maqased)
Tayouneh cemetery	3,230	1982	
Hangars	1,466	1990	
Tayouneh police station	1,000	2007	Settled
Ghobeiry police station	1,000	2007	Settled
Mosque, funeral hall and cemetery for the Sunni community	3,000	2012	
Sunni and Chiite cemetery			On part of plot 1925 and plot 2639 - settled in 2013
Honin charity center (مجمع هونين الخيري)	672	2014	Settlement decision issued
The Field hospital	2,000	2016	Settled by municipal decision in 2016
Excavation of lot No. 2639 to build the General Security Headquarters		2018	Stopped following civil society's pressure after the lot was excavated

Source: Nahnoo, 2019

public land that are used for commercial or touristic purposes and, accordingly, are not entitled to any type of compensation. So far, 386 of the violators who may be implicated in more than one case of infringement on the public domain have filed a procedure for settlement. In May 2020, the Attorney General (النائب العام التمييزي) asked the MoPWT to apply Law 64/2017 and its amendment Law 132/2019, to reclaim the remaining lands associated with infringement cases, as well as the elaboration of a housing plan in collaboration with the Ministry for Social Affairs for cases of residential construction. That said, the regularization of illegal constructions on the public maritime domain does not resolve the public right issue nor does it help repair the environmental damage. It should make the seashore accessible to the public and ensure protection of the environment instead of limiting itself to collecting fees.

Law 139, adopted in 2019, set the settlement of infractions to the building code that occurred between 1971 and 2018. It details the fines applicable depending on the type of violation. However, it allows the settlement of any violation as long as it occurs on a property owned by the violator. This legislation gives legitimacy to any infringement, as long as it is on private land, and thus eliminates any chance of reclamation. Instead, the law focuses on collecting fees for the municipalities, the Treasury and the Public Corporation for Housing[1], rather than proceeding to interventions or demolitions, the justification being that most of the violating structures are too old to remove.

7.2.3.2 Construction Permits on Rural Parcels

Law 139/2019 was portrayed as a tool that would alleviate the housing crisis and contribute to solving the problem of rent legislation and easing the burden of housing costs on the citizen. It indicates the accumulation of settlement laws and with them violations, in a vicious circle that has been repeated for decades: "legislating" violations in a first stage and "settling" them in another stage. This is evidenced in Circular 33, issued by the Presidency of the Council of Ministers in 13/11/2013, clearly showing that the problem has expanded over the years. This circular aimed to oblige the Minister of Interior and Municipalities to cancel circulars allowing the granting of building permits in violation of the law. The latter had issued Circular 483 on 30/5/2013, according to which presidents of municipalities and governors regained the right to

Figure 7-10 Eden Bay Resort, Ramlet el Bayda
Photo Credit: Yazigi Atelier, 2020

issue residential building licenses in rural areas, on condition that the built area does not exceed 150 m^2, with some additional conditions and requirements. The circular had been issued to alleviate tensions and popular protests witnessed at the time in Akkar demanding the reinstatement of building permits that were given by municipalities and cancelled through MoIM Circular 14780 dated of 2010 (Berges, 2019).

Continuing with this approach, MoIM issued Circular 613 in 2014 giving municipalities, for a period of 1 year, the authority to issue construction permits with same the building regulations applied before, thus overriding the role of DGUP and OEA. The stated reasons for this circular included high volume of construction permits issued without consulting engineering or architectural offices, the numerous infringements to the construction law and the migration of youth from rural areas, which the new decision claims to address by making it easier to obtain a building permit. As a result, all types of construction (ranging from small utility shacks to larger residential units) were erected on agricultural and natural lands initially envisioned without any buildings, thus threatening food security, natural resource protection and, accordingly, the environmental identity of the country. The circulars created "parallel legislation" since the MoIM used this tool not to elaborate on internal administrative procedures but instead to establish rules outside of its prerogatives. Despite strong opposition from entities such as the MoE, OEA and activists, new circulars were issued to extend the timeframe of this circular and allowing the addition of an extra floor (Mourad, 2018). The Minister of Interior and Municipalities later admitted that the circular was not legitimate (Ayoub, 2017). The effects of the latest circular expired on March 2020 before the MoIM

[1] The Public Corporation for Housing, established in 1996 as a public institution under the now defunct Ministry of Housing and Cooperatives, aims to provide public housing and facilitation of housing using various financial and legal tools.

granted a one-month extension in June 2020 to enable completion of unfinished works.

7.2.4 Implications of Haphazard Urbanization on the Environment

Inappropriate regulations and lax law enforcement virtually gave carte blanche for market-driven forces to modify the urban landscape without consideration for sustainable development. Most of the time, the provision of a service or agricultural road, although necessary, is the element paving the way to such practices as it is reserved to public authorities, and roads are officially an integral part of public space. Asphalting these dirt roads improves accessibility and encourages encroachment on agricultural fields.

7.2.4.1 Environmental Aspects

Inadequate policies, haphazard construction activities and poorly executed plans all have a significant toll on the environment. Some effects are immediate, such as excavations and quarrying for construction materials, while other appear progressively over time, like the modification of the urban microclimate.

Excavation

Construction regulations make it common to excavate the whole parcel and level it afterwards, regardless of the allowed built density. The natural terrain configuration completely disappears, significantly altering landscapes. This becomes especially problematic on steep slopes since building regulations remain the same as those on flat grounds. The constraints of exploitation ratios are limited to aboveground floors, meaning that underground parts of a building can occupy the whole lot area, encouraging the construction of buildings that will decrease soil permeability, therefore decreasing vegetation cover and increasing flood risk. Other observed consequences include the significant volume of excavated material, most of the time accumulated in open dumps, and increased landslide risks, especially when dense construction is executed on unstable slopes (Lamy, 2017). There is significant responsibility that architects and urban planners bear for this issue.

Construction Material

While most of the construction material in Lebanon is imported, cement, stone tiles and other quarrying products (ex. gravel and sand) are all produced locally at sites such as Tartij (Jbeil) for stone tiles or Chekka (Batroun) and Sibline (Chouf) for cement (MoE/UNDP/ECODIT, 2011). These activities have significant environmental impacts. The cement market is itself distorted given that the price for domestic buyers is almost double that for foreign buyers (BLOMINVEST, 2014). In most of the cases, cement plants rely, for their raw material needs (e.g. limestone), on adjacent lands for their production to improve their business model, which led to quarries spreading over more than 1 million m^2 in the Chekka region, without any gradual rehabilitation *(refer to Chapter 6 – Land Resources for details on quarrying)*. A common strategy of the cement companies is to buy land and start operations as quickly as possible to ensure the plots become impossible to redevelop later on, thus securing their new land assets for the long term (Public Works Studio, 2019). According to Banque du Liban, Lebanon produced in 2019 about 3.2 million tons of cement, down from a peak of more than 5.8 million in 2013 (Figure 7-11). These numbers are consistent with the decreasing activity of the construction sector.

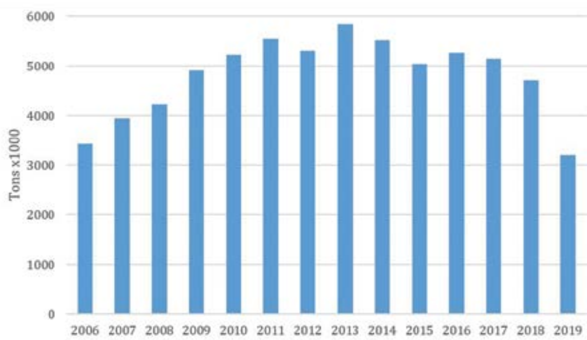


Figure 7-11 Cement Deliveries (2006-2019)
Source: Banque du Liban, 2020

Construction and Demolition Waste

Disposal of construction and demolition (C&D) waste is not regulated in Lebanon. Due to lack of official C&D disposal sites in the country, most of this waste is disposed of in dumpsites, often illegally (for example in houeifat in Aley and Beit Meri and Fanar in Matn), or in the valley banks. In 2016, it was reported that around 324 C&D waste dumpsites are found across the country (MoE/UNDP/ELARD, 2017). Some excavated material is occasionally collected for backfilling behind retaining walls or for land reclamation. The problem of C&W waste was highlighted following the August 4 Beirut Explosion (Box 7-7). Rubble can easily be recycled for such uses as it would simultaneously reduce the amount of dumped material and reduce the cost of landfilling and land reclamation, especially if encouraged by an effective tax policy. *More details on C&D wastes are available in Chapter 8 - Solid Waste.*

Box 7-7 Beirut Explosion of 2020

On 4 August 2020, a massive explosion rocked the capital city of Beirut flattening much of the city's port, severely damaging 40% of the capital. It was the result of a large amount of ammonium nitrate stored at the port catching fire (Strategy&, 2020). The blast killed at least 200 people, injured more than 10,000, and left 300,000 homeless (UNDP, 2021). Almost 9,700 buildings within a 3 km radius of the blast were damaged, which is equivalent to approximately 72,200 apartments, a third of which became uninhabitable (UNICEF, UN-OCHA).

Many of the heritage buildings were already fragile due to lack of maintenance, making them even more vulnerable to the blast. The tremendous damage resulted in an estimated 800,000 to 1,000,000 metric tons of C&D waste excluding the port area (UNDP, 2020). The poor waste disposal strategy coupled with the emergency meant that much debris was dumped in illegal sites and hazardous substances (such as asbestos) were not properly handled.

Loss of Green Cover and Habitat Fragmentation

The progressive encroachment of real estate on forests and green areas will take decades to remedy (Table 7-8). It takes years for ecosystems to recover from total destruction since most of the top soil (or mobile regolith), if not all layers of the regolith (weathered rocks), are needed to be removed for mechanically stable constructions. Post construction added greenery often consists of exotic species for mainly decorative purposes that cannot regenerate local ecosystems (MoE/UNDP/ECODIT, 2011).

Table 7-8 Urban Sprawl on Forested Land in 2013 and 2017

Class	Area (km²) 2013	Area (km²) 2017	Difference
Urban Sprawl on Clear Wooded Land	1.8	2.1	16.67%
Urban Sprawl on Dense Wooded Land	4.0	5.2	%30
Urban Sprawl on Scrubland	7.6	9.3	%23.68

Source: CNRS 2010, 2013, 2018.

Loss of Agricultural Land and Topsoil

Urban sprawl encroaching on agricultural lands is severe in the Bekaa valley and the Akkar plain, where the largest agricultural fields are located (see example in Figure 7-12). Once again, real estate development has proven more attractive financially than any other type of land development. Coastal and peri-urban agricultural lands are exposed to increased ground pollution (CDR, 2016). The influx of Syrian displaced added substantial pressure as many of the tented settlements were erected in those agricultural plains (see Section 7.2.4.2).

Groundwater Pollution

According to the DGUP Administrative Note 2/5 (02/08/2010), connection to the sewer network, if available, is mandatory for any new building; in case the area is not connected to a public sewer network, the owner must build a septic tank and have it inspected to ensure it meets technical standards. Only then could the owner obtain authorization to use it. The septic tank should be regularly emptied, and its content discharged to a nearby wastewater treatment plant.

Construction in remote areas not connected to a sewer network is a common contributor to groundwater pollution. In such places, the construction of septic tanks is the most common practice to dispose of wastewater and, when not done in line with the standards, often leads to seepage (CDR, 2016). But seepage also occurs in areas provided with public sewer infrastructure that leaks due to poor maintenance (Box 7-8). Since 2012, and in line with Decree 8633, some form of environmental assessment (Initial Environmental Examination or EIA) became mandatory for resorts to help tackle such issues.

Figure 7-12 Visible Urban Sprawl in the Plain of Akkar, 2010 (left) and 2018 (right)
Source: Google Earth Imagery 2010-2018

Box 7-8 Substandard Infrastructure in Mountain Areas
Mountain resorts consume significant environmental resources during construction and operation. Planned resorts usually require the technical review and approval of the Higher Council of Urban Planning (if greater than 10,000 m^2). Unfortunately, the review process generally fails to ensure the provision of basic infrastructure that is environmentally sustainable. Mountain resorts are typically implanted in natural areas that have never been intervened on beforehand and therefore lack basic infrastructure including access roads, water supply networks, sewage collection and treatment systems, and electricity. Large scale resorts need a lot of water while generating a lot of wastewater as well as solid waste.

Excerpt from the 2010 SOER

The Urban Microclimate

Many aspects of the urban morphology affect the microclimate of a city. But most, if not all, of them can be regulated with proper governance (Figure 7-13)..

The urban heat island corresponds to a significant rise of temperatures in an urban area due to the high heat potential of hard landscapes. Dark materials like asphalt and highly reflective surfaces greatly contribute to the rise of temperatures, which are expected to increase to 4ºC by 2100 (Mohsen et al., 2020).

The urban design modifications introduced in 2004 have increased the challenge as higher buildings were authorized with fewer open balconies and less green spaces. Furthermore, the Beirut street network is characterized by narrow winding roads, which induces a pronounced street canyon effect, trapping air pollutants and diminishing wind speed (Mohsen et al, 2020).

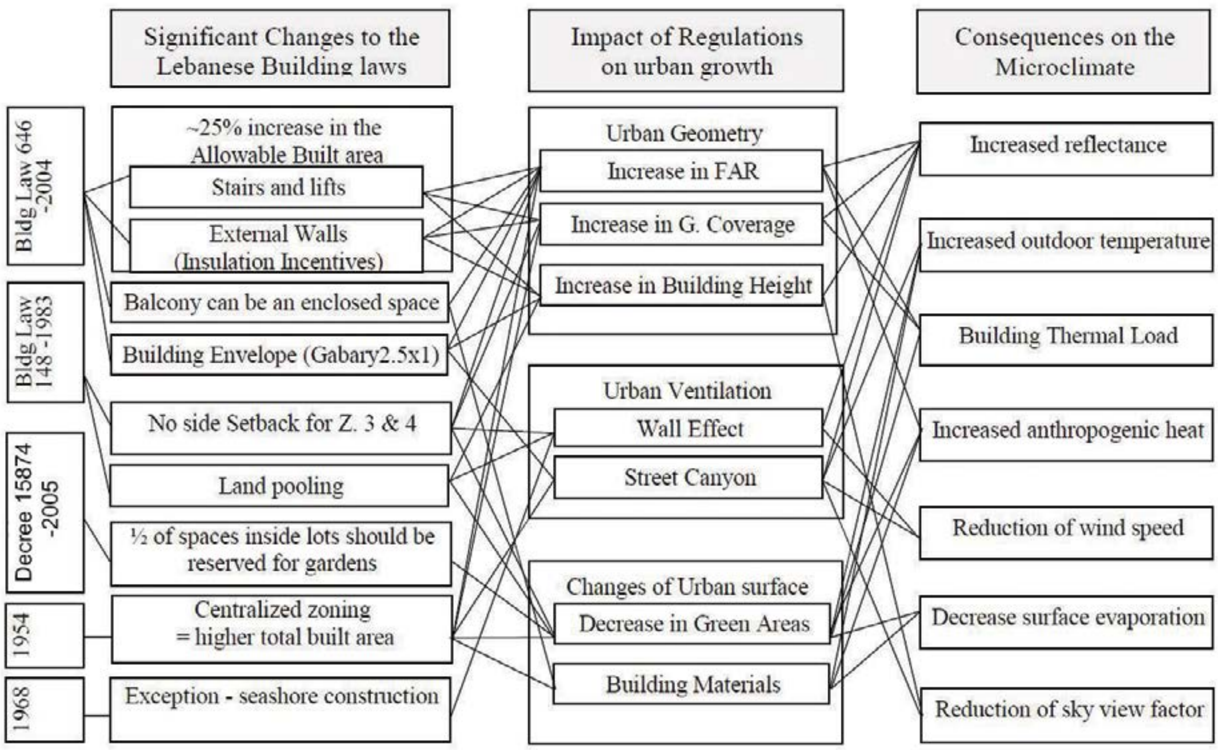


Figure 7-13 Correlations between Changes to Lebanese Building Laws, Urban Growth and Microclimate
Source: Adapted from Mohsen et al., 2020

7.2.4.2 The Additional Pressure from Displaced and Refugees

The influx of Syrian displaced in the 2010s to Lebanon added new pressure on land. In the Bekaa valley, the numerous ITS occupy considerable surfaces on the outskirts of towns or on agricultural fields (Figure 7-14 and Figure 7-15) resulting in the conversion of these lands into residential areas increasing from 12% in 2015 to 19% in 2018 (Doumani, 2019).

The number of ITS dwellers rose steadily as the Syrian conflict dragged on with more displaced unable to pay rent being evicted from conventional housing (MoE/EU/UNDP, 2014). Because ITS cannot grow vertically, they expand, consuming ever more land parcels. Most of the ITSs are located on private lands and therefore residents pay rent to the landowner. Some ITS have morphed into semi-permanent dwellings after many years since their installation (see the detailed Maps in Annex 1).

In parallel, there is considerable contamination of land and water resources due to lack of proper sanitation measures as reported on the Litani where dumping solid waste and wastewater is considerable. Wood is used as a heating fuel, prompting felling of trees in nearby woodlands (UNDP, 2015).

Not only is the environmental impact of ITS considerable, but humanitarian funding has mostly disregarded this aspect, while these impacts accumulated (Table 7-9).

Figure 7-14 Pressure from Urbanization and ITS of Displaced on Agricultural Lands in Mansoura and Ghazze, Bekaa
Source: Google Earth Imagery 2010 (left), 2018 (right)

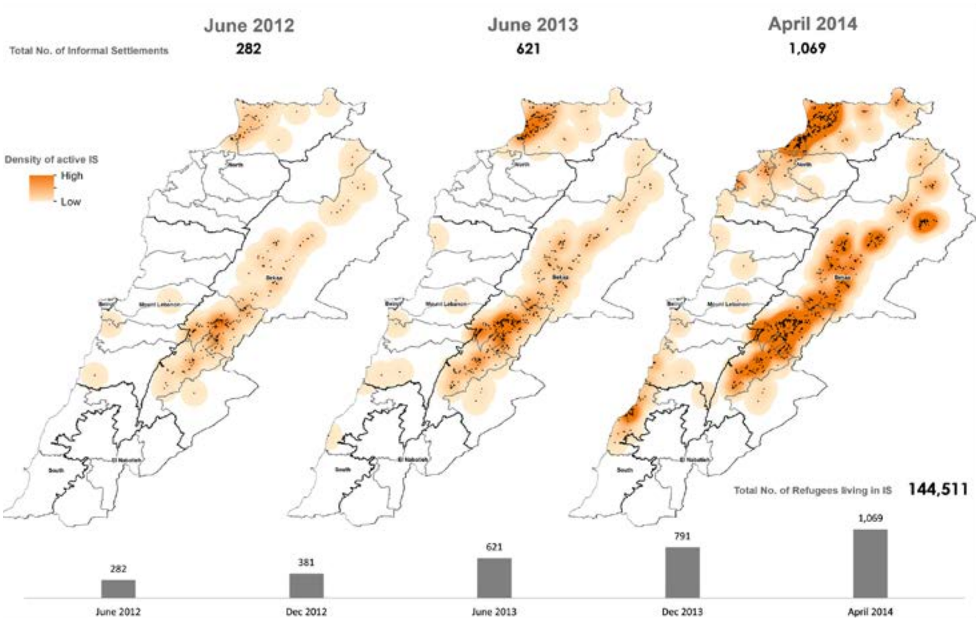


Figure 7-15 Growth of ITS from 2012 to 2014
Source: UNHCR Lebanon, 2014

Table 7-9 Summary Environmental Management Plan for Mitigation of the Environmental Impacts of the Syrian Conflict on Lebanon

Sector	Capital cost (million US$)	O&M costs (MUSD/year)
Solid waste management	131.1	57.6
Water and wastewater management	1,287.30	TBD
Air quality	1,986.80	139
Land use and ecosystems	16	78.5
Total	3,421.2	275.1

Source: MoE/EU/UNDP, 2014

7.3 Policy Outlook and the Way Forward

Urbanization has already caused extensive damage to Lebanon's natural resources, coastal landscapes and mountains, requiring substantive resources to alleviate and reverse the course of action and restore what can still be salvaged.

The following recommendations would help rectify the direction of urbanization to achieve more sustainable development. Both the central government and local governments have a significant advantage when it comes to urban and territorial interventions because of the massive amount of land and built property they own (respectively 808.48 and 101.8 million m^2). They could lead the way to improve the situation with proper reform, especially if they collaborate more often with large property owners such as religious authorities. These recommendations are divided into four sections:

1. Administrative reform
2. Urban planning reform
3. Reform of the construction permitting process
4. Restrictions on ownership by non-Lebanese

Note: the following points marked with an asterisk (*) are recommendations already included in the 2010 SOER. Those points are considered essential and still need to be implemented.

7.3.1 Administrative Reform

There is unanimous consensus in Lebanon that public administration reform has become crucial for the country's development, not just in the urban planning context but at all levels of governance. Efforts should be directed to improve transparency and accountability of public officers to:

1) Accelerate and improve the decentralization process to guarantee sufficient funds and autonomy for local governmental bodies (municipalities, union of municipalities, cazas) and alleviate workload from the central government. Ensure the inclusion within the municipal workforce of a planning unit provided with proper monitoring tools. This would enable it to follow-up developments on the ground and propose new regulation if needed.
2) Accelerate the digitization of mapping, processing and archiving of urban planning procedures by resorting heavily to the use of Geographic Information System (GIS) and Building Information Modelling (BIM), all while synchronizing the databases to ensure live updates across agencies. This would streamline information and greatly facilitate coordination between agencies and end users.
3) Raise awareness and build capacity of public authorities in charge of dealing with non-compliance of construction laws and other regulations concerning urbanization.
4) Limit the HCUP authority to issue exemptions.
5) Reintroduce the Ministry of Planning and transfer the DGUP and HCUP from the MoPWT to it.
6) Appoint environmental prosecutors and investigation judges dedicated exclusively to environmental matters as per the provisions of Law 251/2014 to enhance the environmental enforcement process *(refer to Chapter 2 – Environmental Governance for more details).*
7) Avoid the settlement of illegal constructions and raise public awareness about this issue.

7.3.2 Urban Planning Reform

Sustainable development must be the ultimate goal of the urban planning process and not private interests. A clear vision for the development of cities should drive urban governance while taking into account their integration in the international and regional context. This requires the government to:

1) Update the NPMPLT to include the latest developments and new appropriate recommendations.
2) Formalize the national and regional master plans in the legislative framework by adopting them as decrees. Regional plans covering all of the national territory must be approved as a prerequisite for detailed urban plans. This can be accomplished based on Articles 4, 7 and 8 of the Urban Planning Law 69/1983.
3) Develop detailed urban master plans as fast as possible and prioritize environmentally sensitive areas and zones not yet covered by a plan enforced by decree.

4) Enforce SEA in all planning processes and ensure the participation of all concerned stakeholders.
5) Restrict more vigorously construction on unspoiled land and create new protected areas to limit urban sprawl*.
6) Rethink urban master plans to:
   - Protect natural landscapes, water resources and minimize environmental impact*.
   - Take into consideration the natural hazards including areas prone to flood risk.
   - Involve municipalities in the planning process and include coordination and harmonization between local authorities.
   - Limit excavation works underground to the surface lot coverage. Reuse the excavated topsoil in gardens, nurseries or agricultural fields*.
   - Expand urban green spaces and introduce a biotope coefficient in zoning plans. Keep exotic species in a controlled environment and ensure custom taxes*.
   - Analyze the potential interaction between the proposed urban master plan and existing sectoral strategies, or their lack thereof, particularly in relation to the agricultural sector.
   - Raise awareness about the importance of master plans.
7) Take specific action to tackle the housing of the displaced until a decision is officially taken for their return. Realistic suggested solutions include rehabilitation of buildings and creation of collective shelters. Their main advantage would be the fact they offer protection from unscrupulous property owners and making use of empty or abandoned buildings.
8) Improve guidelines to minimize surface runoff and increase rainwater retention.
9) Incorporate alternative methods such as the landscape approach, broadly defined as "a framework to integrate policy and practice for multiple land uses, within a given area, to ensure equitable and sustainable use of land while strengthening measures to mitigate and adapt to climate change" (Reed et al., 2015). It includes the incorporation of green[2] and blue[3] corridors.
10) Shield urban planning activities from political interference. Serious measures must be taken to ensure expropriation or demolition of illegal construction.

7.3.3 Reform of the Construction Permitting Process

Priority is given to modifications of the constructions permitting process to address fraud and malpractices:

1) Simplify the permit process and limit overlapping of different governmental bodies*.
2) Give extra prerogatives to the authorities involved in the inspection of construction sites (OEA, municipalities) to ensure legal and technical compliance.
3) Include new clauses concerning excavations taking into consideration the slope and surrounding landscape to minimize debris volume and environmental impact. Limit excavation works underground to the surface lot coverage.
4) Minimize building coefficients for underground floors, especially on steep slopes.

7.3.4 Restrictions on Ownership

The following was included in draft Law 94/2009 proposed to amend legislation on ownership by foreigners:

1) Introduce a clear method for calculating the total land area acquired by non-Lebanese at the caza level (10% in Beirut and 3% in all other cazas)*.
2) Restrict property of any state-owned land, municipal property and protected areas from non-Lebanese*.

Other proposed restrictions:

- Raise land registration taxes for foreigners. Those taxes are currently the same as for Lebanese nationals.
- Introduce capital gain tax to limit speculative activity on the market (Lebanese and non-Lebanese)*.
- Introduce recurring building value tax to push land productivity, increase competition, deflate market prices and discourage speculation*.
- Complete the ownership database of all of the Lebanese territory. This will show the proportion of property owned by non-Lebanese buyers*.
- Expropriate all foreign-owned lands that have not started (or completed) construction within the prescribed five-year period*.

[2] Strips of land dedicated to the ecological continuity of unspoiled land even when passing through urban zones
[3] Advanced treatment of developments with regards to their relation with water, facilitating hydrological processes

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قانون منفذ بمرسوم رقم ١١٦١٤	١٩٦٩/١/٤	١٩٦٩/١/٤	اكتساب غير اللبنانيين الحقوق العينية العقارية في لبنان
قانون رقم ٦٩	١٩٨٣/٩/٩	١٩٨٣/٩/٩	قانون التنظيم المدني
قانون رقم ٢٩٦	٢٠٠١/٤/٣	٢٠٠١/٤/٣	تعديل بعض مواد القانون المنفذ بالمرسوم رقم ١١٦١٤ تاريخ ١٩٦٩/٠١/٠٤ (اكتساب غير اللبنانيين الحقوق العينية العقارية في لبنان)
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قانون رقم ٢	٢٠١٧/٢/٢٨	٢٠١٧/٢/٢٨	تعديل قانون الإيجارات
قانون رقم ٦٤	٢٠١٧/١٠/٢٠	٢٠١٧/١٠/٢٠	تعديل واستحداث بعض الضرائب والرسوم
قانون رقم ١١١	٢٠١٨/١١/٣٠	٢٠١٨/١١/٣٠	تعديل المادة ٣٨ من القانون رقم ٢ تاريخ ٢٠١٧/٢/٢٨ المتعلق بقانون الإيجارات
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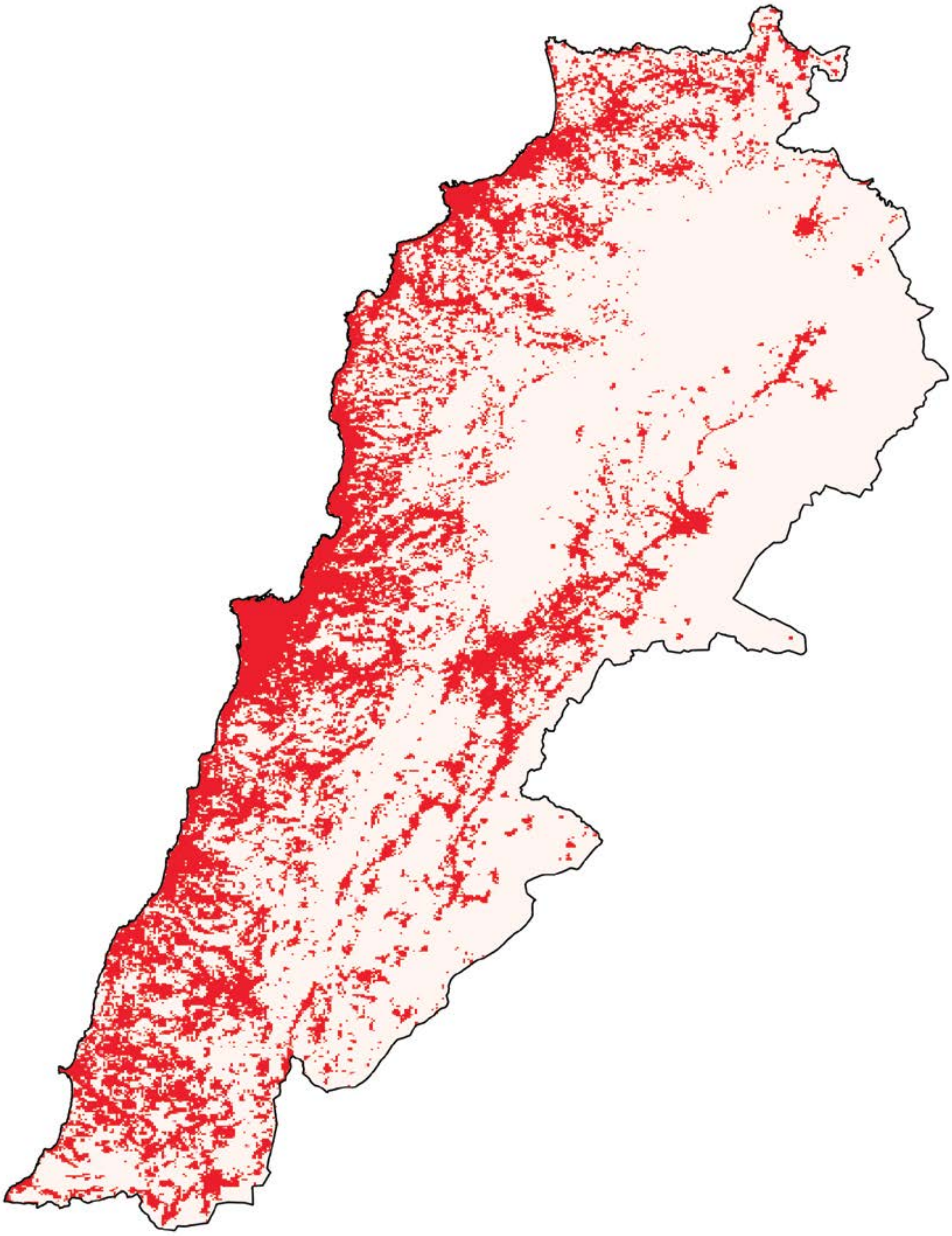
مرسوم إشتراعي رقم ١١٨	١٩٧٧/٦/٣٠	١٩٧٧/٦/٣٠	قانون البلديات
مرسوم رقم ٢٨٦٩	١٩٥٩/١٢/١٦	١٩٥٩/١٢/١٦	تنظيم وزارة التربية الوطنية
مرسوم رقم ١٠٤٩٠	١٩٩٧/٦/٢١	١٩٩٧/٦/٢١	اعادة تنظيم وتحديد ملاك المديرية العامة للتنظيم المدني
مرسوم رقم ٢٣٦٦	٢٠٠٩/٦/٢٠	٢٠٠٩/٦/٢٠	الخطة الشاملة لترتيب الأراضي اللبنانية
مرسوم رقم ٨٢١٣	٢٠١٢/٥/٢٤	٢٠١٢/٥/٢٤	التقييم البيئي الإستراتيجي لمشاريع السياسات والخطط والبرامج في القطاع العام
قرار المجلس الأعلى للتنظيم المدني رقم ١١	٢٠٠٥/٢/٢٨	٢٠٠٥/٢/٢٨	المناطق غير المنظمة

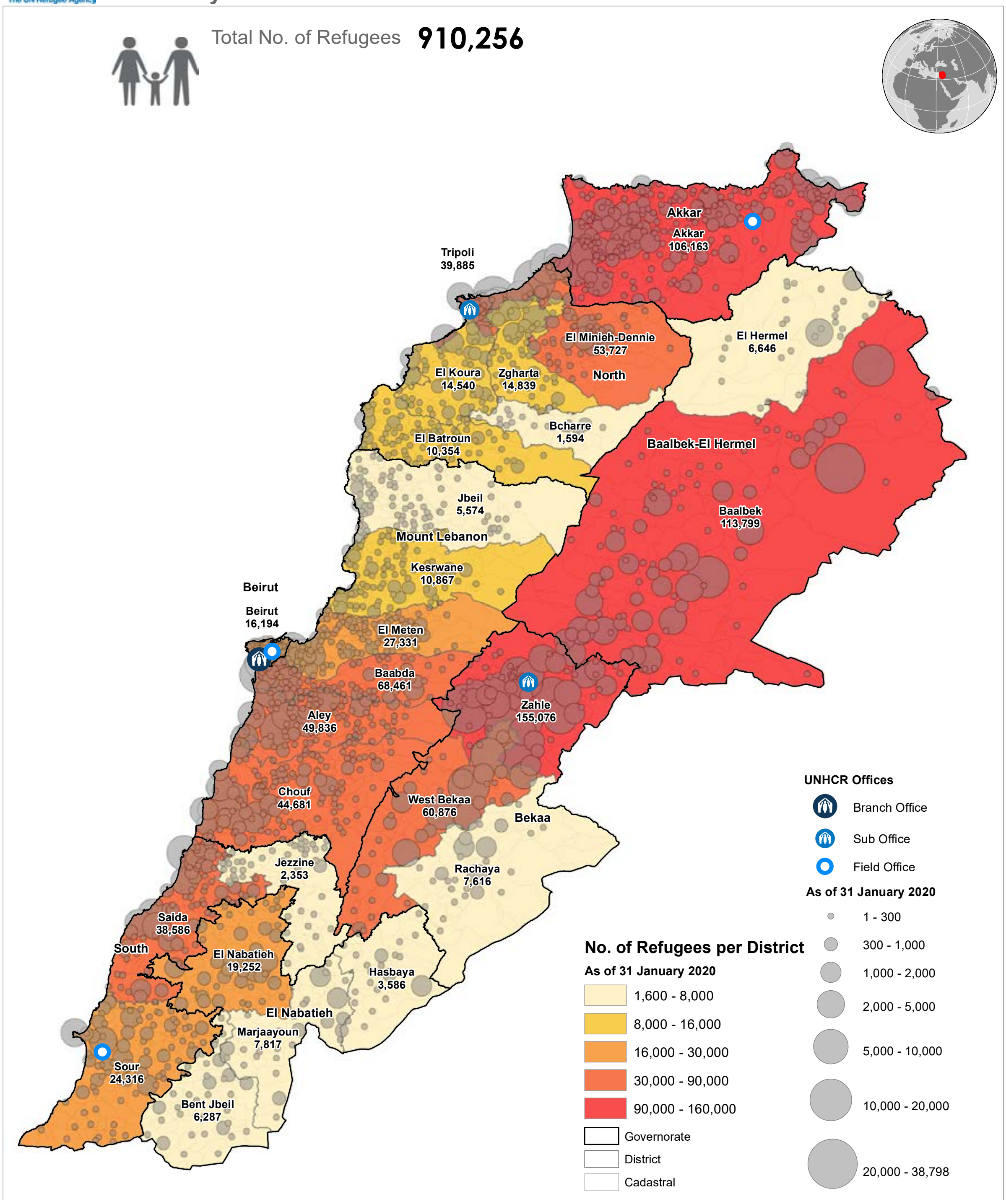
نوع النص	القوانين والأنظمة	التاريخ	عنوان النص
قرار المجلس الأعلى للتنظيم المدني رقم ٢٢	٢٠١٩/٦/١٢	٢٠١٩/٦/١٢	الدراسات التنظيمية ومفاعيلها بعد ثلاث سنوات
تعميم رئاسة مجلس الوزراء رقم ٣٣	٢٠١٣/١١/١٣	٢٠١٣/١١/١٣	التشدد بتطبيق أحكام البناء
تعميم وزارة الداخلية والبلديات رقم ١٤٧٨٠	٢٠١٠/٨/٢٥	٢٠١٠/٨/٢٥	توقيف جميع تراخيص البناء الصادرة عن البلديات في المرحلة السابقة خلال فترة الوزير الحالية
تعميم وزارة الداخلية والبلديات رقم ٤٨٣	٢٠١٣/٩/١٠	٢٠١٣/٩/١٠	يتعلق بالإيجاز لرئيس البلدية والقائمقاميتين في القرى التي ليس فيها بلدات بمنح تصاريح بناء وفقاً لشروط محددة
تعميم وزارة الداخلية والبلديات رقم ٦١٣	٢٠١٤/٥/٥	٢٠١٤/٥/٥	تصريح بإشادة بناء للسكن
تعميم وزارة الداخلية والبلديات رقم ٧٧٠	٢٠١٥/١٠/٩	٢٠١٥/١٠/٩	تمديد العمل بتعميم وزارة الداخلية والبلديات رقم ٦١٣
تعميم وزارة الداخلية والبلديات رقم ٧٣٥	٢٠١٦/٧/٢٨	٢٠١٦/٧/٢٨	يتعلق بالإيجاز وخلال مدة ٦ أشهر من تاريخه لرئيس البلدية والقائمقاميتين في القرى التي ليس فيها بلدات بمنح تصاريح لبناء طابق واحد فقط لمالك العقار او احد فروعه او احد اصوله
تعميم وزارة الداخلية والبلديات رقم ٣٥٢	٢٠١٧/١٠/٢٤	٢٠١٧/١٠/٢٤	تمديد العمل بالتعاميم التي أجازت لرؤساء البلديات والقائمقامين بالنسبة للقرى التي ليست فيها بلديات، إعطاء تصاريح لإشادة بناء طابق سكني يخصص لسكن مالك العقار، او احد فروعه او احد اصوله
تعميم وزارة الداخلية والبلديات رقم ٩٧٨١	٢٠٢٠/٦/٢٢	٢٠٢٠/٦/٢٢	تمديد مهلة لاستكمال أعمال البناء الحائز أصحابها على تصاريح بناء استنادا للتعميم رقم ٣٥٢
مذكرة إدارية من المديرية العامة للتنظيم المدني رقم ٥/٢	٢٠١٠/٨/٢	٢٠١٠/٨/٢	تركيب محطات تكرير للمياه المبتذلة
محضر المجلس الأعلى للتنظيم المدني رقم ٢٠١٢/٥٢	٢٠١٢/١٢/٢٦	٢٠١٢/١٢/٢٦	توضيح أحكام المرسوم ٢٠١٢/٨٦٣٣

Annex 1: Maps

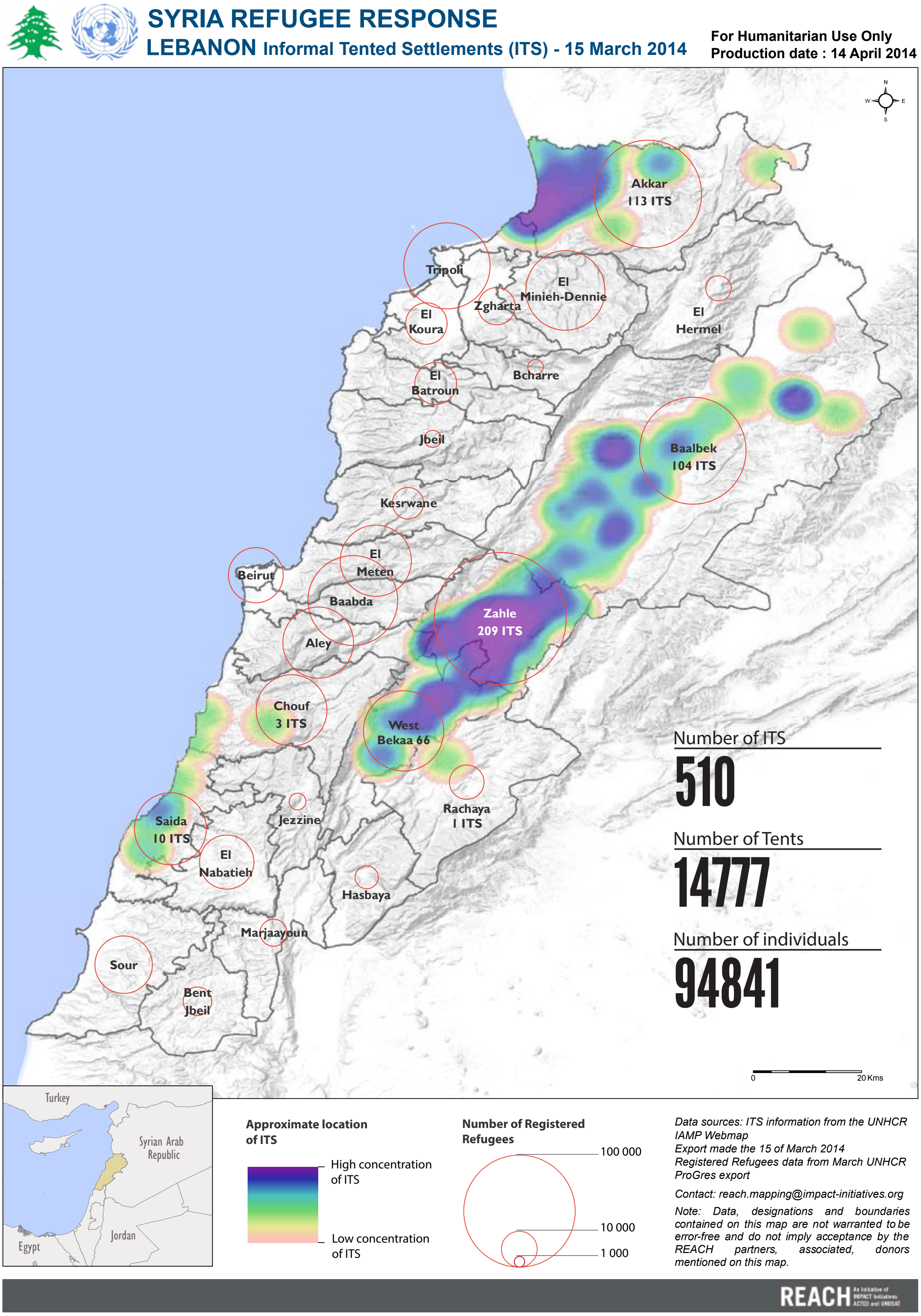


Built Areas in 2014
Source: Corbane at al., 2018

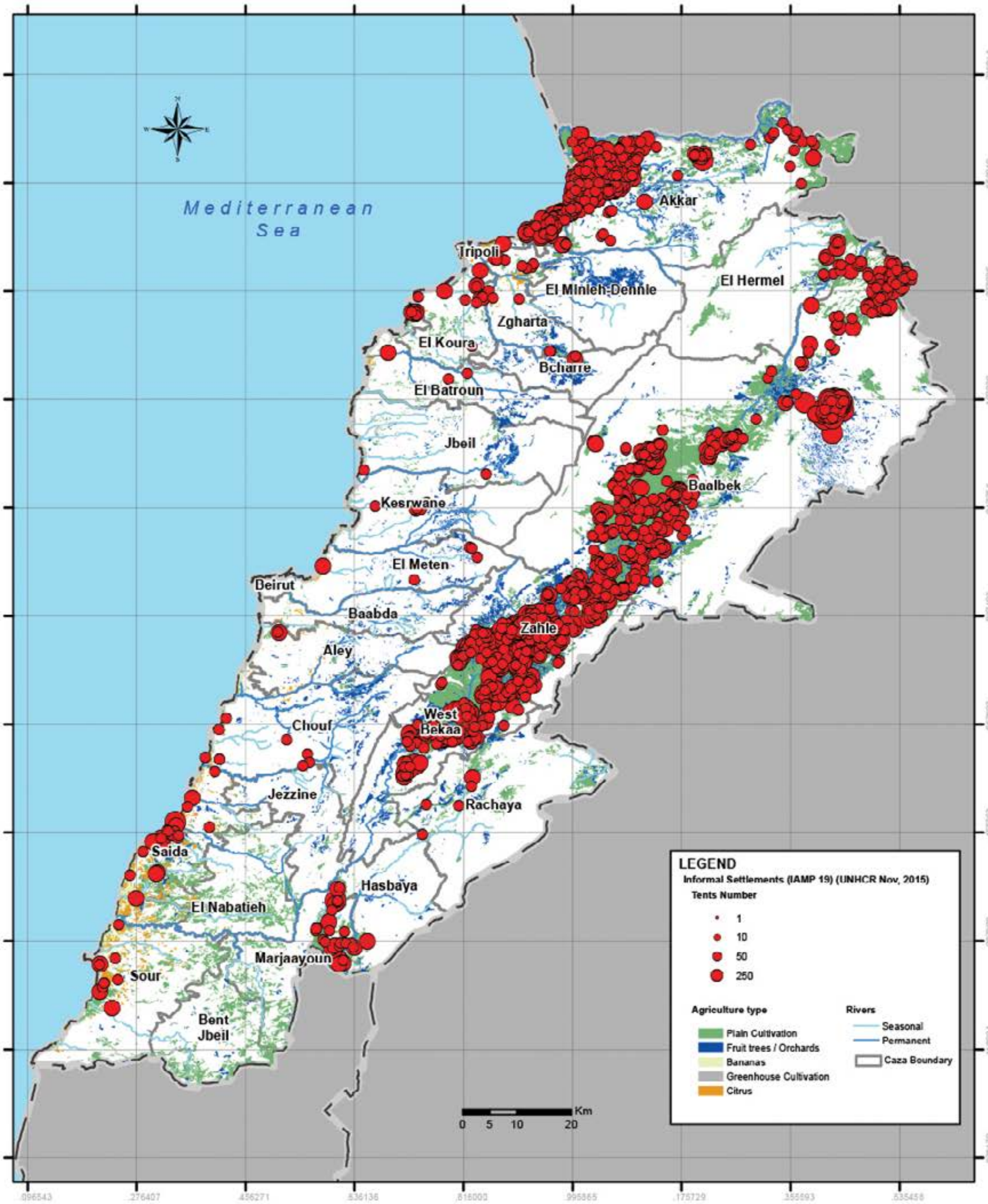
SYRIA REFUGEE RESPONSE
LEBANON Syrian Refugees Registered
31 January 2020



Refugee Population and Location Data
Source: UNHCR, January 2020



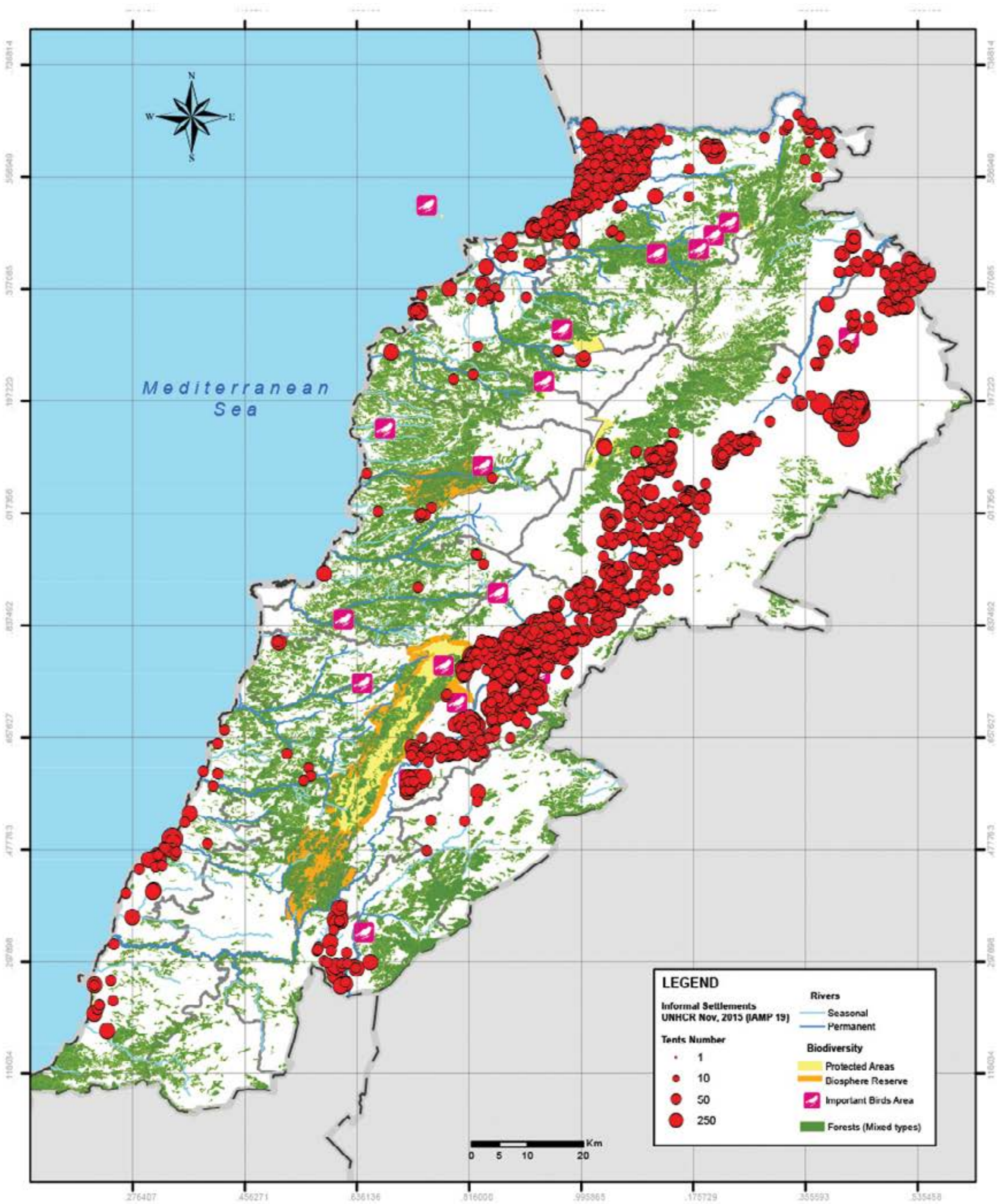
Informal Tented Settlements
Source: UNHCR 2014



Update of the Lebanon Environmental Assessment of the Syrian Conflict & Priority Interventions (2015)

Disclaimer: This map was prepared by UNDP IM Unit, based on the Geo-Database of the National Land Use Master Plan (2004), Data from UNHCR (2015), Landuse Geo-Database of the Ministry of Agriculture (2004). Layers by unit officer: Richard.Shdeed@UNDP.org.
This map is not geographically representative of the boundaries and regions of Lebanon and has been developed for illustrative purposes only.
The projection of the displayed data is provided in WGS84.

Distribution of ITS on Agricultural Areas
Source: MoE/EU/UNDP, 2015



Update of the Lebanon Environmental Assessment of the Syrian Conflict & Priority Interventions (2015)

Disclaimer: This map was prepared by UNDP IM Unit, based on the Geo-Database of the National Land Use Master Plan (2004), Data from UNHCR (2015), Landuse Geo-Database of the Ministry of Agriculture (2004). Layers by unit officer: Richard.Shdeed@UNDP.org.
This map is not geographically representative of the boundaries and regions of Lebanon and has been developed for illustrative purposes only.
The projection of the displayed data is provided in WGS84.

Proximity of ITS to Environmentally Sensitive Areas
Source: MoE/EU/UNDP, 2015

8 Solid Waste

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Abbreviations and Acronyms

CDR	Council for Development and Reconstruction
CDW	Construction and Demolition Waste
CoM	Council of Ministers
EIA	Environmental Impact Assessment
EPR	Extended Producer Responsibility
HBCD	Hexabromocyclododecane
HCW	Healthcare Waste
HH	Household
IPOP	Industrial Persistent Organic Pollution
KPI	Key Performance Indicators
MFA	Material Flow Analysis
ML	Marine Litter
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoF	Ministry of Finance
MoI	Ministry of Industry
MoIM	Ministry of Interior and Municipalities
MoPH	Ministry of Public Health
MSW	Municipal Solid Waste
NIMBY	Not In My BackYard
NIP	National Implementation Plan
OMSAR	Office of the Minister of State for Administrative Reform
PBDE	Polybrominated Diphenyl Ethers
PCBs	Polychlorinated Biphenyls
PFOS	Perfluorooctane Sulfonate
POPs	Persistent Organic Pollutants
PPP	Public–Private Partnership
SEA	Strategic Environmental Assessment
SOER	State of the Environment Report
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNHCR	United Nations High Commissioner for Refugees
UPOP	Unintentionally Released Persistent Organic Pollutant

8. Solid Waste

Traditional and emerging drivers have led to 2,700,000 tonnes of municipal solid waste (MSW) generated yearly, of which only about 20% are diverted from disposal, while 44% and 36% end in landfills and dumpsites, respectively. The level of management of special wastes (healthcare waste, hazardous waste, electronic and electric waste, construction and demolition waste, and others) differs from one stream to another; but currently a considerable amount ends up in the MSW stream.

The main legislative achievement that marks the 2010-2020 decade is the ratification of Law No. 80 (2018) for Integrated Solid Waste Management. Despite some experts' critics and recommendations for amendment, the Law will constitute the backbone of future legislative, technical and communication improvements. It introduces advanced Solid Waste Management (SWM) principles, of which the polluter pays principle and the decentralization principle would become the starting point for major paradigm changes in the solid waste sector in Lebanon.

Yet, for Law No. 80 to be efficiently implemented, the next decade should witness: (1) adoption of a cost recovery system; (2) filling of infrastructural gaps; (3) enhancement of communication; (4) major upgrades in the regulatory and institutional framework and enforcement capacity of national and local authorities, and (5) completion of planning components and development of implementation instruments. In order to quantify and track the evolution of the SW sector, key performance indicators (presented in this chapter) should be assessed periodically.

8.1 Driving Forces

Time patterns of waste data were observed to depict major (1) traditional and (2) emerging driving forces in the solid waste management sector. The data records of the Council for Development and Reconstruction (CDR) facilities, managed by the Consultant LACECO, were used for this purpose. These facilities have the oldest data (that date back to 2008) with separate recording of different flows of waste (received, recovered, landfilled, etc.). They serve a considerable portion of the Lebanese population over a large area (Beirut and Mount Lebanon Governorates in addition to Keserwan Caza), that includes typical urban and rural regions, and manage about 50% of the waste generated in the country. Therefore, the trends observed in LACECO data are considered representative of the trends across the country (or at least, most of it). Yearly volumes received at Zahle and IBC (Saida) facilities (data available starting 2012 and 2013, respectively) are also presented for comparison purposes.

8.1.1 Traditional Drivers

8.1.1.1 Population and SW Patterns

Yearly rates – The amount of waste received at waste facilities show generally increasing trends in yearly rates across all three reported sets of data (by LACECO, MORES, IBC) (Figures 8-1 (a) and (b)). This implies a continuously increasing rate of waste generation across the country, attributed to continuous population increase. As to the changes in the slope (in terms of steepness and direction) of the plots of received waste, the following observations are made:

- In areas serviced by CDR facilities and landfills (Figure 8-1 (a)):
  - A decreasing slope in 2015, followed by a very mild slope in 2016, during the solid waste crisis;
  - A very steep slope in 2017 during the clean-up activities to remove the waste accumulated in the streets of Beirut and other areas serviced by CDR facilities and Nahmeh landfill;
  - A relatively steep slope in 2018 (compared to the years before 2015) that can be attributed to adding the districts of Chouf and Aley to the service area;
  - A decreasing rate in 2019 due to a substantial drop in waste generation during the last three months of the year, at the onset of the economic crisis;
- A relatively stable increasing slope in Zahle (Figure 8-1 (b)).
- A very steep increasing slope of waste received by IBC, Saida, in 2016 because it started to receive waste from Beirut (Figure 8-1 (b)).
- A steep decreasing slope in year 2020, at all facilities, due to a substantial decrease in waste generation rates across the country. This is attributed to two reasons: (1) the economic crisis leading to a nation-wide decline in the purchasing capacity, and (2) the COVID 19 pandemic resulting in repetitive lockdowns leading to slowdown/interruption of activities in most sectors (Figure 8-1).

Summer peak – The 2014-2019 data show a recurrent yearly peak around the middle of each year, i.e. June to August (Figure 8-2). This high-stress period may be attributed to: (1) yearly visits of immigrants during summer break; and (2) touristic activities during the summer season.

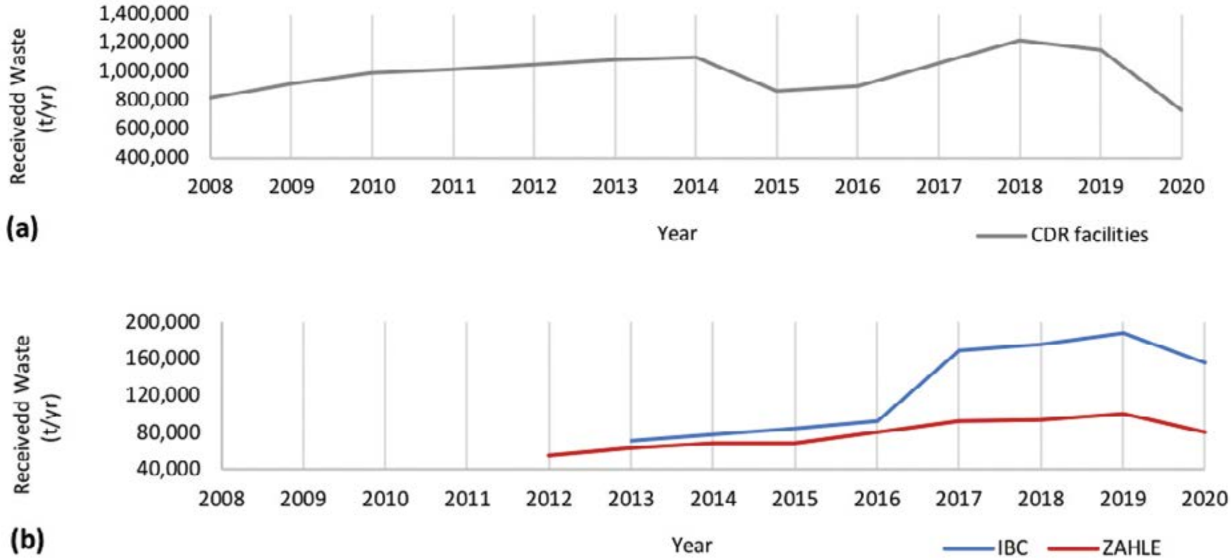


Figure 8-1 Yearly Average of Waste Received by the Facilities of: (a) CDR; (b) Zahle and IBC
Source: Data provided by LACECO, MORES and IBC

High disposal rates – The landfilled portion of the waste remained high over the years. Yet, an improving trend was observed in the facilities serving Beirut and Mount Lebanon by comparing the 2014-2015 period (January 2014 to June 2015) to 2017-2019 period (i.e. before and after the 2015-2016 waste crisis, respectively). The proportion of landfilled waste decreased from 82% to 77% (composed of 71% sorting rejects and 6% compost rejects), during the 2014-2015 and 2017-2019 periods, respectively (Figure 8-2). The rates vary among different regions of the country; for instance, Tripoli facility landfills about 89% (with 7% reported recovery rate of recyclables) and Zahle facility recovers about 11% of the waste as recyclables and landfills the rest as residuals and stabilized organic matter. In comparison, IBC generates about 20% of rejects (stored for further processing) and sends the organic matter for anaerobic digestion. Considering that a large number of municipalities send their waste directly to dumpsites, the overall disposal rate in Lebanon (calculated through the Material Flow Analysis (MFA) presented in this chapter) is about 80% (44% in landfills and 36% in dumpsites).

8.1.1.2 Geographical Constraints

Spatial, topographic and geological constraints, i.e. the small country surface with mountains and karstic aquifers, limit the availability of feasible sites for waste treatment and disposal. The challenge is intensified by the high population density, high land cost and poorly planned urban development. Combined, the aforementioned conditions constitute the ingredients of a "mission impossible" when it comes

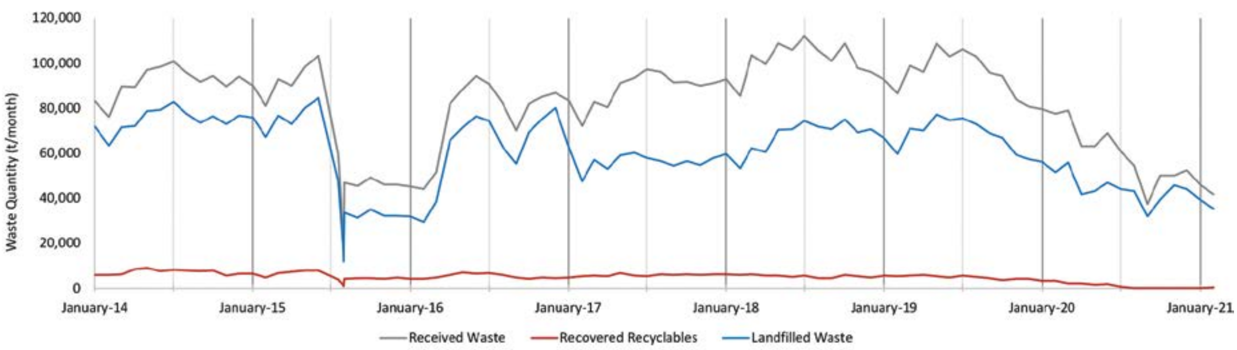


Figure 8-2 Waste Received, Recovered and Landfilled in CDR Facilities
Source: LACECO data, 2020

to siting SW treatment and disposal facilities that are, at the same time, economically, environmentally and socially feasible and sustainable.

8.1.1.3 Market Demand

The amount of inorganic material recovered from CDR facilities (over years 2014 to 2019) fluctuated between 6% and 8% (LACECO data). Yet an improvement was observed in the proportion sold to the industry as secondary raw material from 74% in the 2014-2015 period (before the 2015-2016 waste crisis) to 95% in the 2017-2019 period (after waste crisis) (LACECO data). This may be attributed to the considerable effort put by NGOs and local communities to reduce the accumulated waste during the crisis by sorting and recovering recyclable materials. This has led to sorting initiatives and small businesses that gave a boost to the recycling industry. Yet, a lot remains to be done to create larger and broader secondary material markets and, ultimately, a complete national circular economy framework.

8.1.1.4 Political Indecision

The 2010-2020 decade will be remembered, for years to come, for the detrimental 2015-2016 SW crisis, attributed to the volatile decisions that marked the period before year 2018. While various efforts were made to organize the solid waste sector, it is only until 2018 that the Solid Waste Law No. 80 was ratified, followed by the development of a draft ISWM strategy and a roadmap in 2019 – revisited in 2020. Before 2018, the governmental decisions and plans seldom showed fruitful outcomes:

- In 2010, following the failure of the 2006 SW plan[1], a decision was made by the Council of Ministers (CoM) in 2010 to update the 2006 master plan by introducing incineration and waste-to-energy technologies in large cities, while maintaining the 2006 plan in the rest of the country (Decision No. 55, on 01/09/2010);
- Based on that decision, which requires merging the 2006 and 2010 plans, a proposal was issued on the 2nd of February, 2013, for a draft national SWM plan – yet the endorsement process was interrupted because of the resignation of the Prime Minister and accordingly the government;
- In 2014 and 2015, decisions were issued by CoM to prepare and launch, for the first time, ToRs for a national tender for SWM activities in six service regions across the whole country (Decision No. 46, on 30/10/2014; amended by Decision No. 1, on 12/01/2015). Even though the resulting bids outcompete, both technically and financially, the preceding and following adopted solutions, they were refuted by the CoM through Decision No. 1 on the 25th of August 2015 (Box 8-1).

  The latter decision coincided with the 2015-2016 SW crisis, upon the closure of Naameh landfill. Naameh landfill was the major and only sanitary landfill serving the Beirut and Mount Lebanon region as well as the Keserwan caza and was operational since 1998. It was closed on the 17th of July 2015, resulting in the accumulation of uncollected garbage in the streets of Greater Beirut, Mount Lebanon and Keserwan caza (area serviced by Naameh landfill). The drop of the weight of waste received by CDR facilities (that dispose of their residuals in Naameh landfill) is noticed between July 2015 and May 2016 (Figure 8-1). During this period, the Karantina sorting plant received only the wastes collected from Beirut city; the Amrousieh sorting plant received the waste delivered by the municipalities of the southern suburbs of Beirut. The rejects were temporarily stored in designated sites in Beirut – namely next to the slaughterhouse and the airport. The rest of the waste was either open-dumped or stored in open spaces in bales or bags. In comparison, the waste flow outside Beirut and Mount Lebanon (e.g. Zahle and Saida) was not affected (Figure 8-1 (b)).
- After the refusal of bids on the 25th of August, 2015, a decision was issued by CoM (Decision No. 1 on 09/9/2015) calling for complete decentralization with a transitional period consisting of two temporary (1.5-year lifespan) landfills in Srar (Akkar) and the Masnaa area (Anti-Lebanon Mountains). This decision was not implemented due to public opposition.
- On the 21st of December, 2015, CoM commissioned the CDR (through Decision No. 1) to outsource the export of the waste (generated from Beirut and a part of Mount Lebanon) and landfill it abroad. This decision was not implemented because the export could not take place.
- An emergency decision (Decision No. 1) was issued on the 12th of March, 2016, to establish one temporary landfill in Bourj Hammoud, Jdeideh – Bouchrieh – El Sed, another one in Ghadir River estuary, and a third one serving the Aley and Chouf cazas at a location to be identified

[1] Following the 1997 Emergency Plan (and its amendments), the 2006 SWM Master Plan, proposed by CDR and Ministry of Environment (MoE), was approved by the CoM Decision No. 1 on June 2006 ,28, to provide an integrated plan for the whole country under four service areas, including sorting and composting facilities and sanitary landfills. Yet the 2006 plan was not implemented for various reasons, including: (1) MoE's no approval on the EIAs for the treatment and disposal sites; (2) public opposition to many of the proposed sites; (3) indecision regarding the source of investment for the implementation of the plan and the exact locations of some of the proposed sites.

later. Also, it re-emphasized the decentralization option for municipalities. This is when Beirut municipality started to send about 250 tonnes of waste daily to IBC plant in Saida, which explains the steep increase in waste inflow to the facility between 2016 and 2017 (Figure 8-1 (b)). This decision was implemented immediately – at the exception of the third site intended to serve Aley and Chouf. Amendments to this decision, which are still running until this date, include CoM decision 45 of January 11, 2018, adding the cazas of Aley and Chouf to the area served by Ghadir sanitary landfill.

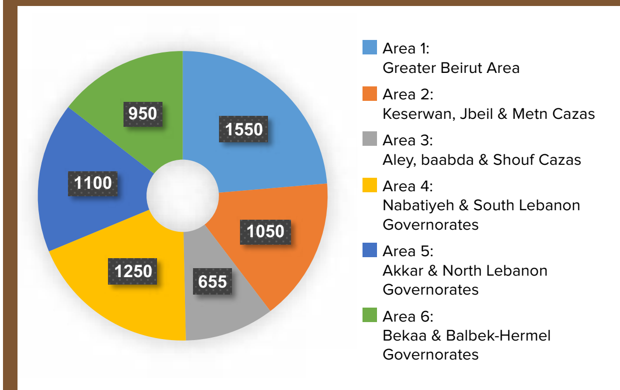
Box 8-1 The 2014-2015 National SWM Tenders

Based on the CoM Decision No. 46 dated 30/10/2014 (amended as per Decision No. 1 dated 12/01/2015), CDR launched (in the first quarter of 2015) national tenders for waste collection, treatment and final disposal for the six service areas (refer to the below Figure). MoE, Ministry of Finance (MoF), and Office of the Minister of State for Administrative Reform (OMSAR) were required to launch tenders, at a later stage, for activities related to the supervision of contracts.

An evaluation committee, headed by MoE, was formed. It comprised representatives of Ministry of Interior and Municipalities (MoIM), MoF, OMSAR, Presidency of the Council of Ministers, and CDR, assisted by three international consultants (Ramboll, IGIP and Fichtner).

The committee received, by the first set deadline (May 26, 2015), three offers for Area 2, one offer for each of Areas 4, 5 and 6, and no offers for Areas 1 and 3. Therefore, the tenders were repeated for all areas except Area 2. On the second deadline (July 13, 2015), 11 offers were received for all remaining areas, except for Area 1 (Great Beirut Area), with two or more offers for each of the 4 areas. The tenders were therefore repeated for Area 1. By the third deadline (August 7, 2015), three offers were received for Area 1, making the total number of proposals received across the country 17, thus meeting the technical, legislative and planning requirements.

Announced on August 24, 2015, the results were considered a major improvement to the previous (prior to the crisis) schemes both technically and financially. Technically, the anticipated recovery ratios were 60% for the first 3 years and 75% for the remaining 4 years. Financially, the average proposed price was USD 120 per tonne, including capital costs, for a seven-year contract. Yet, the results were refuted by the CoM with no reported justification (Decision No. 1 dated 25/08/2015).



8.1.1.5 Poor Governance

National Governance

Lebanon has been idling for years waiting for an "agreement" between the political, administrative and social key players to reach a permanent plan for the management of solid waste. The impact of political indecision is aggravated by the lack of key governance elements that make the Ministry of Environment (MoE) often incapable of moving forward:

- *Human Resources* – MoE was established in 1993 with only three staff members. Even though the number of employees increased with time, MoE remains understaffed and incapable of meeting the overwhelming requirements and challenges of environmental governance in Lebanon particularly monitoring, inspection and enforcement – and the solid waste sector is no exception. Also, the low salary range in the public sector, coupled with the competition from the private sector, make it very hard to recruit and retain qualified personnel (MOE/EU/GFA, 2017).
- *Budget and Procurement* – The budget of MoE is among the lowest compared to other Lebanese ministries. This poses further limitations on the capacity of MoE to play a leading role in environmental governance in general, and SW governance in particular. Furthermore, the lengthy procurement procedures requiring the approval of the Council of Ministers, like all other bureaucratic procedures in Lebanese ministries, are prohibitive to proactive governance initiatives (MoE/EU/GFA, 2017).
- *Data availability* – The available databases and statistics are often limited and address specific topics. National data collection and analysis campaigns are lacking, mostly because of limited budget and insufficient human resources. Consequently, decision making is not always based on sound information, and the subsequent enforcement is compromised (MOE/EU/GFA, 2017). This problem is mostly pronounced in the solid waste sector where local-level solutions are numerous and lack adequate monitoring and data management systems.
- *Legislation* – From a general Environmental Governance point of view, Law 444 of 2002 on environmental protection has been translated into many essential decrees; yet the implementation of many of the decrees is being delayed – mostly because of political disagreements (MOE/EU/GFA, 2017). From a Solid Waste Governance perspective, Law 80 of 2018 on integrated solid waste management provides the needed framework, yet the related decrees and decisions remain to be drafted, endorsed and implemented.

Local Governance

By Decree 8735/1974, solid waste management, which is considered an aspect of the cleanliness of public spaces, is under the jurisdiction of local authorities. Yet, the actions of municipalities are bound by the decisions and approvals of the MoIM and their financial capacity is directly dependent on the decisions of MoF. This, along with the many other barriers listed below, render local waste management governance vulnerable (MoE/UNDP/GEF, 2019; MOE/EU/GFA, 2017):

- *Lack of regulatory and economic instruments* – Despite the recent development of a solid waste Law, the absence of the needed application decrees and decisions makes it ineffective at the local level. From a financial perspective, economic instruments, such as taxes and cost recovery systems, are non-existent. This makes cost recovery a major challenge to most local authorities.
- *Financial limitations and absence of a cost rcovery system/mechanism* – The waste management operations in Beirut, Mount Lebanon and Keserwan Caza, are still subsidized by the national budget, through the Independent Municipal Fund (IMF). However, the municipal income from IMF is not directly managed by the municipalities who have been, and might remain, in debt for years because of centralized waste management decisions. Similarly, municipalities across the country have been struggling with poor national funds, lack of technical know-how and limited capacity building. Alternatively, international funding has been used to build local small-scale waste treatment facilities, with the understanding that operation and maintenance (O&M) will be covered by the Lebanese government. Yet, considering the impact of economies of scale and the lack of auto-financing tools, many municipalities failed to recover the collection/treatment costs and ended up with full financial support from the National Treasury (e.g. through OMSAR) or financial overburden, and accordingly decided to shut down their facilities.
- *Weak citizens' awareness and involvement* – The concept of integrated solid waste management, namely "client inclusivity", is poorly promoted. Citizens are not systematically involved, at the

Figure 8-3 Waste Bags Littering Next to Residential Buildings in Remote Areas

local or the national level, in decision making, public policy development and strategic planning. Despite legal requirements that ensure citizens consultation (e.g. the public participation principle of Law 444/2002, and the public consultation requirement of EIA decree 8633/2012), actual consultation on local decisions remains limited. Lack of involvement leads to loss of interest in learning and acquiring new knowledge. Furthermore, Lebanon lacks a national comprehensive outreach program, and the municipal attempts are often limited to individual (low-efficiency) actions. An example of ultimate citizen carelessness and lack of awareness is found in remote underdeveloped areas, where littering can reach an alarming stage (Figure 8-3).

- *Syrian Conflict* – As at the national level, local governance is equally affected by the impact of the displaced Syrian population in Lebanon. In fact, about 52% of the additional waste is being disposed in open dumps, commonly managed by municipalities, thus creating an additional financial burden on municipalities (MoE/EU/UNDP, 2014).

8.1.1.6 Public Opposition and Lack of Trust

Over the years, Lebanese (national and local) authorities have in general failed to show transparency and accountability in almost all sectors, and the solid waste sector is no exception. The citizens do not trust the capacity, neither the will, of authorities to properly plan and responsibly supervise the implementation of waste solutions. This resulted in acute public opposition and country-wide emergence of Not In My BackYard (NIMBY) and Build Absolutely Nothing Anywhere Near Anything or Anyone (BANANA) syndromes; thus hindering decision-making power and efficient long-term planning (Romboli et al., 2018). Misconceptions (e.g. high income from selling recovered material, catastrophic impacts of incineration, zero residuals solutions, etc.) also created major limitations to social acceptance of engineering-based decisions.

8.1.2 Emerging Drivers

8.1.2.1 Syrian Crisis

The Syrian civil war started officially in March 15, 2011, dating the beginning of the influx of Syrian displaced population into Lebanon. By 2016, the total Syrian displaced population in Lebanon was over 1.5 million. The data reported by UNHCR revealed that about 25% of the total number of registered Syrians were located in the two governorates of Mount Lebanon and Beirut (the area served by CDR facilities). Accordingly, the highest increase in waste generation, by the displaced Syrian population, was recorded in Mount Lebanon (MoE/EU/UNDP, 2014 and 2015). This can be attributed to the fact that CDR facilities have the most systematic data collection system, making it possible to track the increase in collected waste. In fact, records show that a 16% increase in the amount of waste received by CDR facilities was observed in March 2011 – which dropped in subsequent months due to relocation of the displaced population (LACECO data). Yet, the highest impact was observed in the Bekaa and Akkar, leading to high groundwater and surface water threats. The total country-level increase reached 324,568 t/yr[2] (15.7% of total generation) by the end of 2014 (MoE/EU/UNDP, 2014 and 2015).

8.1.2.2 Economic Crisis

The link between socio-economic conditions and waste generation rates is well established in the

[2] To note that SW issues related to the displaced crisis are being addressed within the Social Stability Sector of the UN Lebanon Crisis Response Plan (LCRP).

literature. As a matter of fact, the 2008-2019 waste collection data shows continuously increasing patterns with years, at the exception of two occurrences: 2015-2016 during the waste crisis in Lebanon, and in 2019 (Figure 8-1). Given that there are no other major driving forces in 2019, this (7-10%) annual average drop of waste generation can be attributed to the beginning of the economic crisis and the reduction in the purchasing capacity of the Lebanese population.

8.1.2.3 Covid-19 Lockdown

The first Covid-19 lockdown started officially on March 16, 2020 and the measures were eased temporarily in April 27 of year 2020. A decreasing trend in average monthly waste received by CDR facilities was observed between February (2,820 t/day), March (2,753 t/day) and April (2,377 t/day). This implies a decreasing trend in average monthly generation rates of 2.4% in March and 15.7% in April, with respect to February 2020 (LACECO data). This was followed by repetitive intermittent lockdowns of different extents and durations. The generation of infectious healthcare waste (related solely to Covid-19 cases) increased from 18.3 t/m in March to 63.5 t/m in September, 2020 (Figure 8-4) (arcenciel data- local NGO).

8.1.2.4 Explosion at the Port of Beirut

The explosion of the port of Beirut, in August 4, 2020, resulted in excessive damage that lead to large volumes of demolition waste (DW), both inside and outside the port premises. In response, the EU initiated waste management planning activities inside the port. They categorized the port waste streams into: asbestos elements, asbestos-containing waste piles, containers of chemical and hazardous materials, damaged vehicles, vessels and submerged objects, in addition to structures that need demolition. A strategy for the clearance of the port site was proposed with a waste removal prioritization plan based on hazard ranking. The study emphasized the need for Construction and Demolition Waste (CDW) recycling and disposal facilities and the corresponding regulatory framework. Also, it highlighted the impact of poor communication between stakeholders, lack of standards for disposal of asbestos-containing waste, and weak institutional capacity in terms of monitoring and controlling the collection and treatment of hazardous chemical waste (EU/LDK, 2020).

UNDP led the assessment of the waste generated/ stored outside the port of Beirut. The total DW from Beirut explosion was estimated to be between 800,000 and 1,000,000 tonnes. The weight of shattered glass was found to be more than 20,000 tonnes (UNDP, 2020). Those quantities were validated against other damage assessment reports, including the Building Structural Assessment Report by the Order of Engineers and Architects and the Beirut Rapid Damage Assessment by UN-Habitat and the Municipality of Beirut. The former provides the results of an on-ground survey of 2.8 km^2, whereby the buildings were categorized according to the extent of structural and non-structural damages (OEA, 2020). The latter covered the buildings within 2 km radius from the blast, and estimated the glass content in the removed debris to be 16% (UNHabitat/MoB, 2020). A comprehensive nation-wide plan for CDW management is sought

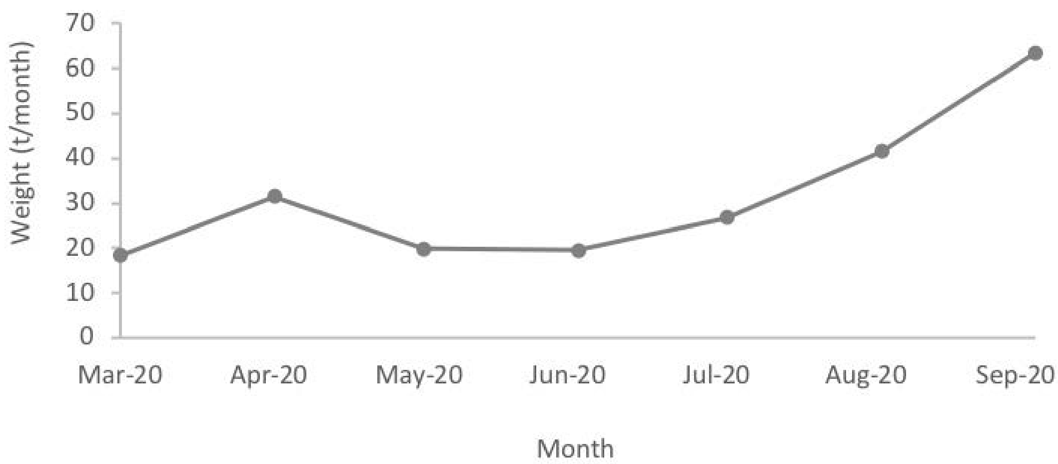


Figure 8-4 Covid-19 Infectious Waste Generation
Source: arcenciel data

after by key stakeholders and donors, and a call for proposals was launched by UNDP.

Several on-ground initiatives took place to reduce the impact of the waste, including: the 110-tonne glass recycling project by Cedar Environmental; the glass sorting/recovery project by arcenciel; and the Rubble-to-Mountains project by the consortium of UNHabitat, American University of Beirut (AUB) Neighborhood initiative, Lebanon Reforestation Initiative and Development inc. Also, a rapid comparative assessment was done by ECODIT for available options for managing broken glass from Beirut explosion (ECODIT, 2021a), followed by an assessment of the asbestos contamination of the waste (ECODIT, 2021b).

Among the impacts associated with the blast, ceasing the operations at the damaged Coral and Karantina facilities contributes a considerable share of the additional burden on the SW sector. Coral, the only composting plant serving Beirut and Mount Lebanon governorates as well as Keserwan caza, became completely non-operational. Sorting activities at Karantina have stopped and the facility is being used only as a transfer station. Amrousieh facility, even though operational, stopped the diversion of organic material to Coral. Until a rehabilitation/reconstruction fund is secured, the waste that used to be received by Coral and Karantina facilities is being sent to landfills.

8.2 Current Situation

8.2.1 Municipal Solid Waste

The total generation of MSW is approximated at 2,700,000 tonnes/year (t/yr), with the highest generation (at the governorate level) being in Mount Lebanon (35%), followed by North Lebanon (24%) and the Bekaa (10%) (Table 8-1, MoE Data, 2018). The average unit generation rate is estimated at 0.95 - 1.2 kg/cap.d in urban areas and 0.8 kg/cap.d in rural areas, with a country weighted average of 1.05 kg/cap.d[3] (MoE/EU/GFA, 2017, SWEEP-net, 2014). To note that the aforementioned SW generated rates may not apply beyond year 2019 (Box 8-2).

The waste generated by displaced people ranges between 0.43 and 0.53 kg/cap.d, and sums up to about 15.7% of the total MSW generated by the Lebanese population (MoE/EU/UNDP, 2014 and 2015). Yet, these figures may no longer be valid due to variation in circumstances of the displaced Syrian population in Lebanon (e.g. living conditions and geographical distribution), and due to the impact of the economic crisis that is affecting waste generation on the national level. As in most developing countries, MSW in Lebanon is dominated by organic materials, mainly food waste (Table 8-2) (MoE/EU/GFA, 2017).

Table 8-1 MSW Generation Rates per Governorate

Governorate	Generation Rate (t/d)(rounded)
Akkar	430
Baalbek-Hermel	350
Beirut	614
Bekaa	740
Keserwan & Ftouh-Jbeil	533
Mount Lebanon	2,558
Nabatieh	516
North Lebanon	1,050
South Lebanon	551
Total Quantity	**7,342**

Box 8-2 Anticipated Deviations of Generation Rates Beyond Year 2020

During year 2020, an acute economic crisis took over Lebanon, leading to the collapse of the Lebanese currency and pushing a high proportion of the Lebanese population below the poverty line. Consequently, the overall purchasing capacity of the population dropped considerably, resulting in a substantial reduction in waste generation. In fact, reported figures show a major drop in collected waste, between 2019 and 2020, of 17% to 20% in Saida and Zahle and reaching 36% in the area served by CDR facilities (i.e. Beirut and most of Metn and Keserwan) (Figure 8-1).

In the absence of projections of the extent and duration of the crisis, there are no indications on when the SW generation rates will go back to pre-crisis level. Also, considering the relatively recent nature of the crisis, one cannot assume that steady conditions have been reached and the period of data collection (about one year only) is considered too short to reach a conclusive estimation of the "new" SW generation rates. Accordingly, the rates of waste generation reported before 2020 will not be applicable in the following years and a new assessment is needed. Similarly, the waste composition might change because of a shift in the priorities of most Lebanese citizens toward the bare necessities of life – i.e. letting go of luxury items that will gradually disappear from the waste stream.

The management of MSW in Lebanon has been unstable and is continuously changing. Currently, it follows four parallel schemes:

1. A national plan for the highly populated area surrounding the capital (Beirut, Mount Lebanon and the Caza of Keserwan) – representing about 50% of the total generated waste. The plan, overseen by the CDR – which shares periodic supervision reports with MoE – consists of collection of comingled waste followed by material recovery in Amrousieh and Karantina facilities (Annex 1).

[3] To keep in mind that these generation rates may not be very accurate, considering the lack of an accurate population count for Lebanon.

Table 8-2 MSW Composition in Lebanon

Waste Component	Proportion
Organic Fraction	50 & 55 % (Urban & Rural Areas)
Paper & Cardboard	15 – 17 %
Plastics	10 – 13 %
Metals	5 – 6 %
Glass	3 – 4 %
Others (Textile, Wood, Misc.)	10 – 12 %

Source: MoE/EU/GFA, 2017

The organic material recovered from both facilities is partially (22% of total received waste) processed in the Coral composting plant and residuals are disposed in the landfills of Burj Hammoud and Costa Brava. A plant similar to Coral is under construction in Costa Brava. Part of the recovered organic material in Coral (8% of total received waste) is sent to the IBC plant in Saida.

2. Small-scale facilities in remote areas of the North, South and Bekaa regions, managed by Office of the Minister of State for administrative Reform (OMSAR) in coordination with local authorities[4] – representing about 25% of the total generated waste. The capital cost is funded mostly by the European Union and operational costs are paid by the Lebanese government. These facilities consist mainly of 15 sorting and composting plants with, in few instances, an additional infrastructure that may support refuse derived fuel (RDF) production. One biogas plant was built as part of Baalbeck facility – but remains incomplete and non-operational. Five facilities have sanitary landfills (of which two are not operational yet), while many others rely on dump sites for final disposal. The location, type of activities and current condition of those facilities are shown in Annex 1.
3. Community-run systems, scattered across the country (about 55 plants, 40% of which are estimated to be operational), that are either self-funded or funded through international donations. Those are under the full responsibility of local authorities or private companies. Operation and monitoring are either outsourced or run by the local authority or private company. Most of those consist of basic sorting, composting and disposal; with few applications related to RDF (Ghosta not operational yet), anaerobic digestion (Saida and Bkessin) and thermal treatment (Qabb Elias) in private facilities.
4. Collection and dumping activities run by local authorities that do not own, or have access to, waste facilities.

In addition to a large number of relatively small MSW dumpsites, operated by small communities, major dumpsites are being adopted as final disposal sites in several locations – excluding scheme 1 above. During the last decade, two major dumpsites (Saida and Burj Hammoud) were rehabilitated. Also, three main dumpsites (Ras El Ain-Tyre, Bar Elias-Zahle, and Tripoli), in addition to several local ones, were closed. Despite these efforts, the total number of MSW dumpsites increased from 504 in 2011 to 617 in 2016, out of which 55% remain operational. The highest number (127) of operational dumps fall in Nabatieh and South of Lebanon, followed by Beqaa and Baalbek-Hermel (96) (MOE/UNDP/ELARD, 2017).

A generic MFA was generated based on 2019 records provided by individual waste management facilities, local authorities, data provided by MoE and CDR, and baseline reports developed by OMSAR (2017) (Figure 8-5). The waste facilities are shown in Annex 1. The total waste flow was verified against MoE data as follows: The total waste received by MSW facilities was found to be 2,187,255 t/yr, which is less than the total estimated generation (2,700,000, MoE Data 2018). The difference of 512,745 t/yr (19%) is assumed to be sent directly to dumpsites. The MFA[5] revealed that the total generated waste is managed as follows:

- About **3% is source-sorted:** 2% sent directly to the waste-to-energy facility in the Bekaa and 1% collected by the informal sector[6];
- About **65% is received in material recovery facilities,** distributed as follows: 5% is recovered

[4] Tripoli facility is cross-cutting between schemes 1 and 2.

[5] Disclaimer: The MFA presented in this chapter serves only as a rough quantification of the status-quo of MSW flows in the country. Data used in the MFA calculations are based on rates provided by local authorities and managing companies. Some of the provided information is reported informally, with roughly approximated values, especially in facilities that lack adequate weighing equipment and/or accurate weight recording and data storage procedures.

[6] The reported %1 value, corresponding to informal collection activities, is underestimated due to the lack of data at major collection points. The informal sector contribution to the recovery of plastic alone was estimated to be %2 of total MSW stream (EDESSA/UNDP, 2020). According to rough (non-documented) estimations by MoE, the informal sector is recovering about %3-2 of the MSW as recyclable material. This would increase the total recovered materials to about %8-7 and reduces the open-dumped waste to about %35-34.

for recycling, 15% is sent for composting[7,8], 4% is sent for anaerobic digestion; and 41% is rejected to landfills and dumpsites[9,10];

- About **32% is directly sent to dumpsites**[11].

Accordingly, the total proportion of disposed waste (directly or after sorting, and including processing rejects) is **44% in landfills and 36% in dumpsites**. The total proportion of recovered non-organic materials delivered to the **recycling industry is about 6%** (including formal and informal sector, and mixed and source-separated waste).

[7] Where the records do not show the proportions of rejects and liquid/gaseous losses resulting from the composting process, it is assumed that the inflow is equally split into: compost product, rejects and liquid/gaseous losses. This assumption is based on calculations of average proportions from the records of Coral composting facility for years 2019-2018 (LACECO data).

[8] Where no clear evidence is provided on the use of the produced compost, it is assumed that the compost is disposed of with the rejects. Unless the organic waste is collected separately, most of the produced compost is of low quality. Therefore, unless there is a clear statement by the facility that the compost is used/sold/given away, it is most likely to be disposed of.

[9] Where the quantities of the sorting residuals are not reported, it is assumed to be %70 of the inflow. This assumption is based on calculations of average reject percentage from the records of Amroussieh and Karantina processing facilities for years 2019-2017 (LACECO data).

[10] Where the records provided by a facility show a difference between inflow and total outflow of waste, the difference is assumed to be rejects sent for disposal.

[11] The waste received by Hbaline dumpsite is assumed to be equal to the generation rate minus the source-sorted waste received at Jbeil city sorting facility (which serves the whole governorate).

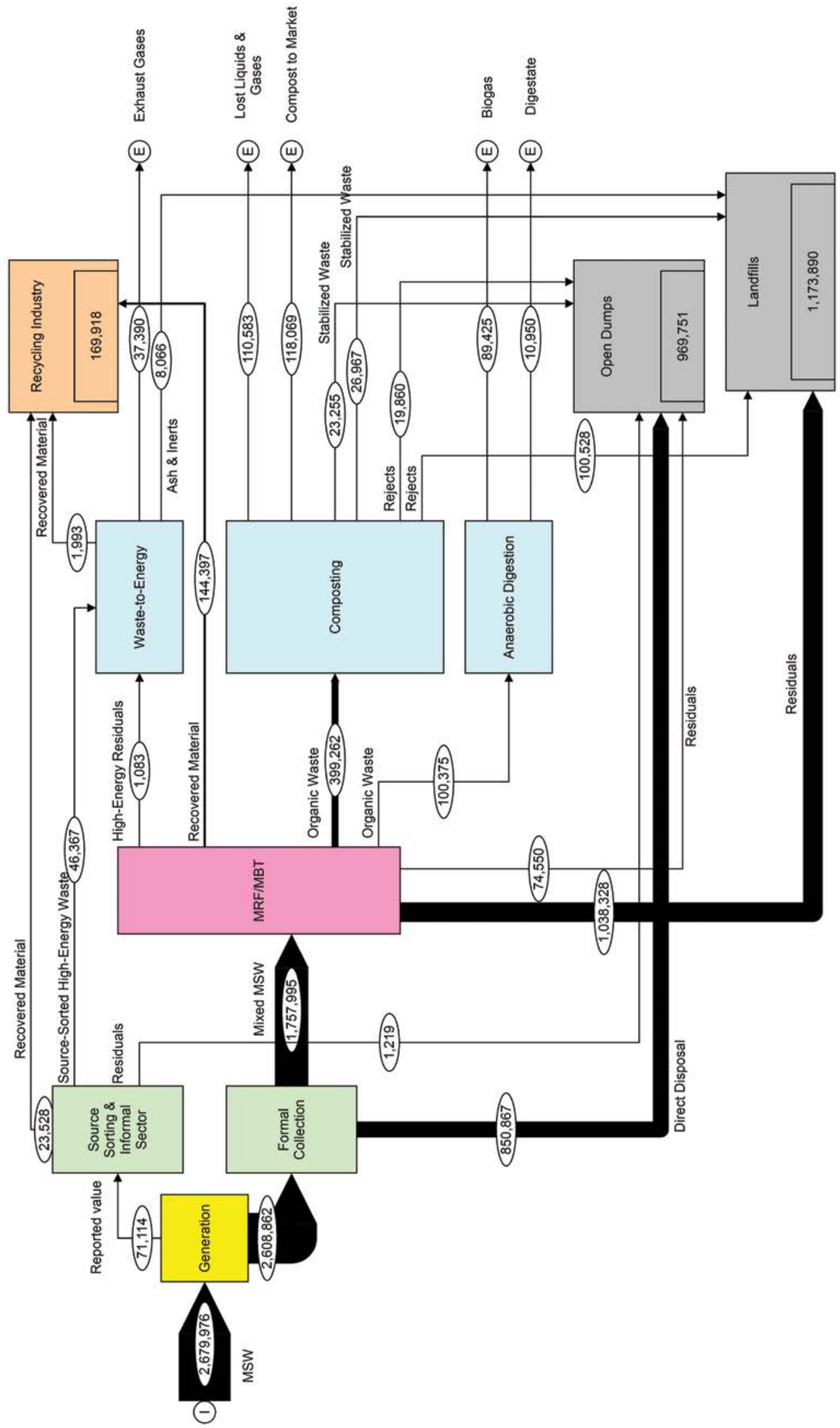


Figure 8-5 Country-Level Material Flow Analysis of MSW for the Year 2019 (t/yr)

8.2.2 Healthcare Waste

Healthcare waste (HCW) is defined by the Lebanese law and the World Health Organization (WHO) as the waste produced by the healthcare institutions: hospitals, clinics and health centers, laboratories, blood banks, medical research centers, retirement homes and pharmacies (Decree 13389/2004). The majority of HCW is generated by the private sector, which owns 75% of the hospitals in the country – most of which (49%) are located in Mount Lebanon – including Keserwan and Jbeil (MoE, 2018). HCW is categorized as hazardous or non-hazardous. The latter is comparable to domestic waste and constitutes about 80% of the HCW stream; the former constitutes the remaining 20% and is further classified into infectious, non-infectious and radioactive (MoE, 2018). The average generation rate of infectious HCW was estimated at 1.42 kg/capita/day (Maamari et al. 2015). Recent data of HCW flows from various sources were obtained from the Laboratory of Hazardous Waste Management at USJ[12] (Table 8-3).

From a management perspective, arcenciel (local NGO) is the main specialized HCW collector in the country, handling more than 80% of the total infectious HCW stream. In addition, the Abbassieh plant, managed by the local authority, serves the southern Cazas, including Tyre, Sidon, Nabatieh, Bent Jbeil, and Marjaayoun. The rest is managed in-house or sent with the MSW stream (Table 8-3).

Infectious portion of HCW is generated at a rate of 14 tonnes daily, of which arcenciel handles 12 t/day and the Abbassieh facility handles 1 t/day. The infectious waste is sterilized, by autoclaving or microwave technology, then disposed with the MSW stream in special bags (MoPH, 2019; MoE, 2018, 2018; arcenciel data). The other types of hazardous HCW (pharmaceutical, chemical and cytotoxic) are being only partially exported as required by Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal. The latest reported exports sum up to 58 tonnes in year 2016 and 271 tonnes in year 2017, consisting mainly of expired pharmaceuticals and chemicals, cytotoxic medicines and contaminated packaging waste (ERS Basel, 2017 and 2018).

A quick assessment targeting 213 primary healthcare centers and 31 public hospitals was conducted in preparation for the Lebanon Health Resilience Project (MoPH, 2019). Regarding primary healthcare centers, the results showed that: 80% sort their medical waste; 39% deliver their waste to specialized HCW collection companies; 28% deliver their waste to hospitals; 1% have their own incinerators; whereas 32% dispose of their waste with the MSW stream. As to public hospitals, 80% responded; of which the 70% send their waste to specialized HCW collection companies and the remaining 10% send their waste with the MSW stream.

Table 8-3 Types, Classification, Generation Sources and Rates and Disposal of Hazardous HCW

Type	Classification	Generation Source & Rate (t/yr)	Management/ Disposal Methods	Source of Data
Infectious HCW (excluding the infectious part of Cytotoxic and Research Waste)		Hospitals: 5,100 Clinics: 82-90 Dispensaries: 10	Delivered to specialized HCW collectors Disposed of in Landfills (usually after disin-fection) or Dumpsites (directly or after disin-fection)	Salameh et al, 2014
Cytotoxic Waste	May contain both infec-tious and non-infectious waste	Hospitals, Universities and Research Centers (1,000)	10% stored and exported 90% disposed of with the MSW stream	Salameh et al, 2014
Research Waste	May contain both infec-tious and non-infectious waste	Universities and Re-search Centers (800)		USJ data, 2020
Pharmaceutical Waste	Considered non-infectious	Pharmacies and importers of pharmaceuticals (120) Households, hospitals, clinics and pharmaceutical industry (480)	Stored and exported Or Disposed of with the MSW stream	Salameh et al, 2014

[12] Saint Joseph University of Beirut, Faculty of Sciences, Laboratory of Hazardous Waste Management

Major gaps in the management of HCW include: (1) insufficient infrastructure; (2) weak enforcement of the existing regulations – specifically environmental audit, monitoring and inspection, as well as permitting/ operation requirements of healthcare institutions; and (3) absence of a waste traceability system to allow the development of a national database.

8.2.3 Hazardous Industrial Waste

Most industries are owned by the private sector and are limited to light manufacturing processes, including: food and beverage (25%), fabricated metal products (12%), non-metallic mineral products (12%), furniture (8%), wood products (8%), clothes and dyeing fur (3%), leather products (2%) and textiles (2%) (MoE, 2018). Industrial waste is categorized into: hazardous and non-hazardous. The latter has the properties of MSW and only the hazardous category, as defined by Basel convention and national Decree 5606/2019, is considered in this section. The total estimated quantity of hazardous waste (HW) generated in 2019 is about 71,800 tonnes, distributed by sector as shown in Table 8-4. HCW and Persistent Organic Pollutants (POPs) are excluded because they are addressed separately in this chapter.

Table 8-4 Hazardous Waste Quantities in 2019

Sector	Weight (t)
Chemicals, petroleum, coal, gas	33,916
Transport equipment	28,346
Textile, clothing and footwear	5,631
Paper products and printing	2,489
Non-metallic products	850
Metal products	546

Source: EBRD, 2019

Nine industries have been identified as major sources of hazardous waste: packaging, paints, fertilizers, printing, metal, textile, tanning, cleaning products and used oil. Fact sheets have been developed, covering the production process and the type and classification of the generated waste, as well as recommended storage and treatment methods (MoE/World Bank, 2016).

Currently, the country lacks the adequate infrastructure for collection, treatment and disposal of HW. Industrial HW is rarely sorted; it usually ends up in the MSW stream or is directly discharged into the environment (by open dumping, open burning and disposal in water streams and the sea) (MoE, 2018; EBRD, 2019). Until this date, the very few pollution control attempts are either individual initiatives or resulting from complaints by neighbors or a case filed by local authorities. Some other informal actions take place occasionally, such as co-processing in cement factories (Abou Hamdan and Frisch, 2016).

The major identified gaps[13] are as follows: (1) insufficient separate collection and specialized storage and absence of HW disposal facilities; (2) even though a regulatory instrument (Decree 5606) to encourage and manage investments in HW markets was introduced in 2019, it remains incomplete – two (out of five) of its application decisions are still missing; (3) limited public and industrial awareness; and (4) need for a national waste catalog for HW.

8.2.4 Electronic and Electric Waste

E-waste is defined by the six EU categories: (1) Temperature exchange equipment, (2) Screens, monitors, and equipment containing screens, (3) Lamps, (4) Large equipment (including photovoltaic panels), (5) Small equipment, and (6) Small IT and telecommunication equipment (Figure 8-6).

The total generation of Electronic and Electric Waste (e-waste), has been estimated in 2016 at 51,000 tonnes by the Global E-waste Monitor (Balde et al., 2017). Also, the average yearly generation rate was approximated at 11.1 kg/inhabitant, compared to a world average rate of 6.1 kg/inhabitant. This may be partially attributed to current custom legislations that allow importing electric and electronic equipment that are close to their end-of-life. Those would end up fast in the SW stream, requiring the consumer to purchase new equipment that will, also, turn shortly into waste.

Recently, the Preliminary Baseline Assessment of E-Wastes in Lebanon, conducted by UNIDO in 2019 in coordination with the Ministry of Industry (MoI), addressed the sustainability of e-waste management in Lebanon and assessed the generation of priority e-waste[14]. This was estimated at 33,704 tonnes in year 2016, which is equivalent to 60% of the total e-waste reported for the same year by the Global E-waste Monitor (UNIDO, 2019). Referring to the data[15] provided by UNIDO (Table 8-5), the generation rate was constantly increasing since 2016.

[13] Mostly identified in Abou Hamdan and Frisch, 2016

[14] Priority e-wastes are defined in UNIDO 2019 baseline report as equipment that either pose health and environmental risks or are bulky or contain a high concentration of valuable resources.

[15] Calculated following the international e-waste statistical method adopted by the global e-waste monitor, based on trade data of electrical and electronic equipment over the last 21 years (1997 onward) and their obsolesce rates.

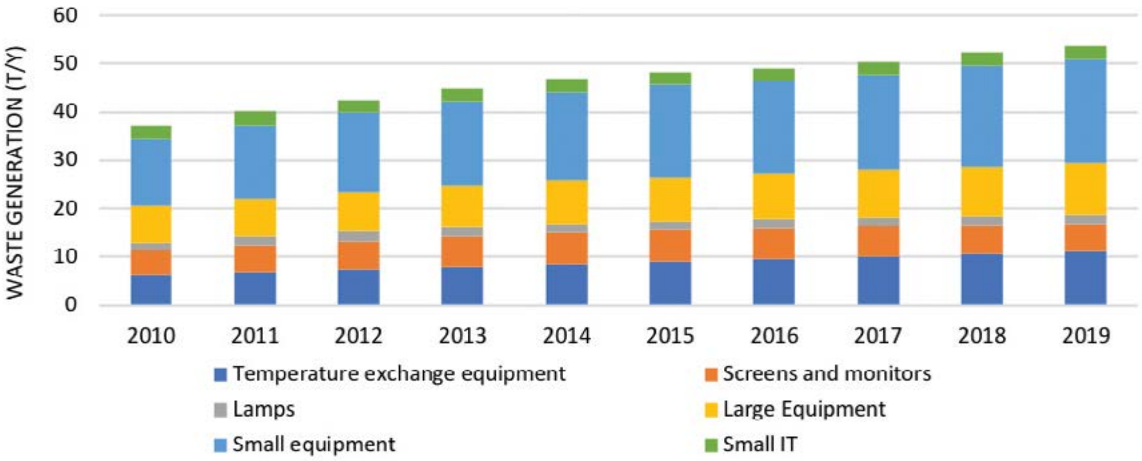


Figure 8-6 E-waste Generated from 2010 till 2018 as Total and per Category
Source: MoE data

Table 8-5 Weight of Generated Priority E-Waste

Period	Weight (t)
January to December, 2016	33,704
January to December, 2017	34,597
January to December, 2018	35,341

Source: UNIDO, 2019

Also, MoE produced national e-waste statistics covering the six EU categories (Figure 8-6). The results showed a consistent increase of generated e-waste of all types, with a yearly increase of total generation ranging between 2% and 8%. Small equipment[16] constitute the largest portion (37-40%), followed by large equipment[17] (19-20%) and temperature exchange equipment[18] (17-20%) (Figure 8-7).

At the management level, as part of the UNIDO-MoI Preliminary Baseline Assessment of E-wastes, a survey of 619 households in Beirut and Mount-Lebanon and 31 public and private businesses and institutions across the country revealed haphazard e-waste disposal practices, mainly consisting of: giving or selling to scrap dealers (22% in households, 33% in businesses); storage (15% in households and 12% in businesses); and disposal with regular wastes – particularly for batteries and lighting equipment (15% in households, 12% in businesses). Handing e-wastes to specialized e-waste actors accounted for only 5% in households vs 19% in institutions/businesses (UNIDO, 2019).

New small businesses for e-waste collection and management have been established: Beeatouna, Verdetech and Ecoserv. The last two being the most active since 2018 and their combined collection data show an overall increasing trend of formal e-waste collection (R^2 = 0.58)[19] (Figure 8-8). Considering the last 12 months of reported data (March 2019 to February 2020), the total collected waste (125 t/yr) is less than 0.3% of total produced e-waste.

The current practice consists of marginal dismantling of recyclable material, mainly plastic, to be sold in local markets as secondary raw material; while the

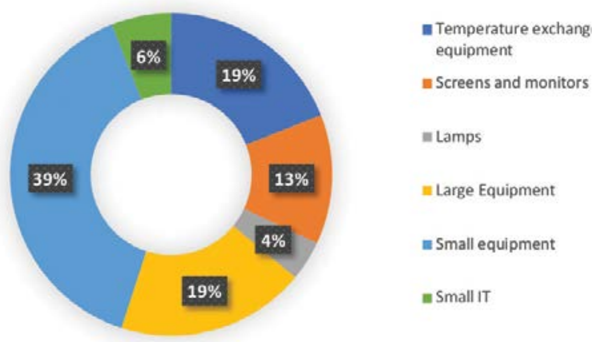


Figure 8-7 E-waste Composition in Lebanon
Source: MoE Data

[16] Typical small equipment include: vacuum cleaners, microwaves, ventilation equipment, toasters, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, electrical and electronic toys, small electrical and electronic tools, small medical devices, small monitoring and control instruments.

[17] Typical large equipment include: washing machines, clothes dryers, dish-washing machines, electric stoves, large printing machines, copying equipment, and photovoltaic panels.

[18] Temperature exchange equipment, more commonly referred to as cooling and freezing equipment, typically include: refrigerators, freezers, air conditioners, heat pumps.

[19] R-squared, also known as the coefficient of determination, is a statistical measure of how close the data are to the fitted regression line.

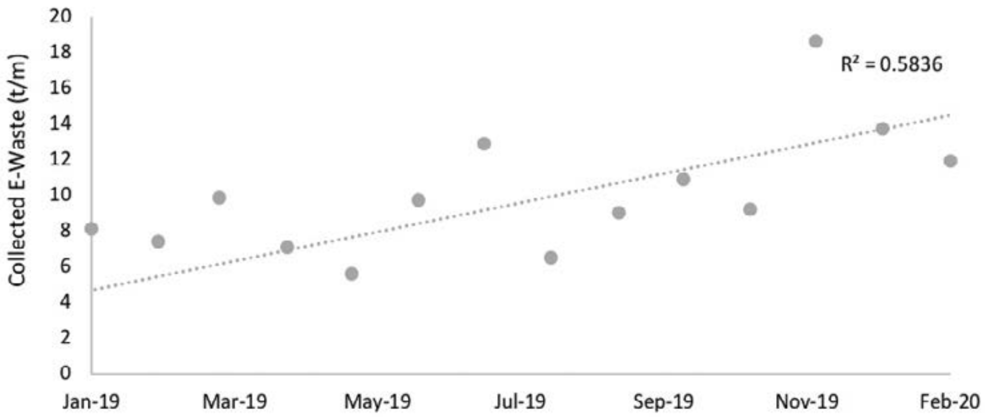


Figure 8-8 Formal E-Waste Collection
Source: Verdetech and Ecoserv data, 2019-2020

rest is stored for subsequent shipment to e-waste processing facilities abroad (UNIDO, 2019; Verdetech data; Ecoserv data). Accordingly, the valuable resources of e-wastes are not being valorized in the country: they are either being landfilled/dumped or being exported abroad by the scrap dealers and e-waste dismantlers for subsequent recycling/valorization abroad (UNIDO, 2019).

Major identified gaps in the UNIDO-MoI assessment in 2019 (prior to the adoption of decree 5606/2019 regulating the management procedures of hazardous waste) include: (1) Poor/limited e-waste recycling infrastructure in Lebanon mainly for high energy costs considerations and, to a lower extent, due to e-waste complexity; (2) handling of most of the e-waste stream by informal actors particularly scrap dealers in the absence of health and environmental safety measures and the lack of incentives for formal e-waste collectors to overcome the cost of transportation and logistics; (3) absence of e-waste specific legislation – it is regulated only as part of HW; (4) limited of awareness, mostly at the household level, about e-waste handling and disposal; and (5) unavailability of e-waste records and statistics (UNIDO, 2019).

8.2.5 Construction and Demolition Waste

National studies and databases on generation and composition of CDW have been absent over the past years (MoE/EU/GFA, 2016a and 2016b). Academic research papers have provided indicative rates; but those remain specific to the study location, period and conditions. Reported unit generation rates of Construction Waste (CW) are: 38-43 kg/m^2 for new development projects in Beirut city (Bakshan et al., 2015) and 76 kg/m^2 for low-rise buildings in the outskirts of Beirut (Ghanimeh et al., 2016). Estimated generation rates of Demolition waste (DW) varied between 1,400 kg/m^2 (Jawad et al., 2016), 1,570 kg/m2 (AlZaghrini et al., 2019) and 1,730 kg/m^2 (Srour et al., 2013). The reported total generations varied as well: 0.91 million tonnes of DW in Beirut during 2009-2010 (Srour et al., 2019); 295,700 tonnes of DW and 7,825 tonnes of CW in Lebanon as yearly average during 2000-2014 (Ghanimeh et al., 2016); 4 million tonnes in Beirut and 17 million tonnes in Mount Lebanon forecasted during 2018-2040 (AlZaghrini et al., 2019).

As to composition, concrete and partitioning blocks constitute 70-90 percent of both CW and DW (Bakshan et al., 2015; Ghanimeh et al., 2016). Accordingly, from a technical efficiency and resource conservation perspectives, the most recommended management method is sorting, crushing and aggregate recycling (Hassanieh, 2016). Yet, to ensure economic feasibility of CDW recycling in Lebanon, a gate fee should be charged and a market for recycled aggregate should be present (Srour et al., 2013). Until this date, most of CDW is being openly dumped (Sweepnet, 2014), resulting in 324 CDW dumpsites across the country in 2016 with a total volume of 2,160,536 m3 (MoE/UNDP/ELARD, 2017). Road-side dumping and burying of CDW as backfill material is common. The lack of CDW management facilities aggravated the impact of Beirut port blast of August 4, 2020. Huge quantities of the CDW generated from the blast ended up piled inside the city for several months, waiting for NGOs and international donors to find sound solutions – a challenge aggravated by the presence of asbestos contamination, requiring special pre-treatment and containment *(refer to Section 8.1.2.4 of this chapter).*

Accordingly, the major gaps include: (1) absence of a recycling/disposal infrastructure; (2) lack of means to control open dumping; (3) absence of a national database and recycling/reuse standards; and (4) lack of a national investigation regarding the suitability of CDW for recycling – as various contaminants may be present depending on the source of the waste.

8.2.6 Other Waste

8.2.6.1 Wastewater Sludge

Most of the wastewater facilities are designed to treat municipal wastewater. Currently, the amount of dewatered sludge generated across the country is about 65,450 m^3/d (MoEW, 2019). However, most of the treatment plants are not yet (or not fully) connected to sewer lines, leading to long cocooning phases or less-than-full-capacity operation (UNICEF, 2016). Also, several new treatment plants have been planned and designed and remain to be constructed. Therefore, the sludge generation rate is expected to increase drastically under the likely scenarios of: (1) running the existing plants at full capacity (595,000 m^3/d vs. 240,00 m3/d current operating load) (MoEW, 2019); (2) constructing new and planned facilities to treat the whole sewage flow (of which only 3.12% currently undergoes secondary treatment) (UNICEF, 2016).

Currently, most of the operated wastewater treatment plants are in rural areas, thus the generated sludge is considered mostly non-hazardous. Yet, once the large-scale plants (e.g. in coastal urban cities) are operational, there will be a risk of industrial discharge being mixed with the municipal wastewater. The resulting sludge may be hazardous. The expected generated sludge in 2025 and 2030 is 86,514 and 110,542 t/y, respectively – excluding the sludge from Tripoli/Minieh plant (13,812 and 17,878 t/y in 2025 and 2030) and Beirut plant (49,582.6 and 61,468.3 t/y in 2025 and 2030) because they are planned to treat their own sludge on-site (EBRD, 2019).

The fate of the generated sludge remains non-documented. While few media reports have shown improper disposal of sludge in remote areas, there exists no national monitoring system for sludge generation, properties, disposal and impacts. A national masterplan was proposed by CDR, in 2003, addressing viable technical methods to stabilize and upgrade the generated sludge for reuse in agriculture, along with a land application scheme. Disposal solutions, i.e. incineration and landfilling, were also favored (CDR/Techswat/KREDO, 2003). Recently, the CDR commissioned a new study for the Bekaa region, with the final report expected to be released in 2021.

Accordingly, the depicted gaps include: (1) absence of plans or initiatives to treat the sludge, and use (where applicable) the resulting biomass, thus reduce the need for disposal (especially in the long-term); (2) lack of collaboration with neighboring countries for valuation and/or disposal of sludge; and (3) lack of legislation (decrees and/or ministerial decisions) for the processing and disposal of sludge – even though guidelines exist (e.g. those of the Food and Agriculture Organization (FAO) in 2010).

8.2.6.2 Slaughterhouse Waste

The records of the Ministry of Industry (MoI) show a total of 62 registered slaughterhouses in Lebanon. There exist other slaughterhouses that are illegally operating; these do not appear in any official record. More than half (32) of the registered slaughterhouses are located in Mount Lebanon, the quarter (15) in Baalbak-Hermel and the rest are distributed over the remaining regions of the country (MoI data). A total slaughterhouse waste generation of 40,000 tonnes per year was reported in State of the Environment Report (SOER) 2010 and in Sweepnet 2014[20]. Considering that this figure dates back to before year 2004 (when the Lebanese population was less than 4.5M), and assuming that consumption patterns and imported meat proportions remained practically unchanged, the current generation is expected to be, at least, 50% higher (with a 2020 population of about 6.8M). Both permitting authorities, MoI and Ministry of Agriculture (MoA), require slaughterhouses to adopt sound management measures of their SW (MoI Decision 7060T/2018 and MoA Decision 553/2012). Also, environmental requirements of slaughterhouses, including SW management, are defined by MoE Decision 4/1 of 2001. Yet, no noticeable improvement has been achieved in terms of management of slaughterhouse and butcher shop SW in the last decade. The waste is either sent with the MSW stream, discharged in the sewers or dumped in the environment – mostly in water bodies. Lately, MoI initiated a survey of existing slaughterhouses whereby the production practices and food safety were checked and recommendations were provided accordingly. In terms of waste generation, the survey investigated only the management of liquid wastes (MoI, 2018). Recently also, a baseline assessment and a master plan have been developed for the slaughterhouse waste in Choueifat, hosting 11 slaughterhouses, 126 butcher shops and 5 farms, and generating 25 tonnes of slaughterhouse SW per day (WV/EDESSA, 2019); the feasibility study of the master plan is under preparation.

Accordingly, three major gaps are identified: (1) lack of national, regional or local infrastructure for the

[20] Based on FITCHNER, CDR, Lebanon, "Treatment and Disposal of Municipal Solid Waste in Lebanon – Request for Proposals – Part IV – Project Information Memorandum", October 2004.

processing and disposal of slaughterhouse waste; (2) incomplete legislation and absence of planning; and (3) poor implementation of slaughterhouse permitting requirements related to SWM.

8.2.6.3 Persistent Organic Pollutants

POPs are conservative pollutants that accumulate in the environment and through the food chain. Lebanon abides by the Stockholm Convention on POPs (ratified in 2001) and the corresponding Law (432 of year 2002). POPs are classified according to their source as: pesticides, industrial (IPOP) and unintentionally released (UPOP).

The import data between 2004 and 2014 showed that no POP containing pesticides have been (legally) imported (at the exception of one tonne of Lindane and Hexachlorocyclohexane in 2009 and another 250 kilograms in 2014). But it is suspected that POP fertilizers are smuggled through the Syrian borders or imported from Turkey and China and are mostly abundant in the Akkar area, followed by the Bekaa region. It is estimated that 1-5% of farmers have used POPs during the last 10 years. POP pesticide containers are usually burned in the field or sent with the MSW stream. In Akkar, 5% of empty containers are disposed in rivers, resulting in waste piles that end up being washed out during winter. Specifically, the following rivers are expected to be contaminated: Bared, Estouane, Aarqa and Litani. (MOE/UNEP/GEF, 2017a)

Industrial and Unintentionally released POPs include (1) Perfluorooctane Sulfonate (PFOS), (2) Hexabromocyclododecane (HBCD) and polybrominated diphenyl ethers (PBDE), (3) Polychlorinated Biphenyls (PCBs), and (4) Dioxins, Furans and other UPOPs:

- Potential sources of **PFOS** are categorized as: surface treatment, paper production and performance chemicals. The waste generated from these categories is sent with MSW (or the bulky wastes stream) to landfills and dumps (MOE/UNEP/GEF, 2017a).
- Sources of **PBDE** in Lebanon are categorized as: Electrical and Electronic Equipment (e-waste), Transport, Furniture, Foam, Mattresses and Pillows, Textile, and Rubber. The management of e-waste was addressed separately in this chapter. For transport, two facilities for the disposal of end of life vehicles are operating in the country (both in the Matn Caza): one facility (DiaMetal) recovers the metal through shredding and sends the rest as waste material for landfilling; while the other one (Evandy) scraps the entire vehicles and exports them to Turkey– with recovery of specific components, e.g. batteries, tires and oil. Also, few (12) obsolete public transport buses remain stored in Beirut. The remaining categories are sent with MSW or bulky items to landfills (MOE/UNEP/GEF, 2017a).
- Sources of **HBCD** include: Expanded Polystyrene (EPS), Extruded Polystyrene (XPS), Polyurethane (PUR), Textile and Paints. The generated wastes and empty packaging items and containers end in MSW dumpsites and landfills; **EPS/ XPS** are piled up on construction sites and mixed with backfilling material or sent to CDW landfills. (MOE/UNEP/GEF, 2017a)
- **PCB** waste is often associated with the power sector, known to be the main source and stock of PCB containing oils and equipment. Contaminated soil and water were found under transformers in Zouk power plant and Bauchrieh storage site and repair shop (MOE/UNEP/GEF, 2017a)[21]. An action plan and inventory of PCB equipment in the power sector (involving the sampling and testing of 22,620 transformers) identified 1,129 transformers and 4 tanks/drums that contain more than 50 ppm of PCB, and pinpointed treatment and disposal methods and priorities (EDESSA/WAC/SLR, 2018). So far, 265 transformers (out of 1129) have been disposed.

The major identified gaps[22] are: (1) limited laboratory analysis capacity and lack of financial resources; (2) need for new laws and decrees and/or updates of existing ones, to comply to the requirements of Stockholm Convention and achieve Lebanon's obligations toward the convention; (3) lack of national databases for POPs and lack of systematic means to list and regulate new chemical pollutants; (4) poor institutional coordination; and (5) insufficient awareness among main stakeholders.

8.2.6.4 Gas and Oil Sector

The newly established gas and oil sector is expected to generate new types of solid waste. The management plan for the waste generated on the mobile offshore drilling unit was approved as part of the Environmental Impact Assessment Report submitted to MoE (Dar/RSK/TEP, 2020). The plan recognizes three types of treatment/management activities:

- On-board treatment of non-hazardous effluents and solids, followed by discharge into the sea. This applies to part of the crushed food waste and treated sewage, oily water and slop water.

[21] Yet, the study does not provide a comprehensive overview of contaminated sites, e.g. PFOS hotspots, agriculture contaminated sites from pesticides, contaminated sites from open dumps and burning of SW, Ports sediments (Beirut and Tripoli), etc.

[22] Mostly based on the National Assessment of POPs Impacts and Management - Pesticides, Industrial and Unintentionally Released (MoE/GEF/UNEP 2017).

- Transportation and management of domestic and non-hazardous waste by Lebanese contractors, abiding by the national MSW management plan such as sorting at Karantina facility and disposal in Burj Hammoud landfill.
- Shipment of HW to Innovating Environmental Solutions Centers (IESC) in Cyprus for treatment and disposal. In fact, the following quantities were exported, as per Basel Convention: 797.1 tonnes of drilling cuttings, 6.6 tonnes of chemical packaging, 532.4 tonnes of waste drilling slops and 0.5 tonnes of oily rags/cloths. The destruction report from the disposal facility has been already issued.

8.2.6.5 Used Tires

The total weight of used tires was estimated at 14,000 t/y in 2014 (Sweepnet, 2014). Also, the number of waste tires in Lebanon may be estimated following the calculation method adopted in OMSAR baseline reports[23]: assuming that one tire is damaged per car every year, about 2,000,000 used tires are anticipated in year 2020. Considering that the weight of a passenger car tire can be anything between 7 and 15 kg, and assuming an average of 10 kg, the 2020 tire waste generation may be roughly estimated at 20,000 tonnes. However, only three tire collection and recycling facilities are active in the country (MoE Circular No. 7/1, 2017). There have been several small initiatives to value used tires, e.g. upcycling or using them as structural elements or drainage material when shredded. But practically, part of the used tires ends in the MSW stream and another part is managed by the formal sector; yet, the largest part is being handled by the informal sector – mostly in non-environmentally friendly applications, such as burning for metals recovery.

8.2.6.6 Used Oil

Used oil may be categorized according to its source as "vegetable" or "organic". The former is the oil used for cooking and is considered non-hazardous. It is mostly exported, with approximate generation rates of 500-600 tonnes/month of liquid oil and 250-300 tonnes/month of shortening, in 2017[24].

However, the organic oil is classified as hazardous waste. It is generated by vehicle repair shops and companies, private electric generators, power plants and any activity that requires periodic change of engine oil. It is generated at a unit rate of 11 kg/cap.year[25]. This rate is considered high compared to an average of 8 kg/cap.year in Europe (GEIR, 2015) and considering the limited industrial activities in Lebanon. Prior to reuse as fuel replacement, the oil should be treated to remove polluting residuals. Currently, there are more than 90 companies and individuals collecting and selling used organic oil; but only one company (Boosters s.a.l.) is reporting to MoE their treatment activities and operating procedures.

Major identified challenges to sound environmental solutions in this sector include: (1) the high number of illegal traders, which create unfair competition to businesses that adopt adequate treatment methods; and (2) absence of regulations that require used oil generators to segregate the different types of oil. This makes it impossible for the service providers to improve their recovery methods and upgrade their reuse targets.

8.2.6.7 Used Batteries

The information on this sector is very limited and generation data is not available. While there are many facilities in Lebanon that recycle used batteries, MoE database shows only four licensed[26] facilities:

- The Lebanese Company for metals in the Middle East for Trade and Industry, located in Beddawi-Minieh-Danniyeh
- The Delta Industrial for Batteries, located in Hermel. This facility may be non-operational
- Imad and Ali Meldan, located in Zahle-Bekaa
- The Arabian, located in Taanyel-Bekaa

8.2.7 Marine Litter

Marine litter is categorized according to its source as land- or sea-based. Even though some sea-based components, namely fishing gear and ghost nets, constitute a considerable pollution source in the Mediterranean Sea, land-based litter remains dominant (UNEP/MAP, 2015). In Lebanon, the main land-based source of marine litter is river discharges and the tourism sector. Due to the lack of adequate infrastructure, the waste generated from upstream domestic, industrial and agricultural activities ends up in the river and is carried into coastal waters (Nader, 2012; LEM and LEF, 2019). Beirut river is a noticeable example, whereby a low flow river (only 3% of the total Lebanese river discharges) is turned into a collection stream for the waste generated from the highly populated surroundings, industrial zones and waste disposal sites along its borders, and has become a considerable contributor to marine litter in the country (LEM and LEF, 2019). Open burning and

[23] Baseline Reports, submitted under the "Technical Support to Upgrading the Solid Waste Management Capacities in Lebanon" project funded by the European Union.
[24] Annual statistics of the Lebanese Customs: www.customs.gov.lb
[25] Annual statistics of the Lebanese Customs: www.customs.gov.lb
[26] But remain to be approved under Decree 5606/2019

dumping sites create another land-based source from which waste escapes into the coast, through seasonal water streams and floods and leaching fluids (Nader, 2012).

Litter has dire impacts on marine ecosystems as it jeopardizes the overall biodiversity, causing: (1) entanglement, ingestion and suffocation of marine species (sea birds, turtles, and other marine mammals), (2) growth of invasive species, and (3) generation of toxic pollutants that disrupt the natural growth process of aquatic species (UNEP/MAP, 2015). Most importantly, Lebanon seems to suffer from alarming plastic contents in marine animals that constitute regular components of the human food chain (Kazour et al., 2019; LEM and LEF, 2019). In addition, large-sized litter (e.g. discarded syringes and sharp objects) may create direct risk for people on the beaches as well as visual pollution; thus, affecting touristic activities and increasing cleaning costs. Finally, littered objects are thought to damage transport ships and fishing vessels and reduce potential fishing catches (LEM and LEF, 2019; UNEP/MAP, 2015).

The Marine Litter Assessment in the Mediterranean (UNEP/MAP, 2015) has revealed that about three thousand tonnes of plastic waste, out of the total 133 thousand tonnes generated yearly in Lebanon, are littered. A field investigation, conducted along the coasts of El-Mina/Tripoli, showed that the marine litter caught in fishermen nets is 78% plastics, followed by 17% metals and 1.7% cloth and fishing material, in addition to small proportions of glass and paper (UNEP/MAP, 2015).

Recent surveys of two Lebanese public beaches in Saida and Ramlet El Bayda (UNEP/MoE/CNRS, 2019) showed that the most abundant litter items are: plastic/polystyrene pieces 2.5-50cm (506 items/100m, 15.7%), cigarette butts and filters (459 items/100m; 14.2%), followed by plastic caps/lids (450 items/100m, 14%). Yet, the plastic category was the dominant one accounting for 73% of the total marine litter debris sampled on these beaches.

A survey of microplastic density in Mediterranean seawater in Beirut and Tyre revealed (UNEP/MoE/CNRS, 2019):

- the highest densities to be 18 particles/m^3 in Dora (in September 2019) and 26.8 particles/m^3 in Manara (in October 2019),
- the lowest densities to be 2 particles/m^3 (in September 2019) and 1.7 particles/m^3 in (October 2019) in Costa Brava (UNEP/MoE/CNRS, 2019).

Identified gaps include: (1) poor monitoring programs, limited to sporadic beach surveys and cleaning activities; (2) absence of accurate identification of sources and transport mechanisms of marine litter; (3) lack of data on quantities, types, composition and distribution of marine liter; and (4) lack of efficient public awareness programs (LEM/LEF, 2019; Mawla, 2016; UNEP/MAP, 2015).

8.3 Legal Framework and Key Stakeholders

8.3.1 Legislation

A list of main regulations related to SW management is provided in Annex 2. Yet, the most important milestone achieved in the last decade is the ratification of the Integrated Solid Waste Management Law No. 80 on the 10th of October, 2018. The law was promulgated following the ISWM policy, adopted by the CoM in 2018 (Decision No. 45 on 11/01/2018), highlighting the law as a key element, as well as the ISWM related principles. In fact, Law No. 80 constitutes the backbone of future SW legislation and introduces major guiding principles, including: (1) integrated household SWM, (2) reduction, reuse and recycling, (3) sustainability of the management scheme, (4) proximity to waste facilities, (5) precautionary measures, (6) prevention of uncontrolled dumping, landfilling and burning, (7) polluter pays principle, and (8) decentralization and subsidiarity principle.

In *terms of planning and coordination*, Law No. 80 requires the development of a national strategy for ISWM, following a participatory approach, to be revised every 10 years or when needed – accompanied by a strategic environmental assessment (SEA). The law requests local authorities to submit their own SWM plans and defines the content and approval procedure. Also, the law requires assigning a National Solid Waste Coordination Committee (NSWCC) of relevant organizations – which was established by virtue of MoE Decision 108 (05/03/2019).

From an *implementation* perspective, Law No. 80 calls for the establishment of a National Solid Waste Management Authority (NSWMA). The latter will be in charge of preparing TORs, supervising and implementing centralized projects and advising the Minister of Environment on local projects (that could be implemented by local authorities, private sector or public–private partnership (PPP)). Also, the law allows the implementation of local/de-centralized projects, as well as those in partnership with the private sector, as per the prevailing regulations.

A three-level *monitoring* system is delineated: (1) self-monitoring by non-household waste producers and service providers, (2) supervision of local/decentralized and national/centralized projects by local authorities and the NSWMA, respectively, while PPP projects follow the biding regulations (Law 48/2017), and (3) compliance monitoring by MoE. Also, Law No. 80 calls for the establishment of a *data collection*, management and reporting system whereby the resulting databases are made freely and easily accessible to the public.

The law differentiates between non-hazardous and hazardous waste. For the non-hazardous category, general guidelines are provided for each individual stage of the management process, i.e. from collection to final disposal. General rules pertaining to hazardous waste are provided, along with import, export and transport requirements and the revision of the national HW list. Also, Law No. 80 defines the responsibilities of local and national authorities, reporting of violations and the different types of penalties.

Even though some of the requirements of Law No. 80 have been achieved (e.g. drafting of the ISWM strategy and establishment of NSWCC), other major components (e.g. local SWM plans and establishment of NSWMA, among others) remain lacking. The 2019-2030 roadmap submitted by MoE, and approved by CoM Decision No. 3, on the August 27, 2019, addresses major aspects needed for the implementation of Law No. 80, including financial instruments (among others). The roadmap was re-visited in June/July 2020 following the emerging drivers discussed in section 8.1.2 – refer to Section 8.4.2.1 of this chapter for a complete description of the road map and its update.

8.3.2 Key Stakeholders

Law No. 80 identifies, in addition to the Waste Producers, the following five primary stakeholders to plan, coordinate, execute and supervise the SWM activities in the country:

- **MoE** in charge of: drafting waste regulations, standards and guidelines; developing national strategies and plans; proposing economic instruments; approving, inspecting and monitoring local plans, treatment technologies, and import/export of waste; reviewing ToRs; approving EIAs and SEAs; monitoring the implementation of legislation and strategies; setting up a national database; and outreaching to the public.
- **NSWCC** in charge of: coordinating issues pertaining to the solid waste sector, under the leadership of the MoE. It consists of 7 representatives of the public sector (MoIM, MoF, MoI, MoPH, MoEW, MoA), in addition to CDR and OMSAR, and 6 representatives of economic and academic bodies and environmental NGOs (OEA, ALI, academia, consulting companies, contracting companies and NGOs) (MoE Decision No. 108 of 05/03/2019).
- **NSWMA** in charge of: preparing centralized projects and EIAs; supervising the implementation of these projects; and reporting to MoE on the progress of projects and on the achievement of targets.
- **Local Authorities** (LA) in charge of: planning, implementing and monitoring local waste management services (including reduction, collection and street sweeping in addition to treatment and disposal services, if environmentally and economically feasible); as well as raising awareness.
- **Private Service Providers** (and/or partners in PPP projects) in charge of: constructing, operating, self-monitoring and reporting on private or PPP SW projects.

On the ground, and given the fact that the NSWMA is not established yet, CDR, as originally mandated by the CoM in the 1990s, is still holding various planning, implementation, supervision and monitoring responsibilities, which are expected to be eventually transferred to the primary stakeholders, as required by Law No. 80. Similarly, OMSAR has been tasked to oversee the design, construction and management of SW facilities funded by EU – OMSAR's mandate in SW is expected to run till December 2021. As such, CDR and OMSAR are categorized in this chapter as "transitional" stakeholders. In addition, secondary stakeholders are expected to have direct or indirect contributions to the overall SWM system (Table 8-6). Noting that supervision and monitoring take place at three levels as mentioned earlier (Figure 8-9).

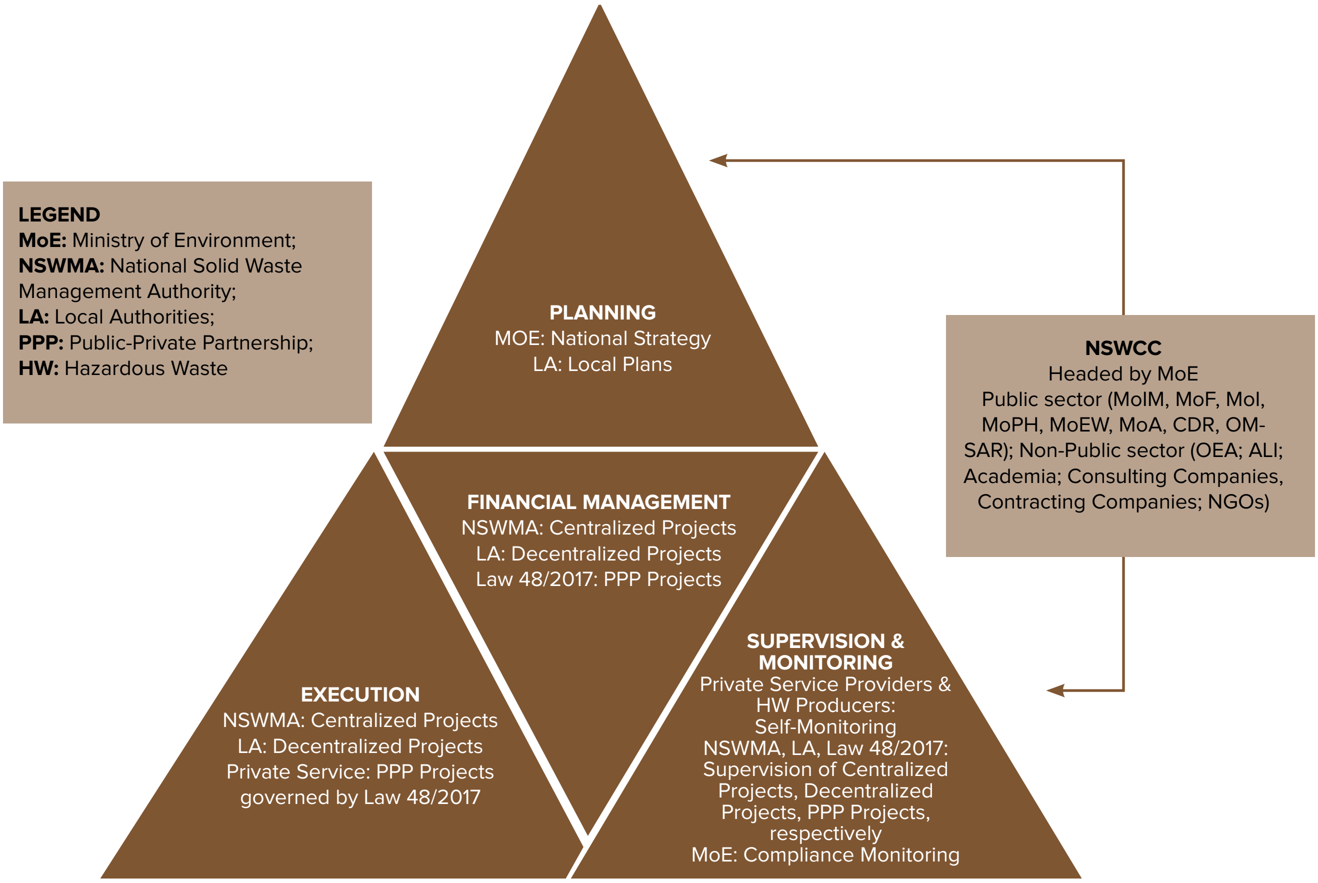


Figure 8-9 Management Structure of Law No. 80 /2018

Table 8-6 Roles of Stakeholders in SW Management

	Stakeholder	Planning, Coordination & Information Management	Implementation	Supervision & Monitoring	Awareness
PRIMARY [27]	MoE	X		X	X
	NSWCC	X		X	
	NSWMA		X	X	
	LA	X	X	X	X
	Private Service Providers		X	X	
	Waste Producers		X		
TRANSITIONAL	CDR[28]	X	X	X	
	OMSAR[29]		X	X	
SECONDARY	MoIM [30]	X			
	MoI [31]	X			
	MoPH [32]		X	X	
	Ministry of Economy & Trade [33]		X		
	MoF [34]		X		
	The Informal Sector [35]		X		
	The Private Sector [36]		X		X
	NGOs [37]		X		X
	Funding Agencies [38]	X	X		X

[27] As defined by Law No. 80 (2018)
[28] Relating to solid waste facilities servicing Beirut, Keserwan and part of Mount Lebanon (CoM Decision 1 dated to 17/3/2016)
[29] Relating to waste facilities funded by international donors, mainly outside the area serviced by CDR facilities
[30] Relating to local waste management plans, local financial instruments and SWM service fees (Decree 4082 dated 14/10/2000: Regulation of the Ministry of Interior and Municipalities)
[31] Relating to waste facilities permitting, implementation of the Extended Producer Responsibility (EPR) principle and creation of markets for secondary materials (Decree 13173/1998: Regulation of the Ministry of Industry)
[32] Relating to public health protection (Decree No. 8377 dated 30/12/1961: Organization of the Ministry of Public Health).
[33] Relating to the implementation of EPR principle (Decree No. 2896 dated to 16/12/1959: Organization of the Ministry of Economy and Trade).
[34] Relating to its role of managing the Independent Municipal Fund, which is currently financing the collection and management of MSW in areas served by national facilities (Decree 2868 dated 16/12/1959: Organization of the Ministry of Finance).
[35] Relating to their contributing to material recovery and recycling
[36] Relating to the role of industrial, commercial and other businesses in creating secondary material market and advertising for it, as well as valorization of high energy content in energy-intensive industries
[37] Relating to promoting waste prevention and sorting and raising public awareness
[38] Relating to their role in assisting authorities in developing legislation, as well as funding of SW projects, national and local capacity building and awareness raising

8.4 Selected Responses

8.4.1 Regulatory Framework

8.4.1.1 Law 80/2018 & Its Application Decrees and Decisions

Following the adoption of Law 80/2018 organizing the sector, several of its application decrees and decisions were issued, including: Decree 5605 (2019) on source sorting of MSW; Decree 5606 (2019) on management procedures of hazardous waste; MoE Decision 108 (2019) on appointing the ISWM coordination committee; MoE Decision 58 (2020) on classification of RDF; MoE Decisions 59 (2020), 998 and 999 (2019) addressing, respectively, storage, generators and transporters of hazardous waste. Earlier, MoE Decisions 1294 and 1295 (2017) defined, respectively, the requirements for transport and treatment facilities of hazardous waste.

8.4.1.2 Regulatory Framework Specific to the Management of HW

Lebanon ratified Basel Convention for the transboundary shipment of hazardous waste in 1994, (Law 389/1994), then Stockholm Convention for the management and treatment of POPs in 2001 (Law 432/2002).

Also, the recently endorsed ISWM Law (80/2018), addresses HW management under section IV. In application to this section, Decree 5606 of 2019, and application decisions, on management procedures of HW were released. MoE Decisions 59 (2020), 998 (2019) and 999 (2019) cover different aspects including, respectively: storage, generators and transport conditions. Yet, MoE Decision No. 71/1 (1997), that banned the import of hazardous waste into Lebanon and listed the types and conditions of wastes that are allowed to enter the country, remain to be amended to reflect the developments in this field.

In 2018, MoE submitted to the high council for privatization and PPP a pre-feasibility study for a Hazardous Waste Transport and Interim Storage project. The purpose of the suggested project is to develop a national structure for the collection, storage and shipment of hazardous waste, with a minimum of three interim storage facilities across the country.

8.4.1.3 Regulatory Framework Specific to the Management of HCW

In addition to the aforementioned Laws 389/1994 and 432/2002, as well as Law 444/2002 (Protection of the Environment), HCW is bound to Decree 13389/2004 on permitting mechanism for infectious HCW treatment facilities (amendment to Decree 8006/2002), and decisions 1294 (2017) and 1295 (2017) on treatment facilities establishment and operation. Currently, HCW management is monitored by MoE through a periodic reporting framework adopted by hospitals and, to a lower extent, healthcare centers.

8.4.2 Planning

8.4.2.1 MSW Management Roadmap

Upon the endorsement of the solid waste Law 80 by the Lebanese parliament in 2018, MoE submitted to the Council of Ministers, on June 3, 2019, a roadmap for the way forward in ISWM including:

1. Draft decree on source sorting
   (The decree was approved by CoM)
2. Draft law on financial instruments related to the law 80/2018, allowing local authorities to implement the decentralization concept recommended in Law 80
   (A committee of MoE, MoF and MoIM was established to review the draft law on cost recovery. The committee completed its work and shared it with the CoM Secretariat General in October 2019. The progress was interrupted by the onset of protests, followed by COVID 19 pandemic and lockdowns.)
3. Draft integrated solid waste management strategy
   (The endorsement of the draft ISWM strategy is pending the preparation of the corresponding SEA and the finalization of the strategy accordingly.)
4. Template ToRs for sweeping and waste collection
   (The sweeping and collection ToRs were to be finalized based on input from CDR and then sent to MoIM for circulation.)
5. The proposed locations for the construction and/or expansion of the sanitary landfills
   (Some local authorities have objected on the suggested locations.)
6. The summary specs for the operation, maitenance and upgrade of the sorting and treatment facilities
7. EIA guidelines for Waste to Energy facilities
   (The draft guidelines have been completed by MoE.)
8. The estimated cost for the closure and rehabilitation of uncontrolled dumps
9. The environmental guide for municipal police
10. Draft decree related to the management of hazardous waste
    (The decree was approved by CoM)
    In 2020, and following the major events in the

country (i.e. protests, economic crisis and COVID 19 pandemic), the PM established a technical committee (Decision 96 on 05/06/2020), to support the household (HH) SWM ministerial committee by revisiting the 2019 roadmap and suggesting modifications as needed. The technical committee issued its final report, on 10 July 2020, whereby a 2020-2030 roadmap, of short-, medium- and long-term actions, was suggested, addressing (1) technical and implementation measures, (2) institutional and legal aspects, and (3) economic and financial issues, along with the infrastructural gap by governorate (Box 8-3).

Box 8-3 Report of the Technical Committee, in Support of the HH SWM Ministerial Committee

The Prime Minister issued Decision No. 96/2020, dated 6/5/2020, establishing a Technical Committee to support the ministerial committee studying the issue of HH SWM (Cabinet Resolution No. 1 dated 28/2/2020, amended by Resolution No. 3 dated 9/4/2020). The Technical Committee included representatives of: Presidency of COM, OMSAR, MoIM, MoPH, MoI, MoE and CDR, in addition to one academic institution (AUB) and an NGO (The Waste Management Coalition).

The Technical Committee released, on July 10, 2020, their final report addressing: (1) the current state of HH SWM, (2) practical guidelines for the management to HH SW, (3) main (persisting and emerging) challenges, and (4) roadmap of integrated HH SWM for the period 2020-2030. The roadmap covered: technical and implementation measures, institutional/legal aspects, and economic/financial issues.

The *most pressing actions* were classified, in the roadmap, as "short-term" measures (to be applied in 2020-2021):

- *Technically*, the committee recommended to: finalize missing/incomplete legislation (e.g. RDF draft decree, amendment of Decision 8 of 2001, standards for waste collection & transportation, and specs for waste transfer stations and landfills), construct additional sanitary landfills, reduce waste prepackaging during transportation, and initiate awareness-raising programs and national dialogues on controversial SW issues.
- At the *economic/financial* level, the most pressing issues include: paying the contractors and municipalities dues, rescheduling the municipalities debts, and documenting the SWM cost while estimating the share paid to cater the refugees – with the intention to subsequently request the support of international organizations.
- At the *legal and institutional* level, the short-term recommendations of the committee include: (1) investigating means to implement Law 251/2014; (2) establishing the Environmental Police (as per Decree No. 3989/2016); (3) finalizing missing/incomplete legislation, such as the draft decrees regulating and appointing the members of the SWMA, and the codes of practice for operating sanitary landfills; and (4) encouraging private investments in SW facilities (as per Decree #167/2017) and establishing participatory supervisory committees.

The *medium-term* (2021-2025) recommendations, from a legal/institutional perspective, are: drafting the amendment to Law No. 80/2018 according to the observations made by the concerned parties/stakeholders, developing field inspection and self-control mechanisms, intensifying educational programs and strengthening the capacity of the relevant departments (municipal police, customs, and others).

The *long-term* (2025-2030) recommended actions focus on law enforcement, database development and promoting circular economy.

8.4.2.2 Establishing the NSWCC

In 2019, the Minister of Environment established the NSWCC, as per MoE Decision No. 108 dated 05/03/2019, with a two-year mandate. In addition to representatives of 9 national authorities, OEA and ALI, the committee included representatives of NGOs (TERRE Liban), academia (Notre Dame University – Louaize), consulting companies (Rafik El Khoury & Partners) and contracting companies (JCC) – selected through a competitive call for nominations. NSWCC discussed and provided recommendations regarding pressing SWM issues and critically reviewed the roadmap of 2019. Yet, upon the resignation of the CoM, the committee meetings were suspended.

8.4.2.3 Draft National Strategy

The National Strategy of ISWM is a legislative requirement of Article 10 of Law 80/2018. It was drafted by MoE and discussed in two expert consultation meetings; but final endorsement is pending SEA approval. The draft addresses all SW types, categorized into 12 general streams, and defines the requirements for establishing a SWM "service area". It provides objectives and 10-year targets under six thematic areas: (1) policy, legislation and enforcement, (2) sustainable financing, (3) capacity development, (4) waste reduction, recycle, reuse, (5) sustainable integrated waste management, and (6) public awareness/consultation.

The draft addresses enforcement requirements and identifies mandatory measures for adequate implementation of the strategy. Those are split into: legal, organizational/administrative, infrastructure, financial, awareness/education, plans/guidelines/studies. Also, it defines the responsibilities of various stakeholders and tackles outreach aspects, such as stakeholder engagement, public awareness, and data management and reporting.

8.4.2.4 POPs Planning

In 2017, MoE has prepared the National Implementation Plan (NIP) on Persistent Organic Pollutants with the purpose of meeting the requirements of Stockholm Convention (MOE/UNEP/GEF, 2017b). The NIP addresses management and monitoring requirements throughout the life cycle of POPs and requires the establishment of a specialized unit at MoE. The NIP sets three implementation packages, each addressing selected strategic objectives. The first package is a "technical assistance" package addressing strategic objectives on: (1) the legal and institutional framework, (2) research and development, and (3) monitoring, evaluation and reporting. The second and third packages are "implementation packages" addressing industrial and Unintentionally released POPs, and pesticides POPs, respectively. One key project under this plan is the PCB Management in the Power Sector Project, under which the action plan and inventory of PCB equipment in the power sector have been implemented by MoE. So far, 22,620 transformers have been actually sampled and tested, and 265 transformers (out of 1129 that contain more than 50 ppm of PCB) have been disposed *(refer to Chapter 10 – Chemical Management for more details).*

8.4.2.5 Planning for the Closure and Rehabilitation of Dumpsites

In 2017, MoE and UNDP published the "Updated Master Plan for the Closure and Rehabilitation of Uncontrolled Dumps in Lebanon" (following the first plan published in 2011). In total, 617 MSW dumpsites were identified, of which 341 dumps are operational with a total (operational) volume of 4,588,218 m^3. Also, 324 CDW dumpsites were identified, of which 178 sites are operational and have a total (operational) volume of 964,223. The top 20 priority dumpsites were identified based on a Risk Sensitivity Index and optimum recovery methods were recommended and rehabilitation costs were estimated (MoE/UNDP/ELARD, 2017). The draft National Strategy of Integrated Solid Waste Management highlighted in its vision (1) diversion of waste from dumpsites and (2) closure and rehabilitation of existing dumpsites. This is aligned with Law 80/2018 (Article 10), that clearly highlights the closing of dumpsites as a priority and requires the identification of closing/rehabilitation methods as an integral part of the national ISWM strategy.

8.4.3 Opportunities and Funding Programs

The solid waste Law No. 80 (of 2018) allowed decentralized solutions; and the corresponding integrated solid waste management strategy (currently under development) promotes fundamental concepts such as the 3Rs approach, polluter pays principle, economic instruments and circular economy. These newly introduced concepts, along with decentralization, provide opportunities including, but not limited to: investments in waste treatment facilities, technical innovations, secondary raw material markets, improved service quality due to competition, and drivers for small-scale businesses and/or local initiatives in waste reduction and sorting. Also, consultancy and contracting opportunities in the waste management sector, at both national and local levels, are driven by high availability of international funding. International development partners that are currently involved include: EU, World Bank, UNDP, UNEP, UNIDO, UNICEF, UNHCR, UN-HABITAT, ESCWA, USAID, JICA and various entities from European counties such as UK, France, Germany, Italy and The Netherlands among others.

8.5 Policy Outlook and Way Forward

8.5.1 Adopting a Cost Recovery System

For effective implementation of the decentralization concept of the SW law No. 80, the financial autonomy of the local authorities shall be secured. This may be achieved through a SWM cost recovery system with sustainable and diversified income sources. The latter may include various taxes (e.g. residential, commercial, industrial), service fees and governmental funds.

8.5.2 Establishing the NSWMA

The NSWMA should be established, as required by Law No. 80 (2018). This necessitates the development of needed procedures (e.g. for its establishment and operation). Ultimately, implementation and monitoring of SW activities, currently assumed by CDR and OMSAR, should be transferred to the NSWMA.

8.5.3 Completing the Legislation Framework

A comprehensive list of individual laws, decrees, decisions and studies needed to complete the regulatory framework of the SW sector was prepared by MoE (Annex 3). Yet, the main target to be set for the next decade is drafting, endorsing and enforcing the needed decrees and decisions to implement Law 80/2018. Also, amendments of the law need to be considered, based on experts' feedback – previously communicated to MoE during participatory meetings – particularly the re-introduction of the financial instruments needed to ensure cost-recovery.

HH Solid Waste – A detailed list of the needed short-, mid- and long-term legislation and institutional needs is provided in the technical committee report of July 2020 (Box 8-3). Of particular importance are the cost recovery and other legal tools needed by LA to meet decentralization requirements.

Healthcare Waste – The HCW is among the most organized sectors among hazardous waste streams. MoE has developed a set of guidelines for Environmental Auditing of Hospitals and HCW management is being monitored by MoE through a periodic reporting framework. However, hospital standards developed by MoPH (in 2000 with subsequent amendments) include only one chapter, out of 40, addressing waste management requirements (with only 8 standards). Thus, more emphasis on HCW aspects in future amendments needs to be considered. In this context, the impacts and management of waste needs to be more emphasized in the permitting and operation requirements of healthcare institutions. Even though the waste management aspects and mitigation procedures are mandatory through the EIA approval process, they need to be clearly identified under a separate section of the permitting requirements. Most importantly, enforcement needs to be strengthened through environmental audits, monitoring and investigations that reach 100% of the sector.

Industrial Hazardous Waste – HW management in Lebanon is bound namely by the recent Decree 5606/2019 and MoE Decisions 998 and 999 of year 2019 and 59 of year 2020, along with international conventions (Law 387/1994 and Law 432/2002) and general text legislations (e.g. Decree 5243/2001 and Decree 8471/2012). Yet, more specific legislation is needed in order to address the variability in hazardous waste characteristics and uses, such as:

- *Required Decision* – Following the MoE Decisions related to generators (998/1 of 2019), transporters (999/1 of 2019) and storage facilities (59/1 of 2020), two decisions remain lacking to complete the requirements of Decree 5606/2019: (1) Recovery and/or Treatment and/or Disposal Facilities, and (2) Financial Guarantees.
- *Co-Processing Legislation* – Policies and standards for co-processing of industrial waste in high energy demand industries (e.g. cement factories).
- *Hazardous Waste Market Legislation* – Policies and economic instruments to encourage and improve the feasibility of investments in the hazardous waste market.

Electronic and Electric Waste – The UNIDO-MoI Preliminary Baseline Assessment of E-Wastes in Lebanon (UNIDO, 2019) identified the following needs:

- *E-waste Legislation* – E-waste management has mainly been addressed indirectly in relevant laws and decrees (e.g. laws pertaining to the ratification by Lebanon of relevant Multilateral Environmental Agreements; Law 80/2018; Law 444/2002; Law 64/1988; MoE Decision 71-1/1997) or as part of recent legislation (MoE decree 5606/2019). E-waste specific legislation remains to be developed.
- *Differentiation at the Customs* between new and used electronic and electric equipment – Used equipment constitute around 20% of EEE imports, and can enter the country towards the end of their life to be soon transformed into e-wastes, in a deflection of Basel Convention obligations on the control of the transboundary movement of hazardous wastes.
- *Restrictions on export* – It is currently not possible to track the hazardous e-waste scrap from the metal and plastic scraps, the export of which ranged from 300,000 t/yr to 600,000 t/yr in the last 8 years.

POPs – Based on the National Assessment of POPs Impacts and Management (MOE/UNEP/GEF, 2017), practical decrees are needed to achieve Lebanon's commitment to Stockholm Convention. As per the provisions of Law 444 (1994), it is required to (1) develop national standards and pollution control measures, (2) provide the list of items to be banned from or allowed to enter the Lebanese territories, and (3) establish a framework for the management of POP containing products and their waste *(refer to Chapter 10 – Chemical Management for more detail).*

8.5.4 Adopting the ISWM Strategy

Upon ratification of SW law No. 80 in 2018, the National Strategy for Integrated Solid Waste Management was drafted; but the corresponding SEA (required by Law 80/2018) remains under preparation and the final endorsement is pending the submission and approval of SEA. Subsequently, the draft strategy shall be revised, based on the SEA findings, and re-submitted to CoM for final approval.

8.5.5 Completing and Adopting the Local SWM Plans

Law 80/2018 requires local authorities to submit their SWM plans for approval. The prerequisites for this to be practically achievable are: (1) adopting the draft ISWM cost recovery law, (2) endorsing the ISWM strategy, (3) finalizing the service zones, (4) completing the guidance documents, and (5) sustaining capacity building activities. Furthermore, circulars and memos on practical information and guidance, such as the MoE memo of 16/11/2017 on source sorting practices, need to be continuously updated and delivered to local authorities.

8.5.6 Enforcing Legislation

Despite the fact that the regulatory framework of SW is still incomplete, improved enforcement of the existing legislation has the potential to decrease the impacts of current gaps. As highlighted in several instances throughout this chapter, poor environmental law enforcement made it impossible to control specific waste streams. To note that Law 80/2018 calls for application of advanced SWM principles that require meticulous enforcement at both national and local levels. Accordingly, environmental law enforcement will become even more critical in the next decade. Means to improve enforcement include, but are not limited to: (1) tools foreseen under Law No. 80, including forming the NSWMA (as per Law 80/2018) and developing means for self-supervision and reporting to MoE, among others, and (2) various empowerment means such as dedicating full-time environmental prosecutors and investigation judges (as per Law 251/2014), establishing the environmental police (as per Decree 3989/2016), developing local participatory supervising committees, capacity building of local (municipal) police and general empowerment of the law enforcement authorities

8.5.7 Waste Minimization and Marine Litter

Waste minimization is considered a win-win step of any SWM system. As such, it is recommended to put in place a national plan to reduce waste generation, including reduction of packaging waste, among others. The strategy can benefit from the experience of the European Union in applying the principles of circular economy. Also, it is recommended to activate the implementation of Decree 5605/2019 on source-sorting of household waste and finalize the ToR templates for SW collection and transportation and disseminate it to local authorities. Concomitantly, a plan to reduce marine litter is needed.

In order to limit the growth and impacts of marine litter, the following actions are recommended: (1) developing a national baseline; (2) designate the concerned authorities in charge of the management of waste, and provide the needed legal instruments, to oversee the implementation of beach littering regulations; and (3) implement general waste management priorities such as reducing/reusing/recycling and closure of coastal dumpsites (Mawla, 2016).

8.5.8 Enhancing Communication

Like any management plan, for a SWM plan to be efficiently implemented, it requires the consent of the clients (i.e. waste generators) and their willingness to participate. With this in mind, national and local communication strategies are needed, with the purpose of: (1) enhancing the knowledge of the public on sound SWM practices and their benefits, (2) restoring the trust of the public in national and local authorities managing the SW sector, and (3) raising the public interest in participating.

Also, controversial issues, e.g. thermal treatment, require extensive discussions at the national level – with the assistance of the NSWCC. Equally important, a strong and transparent public reporting (including public sharing of databases) and feedback system is needed. Finally, the basics and methods of applying the participatory approach in the SW sector need to be identified and put into action at all levels (national, local, commercial, industrial, etc.).

8.5.9 Incentivizing Investments in New Secondary Material Markets

In order to divert special streams (CDW, e-waste, etc.) from landfills and dumpsites, recycling/reuse should become economically feasible through: (1) implementation of decrees and decisions that incentivize investments in new secondary material markets (e.g. aggregate, glass, etc.), such as Decree 167/2017 on tax reduction for activities that aim at protecting the environment, and (2) development of national standards for the use of the recovered materials.

8.5.10 Completing the Technical and Infrastructure Gaps

Infrastructure gaps that need to be considered in the next decade based on the 2020-2030 MSW roadmap include: more sanitary landfills, more waste sorting and treatment facilities (including RDF production lines), thermal (incineration and other waste-to-energy) plants, recycling industries, drop off and reuse centers as well as environmental labs (Annexes 4 and 5).

Also, final closure and rehabilitation of open dumps (at least the priority ones) is to be completed – as per the master plan of 2017 (MoE/UNDP/ELARD, 2017). The cost-benefit analysis showed savings of USD 33 to 65 million if only priority dumpsites are closed and rehabilitated, vs. USD 44 to 92 million if all dumpsites are rehabilitated (Box 8-4). In addition, technical standards, requirements and codes of practices are needed for all the stages of the SWM scheme: sorting, recycling, treatment, waste-to-energy, RDF, landfilling and export.

Box 8-4 Cost-Benefit Analysis of Closure and Rehabilitation of Uncontrolled Dumpsites

In this exercise, the costs of implementing the priority projects identified in the Updated National Master Plan for the Closure and Rehabilitation of Uncontrolled Dumpsites (MOE/UNDP/ELARD, 2017) are compared to the cost of extending the status quo.

a. Status quo

The Rapid Cost of Environmental Degradation Report of 2018 estimates the annual loss from the status quo in terms of poor treatment and poor disposal of solid waste to be USD 200 million in 2018, or 0.4% of GDP (Rapid Cost of Environmental Degradation Report 2018). The costs accounted for include foregone composting and recycling of organic and recoverable material that is currently dumped, land value loss at dumping sites and surrounding areas, soil and water contamination by untreated leachate, and foregone energy generation from uncaptured methane from non-engineered disposal sites.

b. Rehabilitation of dumpsites

The Updated National Master Plan identifies a number of priority projects of rehabilitation of dumpsites of Municipal Solid Waste (MSW). These priority sites together account for 66% total MSW volume in dumpsites.

The cost of rehabilitation is estimated at USD 35.66 million for the 20 priority MSW dumpsites. The same Master Plan estimates the cost of rehabilitating the remaining dumpsites at USD 24.55 million for MSW dumpsites. The costing of each project is based on the rehabilitation and treatment needs for each site.

c. Methods and assumptions

In this exercise, the costs of implementing rehabilitation projects for open dumpsites were compared to the cost of extending the status quo. Two scales of rehabilitation projects are considered: (i) rehabilitating only priority uncontrolled dumpsites and (ii) rehabilitating all uncontrolled dumpsites. The exercise assumes the cost of rehabilitation is a one-time cost.

Given the types of costs included in computing the cost of environmental degradation (COED) from MSW, it was assumed that these costs are attributable to waste disposed in open dumpsites and in landfills (excluding the waste recycled or composted) – the rapid COED report separates costs due to poor treatment (USD 100 million) from costs of poor disposal (USD 100 million). Yet, it does not disaggregate the estimated costs from open dumping and other management methods. Thus, in order to estimate the costs attributable to open dumps, two scenarios were considered:

1. a conservative scenario, in which the environmental impacts of open dumping are considered equivalent to those of landfilling (which is far from being the case). Accordingly, COED attributed to dumpsites is proportional to their share of total disposed waste, i.e. 52% (41% open dumped out of a total of 79% disposed waste).

2. a more realistic scenario in which the COED from poor treatment (USD 100 million) is fully attributed to open dumps and the COED from poor disposal are apportioned according to the share of open dumps.

The estimated savings from implementing the two scales of rehabilitation are reported in Table below:

Estimated Savings from Rehabilitating Uncontrolled MSW Dumpsites

	Estimated Savings from rehabilitating Uncontrolled MSW Priority Dumpsites (in millions of USD)	**Estimated Savings from Rehabilitating All Uncontrolled MSW Dumpsites (in millions of USD)**
	Scale i	Scale ii
Conservative Scenario	32.85	43.59
Realistic Scenario	64.59	91.69

8.6 Performance Indicators

The adopted key performance indicators (KPIs) are intended to be measurable and specific to individual waste streams and clearly relevant to the evolvement of the management schemes. The list of the selected KPIs (Table 8-7) is by no means extensive.

A major selection criterion was the possibility of calculating their current value with the currently available data and under the prevailing limits and constraints. **The description and selection rationale of the KPIs below are provided in Annex 6.**

Table 8-7 Summary of SW KPIs

SW sector	KPI	Current value (source)	Benchmark (source)
MSW	Percent of waste to uncontrolled dumpsites	36% (Section 2.1 of this chapter)	0% (draft national ISWM strategy)
	Percent of waste to sanitary landfills	44% (Section 2.1 of this chapter)	25% (provided all dumps are closed, draft national ISWM strategy)
	Percent of total recovered waste[39]	27% (Annex 6 of this chapter)	50-55% (draft national ISWM strategy)
HCW	Unit mass generation of infectious HCW	1.42 kg/cap.d (Maamari et al., 2015)	N/A
E-Waste	Yearly generation rate per capita	11.1 kg/yr.cap (Blade et al., 2017)	Global average generation of 6.1 kg/yr.cap in 2016, and 6.8 kg/yr.cap in 2021 (Blade et al., 2017) Separate collection of 4 kg/yr.cap & Recover of 2 kg/yr.cap (draft national ISWM strategy)
CDW	Unit generation rate of CW	38 – 76 kg/m² (Ghanimeh et al., 2016; Bakshan et al., 2015) – mostly disposed	50% recovery And < 30% disposal (draft national ISWM strategy)
	Unit generation rate of DW	1,400 – 1,730 kg/m² (AlZaghrini et al., 2019; Jawad et al., 2016; Srour et al., 2013) – mostly disposed	
Marine Litter	Total volume of marine litter waste generated	Values of the proposed KPIs are expected to be provided by the ongoing study by The World Bank and MoE – anticipated to be out in 2021	N/A
	Proportion of plastics in the generated marine litter waste		N/A
Infrastructure for special wastes	Total capacity of CDW treatment facilities	0	N/A
	Rate of e-waste managed by licensed service providers [40]	< 0.3% (Section 2.4 of this report)	4 kg/yr.cap (national ISWM strategy) – about 36% [41]
	Number of national HW storage & disposal facilities [42]	0	> 3 storage facilities (MoE, 2018)

[39] These include all materials "recovered" from waste, including the waste sent for composting. To note that upon processing, some of the recovered material turns into "residuals" and end up in disposal sites. This indicator is different from the amount of waste "deviated" from disposal – which is %20.
[40] As per Decree 2019/5605
[41] Adopting the generation rate of 11.1 kg/yr.cap reported by the Global E-waste Monitor (Balde et al., 2017)
[42] Number of (national) specialized HW (including hazardous HCW) storage and disposal facilities

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UNHabitat and Ministry of Beirut (2020): Beirut Municipality Rapid Building-level Damage Assessment.

United Nations Development Program (UNDP) (2020). Demolition Waste Assessment Outside the Port of Beirut.

United Nations Industrial Development Organization (UNIDO) (2019). Preliminary Baseline Assessment of E-Wastes in Lebanon.

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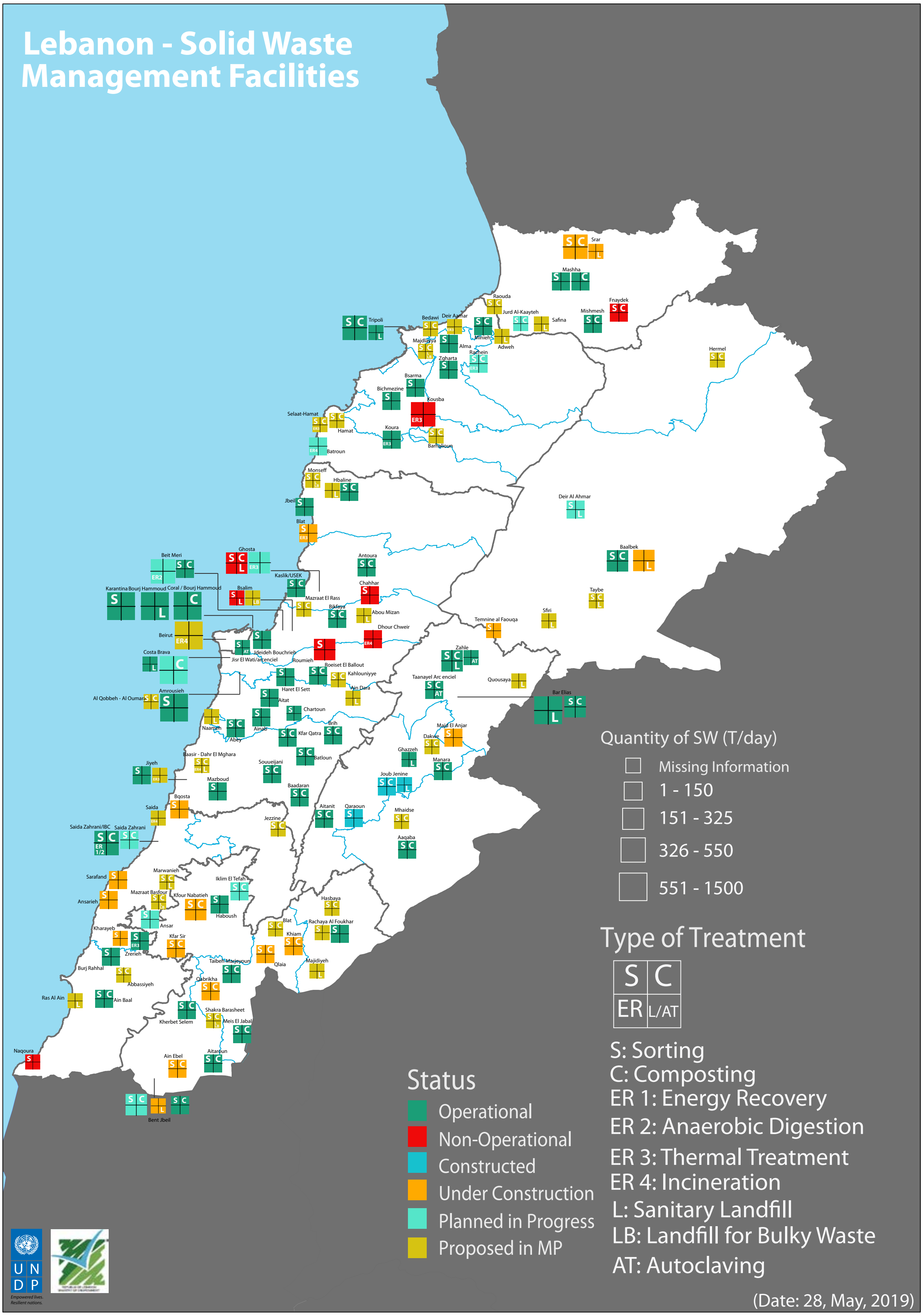
Annex 1: Lebanon Municipal Solid Waste Facilities (UNDP, MoE data, March 2020)



Annex 2: Laws, Decrees and Decisions Pertaining to Solid Waste Management Listed, Chronologically and by Category

Regulations	N°	Date	Title / Objectives
Law	80	10 October 2018	Integrated solid waste management law
Law	2	3 February 2017	Ratification of Minamata convention on Mercury
Law	29	24 November 2015	Ratification of the Basel convention amendment to control transboundary movements of hazardous wastes and their disposal
Law	280	30 April 2014	Grant of financial incentives to the municipalities surrounding the Abieh Ain Darfil landfill, and exempting them from certain deductions and dues due to them
Law	738	15 May 2006	Kyoto protocol to the United Nations framework convention on climate change aiming to fight global warming
Law	728	15 May 2006	Ratification of Rotterdam convention (convention on the prior informed consent for certain hazardous chemicals and pesticides in international trade)
Law	432	08 August 2002	Stockholm convention on persistent organic pollutants
Law	387	21 December 1994	Basel convention on the control of trans-boundary movements of hazardous wastes and their disposal
Law	253	21 March 1993	Montreal protocol on substances that deplete the ozone layer
Law	64	12 August 1988	Protection of the environment from hazardous wastes and hazardous materials
Law	126	30 June 1977	Barcelona convention for the protection of the Mediterranean Sea against pollution
Law	444	29 July 2002	Protection of the environment
Decree	5606	11 September 2019	Management procedures of hazardous waste
Decree	5605	11 September 2019	Household solid waste sorting from the source

Regulations	N°	Date	Title / Objectives
Decree	8471	28 March 2012	Environmental compliance for establishments [43]
Decree	8633	28 March 2012	Environmental impact assessment
Decree	13389	14 September 2004	Specification of the types of healthcare wastes and their disposal methods (amendment to Decree 2002/8006)
Decree	8735	23 August 1974	On the preservation of public hygiene
CoM Decision	46/2018	11 January 2018	Policy Summary on integrated solid waste management
MoE Decision	1/58	21 January 2020	Classification of RDF
MoE Decision	1/59	21 January 2020	Principles and procedures for storage of hazardous waste
MoE Decision	1/998	24 December 2019	Determines the procedures and principles for implementing the first chapter (HW generators and its obligations) of the second section of the principles of HW management Decree (5606 of 2019)
MoE Decision	1/999	24 December 2019	Determines the procedures and principles for implementing the second chapter (HW transporters and its obligations) of the second section of the principles of HW management Decree (5606 of 2019)
MoE Decision	1/108	5 March 2019	Appointing the ISWM coordination committee
MoE Decision	1/1295	28 December 2017	Environmental conditions for the establishment and operation of sterilizing facilities for hazardous and infectious waste from health institutions and defining the principles for granting an environmental license to operate such facilities
MoE Decision	1/1294	28 December 2017	Environmental conditions for the transport of hazardous and infectious waste from health institutions
MoE Decision	1/260	12 June 2015	Procedure for the review of IEE reports
MoE Decision	1/261	12 June 2015	Procedure for the review of scoping and EIA reports

[43] Each establishment should submit an environmental audit report confirming their environmental compliance to the MoE. MoE, after approving the report, will issue an "Environmental Compliance Certificate" that should be revised every 3 years.

Regulations	N°	Date	Title / Objectives
MoE Decision	1/262	12 June 2015	Procedure for the review of objections on the MoE's decisions on EIA reports
MoE Decision	1/8	30 January 2001	Updates/replaces Decision 1996 – 1/52 by developing National Standards for Environmental Quality (NSEQ) related to air pollutants and liquid waste emitted from classified establishment and wastewater treatment plants into receiving water bodies.
MoE Decision	1/71	19 May 1997	Regulates the import of waste and amends Decision No. 1/22 dated 1996/12/17
MoE Decision	1/161	31 October 1997	Amends Decision 1997 – 1/71
MoE Decision	1/52	29 July 1996	Specifying the national standards for environmental quality and the environmental limit values for air, water, and noise.
MoE Circular	1/7	16 November 2017	Amends Circular No. 1/8 dated 2015/11/16 related to some instructions related to Integrated solid waste management for Municipalities, Union of Municipalities, Qa'imakams and Governors
MoE Circular	1/11	24 March 2011	Template for the trimestral report to be submitted by licensed health care waste treatment facilities to the MoE

Annex 3: List of Individual Laws, Decrees, Decisions and Studies Needed to Complete the SW Regulatory Framework

Decrees and Decisions Needed for the Implementation of Law 80

Ref #	Decrees identified in the ISWM Law
DCL1	Appointment of the National Solid Waste Authority Members (Article 13 of Law 80/2018)
DCL2	Bylaws of National SWM Authority (Article 13 of Law 80/2018)
DCL3	Non-financial incentives for Solid Waste Management (Article 29 of Law 80/2018)
Ref #	**Decisions identified in the ISWM Law**
DEL1	ISWM Strategy (Article 10 of Law 80/2018)
DEL2	Clause of the local programs to be prepared by local authorities (Article 11 of Law 80/2018)
DEL3	Clauses for self-monitoring reports (Article 15 of Law 80/2018)
DEL4	Mechanism for the field inspections and their reports (Article 17 of Law 80/2018)
DEL5	Clauses for data and database system for Solid Waste Management (Article 18 of Law 80/2018)
DEL6	Standards and conditions for collection and transportation (Article 20 of Law 80/2018)
DEL7	Standards and conditions for sorting at source and mechanical sorting (Article 21 of Law 2018/80)
DEL8	Standards and conditions for reuse and recycling (Article -22A of Law 2018/80)
DEL9	Standards and conditions for composting, biological disintegration and RDF production from organics (Article -22B of Law 2018/80)
DEL10	Standards and conditions for RDF production, thermal disintegration, and management of Ash (Article -22C of Law 2018/80)
DEL11	Standards and conditions for preparation of waste prior final disposal (Article 23 of Law 2018/80)
DEL12	Standards and conditions for final disposal (Article 24 of Law 2018/80)
DEL13	Technical specifications for each type of sanitary landfill (Article 24 of Law 2018/80)
DEL14	Standards and conditions for final disposal of inert waste (Article 24 of Law 2018/80)
DEL15	Standards and conditions for Hazardous Waste Management for Operators (Article 27 of Law 2018/80)

Additional Needed Laws, Decrees and Decisions

Ref #	Proposed Laws for SWM
L1	Establish a mechanism for SWM financing and cost recovery
L2	ISWM Debt (mainly for Beirut and Mount Lebanon Governorates)
L3	Financial incentives and penalties
	Additional Needed Decrees and/or CoM Decisions related to SWM
ADC1	Defining service areas for collection and treatment
ADC2	A plan to define the location of facilities that would serve the Solid Waste Sector
ADC3	National plan for prevention, minimization, reusing, and enhanced recycling of solid waste in Lebanon
ADC4	National plan to reduce plastic products
ADC5	National plan for marine litter prevention
ADC6	National plan for awareness and capacity building (decision makers, media, municipalities, schools and universities, etc.)
ADC7	Contingency plan in case of exceptional catastrophic accidents
	Additional Needed MoE Decisions for SWM
ADE1	Guidelines related to EIAs for waste to energy facilities
ADE2	Standards and conditions for closure and rehabilitation of dumpsites (including means of converting plausible dumpsites into sanitary landfills)
ADE3	Guidelines for mitigation measures related to waste to energy and landfills (emissions, odors, Leachate, ashes, etc.)
ADE4	Health, Safety and Environment standards and conditions for solid waste facilities
ADE5	Amend/update Decision 8/1 issued in 2001 and ELVs for odors
ADE6	Unified Systems for monitoring SWM and the use of abandoned quarries for final disposal
ADE7	Reuse of some of the sorted material and of construction and demolition waste
ADE8	Tools to assess and classify new technologies for SWM
ADE9	Classification of the companies that are eligible to conduct environmental studies
ADE10	Classification of consulting companies specialized for supervision of SW facilities

Ref #	Proposed Laws for SWM
ADE11	Classification of wastes operators
ADE12	Setting the framework and standards for classification of environmental laboratories
	Additional Needed Studies for SWM
ASR1	Baseline for solid waste data
ASR2	An assessment study of existing solid waste facilities, and developing a plan to upgrade or capitalize on these facilities to meeting the targets of the National solid waste strategy
ASR3	A study of the existing infrastructure for collection and transportation of solid waste and develop a plan to upgrade the existing infrastructure in order to optimize the collection and transportation system.
ASR4	Develop tender documents for central government bids that cover various phases of the treatment
ASR5	Identification of financial resources for solid waste management
ASR6	Studies related to the impacts and sustainability of SWM, including feasibility studies, socio-economic studies, and cost of environmental degradation, among others. Such studies aim at providing tangible guidelines for new legislations.

Annex 4: Number of Additional Landfills to be Constructed[44]

Governorate	Area (~km²)	Amount of generated household waste (~ tons/day) [45]	Number of available sanitary landfills		Number of additional sanitary landfills to be constructed	
			Operational	They will be operational before the end of 2020	Immediately	Within a year
Akkar	788	430	---	1 (Srar)	---	---
North Lebanon	1,236	1,050	1 (Tripoli)	---	1	1
Kesrwan - Jbeil	766	530	---	2 (Ghosta and Hbaleen)	---	---
Mount Lebanon	1,208	2,560	2 (Jdeideh and Ghadeer)	---	2	2[46]
South Lebanon	934	550	---	---	2	---
Nabatiyeh	1,058	515	---	---	2	---
Bekaa	1,433	740	3 (Zahleh, Bar Elias, Jeb Jannine)	---	---	1
Baalbek - Hermel	3,009	350	---	2 (Baalbek and Deir Al-Ahmar)	---	---
Beirut	20	615	They shall be equally distributed to sanitary landfills in the Mount Lebanon Governorate			
Total		**7,340**	**6**	**5**	**7**	**4**

[44] Source: The report of the technical committee established pursuant to Decision No. 96/2020 of the Presidency of the Council of Ministers, dated 6/5/2020, to support the ministerial committee entrusted with studying the issue of solid waste treatment (10/July/2020).
[45] It includes waste generated by refugees and displaced persons.
[46] In case the two landfills foreseen immediately are not constructed according to the appropriate capacity.

Annex 5: Additional Sorting and Treatment Capacity Needed [47]

Governorate	Area (~km²)	Amount of generated household waste (~ tons/day) [45]	Number of available sorting and treatment plants (and their capacity (~ tons/day)[49]				The additional capacity required (tons/day) for sorting and treatment and which varies according to the volume of sanitary landfilling[50] to be achieved			
			Sorting	Composting	Producing alternative fuels	Energy recovery	Sorting[51]	Composting [52]	Producing alternative fuels	Energy recovery [53]
Akkar	788	430	1 (300)	1 (150)	1 (60)[54]	---	150	75	---	Total capacity required ~ 1,000 tons/day; determining the need for additional plants and their number depends on the alternative fuel produced (quantity, quality, disposal)
North	1,236	1,050	2 (580)	2 (290)	---	---	600	300	200	
Keserwan - Jbeil	766	530	3 (650)[55]	2 (150)	1 (30)	1 (150) 55	---	---	---	
Mount Lebanon	1,208	2,560	1 (2,400)	2 (1,500)	---	---	---	---	300	
South Lebanon	934	550	2 (650)	2 (130)	---	1 (300)	---	---	100	
Nabatiyeh	1,058	515	1 (250)	1 (125)	---	---	300	150	60	
Bekaa	1,433	740	3 (600)	3 (300)	1 (60)54	1 (200)	250	125	---	
Baalbek - Hermel	3,009	350	2 (320)	2 (160)	1 (50)54	---	---	---	---	
Beirut	20	615	1 (1,800)	---	---	---	---	---	400	
Total		**7,340**	**16 (7,550)**	**15 (2,805)**	**4 (200)**	**3 (650)**	**1,300**	**650**	**1,060**	**1,000**

47 Source: The report of the technical committee established pursuant to Decision No. 96/2020 of the Presidency of the Council of Ministers, dated 6/5/2020, to support the ministerial committee entrusted with studying the issue of solid waste treatment (10/July/2020).

48 It includes waste generated by refugees and displaced persons.

49 Plants whose capacity exceeds 50 tons/day, noting that there are about 60 additional plants with a capacity of less than ~ 30 tons/day per plant (with an average of ~ 15 tons/day per plant). This can be considered a correction factor to any inaccurate estimate, noting that about 40% of the plants are not operational.

50 Compared to the volume received by the plants and assuming that the sorting quality (sorting at source and secondary sorting) is good.

51 The sorting process alone produces a sanitary landfilling volume of no less than about 90%.

52 The sorting and composting process produces a sanitary landfilling volume of no less than about 55%.

53 The sorting, composting and/or energy recovery process produces varying volumes of sanitary landfilling with a maximum of about 40% according to the technique used. As for the accepted techniques, they have proved effective globally (anaerobic digestion, the use of alternative fuels in plants, thermal decomposition and other thermal treatment techniques, and so forth), provided that the related projects are subject to an Environmental Impact Assessment study (EIA) study according to the rules.

54 The equipment needed to produce alternative fuels is incomplete.

55 Includes an existing and non-operating sorting and energy recovery plant.

Annex 6: Rationale for Selection of Key Performance Indicators

Municipal solid waste

Despite various efforts, to divert wastes from landfills, final disposal remains a major challenge for the waste management sector in Lebanon. Accordingly, two H2020/NAP[56] sub-indicators on "Environmental Control" were found relevant: 2.B.1 (% of waste to uncontrolled dumpsites); 2.C.1 (% of plastic waste generated that is recycled). However, sub-indicator 2.C.1 cannot be used as is because of lack of national data on the proportion of recovered and recycled plastic; instead, the "% of total recovered waste" (including composted waste) is suggested as a second KPI. A third KPI on "% of waste to sanitary landfills" is recommended. The current 2020 values of the following KPIs are adopted from the MFA presented in this chapter.

$KPI_{MSW\text{-}\%Dumping,\ SOER\ 2020}$ = 36%

Benchmark: 0% (national ISWM strategy)

$KPI_{MSW\text{-}\%Landfilling,\ SOER\ 2020}$ = 44%

Benchmark: 20% (provided all dumps are closed, national ISWM strategy)

$KPI_{MSW\text{-}\%Recovery,\ SOER\ 2020}$ = 27% (3% source-sorted, 15% composted, 4% anaerobically digested & 5% recovered recyclables from MRFs – ref. Section 2.1)

Benchmark: 50-55% (national ISWM strategy)

Healthcare waste

The adopted KPI is the unit mass generation of infectious HCW, as suggested in the Guide of the Healthcare Waste Management (Arc-En-Ciel, 2014). A drop in the value of this KPI implies more efficient sorting (Arc-En-Ciel, 2014), which can be attributed to better awareness and higher commitment of both, the staff and the institution's management. Also, waste generation per bed is a commonly indicator. WHO guidelines and standards use an average of 2 kg HCW/bed in hospitals in Eastern Mediterranean countries. In addition, KPIs that express the generation rates of individual components of HCW are recommended for future SOERs; Yet, they are not included in this chapter due to the current lack of national figures.

KPI*I-HCW, SOER 2020* = 1.42 kg/cap.d (Maamari et al. 2015)

Electronic and electric waste

The KPI adopted for e-waste is the yearly generation rate per capita. It reflects the aggregated effect of efforts by all stakeholders (consumers, importers, authorities, etc.) to reduce the generation of e-waste. Yet, a major driver for reduction of this KPI would be new custom legislation that limit the import of electric and electronic equipment that are close to their end-of-life. The current value (for SOER 2020) is adopted from the Global E-Waste Monitor for year 2016 (Blade et al., 2017).

$KPI_{e\text{-}waste,\ SOER\ 2020}$ = 11.1 kg/yr.cap (Blade et al., 2017)

Benchmarks: global average of 6.1 kg/yr.cap in 2016, and 6.8 kg/yr.cap in 2021 (Blade et al., 2017)

Construction and demolition waste

Two KPIs are proposed in order to separately assess CW and DW using unit generation rates. Due to the lack of national figures, the generation rate is expressed as a range that covers all values reported in the literature – often addressing specific locations and structure types.

$KPI\text{–}CW_{SOER\ 2020}$ = 38 – 76 kg/m^2 (Ghanimeh et al., 2016; Bakshan et al., 2015)

$KPI\text{–}DW_{SOER\ 2020}$ = 1,400 – 1,730 kg/m^2 (AlZaghrini et al., 2019; Jawad et al., 2016; Srour et al. 2013)

Marine litter

Most member states of the European Union adopt beach monitoring as a fundamental tool to assess the amount of litter entering the marine environment. For instance, the number and proportions of beach debris items is one of the mostly used indicators for which data is commonly available (UNEP/MAP, 2015). Similar indicators were suggested for Lebanon, through the National Action Plan for the Implementation of the Land-Based Sources Protocol (Mawla, 2016), consisting of monitoring the trends of the quantity, composition and source of litter wasted ashore. Yet, this data is still lacking in Lebanon, despite the repetitive attempts by local NGOs to clean and collect beach litter data.

[56] H2020/NAP Waste Management Indicators (EU/EEA/UNEP-MAP, 2016): https://eni-seis.eionet.europa.eu/south/areas-of-work/indicators-and-assessment

Alternatively, the KPIs proposed in this chapter reflect a more direct assessment of the “volume of marine litter (ML) waste generated” and “% of plastic in the generated marine litter”. Both KPIs are independent of external conditions such as the efficiency of the monitoring/cleaning campaign. Values of the proposed KPIs are expected to be provided by the ongoing study by The World Bank and MoE (anticipated release date is 2021).

$KP_{IML\_Volume,\ SOER\ 2020}$ = Total volume of marine litter waste generated

$KPI_{ML\_\%PL,\ SOER\ 2020}$ = proportion of plastics in the generated marine litter waste

Infrastructure indicators for special wastes

In addition to the above, the following infrastructure indicators are suggested for special waste streams:

(1) Total capacity of CDW treatment facilities:

$KPI_{Infrastructure\_CDW,\ SOER\ 2020} = 0$

(2) Rate of e-waste collected/managed by licensed service providers, as per Decree No. 5605/2019

$KPI_{Infrastructure\_E\text{-}waste,\ SOER\ 2020} < 0.3\%$

(3) number of specialized HW (including hazardous HCW) storage facilities and disposal facilities

$KPI_{Infrastructure\_HW,\ SOER\ 2020} = 0$

9 Climate Change and Energy

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Abbreviations and Acronyms

AFOLU	Agriculture Forestry and Other Land Use
BAU	Business- As-Usual
BDL	Banque du Liban
BREEAM	Building Research Establishment Environmental Assessment Method
BUR	Biennial Update Report
CAS	Central Administration of Statistics
CC	Climate Change
CDM	Clean Development Mechanism
CDR	Council for Development and Reconstruction
CEDRO	Community Energy Efficiency and Renewable Energy Demonstration Project
CER	Certified Emission Reduction
CH4	Methane
CO2	Carbon Dioxide
COM	Council of Ministers
DSPs	Distribution Service Providers
E&P	Exploration and Production
EDL	Electricité du Liban
EE	Energy Efficiency
EIA	Environmental Impact Assessment
EPA	Exploration and Production Agreement
ESCWA	United Nations Economic and Social Commission for Western Asia
EU	European Union
FSRU	Floating Storage Regasification Unit
GAP	Good Agricultural Practices
GDO	Gas/Diesel Oil
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Gigagram
GHG	Greenhouse Gases
GoL	Government of Lebanon
GWh	Gega Watt hour
HFC	Hydrofluorocarbon
HFO	Heavy Fuel Oil
ICEs	Internal Combustion Engines
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producers
IRENA	International Renewable Energy Agency
KTOE	Kilo Ton Oil Equivalent
LBP	Lebanese Pound
LCEC	Lebanese Center for Energy Conservation
LCRP	Lebanon Crisis Response Plan
LEDS	Low Emission Development Strategy
LEED	Leadership in Energy and Environmental Design
LIBNOR	Lebanese Standards Institution
LPA	Lebanese Petroleum Administration
LPG	Liquefied Petroleum Gas
LRA	Litani River Authority
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoF	Ministry of Finance
MoPWT	Ministry of Public Works and Transportation

MVA	Mega-Volt Ampere
MW	Megawatts
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NC	National Communication
NDC	Nationally Determined Contribution
NEEAP	National Energy Efficiency Action Plan
NEEREA	National Energy Efficiency and Renewable Energy Action
NGO	Non-Governmental Organization
NO2	Nitrous Oxide
ODS	Ozone Depleting Substances
OEAB	Order of Engineers and Architects of Beirut
PV	Photovoltaic
RCP	Representative Concentration Pathways
RCREEE	Regional Center for Renewable Energy and Energy Efficiency
RE	Renewable Energy
RICCAR	Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources in the Arab Region
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SME	Small and Medium Enterprise
SWH	Solar Water Heaters
TWh	Terawatt hours
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

9. Climate Change

Climate change (CC) is happening (IPCC, 2013) as several climate variables, including global and local temperatures and sea level, have repeatedly broken long-term records in recent years. CC has substantially increased the occurrence of climate and weather extremes, including heat waves, heavy precipitation, floods and droughts, in Lebanon and all around the globe (World Bank, 2018a). CC is a key environmental, economic and social challenge globally and locally. On the one hand, most economic activities, especially those that require burning of fossil fuel, are contributing to CC by emitting greenhouse gases (GHG) or affecting carbon sinks (e.g. through land use change); on the other hand, all ecosystems, many economic activities and human health and well-being are sensitive to CC.

This chapter gives an overview of the causes of CC, of past and projected changes in the climate system in Lebanon and of selected impacts on the environment, the economy and people in Lebanon. This chapter also addresses the two fundamental policy areas to limit the adverse impacts of CC: mitigation and adaptation. Energy is also addressed in this chapter, as it is the key source of GHG emissions whereby the energy crisis, an ongoing challenge for the Lebanese government and people, is also presented[1].

9.1 Driving Forces

Drivers for GHG emissions and the energy sector are closely intertwined as energy supply is the largest contributor, responsible for approximately 35% of global anthropogenic emissions in 2010 (IPCC, 2013). Candidate drivers for Lebanon's GHG and energy consumption are: population, economic growth, technology, industrial sector, agriculture and land use, waste and wastewater, transportation and building sectors.

9.1.1 Population

Many analysts uncritically assume that changes in the scale of the human population produce proportional changes in stress on the environment by dividing population size into aggregate measures of stress (for example, GHG emissions) to yield per capita stress (for example, GHG emissions per capita) (Rosa & Dietz, 2012). However, it is plausible that there are economies or diseconomies of scale associated with larger populations. For example, larger populations may allow more effective use of mass transit systems, reducing per capita impact at higher levels of population. On the other hand, larger populations may produce 'frictional' problems such as traffic congestion, resulting in increased impacts, such as carbon dioxide (CO_2) emissions, as is the case in Lebanon.

The population of Lebanon was estimated in 2018 at around 4.842 million people, excluding people living in non-residential units, refugee camps and informal settlements. Around 80% of residents are Lebanese and 20% are citizens of other countries (EU/CAS/ILO, 2019). Although the size of a population may not be the only demographic driver of GHG emissions, a few disaggregated components of size have been investigated such as:

- *Number of households:* The importance of households for GHG emissions is evident in Lebanon, as a large proportion of household energy consumption is used to heat, cool and light dwellings and power the appliances in them, and such uses may be insensitive to the number of occupants. Transportation is probably quite sensitive to the number of households when their growth is in the urban periphery where low-density suburban landscapes prevail. This results in more passenger vehicles and more commuting adding to fossil fuel consumption. The estimated total number of households in Lebanon is around 1.266 million. The average size of the household was 4 persons, such that only 10% of households were composed of one person (EU/CAS/ILO, 2019).
- *Age structure:* The age structure of a population changes as rates of population growth change. It has been proposed that age structure, in particular the fraction of the population in the ages generally considered economically active (typically 15–65), may contribute inordinately to energy consumption and thus GHG emissions *(Refer to Chapter 1 – Introduction and Methodology for Lebanon's age pyramid).*
- *Rate of growth:* Although human population size is most often invoked as a driver of virtually all stresses on the environment, rapid population growth may make it difficult to provide environmentally benign infrastructure and strain the institutions required to manage it. Population growth in Lebanon is not considered a major driving force; however, the influx of large numbers of Syrian displaced during the last decade has been a major contributor to the rate of growth.

[1] Disclaimer: Not all policies, strategies, plans and projects mentioned in this chapter have undergone the environmental assessment process in line with Decrees 8213 and 2012/8633 and obtained MoE position on them. However, they have been included as they are essential for a comprehensive understanding of progress made in the sector to date.

9.1.2 Economic Growth

It has long been axiomatic that economic growth and energy demand are linked. As economies grow, energy demand increases; if energy is constrained, GDP growth pulls back in turn (McKinsey, 2020). The deterioration in GDP and economic growth that Lebanon has been experiencing is driven by a higher debt service and increased transfers to the state-owned power utility Electricité du Liban (EDL) due to more expensive fuel (World Bank, 2020a). A study conducted by Dagher and Yacoubian (2012) found strong evidence of a bidirectional relationship between energy consumption and economic growth in Lebanon over the period 1980–2009 both in the short-run and in the long-run, indicating that energy is a limiting factor to economic growth in Lebanon. Moreover, a model developed at the MoE (2020a) showed that the GHG emission trajectory follows closely that of the GDP for the period 1999-2015 as seen in Figure 9-1 below.

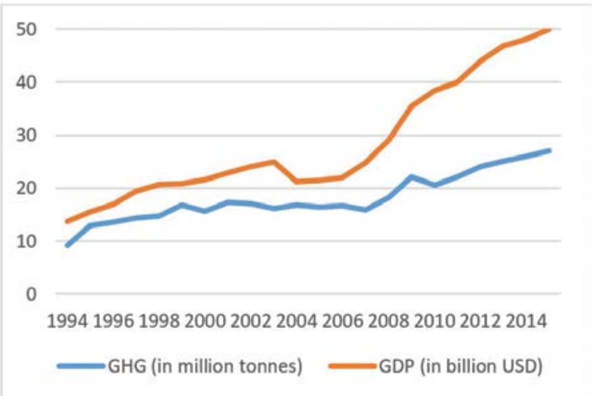


Figure 9-1 Time Series of GHG and GDP in Lebanon
Source: MoE, 2020a

Energy consumption boosts economic growth and financial development contributes to economic growth by capitalization enhancing effect (Abosedra et al., 2015). Figure 9-2 shows the relation of the total primary energy supply to real GDP in Lebanon for 1990-2017. With economic growth, the living standards of people in the country also begin to rise and domestic energy consumption increases as they start using more electrical appliances, vehicles consuming more petrol, etc. Lebanon witnessed a period of high economic growth between 2006 and 2010 (9.2% GDP growth) that turned into stagnation between 2010-2017 with an average GDP growth of 1.3%. This situation was coupled with a growing public debt that increased from 137% of GDP in 2006-2010 to 149% of GDP in 2010-2017. This period was also marred by a worsening business environment, whereby Foreign Direct Investments dropped from USD 3.9 billion in 2006-2010 to USD 2.8 billion in 2010-2017 (McKinsey, 2018), leading to the financial crash of 2019.

9.1.3 Technology

The main drivers behind the increase in global carbon emissions 2000–2014 was increasing consumption and production in developing and rapidly growing economies (Jiborn et al., 2020). Applying smart electric grid technologies can potentially reduce energy consumption, and consequently GHG emissions. Smart generation includes the use of renewable en-

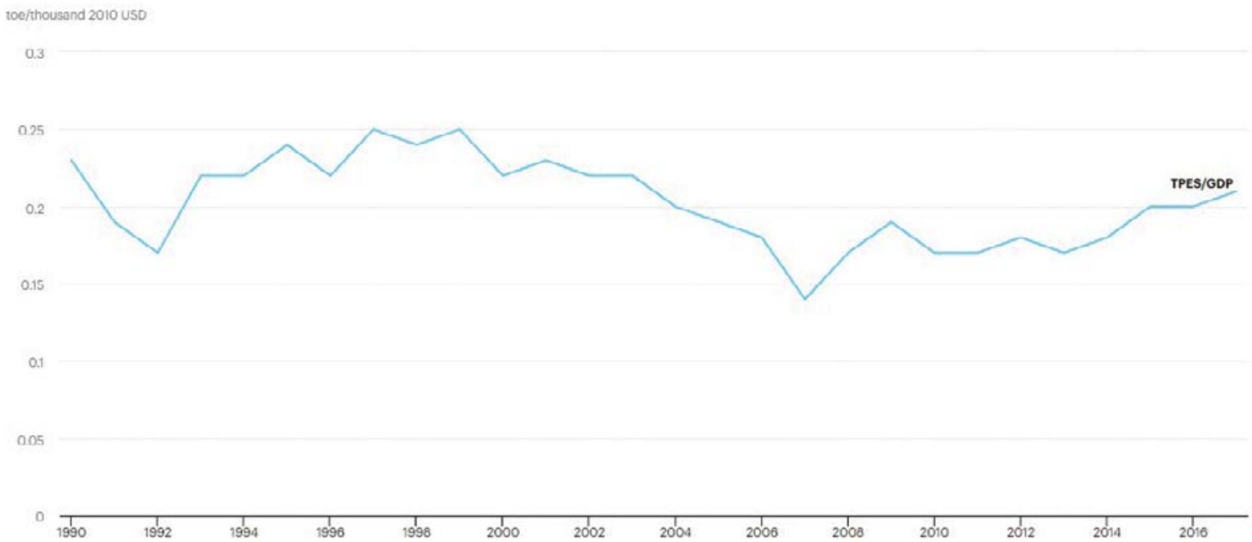


Figure 9-2 Total Primary Energy Supply by GDP, Lebanon 1990-2017
Source: IEA, 2020

ergy (RE) sources (wind, solar or hydropower). Smart transmission and distribution rely on optimizing the existing assets of overhead transmission lines, underground cables, transformers and substations, such that minimum generating capacities are required in the future. Smart consumption depends on the use of more efficient equipment like energy-saving lighting lamps, enabling smart homes and hybrid plug-in electric vehicle technologies. Challenges include shortage of investments, absence of political will, aging of transmission and distribution infrastructure, and lack of consumer awareness for power utilization (Abdallah and El-Shennawy, 2013). As for the transport sector, which is responsible for approximately 23% of global total energy-related CO_2 emissions, avoided journeys and modal shifts due to behavioral change, uptake of improved vehicles and engine performance technologies, low-carbon fuels, investments in related infrastructure, and changes in the built environment, together offer high mitigation potential (IPCC, 2013).

9.1.4 Industrial Sector

Industry-related global GHG emissions have continued to increase and are higher than GHG emissions from other sectors (IPCC, 2013). The growth in industrial emissions in the world stems primarily from increased use of refrigeration and air conditioning, which produce hydrofluorocarbons (HFCs), potent greenhouse gases. In Lebanon, the following industrial process subcategories emit CO_2: Cement, lime and glass production, use of lubricant and paraffin wax and other process uses of CO_2 carbonates. Industrial Processes and Product Use emitted in 2015 an estimated 8% of Lebanon's total GHG emissions, while the use of energy in industries (referred to as Manufacturing industries and construction) emitted 17% (MoE/UNDP/GEF, 2019). The industrial sector is therefore a major source of GHG emissions from (1) its use of energy for electricity and heat generation and (2) its chemical processes required for the manufacturing of products.

Due to the intermittent electricity supplied by EDL and the constant power shortages, most industries in Lebanon generate their own energy from in-house generators thus consuming considerable amounts of Gas/Diesel Oil (GDO) (refer to Section 9.2.4.3 – Informal Sector). Other than emissions from GDO for private electricity generation, manufacturing industries and construction activities also emit GHG emissions from their consumption of Liquefied Petroleum Gas (LPG) for heating, heavy fuel oil for heat generation in industries and petroleum coke for cement production. Table 9-1 presents CO_2 emissions from manufacturing industries in 2015 in Lebanon.

Table 9-1 CO_2 Emissions from Manufacturing Industries in 2015

Fuel Type	Emissions in 2015 (Gg CO2eq)
GDO for private generation	2,405.00
Heavy fuel oil	543.15
LPG use	75.75
Petroleum coke	1,264.77
Total	4,288.67

Source: MoE/UNDP/GEF, 2019

During the period 1994-2015, emissions from manufacturing industries and construction increased by 60%, with the lowest value in 2007 (1,382 Gg) and the highest value in 2015 (MoE/UNDP/GEF, 2019).

In terms of emissions from industrial processes, in 2015, total GHG emissions in Lebanon amounted to 2,284 Gg of CO_2eq. The major source of emissions from industrial processes was the cement industry with 2,276.36 Gg CO_2eq., while the lime production (2.12 Gg CO_2eq.), other process uses of carbonates (5.01 Gg CO_2eq.) and paraffin wax use (0.87 01 Gg CO_2eq.) had minimal contributions (MoE/UNDP/GEF, 2019).

9.1.5 Agriculture and Land Use

Agriculture and forestry are considered sources of GHG mainly from energy consumption for agricultural activities and from biological and chemical processes that are used in agriculture, livestock, manure management and application of fertilizers. In addition, land use changes such as deforestation, forest fires and, most importantly, urbanization affect GHG emissions. Land use can also act as a GHG sink mainly attributed to the increase in vegetation cover within forest lands, croplands and grasslands (MoE/UNDP/GEF, 2019).

The agriculture, forestry and fisheries sectors are responsible for fuel consumption associated with fish farms, water pumps, grain drying, agricultural greenhouses, traction vehicles on farmland and in forests as well as inland and coastal and deep sea fishing. According to the National GHG Inventory established for the energy sector, and due to the lack of activity-specific energy use data in the sector, fuel consumption in agriculture/forestry/fisheries has been estimated as presented in Table 9-2. (MoE/UNDP/GEF, 2015a).

Table 9-2 Activity Data for Gas Diesel Oil Consumption in Agriculture/Forestry/Fisheries for 2015

End-use	Quantity (kton)	GHG Emissions (Gg CO2eq)
Mobile equipment	73.42	226.32
Fishing boats	36.70	111.79

Assumption: 48% of the remaining quantity of gas diesel oil after consumption in energy industries, transport and private generation is used by agriculture/forestry/ fisheries.
Source: MoE/UNDP/GEF, 2019

In terms of GHG emissions not emitted from energy related sources, the Agriculture, Forestry and Other Land Use (AFOLU) sector is responsible for just under a quarter (~10–12 $GtCO_2eq/yr$) of global anthropogenic GHG emissions mainly from deforestation and agricultural emissions from livestock, soil and nutrient management (IPCC, 2013). In 2015, 3% of the total GHG emissions in Lebanon came from the following AFOLU subcategories: Enteric fermentation, manure management emissions from biomass burning, urea application, direct N_2O emissions from managed soils, indirect N_2O emissions from managed soils and indirect N_2O emissions from manure management. In 2015, total GHG emissions from the agriculture sector in Lebanon amounted to 879.95 Gg of CO_2eq. Direct emissions from livestock (enteric fermentation and manure management) represented 67.48% of these emissions (MoE/UNDP/GEF, 2019).

Emissions from agriculture during the period 2005-2012 slightly decreased, with emissions in 2012 about 5% lower than the base year 2005. This is largely a result of a decrease in emissions from enteric fermentation CO_2eq. and to a lesser extent a decrease in N_2O and CH_4 emissions from manure management. This is the result of a decrease in livestock population, primarily sheep and goats (MoE/UNDP/GEF, 2015c & d, MoE/UNDP/GEF, 2019).

Land use and land use changes can significantly contribute to overall GHG emissions. Vegetation and soils typically act as a carbon sink, storing CO_2 that is absorbed through photosynthesis. When the land is disturbed, the stored CO_2 - along with methane (CH_4) and nitrous oxide (N_2O), both potent GHGs - is emitted, re-entering the atmosphere. The clearing of land can result in soil degradation, erosion, and the leaching of nutrients; which can also possibly reduce its ability to act as a carbon sink. This reduction in the ability to store carbon can result in additional CO_2 remaining in the atmosphere, thereby increasing the total amount of GHG. Emissions from aggregate sources and non-CO_2 emissions sources on land were mainly 32.52 Gg of CO_2eq. GHG removal through land use (forests) were estimated at -3,311.38 Gg of CO_2eq., resulting in net removals of -2,431.43 Gg of CO_2eq. from this sector (MoE/UNDP/GEF, 2015c & d, MoE/UNDP/GEF, 2019).

GHG estimations showed a remarkable increase in GHG emissions and decrease in removals from Land Use, Land-Use Change and Forestry (LULUCF) over the past two decades, resulting in a net decrease in removals of about 12% from 1994 to 2012 (MoE/UNDP/GEF, 2015c & d, MoE/UNDP/GEF, 2019).

9.1.6 Waste and Wastewater

Waste and wastewater disposal can contribute to GHG emissions through consumption of energy for operation of the treatment facilities and emission of methane gas (CH_4) and N_2O, during biological and chemical treatment processes and different disposal media.

Unfortunately, data on the energy consumption for the waste and wastewater treatment facilities is not available in Lebanon. As for non-energy related emissions, in 2015, they were estimated at 930.64 Gg of CO_2eq. with 224.62 Gg of CO_2eq. from solid waste disposal, 53.57 Gg of CO_2eq. from biological treatment of solid waste, 165.80 Gg of CO_2eq. from incineration and open burning of waste, and 486.65 Gg of CO_2eq. from wastewater treatment and discharge. In total, these processes contributed to 3% of Lebanon's total GHG emissions, with CH_4 being the main gas emitted, as shown in Figure 9-3 below (MoE/UNDP/GEF, 2019).

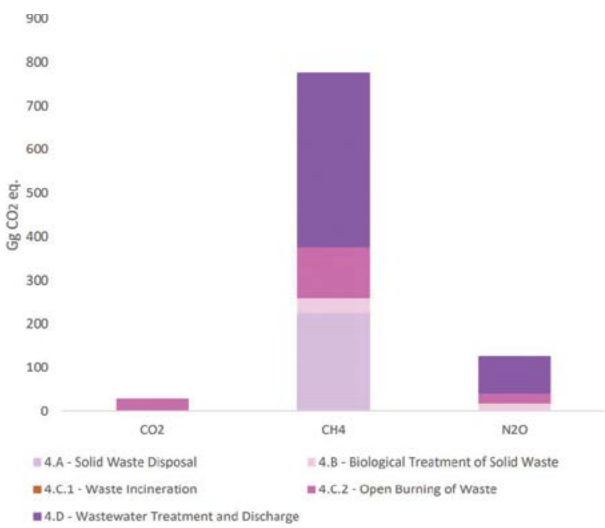


Figure 9-3 GHG Emission from the Waste Sector in 2015 per Subcategory
Source: MoE/UNDP/GEF, 2019

The increase in GHG emissions of around 1,300 Gg CO_2eq. in the waste sector from 1994 to 2011 appears to be directly related to population increase, considering the unchanged waste and wastewater management practices (MoE/UNDP/GEF, 2015d, MoE/UNDP/GEF, 2019).

9.1.7 Transportation Sector

The Lebanese energy bill includes the import of gasoline and diesel oil, and that imported gasoline is strictly used in the transport sector. Figure 9-4 shows the gasoline and diesel oil consumption in Lebanon between 1995 and 2015, which shows a significant increasing trend after the late 2000s (MoEW/LCEC, 2018).

9.1.8 Buildings Sector

All building types in Lebanon, except for industrial buildings, consumed around 13,251 GWh in 2010. The residential sector share of the building sector energy demand varied between 30% in 2009 and 37% in 2015, the commercial sector between 30% and 32%, followed by the health and education sector, which consumed between 21% and 24% (MoEW/LCEC, 2018).

GHG emissions from the commercial/institutional sector have increased by a rate of 1.4 over the 1994-2015 period, with the lowest value recorded in 2008 (186 Gg) and the highest in 2015 (2,501 Gg).

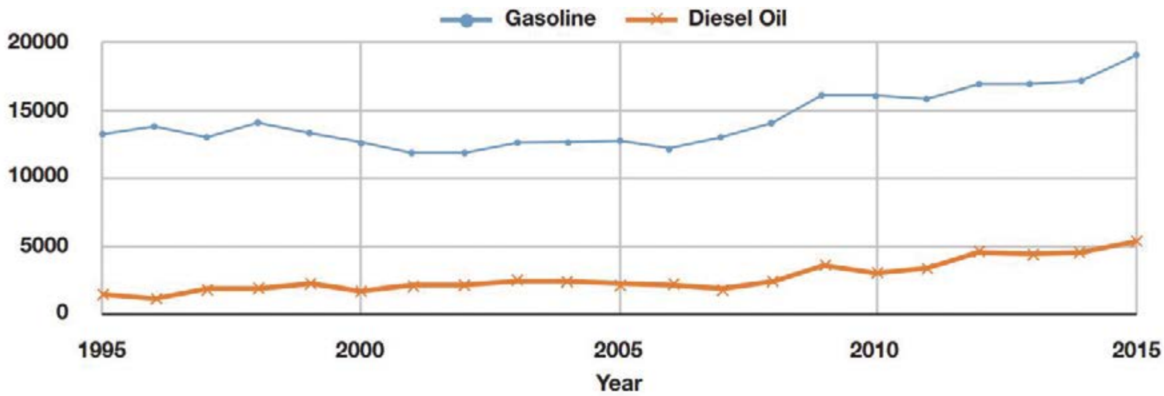


Figure 9-4 Fuel (ktons) Used in The Transport Sector (1995–2015)
Source: MoEW/LCEC, 2018

In fact, the annual growth in emissions from transport sector fluctuated during the period 1994-2015, with an average increase of by 7%. This fluctuation is a result of the advancements in reduction of consumption and emissions of new vehicles with emission control technologies. However, this technology advancement in emission savings did not reduce the fleet average emissions over the period extending from 2005 to 2013 due to the 8.62% yearly increase in the number of registered vehicles over the same period, and more likely to the increase in the annual average distance travelled. In 2015, GHG emissions from the transport sector were estimated at 6,146.76 Gg CO_2eq. with CO_2, CH4 and N_2O contributing to 97.65%, 0.62% and 1.73% of total CO_2eq., respectively (MoE/UNDP/GEF, 2019) *(Additional information on the transport sector and its emissions can be found in Chapter 4 – Air Quality).*

Table 9-3 presents CO_2 emissions from the commercial/institutional sector in 2015 in Lebanon. (MoE/UNDP/GEF, 2019).

Table 9-3 CO_2 Emissions from the Commercial /Institutional Sector in 2015

Fuel Type	Emissions in 2015 (Gg CO_2)
GDO for private generation	2,405.00
Heavy fuel oil	-
LPG use	96.41
Petroleum coke	-
Total	2,501.41

Source: MoE/UNDP/GEF, 2019

According to the Third BUR, emissions from GDO and LPG used for space and water heating in households were estimated at 566.47 and 518 Gg CO2eq., respectively, in 2015. From 1994 until 2015, emissions from the residential sector have increased by a rate of 1.45 mainly due to the rapid population growth and changes in socio-economic conditions during this period (MoE/UNDP/GEF, 2019).

9.2 Current Situation

The sections below present the current situation in Lebanon in terms of climate change patterns, GHG emission patterns and energy availability and consumption.

9.2.1 Climate Change Patterns and Projections for Lebanon

Lebanon has a Mediterranean-type climate characterized by hot and dry summers and cool and rainy winters, with an average annual temperature of 15°C. Along the coast, summers are hot and humid with temperatures surpassing 35°C in August. January is the coldest month, with temperatures around 5 to 10°C. The mean annual rainfall on the coast ranges between 700 and 1,000 mm. About 70% of the average rainfall in the country falls between November and March and is concentrated during only a few days of the rainy season, falling in heavy cloudbursts or violent storms. Rainfall in inland Lebanon is higher in the mountains than along the coast and includes snow (MoE/UNDP/GEF, 2016 & 2019).

Since 1960, climate trends in Lebanon have included (McSweeney et al., 2010):

- Increase in annual mean temperature of 0.11°C per decade, more in spring and summer
- Increase in the number of hot nights by 7 percent (mostly in summer)
- Decrease in precipitation of 11 mm per month on average (since 1950)
- Increase in the amount of rainfall received during one-day extreme rainfall events
- Rising Mediterranean Sea levels of roughly 20 mm per year
- Increase of 1.3°C in Mediterranean Sea surface water temperature (since 1982).

Another study conducted by Shaban (2011) found that the annual precipitation in Lebanon has decreased by 50 mm since 1963 while the average precipitation has increased by 1.5 mm during the same period.

Analysis of historical climatic records of Lebanon from the early 20th century with future emission trajectories indicates that the expected warming in Lebanon has no precedent (MoE/UNDP/GEF, 2016). Dynamical downscaling climate projections were conducted for the Second and Third National Communication (NC) reports submitted by the Ministry of Environment (MoE) to the United Nations Framework for Climate Change Convention (UNFCCC) (MoE/UNDP/GEF, 2011 & 2016), as well as by the World Bank (2018a) and independent research (El-Samra et al., 2017, 2018).

In the Second NC report, the PRECIS (Providing Regional Climates for Impacts Studies) regional climate model, developed at the Hadley Centre and based on the HadCM3 Global Climate Model, is applied in a 25km x 25km horizontal resolution whereby Eastern Mediterranean and Lebanon particularly are at the center of the model domain, ensuring optimal dynamical downscaling. The decline in the ratio of effective precipitation - the remaining rainfall after evaporation and infiltration (FAO, 2018) - to total precipitation (Pa/P) was found to be the highest in Beirut and the Cedars and the lowest in Daher-el-Baydar and Zahleh, and the percent Pa/P declines considerably more in the second half of the century, as appears in Figure 9-5. Although the model predicted an increase in temperatures and decrease in precipitation, it was concluded that a more refined grid is needed, thus allowing for a more realistic representation of the local

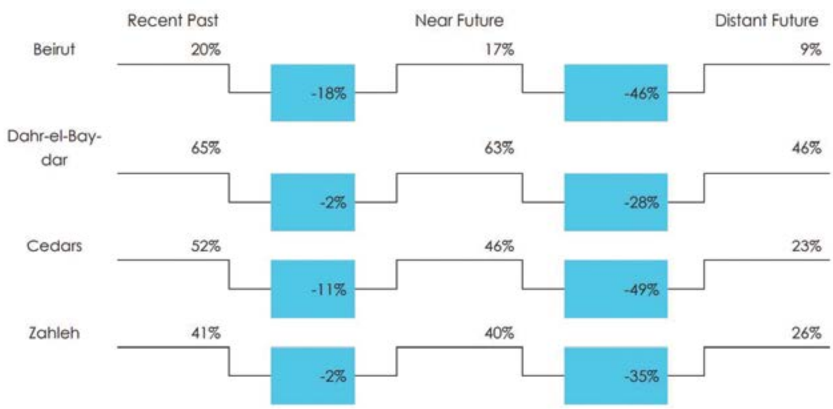


Figure 9-5 Decline in the Proportion of Effective Precipitation out of Total Precipitation by Region over Time
Source: MoE/UNDP/GEF, 2011

topography, which is considered a limitation for contemporary Regional Climate Model projections (MoE/UNDP/GEF, 2011).

In the Third NC report, the Regional Initiative for the Assessment of the Impact of CC on Water Resources in the Arab Region (RICCAR), which was led by the United Nations Economic and Social commission for Western Asia (ESCWA), was used for the climate projections (MoE/UNDP/GEF, 2016). Regional climate modelling outputs were generated by SMHI using the Rossby Centre Regional Atmospheric Model (RCA4), forced at its boundaries by three state-of- the-art global climate models, namely EC-Earth, CNRM-CM5 and GFDL- ESM2M. An average of the three-model output ("ensemble") was derived for Representative Concentration Pathways (RCP) 4.5 and RCP 8.5 (See Box 9-1 for definitions) for the various climate variables up to the end of the 21st century at a horizontal resolution of 50km x 50km (ESCWA et al., 2017). Climate projections (MoE/UNDP/GEF, 2016) suggest:

- An increase in temperature of 1.2°C by mid-century and over 2°C by 2100 with a reduction of 6 – 8% of the total volume of water resources with the increase in 1°C and 12 -16% with a 2°C rise;
- A decrease in precipitation of 4 -11% with drier conditions by the end of the century (up to 5 mm decrease in average monthly precipitation);
- An increased trend of warming, reaching up to 15 additional days with maximum daily temperature higher than 35°C and an increase in number of consecutive dry days when precipitation is less than 1.0 mm by the end of the century;
- An increased incidence of drought conditions due to longer and geographical expansion of drought periods resulting in a hotter and drier climate;
- A continued sea level rise of 30-60 cm between 2020 and 2050.

Box 9-1 Representative Concentration Pathways

RCPs are scenarios that describe alternative trajectories for carbon dioxide emissions and the resulting atmospheric concentration from 2000 to 2100. They encompass the range of possible climate policy outcomes for the 21st century. Four RCPs were selected and defined by their total radiative forcing (cumulative measure of human emissions of GHGs from all sources expressed in Watts per square meter) pathway and level by 2100. The RCPs were chosen to represent a broad range of climate outcomes, based on a literature review, and are neither forecasts nor policy recommendations (IPCC/WMO/UNEP, 2019).

The RCP 4.5 scenario is a stabilization scenario, which means the radiative forcing level stabilizes at 4.5 W/m2 before 2100 by employment of a range of technologies and strategies for reducing greenhouse gas emissions (NOAA, 2013a). In the RCP 8.5 emissions scenario the radiative forcing level reaches 8.5 W/m^2 characterized by increasing greenhouse gas emissions over time representative for scenarios in the literature leading to high greenhouse gas concentration levels (NOAA, 2013b).

According to Intergovernmental Panel on Climate Change (IPCC) 2013 data as reported by the World Bank (2018a), temperatures are projected to increase for all seasons. The CMIP5 models indicate that for the RCP8.5 scenario by the end of the 21st century, country-scale temperatures could increase by 3–6°C during winter and spring, 4–7°C during summer and 3.5–6°C during fall. Precipitation amounts may be reduced by 10 to 30% in the wet season (October–April), 10 to 40% in the dry season (May–September) and 10 to 40% annually.

Another study conducted by El-Samra et al. (2017 & 2018) using downscaling simulations at high spatial resolution (3km x 3km) was performed using the Weather Research and Forecasting model to generate future climate projections of annual and seasonal temperature and precipitation changes over the Eastern Mediterranean (with a focus on Lebanon) for the period 2001-2050. The model was driven with the High-Resolution Atmospheric Model, running over the whole globe at a resolution of 25km, under the conditions of two RCPs (4.5 and 8.5). The potential impacts of CC on the production of silage maize in central inland regions were also investigated.

Climate projections for temperature changes (Figure 9-6) indicators are as follows:

- For RCP 4.5: temperature decreases in winter (1.3°C) and spring (1.4°C) and increases on average in summer (1.5°C) and autumn (2.5°C);
- For RCP 8.5: temperature decreases on average in the winter (0.63°C) and spring (0.94°C) and increases on average in summer (1.2°C) and autumn (2.2°C);
- Maximum temperature will increase: RCP4.5: on average 1% (coast) and 13% (central inland); RCP8.5: on average 5% (coast) and 15% (central inland);
- Summer days (Tmax>25°C): Mountains have the highest increase with more than 80 days (increase of 98% in RCP4.5 and 82% in RCP8.5);
- Consecutive Summer Days (Tmax>25°C) could double in the central inland region, and triple for the mountainous region in both RCPs;
- Percent of very warm days: Most vulnerable region is the central inland zone where this index increases by 25% in RCP4.5 and 21% in RCP8.5;
- Minimum temperatures are projected to decrease across all regions and more pronounced in RCP4.5 than RCP8.5;
- Number of Consecutive Frost Days in RCP4.5 would increase by over two folds in all regions;

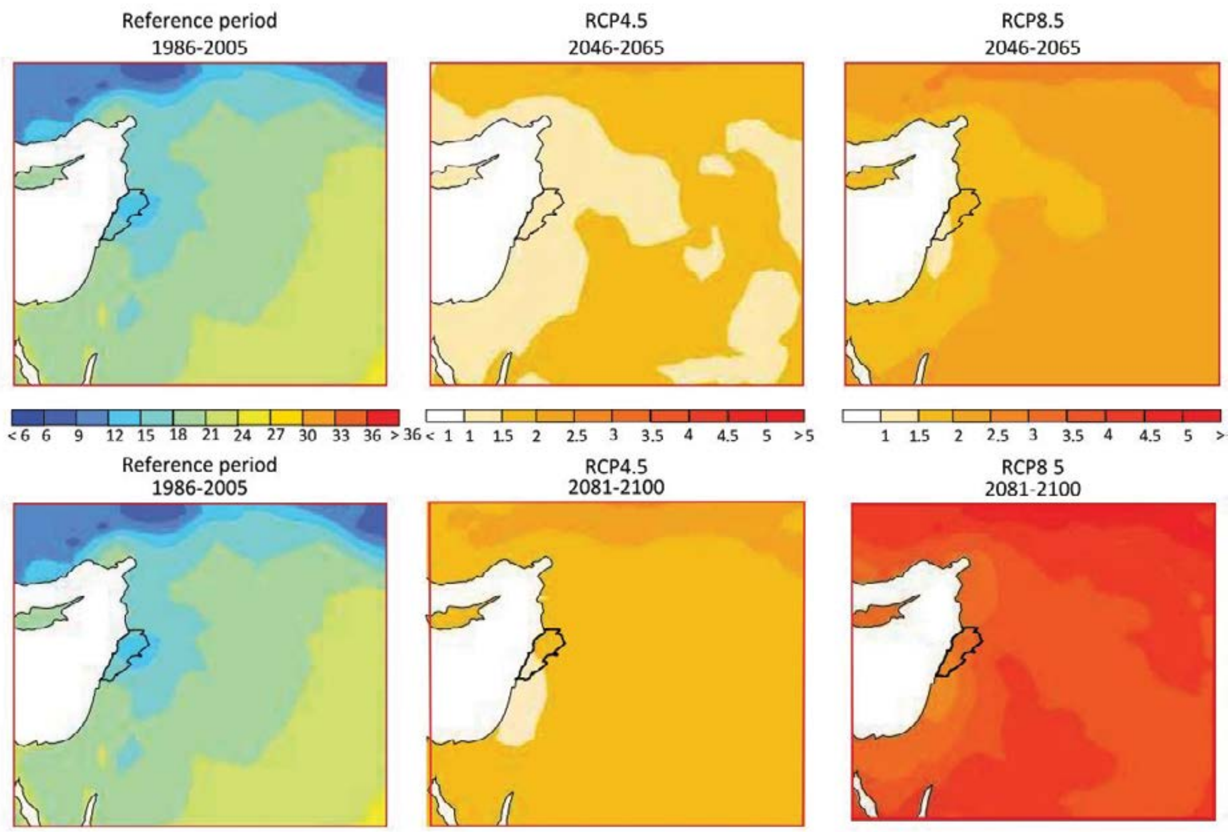


Figure 9-6 Projected Changes in Temperature (Moderate Projection)
Source: MoE/UNDP/GEF, 2016

- A 50% reduction in snowfall by mid-century in the mountains in both RCPs.

Projections related to precipitation (Figure 9-7) are as follows (El-Samra et al., 2018):

- Both RCPs produce a decrease in rainfall over the coastal zone (between 12 and 30%);
- Rainfall in the mountainous areas is expected to decrease by approximately 16 to 33% in RCP4.5, and 14 to 24% in RCP8.5;
- Most notable changes are projected for the inland regions, especially in the northern area (15 to 54% decrease in rainfall);
- Decrease in rainfall is more pronounced in RCP4.5 (–35%) than in RCP8.5 (–29%)
- Heavy precipitation days (rainfall ≥ 20 mm) (in RCP8.5 larger than in RCP4.5) along the coast and in the mountains;
- Consecutive Dry Days: increase up to 75% in mountains;
- Consecutive Wet Days: decrease of over 50% in northern inland region.

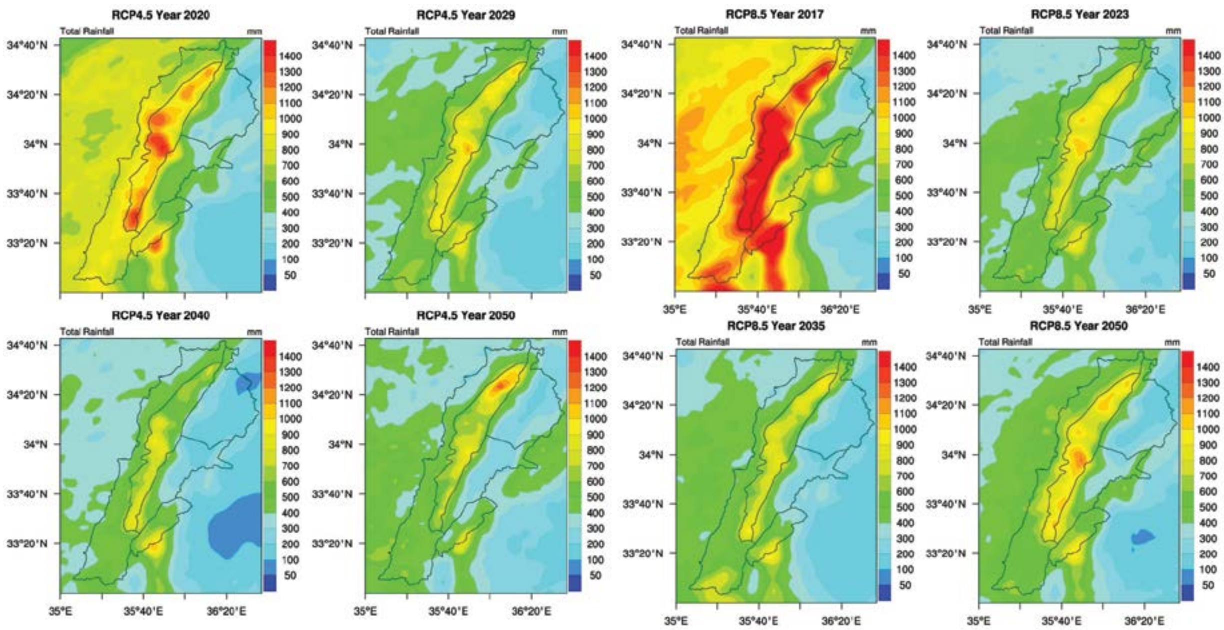


Figure 9-7 RCP4.5 (Left) and RCP 8.5 (Right) Accumulated Rainy Season Rainfall (mm)
Source: El-Samra et al., 2018

9.2.2 Impacts of Climate Change in Lebanon

Lebanon has a diverse natural environment including coastal, agricultural, forest and mountainous areas, many of which have unique biodiversity and ecosystems that are sensitive to CC (NDC, 2015). The land structure consists of high sloping and steep lands, which are prone to water erosion causing loss of top-soil and the capacity to retain water. Degraded sandy soils contribute to dust and sand storms, which are hazardous to humans and livestock (World Bank, 2018a).

Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity (IPCC, 2013). Readiness measures a country's ability to leverage investments and convert them to adaptation actions by looking at the country's economic, governance and social readiness. Globally, relative to other countries, Lebanon's current vulnerability ranking is 105 out of 181 and placed as 136th least ready country to adapt to future climate challenges (ND-GAIN, 2017).

Lebanon's vulnerability to climate change manifests in the following trends (World Bank, 2018a):

- The country experiences 1 to 2 cases of flooding annually, a number that is likely to rise with CC. Flooding is mainly caused by irregularities in rainfall patterns (Figure 9-8);
- Heavy rains measure up to 100 mm per hour during storm events causing damage to property and agricultural lands, and often set off landslides that deposit solid waste into the Mediterranean Sea;
- About 10% of the Lebanese population is susceptible to drought. Increased surface runoff coupled with reduced precipitation is likely to increase with rising temperatures, leading to increased drought severity;
- In the recent past, Lebanon experienced deviation in rainfall patterns, which has been attributed to increasing temperatures. Changes in rainfall patterns are affecting the frequency of intense rainfall events and altering catchments and drainage basins. Increased winter rainfalls lead to destructive flooding;
- Fire-prone areas in Lebanon include woodland/forests in rural and mountain areas; however, plantations and natural forests near urban areas are highly susceptible and pose risks to populations given the high rate of urbanization.

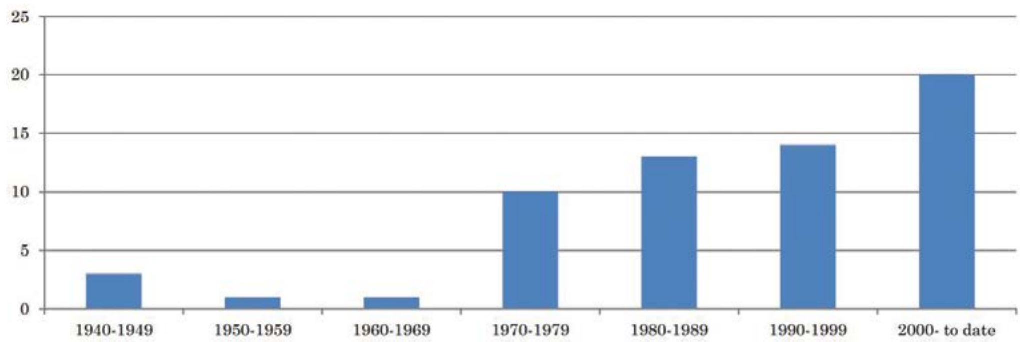


Figure 9-8 Number of Major Flooding Events in Lebanon in the Last 7 Decades
Source: Awad, 2013

The implications of CC will continue to manifest by (adapted from World Bank, 2018a):

- Increased temperature and drier conditions which may increase the severity and intensity of fires. Forest fires already constitute over half the incidents of natural disasters in the country (Figure 9-9);
- Increased temperatures and evapotranspiration coupled with declining, but increasingly erratic rainfall, which may lead to more severe drought conditions;
- Depletion of groundwater supplies due to drier conditions that are currently under pressure from extraction for agriculture and industrial activities.

Another study found that the climate regime shifts have altered Lake Qaroun's ecosystem. In the past, Lake Qaroun was characterized by a highly diversified microflora dominated by diatoms and green algae. Recent climatic fluctuations, with culmination in 2008–2011 and temperatures exceeding 40°C have upset this biodiversity (Slim et al., 2013). Box 9-2 presents projected impacts of climate change on certain sectors in Lebanon according to the Third NC to the UNFCCC.

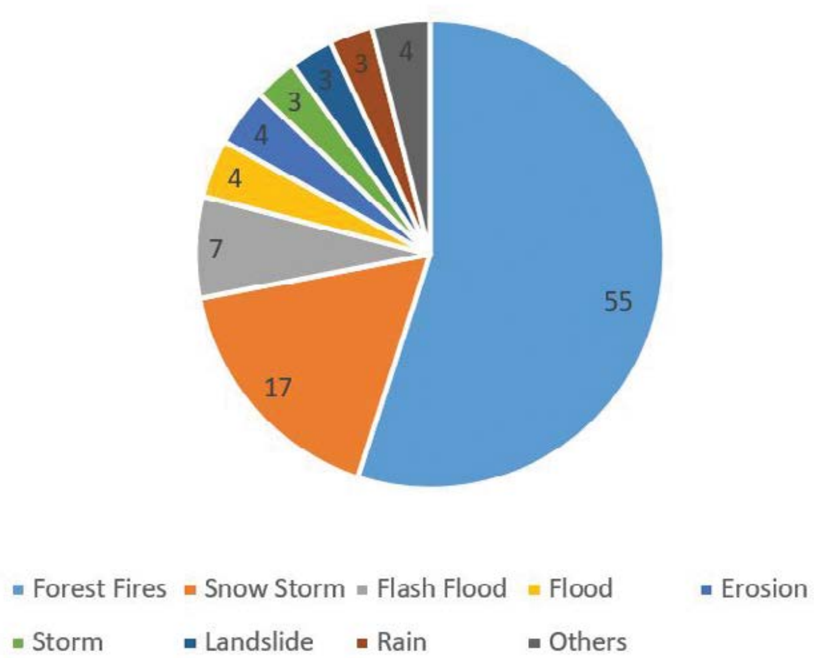


Figure 9-9 Types and Frequency of Natural Disasters in Lebanon
Source: UNISDR, 2017

Box 9-2 Sectoral Impacts of Climate Change for Lebanon

Less Snow: Less snow will fall, shifting from 1,500 m to 1,700 m by 2050 and to 1,900 m by 2090.

Less water availability: Snow will melt earlier in spring, affecting the recharge of most springs, reduce the supply of water available for irrigation during the summer, and increase winter floods by up to 30%.

Increase drought period: Droughts will occur 15 days to 1 month earlier, and countrywide drought periods will extend 9 days longer by 2040 and 18 days longer by 2090.

Less agriculture productivity: Soil moisture will decline in response to higher temperatures, reduced precipitation, and higher evapotranspiration. Changes in temperature and rainfall will decrease productivity of lands currently used to produce most crops and fruit trees.

Higher energy demand: Higher temperatures in summer will increase demand for cooling, with related consumption of electricity.

Weakened tourism: Winter outdoor tourism will diminish as warmer temperatures and reduced precipitation shorten the skiing season.

Sea level rise: The higher sea levels will lead to seawater intrusion into aquifers, increase the risk of coastal flooding and inundation, increase coastal erosion, cover sand beaches, and alter coastal ecosystems in natural reserves and elsewhere.

Forests at risk: Forests will be adversely affected, especially that they already suffer from fragmentation, pest outbreaks, forest fires and unsuitable practices.

Increased mortality and morbidity: Effects include outbreaks of infectious diseases from changing temperatures, increased morbidity and mortality from heat and other extreme weather events, malnutrition from droughts and floods and other water-borne, rodent-borne and vector-borne diseases.

Damaged infrastructure: Buildings and public infrastructure will suffer damage from changing patterns in precipitation, sea level rise, and increased frequency and intensity of storms (MoE/UNDP/GEF, 2016).

Other potential consequences of climate change resulting from shorter, more intense periods of rain and decreased precipitation rates, especially snow, include (Abdallah et al., 2018):

- Loss of drinking water stock;
- Reduced agricultural production due to water scarcity;
- Decreased soil fertility or erosion;
- Spread of pests and diseases including new types affecting crops.

This is expected to lead to a reduction in the quality of life, the level of income and loss or reduction in employment opportunities especially for agricultural workers (MoE/UNDP, 2011). Poverty-prone agricultural workers and their families are particularly at risk from loss of livelihoods due to drought or environmental stress. Children, mainly girls, might have to sacrifice their education and work to supplement the family income. Furthermore, because of the role they hold in the society, women and girls (as the main household managers) are particularly impacted by climate change as they are responsible for food production, hygiene, and children and elderly care. Consequently, climate change directly affects their lives by increasing the time they spend for water and energy management. Moreover, health related impacts of climate change can affect men and women differently because of the role women have in the household and the different environments they both work in.

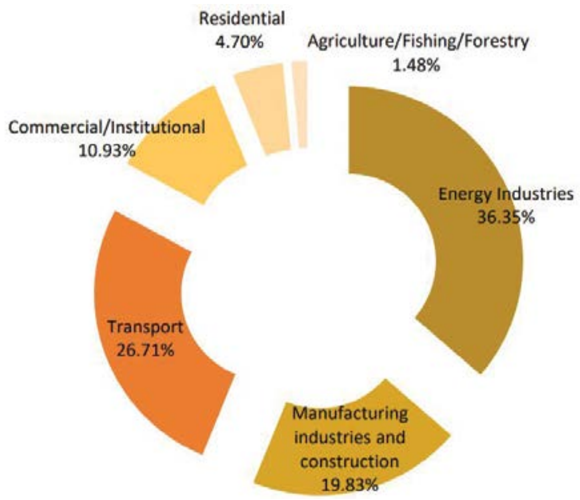
The Economic Costs to Lebanon from Climate Change report estimated the direct and indirect costs that Lebanon would experience in 2020, 2040 and 2080 from the cumulative effects of global GHG emissions between 2015 and each of the above-mentioned years under the IPCC's highest-emissions scenario (RCP8.5). According to the report, the direct economic damage of climate change will likely result from environmental disasters, habitat alterations, human health risks and industrial stresses, imposing a total cost on Lebanon of about USD 320 million in 2020, UDS 2,800 million in 2040 and USD 23,200 million in 2080. As for the indirect costs, these would occur as a result of slowing down of Lebanon's economic growth, thus reducing its GDP by around USD 1,600 million from 2015 till 2020, USD 14,100 million by 2040 and USD 115,700 million by 2080. As such, the expected total costs, direct and indirect, that global emissions would impose on Lebanon is estimated to be around USD 1,900 million in 2020, USD 16,900 million in 2040, and USD 138,900 million in 2080 (MoE/UNDP/GEF, 2015).

The study also estimated that the highest costs result from the increase in human health risks (death, illness or disability) from climate-related factors including heat stress, malnutrition, diarrhea, malaria, floods and cardiovascular disease (MoE/UNDP/GEF, 2015). Children in particular are highly vulnerable to some of the most severe effects, including heatwaves, droughts and floods. Changes in weather patterns can spread or intensify vector-borne diseases. Physical injuries from more intense storms can expose children to more infections, disability or even death. More intense heat waves severely affect children, especially infants. Health services and educational institutions are susceptible to damage from floods, storms and interrupted power supplies.

9.2.3 Lebanon's Contribution to GHG Emissions

Lebanon has produced three NC reports, submitted in 1999, 2011 and 2016, and three Biennial Update Reports (BUR), submitted in 2015, 2017 and 2019, each containing a national GHG inventory as required by UNFCCC. The last GHG inventory, reported in Lebanon's 3rd BUR, covers a time series from 1994 to 2015 and compiled using the IPCC software version 2.54 (MoE/UNDP/GEF, 2019).

In 2015, Lebanon contributed about 0.062% of global GHG emissions (CAIT, 2016). A total of 27,107 Gg CO_2eq was emitted with the most significant GHG being CO_2, primarily produced from the burning of fossil fuels, while 3,311 Gg CO_2 was removed from forestry and land use change, bringing Lebanon's net emissions to 23,796 Gg CO_2eq. An estimated 99.09% of the emissions from the energy sector were CO_2, 0.27% CH_4 and 0.64% N_2O. Figure 9-10 shows the contributions of the energy consuming sectors by Lebanon and globally. Electricity generation from public power plants is the main fuel consumer, responsible for 36.35% of the sector's emissions, followed by transport (26.71%), manufacturing industries (19.83%) and commercial/institutional sector (17.11%) (MoE/UNDP/GEF, 2015a, MoE/UNDP/GEF, 2019). Figure 9-11 shows the trend of increase in total GHG emissions, which closely follows the trend of emissions from the energy sector, which includes



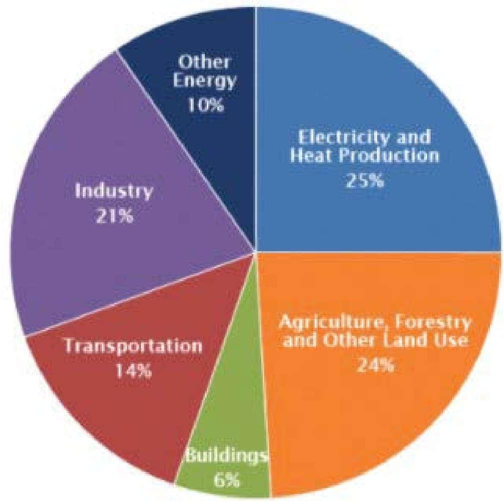


Figure 9-10 Contribution of Energy Emission Sources to the Sector's Total (Left) Lebanon for 2015, (Right) Globally for 2010
Source: MoE/UNDP/GEF, 2019 for Lebanon; IPCC, 2013 for Global

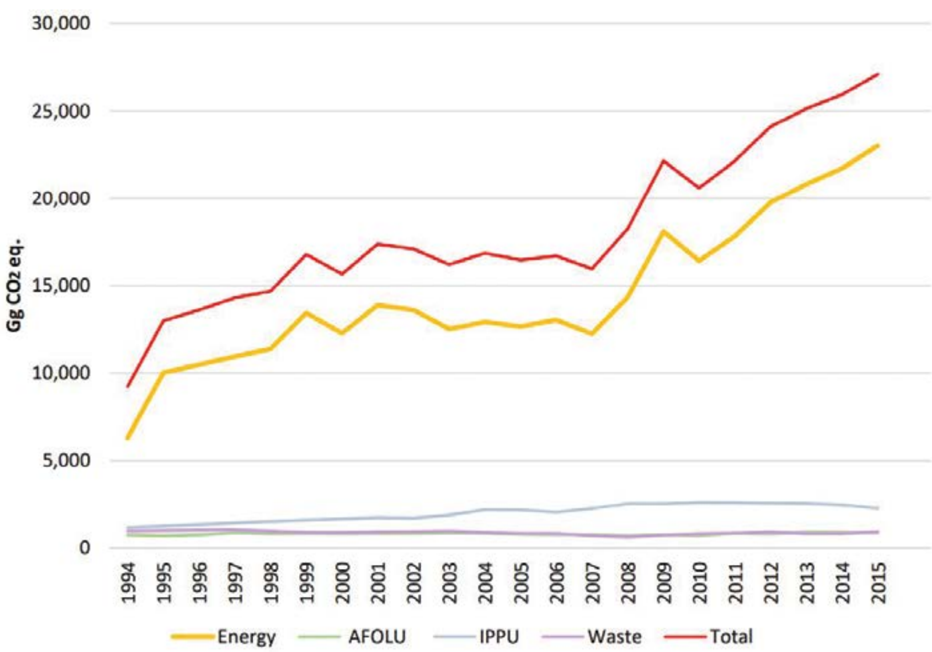


Figure 9-11 Trend in Total and Sectoral GHG Emissions 1994-2015
Source: MoE/UNDP/GEF, 2019

power generation and transport. This sector contributes to 85% of Lebanon's GHG emissions. Over the period 1994-2015, total GHG emissions increased by approximately 3-fold. This significant growth in emissions reflects the growing demand for electricity, due in part to the changing socio-economic conditions and to the expansion of the national grid. In fact, the increase noticed between the 1994 and 2000 emissions is due to the increase in GDO consumption that accompanied the installation and operation of 4 thermal diesel power plants (Baalbeck, Tyre, Beddawi and Zahrani) during this period (MoE/UNDP/GEF, 2019).

9.2.4 Energy Consumption and Supply

Energy fuels communities' access to water, to social services like health and education, to transport and communication needs, and is critical for regenerating livelihoods and local economies. That is why a country should target an energy mix that sustains its supply. During the period 2010-2017, the composition of Lebanon's energy mix did not undergo fundamental changes except for the increase in demand for oil and the introduction of renewables (mainly solar) into the market (Figure 9-12) (IEA, 2019).

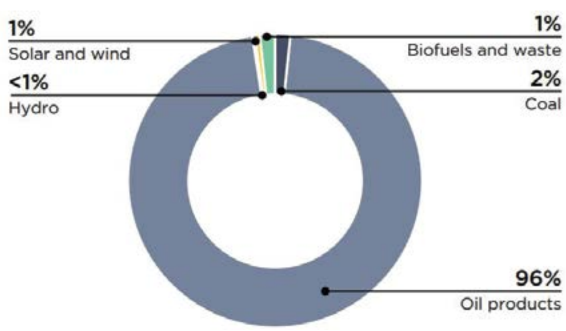


Figure 9-12 Total Primary Energy Supply by Source (%)
Source: IEA, 2019

9.2.4.1 Fuel Consumption

Lebanon is currently one of the only countries in the region with no fuel refining capacity, and consequently dependent entirely on imported fuel sources (UNDP/MoEW/LPA/ILF, 2016). Imported energy is primarily in the form of oil products, and secondarily as electricity. This energy is exploited in two ways: 1) as fuel for transport and, to a lesser extent, for domestic heating; and 2) it is turned into electricity, either by the public utility in charge of thermal power plants or by private generators, which are poorly identified in the statistics (refer to Section 9.2.4.3 – Informal Sector). In 2018, the total primary energy supply for Lebanon was 8,617 Kiloton Oil Equivalent (ktoe) (Figure 9-13) (MoEW / LCEC / IRENA, 2020).

The sharp increase in demand for oil started in 2011. This coincides with the Syrian crisis with increasing numbers of displaced arriving each year. The current exact number of Syrians displaced to Lebanon is not known, but it has been estimated to have reached 1.5 million at some point during the crisis (LCRP, 2019), with 892,310 displaced registered with the United Nations Human Commissioner for Refugees (UNHCR, 2020). A large number of the displaced population live in camps, increasing demand for energy and oil and thus stress on the already vulnerable energy sector (LCRP, 2019). Another cause to the increase in oil demand may also be smuggling of highly subsidized oil to neighboring countries, which is currently under investigation.

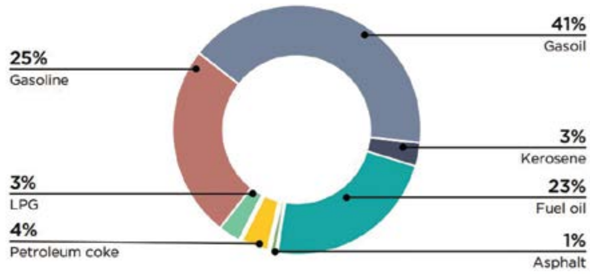


Figure 9-13 Primary Energy Mix for Lebanon in 2018 (TOE, %)
Source: MoEW / LCEC / IRENA, 2020

Since the Lebanese energy sector was weak, inefficient and unable to meet the electricity demand even before the crisis, this massive and abrupt increase in demand caused more frequent power cuts and aggravated the quality of power supply, forcing people to rely on expensive, inefficient and polluting private diesel generators.

A considerable share of the fuel oil imported by MoEW goes to EDL, while another minor quantity goes to the local market (mainly used in industries). As for liquid gas, octane, gasoline, kerosene, diesel oil and asphalt, their destination is the local market (MoEW/LCEC, 2016a).

Fuel expenses for power generation and thermal use account for 3.5% of the country's GDP (World Bank, 2019a). With the electricity tariff being subsidized (9.5 cents for each kWh consumed, while the cost of generation is around 20 cents/kWh, much less at the current parallel market exchange rate), these expenses contribute to the country's national debt through the financial deficit of EDL, which reached US$2.6 billion in 2018 (World Bank, 2020b). The situation is expected to worsen considerably since the financial crash and currency devaluation of 2019.

9.2.4.2 Oil and Gas Sector

In 2010, the U.S. Geological Survey estimated the undiscovered oil and gas resources of the Levant Basin Province to be around 1.7 billion barrels of recoverable oil and 122 trillion cubic feet of recoverable gas (USGS, 2010). The geological survey implies that Lebanon may have oil and gas within its maritime domain. Moreover, Lebanon is well positioned to export natural gas to neighboring countries.

A total of ten offshore drilling and exploration blocks have been defined within Lebanon's exclusive economic zone (LPA, 2015). In December 2017, the Lebanese government approved a bid presented by a consortium of three companies to start oil and gas exploration. As a result, the French Total (40% of the consortium), the Italian ENI (40% of the consortium) and the Russian Novatek (20% of the consortium) have been granted exclusive licenses to start the exploration of oil and gas in Lebanon (Total, 2018). The consortium received the rights to explore oil and gas in two out of ten maritime blocks (4 and 9) (Figure 9-14) and the profits are to be shared between the consortium and the state (LPA, 2015).

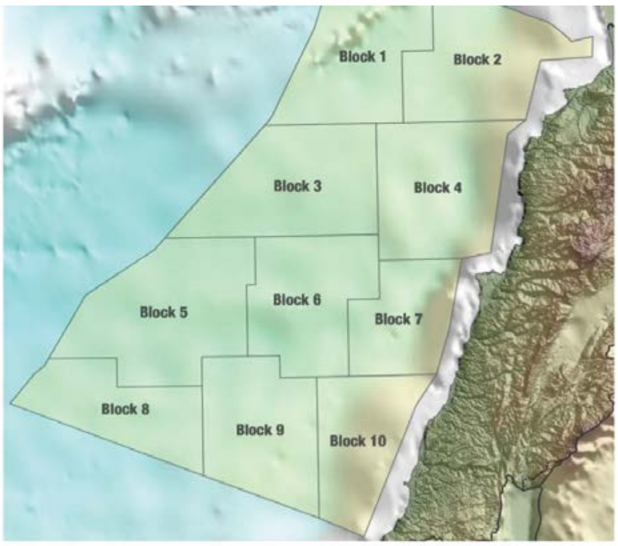


Figure 9-14 The Ten Oil and Gas Maritime Blocks
Source: LPA/EU, 2020

In February 2020, the update of the Strategic Environmental Assessment (SEA) for exploration and production (E&P) activities for offshore petroleum resources in Lebanon was published by the Lebanese Petroleum Administration (LPA). The SEA aimed to ensure that environmental impacts and their sources are identified, and that effective measures to manage these impacts are in place early on prior to the start of petroleum activities. Box 9-3 presents the relevant findings and recommendations of this SEA.

Box 9-3 Findings and Recommendations of SEA for Offshore E&P in relation to Climate Change

Based on the SEA results, offshore E&P activities are not expected to compromise Lebanon's commitments in terms of GHG emission reductions, except under one of the scenarios considered (the High Development Scenario) and depending on actual export rates and export modality (via pipelines or using Liquified Natural Gas), for which development options would significantly increase Lebanon's GHG emissions and negatively affect Lebanon's commitments towards emission reductions unless they could be further offset. Mitigation measures to reduce impacts from E&P activities on climate change include:

- MoEW/LPA, in coordination with MoE, should strictly enforce Offshore Petroleum Resources Law and Petroleum Activities Regulations provisions related to flaring and venting.
- Implementation of the Paris Agreement.
- Operators should offset a portion of their emissions during production (15% is recommended as a minimum, in line with NDC commitments)(which now needs to increase to 20% with the 2020 NDC update targets); such offset could be done by directly financing renewable energy projects and energy efficiency initiatives, reforestation (or enhancement of carbon sinks) and/or contributing in local funds, such as the Banque du Liban (BDL) scheme of National Energy Efficiency and Renewable Energy Action (NEEREA) or any subsequent similar frameworks, including the National Fund for the Environment or the Lebanon Green Investment Facility or any combination of the above; if development plans lead to excessive GHG emissions negatively affecting Lebanon's national commitments, then offset plans should compensate the additional emissions in a way to ensure meeting the unconditional emissions reduction targets set by the government
- Consider introduction of renewable energy technologies in exploration and production activities.
- GHG emissions reduction demonstrations are mandatory as part of EIA studies (demonstrating that GHG emissions were reduced to the maximum extent possible before incremental emissions reduction costs become excessive)
- GHG emissions should be mandatorily reported by Operators on the longer term, and as production fields become available, carbon capture and sequestration initiatives should be considered as part of development and production plans (LPA/EU, 2020).

As per an international tender, and after conducting the necessary Environmental Impact Assessment (EIA), the consortium contracted Tungsten Explorer drillship to start the drilling activity in Block 4. The drillship reached Lebanese waters on 25 February 2020. Drilling of the first exploration well on Block 4 was completed on 26 April 2020 and the consortium is planning to drill its first exploratory well in

Block 9 in 2021. Traces of gas were observed confirming the presence of a hydrocarbon system, but no reservoirs were encountered. Based on the data acquired during drilling, studies will be conducted to understand the results and further evaluate the exploration potential of the Total operated consortium blocks and the Lebanese offshore (Total, 2020).

9.2.4.3 Electricity Sector

Access to a reliable and continuous supply of electricity is essential to all economic activities. Vital services depend on this supply and therefore have an impact on the lives of children and vulnerable populations. In the health sector, a stable electricity supply is necessary to ensure proper functioning of life-saving medical equipment in health facilities including vaccine refrigerators. Similarly, school children and the elderly are impacted by poor energy supplies leading to insufficient heating in winter and limited cooling in summer, just as projections warn of increasing risk of heat stress. Health and education institutions now rely on backup generators which increase the costs to already stretched budgets. In Lebanon, ensuring such access has remained elusive, with electricity generation and supply divided between the formal and non-formal sectors.

Formal Sector

Currently, EDL controls over 90% of the Lebanese electricity sector (including the Qadisha concession in North Lebanon). Other participants in the sector include hydroelectric power plants owned by the Litani River Authority and concessions for hydroelectric power plants such as Nahr Ibrahim and Al Bared (Table 9-4). The sector also includes distribution concessions in Zahle, Jbeil and Bhamdoun (EDL, 2019). Since the end of the Civil War in the early 1990s, Lebanon has never enjoyed a reliable power supply. Recent figures show that electricity

Table 9-4 Generation Capacity in MW of Existing Power Plants

Name of the Facility	Fuel Type	Installed Capacity (MW)	Effective Capacity 2018(MW)
Existing EDL			
Zouk 1 Thermal Power Plant	HFO	607	440
Jieh 1 Thermal Power Plant	HFO	343	180
Zouk 2 ICE Power Plant	HFO/NG-Z	198	157
Jieh 2 ICE Power Plant	HFO/NG-J	78	63
Zahrani I CCPP	DO/NG-ZAH	469	420
Deir Ammar I CCPP	DO/NG-DA	464	430
Baalbeck Open Cycle GT	DO	64	57
Tyr Open Cycle GT	DO	72	56
Richmaya-Safa Hydro	-	13	3
Naameh (Landfill Gas)	-	7	7
Existing Barges			
Power Barge Zouk	HFO/NG-Z	187	195
Power Barge Jieh	HFO/NG-J	187	195
Existing IPP's			
Litani Hydro	-	199	47
Nahr Ibrahim Hydro	-	32	17
Bared Hydro	-	17	6
Khadisha Hydro	-	21	15
Hrayche Thermal Power Plant	HFO	35	46
Power Wheeling			
Imports from Syria	Syria	276	69

ICE: Internal Combustion Engine, CCPP: Combined Cycle Power Plant, GT: Gas Turbine, HFO: Heavy Fuel Oil, NG: Natural Gas, DO: Diesel Oil
Source: MoEW, 2019

consumption per capita has grown at an average rate of 7% per year, whereas electricity generation has always lagged behind (Fardoun et al., 2012). More than 7.5% of electricity supply (1,116 GWh) has been imported from Syria and Egypt through the regional interconnection grid. As the Syrian war intensified in 2011, Lebanon became an energy island; electricity imports were disrupted and a substantial demand for electricity was provoked by the influx of Syrian displaced to Lebanon, leading to a wider electricity shortage.

Many factors contributed to the financial deficit, and hence lack of development in the power sector, of EDL including the freezing of the tariff at a level below the average cost of production, the operation of old power plants having low efficiencies and high operating costs, 16% technical losses, 21% non-technical losses and the burden of the displaced Syrians (See Box 9-4).

Box 9-4 Additional Energy Needs for Syrian Displaced
The yearly consumption of Syrian displaced households has been estimated at 2,013 GWh/year– an average power consumption of 428 MW, or an equivalent capacity that should be generated by EDL's existing power plants of 486 MW. As the average production cost is estimated at US¢13.5/kilowatt hour (US¢/kWh), and that fees are collected at a subsidized rate of 8.97 US¢/kWh, the cost of providing an additional 486 MW by the national utility was US$ 313 million in 2016, leading to an estimated deficit of $222 million per year. These losses are covered by the Government of Lebanon (GoL), which already lacks the means to cover its subsidies to the sector. In addition, this increased demand on the public power sector is depriving resident customers from 5 additional hours of supply at peak times. Its cost on households has been estimated at US$ 150 million annually in private generator bills (LCRP, 2019).

Approximately 45% of EDL's electricity bills are not collected, which not only implies loss of revenue for the Government and EDL, but also incurs technical losses and damages on the grid where illegally connections are made (Figure 9-15) (MoEW, 2019).

Figure 9-15 Illegal Connections to the Power Grid
Photo Credit: BBC

In 2010, the GoL recognized the critical need to the tackle the challenges in the energy sector by endorsing a Policy Paper in June 2010 (MoEW, 2010). As a result, several projects to increase electricity supply were initiated (LCRP, 2019). These included adding 715 MW to the national grid through renting power barges (380 MW) (Figure 9-16), annexing two new power plants in Zouk and Jiyeh to the existing ones (272 MW) and upgrading Deir Ammar and Zahrani power plants (63 MW). The plan for the heavy fuel oil (HFO) conditioning of the Zouk power plant has been cancelled while construction of the Deir Amar Plant (DACCPP II 539.2 MW- HFO) is still in process and it is expected to enter in service in 2021 (MoE/UNDP/GEF, 2019).

Figure 9-16 Fatmagul Power Ship at Jiyeh Power Plant
Photo Credit: Karpower

In addition, three Gas Insulated Switchgears (220 kV) were installed in Dahieh, Achrafieh and Bahsas in Beirut, 6 new transformers (70MVA) were added in existing substations in Deir Nbouh, Deir Ammar, Zouk, Bsalim, Zahrani and Sour and capacitor banks have been added inside remote substations to sustain the level of voltage in Nabatieh (Nabatieh caza), Sultanieh (Bint Jbeil caza), Labiue (Baalbek caza), Hermel (Hermel caza), Qobayyat (Akkar caza). An overhead transmission line 66 kV double circuit from Dear Nbouh to Baalbeck was also installed.

The increase of total energy production became tangible at the end of years 2017 and 2018 when installation of the new infrastructure had been completed and operation commenced. Till year 2019, EDL has 2,950 MW of installed capacity (not necessarily generated) available at peak supply, which is almost 90 percent of the current peak national demand of 3,562 MW (MoEW, 2019). In addition to simply having insufficient installed generating capacity, the efficiency of the existing system is below normal levels due to poor maintenance, deterioration of facilities, high losses and the need for reinforcement of the transmission network (LCRP, 2019).

In terms of GHG emissions, public power plants in Lebanon emitted on average 666 tonnes CO_2eq. per GWh produced in 2015 (MoE/UNDP/GEF, 2019). It is estimated that the Zouk (Caza Mount Lebanon), Zahrani (Caza Saida), and Deir Aamar (Caza Minieh-Danniyeh) power plants are the highest emitters of GHG, given that they are the largest power plants in terms of capacity, electricity generation and fuel consumption. However, the Hrayche (Caza Koura) and Tyre (Caza Tyre) power plants are considered the most polluting installations, with the lowest operational efficiency and the highest emission intensity, generating around 1,000 tonnes CO_2eq per GWh of electricity produced (Figure 9-17) (MoE/UNDP/GEF, 2015a, MoE/UNDP/GEF, 2019).

(known as energy not supplied (ENS)) is being met by private generators. Therefore, it is estimated that, in 2015, private generators supplied 6,296 GWh of electricity (whereby supply was 12,237 GWh and demand 20,368 GWh) (MoE/UNDP/GEF, 2019).

In 2010, a comparative analysis on the quantity of GDO that is considered to have been consumed by private generation of electricity was conducted. The quantity is assumed to be 732,862 tonnes or 877,679,042 litres based on a density of 0.835 kg/l. Based on a generic efficiency of diesel generators of 3.33 kilowatt-hours (kWh)/l, the consumed quantity of diesel would have resulted in a total of 2,950 GWh private electricity generation (MoEW/LCEC, 2016b).

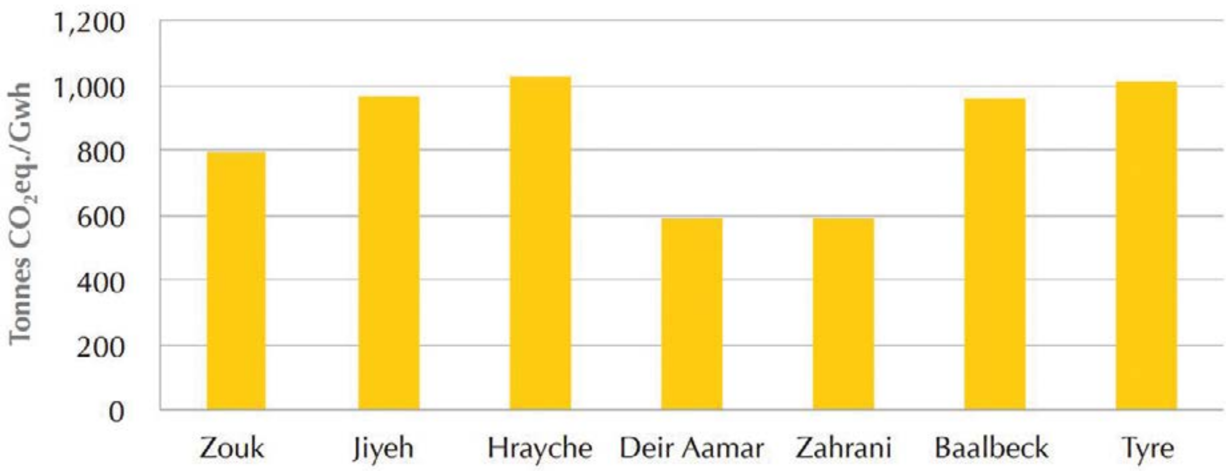


Figure 9-17 Emission Intensity of Thermal Power Plants
Source: MoE/UNDP/GEF, 2015a

Informal Sector

Lebanese citizens suffer daily power cuts such that without a generator, daily power cuts vary from three hours in Beirut to 18 hours in some rural areas. Lebanese consumers pay an additional cost of US$ 1 billion per year for private generators to partially satisfy their energy needs (MoEW, 2019). The state has long tried with various successes to regulate the generator industry and shield consumers from exploitation by making generator owners install meters that charge subscribers based on their energy consumption (Refer to Section 9.3.2.3 - Informal Sector for more details).

Unfortunately, no data is available on the number, capacity or quantity of fuel consumption, and thus power supplied by private generators in the country. Therefore, based on an estimate agreed upon between MoEW, EDL, private distributers of fuel and generator owners, it is assumed that 80% of the gap between public electricity supply and demand

9.2.4.4 Renewable Energy Sector

In 2018, the total installed renewable energy power capacity in Lebanon amounted to 350MW including 286MW from hydropower sources, 7MW from landfill and 56.37MW from solar power (MoEW / LCEC / IRENA, 2020). RE contribution to total power production in Lebanon is estimated at between 4% and 6% mainly through hydropower (Moore and Collins, 2020).

The cumulative installed decentralized small-scale solar photovoltaic (PV) capacity grew by the rate of 89% per year from 2010 until 2019, reaching a total of 78.65 MWp installed capacity, with a total investments value of US$ 125.83 million, and contributing in 0.73% of the total annual electricity generated by EDL (MoEW/LCEC, 2021). Box 9-5 presents information on the RE projects that were implemented in the country in the last decade (Additional details can be found in Section 9.4.2).

Box 9-5 Selected Renewable Energy Facilities

Solar PV public projects implemented by MOEW:

- 2,600 solar public street lighting systems (MoEW/LCEC, 2016b)
- Chinese Government grant of 500 solar public street lighting systems (MoEW/LCEC, 2016b).
- The Beirut River Solar Snake Project (BRSS) (1.08 MWp) (connected to the Lebanese national grid since September 2015) (MoEW/LCEC, 2016b)
- Ministry of Economy and Trade – Wheat Silos – Beirut Port (220 kWp) (MoEW/LCEC, 2021) (noting this has been destroyed with the port explosion)
- Casino du Liban – Jounieh (309 kWp) (MoEW/LCEC, 2021)
- Al Zahrani Oil Installations Project (1.09 MWp) (MoEW/LCEC, 2021)
- The MOEW Rooftop (135.30 kWp) (MoEW/LCEC, 2021)
- Directorate of Engineering and Planning - Lebanese Armed Forces (155.70 kWp) (MoEW/LCEC, 2021)
- El Helou Barrack (32.30 kWp) (MoEW/LCEC, 2021)
- Lebanese Army Health Dispensary of Qobbeh (54.40 kWp) and Ablah (54.40 kWp) (MoEW/LCEC, 2021)

Solar PV public projects implemented by CDR:

- 11 solar water pumping sites in Union of Baalbek Municipalities – total of 1.4 MWp (MoEW/LCEC, 2021)
- Solar street lighting in three Unions of Municipalities in the Bekaa – 800 PV street lighting poles (MoEW/LCEC, 2021)

Solar PV projects implemented by the Ministry of Public Works and Transportation (MoPWT)

- 500 solar public street lighting systems (MoEW/LCEC, 2016b)

Solar panels and SWHs implemented by MoE

- Installation of 1,640m2 of solar panels and 66 SWHs in public buildings throughout Lebanon - Climate Change Mitigation Project funded by the Italian Government

Facilities installed by the UNDP Community Energy Efficiency and Renewable Energy Demonstration (CEDRO) can be found in Section 9.3.3.3.

In addition, there is noted use of solid biomass for heating but information is not available in order to quantify it (UN/ESCWA, 2019). Naameh landfill 7MW biogas power plant is connected to a local grid and started operations in October 2018 (UN/ESCWA, 2019).

As for wind energy, which is yet to be used in Lebanon, the government signed three Power Purchase Agreements with private developers for the installation of three wind farms in the northern and mountainous district of Akkar with a total capacity of 227 MW (UNDP, 2019a). This project is on hold due to the current economic uncertainties in the country.

The main barrier to full deployment of RE technologies is the low and not cost-reflective electricity tariffs because of the long amortization period. EDL cannot increase the tariffs until infrastructure and the grid are reliable, but, at the same time, EDL does not have the finances to improve the system's reliability (UNDP/CEDRO, 2019). Nevertheless, a market for renewable energy exists in Lebanon as by 2020, at least 59 companies were found to be delivering services in the field of RE and EE, which had been rising since the 1990s, but slowing down in the last three years. This growth was concurrent with the launch of several UN-funded initiatives, the green loan support program offered by the BDL, in cooperation with the MoEW and the Lebanon Center for Energy Conservation (LCEC) solar water heaters support program, which is the National Energy Efficiency and Renewable Energy Action (NEEREA). This indicates that without financial support programs, the demand for RE remains low (EU-UNDP/CEDRO, 2020).

Other drawbacks include the fact that energy generation from fossil-fuel is mostly dependent on its availability while energy output from a solar panel can drop due to presence of clouds. Similarly, wind speeds cannot be reliably forecasted.

As EDL will be the main customer for all large-scale RE projects, their financial deficit and bankability problems increase the risk of investment. In addition, there is no dedicated department within EDL for incorporating RE into the national grid and no grid codes exist internationally that could be adopted (UN/ESCWA, 2018).

Another constraint to a RE transition for Lebanon is the vested interest throughout the economy in oil imports and the entrenched nature and power of the private generator owners. This gives these lobbies power and influence over lawmakers in an already fraught political sphere (World Bank, 2019b).

Although implementation of several RE projects has been successful, the country also faces a significant challenge regarding the sustainability of such projects mainly due to the operation and maintenance (O&M) costs that are not always feasible for the operator. For example, for the development of a typical 50 MW solar PV project, the highest labour requirements are in O&M (56% of 230,000 person-days). For the development of a 50 MW onshore wind project, 144 000 person-days will be needed, 43% of which for are for O&M (MoEW/LCEC/IRENA, 2020). As a result, and due to the current low cost of nonrenewable energy mentioned earlier, RE projects can only be sustainable if O&M costs are included in the project budget such that the energy service provider and beneficiary are engaged throughout.

9.3 Legal Framework and Key Stakeholders

This section describes key stakeholders, regulations and policy related to the CC and energy sector. All laws and regulations related to climate change and energy in Lebanon are listed at the end of this chapter.

9.3.1 Multilateral Environmental Agreements

Lebanon is party to several multilateral environmental agreements related to CC and the energy sector. These include:

- UNFCCC, signed by Lebanon in 1992 and ratified by Law 359/1994, Kyoto Protocol, ratified by Law 738/2006, Paris Agreement, signed in 2016 and ratified by virtue of Law 115/2019 and Decree 5599/2019 (See Box 9-6 for provisions of Article 6 of this agreement).
- Montreal Protocol on Substances that Deplete the Ozone Layer ratified by Law 253/1993 and its six amendments, with the latest Kigali Amendment that impacts indirectly climate change *(Refer to Chapter 10 – Chemical Management Chapter for details on phasing out ODSs).*

In addition, in 2009, Lebanon signed the statue to become a member of the International Renewable Energy Agency (IRENA), which was ratified by Decree 620/2017.

Box 9-6 Mechanism and Approaches Established by Article 6 of the Paris Agreement

Article 6.4 of the Paris Agreement states that a mechanism to contribute to the mitigation of GHG emissions and support sustainable development has been established and aims to:

a) Promote the mitigation of GHG emissions while fostering sustainable development;

b) Incentivize and facilitate participation in the mitigation of GHG by public and private entities;

c) Contribute to the reduction of emission levels in the host Party, which will benefit from mitigation activities resulting in emission reductions that can also be used by another Party to fulfill its NDC; and

d) Deliver an overall mitigation in global emissions.

Article 6.8 states that Parties recognize the importance of integrated, holistic and balanced non-market approaches being available to Parties to assist in the implementation of their NDCs, in the context of sustainable development and poverty eradication, in a coordinated and effective manner, including through, inter alia, mitigation, adaptation, finance, technology transfer and capacity-building, as appropriate. These approaches shall aim to:

a) Promote mitigation and adaptation ambition;

b) Enhance public and private sector participation in the implementation of NDCs; and

c) Enable opportunities for coordination across instruments and relevant institutional arrangements.

9.3.2 Policy and Legislation

The sections below present the policies and legislation adopted by the GoL in order to improve the country's readiness for climate change impacts, reduce GHG emissions in line with its international commitments and regulating and improving the energy sector.

9.3.2.1 Mainstreaming Climate Change in National Plans and Strategies

The different sectoral policies that make up Lebanon's NDC and the Sustainable Development Goals (SDGs) share several common goals as well as target year (2030). In addition, many synergies exist between the two agendas and addressing those linkages from an integrated institutional viewpoint enhance the implementation, coordination and tracking of the different actions (MOE/GEF/UNDP, 2019). The linkage between the SDGs and Lebanon's NDC policies is presented in Figure 9-18.

Figure 9-18 Number of Main SDG linkages in Lebanon's NDC Policies
Source: MOE/GEF/UNDP, 2019

The sections below present efforts made by the GoL to mainstream climate change into national planning and legislation.

Transport

In 2014, the MoPWT presented to the Council of Ministers (CoM) the National Transport Policy, with a master plan to revitalize the land public transport for passengers. It encloses a set of actions to be implemented on the short and medium terms, shifting the passenger transport demand to mass transit systems. The main actions with direct impact on reducing GHG emissions include the development of a mass transit system covering territories all over Lebanon and commuting cities such as the Bus Rapid Transit on Beirut north and south gates, the implementation of the rail lane connecting the port of Tripoli to the Syrian border, the revitalization and restructuring of the operation of public buses inside cities and the improvement of pedestrian infrastructure.

In addition, a tax incentive scheme has been issued by the Government in the budget Law of 2018 79/2018 (Article 55) and renewed in 2019 (Law 144/2019 – Article 25.c) providing cuts on customs and registration fees for the purchase of hybrid and electric vehicles in Lebanon. As per the law, buyers pay only 20 percent customs for a hybrid vehicle for private use, and 10 percent for public use. Meanwhile, electric vehicles are be exempted from customs altogether. In addition, for both hybrids and EVs, taxi drivers do not pay registration nor the first Motor Vehicle Usage tax.

Agriculture, Forestry and Biodiversity

In an effort to increase climate resilience of the agricultural and forestry sector, the Ministry of Agriculture (MoA) introduced for the first time "Responding to climate change impacts" as one of the central courses of action for its 2015-2019 strategy. As such, the Ministry plans to assist the agricultural sector in many areas of intervention to better adapt to the impacts of climate change and to reduce its emissions, mainstream MoA activities related to climate change, introduce the adaptation measures through various implemented programmes, and conduct a study to estimate GHG emissions from the agricultural sector, land use changes and forestry. The strategy has been updated in 2020 and also included "Improving climate change adaptation and sustainable management of agrifood systems and natural resources" as a one of the five pillars of the strategy, hence renewing its commitment to enhance adaptation to climate change and sustainable management of natural resources, as well as increase the use of low carbon technologies and practices. This pillar includes four programmes as follows (1) increase climate change adaptation and encourage related private investment along the agrifood value chains, (2) promote sustainable use of natural resources (soil, pastures, forests and fisheries), (3) enhance the efficient use of irrigation water and expand the supply of water resources for irrigation, and (4) encourage and support the use of renewable energy in the agricultural sector.

Both strategies put forests and wooded lands at the center of climate change activities, highlighting the importance of forest conservation, reforestation and afforestation as a main source of carbon sequestration, calling for the enforcement of efficient pest management and common forest property and developing fire prevention and early warning systems. In addition, the MoA in partnership with the Food and Agriculture Organization launched in December 2012 a national initiative to plant 40 million forest trees for recovering lost forest areas in the last decade in compliance with the objectives of the National Reforestation Program. By increasing the green cover from 13% of Lebanon's total area (currently) to 20% over a period of 20 years, this program aims at both increasing the resilience of forests to the impacts of climate change and reducing national GHG emissions by creating additional carbon sinks.

Besides conserving forest trees and forest cover in the country, conservation of biodiversity is a key adaptation element to face the negative impacts of climate change on ecosystem services, including health, leisure, cultural heritage, tourism among others. The MoE has therefore updated its National Biodiversity Strategy and Action Plan for the period 2016-2030 as required under the Convention on Biological Diversity. Climate change was identified as one of the priority areas of the strategy with an overarching objective of developing and implementing adaptation plans for ecosystems vulnerable to climate change by 2030.

Public Health

A regional strategy on health and the environment and plan of action for the period 2014–2019 in the Eastern Mediterranean Region has been developed the World Health Organization and endorsed by the Lebanese Ministry of Public Health. The strategy calls for the development of health system response plans and projects taking into account the impacts of climate change and community vulnerabilities and their integration into the national health strategy.

Water Sector

The National Water Sector Strategy issued by the MoEW in 2010 and updated in 2020 takes into consideration the impacts of climate change on water availability and use and suggests measures to alleviate impacts and increase resilience of water infrastructure. The updated draft document includes a section on the impacts of climate change on water resources (Section III A.2), anticipating shorter rainy, higher rain intensity, reduced infiltration towards aquifers, reduced snowpack and increased evapotranspiration, which will lead to an increase in water demand for irrigation and domestic use. The updated strategy also calls for the establishment of a data management system to "improve the knowledge of global climate change impact on Lebanese water resources for better adaptation strategies". The 2020 NWSS proposes to the expand the existing hydrometric network and install snow monitoring stations to improve meteorological data collection and to track the impacts of climate change on hydrology.

In addition, a SEA was developed for the 2010 NWSS in 2015 identifying 12 key environmental, social, and economic issues potentially affected by the proposed water and wastewater projects, including climate change. A new SEA is planned for the 2020 NWSS update that will be developed based on the 2015 SEA and the 12 defined issues *(Refer to Chapter 3 – Water Resources for details).*

Air Quality

One of the goals of the 2015-2030 National Strategy for Air Quality Management is mainstreaming air quality management in priority sectors to ensure synergies with national climate change policies and plans through including air quality emissions in plans and projects related to climate change mitigation and adaptation.

Commercial, Institutional and Industrial Sectors

MoE Decision 99/1 of 2013 provides an incentive to the private sector including commercial, institutional and industrial enterprises to report to the MoE on a voluntary basis their GHG emissions and related activity data using a simple MS Excel-based tool. This scheme is developed along with an awareness raising method to encourage the private sector on GHG reporting culture and to provide a self-tracking tool to monitor their GHG emissions. Participants in this initiative receive a reporting certificate signed by the MoE.

9.3.2.2 National Adaptation Plan

Adaptation is increasingly recognized as an important response to CC. Key steps in adaptation actions are the assessment of current vulnerabilities to weather extremes and the adoption of gradual changes, determining how these vulnerabilities can be reduced in the context of trends and projected changes, and carrying out the actions required to achieve these goals. Lebanon has already set its adaptation priorities as part of the 2015 NDC and its 2020 update (Refer to Section 9.4.1). In 2017, the country initiated its National Adaptation Process Development to prepare an integrated and comprehensive National Adaptation Plan (NAP); however, no separate national adaptation strategy or plan currently exists in Lebanon.

9.3.2.3 Electricity Sector

Formal Sector

Law 462/2002 aims to restructure the electricity sector in Lebanon, increase the participation of the private sector and establish an independent regulatory authority, the National Electricity Regulatory Body. This law was amended in 2006 (Law 775), 2014 (Law 288) and 2015 (Law 54) empowering the CoM, upon joint recommendations from MoEW and the Ministry of Finance (MoF), to grant temporary permits and licenses to produce electricity pending implementation of Law 462.

The Policy Paper for the Electricity Sector was first developed in 2010 by the MoEW unanimously approved by the CoM in June 2010 (CoM Decision 1 dated 21/06/2010). The Policy Paper tackles the addition of generation capacity to cover the existing gaps and commits to meeting these additions through at least 12% RE. In an effort to reduce EDL's financial deficit and to benefit from international financial support to the energy sector, MoEW, with support from the World Bank, updated the Policy Paper in 2019. The 2019 Policy Paper consists of proposed solutions to be achieved in the short and long term, integrating the following:

- Reduction of the technical and non-technical losses from 34% at the beginning of 2019 to 12% at the end of 2021 through the implementation of the transmission and distribution initiatives and the resolution of the nontechnical losses.
- Increasing the generation capacity through improvement of the generation system in terms of efficiency and type of fuel used, replacement of old plants by new ones and the conversion to natural gas, and 30% renewable electricity.
- Increasing the tariff to cover the cost of generation, transmission and distribution including the expected additional generation for the next five years.

Informal Sector

The GoL has long tried to regulate the private generator industry, shield consumers from exploitation and manage energy demand by mandating the installation of meters that charge subscribers based on their energy consumption. With Decisions 135/1/ET of 28/7/2017, 100/1/ET of 6/6/2018 and 176/1/ET of 28/09/2018, the Ministry of Economy and Trade decreed that all generator owners must install consumption meters for their subscribers in a bid to end the practice of charging an expensive flat rate that has been in place since the 1975-1990 Lebanese Civil War. As of October 1st, 2018, the generator owner has no right to collect any upfront tariff from subscribers because the monthly tariff shall be in compliance with the kilowatt consumed according to the monthly tariff determined by the MoEW (MoET, 2018).

9.3.2.4 Oil and Gas

Issued by parliament in August 2010, the Offshore Petroleum Resources Law 132/2010 sets the pillars of the petroleum sector legislative framework. It requires the State to conduct a SEA for the sector before any petroleum rights are awarded or petroleum activities initiated (Article 7-Clause 2). This SEA was conducted in 2012 and updated in 2020 (Refer to Box 9-3 for findings and recommendations related to climate change). The law also obliges the operator to submit an EIA for any plan for development, production, transportation, storage or utilization of oil and gas (Article 32). Articles 54 to 60 provides the necessary framework for health, safety and environmental protection over which the MoE is in charge of supervising.

Petroleum Activities Regulations-Decree 10289/2013 is main decree that governs offshore petroleum activities. It details different phases licensing conditions and provisions as well as health, safety and environmental requirements. The decree sets regulations on requirements for SEAs and EIAs for the sector. Some of its articles are amended by Decree 1177/2017.

The Exploration and Production Agreement (EPA) - Annex 2 of Decree 43/2017: E&P rights are awarded through an EPA approved by the CoM and signed by the oil and gas company and the MoEW. The decree also states that an EIA is required for the various petroleum activities and decommissioning of facilities. In an effort to support the oil and gas sector, specific guidelines were developed by MoE and LPA in 2019, with support from the Norwegian Oil for Development Program, covering the entire EIA process from screening to MoE approval.

Strengthening Transparency in the Petroleum Sector Law No. 84/2018 is considered as a significant step forward reflecting Lebanon's intentions to strengthen transparency and accountability in the petroleum sector. However, provisions set by this law are not implemented yet and are awaiting the issuance of implementation decrees.

9.3.2.5 Energy Efficiency and Renewable Energy

The Draft Energy Conservation Law aims to promote energy efficiency (EE) and RE in Lebanon. This draft law provides a legal framework for energy audits, energy efficiency standards and labels, financial incentives for energy efficient appliances and net-metering and the institutionalization of the LCEC to grant it all required and relevant powers with respect to renewable energy projects and initiatives. However, this draft law has not yet been approved by the Lebanese Parliament.

The first National Energy Efficiency Action Plan for Lebanon (2011-2015) was developed in line with 2010 Electricity Policy Paper (MoEW/LCEC, 2011). This action plan was adopted by the CoM in 2011 (CoM Decision 26 dated 10/11/2011) and included fourteen initiatives related to EE and RE with proposed milestones and targets. Many initiatives have been implemented during this period while others faced problems or delays. In March 2016, the Second National Energy Efficiency Action Plan (NEEAP) (2016-2020) was published, building on the first and but focusing and expanding on the energy efficiency component. It categorized initiatives between energy savings in the Lebanese power sector and end-use energy saving measures in buildings, industries, small and medium enterprises, agriculture, mobility and transport, and public services sectors. It also included different types of measures at the policy and legal levels (MoEW/LCEC, 2016a). The sum of the overall estimated savings of the proposed measures of the second NEEAP's implementation were around 686.1 GWh for primary energy (including electricity generation, transmission and distribution) and 828.1 GWh for end-use energy (including building, industrial and public sectors) (MoE/UNDP, 2019b).

The National Renewable Energy Action Plan (2016 – 2020) was developed by LCEC and published in November 2016 also as a follow up to the NEEAP (2011-2015), identifying clear quantitative targets to develop different RE technologies and legal framework needed to reach the target of 12% renewable energy by 2020, with indicative technology mix for the years 2025 and 2030. In parallel to preparation of this plan, the MoE conducted an SEA for the RE sector in Lebanon in 2015. Lebanon's Nationally Determined Contribution (NDC) then set the RE target at 15% unconditionally or 20% conditionally by 2030 (NDC, 2015). The 2019 Policy Paper for the Electricity Sector enhanced that number further to 30% (of electricity) by 2030 (MoE/UNDP, 2019a). In 2020, MoEW and LCEC, in collaboration with support from IRENA, launched the Renewable Energy Roadmap (REmap) with that goal and going further by defining the individual target capacities for each technology: 1,000 MW of wind, 601 MW of hydropower, 2,500 MW of centralized solar PV, 500 MW of decentralized solar PV and 13 MW of biogas (MoEW / LCEC / IRENA, 2020), paving the way for Lebanon's updated RE targets of 18%-30% as part of the 2020 NDC update under the Paris agreement.

9.3.2.6 Environmental Safeguards

SEA Decree 8213/2012 and EIA Decree 8633/2012 require that any proposed strategy/programme or project (including electricity and RE projects) undertake an SEA or EIA, respectively, in order to identify, analyze and mitigate potential environmental and social impacts. In terms of environmental standards and limits, MoE Decisions 52/1-1996 and 8/1-2001 set gaseous concentration limits for specific air pollutants emitted into the air from several sources including power plants and generators.

9.3.3 Key Actors and Stakeholders

9.3.3.1 Government Institutions

The following sections describe the roles and mandate of the various institutions that have a responsibility for mitigating or adapting to climate change in Lebanon, directly and indirectly, or involved in the energy sector. Table 9-5 below presents a responsibility matrix for these entities, whereas the sections below describe these entities and the relevant legislation stipulating their mandate.

Table 9-5 Responsibility Matrix

Mandate / Responsibility	MoEW[1]	MoE[2]	MoA[5]	MoPWT[6]	MoI[7]	EDL[9]	LPA[10]	CDR[11]	BDL[12]
Setting policies, strategies and action plans	X	X	X	X	X				
Proposing laws and decrees and issuing decisions	X	X	X	X	X				
Enforcing environmental compliance		X[3]			X[8]				
Providing subsidies for and renewable energy/energy efficiency projects									X
Implementing climate change and energy projects	X	X	X			X		X	
Managing the oil & gas sector							X		
Power generation and electricity distribution						X			
Documenting and reporting GHG emissions		X[4]							

[1] Law 462/2002: Organization of energy sector.
[2] Law 690/2005: Regulating the MOE and defining its tasks and competences and then detailed by Decree 2275/2009
[3] Law 444/2002: Environment protection
[4] Law 359/1994: Ratification of UNFCCC
[5] Law 31/1955: Designating the tasks of the MoA; Decree 5246/1994: Organization of the MoA and designation of its mandate
[6] Decree 2872/1959: Organization of MoPWT
[7] Law 642/1997 amended by Law 20/2008: Establishment of MoI
[8] Decree 9765/2003: Inspection procedures by MoI
[9] Decree 16878/1964: Establishment of EDL
[10] Decree 7968/2012: Establishing the LPA
[11] Legislative-Decree 5/1977: Establishment of CDR
[12] Decree 13513/1963: The Code of Money and Credit

Ministry of Energy and Water

The MoEW is the leading government body responsible for the development of the energy and water sector in Lebanon. Its role includes energy production, licensing of RE projects and programs as well as definition of sector policy and strategies. As for the water sector, its role includes preparation of the masterplan for water and wastewater, evaluation and implementation of water and wastewater infrastructure projects and identification and promotion of water conservation campaigns. The MoEW consists of three General Directorates, the Directorate of Water and Electrical Resources, the Directorate of Investment and the Directorate of Oil. The Directorate of Water and Electrical Resources studies, implements and monitors the implementation of electricity projects while the role of the Directorate of Investment has the authority of administrative supervision of all bodies working in the electricity field. As for the Directorate of Oil, it is responsible for conducting studies to identify the country's needs of oil and its derivatives and to develop national plans related to the oil field. Monitoring of several oil related activities is also performed by this Directorate.

Ministry of Environment

As the national climate change focal point, the MoE has been leading on the development and co-ordination of CC research and policy in Lebanon to inform a low carbon, climate-resilient Lebanon by 2030 and beyond. The approach is to develop national capacity in cooperation with other state agencies and government departments and to advance research along four linked thematic areas:

- GHG emissions and removals data management systems that aim to improve quantification / reporting of emissions and removals of GHGs
- Research carried out under the theme of 'Lebanon and future climate, impacts and adaptation'

- Socio-economic and technological solutions and transition management
- Air pollution/quality research will aim to address the trade-offs between air pollutants and CC.

The MoE is also the national focal point of the UNFCCC, Green Climate Fund, Adaptation Fund, Global Environment Facility, Climate Technology Center & Network, Union for the Mediterranean-Climate Change Expert Group and IPCC. In addition, the UNDP Climate Change Projects at MoE are responsible for supporting Lebanon in its reporting obligations under the UNFCCC, particularly the NC/BUR reports on CC, as well as the BURs. Refer to Box 9-7 for a full list of publications by MoE/UNDP Climate Change Projects.

Box 9-7 Selected CC Publications by MoE/UNDP Climate Change Projects

Lebanon's National Communications to the UNFCCC – First (1999), Second (2011), Third (2016)

Lebanon's Biennial Update Report to the UNFCCC – First (2015), Second (2017), Third (2019)

Economic Cost of Climate change in Lebanon

De-Risking Renewable Energy Investments

Climate-Proofing Lebanon's Development Plans

Standard Operating Procedures to Integrate Gender in Climate Related Policies and Strategies SDG NDC

Standard Operating Procedures to Integrate Gender in Climate Reporting and Planning

Teacher's Climate-Proofing Lebanon's Development Plans

Guidebook on Climate Change for Schools in Lebanon (English and French)

How to create value from climate change: A guide for your company in Lebanon

Working tools:

SDG NDC Integration Sheet for Agriculture, Forestry, Energy, Waste, transport, water, biodiversity, Industry

Infographics:

Lebanon's 2015 GHG Inventory in Brief

Energy and Climate Change in Brief

Agriculture and Climate Change in Brief

Forestry and Climate Change in Brief

Transport and Climate Change in Brief

Waste and Climate Change in Brief

Gender and Climate Change in Brief

Transport NAMAs

Solid Waste NAMAs

De-Risking Renewable Energy Investments

Lebanon's 2015 Nationally Determined Contribution

All publications can be accessed on http://climatechange.moe.gov.lb/publications

In 2013, the MoE was appointed by the CoM (Decision 44 dated 17/1/2013) as the official national coordinator for Nationally Appropriate Mitigation Actions (NAMAs) in Lebanon and in 2014, the MoE issued Decision 196/1 that established and officiated a mechanism for approving and submitting NAMAs to the UNFCCC NAMA registry. The purpose of this mechanism is to record the demand for international support for implementation of NAMAs and to facilitate the matching of financial resources, technology and capacity building support with these measures. In 2017, two NAMAs targeting the transport and municipal solid waste sectors were approved by the CoM (Decision 14 dated 12/10/2017).

The MoE is also in charge of providing their position on policies, plans and projects from an environmental perspective based on the submission of SEAs and EIAs by public authorities and developers, including power generation and petroleum activities.

Ministry of Agriculture

The MoA is responsible for formulating the national strategic vision for the agricultural sector and developing related policies and programmes. The MoA is also responsible for proposing legislation governing the agricultural sector. MoA has a key role in the management of natural resources (agricultural land, irrigation water, forests and forestry, fisheries and rangelands) and in the preparation and implementation of rural development programmes.

Ministry of Public Works and Transport

In 2000, Law 247 merged the Ministry of Transport with two Directorates affiliated to the Ministry of Public Works to create the MoPWT which conducts technical and financial studies, evaluates and monitors the implementation and maintenance of public construction projects such as buildings and road networks and regulates and sets national strategies for land, sea and air transport. The MoPWT is the marine competent authority responsible for all matters related to national maritime transportation activities and coordinates with MoE to protect the marine environment from pollution.

Ministry of Industry

Established in 1997 through Law 642, the MoI is responsible for the setting strategies for and regulating the industrial sector in Lebanon. This includes ensuring control of air emissions from this sector. It also sets the standards and requirements for industrial production.

Electricité du Liban

EDL benefits from a monopoly on the production, transfer and distribution of electric power in Lebanon with the exception of limited private concessions and Independent Power Producers (IPP) (refer to Section 9.2.4.3 – Formal Sector). In line with the Policy Paper for the Electricity Sector, EDL outsourced a number of tasks of its distribution activities through the Distribution Service Provider project aiming to optimize customer service and maximize the revenues of EDL through reducing the technical and non-technical losses. However, the project encountered several obstacles mainly due to technical issues with the tender documents, limited technical and financial capacity of economic operators and political issues.

Lebanese Petroleum Administration

The LPA was established in 2012 as an independent public entity that operates under the guidance of the MoEW. It is the regulatory body in charge of managing the petroleum sector in Lebanon and is responsible for the environmental management of petroleum activities in the country. The LPA coordinates with MoE and other concerned authorities to supervise and manage environmental issues related to petroleum activities (Law 132/2010, Article 60).

Council for Development and Reconstruction

CDR is a public institution established in 1977. Originally tasked with reconstruction of post-war Lebanon, it is currently responsible for securing funding for projects, allocating funds to different government agencies, managing construction of facilities and infrastructures, supervising the execution of plans and contributing to the rehabilitation of public institutions.

Banque du Liban

BDL is a financially and administratively independent public entity. It closely cooperates with institutions such as MoEW/LCEC to encourage cleaner production and RE projects through the provision of low interest loans, such as the NEEREA.

In addition to public administrations, other institutions are also engaged in activities that promote climate change policies and energy conservation. Some of these institutions are described in this section.

9.3.3.2 Other Institutions

Lebanese Center for Energy Conservation

LCEC, originally a UNDP project at the MoEW, became an NGO affiliated to the MoEW (Attestation 172 dated 27/1/2011). LCEC supports the MoEW on developing and adopting national strategies and action plans, as well as updating and developing the legal and administrative framework needed for greening the energy sector in Lebanon. LCEC has implemented numerous EE and RE projects in the country in addition to supporting the preparation of the NEEAPs and NREAPs.

Order of Engineers and Architects in Beirut

In addition to organizing the architectural and engineering sector and building permits in Lebanon, the Order of Engineers and Architects in Beirut (OEAB) co-organizes, sponsors and funds frequent seminars and events related to EE and RE. For example, OEAB support the International Beirut Energy Forum, a highly attended energy event in the Middle East dedicated to sustainable energy issues and projects. In 2012, OEAB partnered with UNDP by signing a Memorandum of Understanding to promote solar water heaters (SWHs) among engineers and architects who play a significant role in guiding the real estate market.

Non-Governmental Organizations

In addition to advocating for climate change adaptive and mitigation measures, NGOs in Lebanon have been fostering youth engagement with climate action to empower young people to become responsible climate citizens. One strategy has been through technical and vocational education and training (TVET), on-the-job training in green initiatives of environmental protection, renewable energy and energy efficiency, sustainable construction, forest management, water conservation, air quality monitoring and marine protection. Several specialized NGOs are present in Lebanon aiming to push forward research, enactment of legislation and implementation of existing plans in the energy sector. These NGOs include the Lebanese Green Building Council, which gained its member status in 2014 as part of the World Green Building Council and the Association Libanaise pour la Maîtrise de l'Énergie et pour l'Environnement that has developed standards for sustainable building requirements specific to Lebanon such as the Lebanese rating system ARZ for existing commercial buildings and the GRASS rating system for new built, the Lebanese Solar Energy Society that conducts research and awareness campaigns on solar energy related topics through educational and demonstration projects such as the EcoTruck demonstrative project.

In the oil and gas sector the Lebanese Oil and Gas Initiative that focuses on creating a network of Lebanese experts in the global energy industry and provide them with a platform to lobby Lebanese policy makers and raise awareness among the Lebanese citizens on the key decisions facing the country in the oil and gas sector. The initiative has conducted several training sessions, as well as public consultation sessions during the development of the EIA for offshore exploration drilling. In addition, NGOs engaged in climate change actions include Green Mind, which organize the Lebanon Climate Act program in partnership with other institutions to support and encourage businesses in becoming engaged in the fight against climate change, forestry NGOs that conduct adaptation and mitigation measures in the forestry and land use sector *(refer to Chapter 2 – Environmental Governance for more details)*, IndyAct that is leading an «Arab World Climate Campaign» aimed at taking urgent action against climate change and the Arab Youth Climate Movement-Lebanon that works to create a generation-wide movement to solve issues related to climate change and others.

9.3.3.3 Selected Programs

In the last decade, several programs have been operational tackling issues related to climate change and energy policy. Some of these programs are described in this section.

The Community Energy Efficiency and Renewable Energy Demonstration Project

In partnership with MoEW, MoF, and CDR, UNDP is managing CEDRO project (www.cedro-undp.org), which started in 2007. The aim of this project is to promote EE and RE in Lebanon through demonstrations projects, awareness, capacity building, market incentives for EE and RE installations, as well as assisting the formulating a sustainable energy strategy and action plan. Between 2014 and 2017, CEDRO IV, funded by the European Union (EU), included new financing modalities, EE and RE technologies and policies. Until then, the project had completed the following:

- 12 solar PV sites
- 43 transformers and related infrastructure
- 50 solar powered street lighting poles
- 300 solar homes systems
- 2 biomass briquetting plant upgrades
- 15 public school solar systems refurbishment (UNDP/CEDRO, 2018a).

In July 2019, a new EU funded project titled “Sustainable Energy for Security: Interventions for the Lebanese Armed Forces along the North-eastern Lebanese Border” was initiated aiming to enhance the safety and security of the duty stations and surrounding communities through RE applications. The current CEDRO V project “Country Entrepreneurship for Distributed Renewables Opportunities”, also funded by the EU, started in November 2019 and has a mandate until November 2023. Beside its aim in supporting the GoL in to reach its NDC targets for RE/EE, the project also aims to establish an innovation and entrepreneurship environment dedicated to find creative solutions to challenges in the energy sector, create new markets and value chains and attract strong buy-in from the existing small and medium energy enterprises.

Climate Change and Environment Program / Issam Fares Institute

This program was launched in 2008 as ‘‘The Research and Policy Forum on Climate Change and Environment in the Arab World”, as part of Issam Fares Institute for Public Policy and International Affairs at the American University of Beirut. The program aims to use academic and technical expertise to provide analytical information on CC in Lebanon and the Arab World that inform policy making. It also aims to promote research in in different fields (such as transportation, water and agriculture) to influence debates related to CC and sustainable development.

9.4 Selected Responses

With the support of the international community, the Lebanese government has embarked on several programs and initiatives to assess and improve Lebanon’s adaptive capacity to face the changing climate over the coming decades, reducing Lebanon’s contribution of GHG emissions while tackling challenges in the energy sector.

9.4.1 Decreasing Vulnerability and Increasing Adaptation

Lebanon has already assessed and presented its projected climate change impacts and vulnerabilities in its successive national communications and has proposed different sets of adaptation measures to be implemented at the national, sectoral and local levels. As mentioned in Section 9.3.2.2, in July 2017, the country initiated its National Adaptation Process Development to prepare an integrated and comprehensive NAP. This included conducting a broad multi-sectoral consultative process to discuss the way forward to adapt to the incoming changes and reduce the overall costs of damage from climate change. The NAP would identify medium and long-term adaptation needs and action plans in various sectors as well as cross-sectorally, with the ultimate aim of increasing Lebanon's adaptive capacity and resilience (MoE, 2017).

Furthermore, adaptation principles and priorities have been strengthened in the updated NDC of 2020, which includes the following 6 priorities of action for 2030:

- Strengthen the agriculture sector's resilience to enhance Lebanon's agricultural output in a climate-smart manner
- Promote the sustainable use of natural resources, restore degraded landscapes and increase Lebanon's forest cover
- Structure and develop sustainable water services, including irrigation, in order to improve people's living conditions
- Value and sustainably manage terrestrial and marine biodiversity for the preservation and conservation of its ecosystems, habitats and species
- Reduce the vulnerability of coastal zones, especially cities, to climate change impacts
- Ensure overall public health and safety through climate-resilient health systems
- Reduce disaster risk and minimize damage by mitigating and adapting to climate-related natural hazards and extreme weather

In addition, the following adaptive responses were implemented in agriculture and forestry:

- Projet d'Appui à la Résilience Sociale, aux Infrastructures, à la Forêt et à l'Agriculture au Liban (PARSIFAL) - l'Agence Française de Développement (AFD), 2020-2024: Project components include reforestation of several sites throughout Lebanon covering an area of 700 ha, in addition to the establishment and rehabilitation of nine hill lakes in the governorates of Akkar, Baalbeck-Hermel and Bekaa.
- Restauration des surfaces dégradés et assistance à la population vulnérable de Rashaya Et Chmistar par des activités de reboisement et de sensibilisation- MoA/France, 2018-2021: Project components include increasing the green cover through reforestation of 150 ha of degraded lands in Rashaya and 50 ha in Chmistar.
- Implementation of forest management related livelihoods activities in the North and Beqaa – MoA/Germany 2018-2019: This project implemented reforestation, forest management and trail management activities while providing seasonal job opportunities for vulnerable Lebanese rural citizens and Syrian refugees.
- Smart Adaptation of Forest Landscapes in Mountain Areas (SALMA) - MoA/GEF, 2016-2021: Project outputs include reducing soil erosion, fragmentation of forest resources and biodiversity losses for more resilient forest and rural mountain forest communities and increasing technical and institutional capacity at national level to replicate participatory climate proof forest management.
- Promotion of Agricultural Livelihoods and Employment through Investment in Land Reclamation and Water Reservoirs MoA/the Netherlands, 2016-2019: The project aims to sustain the agriculture and rural livelihoods of small and medium men and women farmers in Lebanon, while adapting climate change sustainable natural resources management and conservation approaches.
- Climate Smart Agriculture - Enhancing Adaptive Capacity of the Rural Communities in Lebanon (AgriCAL) – Green Plan/Adaptation fund/Italian Government, 2015-2020: Project objective is to enhance the agricultural sector's adaptation capacity to climate change.
- Agriculture and Rural Development Project (ARDP)-MoA/European Union, 2015-2018: Project outputs include the execution of irrigation infrastructures, promoting sustainable water management and improving the livelihoods and income of quality of their agricultural production and increasing its quantity.
- Assisting reforestation and forest development activities in partnership with local communities (ARDAC) - MoA/European Union, 2014-2018: This included the reforestation and sustainable forest management activities in Menjez, Akkar – 10 hectares in 2015.
- Reforestation/afforestation activities in Deir el Ahmar, Ainata and al-Barqua, Hasbaya, Kawkaba, Baalbeck and Aramoun - MoA/European Union, 2014-2018: This included Reforestation and sustainable forest management activities Deir el Ahmar and Ainata- 4 ha in 2015.
- Adaptation to Climate Change through Improved Water Demand Management in Irrigated Agriculture by Introduction of New Technologies and Best Agricultural Practices – ACCBAT MoA/ENPI/Italy, 2013-2016: Its objective is to reduce the use of freshwater in irrigated agriculture
- Lebanon Reforestation Initiative- USAID, 2011-2018: Project outputs include promoting sustainable management of natural resources in Lebanon and building social stability and promoting sectarian harmony in host communities, through sustain-

able participatory reforestation capacity building, and protection from environmental threats.

9.4.2 Reducing GHG Emissions through Investing in EE and RE

Mitigation of GHG emissions is the primary response to the threat of CC. The aim of holding the increase in the global average temperature to well below 2°C, relative to pre-industrial temperature, frames mitigation actions from global to local levels. To achieve this objective, global emissions of GHGs must be brought to near or below zero by the end of this century (Rogelj et al., 2015). In compliance with the provisions of the Paris Agreement, Lebanon published its NDC to mobilize international finance and set a long-term strategy to reduce national GHG emissions and improve resilience to negative impacts of CC. Lebanon has set targets for public transport mode at 36% (unconditional) and 48% (conditional on receiving financing), and 20% (conditional) for fuel-efficient vehicles by 2030. Figure 9-19 shows Lebanon's 2030 renewable energy and energy efficiency targets as set by the country's NDC update.

During the last decade, the MoEW, EDL and the Distribution Service Providers (DSPs) have completed a number of projects for rehabilitating and upgrading the grid that contributed to a decrease in grid losses and hence improved energy efficiency. Since launching of the DSP projects in April 2012, the electricity sector has experienced a reduction in losses and improvements in collection. However, the grid losses were still high at the beginning of 2019 (34%). Despite its clear objectives that included fixing and upgrading the distribution network through investments for the implementation of a smart grid, collection improvement, and the reduction of technical and non-technical losses, the implementation of the DSP project has faced several challenges that hindered its implementation (MoEW, 2019).

In terms of RE, the joint initiative of BDL, UNDP and EU, "The NEEREA", was launched in 2010 to offer interest-free long-term loans for green energy projects, including LEED Gold, SWH and EE projects. Since its inception and until July 2020, NEEREA had disbursed loans for more than 1,000 projects, 76% of which included solar PV rooftop installations. However, its contribution to RE uptake on a national level remains limited, as it was designed to finance individual projects and is not fit for IPP purposes. In fact, up until 2020, 42% of the NEEREA loan amounts were for green buildings, as opposed to RE/EE projects (LCEC, 2021).

Another similar mechanism is the Lebanon Energy Efficiency and Renewable Energy Finance Facility that was launched in 2018. Developed by European Investment Bank, the French Development Agency and BDL, this financial mechanism offers low interest loans to Lebanon's private sector to install EE and RE projects, although it is currently stalled due to current economic crisis. Under this mechanism, Lebanon's Central Bank provides interest rate subsidies and the European Union finances technical as-

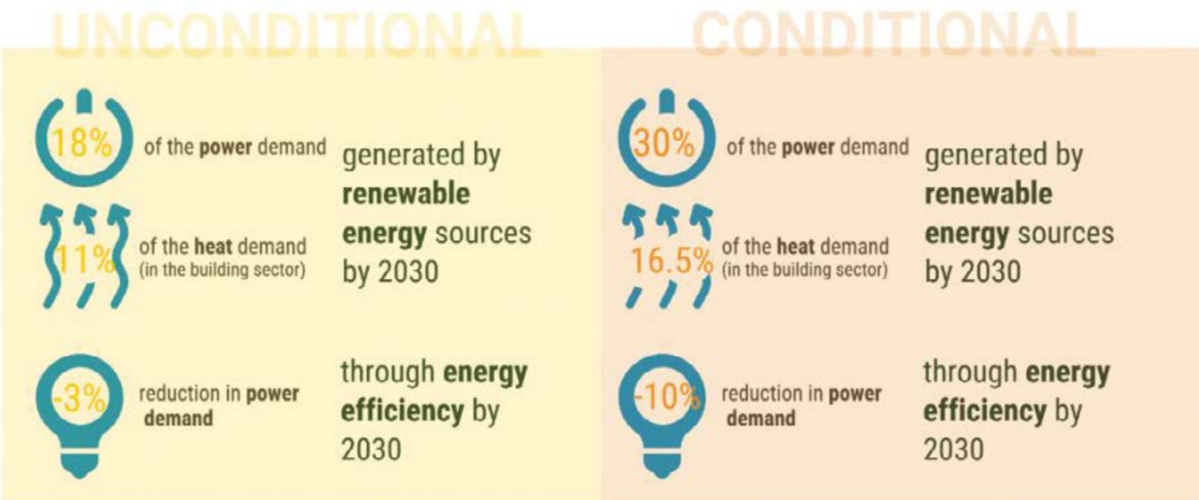


Figure 9-19 2020 NDC Update Energy Targets (Unconditional and Conditional)[2]

[2] Lebanon considers that the achievement of its targets presumes: (1) The reinstatement, as soon as possible, of the prevailing national circumstances prior to the latest regional crisis, a matter considered as Lebanon's legitimate right; (2) The absence of the emergence of any new crisis which could adversely affect Lebanon's national circumstances (Lebanon 2015 NDC and 2020 NDC).

sistance to projects (MoE/UNDP/GEF, 2019). Others include the European Bank for Reconstruction and Development-funded Lebanon Green Economy Finance Facility, which plans to finance up to EURO 200 million to finance private sector loans for investment in green technologies and services supporting Green Economy Transition. This project has passed final revision in October 2019 however, its approval is still pending (EBRD, 2020)

In addition, the various phases of CEDRO project (refer to Section 9.3.3.3), the current being CEDRO V "Country Entrepreneurship for Distributed Renewables Opportunities" (2019-2023) supported various activities that aim to promote uptake of EE and RE technologies. For example, CEDRO 4 project built on the previous phases of CEDRO (2007-2013) whereby more than 100 RE applications have been demonstrated across the country, varying from photovoltaic and micro-wind systems, to large-scale SWH, pico-hydro and ground source heat pump projects (CEDRO/UNDP, 2014). Figure 9-20 shows an example of PV street lighting installed under CEDRO project.

Figure 9-20 PV Street lighting in Mokhtara Municipality, Chouf
Photo Credit: CEDRO Project

Energy production from SWHs in Lebanon contributes to the achievement of RE targets and national commitments for reduction in GHG emissions. Up to 2017, SWHs have reduced energy production in Lebanon by 239,820 megawatt-hours/year and an estimated (ex-ante) offset of the yearly emission of 156 kilotons of CO_2 (MoEW/LCEC, 2019).

Furthermore, in 2011, the MoE implemented the Climate Change Mitigation Project funded by the Italian Government aiming to encourage the use of renewable energy in the country. The project ended in 2014 and included the installation of 1,640m^2 of solar panels and the installation of 66 SWHs in public buildings throughout Lebanon including Red Cross centers, orphanages, elderly care centers, prisons, health care centers and hospitals, and the National Center for Marine Sciences (Figure 9-21). The project also included training sessions for Lebanese experts in the energy field and an advertising campaign. The project resulted in reducing energy demand by around 1,000 megawatt-hours/year, reducing CO_2 emissions by about 400 tonnes per year, and reducing the cost of hot water production at the installed locations by an estimated 60%.

Another initiative is currently conducted by UNICEF, who are working with the Ministry of Education and Higher Education to develop technical guidelines on green school construction materials, lower energy consumption (solar panels and LED lights) and water harvesting.

Through initial support from the European Commission- LIFE Programme (EC-LIFE), United Nations Industrial Development Organization, Austrian Government and MoE, the Lebanese Cleaner Production Centre project was established in 2002 aiming to assist national industries, especially SMEs, in the adoption of sustainable production modes to reduce energy consumption through the application of cleaner production and the transfer of cleaner and environmentally sound technologies. The center is currently not operational due to lack funding.

9.4.3 Improving the Power Sector

There have been many studies that analyzed the prevailing issues in the electricity sector and provided recommendations for their resolution (Ahmad, 2020; Dagher and Yacoubian, 2012; Fardoun et al., 2012; LCRP, 2019; McKinsey, 2020; MoE, 2020c; MoE/UNDP, 2015, 2019a, 2019b, 2020; MoE/UNDP/ECODIT, 2011; MoE/UNDP/GEF, 2015a; MoEW, 2010; MoEW, 2019; MoEW/LCEC, 2011; UNDP, 2019a; World Bank 2008; 2009; 2019; 2020b; World Bank/EDL/MoEW, 2020). As mentioned previously, the MoEW developed a sector policy in 2010 that provided solutions to address the generation deficit by increasing generation and transmission capacity, reducing sector costs by installing floating storage regasification units (FSRUs) to import natural gas to replace liquid fuels for power generation, and corporatizing EDL to modernize its functions and systems (MoEW, 2010). Political disagreements and constraints resulted in little progress in implementing this plan.

In 2019, the MoEW updated this plan to primarily add greater emphasis on reducing EDL's network losses, recovery of billing arrears, and increasing electricity tariffs (MoEW, 2019). The COM adopted this update in April of the same year. MoEW and EDL made commendable progress since then on reducing technical and non-technical losses, but progress in imple-

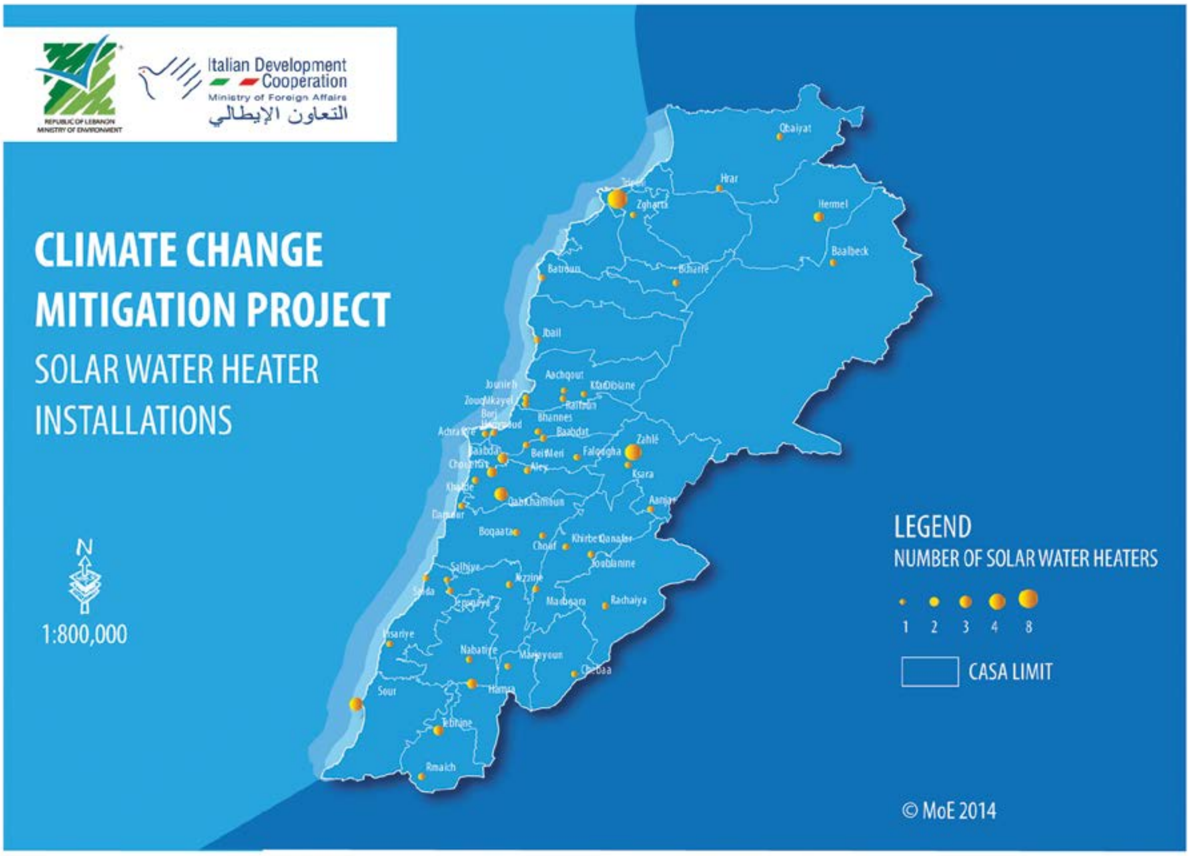


Figure 9-21 Distribution of SWH under the Italian Funded Climate Change Mitigation Project

menting this updated plan stalled again when COM decisions were needed on several fronts. While EDL reforms, including its external and internal governance, may not have immediate fiscal returns, they are vitally important to ensure the sector's economic efficiency and its long-term sustainability. Modernization of all EDL's core business areas and administrative processes are urgently needed as the basis for improving EDL's operational and financial performance and as a foundation for attracting private sector participation (World Bank, 2020b).

9.5 Policy Outlook and the Way Forward

Climate change is already affecting Lebanon. Unabated, its future negative impacts will likely be vast, costing much more than preventing it. The recent IPCC *Special Report on Global Warming of 1.5°C* has underlined the urgency of taking decisive steps to tackle climate change, including through adaptive measures and reducing GHG emissions through the transformation of energy use. Considering that two thirds of GHG emissions originate from the energy sector, the IPCC unequivocally calls for an immediate, large-scale shift to RE and EE (IPCC, 2018). As such, strategic planning and investment are required for Lebanon to make an effective contribution to global actions to avoid dangerous and irreversible impacts of climate change and to benefit from the multiple opportunities that arise from required actions. In addition, a national integrated energy policy should be developed tackling the relevant sectors in a holistic approach and in parallel with the SEA process, with the aim of improving energy supply in an environmentally sustainable and cost-effective manner, while at the same time decreasing Lebanon's overall GHG emissions. This strategy should take into consideration the expected increase in energy demand as a result of our changing climate.

9.5.1 Implementing NDC

The GoL should demonstrate its genuine backing of the NDC through a credible financing strategy of its implementation, with the knowledge that any investment will eventually be recuperated by ensuring a sustainable future for the country. As part of the financial recovery plan, in December 2020, preparations for the World Bank/Islamic Development Bank funded project "Lebanon Green Investment Facility" were initiated aiming at accelerating NDC implementation, focusing on enabling measures that contribute to lowering GHG and increasing resilience across sectors. Currently, the project is at the drafting stage of the design documents and the bylaws which are expected to be finalized in 2021. Priority should be given to institutionalize this facility and proceed with this project.

9.5.2 Adapting to Climate Change

Lebanon should have a clear National Adaptation Strategy and roadmap to preserve and restore the natural capital and enhance and protect the built capital, as well as livelihoods, to ensure sustainable growth and resilience to climate change. The preparation of a National Adaptation Plan and its subsequent implementation is highly interactive and should be guided by the following principles (NDC, 2020):

1. Achieve food and water security through the sustainable management of resources
2. Enhance the resilience of the infrastructure, urban and rural areas to subsist climate-related disasters
3. Ensure and protect public health, well-being and safety of all communities through climate-resilient systems
4. Incorporate Nature-Based Solutions as a first line of defense from adverse impacts of climate change
5. Combat desertification and land degradation by achieving Land Degradation Neutrality
6. Substantially reduce the risk of climate and non-climate related disasters to protect lives, the economy and physical and natural assets

9.5.3 Reducing Greenhouse Gas Emissions

Lebanon is currently preparing its low emission development strategy (LEDS) with the support of UNDP. Gap analysis indicates that many LEDS related activities are underway by the GoL across ministries and third-party institutions. With enhancement and expansion, the LEDS can help improve national objectives for fiscal, macroeconomic, investment, energy security, environmental sustainability, and equity gains. Many of these sector-based efforts are not explicitly tied to the national LEDS program at this time. However, they provide direct opportunities for coordination of policy and program development across issue areas and ministries. As a result, Lebanon's LEDS plan will create an untapped opportunity for synchronization of a range of national goals. The consolidation of studies and proposals across ministries and sectors resulted in a detailed framework of sector-based policies and programs in Lebanon that cut across all sectors and could be integrated into a future LEDS plan (MoE/UNDP/GEF, 2019).

As mentioned in Section 9.2.3, the majority of Lebanon's emissions are from the energy sector followed by transport. Energy is a strategic resource for Lebanon as the country is almost completely reliant on the import of oil for energy needs. Therefore, climate mitigation in this sector plays an important role in achieving positive environmental, economic and social impact through demand side management and cleaner energy production. Additional initiatives to reduce GHG emissions also need to be implemented for industrial processes, agriculture, forest and other land use, and water and wastewater sectors.

Research must advance along three linked thematic areas – energy, transportation, and air pollution – but directed specifically at GHG emissions, including:

- Reduction of CO_2 emissions from energy supply through the promotion of renewables (such as wind, solar, and bioenergy), and natural gas electric generation with carbon capture and storage;
- Reduction in CO_2 emissions from energy end-use and infrastructure through the adoption of energy-efficient components and systems – including buildings, vehicles, manufacturing processes, appliances, and electric grid systems;
- Reduction of emissions of non-CO_2 GHG and black carbon; for example, by lowering methane emissions from energy and waste, transitioning to climate-friendly alternatives to HFCs, cutting CH_4 and NO_2 emissions from agriculture, and improving combustion efficiency and means of particulate capture.

To date, given the constraints and uncertainties, both climate and energy related, and the growth of energy demand in Lebanon, stepping up the role of RE and EE in all sectors has become a necessity, not a choice.

9.5.3.1 Increasing Share of Renewable Energy

Preliminary analysis of EDL's least-cost generation expansion path indicates the need to significantly increase the share of RE capacity in the system. This supports the Government's aggressive new target to allow the country to meet 30% of the total electricity and heat from RE by 2030 and is integral to Lebanon's NDC to the global CC agenda. However, to meet this target, which amounts to an almost 14-fold increase from 350 MW (including 282 MW of hydropower and 7 MW from landfill gas) currently operating to 4,714 MW over 10 years, a significant ramp-up of investments in RE capacity is needed (World Bank, 2020b). This will not just address cost and environmental considerations, but also safeguard the country's energy security.

These investments will pay for themselves in the long run. However, to maximize investment impacts, both policy and financial risks need to be alleviated (de-risked). De-risking, while it incurs a cost on the public sector, will accelerate the wider deployment of green technologies (e.g. renewable energy) and provide savings on the long run. For example, by investing US$ 46 million to de-risk the installation of 300 MW utility scale solar PV by 2030, the Lebanese government can decrease the price of electricity from solar PV by 18% and generate US$ 97 million of economic wide savings over 20 years (UNPD/MoE, 2017a). Similarly, by investing US$ 98 million in de-risking measures to reach the target of 450 MW from wind farms by 2030, the Lebanese government can decrease the price of electricity from wind farms by 18% and generate $221 million of economic wide savings over 20 years (UNDP/MoE, 2017b). To support this target, derisking the RE sector will be essential to promote private sector investment in large-scale wind energy and solar PV in Lebanon (UNDP, 2017a).

In 2017, to support the GoL, UNDP prepared a report using the Derisking Renewable Energy Investment (DREI) methodology sets out the modelling results for systematically assessing investment risks and selecting public instruments to attract renewable energy investment in large-scale projects. This was seen as crucial to meet the targeted RE capacity. Ultimately, adding wind energy and solar PV to the grid will increase security of supply with energy that is clean and affordable – to the benefit of Lebanon's people, economy, and environment. Table 9-6 presents the proposed key policy and financial derisking instruments to achieve the envisioned NREAP investment targets for wind energy and solar PV.

Table 9-6 Key Policy and Financial Instruments for Derisking RE in Lebanon by Risk Category

Risk Category	Derisking Measures to Further Minimize Risk	Immediate priority (1-year)	Short -term priority (1-2 years)	Medium- term priority (3-5 years)
Currency & macroeconomic risk	• Fiscal and monetary reforms for accessing funds for RE projects	X		
	• Establish a risk-based financing facility blended with finance from IFIs / donors	X	X	
	• Partial indexing of PPA tariffs to hard currencies such as EUR or USD	X	X	
Financing risk	• Appoint experts for overseeing PPA process and assessing project bankability	X		
	• Establish an impact fund / financing facility by blending finance from IFIs and local investors	X	X	
	• Explore climate related concessional funding		X	
Political risk	• Establish a new asset risk product through collaboration with IFIs and National banks		X	
	• Establish a regulation that licenses private generation of power			X
Power markets risk	• Establish a tender regulatory framework	X	X	
	• Establish an independent regulatory authority	X	X	
	• Conduct a pre-qualification assessment of bidders		X	
	• Identify few location (preferably on government land) for large projects >50 MWp		X	
Grid / Transmission risk	• Undertake grid stability and connectivity assessment	X	X	
	• Define a capacity building plan for strengthening EDL's grid management capability	X	X	
Developer risk	• Conduct resource mapping study for solar and wind with optimal location for projects	X		
	• Develop a safeguard strategy to secure land for developer		X	
Counterparty risk	• Decommission expensive thermal power plants and add solar & wind to recover some deficits			X
	• EDL organization restructuring exercise	X	X	
	• Government backed -6month guarantee for PPA payments by EDL must be in USD	X		
Social Acceptance risk	• Implement a legislation that allows developers to setup mini grids or micro grids			X
	• Undertake mini grid / micro grid technical assessment			X
Permits risk	• Fast track approval of permits			X

Source: UNDP, 2020

A key conclusion from the modelling undertaken in this study is that investing in derisking instruments is a cost-effective approach for achieving Lebanon's wind and solar PV investment objectives. The derisking measures that are modelled bring down the generation cost of wind energy from USD 11.4 cents per kWh to USD 9.4 cents per kWh, and solar PV energy from USD 10.0 cents per kWh to USD 8.2 cents per kWh (UNDP, 2017a). It is important to note that since this study, the generation cost of wind and PV energy has declined.

Making renewable energy investments cost-competitive will contribute positively to Lebanon's power sector, increasing the reliability of the supply, decreasing the country's dependence on fuel imports, improving the affordability of the energy mix and reducing the need for subsidies to EDL. The removal of the subsidies and global reduction in RE technology prices is expected to encourage investment in RE sources (MoE/UNDP, 2015). Accounting for O&M costs throughout the lifetime of a RE installation is also key to its sustainability and essential for achieving the national target.

Lebanon has ample renewable energy resources that may be utilized to achieve these targets, including both solar and wind potential. An action plan to guide the development of these resources has been produced by the LCEC. For such end, a study, which was done by IRENA in collaboration with Lebanon's MoEW and the LCEC, provided an in-depth assessment of the policy, regulatory, financial and capacity challenges that must be overcome to achieve the targets set out for 2030. This study also provides an in-depth analysis based on the Renewable Energy Roadmap (REmap) analysis approach, identifying additional renewable energy potential and quantifying other factors such as costs, investment needs and effects on externalities related to air pollution and the environment (MoEW / LCEC / IRENA, 2020).

The successful realization of the REmap deployment would require major adjustments to policy, regulatory, technology, infrastructure and financing mechanisms based on the following recommendations (MoEW / LCEC / IRENA, 2020):

1. Implement more stable and integrated regulations for RE deployment;
2. Adopt new measures for small-scale applications;
3. Complement national targets with technology-specific RE targets;
4. Set enabling tools for the installation of heating and cooling;
5. Reform the current market framework to increase investments and project bankability;
6. Reinforce the grid and conduct grid impact assessments;
7. Finance and the role of the private sector.

A study on "Prioritization and assessment of value chains within the renewable energy sector in Lebanon" conducted in 2019, offered an action plan to harvest the job creation potential in Lebanon for these specific sectors. A number of key priority actions can be highlighted (MoEW/Kingdom of Netherlands/UNDP, 2019):

- Establishing a central RE knowledge hub that provides general RE but also technology-specific support and services;
- Promoting research and development and companies working on hybrid systems;
- Implementing a quality assurance framework for PV;
- Providing education and training, especially for PV installers and wind service engineers.

9.5.3.2 Implementing Energy Efficiency Measures

In addition to increasing utility-scale RE, small-scale and distributed generation, implementation of EE measures to reduce energy consumption and related operations costs should be reinforced. Synergy between renewable technologies and EE measures is required to increase the country's energy security and sustainability, and to exploit the huge opportunities for development.

As such, implementation of EE measures across all sectors needs to be reinforced, with special focus on the buildings sector, which is the main source of savings on the end-user side (up to US$46 million of savings per year) (World Bank, 2020b). For such end, a study was conducted to establish the baseline characteristics of Lebanese household appliances and the perception and willingness of Lebanese householders to shift towards more energy efficient choices (UNDP/CEDRO, 2018b).

The participation of the industry sector in reducing its consumption is crucial to meet the EE national plan energy savings target. Industrial facilities, with focus on the higher consumers, should conduct mandatory regular energy audits and implement EE measures to reduce their energy consumption and operation costs (UNDP/CEDRO, 2016).

Moreover, given the high energy consumption of heating and cooling for both space and water, integrating efficient and sustainable heating and cooling applications also needs to be strengthened. Updating the building code to force developers to incorporate and accommodate renewable and energy efficiency technologies at the design phase should also be considered. Moreover, reinforcing green financing mechanisms and other incentives and grants is essential, along with documenting their achievements and building on success stories. In addition, the Government should increase awareness, build capacity and gain trust of all stakeholders working in the EE and RE sectors through regular communication, consultations, and information disclosure.

9.5.4 Improving the Electricity Sector

Focus in Lebanon has traditionally been on increasing energy generation capacity, which is important, but it needs to be accompanied by fuel switching, reducing losses on the electricity network and improving end-use energy efficiency to reduce supply costs and ensure sustainable solutions. This can only be done by preparing and adopting an integrated electricity policy that combines thermal and renewable based on least-cost options.

9.5.4.1 Modernizing EDL

In an effort to improve the operational, commercial and financial performance of the power sector, and strengthen the governance of EDL leading to decreased dependence of the population on private power generators, the World Bank proposed in 2019 a program to contribute to the following three key results areas:

a. Decrease total system (technical and non-technical) losses
b. Increase the cost recovery of tariff revenue
c. Roll out the modernization of EDL

The Program is composed of two components. The first component (US$490 million), covering 2019-2023, will support three key objectives of the Government's CEDRE reform program: operational performance, financial viability, and governance of the sector. It is structured around three result areas: (i) improving the operational and commercial performance of the sector (US$200 million); (ii) enhancing the sector financial viability (US$200 million); and (iii) strengthening EDL's governance and transparency (US$90 million). The second component (US$10 million) will finance technical assistance to MoEW and EDL to support their overall capacity building. The Program expenditure covers the costs of activities required to achieve the Program objectives, implementation of EDL's modernization plan, and EDL's labor cost (as the plan involves staff across all EDL's functions) and adds up to US$ 999 million. The remaining financing comes from the Government budget as part of its continued subsidy to EDL before the sector achieves cost recovery (World Bank, 2019b).

As part of the "Least cost generation plan for 2020 – 2030" project mandated by the World Bank to Electricité de France on behalf of the MoEW and EDL, a base case least cost generation plan has been developed under the assumption of a demand growth of 3% per year and an exceptional 8% decrease in 2022. Brent price is set to 40 $/barrel for 2020 with a 1.5% increase each year. The first priority of this plan is to build generation capacity as fast as possible. To this extent, demand is expected to be fully met by 2022, following the installation of 1,616 MW of solar, wind and Internal Combustion Engines (ICEs). Until then, Jbeil and Joubb Jannine small ICEs, in addition to the existing Zouk and Jieh power barges are used as fast-track solutions. Starting 2026, additional installations will contribute to the firm capacity margin, reaching 10% by 2030 (World Bank/EDL/MoEW, 2020).

Tariff reform needs to be pursued under a clear action plan to address interrelated sector challenges in parallel with a framework to eliminate subsidies through efficient and cost-reflective tariffs while protecting the poor. If the reform measures outlined in the priority actions in 2019 Policy Paper for the Electricity Sector are implemented, the cost of electricity could decrease from as high as US¢27/kWh (billed) today to around US¢16.4/kWh by 2022. Supply could increase to provide all customers with reliable 24 hours of electricity, eliminating the need to rely on expensive and polluting private diesel generation. Even if tariffs are increased to recover costs, hence removing subsidies and saving the Government US$1-2 billion a year, they would be at the current weighted average cost to consumers (the current costs average consumers pay for both public and private electricity). This would result in almost neutral impact on poverty and may even lead to positive economic impact for customers who rely more on private generators, which cost up to US¢30/kWh (World Bank, 2020b).

Moreover, several projects in Lebanon aim at increasing energy production while decreasing GHG emissions. These projects, implemented by the MoEW, the LCEC, the CEDRO project and other private entities, have induced an estimated 262,712 tons CO_2 eq. abatement. If these activities are well sustained, it is expected to eliminate the emissions a minimum of 119,184 tons CO_2 eq. per year. This does not take into account the implementation of other additional planned activities across the energy sector (MoE/UNDP/GEF, 2015a).

9.5.4.2 Switching to Natural Gas

As mentioned previously, Lebanon currently relies on gasoline, fuel oil and gas oil, which are 100% imported. Energy security concerns, combined the need to support economic growth, have driven an energy diversification strategy (Fattouh and El-Katiri, 2015). Natural gas has played a very limited role in Lebanon's energy mix. The main constraint to the penetration of natural gas in its energy mix has been a lack of access to gas supplies. Lebanon has no proven natural gas reserves and its options to import gas from neighboring countries have been limited. Furthermore, relatively low world market prices for oil during the 1980s and 1990s reduced the incentive to switch from the use of fuel oil in the power sector (Fattouh and El-Katiri, 2015).

A long-term importer of energy, Lebanon could benefit tremendously from developing its prospective gas reserves (previously discussed in Section 9.3.2.4) by generating a new and potentially important stream of revenue, enhancing its energy security and reducing air pollution by replacing fuel oil in power generation. Therefore, in the short term, it is expected that Lebanon will import natural gas to help it gradually replace oil in power generation and prepare the domestic market for what may yet turn into a fundamental turn of fortunes. The successful development of Lebanon's offshore gas resources, through an environmentally sustainable and transparent process, could indeed turn Lebanon into a self-sufficient producer and a potential exporter of natural gas (Fattouh and El-Katiri, 2015).

In the meantime, Lebanon's economy could significantly benefit from interim imports of natural gas; flexible liquefied natural gas imports would be the most practical option given the current lack of regionally available pipeline gas supply options. As end-user electricity prices are essentially determined by the government (at levels significantly below the full cost of generation) the state-owned power generating sector budget can save a significant amount of money by switching from oil to gas. The MoEW estimates that at the price of $90 per barrel, Lebanon can save $1.9 billion on its annual fuel bill if it switches its power generation to gas (Fattouh, 2015).

In addition to going forward with the World Bank programs mentioned in Section 9.5.4.1, work in the coming decade should also include the installation of FSRUs to import gas at Zahrani and Deir Amar and the speedy launching of separate tender processes for additional temporary and permanent generation capacity. However, before proceeding with these activities, environmental due diligence should be undertaken, including conducting an EIA for each planned facility. This EIA should also look at climate change related impacts of various alternatives and recommend climate proofing conditions for the developer that include adaptive as well as mitigation measures. For example, GHG emissions from the FSRU development can be offset by investing in a RE subsidy programme.

9.5.5 Promoting Climate Change Governance

Measures for sustainable development and climate action are most effective if based on robust governance mechanisms, regulations and partnerships. In order to achieve more ambitious and effective climate actions, several Climate Action Enablers are needed including climate governance to enable institutions to (1) plan, prepare and react to climate change, (2) incentivize action and fiscal reform to de-risk climate-relevant investments and accelerate the deployment of technology, (3) strengthen partnerships to scale-up actions using a bottom-up approach, (4) undertake innovative research to reduce the carbon intensity of the economy and improve its scientific aptitude to guide decision-making, comprehensive integration of solutions to tackle also the economic recovery and effective inclusion, and finally (5) implement enhanced monitoring and transparency to improve institutional arrangements, data availability and periodicity, as well as monitoring and evaluation of mitigation and adaptation projects.

Through its position as the entity that sets monetary policy in the country, BDL, as any other central bank, can play an integral role in mainstreaming climate change considerations into decision-making (Box 9-8).

Education at all levels should be tackled to promote better ways to build for the environment, starting with display areas to raise awareness of the public about climate-friendly buildings, as well as in schools. Lebanese and international NGOs have embarked on a mission to encourage private and public schools to turn green. Importantly, school children, who are the climate fighters of the future, will learn about these and other sustainable ways to mitigate and adapt to climate change.

In addition, gender-responsive national policies and instruments should be taken into consideration to ensure an active, full and equal participation of women and men in the consultation and decision-making processes for the control and access to natural resources, management of GHG emissions and generation of mitigation and adaptation strategies.

Box 9-8 Climate Change and Monetary Policy

The Network for Greening the Financial System, a network of 83 central banks and financial supervisors, aims to accelerate the scaling up of green finance and develop recommendations for central banks' role for climate change. Takeaways from its Climate Change and Monetary Policy Technical Document include:

- Central banks should consider the possible effects of climate change on the economy. These effects may be relevant to monetary policy even if they only materialize beyond the conventional three- to five-year policy horizon. Central banks should acknowledge that climate change already is part of their monetary policy contexts.
- Central banks would benefit from enhanced assessments of the potential impact on the natural interest rate since they could reveal that policy space is more limited than previously thought, which has implications for the conduct of monetary policy.
- Central banks should assess the implications for risk management practices, as climate related shocks may affect the riskiness of their financial portfolios and market operations.
- Work by central banks and the research community is needed to understand whether climate change may have fundamental implications for the design of monetary regimes, including the choice of (i) the central bank's target, (ii) the horizon over which a central bank is expected to meet its target, and (iii) the degree of flexibility embedded in monetary strategy.
- Central banks should consider enhancing their communication strategies to help accustom households, businesses, governments and financial market participants to the risks that climate change and transition policies (or their absence) may exert on the economy and the financial system (NGFS, 2020).

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Cited Legislation related to Climate Change and Energy

قوانين الاتفاقيات الدولية

نوع النص	الرقم	التاريخ	عنوان النص
قانون	١١٥	٢٠١٩/٠٣/٢٩	الموافقة على إبرام اتفاق باريس الملحق باتفاقية الأمم المتحدة الإطارية بشأن تغيّر المناخ
قانون	٧٣٨	٢٠٠٦/٠٥/١٥	الإجازة للحكومة الانضمام إلى بروتوكول كيوتو الملحق باتفاقية الأمم المتحدة الاطارية بشأن تغير المناخ المحررة في كيوتو
قانون	٣٥٩	١٩٩٤/٠٨/١	الاجازة للحكومة ابرام اتفاقية الامم المتحدة الاطارية بشان تغيير المناخ الموقعة في ريو دي جينيرو بتاريخ ١٩٩٢/٠٦/٥
قانون	٢٥٣	١٩٩٣/٧/٢٢	الإجازة للحكومة الانضمام إلى معاهدتين متعلقتين بطبقة الأوزون

القوانين والأنظمة

نوع النص	الرقم	التاريخ	عنوان النص
قانون	١٤٤	٢٠١٩/٠٧/٣١	الموازنة العامة والموازنات الملحقة عام ٢٠١٩
قانون	٨٤	٢٠١٨/١٠/١٠	دعم الشفافية في قطاع البترول
قانون	٧٩	٢٠١٨/٠٤/١٨	الموازنة العامة والموازنات الملحقة لعام٢٠١٨
قانون	٥٤	٢٠١٥/١١/٢٤	تمديد العمل بأحكام القانون رقم ٢٠١٤/٢٨٨ (إضافة فقرة الى المادة السابعة من القانون رقم ٤٦٢ تاريخ ٢٠٠٢/٩/٢ - تنظيم قطاع الكهرباء)
قانون	٢٨٨	٢٠١٤/٠٤/٣٠	إضافة فقرة الى المادة السابعة من القانون رقم ٤٦٢ تاريخ ٢٠٠٢/٩/٢ (تنظيم قطاع الكهرباء)
قانون	١٣٢	٢٠١٠/٠٨/٢٤	قانون الموارد البترولية في المياه البحرية
قانون	٧٧٥	٢٠٠٦/١١/١١	تعديل المادة السابعة من القانون رقم ٤٦٢ تاريخ ٢٠٠٢/٩/٢ (تنظيم قطاع الكهرباء)
قانون	٦٩٠	٢٠٠٥/٠٨/٢٦	تحديد مهام وزارة البيئة وتنظيمها
قانون	٤٤٤	٢٠٠٢/٧/٢٩	قانون حماية البيئة
قانون	٤٦٢	٢٠٠٢/٠٩/٠٢	تنظيم قطاع الكهرباء
قانون	٢٤٧	٢٠٠٠/٠٨/٠٧	دمج والغاء وانشاء وزارات ومجالس
قانون	٦٤٢	١٩٩٧/٠٦/٠٢	احداث وزارة الصناعة
مرسوم	٢٢٧٥	٢٠١٩/٠٦/١٥	تنظيم الوحدات التابعة لوزارة البيئة وتحديد مهامها وملاكها وشروط التعيين الخاصة في بعض وظائفها
مرسوم	١١٧٧	٢٠١٧/٠٧/٣١	تعديل بعض مواد المرسوم ١٠٢٨٩ تاريخ ٢٠١٣/٤/٣٠ المتعلق بالأنظمة والقواعد المتعلقة بالأنشطة البترولية تطبيقا للقانون رقم ١٣٢ تاريخ ٢٠١٠/٨/٢٤ (الموارد البترولية في المياه البحرية)
قرار	١٣٥/١/أ/ت	٢٠١٧/٠٧/٢٨	آلية تصريح اصحاب المولدات الكهربائية الخاصة لدى وزارة الاقتصاد والتجارة
مرسوم	٦٢٠	٢٠١٧/٠٤/٢٥	إبرام اتفاقية النظام الاساسي للوكالة الدولية للطاقة المتجددة (IRENA)
مرسوم	٤٣	٢٠١٧/٠١/١٩	دفتر الشروط الخاصة بدورات التراخيص في المياه البحرية ونموذج اتفاقية الاستكشاف والانتاج
مرسوم	١٠٢٨٩	٢٠١٣/٠٤/٣٠	الأنظمة والقواعد المتعلقة بالأنشطة البترولية تطبيقا للقانون رقم ١٣٢ تاريخ ٢٠١٠/٨/٢٤ (الموارد البترولية في المياه البحرية)
مرسوم	٨٦٣٣	٢٠١٢/٨/٧	اصول تقييم الاثر البيئي
مرسوم	٧٩٦٨	٢٠١٢/٠٤/٠٧	هيئة ادارة قطاع البترول
مرسوم	٨٢١٣	٢٠١٢/٠٥/٢٤	التقييم البيئي الاستراتيجي لمشاريع السياسات والخطط والبرامج في القطاع العام
مرسوم	٩٧٦٥	٢٠٠٣/٠٣/١١	الرقابة والتدابير والعقوبات المتعلقة بالمؤسسات الصناعية
مرسوم	٥٢٤٦	١٩٩٤/٠٦/٢٠	تنظيم وزارة الزراعة وتحديد ملاكها وشروط التعيين في بعض وظائف هذا الملاك وسلسلة رتب ورواتب الموظفين الفنيين فيه
مرسوم إشتراعي	٥	١٩٧٧/٠١/٣١	انشاء مجلس الانماء والاعمار
قانون منفذ بمرسوم	١٦٨٧٨	١٩٦٤/٠٧/١٠	انشاء مصلحة كهرباء لبنان
قانون منفذ بمرسوم	١٣٥١٣	١٩٦٣/٠٨/٠١	قانون النقد والتسليف وانشاء المصرف المركزي
مرسوم	٢٨٧٢	١٩٥٩/١٢/١٦	نظيم وزارة الاشغال العامة والنقل

نوع النص	الرقم	التاريخ	عنوان النص
مرسوم اشتراعي	٣١	١٩٥٥/٠١/١٨	تحديد مهام وزارة الزراعة
قرار وزارة الاقتصاد والتجارة	١/١/١٧٦/أ/ت	٢٠١٨/٠٩/٢٨	ملحق بالقرار رقم ١٠٠ /١ /أ. ت تاريخ ٦ /٦/ ٢٠١٨ المتعلق بآلية تصريح أصحاب المولدات الكهربائية الخاصة لدى وزارة الاقتصاد والتجارة
قرار وزارة الاقتصاد والتجارة	١/١/١٠٠/أ/ت	٢٠١٨/٠٦/٠٦	تعديل القرار رقم ١/١/١٣٥/أ.ت تاريخ ٢٠١٧/٧/٢٨ المتعلق بآلية تصريح اصحاب المولدات الكهربائية الخاصة لدى وزارة الاقتصاد والتجارة
قرار مجلس الوزراء	١٤	٢٠١٧/١٠/١٢	الموافقة على إجراءي التخفيف المتعلقين بقطاع النفيات المنزلية الصلبة وقطاع النقل البري الخاص من اجل تسجيل إجراءات التخفيف الملائمة وطنياً لمكافحة تغير المناخ الملائمة وطنياً لمكافحة تغير المناخ في السجل الرسمي لدى الأمانة العامة لاتفاقية الأمم المتحدة الإطارية بشأن تغير المناخ بهدف تنفيذ الإجراءات من قبل الجهات المعنية
قرار وزارة البيئة	١/١٩٦	٢٠١٤/٠٧/١٨	آلية تقديم و مراجعة المشاريع المقدمة المتعلقة بإجراءات التخفيف الملائمة وطنياً لمكافحة تغير المناخ
قرار وزارة البيئة	١/٩٩	٢٠١٣/٤/١١	مبادئ توجيهية عن كيفية تقديم معلومات عن إنبعاثات الغازات الدفيئة من قبل الشركات والمؤسسات الصناعية والتجارية للحصول على إفادة تصريح
قرار مجلس الوزراء	٤٤	٢٠١٣/٠١/١٧	منح وزارة البيئة صفة المنسق الوطني لإجراءات التخفيف الملائمة وطنياً العائدة للبلدان النامية تحت سقف اتفاقية الأمم المتحدة الإطارية بشأن تغير المناخ
قرار مجلس الوزراء	٢٦	٢٠١١/١١/١٠	طلب وزارة الطاقة والمياه الموافقة على الخطة الوطنية لكفاءة الطاقة
قرار مجلس الوزراء	١	٢٠١٠/٠٦/٢١	عرض وزارة الطاقة والمياه ل "ورقة سياسة قطاع الكهربا"
قرار وزارة البيئة	١/٨	٢٠٠١/٠١/٣٠	المواصفات والمعايير المتعلقة بملوّثات الهواء والنفايات السائلة المتولدة عن المؤسسات المصنفة ومحطات معالجة المياه المبتذلة
قرار وزارة البيئة	١/٥٢	١٩٩٦/٧/٢٩	تحديد المواصفات والنسب الخاصة للحد من تلوث الهواء والمياه والتربة

10 Chemical Management

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Abbreviations and Acronyms

CDR	Council for Development and Reconstruction
CFCs	Chlorofluorocarbons
CHD	Coronary Heart Disease
Cr	Chromium
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
EDL	Electricité du Liban
EU	European Union
GAP	Good Agricultural Practices
HS	Harmonized System
ICCM1	First International Conference on Chemicals Management
IRI	Industrial Research Institute
ISIC	International Standard Industrial Classification
GDP	Gross Domestic Product
GHG	Green House Gases
GWP	Global Warming Potential
HBCD	Hexabromocyclododecane
HCB	Hexachlorobenzene
HCFCs	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbon
IPM	Integrated Pest Management
LCA	Lebanese Customs Administration
LRBMS	Litani River Basin Management Support
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoET	Ministry of Economy and Trade
MoI	Ministry of Industry
MoPH	Ministry of Public Health
NGOs	Non-governmental Organizations
NOU	National Ozone Unit
OCPs	Organochlorine Pesticides
ODS	Ozone Depleting Substances
PBDE	Polybrominated Diphenyl Ethers
PCBs	Polychlorinated Biphenyls
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofurans
PFOS	Perfluorooctance Sulfonic Acid
POPs	Persistent Organic Pollutants
RAC	Refrigeration and Air-Conditioning
SCP	Sustainable Consumption and Production
SOER	State of the Environment Report
ULR	Upper Litani River
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNHCR	United Nations High Commissioner for Refugees
UPOPs	Unintentionally Released Persistent Organic Pollutants
USEPA	United States Environment Protection Agency
WHO	World Health Organization

10. Chemical Management

Over the last years, the use of chemicals has grown in Lebanon, predominantly in agriculture and industry (MoE, 2018a). Several challenges for chemical management exist in the country, involving the increasing consumption of hazardous chemicals and generation of hazardous waste, and the information gaps and lack of awareness on the hazards that these chemicals pose to human health and to the environment.

This chapter describes the driving forces affecting chemical management in Lebanon (Box 10-1), the current situation, existing legal framework and key stakeholders, major national responses and interventions, and opportunities for improving the management of chemicals in the future. The chemicals tackled in this chapter include Heavy Metals (with focus on Mercury and Lead), Persistent Organic Pollutants, Pesticides, Asbestos, and Ozone-Depleting Substances. *Expired pharmaceuticals used in the healthcare sector are addressed in Chapter 8 - Solid Waste.*

Box 10-1 What is Chemical Management?
Chemical Management is the process of tracking chemical products from procurement to storage and usage until final disposal. It can entail balancing between economic and political interests that may be conflicting. A key role of policy makers and regulators is to maintain an acceptable level of environmental and human health protection without necessarily limiting the benefits of modern chemistry (Selin, 2009).

10.1 Driving Forces

The driving forces affecting the management of chemicals in Lebanon are population growth and urbanization, economic growth, market competitiveness, emerging technologies and commitments to international conventions and agreements. Many forces, emerging mainly from anthropogenic activities, act together or in isolation and impact the country's ability to properly manage chemicals.

10.1.1 Population Growth and Urbanization

Population growth and urbanization drive the demand for energy, housing, transport, infrastructure, and food, thus increasing the pressure on the natural environment and fragile ecosystems. Lebanon's total population increased from around 3.8 million in 2007 to approximately 4.8 million in 2018-2019, of whom 79.8% are Lebanese and 20.2% non-Lebanese (CAS, 2008; CAS/ILO/EU, 2020). According to the United Nations High Commissioner for Refugees (UNHCR), around 950,000 registered Syrian refugees and displaced reside in Lebanon, even though the Government estimates their number to be about 1.5 million. An additional number of 18,000 refugees of Iraqi, Sudanese and other origins reside in the country (UNHCR, 2019). The number of housing units in Lebanon has increased dramatically in the last 15 years, from 888,814 in 2007 to 1,321,600 in 2018-2019 (CAS, 2008; CAS/ILO/EU, 2020). The capital Beirut currently comprises about 7.1% of the total population and 8% of the total primary residences in Lebanon (CAS/ILO/EU, 2020). The increased number of the population and urbanization, including development and reconstruction, is expected to be coupled with growing consumption and waste generation leading to chemical management issues and further environmental degradation. The presence of a large number of refugees and displaced populations represents an additional pressure on infrastructure, services, and the environment.

10.1.2 Economic Growth

Lebanon's economy is moderately diversified relying on manufacturing, construction, trade, and finance. Gross Domestic Product (GDP) has stalled in the last decade as the real GDP growth dropped from a high of 10.23% in 2009 to 0.85% in 2017, after which it contracted by 6.7% in 2019 (World Bank Group, 2021). The World Bank expects that in 2020, the real GDP would have declined by 19.2% and a further 13.2% in 2021 (World Bank, 2020). The largest contributor to GDP is the market services sector, which contributed to over 78% of GDP in 2015. This is followed by the industrial and agricultural sectors contributing to 16.6% and 4.8% of the total GDP, respectively during the same year (Figure 10-1) (GoL, 2018). These two sectors are considered the leading sectors in terms of chemical usage and its subsequent release into the environment. Further information related to the use of chemicals in the industrial and agricultural sectors can be found in Sections 10.2.1.1 and 10.2.1.2, respectively.

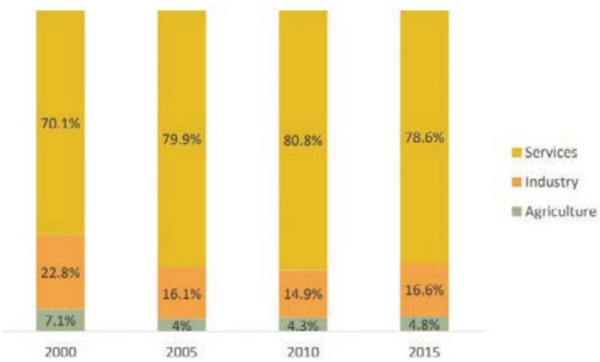

Figure 10-1 GDP by Economic Activity, 2000-2015
Source: GoL, 2018

10.1.3 Market Competitiveness

In an effort to ride the international market-growth waves and in order for the industrial sector to compete within this market, some of the Lebanese industries are looking beyond their home markets and are considering methods to flow with the dynamics that are transforming the industrial sector into a more sustainable one. One of the key elements that the industrial sector must consider in Lebanon is the use of chemicals in the end products. For example, certain chemical standards and specifications are required to be achieved in products to be able to be exported to specific countries. As such, industries will be triggered to manage the use of certain chemicals in line with best environmental practices and best available techniques to enhance their attractiveness in the international market.

10.1.4 Emerging Technologies

Technology innovation has accelerated progress in reducing the use of chemicals and hazardous substances in various products. For instance, oil-based transformers containing Polychlorinated Biphenyls (PCBs), a banned persistent organic pollutant (POP), are being replaced by dry transformers. Efforts are being made to integrate technologies from different disciplines to minimize the use of chemicals such as fertilizers and pesticides in the agricultural sector. These technologies include genetic engineering and agricultural biological applications. Technological innovations are also focusing on improving efficiency in the use of raw materials including chemicals in the industrial sector. In addition, shifting to sustainable consumption and production patterns through the implementation of innovative and efficient Circular Economy concepts have reduced the use of resources including raw material and chemicals, especially in the industrial sector (SCP/RAC/UN Environment/UNIDO, 2018). All these technologies and approaches drive industry in Lebanon to reduce its dependence on chemicals and help decouple it from economic growth.

10.1.5 Commitments to International Conventions and Protocols

Lebanon is driven to manage its chemicals as it is signatory to several chemicals-related multilateral environmental conventions and agreements (refer to Section 10.3.1). These agreements play an important role in complementing national legislation and regional agreements providing an overarching international legal basis for national efforts to address particular issues related to chemicals in the country.

In addition, being a party to such conventions commits the country to abide by its control measures, thus managing its chemicals in line with best practices. For example, Lebanon is set to eliminate/restrict POPs in compliance with the Stockholm Convention on POPs and to phase out ozone depleting substances (ODSs) as set by Montreal Protocol. As party to these international instruments, Lebanon is also responsible to submit national reports including information on the measures taken by the country in implementing the provisions of these conventions and is often provided with technical and financial support to do so. The information provided in the national reports is one of the main references used for the evaluation of the effectiveness of the convention including the progress towards chemical management.

10.2 Current Situation

This section describes the current situation in Lebanon in terms of the main sectors in which chemicals used, their import and export, their presence in the environment through emissions and release and their associated health impacts and economic costs.

10.2.1 Overview of Relevant Sectors

The use of chemicals in Lebanon is increasing over time, especially in the industrial and agriculture sectors (MoE, 2018a). In addition, the power sector is associated with significance use of various toxic chemicals. This section provides an overview of each of these sectors and their prevalence in the country.

10.2.1.1 Industrial Sector

Different industries use different chemicals throughout their production process depending on the type of products they are manufacturing. In Lebanon, various types of industries are distributed throughout the entire country. There are more than 133 officially classified industrial zones in Lebanon distributed as follows: 61 in Mount Lebanon and Keserwan Ftouh-Jbeil governorates, 22 in Bekka and Baalbeck-Hermel governorates, 31 in North and Akkar governorates and 19 in South Lebanon and Nabatieh governorates. Figure 10-2 shows the location of the classified industrial zones along with the distribution of industries across the Lebanese territory. Beirut governorate does not host any industrial zones; however, it includes a large number of previously licensed industries that are widespread within the capital's residential areas (UNIDO/MoI, 2018). The unorganized and random distribution of industrial zones creates challenges for the proper environmental monitoring of the sector and implementation of management measures such as those related to the use and release of chemicals.

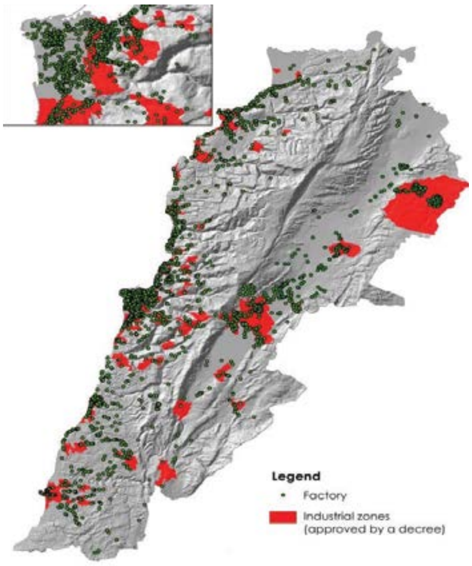

Figure 10-2 Geographic Distribution of Industries and Industrial Zones in Lebanon
Source: UNIDO/MoI, 2018

Decree 5243/2001 classifies each type of industry in Lebanon into one of the categories defined by the International Standard Industrial Classification (ISIC). This categorization is based on the type of productive activity, as well as several environmental criteria (e.g., impact on water, air and soil and odour and noise emissions). Figure 10-3 presents a map of the geographical distribution of licensed industries in Lebanon by ISIC classification across the eight governorates according to Ministry of Industry (MoI) data, which does not include food industries. The figure shows that most of the industries are located in Mount Lebanon governorate (including Keserwan Ftouh-Jbeil), having a total of 324 industries. In general, chemical production industries are the predominant type across all governorates (45.64%). This category includes manufacturing of basic chemicals, fertilizer and nitrogen compounds, plastics and synthetic rubber in primary forms, soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations, paints, varnishes and similar coatings, printing ink and mastics.

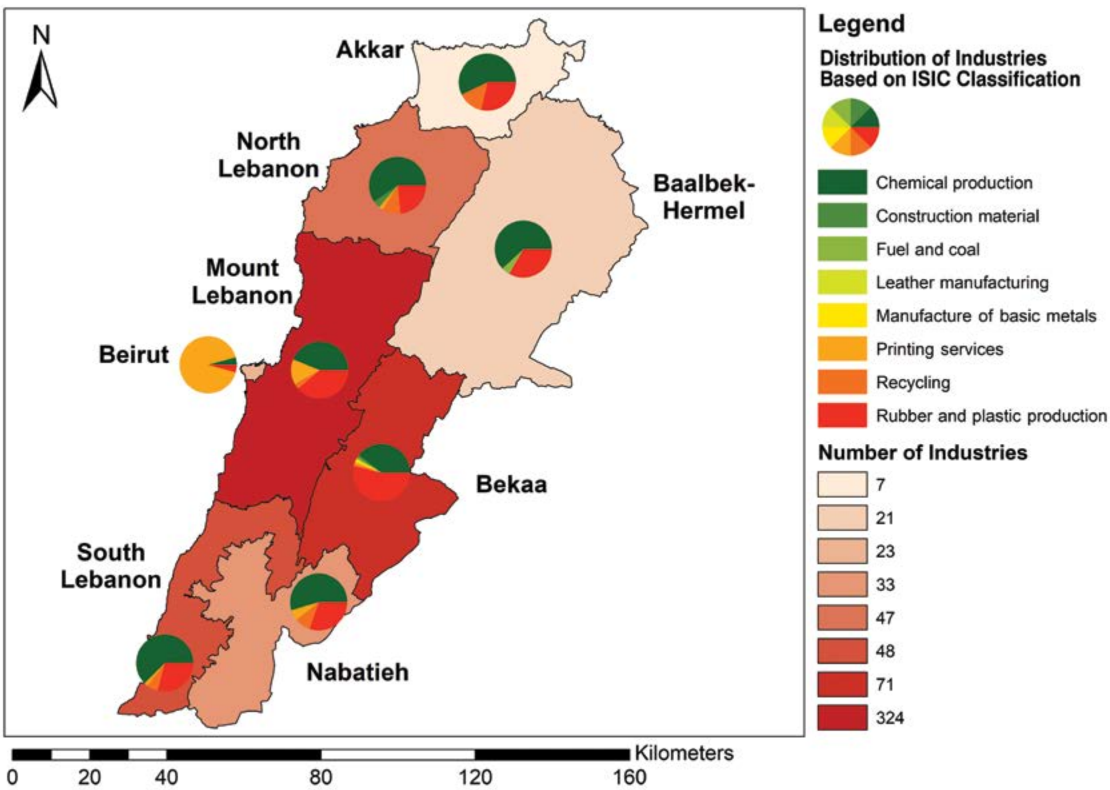

Figure 10-3 Distribution of Industries within Governorates Based on ISIC Classification
Source: Data provided by MoI in November 2020

10.2.1.2 Agriculture Sector

Chemicals of relevance used in the agricultural sector are mainly pesticides that are applied by farmers on agricultural lands throughout the county. Cadmium, a heavy metal with considerable toxicity, is also associated with the use of fertilizers and pesticides. Figure 10-4 shows that Baalbek-Hermel governorate has the largest area of agricultural lands (767 km^2) followed by the governorates of Bekaa, Nabatieh, Akkar, and South Lebanon. Mount Lebanon and North Lebanon governorates have less agricultural lands (359 and 301 km^2, respectively) while Beirut has none.

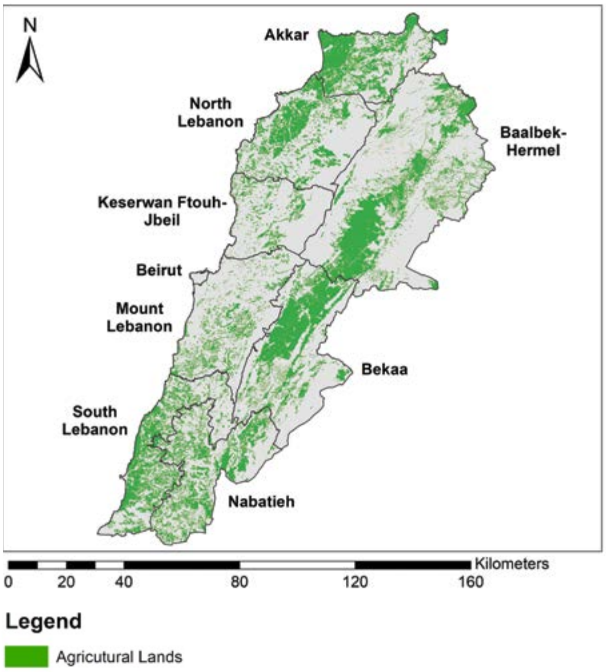

Figure 10-4 Distribution of Agricultural Lands across the Governorates
Adapted from LULC shapefile CNRS, 2017

10.2.1.3 Power Sector

The power sector components including production plants, transmission stations, and distribution grids are considered as potential users/stock of PCB oil and PCB-containing equipment. This section describes the current status of the sector while the presence of PCB in the power sector in Lebanon is discussed in Section 10.2.3.2 (PCBs). The main electricity provider in Lebanon is the state-owned power utility Electricité du Liban (EDL), which owns seven thermal power generation plants across different regions in the country (Figure 10-5).

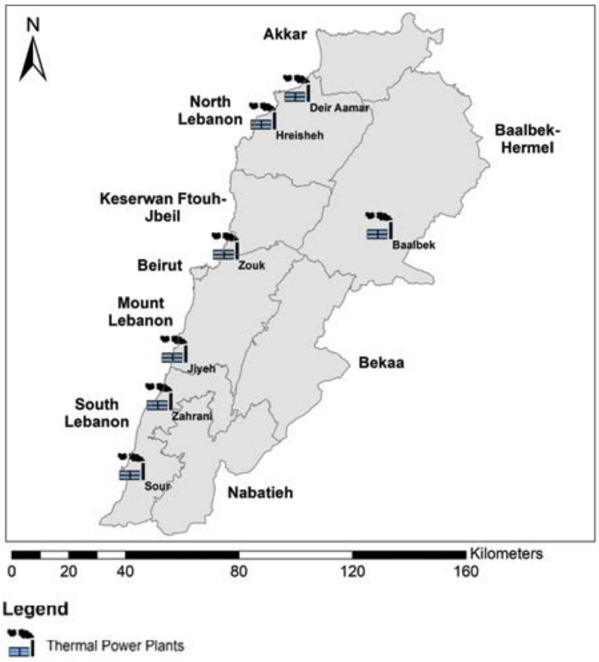

Figure 10-5 Thermal Power Plants Location in Lebanon
Source: Adapted from EDL Website

EDL also operates a total of 66 main substations that are distributed throughout the Lebanese territories as represented in Table 10-1.

Table 10-1 Distribution of EDL Main Substations in Lebanon

Governorate	Number of Substations
Beirut	11
Bekaa and Baalbek-Hermel	11
Mount Lebanon and Keserwan Ftouh-Jbeil	25
North Lebanon and Akkar	11
South Lebanon and Nabatieh	8
Total	**66**

Source: Adapted from EDL website

In addition, around 29,238 power transformers are owned and managed by different stakeholders (mostly by EDL and concessions) in Lebanon. Table 10-2 presents the distribution of power transformers by owner/provider (MoE, 2018a). Noting that the below table excludes the power transformers owned and managed by the private sector such as industries, healthcare facilities, academic facilities and others.

Table 10-2 List of Transformers Provided by Different Stakeholders

Owner/Provider (Caza/Governorate)	Number of Transformers
Aley Concession (Aley/Mount Lebanon)	213
Beddawi Refinery (Minieh-Dannieh/North Lebanon)	7
Bhamdoun Concession (Baabda/Mount Lebanon)	66
EDL	24,990
Jbeil Concession (Jbeil/Keserwan Ftouh-Jbeil)	503
Litani River Authority	30
Military	22
Nahr Bared Concession (Minieh Dannieh/ North Lebanon and Akkar/Akkar)	10
Nahr el Jaouz Concession (Batroun/North Lebanon)	56
Nahr Ibrahim Concession (Jbeil/ Keserwan Ftouh-Jbeil)	19
Qadisha Concession (Bcharreh/North Lebanon)	2,369
Zahleh Concession (Zahle/Bekaa)	872
Zahrani Oil Installations (Nabatieh/ Nabatieh)	81
Total	**29,238**

Source: MoE, 2018a

10.2.2 Chemical Exports and Imports

In 2015, the value of Lebanese chemical exports, corresponding to 390,000 tons, reached USD 355 million and accounted for 14% of total industrial exports from the country. It was placed third in terms of the most exported industrial product. Figure 10-6 illustrates the evolution of the Lebanese chemical exports and imports between 2012 and 2015.

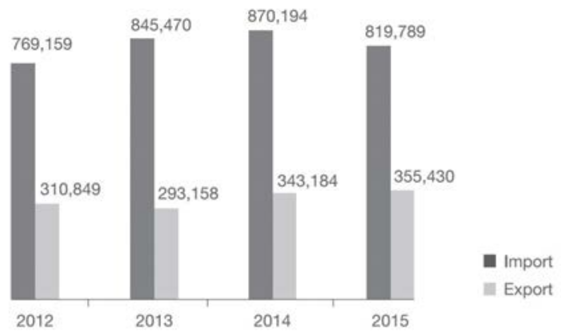

Figure 10-6 Evolution of Lebanese Chemical Exports and Imports (2012 and 2015) in thousand USD
Source: IDAL, 2016

Essential oils, resinoids, cosmetics and toilet preparations are highest (27% of total chemical exports), followed by plastics and articles thereof (26%) and fertilizers (17%). As for chemical imports, plastics and articles thereof are highest (40% of total chemical imports), followed by essential oils and resinoids, cosmetics and toilet preparations (14%), and miscellaneous chemical products (10%). Lebanon is a net exporter of inorganic chemicals, which constituted 2% of total exports in 2015 and fertilizers (3%) (IDAL, 2016).

Lebanon does not manufacture pesticides but depends on imports to meet its needs. Suppliers, who are mainly agent distributors for international firms, are registered and licensed by the Ministry of Agriculture (MoA) for agricultural use pesticides and the Ministry of Public Health (MoPH) for domestic use pesticides (refer to Section 10.3.2.2 for process). In December 2019, there had been 53 licensed agricultural pesticide importers in Lebanon and two local licensed formulators. They are controlled by national regulations and are regularly monitored by the relevant authorities (Abou Zeid, 2020). At the local level, the distributors purchase pesticides from the suppliers. Some distributors are registered in the chambers of commerce, industry and agriculture and at the Ministry of Economy and Trade (MoET) and others are informal, not necessarily following national regulations or registered with relevant authorities (MoE/UNEP/GEF, 2017b).

According to (FAO, 2020), above-average quantities of fungicides and herbicides were imported in 2019. Although the amount of insecticides was below the ten-year average, it was similar to the amount imported in the last five years (Figure 10-7). Due to the restrictions on foreign currency transaction in place since October 2019 in Lebanon, it has been observed that the agricultural sector has moved to a low input system (FAO, 2020). This has likely already led to a decrease in purchase of imported pesticides as farmers search for cheaper alternatives. These alternatives usually include older generic products that pose higher environmental and health risks than new products due to their higher intrinsic hazard and their method of application (MoE/UNDP, 2011).

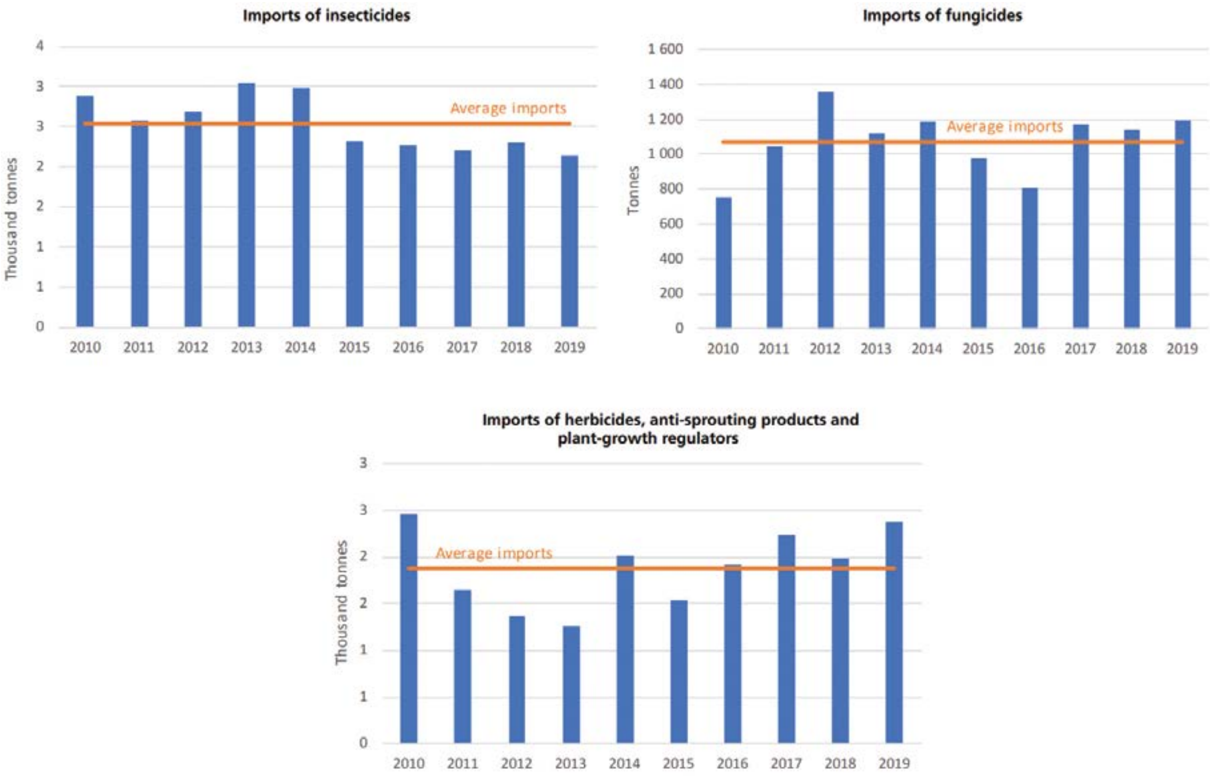

Figure 10-7 Imports of Insecticides, Fungicides and Herbicides from 2010 – 2019
Source: FAO, 2020

10.2.3 Chemical Emissions/Release

Chemicals are introduced into the environment through acts of nature (e.g., volcanoes, hurricanes), spills on land, emissions to air, and discharges to water, thus degrading its resources. Some of these chemicals break down quickly, while others persist for long periods in the environment and may bio-accumulate in the food chain (USEPA, 2018). In this section, the release of different kinds of chemicals into the Lebanese environment is described based on available studies conducted on the release of various chemicals into water, air and soil in different regions.

10.2.3.1 Heavy Metals

The presence of heavy metals in the water and sediments of Lebanese rivers is due to contamination from anthropogenic sources, particularly industrial and domestic wastewater discharged untreated into the rivers, water runoff, urbanism and landfills. Information on the level of pollution in surface and groundwater, sediments and soils by heavy metals and micropollutants is limited across Lebanon to a few sporadic studies presented in this section.

River and Lake Waters and Sediments: The presence of heavy metals in sediments of the El-Kabir River, the lower Litani River Basin, and the Qaraoun Lake has been documented in several studies (Table 10-3). High levels of certain heavy metals, especially Zinc, Chromium, and Nickel, were found in El-Kabir Riverbed (Thomas et al., 2005). In Qaraoun Lake, moderate to high levels of heavy metals were detected in the sediments indicating moderate to heavy Lead, Copper and Zinc pollution and heavy Chromium and Nickel pollution (Haydar et al., 2014). The Litani River Basin suffers from severe stress on its surface and groundwater. High concentrations of heavy metals have been detected in the bed sediments of the Lower Litani River Basin compared to permissible limits, especially during dry seasons. Significant sediment pollution was also detected at the end point of the Litani River due to the deposition of pollutants in this site (Nehme et al., 2014). These studies conclude that sources of water and sediment contamination by heavy metals are mainly agricultural and industrial activities as the sampled sites were in close proximity to intensively cultivated agricultural areas or surrounded by industries such as leather tanning and metal plating. These sources transport pollutants, including heavy metals, through direct effluent discharges and runoffs into water and sediments.

Table 10-3 Heavy Metal Concentrations in El-Kabir River, Qaraoun Lake, and Lower Litani River Basin

Heavy Metal	El-Kabir River (mg/kg, dry weight)[1]	Qaraoun Lake (mg/kg, dry weight)[2]	Lower Litani River Basin (mg/kg, dry weight)[3]	ISQG (mg/kg)[4]
Zinc	200	162.5	110.7 (Rainy Season) 40.3 (Dry Season)	123
Lead	11	39	70.3 (Rainy Season) 35.3 (Dry Season)	35
Cadmium	-	2.4	8.7 (Rainy Season) 23.3 (Dry Season)	0.6
Chromium	732	151	15.3 (Rainy Season) 21.7 (Dry Season)	37.3
Nickel	486	65.3	4 (Rainy Season) 8.7 (Dry Season)	23

[1] Source: Thomas et al., 2005,
[2] Source: Haydar et al., 2014
[3] Source: Nehme et al., 2014
[4] Interim Freshwater Sediment Quality Guidelines (ISQGs) (Source: Nehme et al., 2014)

Another study conducted within Al Ghadir River catchment indicated the presence of heavy metals in sediments. Mercury levels at one site (0.202 mg/kg) were slightly above the Western Australia Department of Environment and Conservation low standard[1] (0.15 mg/kg). At another sampling site, significantly high Zinc concentrations were reported (580 mg/kg), well above the high standard1 (410mg/kg). Elevated concentrations of heavy metals may be explained by the discharge of industrial wastewater into the river without prior treatment as the sediment samples were taken from locations near a cluster of industries (EIB/MoE/Enviroplan/Ecocentra, 2018).

Groundwater and Springs: A survey conducted under the Litani River Basin Management Support (LRBMS) Program was used to assess levels of trace metals in groundwater (springs and wells) of the Upper Litani Basin during the wet and dry seasons of 2010-2011. All macro- and microelements tested in this survey were within the limit values set by the United States Environment Protection Agency (USEPA) Standards and World Health Organization (WHO) Guidelines for both wet and dry seasons, except for Cadmium and Manganese. Results reported on Cadmium showed that the mean level (0.00736 mg/L) exceeded the recommended USEPA standards of 0.005 mg/L by 1.5 folds during the dry season. Mean Manganese concentration (0.07 mg/L) showed an exceedance by 1.4 folds of the USEPA standard levels (0.05 mg/L), for the dry season. Barium concentrations were detected during both seasons at levels below the recommended USEPA limit. It was also noted that all measured trace metals exhibited a decreasing trend during the wet season except for Molybdenum and Chromium. However, both mean levels were still less than the WHO acceptable limits. This confirms the presence of point and non-point sources of pollution (i.e. domestic and industrial wastewater effluents, agricultural runoff) as mostly all sampled water springs were located in an area with a mixed residential, agricultural, industrial and recreational setting (LRBMS, 2011).

As for samples collected from wells in the Upper Litani Basin, high Manganese concentrations were detected during the wet season at four sampling sites, one of them (Mansoura, West Bekaa Caza) recording 0.064 mg/L and exceeding the 0.05 mg/L USEPA standard limit and another in Ablah, Caza Zahle recording 0.038 mg/L, which is below the limit (LRBMS, 2011), compared to higher levels detected during the dry season, reaching in Ablah levels 2.7 folds the USEPA standard level (LRBMS, 2010). Concentrations of all other measured trace metals were diluted during the wet season except for Zinc levels that increased 1.59 folds, still remaining below the acceptable USEPA level of 5 μ/L. The presence of high heavy metal concentrations at these sites can be explained by the presence of anthropogenic activities near the sampled well sites, including agricultural activities, as mostly all groundwater sources are located in mixed residential and agricultural settings (LRBMS, 2011).

Marine Water: The Lebanese marine water is exposed to various chemical contaminants from several sources such as industrial and residential wastewater effluents, coastal agricultural runoffs, dump leachates and oil spills. A study on marine waters in Lebanon found that the highest levels of Zinc were reported in the vicinity of a waste dumpsite and a ceramic factory,

[1] The trigger/low value under this standard is a threshold concentration and below this concentration the frequency of adverse effects is expected to be very low while the High concentration is intended to represent a concentration above which adverse biological effects are expected to occur more frequently.

of Copper in the vicinity of paints and plastic factories and ceramic and electroplating workshops and of Chromium next to tanneries, slaughterhouses and metal processing facilities. The highest concentrations of Lead were reported close to metal processing facilities and petroleum stations, those of Mercury near hospital wastewater effluents and solid waste dumps, and Cadmium in the vicinity of fertilizer producing factories (Korfali and Jurdi, 2012).

Many of the major industries in Lebanon are located outside industrial zones and dispose of cement, pharmaceuticals, paints, plastic, paper, fertilizers, textile, tanneries and metal processing waste without prior treatment into the sea. Tanneries are estimated to release approximately 40 tons of Chromium directly into the sea. One fertilizer company is estimated to release yearly around 0.7 tons of Cadmium, 2 tons of Lead, and 2 tons of Nickel into the sea. The discharged heavy metals are non-biodegradable and accumulate in the aquatic ecosystem, deteriorate water quality and consequently human health. According to the toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota (TRV), data on the levels of heavy metals in marine water show high levels of Zinc (404.71 μg/L; TRV 120 μg/L), Copper (84.88 μg/L; TRV 6.54 μg/L), Chromium (215 μg/L; TRV 117 μg/L), Lead (18.88 μg/L; TRV 1.32 μg/L), Mercury (4.57 μg/L; TRV 0.012 μg/L), and Cadmium (1.13 μg/L; TRV 0.66 μg/L) (Korfali and Jurdi, 2012). Continuous monitoring data related to actual release of heavy metals into the environment from such industries is not available. However, in the last few years, environmental audits for industries have been conducted and reported to MoE. This will help in establishing a monitoring database in the future.

Soils: Heavy metals are introduced to the soil through various industrial and agricultural activities, changing the natural, chemical and biological soil characteristics and affecting all living beings (Chaza el al., 2018). The results of a study to assess the presence of pesticides and heavy metals in the agricultural soils of Akkar detected heavy metals such as Arsenic, Copper, Nickle, Lead and Zinc. Their concentrations were within the maximum allowable in neutral soil after agricultural and sewage sludge application fixed by European Union (EU) Directive 86/278/EEC. However, the mean Cadmium concentration in the soil samples (7.8 mg/kg) exceeded the EU limits (3 mg/kg) by over 2.5-fold. This high concentration may be attributed to presence of this heavy metal in many fertilizers (Chaza el al., 2018). Another study assessed the presence of heavy metal in the soil around a phosphate fertilizer industry located on the coast. The industry was storing and disposing its solid waste directly into the surrounding environment without any prior treatment. The study concluded that the main source of heavy metal contamination is the transportation of raw material and waste along the main road leading to the industry, followed by the storage of waste at atmospheric conditions (Aoun et al., 2010).

Kanbar et al. (2014) investigated the soil and sediment quality at two sites within the eastern side of the Qaraoun reservoir in the Beka'a. The two sites showed distinguishable properties for features such as metal content (Cadmium, Copper and Lead). Reported high Cadmium levels may be explained by the presence of agricultural practices close to the reservoir. Copper and Lead levels may be attributed to the presence of a nearby smelting operation, such that Lead is also associated with automobile emissions. In addition, the proximity of the Qaraoun to agropastoral factories (Ablah and Chtaura), food and milk processing industries (Ferzol, Anjar and Jdita), paper mills (Kab Elias and Qaa Al-Rim), rock cutting industries (Chtaura and Zahle), wastewater treatment plants (Mekse, Chtaura, Qab Elias and Zahle), and slaughterhouses (Zahle) also contribute to soil pollution especially with heavy metals (Kanbar et al., 2014). Input of trace metals in agricultural soils from phosphate fertilizers was further assessed in Lebanon with the aim of inciting emerging Eastern Mediterranean countries to set new limits for trace metals in phosphate fertilizers and better control their use in alkaline soils. The study concluded that the presence of alkaline soils combined with the arid to semi-arid climate in Eastern Mediterranean countries facilitates the accumulation of trace metals. Therefore, careful attention must be paid when setting the limits for trace metal inputs in soils (Azzi et al., 2017).

Food Chain: Heavy metals may be adsorbed from the air and deposited on the surface of vegetables or may be absorbed by the crop roots from contaminated water used for irrigation and integrated into the edible part of plant tissues. Evidence of heavy metal contamination was found in vegetables grown and sold in various areas in Lebanon. High concentrations of Lead, Cadmium, and Chromium and low concentrations of Arsenic were detected in different types of vegetables (Al-Chaarani et al., 2009). Higher levels of heavy metals were found in leafy vegetables such as zaatar (thyme), bakleh (purslane), parsley, spinach, lettuce and mint, compared to aboveground and underground vegetables. Thorough washing of vegetables with water was found to decrease the concentrations of toxic metals (Figure 10-8).

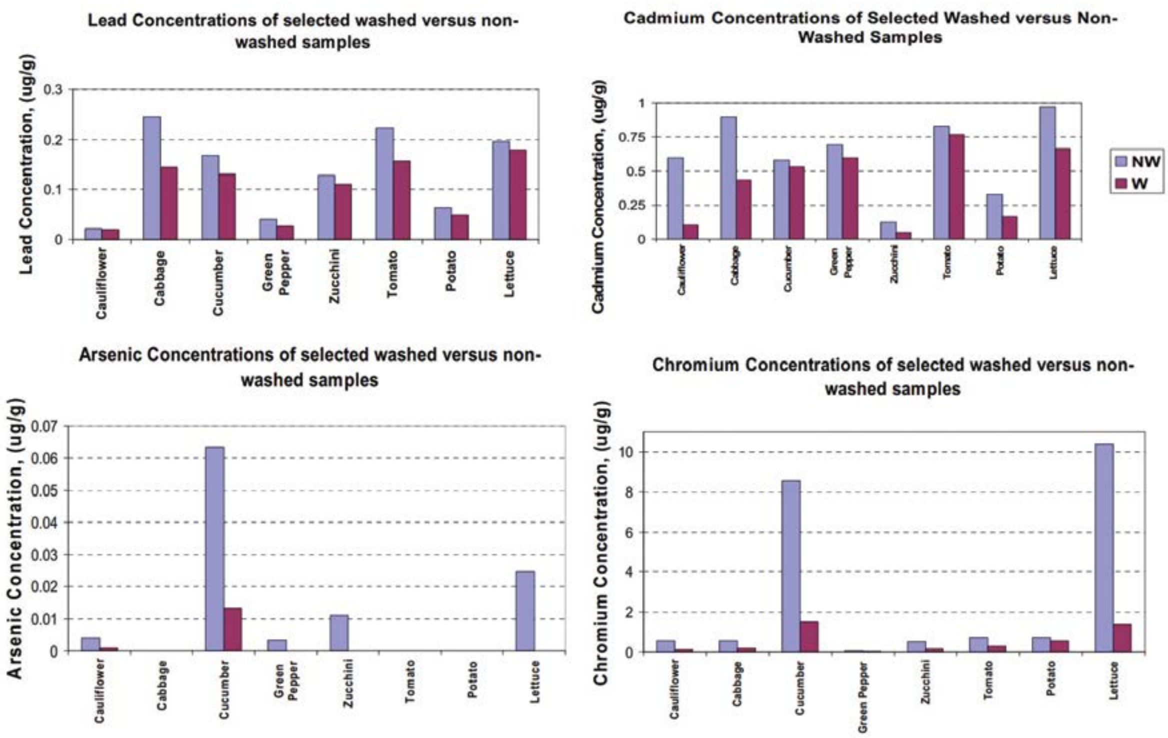

Figure 10-8 Heavy Metal Concentrations in Washed (W) and Non-Washed (NW) Vegetables
Source: Al-Chaarani et al., 2009

The accumulation of heavy metals was assessed in soil and leaf tissue of spinach cultivated in Khirbet Kanafar village in the Bekaa region and irrigated with wastewater. Although the results showed that the heavy metals contents in soil and leaves were below the permissible limits recommended by EU Directive 2002/32/EC, the study concluded that continuous monitoring of heavy metals in soil and in plant tissues is important to prevent the build-up of these metals in the human food chain (Mcheik et al., 2018).

As for canned food, Kassouf et al. (2013) monitored the migration of trace metals (Iron, Tin, Lead and Cadmium) in chickpea cans marketed in Lebanon. The results showed that Iron and Lead are released from chickpea cans thus altering the organoleptic properties of the food. (Kassouf el al., 2013). Another study examined the exposure of the Lebanese population to trace elements from the consumption of white pita bread. The study quantified trace elements coming from three pita brands. Nickel, Cobalt, Arsenic, Cadmium, Chromium, Mercury and Lead were detected at various concentrations in the three examined brands. In terms of risk characterization, no safety concerns were indicated for Mercury, Cadmium, Chromium or Cobalt (except for the 95th percentile of 6–9 years old). However, there were safety concerns related to Arsenic and Lead as the highest exposures (95th percentile) were above toxicological reference values suggesting an alarming risk for the Lebanese population (Lebbos et al., 2019).

These studies demonstrate that different environmental components in various regions of the country are contaminated with heavy metals, which necessitates efforts to conduct continuous targeted monitoring campaigns to protect the environment and public from associated risks of these hazardous chemicals.

Mercury

According to the WHO, Mercury is considered one of the top ten chemicals of major public health concern. The sources of mercury in the environment are anthropogenic, mainly medical waste, power and cement plants, and industrial applications (WHO, 2017).

Healthcare Sector: In Lebanon, the healthcare sector is the highest contributor to environmental mercury pollution. Healthcare establishments generate mercury from healthcare wastes containing mercury-based products and discharge of untreated wastewater. The estimated burden of mercury released annually is 31 kg (IndyAct, 2011; Obeid et al., 2017). Mercury is mainly contained in common medical measuring devices (thermometers, sphygmomanometers, blood pressure devices) and a number of gastro-intestinal devices (IndyAct, 2011). Mercury waste including mercury thermometers in two assessed facilities under the “Demonstrating and Promoting Best Techniques and Practices for Reducing Health-Care Waste to Avoid Environmental Releases of Dioxins and Mercury” project used to be thrown with regular waste. This healthcare waste was then disposed in nearby open dumps that caught fire either accidently or intentionally causing the generation of toxic dioxins. After implementation of this project, the two pilot facilities improved their health waste management practices, thus improving environmental conditions within the surrounding area (MoE/UNDP/GEF, 2013). However, no updated data is available on the current practices of these facilities.

Mercury is also present in amalgams used by dentists in tooth-filling operations. One study found that in dental care clinics that use these amalgams without any specific control, mercury levels exceeded 3,000 ng/m^3. In clinics that still use mercury amalgam, but in a packaged form and utilize a mechanical closed mixer, mercury levels were between 214 and 797.1 ng/m^3. In clinics that have stopped the use of mercury amalgam but still use them in rare and special cases, mercury levels were found to be between 62 and 170.4 ng/m^3, revealing that mercury can persist in closed spaces. In the clinics that completely stopped the use of mercury amalgam for a long period of time, mercury levels were detected between 2.4 - 31.4 ng/m^3 (IndyAct, 2011).

Atmosphere: Evidence of Mercury in the atmosphere has been found in a 2011 study that measured the levels of Mercury in ambient air in different areas in Lebanon. Average levels of Mercury ranging between 1.6 - 2.7 ng/m^3 were measured in rural areas in the South, the North and Mount Lebanon. This result was explained by the existence of uncontrolled dumps and burning of waste containing Mercury in rural areas. Results of measurements in urban areas showed average levels between 0.5 and 4.3 ng/m^3 in some areas such as Choueyfat, Khaldeh, Jbeil, Beirut Sassine Square, Beirut Burj Abou Haydar and Saida’s North entrance. Higher levels of Mercury (between 5 and 20 ng/m^3) were found in other areas, such as Saida Etoile Square and in Beirut in locations near Rizk Hospital and American University of Beirut - Medical Center and near its boilers. The highest levels of Mercury in urban areas were explained by medical waste incineration in the vicinity of the hospitals, burning of a large amount of fuel in the vicinity of the boilers and heavy traffic (IndyAct, 2011). High levels of Mercury were also detected in the vicinity of the cement industry zones (between 2 to 80 ng/m^3) and of the power plant in Jiyeh (between 6.6 - 12.7 ng/m^3 at a distance of 400 m and between 7.9 - 18.3 ng/m^3 at a distance of 800 m). Evidence of Mercury was reported next to uncontrolled dumps in Kfar Tibnit (Nabatieh), Ras El Ain (Tyr), and Saida (IndyAct, 2011).

Marine Fish: The presence of Mercury has been documented in several studies on fish caught along the Lebanese coast, as well as in frozen and canned seafood products in Lebanese markets. In 2011, high total Mercury accumulation was detected in fish samples collected from local markets along the northern Lebanese coast. High levels of Mercury were reported in local fresh samples with the highest levels in shrimp (0.5697 μg/g), followed by Mallifa (0.4445 μg/g), Ghobbos (0.3831 μg/g), Sargous (0.3408 μg/g), Ajaj (0.2346 μg/g), Zellek (0.2242 μg/g), Bezri (0.2115 μg/g), Abou Shawki (0.1833 μg/g) and Sardine (0.1739 μg/g). Most of these exceed the USEPA reference dose of 0.22 μg/g. Frozen and canned fish such as fish fillet, fish burger, small shrimp and crab contained lower levels of Mercury that were within the USEPA reference dose. The Mercury levels in fish were higher in the areas of El Abde, Deir Aamar and Anfeh, indicating that the shores in these areas are more polluted with Mercury (Figure 10-9). Indeed, one of the largest power plants is located in the areas of El Abde and Deir Aamar and two cement industries are located in Chekka, near Anfeh, which may be responsible for the release of Mercury (Obeid et al., 2011).

Lead

According to the WHO, Lead is a toxic metal whose widespread use has caused extensive environmental contamination and health problems globally. Sources of Lead are mostly anthropogenic including mining, smelting, refining and recycling of lead, use of leaded petrol (gasoline) and manufacturing of lead-acid batteries, paints, glazes and leaded glass (WHO, 2019). The Lebanese government banned the use of leaded petrol in 2002. A study had been conducted a year earlier targeted individuals working in sectors known to be exposed to Lead including traffic flow controllers, taxi drivers, gasoline station staff, pipe soldering workers, glass industry workers, battery recycling workers, oil refinery workers and lead-containing pigments industry workers. The results showed that high levels of Lead were found in the hair of occupationally exposed individuals. Non-occupationally exposed individuals also had measurable Lead concentrations in their hair. However, a 5 to 6-fold difference in hair Lead levels was found between occupationally exposed (23.60 ppm) and non-exposed (4.33 ppm) individuals (Salameh et al., 2008).

Although legal measures had been taken by the Lebanese government to ban its usage in paint, some industries are still using Lead in their manu-

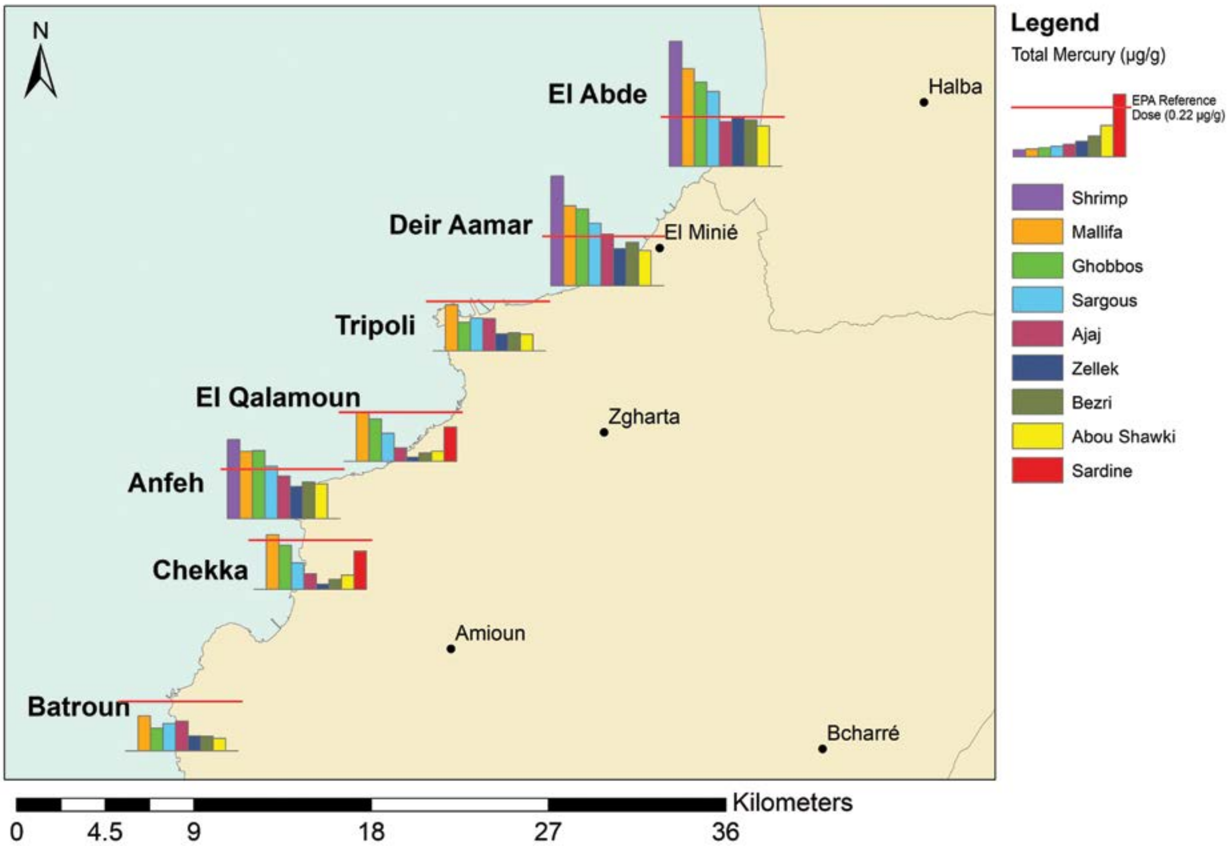

Figure 10-9 Mercury Concentrations in Fresh Fish and their Locations of Purchase
Source: Adapted from Obeid et al., 2011

facturing process. Lead concentrations were detected in new enamel decorative paints in three different countries of the world, including Lebanon. In fact, the highest concentrations of Lead in different paint brands were found in Lebanon (236,000 ppm) (Clark et al., 2015). High blood Lead levels were also reported among the Lebanese population in a study undertaken to assess the use of toxic chemicals that are frequently found in the Mediterranean region. The mean blood Lead level in Lebanese children with an age range of 1-3 years was 66 µg/L, with 14% of the children having Lead levels above or equal to the intervention level of 100 µg/L adopted in the United States. The study concluded that the main source of Lead is from pigments present in decorative paints (SCP/RAC, 2018).

Lead content was analyzed in cactus cladodes and roots, dust deposited onto the cladodes and in soil samples collected in the vicinity of heavily polluted sites, including the area around a fertilizer production industry and Saida city next to the busy coastal highway. Results of this study show obvious soil contamination with Lead in samples collected near the fertilizer company (54.8±20.6 mg.kg−1) and Saida (168.2 mg.kg−1) (El Hayek et al, 2015). The presence of Lead was also documented Section 10.2.3.1 in conjunction with other heavy metals in river sediments, marine water, Qaraoun Reservoir, vegetables and canned food. Due to its acute toxicity at very low levels, Lead requires more thorough monitoring to detect its evolution in canned foodstuff as a 2013 study showed increased concentrations that may lead to levels exceeding allowable limits in canned food (Kassouf el al., 2013).

10.2.3.2 Persistent Organic Pollutants

Persistent organic pollutants (POPs) are organic compounds of global concern due to their resistance to degradation, persistence in the environment, and ability to bio-concentrate in the ambient environment and bio-accumulate through the food chain (MoE/UNEP/GEF, 2017b). POPs are grouped into three main categories according to their uses and chemical formulae: Pesticides, Industrial (IPOPs) and Unintentionally Released (UPOPs).

In compliance with the Stockholm Convention on POPs, ratified by the Government of Lebanon (GoL) in 2003, a National Implementation Plan for POPs was adopted in 2005 and updated in 2017, including national inventories of PCBs and pesticides. In addition, a National Assessment of POPs Impacts and Management, including agricultural, industrial, and unintentionally released POPs, was prepared in 2017. An additional assessment of some IPOPs was also conducted in 2018.

Industrial POPs

Industrial POPs such as PCBs, Perfluorooctance Sulfonic Acid (PFOS), Polybrominated Diphenyl Ethers (PBDE), Hexabromocyclododecane (HBCD) and Short Chain Chlorinated Paraffin (SCCP) are not currently manufactured in Lebanon. In fact, data about IPOPs prevalence and emissions in Lebanon is quite limited and can only be estimated.

PCBs

The primary known source of PCBs in Lebanon are the insulating oils that were previously found in power equipment (namely transformers and capacitors) used by the power sector in Lebanon, mainly EDL. Even though PCBs are not manufactured in Lebanon, local industries can be considered as unintentional sources of PCBs. Before the ban of PCBs, insulation oils contained substances composed of highly chlorinated PCBs. Potential hotspots for PCBs include almost all production power plants (thermal and hydro), transmissions substations and network distribution grid, in addition to large private facilities (industries, academic facilities, healthcare facilities and others). Under the World Bank "PCB Management in the Power Sector Project", a national PCB inventory (2016-2019) had been carried out for around 22,983 power transformers, 80% of the overall 29,238. Even though PCB-free oils have been in use since 1997, the results of the oil sampling and laboratory testing that occurred during the national inventory, showed that 1,274 transformers (scrap, out-of-service and in-service) in Lebanon were contaminated with PCBs at levels above 50 ppm, mainly due to cross-contamination during operation and maintenance. Thus, the total amount of PCB waste that needs to be disposed from those identified PCB contaminated transformers, was estimated to be 1,637 tons. The national inventory targeted at that time only the power assets (transformers and capacitors) owned and/or operated by public sector (EDL, concessions, oil refineries, water establishments, army). PCB contaminated transformers by service provider indicate a significant percentage within the concessions, followed by public institutions, EDL transmitters and depot, and EDL distributors. The highest number of PCB contaminated transformers was found in Qadisha Concession (316 transformers) followed by the Baouchrieh depot/EDL (256 transformers) as shown in Figure 10-10 presenting the distribution of the number of contaminated transformers by owner/provider (MoE, 2018a).

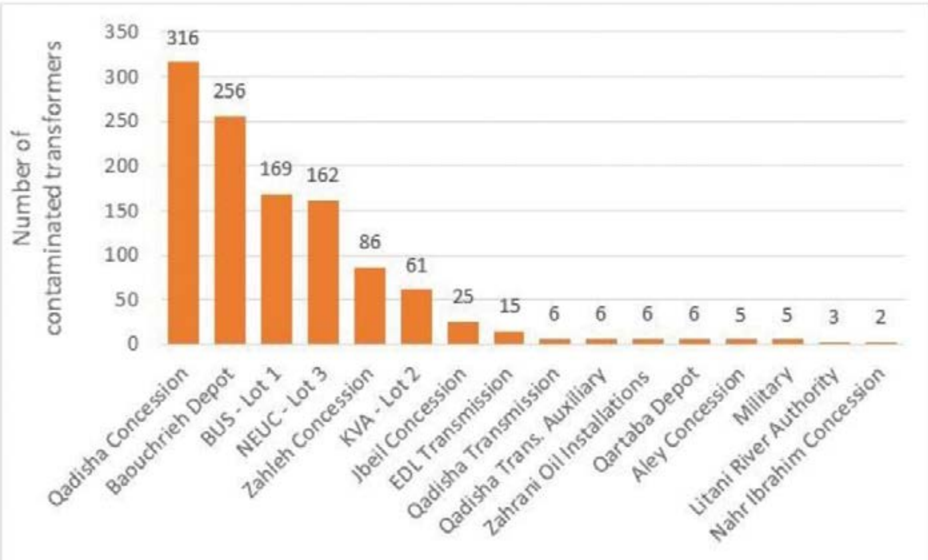

Figure 10-10 Distribution of PCB-contaminated Transformers by Owner/Provider
Source: MoE, 2018a

As for PCB concentration, the inventory showed that the highest proportion was for transformers contaminated at levels ranging between 50 and 500 ppm (76%). The Military had the highest percentage of PCB-contaminated transformers with levels higher than 2,000 ppm (100%), since all were found to be Askarel (PCB congener concentrations between 30% and 70%) (Figure 10-11).

age concentration of all soil samples was 105 mg/kg indicating that the entire site may be contaminated with PCB (COWI/ECODIT, 2011). Figure 10-12 shows the status of the ground at the storage site indicating oil leakages.

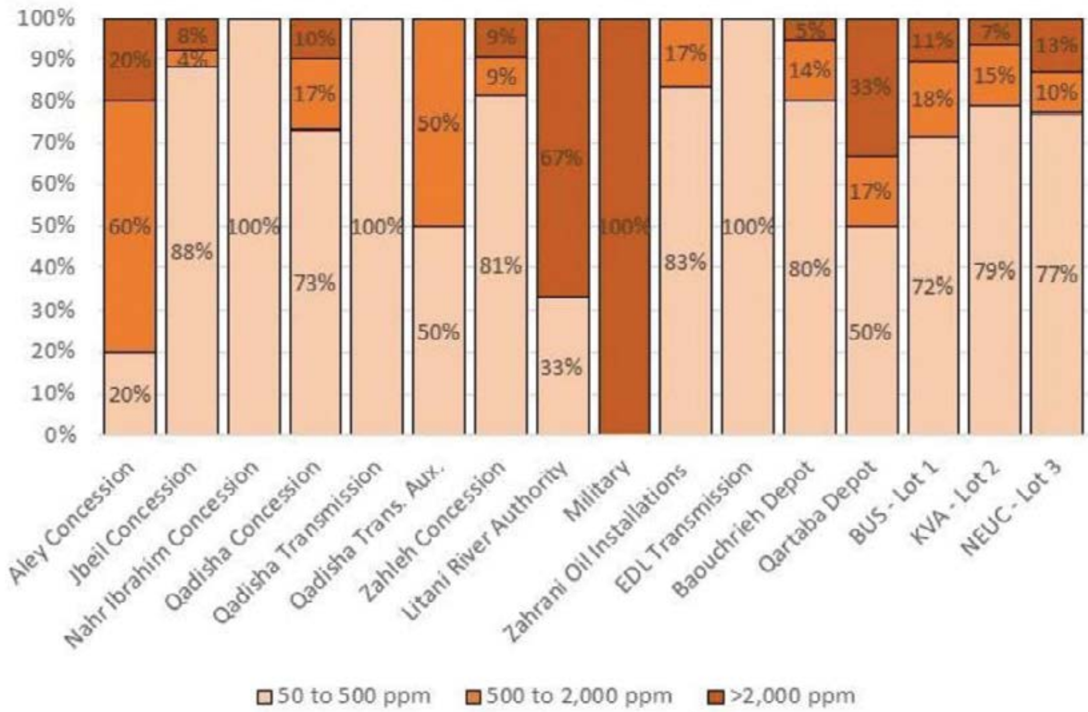

Figure 10-11 Distribution of PCB-contaminated Transformers by Range of PCB Concentration
Source: MoE, 2018a

In addition, about 83% of PCB contaminated transformers are more than 20 years of age. Out of the 33 drums and tanks used to store or transfer oil, two in Baouchrieh Depot/EDL and two in Behsas Depot/ Qadisha concession were found to contain PCB concentrations above 50 ppm.

The primary PCB hotspot in Lebanon is the EDL repair shop located in the suburbs of Beirut (Bauchrieh). It is the main centralized storage area where damaged transformers are stored. (MoE, 2018a). In 2010, the site was assessed for PCB contamination. The results showed that out of the eleven soil samples, seven samples were PCB-contaminated (above a level of 50 mg/kg). The highest concentration was 376 mg/kg whereas the lowest concentration was 16 mg/kg. Even inside the workshop, the concentration in the upper floor was above 50 mg/kg. The reported aver-

Figure 10-12 Bauchrieh Storage Site Showing Cracked Pavement and Oil Leakages

As for the assessment of PCBs in open applications in Lebanon, in 2016, a rapid study was conducted under the "PCB Management in the Power Sector Project" to identify whether PCBs were used in construction materials in Lebanon. Paints and materials used in construction along with buildings constructed or rehabilitated between 1950 and 1980 were targeted as that period experienced a high level of activity and PCB had been used globally in construction. The assessment confirmed the historical use of PCBs in open applications mainly for paints used in road marking, for coatings in selected metal applications and possibly in further use. It is worth mentioning that PCB paints were not manufactured in Lebanon but were imported. As for sealants, the assessment indicated minor use in Lebanon (Weber&Karam, 2017).

In terms of presence in the Lebanese environment, studies have found detectable levels of PCBs in the Hasbani River and in the sediments in Tripoli Harbor. The Hasbani River was found to be contaminated with the PCB52 congener at levels exceeding the permissible limit set by the USEPA (Badr et al., 2014). The sediments in Tripoli Harbor, the second largest port in the country, were also found to be contaminated with 24 types of PCBs, of which 60% are the more active tetra-, penta- and hexa-chlorinated PCBs. The abundance of the detected PCBs may be the consequence of atmospheric emissions from shipping and transit activities, generators and port equipment (Merhaby et al., 2015). In addition, a recent study has shown that the Abou Ali River in North Lebanon contributes a significance amount of PCB into the Mediterranean (Merhaby et al., 2019). High levels of PCBs have also been detected along the Lebanese coast, with the highest levels in the sediments of Beirut Port. These have been associated with paints, old equipment or materials used in some vessels, particularly from ship maintenance, and the use of capacitors and transformers in the industrial area surrounding the port (Merhaby et al., 2020).

PFOS

According to the 2017 National Assessment of POPs, potential sources of PFOS, which is not yet banned in Lebanon (refer to Section 10.3.2.2), include surface treatments, paper production and performance chemicals. According to the database of the Lebanese Customs Administration (LCA), products containing a total of 75.5 to 226.5 kg and 105 to 315 kg of PFOS were imported to Lebanon in 2016 and 2017, respectively. For the same two years, an estimated 31.3 to 93.9 kg (2016) and 159.874 to 479.622 kg (2017) of PFOS were estimated to have been imported from firefighting suppliers (MoE, 2018b).

In the surface treatments category, textile and synthetic carpet production and leather tanneries are considered as a main source of PFOS release into Lebanese rivers, groundwater and sea. However, there is no quantification of PFOS emissions for this category. Regarding the paper production category, paper mills and food packaging, industries follow strict EU standards and thus their products are not expected to contain PFOS.

In the performance chemicals category, potential sources of PFOS comprise firefighting foams, metal-plating industry, paints, and plastic and rubber products. Although not all firefighting equipment contain PFOs (such as powder-based ones), firefighting foams with fluorosurfactants used for turning off liquid fuel fires do contain it. Available data shows that, between 2001 and 2014, an estimated 56 to 167 kg of PFOS may have been emitted into the environment, mainly attributed to the activities of the Beirut Fire Brigade in putting out fires, and, to a much lesser extent, to the activities of the Middle East Airlines at Beirut International Airport (MoE, 2018b). Potential PFOS hotspot sites include areas in Greater Beirut such as Ashrafieh, Beirut Port, Koraytem, Zarif, Zokak Belat, Karantina, Talet Khayat, Biel and Jnah, where large fire incidents occurred in residential, commercial and industrial areas between 2006 and 2014 (MoE/UNEP/GEF, 2017a; MoE/UNEP/GEF, 2017b).

As for the metal-plating industry, there is a lack of accurate data regarding the use of PFOS. However, the majority of paints and plastic industries in Lebanon do not use PFOS-containing chemicals in their production activities (MoE/UNEP/GEF, 2017a; MoE/UNEP/GEF, 2017b).

PBDE and HBCD

PBDE and HBCD are used as flame retardants in various consumer products. Potential sources of PBDE in Lebanon include electrical and electronic equipment, transport vehicles, furniture, foam, mattresses and pillows, textile and rubber. These products are either locally produced or imported, except for transport vehicles that are only imported. Textile and rubber are imported in raw forms and further processed in the country to manufacture secondary products. Transport vehicles produced before 2004 are considered as a major source of PBDE release into the environment. A total of 10,506 kg of c-PentaBDE have been estimated to be found in cars between 2004 and 2014. The presence of PBDE in imported electrical and electronic equipment is also likely with about 1.34 tons of OctaBDE estimated to have been imported between 2004 and 2014 in cathode-ray tube monitors. The main manufacturer of electrical and electronic equipment in Lebanon does not currently use PBDE. Low levels of PBDEs are likely in furniture and mattresses, especially those imported from the United States and United Kingdom as furniture in these countries are often flame-retarded.

As for HBCD, potential sources include construction insulation foams, textile and paints. The summary of HBCD assessment findings (2004-2014) showed that 12% of the contacted EPS/XPS/PUR producers and retailers likely imported a total of 3,300 tons of HBCD between 2004 and 2014 (MoE/UNEP/GEF, 2017a).

SCCP

Short-chained chlorinated paraffins (SCCP) are mainly used as a plasticizer in rubber, paints, adhesives, flame retardants for plastics and as an extreme pressure lubricant in metal working fluids (MoE, 2018b). Human health risks and environmental hazards associated with SCCPs are associated with their strong bonding properties to soil and sediments, where it can remain for a significant time and be detected in the ecosystem including freshwater, foods and aquatic and terrestrial mammals (UNEP, 2018). SCCP is not currently produced in Lebanon. Its potential sources in the country include paints and sealants, metal working and lubricants for metal working, polyvinyl chloride and rubber. There are 68 paint and 33 metal working industries operating in the country. However, there is lack of data about their use of SCCP. In fact, the steel industries are not aware of type of oil they use as they import the steel oiled and do not add lubricants to it themselves. In the polyvinyl chloride category, available data indicates that the annually imported chlorinated paraffins is likely between 770 to 1,010 tons per year. In the rubber category, 11 rubber manufacturers exist in the country but there is no primary rubber production (MoE, 2018b).

Unintentionally Released POPs

The main sources to UPOPs are waste incineration, metal production, heat and power generation, production of mineral products, transport, open burning processes, and chemicals and consumer goods. According to the 2017 National Assessment of POPs, evidence of the presence of several types of UPOPs, in particular Polychlorinated dibenzo-p-dioxins (PCDD), Polychlorinated dibenzofurans (PCDF), PCB and Hexachlorobenzene (HCB), has been documented in Lebanon between 2004 and 2014 through calculations based on estimates and emission factors but not on actual measurement. *Refer to Chapter 4 - Air Quality for further information related to UPOPs estimated emissions and their associated sources.*

UPOPs potentially contaminated hotspots include open dump sites, the landfills of Naameh, Bsalim, Zahle, and the controlled dumpsite of Tripoli (MoE/UNEP/GEF, 2017b). In addition, POPs (UPOPs and PFOS) potentially contaminated hotspots include sites where fire incidents had occurred such as near the Bourj Hammoud Landfill, Ain El Remmaneh (fire incident in 2010), the UNHCR warehouse in Jnah (2006), a warehouse owned by the merchandise distributor “Transmed” (2006), the Carpet Plus three-story facilities in Dbayeh (2011), a carpet factory in Safra (2012) and a disposable cups and dishes production facility in Mazraat Yashou (2011). In addition, other POPs potentially contaminated sites include several industrial facilities and key energy-related infrastructures that were damaged during the 2006 war such as the Jiyeh power plant fuel storage tanks, the kerosene fuel storage tanks of the Beirut Rafic Hariri International Airport, transmission and distribution networks and several petrol stations in the South, Nabatiyeh and Bekaa Governorates (MoE/UNEP/GEF, 2017b). The site of the August 4 Beirut explosion is also considered a UPOPs hotspot.

10.2.3.3 Pesticides

Over the past 20 years, agricultural growth in Lebanon has relied primarily on the excessive use of pesticides. Of particular interest is the use of organochlorine pesticides (OCPs), which have been severely restricted in accordance with the Stockholm Convention due to their persistence and bioaccumulation in the environment and their potential harmful effects on wildlife and humans (Helou et al., 2019). Common examples of OCPs include HCB, Endosulfan and metabolites of Dichlorodiphenyltrichloroethane (DDT), including Dichlorodiphenyldichloroethane (DDD) and Dichlorodiphenyldichloroethylene (DDE) (ATSDR, 2011).

Despite the ban of OCPs in Lebanon in 1982, a review of the available data over the past decade shows the presence of various types of OCPs in Lebanon’s rivers, groundwater and sediments, with levels exceeding permissible limits in some sites (Helou et al., 2019). In the Hasbani River, banned OCPs such as DDE, HCB and b-endosulfan have been detected at measurable levels. DDE has shown the highest levels, exceeding the maximum permissible levels set by the USEPA and has demonstrated an increasing trend. Lower levels of HCB, b-endosulfan, and heptachlor have also been measured (Youssef et al., 2015; Badr et al., 2014; Hneine et al., 2017). In the Litani River and the Qaraoun Lake, measurable amounts of nine OCPs have been detected, including DDD, DDE, endosulfan sulfate, b-endosulfan, HCB, heptachlor, lindane, methoxychlor and tetradifon. DDE concentrations have been below the permissible levels in the Litani riverbed but higher than the limit in the Qaraoun Lake, where POPs could accumulate (Kouzayha et al., 2013, Hneine et al., 2017). In the Orontes River, the presence of DDE, HCB, methoxychlor and tetradifon has been reported (Kouzayha et al., 2013) and in the Ibrahim River, the presence of b-endosulfan, HCB and heptachlor have been detected, in addition to high levels of DDE (Hneine et al., 2017). In Abou Ali River, the presence of alachlor, endosulfan, methonyl and chlorpropham has also been detected (Jabali et al., 2020). The following map shows rivers in Lebanon where OCPs have been reported in various research studies (Figure 10-13).

Evidence of OCP contamination in Lebanese groundwater has been found with a total of 21 OCPs detected. In Akkar, the heavy and unrestrained use of pesticides and the nature of the agricultural lands make groundwater highly vulnerable to contamination due to infiltration of pesticide residues from rainwater and irrigation water. Evidence of 20 OCPs has been shown in Akkar groundwater. The detected OCPs exceed permissible limits and indicate illegal use of pesticides (Chaza et al., 2017). The presence of seven OCPs has been detected in the groundwater of the Hasbani basin, with high levels of DDE (Youssef et al., 2015). In addition, evidence of OCP contamination, in particular DDT and DDE, has also been found in Lebanese soil and in the sediments in the Kebir River de-

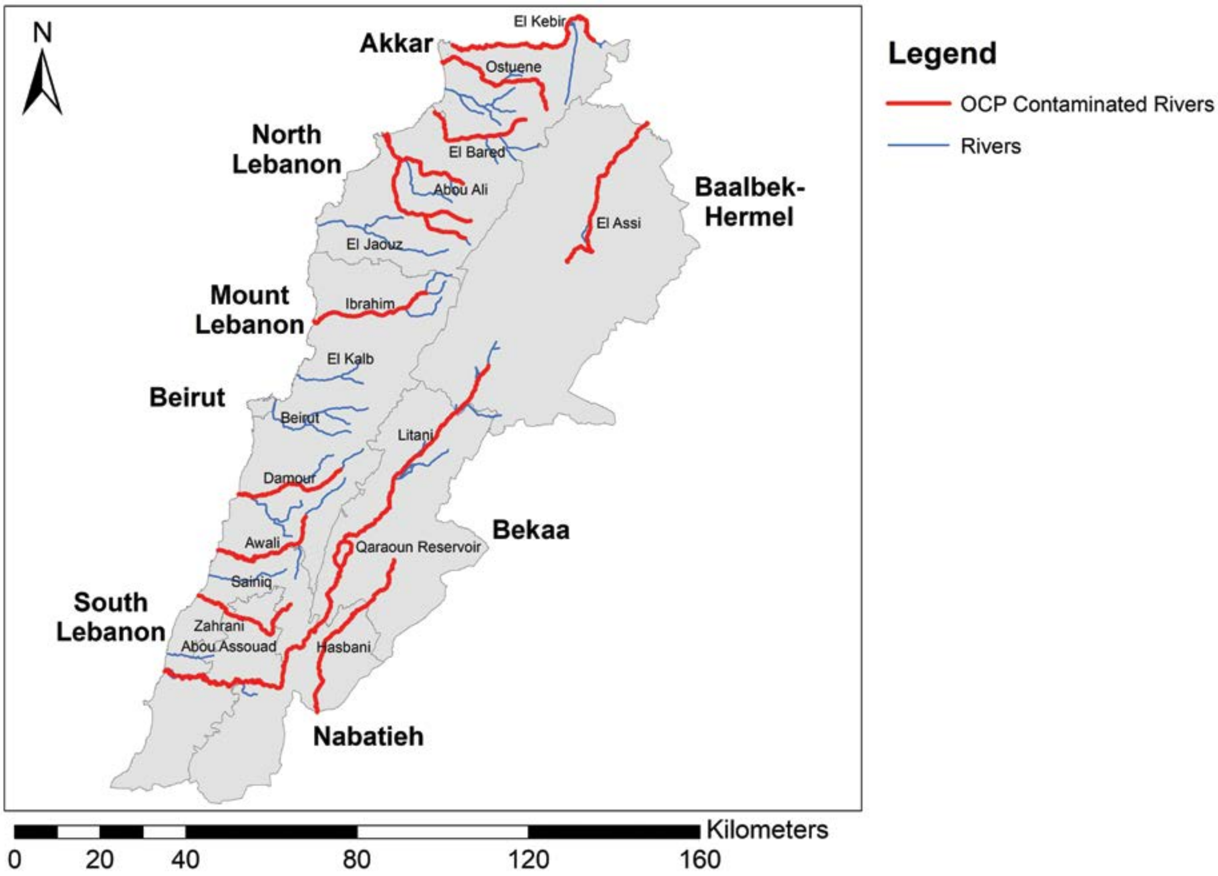

Figure 10-13 Rivers Reportedly Contaminated with OCP in Lebanon
Source: Adapted from Helou et al., 2019

spite their ban (Bashour et al., 2004). *Refer to Chapter 6 - Land Resources for more information about soil contamination with pesticides.*

The 2011 Business Plan for Combatting Pollution of the Qaraoun Lake found high levels of pesticide use during a field survey, such that several pesticides were being applied at almost twice the recommended rates. In addition, the survey found that during one season, successive pesticide application was made 3 to 5 times, potentially leading to increased resistance to the pesticides used. Other conclusions of the survey were that farmers generally did not have a high level of understanding between types of pesticides and how they are appropriately used, as some farmers were not able to differentiate between them. There was a general lack of knowledge of alternative pest management techniques and some resistance to integrated pest management (IPM) (MoE/UNDP, 2011).

Pesticides are predominantly stored by farmers in agricultural areas. About 10% of pesticides in the South and 17% in northern Mount Lebanon are stored in residential areas, while 4% of pesticides in the South are stored in industrial areas. As for disposal, the majority of farmers burn empty containers (87% in Akkar and 64% in the South) or throw them with the municipal waste (60% in northern Mount Lebanon and 50% in Central Bekaa). Other practices include throwing empty containers in fields or rivers, handing them over to municipalities or selling them (MoE/UNEP/GEF, 2017b).

Pesticides that are suspected to enter the country illegally include banned POPs such as Endosulfan, DDT, Chloropyrifos and Paraquat. Most banned POPs pesticides are potentially being used in Akkar region and to a much lesser extent in the Central Bekaa. Other areas where POPs pesticides might be used include Danniyeh and Baalbeck-Hermel, which are close to the borders and where smuggling activities are common (MoE/UNEP/GEF, 2017b) (Figure 10-14).

Evidence shows that a large number of farmers are aware that some pesticides are illegal but lack awareness of the impacts on health and environment or of the active ingredients present in the pesticides they use.

10.2.3.4 Asbestos

Asbestos is used for insulation in buildings and as an ingredient in a number of products, such as water supply lines roofing shingles, fire blankets, clutches and brake linings, due to its extraordinary tensile strength, poor heat conduction and relative resistance to chemical attack (WHO, 2018). Exposure to asbestos occurs through inhalation of fibers in air in the workplace, ambient air within the vicinity of point sources such as factories handling asbestos, or indoor air in housing and buildings containing asbestos materials (WHO, 2010). Due to their well-documented health effects, most countries have banned the use of asbestos, including Lebanon.

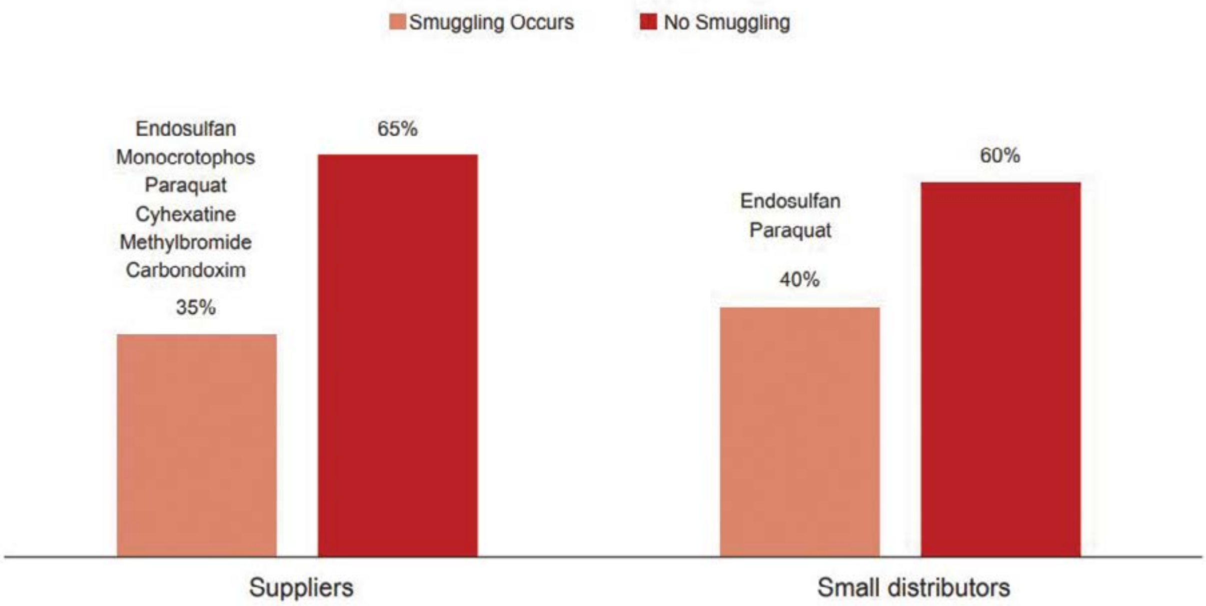

Figure 10-14 Smuggling of Pesticides in Lebanon
Source: MoE/UNEP/GEF, 2017b

Evidence of the presence of asbestos in the environment has been demonstrated in the area of Chekka, where an asbestos-cement factory shutdown in 2002 is located. Piles of asbestos-cement products, particularly in the form of water reservoirs, pipes and corrugated sheets used as rooftops, are currently dispersed and left stored in the open air next to the premises of the factory (Figure 10-15). Thus, large quantities of asbestos-cement products are exposed to weathering. A study recently conducted to assess the asbestos-cement rooftop friability in the city of Chekka revealed the presence of different forms of asbestos fibers on some rooftops and the possible exposure of the nearby population to these fibers (Kfoury et al., 2019).

Figure 10-15. Large Pipes Left Outside the Closed Asbestos-Cement Factory in Chekka
Source: Al Akhbar, 2013

An initial inspection of certain areas of the Jieh power plant was conducted following suspicion of the presence of asbestos-containing materials on the plant's premises due for refurbishment. Results showed that asbestos-containing material was indeed present at different locations onsite. In addition, these materials were found to be in bad condition thus potentially creating high levels of airborne fibers.

After the August 4 Beirut Explosion, an assessment was undertaken to identify and quantify disaster waste, including hazardous waste, within the area surrounding the Beirut Port that was damaged by the explosion. The assessment indicated the presence of asbestos in buildings, in certain damaged structures and in the rubble piles. As such, additional health and safety precautionary measures were found to be necessary for workers during the clean-up operation in the area (UNDP, 2020).

10.2.3.5 Ozone-Depleting Substances

ODS are chemicals that damage the ozone layer including Chlorofluorocarbons (CFCs), Hydro chlorofluorocarbons (HCFCs), Halons, Carbon tetrachloride (Tetrachloromethane), 1,1,1-trichloroethane, Methyl bromide, Hydrobromofluorocarbons and Bromochloromethane. The most predominant, CFC and HCFCs, have been mainly used in refrigeration, air conditioning and heat pump systems, as well in foam production. Sources of Halons and Hydrobromofluorocarbons include fire suppression systems and firefighting equipment. Carbon tetrachloride (Tetrachloromethane) and 1,1,1, -trichloroethane have been used in laboratories and chemical and pharmaceutical industries, whereas methyl bromide has been historically used in fumigation, soil treatment, pest control, quarantine and pre-shipment disinfection.

As party to the Montreal Protocol, Lebanon is committed to phase-out the use and importation of all ODSs, as all ODSs, except HCFCs, have been banned since January 2010. HCFC consumption shows a decreasing trend, which is project to accelerate to reach 1.84 ODP tons by 2028 (Figure 10-16).

The major alternative of ODS used in Lebanon is Hydrofluorocarbon (HFC), which has been introduced into commercial use largely due to their effective refrigerant capabilities as a substitute to CFCs and HCFCs. While HFCs do not deplete the ozone layer, they have a high global warming potential (GWP) *(Refer to Chapter 9 - Climate Change and Energy for more information).* The global use of HFCs is increasing rapidly in line with global economic development and population growth. It was observed that, in Lebanon, HFC-134a, R-404A, R-407C, R-410A and the newly introduced refrigerant R-32 (2018 onwards) are widely used in various applications in refrigeration and air-conditioning (RAC) sectors, including manufacturing and servicing. In addition, there has been applications of HFC-227ea in fire protection systems.

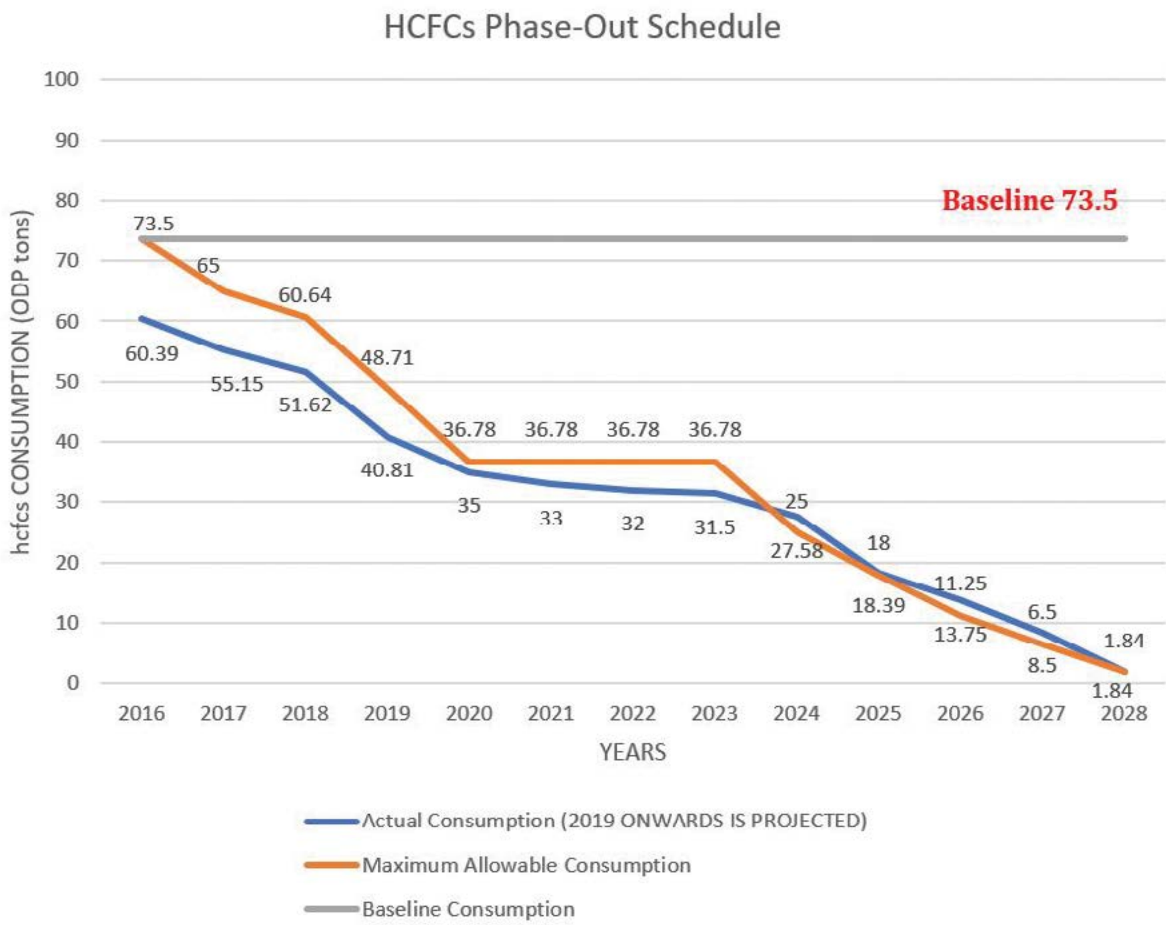

Figure 10-16 HCFCs Phase-out Schedule
Source: National Ozone Unit at MoE

10.2.4 Health Impacts and Economic Costs

A large segment of the population is at high risk of exposure to chemical pollution and its subsequent health effects, in particular individuals who are in direct contact with chemicals in their professional settings such as farmers, traffic controllers and industry and hospital workers, individuals who are exposed to chemicals through food intake and individuals who live in close proximity to contaminated sites or in dwellings with poor indoor air quality.

Heavy Metals: Heavy metals are non-biodegradable and impact the quality of the marine water through their bioaccumulation in the aquatic organism ecosystem. Subsequently, they can be transmitted to humans through seafood consumption, threatening their health. Table 10-4 lists a number of heavy metals and their sources and projected health risks.

Table 10-4 Sources of Heavy Metals and Projected Health Risks

Metal	Source	Projected Health Risk
Aluminum	Construction material, aluminum plants, ceramics, pharmaceutical and cosmetic products	Kidney and brain disfunctions, anemia
Arsenic	Pesticides, wood preservatives, glass products	Liver and nervous system damage, cancer
Barium	Cement, ceramic glazes, glass and paper making, pharmaceutical and cosmetic products	Little is known about health effects. The degree of absorption depends on solubility of compound. High amounts lead to cardiovascular disease
Cadmium	Batteries, plastics, fertilizers, pesticides, paints, electroplating	Bone and cardiovascular diseases, cancer, liver and nerve cell damage
Cobalt	Alloy, ceramics, paints	Respiratory irritation, heart damage and failure, thyroid problems
Chromium	Stainless steel, alloy, cast iron, pigments and wood treatment, tanneries	High doses cause gastrointestinal irritation, stomach ulcer, kidney and liver damage, cancer
Copper	Smelting and metal plating operations, fertilizers and animal feeds, electrical works, pesticides and fungicides	Gastrointestinal diseases, anemia, liver and kidney damage
Mercury	Electrical industry, paints, pesticides and fungicides	Adrenal dysfunction, brain and central nervous system damage, hearing loss, may be associated with autism and multiple sclerosis
Manganese	Steel and alloys; fertilizers, ceramics, and fungicide, dry-cell batteries, fireworks, disinfectants	Little is provided for its toxicity or health and it is related to water hardness
Nickel	Alloys, electroplating, ceramics, pigments, alkaline batteries, catalyst in plastic and rubber industry	Gastrointestinal distress and intestinal cancer, kidney and heart damage
Lead	Smelting operations, automobile emissions, urban runoffs, pesticides, plastics, paints, ceramic glaze	Central nervous system and kidney damage, impact on fetal development, delay in growth and learning disabilities
Vanadium	Processing of phosphate rock for production of fertilizers and phosphoric acid	Most studies are related to inhalation, less is known about effect of ingestion by food or water
Zinc	Galvanization works, motor oil, tire wear, pigments, pesticides	Little is known about long term effects of its ingestion from food or water but associated with anemia and pancreas damage

Source: Korfali and Jurdi, 2012

In Lebanon, Arsenic, Cadmium and Lead contamination have been reported in the breast milk of lactating mothers; however, the reported levels were lower than the limit set by international guidelines (Bassil et al., 2018). The presence of Mercury has been documented in the hair of dentists, who may be using Mercury-containing amalgams, such that among 99 dentists in Beirut, 25.25% showed mercury levels above the safe baseline (Harakeh et al., 2002). Another study examining the association between Mercury levels in the hair of Lebanese young adults and fish consumption reported measurable levels exceeding the safe baseline in 19.3% of the studied population and indicated that an association indeed exists (Obeid et al., 2017).

POPs: Human exposure to POPs occurs through air, water and food. Direct contact with POPs typically occurs in the occupational environment. The most common route of exposure to humans is through ingestion of food contaminated by POPs (MoE/UNEP/GEF, 2017b). POPs tend to accumulate in the human adipose tissue and can cause, even at low levels, changes in the immune system, genotoxicity, reproductive disorders, birth defects, endocrine disruption and an increased risk of cancer (Korfali and Jurdi, 2012). In Lebanon, a biomonitoring study of PCBs and OCPs in human serum in 2017 reported levels below reference values but exceeding the limits set by the US National Health and Nutrition Examination Survey (Helou et al., 2019). Another study conducted in 2018 reported that PCB congener and OCP concentrations were detected in 55% and 59% of the maternal serum samples, respectively. However, these concentrations were lower than the German and French guidance values for women of childbearing age. The study concluded that detected PCB concentrations showed a positive relation with illegal waste incineration and consumption of eggs, fruits and vegetables, whereas concentrations of OCPs were linked to intake of meat and cold cuts (Helou et al., 2021).

Limited data is currently available on the magnitude of economic and societal costs of POPs in Lebanon. However, these costs may be significant and need to be emphasized and addressed in government policy and strategies. Two case studies illustrating economic and societal costs of POPs in Lebanon are presented in Box 10-2.

Pesticides: Pesticides have been documented to be toxic to humans and can have both acute and chronic health impacts, including detrimental effects on the reproductive, immune or nervous systems, as well as different types of cancers. Their impact is dependent on the active ingredient, quantity, duration and means of exposure (WHO, 2021). As described Section 10.2.3.3, pesticide residues have been documented in the Lebanese environment in several research studies. In terms of direct impact on health, Salameh et al. (2006) found a high correlation between asthma in adult patients and exposure to pesticides, with occupational use presenting the highest association, followed by regional and household exposure. A study conducted in 2019 in a Syrian refugee camp located in North Lebanon found residues of the pesticides were in only 5% of 120 samples of breast milk (Smadi et al, 2019). Another study detected OCP pesticide residues in blood serum samples taken during the period 2013-2014. However, the study concluded that the levels of OCP were generally lower than those documented in other countries. In fact, the concentrations were lower than the biomonitoring equivalents and are therefore not considered to have any appreciable health risk (Harmouche-Karaki et al., 2018).

Box 10-2 Economic and Societal Costs of POPs in Lebanon

Case Study 1: Estimating the Societal Costs of Open Burning of Waste

The following study demonstrates the estimated health and productivity impacts related costs of open waste incineration during the 2015 waste crisis in the area of administrative Beirut, as an illustration of the potential social costs of exposure to POPs in Lebanon. An increased risk of cancer is estimated as a result of high levels of PCDDs (dioxins) and PCDFs (furans) emitted near the open incineration sites (estimated average 0.858 µg TEQ/m^3 on day of burning). Assuming a two year-exposure to the estimated average of dioxins and furans, the number of additional cancer cases is projected to be around 18 per million exposed individuals.

Direct costs include health impact related costs such as hospitalization costs, outpatient treatment and doctor's visits. Indirect costs include costs from productivity losses from premature deaths, from days of absenteeism from work on account of illness and from absenteeism from work by close relatives to cancer patients. Based on the mentioned estimations and assumptions, the social costs of further cancer cases resulting from exposure to PCDD and PCDF from open waste incineration in the area of administrative Beirut are US$ 4.3 million using a 3% discount rate (US$ 6.7 million using a 0% discount rate) divided as follows: US$ 3.6 million (US$ 5.4 million) in direct medical costs, US$ 560,000 (US$ 1.2 million) in productivity losses from premature deaths and US$ 140,000 (US$ 100,000) in lost productivity from absenteeism.

Case Study 2: Estimating the Societal Costs of Living in Proximity to a POPs-Contaminated Waste Dump

Large dumpsites in Lebanon (Qarantina, Bourj Hammoud, Naameh, Saida, Tripoli and Zahleh) are expected to be POPs contaminated, especially in the nonexistence of separation and treatment for POPs-containing wastes. This study estimates the annual costs of additional cases of coronary heart disease associated with living in the vicinity of a POPs-contaminated waste dumpsite in Lebanon. Proximity to a POPs-contaminated dumpsite is assumed to increase coronary heart disease deaths and diagnosed cases.

The direct and indirect costs were calculated based on estimates to the size of the 150,000 population of Bourj Hammoud municipality. The lower bound estimate of total annual costs from additional coronary heart disease risk to Bourj Hammoud municipality over the current life expectancy is US$ 7.4 million using a 3% discount rate (US$ 9.3 million using a 0% discount rate) divided as follows: US$ 430,000/year in direct medical costs, US$ 6.3 million/year in productivity losses from premature deaths and US$ 640,000/year in lost productivity from absenteeism (Source: MoE/GEF/UNEP, 2017b).

Asbestos: Exposure to all types of asbestos cause different types of cancer in human, including in the lung, larynx, ovaries and the pleural and peritoneal linings (known as mesothelioma, an asbestos-related lung cancer). In addition, asbestos exposure is also responsible for other diseases including asbestosis (fibrosis of the lungs) and plaques, thickening and effusion in the pleura (WHO, 2018). Occupational and environmental exposure to asbestos was studied between 1991 and 2000 by Kattan et al. (2001) to assess its relationship with pleural mesothelioma incidents. The study reported a clear relationship between occupational exposure and pleural mesothelioma for workers at the asbestos-cement factory of Chekka. In fact, occupational exposure was found in 83% of the malignant mesothelioma investigated cases. The impact of the presence of asbestos material in the country was confirmed by the increase in cases of mesothelioma reported by the National Cancer Registry of the MoPH, from 12 cases in 2005 to 27 cases in 2015 (Kfoury et al., 2019).

10.3 Legal Framework and Key Stakeholders

This section presents the multilateral environment agreements, policies, laws, decrees and decisions related to chemical management in Lebanon. The major actors and stakeholders associated with the management of chemicals are also presented along with their relevant role. All legislation pertaining to chemical management in Lebanon are listed at the end of this chapter.

10.3.1 Multilateral Environmental Agreements and Initiatives

Lebanon is party to several multilateral environmental conventions and agreements that aim to control and manage chemicals in terms of production, use, transport and trade. Table 10-5 presents all these conventions along with their description and ratification laws.

In addition to these conventions, international and regional frameworks and initiatives of relevance to chemical management are presented in Table 10-6.

10.3.2 Policies and Legislation

This section summarizes the relevant key policies, strategies, laws, decrees and decisions related to chemical management in Lebanon in terms of environmental and public health protection, chemical import and export, agricultural chemicals and hazardous waste.

10.3.2.1 Protection of the Environment and Public Health

Law 444/2002 is the framework law for environmental protection in Lebanon, in which Article 44 of Chapter VI states that chemicals should be managed according to a decree issued by the Council of Ministers. Chapter III (Articles 41-52) of Decree 11802/2004 on regulating occupational prevention, safety and health in all enterprises subject to the Code of Labor addresses the safety conditions for workers while using chemicals at the workplace.

10.3.2.2 Import and Export of Chemicals

All imported and exported goods and products are subject to inspection by the LCA. According to Article 144 of the Lebanese Customs Decree 4461/2000, LCA can destroy any analyzed good that is incompatible with local laws and regulations. Article 57 of this decree lists the restrictions imposed on the entry and exit of certain types of merchandise. Moreover, health inspections are regularly undertaken by specialized LCA officials including chemists to verify

Table 10-5 Chemical-related Multilateral Conventions/Protocols and Initiatives

Convention / Protocol	Description / Ratification
Land Based Sources Protocol of the Barcelona Convention	Aims to protect the Mediterranean Sea against pollution. Its protocols are the assessment, control and protection of the marine environment and coastal region of the Mediterranean Sea. Lebanon ratified the Barcelona Convention by virtue of Decree 1977/126 and its amendments Law 2008/34.
Montreal Protocol on Substances that Deplete the Ozone Layer	Aims to protect the Earth's ozone layer by phasing out the production and import of ozone depleting substances. Lebanon ratified it through Law 1993/253 and its amendments through Law 1999/120 (Copenhagen), Law 2006/758(Bejing) and the Law 2019/119 (Kigali).
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	Aims to regulate transboundary movement of hazardous waste and reduce them to ensure protection of the environment and public health. Lebanon has ratified the convention through Law 1994/387 as well as its amendments by virtue of Law 2015/29 and Decree 2017/617.
Stockholm Convention on POPs	Aims to eliminate the production and use of persistent organic pollutants including PCBs and pesticides. The GoL ratified it through Law 2002/432.
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides used in International Trade	Aims at preventing the introduction of hazardous chemicals into countries by controlling their trade and sharing the responsibility between the countries that import and those that export agriculture pesticides and dangerous chemicals. Lebanon ratified this convention through Law 2006/728.
Minamata Convention on Mercury	Aims to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds (Article I). Lebanon ratified through Law 2017/2. A legal framework is yet to be developed to ensure that all relevant sectors abide by its provisions.

Table 10-6 International Frameworks relevant to Chemical Management

Framework/Initative	Description
Pollutant Release and Transfer Register	Initiated in 2013 aiming at developing an environmental inventory of the possibly harmful emissions and their transfer to the physical environment from both diffused and point sources. However, the register has not been completed in Lebanon until now due to lack of expertise and equipment
Strategic Approach to International Chemicals Management	Policy framework to promote chemical safety around the world through the production and use of chemicals in ways that minimize significant adverse impacts on the environment and human health. Lebanon is a member of the of this initiative.
SwitchMed I Initative	Funded by the European Union with the aim of achieving a circular economy in the southern Mediterranean by changing the way goods and services are produced and consumed. As part of this initiative, the Sustainable Consumption and Production (SCP) Action Plan for the Industrial Sector was developed by the MoE in partnership with the MoI with support from UN Environment to promote SCP in the industrial sector, introduce SCP approaches related to the industrial sector in the policy and institutional frameworks and educate and raise consumer awareness on SCP in the industrial sector.

the nature of the chemicals and ensure that they are not harmful to human health.

POPs: The Stockholm Convention ratified by the GoL requires the elimination of all the POPs listed in Annex A and restriction of those in Annex B of the Convention, including the amended annexes that have additional new POPs. As there has been no record of specific exemptions, Lebanon is committed to the full application of this Convention, which currently includes the banning of all Annex A POPs (MoE/UNEP/GEF, 2017b). In fact, Lebanon has specifically banned PCBs and POPs pesticides through ministerial decisions. Nevertheless, Lebanon still needs to issue regulatory texts related to the restriction of new POPs and IPOPs in order to phase them out in compliance with the Stockholm Convention.

Pesticides: The responsible authority to control the import and use of pesticides in the agriculture sector is MoA, while the MoPH has the mandate over pesticides for domestic use. Although no holistic legislation exists to tackle pesticide management in Lebanon, various legal texts have been enacted, to various successes, to organize the import, licensing and registration, use, packaging and setting standards for agriculture pesticides. The MoA has issued a list of banned pesticides and growth regulators through specific ministerial decisions. This process commences with MoA elaborating a list of POPs and banned pesticides based on the annexes of the Stockholm Convention and any of its updates through its Department of Phyto-Pharmacy, which raises it to the Pesticides Committee[2] for their approval. This is followed by a ministerial decision to update the POPs listing (MoE/UNEP/GEF, 2017b).

MoA Decision 310/1-2010 regulates the import, registration and use of agricultural pesticides in Lebanon and defines the requirements and conditions for registration, including general information regarding the names and addresses of producers or importers, official certificates, trade name of the pesticide, use of parasitic, insecticide and plant growth regulators, type of registration and certificate of use and registration. MoA Decision 311/1-2010 requires that pesticide consignments be inspected at the port of entries and representative samples of each imported batch analyzed at the MoA Phyto-Pharmacy Lab for active ingredient content and impurities that may have toxicological characteristics. Figure 10-17 presents the process by which pesticides are approved for import to Lebanon through the MoA (MoE/UNEP/GEF, 2017b).

Regarding domestic pesticides, the MoPH issued Decision 764/1 in 2017 regulating the import of insecticides and rodenticides. However, the process lacks a technical committee to review the registration dossier or an inspection procedure and testing method at the port of entry. Also missing from the legislation is the requirement to inspect the level of compliance at the points of sale and use (Abou Zeid, 2020).

[2] The Pesticides Committee includes MoA technicians and representatives from the private sector (service providers). The role of the committee is to review and update the list of banned pesticides (including POPs), as well as to agree on regulations concerning pesticide storage, packaging and labeling, and the disposal of obsolete pesticides. According to the committee's outputs, MoA issues the appropriate legal texts.

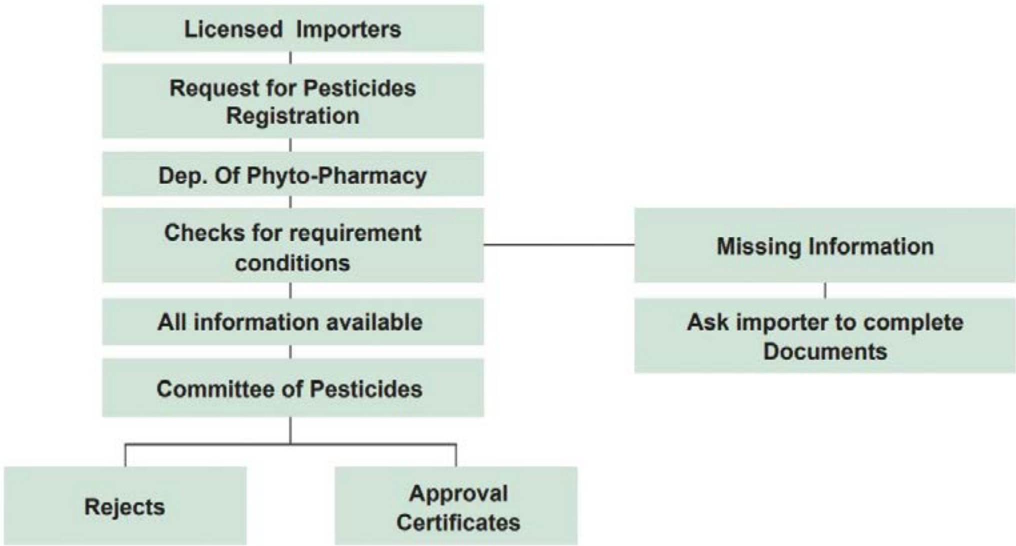

Figure 10-17 Procedures of Pesticide Import
Source: MoE/UNEP/GEF, 2017b

ODS: Lebanon has taken a proactive, forward-looking and targeted approach for regulating ODSs. Import of CFCs, Methyl bromide and Halons has been controlled in Lebanon since 2009, upon the enforcement of the ODS Decree 2604 dated 24/09/2009. In addition, regulating ODS was also targeted under the mandate provided by the overarching Law 253/1993 and the ODS quotas and licensing system under Decree 3277/2016. This decree was followed by Ministerial Decision 404/1 dated 21/09/2019 (Banning the import and use of the ODS HCFC-141b in the cleaning process of RAC equipment and devices). Several ministerial decisions were amended with regards to the quota systems and quotas for importers over the past two years, deadlines of submission of import licenses, harmonized system (HS) codes for HCFCs and blends and HFCs, as well the enforcement of the general procedures for issuing import licenses, which include issued quotas versus actual quotas.

The LCA controls the imports and exports of HCFCs through a quota system. MoE is in-charge of issuing licenses of HCFC imports and is also in-charge of controlling the total quotas for each year. The quota system includes all HCFCs indicated in the Annex C Group I of the Montreal Protocol. The quota for each year is set by the National Ozone Unit project at MoE based on set targets for the HCFCs phase-out to control the current levels of imports in each year to comply with the Montreal Protocol control parameters and national targets. This is communicated to the LCA on an annual basis. In 2021, the ODS quota and licensing system will be revised and amended to include the control of uses and import, as well as exports of HFCs in Lebanon.

10.3.2.3 Agricultural Chemicals and Pesticides

In 2020, the MOA published the National Agriculture Strategy for 2020-2025. The strategy's second pillar (Increasing agricultural production and productivity) includes priority intervention, which include, under Programme 2.2, implementing a nationwide program for the adoption of good agricultural practices (GAP), supporting and training farmers on the use of biological pest control and integrated control with the aim of decreasing the use of chemicals and pesticides and mitigating pollution.

10.3.2.4 Hazardous Waste

Law 80/2018 on Integrated Solid Waste Management and Decree 5606/2019 on the identification of the fundamentals of hazardous waste management specify the general regulations related to hazardous waste management, especially in terms of classification and characterization, import, transport, storage, sorting and disposal, in addition to putting in place control and monitoring systems. Moreover, the MoE has recently issued Decision 998/1-2020 on the generators of hazardous waste, Decision 999/1-2020 on the transporters of hazardous waste and Decision 59/1-2020 on the procedures and principles for the application of hazardous waste storage facilities (Chapter 1 of Section 3 of the Decree 5606/2019).

Additional information on this subject can be found in Chapter 8 – Solid Waste.

10.3.3 Key Actors and Stakeholders

This section presents an overview of the key stakeholders engaged in the chemicals sector in Lebanon. Table 10-7 lists the main governmental institutions that are involved in chemical management and summarizes their main responsibilities. The sections that follow describe the legal mandate of the key stakeholders.

10.3.3.1 Government Institutions

Ministry of Environment

The MoE was established in 1993 under Law 216 and then reorganized in 2005 under Law 690. It is the main governmental entity responsible for protecting Lebanon's environment and for setting environmental policies and strategies. The Department of Chemical Safety at the Service of Environmental Technology is responsible for the sustainable and integrated management of chemicals including POPs, industrial chemicals and pesticides. Its responsibilities also include the classification of all types of chemicals and their uses and the issuing of decisions relevant to the management of chemicals from extraction to disposal as well as the import/export of chemicals and the approval of the customs declaration and decision on expired or damaged products. Moreover, the Department of Protection of Urban Environment at the Service of Urban Environment works on the rejection or the approval of the MoI permits for the environmental conditions for industrial establishments.

Ministry of Industry

The MoI was established in 1997 under Law 642 amended by Law 20/2008. It is responsible for the setting strategies for and regulating the industrial sector in Lebanon. This includes management of chemicals used in this sector. It sets the standards and requirements for sampling and analysis of industrial production. Moreover, it issues permits for the establishment and operation of industries and classifies industrial facilities according to the ISIC. In addition, the Director General of the MoI has the authority to prepare inspection programs of industries in accordance with Decree 9765/2003. This decree defines inspection procedures of all classes of industrial establishments by the Control Department at MoI. According

Table 10-7 Responsibilities of National Authorities in the Chemicals Sector

Responsibility	MoE[1]	MoI[2]	MoA[4]	MoET[6]	MoPH[8]	LCA[9]	CD[10]	EDL
Reporting on multilateral conventions and agreements	X		X					
Setting legislation including classifica-tion, storage, use, labeling and ban-ning of hazardous chemicals	X	X			X			
Policy making and planning for chem-ical/ pesticide management	X	X	X	X[7]	X			
Issuing permits related to the use and disposal of chemicals	X	X	X		X			
Follow up and monitoring	X	X[3]	X	X	X	X		
Enforcement of legislation including control of chemical import and use	X		X[5]		X	X		
Proper use and disposal of chemicals					X	X	X	X

CD: Civil Defense
[1] Law 690/2005: Regulating the MoE and defining its tasks and competencies
[2] Law 642/1997 amended by Law 20/2008: Creation of MoI
[3] Decree 9765/2003: Inspection procedures by MoI (Control Department)
[4] Decree 5246/1994: Organization of the MoA and designation of its mandate
[5] Law 31/1955: Designating the tasks of the MoA
[6] Decree 6821/1973: Determination of MoET tasks
[7] Decree 841/2008: Organizing the Consumer Protection Directorate
[8] Decree 8377/1961: Organization of the MoPH
[9] Decree 4461/2000: Customs Law
[10] Decree 50/1967 amended by Law 289/2014: Civil defense system and organization

to this Decree, the inspection program may involve other agencies including MoE and MoPH. Inspection programs, however, are based on industrial pollution complaints received from citizens and are conducted to verify compliance with regulations and environmental standards.

Ministry of Agriculture

The MoA was established in 1994 by virtue of Decree 5246 and its tasks designated by Law 31/1955 and its amendments. Article 2 of this law gives MoA the responsibility of protection of agriculture lands, forests and soils and management of pesticides in Lebanon through controlling the mechanisms of granting import permits and registrations, production and the disposal and handling of empty fertilizer containers. The Plant Protection Department at the Service of Plant Protection at the MoA is in charge of issuing licenses to importers of pesticides while the Phyto-Pharmacy Department registers pesticides as described in Section 10.3.2.2. Through various decisions and in line with the Stockholm Convention, the MoA bans the use and import of all POPs pesticides listed in the Convention. Currently, the import of 137 pesticides and 5 plant growth regulators is banned in Lebanon. MoA also has a role related to adherence to the Rotterdam Convention of regulating the import of pesticides listed in Annex III of the Convention.

Ministry of Public Health

The MoPH was established in 1944 and is responsible of all public health care establishments and all human health problems in Lebanon. Article 35 of Decree 8377/1961 on the organization of the MoPH stipulates that the Sanitary Engineering Service has the mandate over pesticides for domestic use such as public health pesticides, biocides and homeowner pesticide products. In addition, MoPH is responsible for issuing the approval, rejection, cancellation and investigation of registered products by importers.

Ministry of Economy and Trade

The MoET is responsible for the management of Lebanon's economic and commercial affairs as stipulated in Decree No. 6821 of 1973 that specifies its duties. Article 1 of this decree mandate the MoET to take the appropriate measures to improve the country's commercial, supply and consumption conditions, granting licenses for the import and export of goods, submitting proposals for the improvement of customs conditions and following-up and monitoring on issues relevant to chambers of commerce, industry and trade associations. Decree 841 dated 06/12/2008 states that the Consumer Protection Directorate at MoET has the mandate of developing strategic and annual work plans in coordination with the Directorate General for Economy and Trade.

Ministry of Finance / Lebanese Customs Administration

Under the authority of the Ministry of Finance, the LCA is responsible for controlling the import and export of goods to and from Lebanon by virtue of Customs Decree-Law 4461/2000 for enforcing import and export restrictions to ensure that all prohibited products and substances do not enter Lebanon. Under this law, the LCA has the authority to destroy goods proved to be inconsistent with applicable laws and regulations according to analysis and inspection. In case such destruction is harmful to the environment, re-export shall be done instead under conditions set by the Director General of Customs. The LCA also sets risk management techniques to detect smuggling and uncover fraudulent activities.

Ministry of Interior and Municipalities / Civil Defense

The Civil Defense was established in Lebanon in 1945. Through Law 6/1979, the Civil Defense was attached to the Ministry of Interior and Municipalities. On 4/8/1994, the Council of Ministers Decision 15 made the Civil Defense a General Directorate. Decree 50/1967, amended by Law 289/2014, organizes the role of the Civil Defense. The Civil Defense is responsible for carrying out different tasks to protect public health and avoid and respond to all natural and man-made disasters and hazards. In the case of fires, it is responsible for firefighting through its Fire Brigades. For this purpose, the used firefighting equipment and foams (Fluoro-Protein foams, Aqueous Film-Forming foams, Film-Forming Fluoro-Protein foams and Alcohol-Resistant Aqueous Film-Forming foams), some of which may contain PFOS, are purchased from retailers and stored at the various Fire Brigade centers.

Electricité du Liban

EDL was established in 1964. It is a public institution with administrative and financial autonomy. It falls under the authority of the Ministry of Energy and Water. EDL is responsible for the power sector in Lebanon through production, transmission and distribution of electricity. The MoE and EDL have joint responsibility to manage the power equipment containing PCBs. The Department of Workshops, Equipment, Spare Parts and Transformers at EDL repairs transformers, inspects their storage and regularly performs oil tests to document and follow up on the presence of PCBs.

10.3.3.2 Research Institutions

Several institutions, universities and research centers are active in conducting studies on the presence and release of chemicals into the environment and have also been a major contributor to advancing knowledge on identifying contamination hotspots. Nevertheless, these studies remain fragmented and little opportunities for collaboration and data sharing currently exist.

Industrial Research Institute

The Industrial Research Institute (IRI) was established in 1955 as a public and scientific research institution with administrative and financial autonomy. It was associated to the MoI in 1997. The relevant regulatory chemical analyses conducted by the laboratories of IRI are pesticide residue, heavy metals, wet chemistry and physical chemistry and petroleum products.

National Council for Scientific Research

Established in 1962, the National Council for Scientific Research is a public autonomous institution directly linked to the Presidency of the Council of Ministers to assist in science policymaking. The council encompasses four specialized research centers that are the National Center for Marine Sciences, the National Center for Geophysics, the National Center for Remote Sensing and the Lebanese Atomic Energy Commission. The National Center for Marine Sciences conducts environmental monitoring programs for the coastal area of Lebanon. These studies include detection of pollution hotspots, location of bioaccumulated chemical compounds along the coast and in the marine ecosystems including chemical contamination by heavy trace elements and hydrocarbons and regression of marine biodiversity due to chemicals exposure.

Others

Several academic institutions are conducting research studies related to the use and impact of chemicals in the country *(refer to Chapter 2 - Environmental Governance)*. For example, the Lebanese University - Environmental Platform in Hadath carries out several studies in this field; however not all research conducted is being published.

10.4 Responses and Interventions

Actions focused on chemical management in Lebanon include identification, collection, storage and shipping of equipment and materials containing hazardous chemicals from various sectors for proper treatment and disposal, in addition to substantial measures to reduce ODS.

10.4.1 Reducing the Use and Release of Heavy Metals

The "Demonstrating and Promoting Best Techniques and Practices for Reducing Health-Care Waste to Avoid Environmental Releases of Dioxins and Mercury" project, funded by GEF, managed by UNDP and implemented by MoE, ran from 2009 until 2013. Project objectives included the establishment of model facilities and programs to exemplify best practices in health-care waste management and the development of materials to facilitate replication, for which two healthcare facilities were selected as pilots. The project also included the introduction of mercury-free devices in the selected facilities, evaluated their acceptability and efficacy, and developed and disseminated awareness-raising and educational materials on mercury (MoE/UNDP/GEF, 2013).

10.4.2 POPs Reduction and Elimination

In order to properly address the use and disposal of POPs in Lebanon, the MoE has undertaken several studies that attempted to inventory these chemicals. In the last decade, the MoE, with support from the international community, produced the Assessment of POPs Impacts and Management (MoE/UNEP/GEF, 2017b) and Action Plan (MoE/UNEP/GEF, 2017a), Assessment of New Industrial POPs (MoE, 2018b) and Action Plan and Inventory of PCB Equipment in the Power Sector (MoE, 2018a). These documents pave the way for tackling POPs in the country. During the same period, and in addition to enacting legislation that effectively ban Annex A POPs and restrict Annex B POPs from entering the country, the GoL has also made progress towards eliminating some POPs from the Lebanese environment.

10.4.2.1 Elimination of PCBs

As party to the Stockholm Convention, Lebanon is committed to phase out PCBs in 2025. Within the framework of the "PCB Management in the Power Sector Project", the MoE, in cooperation with EDL, commenced in 2015 assembling contaminated equipment and volumes of oil greater than 0.05 L containing more than 50 ppm PCBs from the power sector. These included out-of-service equipment, capacitors and contaminated soil and debris. The PCB waste from EDL sites were transported to the Zouk and Baouchrieh interim storage sites, over the two phases of the project, where the final storage and loading activities prior to export were conducted. Figure 10-18 shows packaged and labeled PCB-contaminated waste ready to be exported.

Figure 10-18 Packaged PCB-Contaminated Waste

In 2016, 91 tons of collected PCB equipment and oils were shipped for proper off-site treatment and disposal. Approvals from all transit countries and the receiving country (France) were obtained, in compliance to Basel Convention. The waste was incinerated and treated in France by Tredi, a company licensed for the destruction of such wastes. In March 2020, an additional 298 tons were exported to France for treatment and disposal, such that the total amount remaining to be disposed of is 1,248 Tons. The main storage site for PCBs in Baouchrieh is currently being assessed for soil and groundwater contamination in order to commence the cleanup process (MoE, 2020).

The management and disposal process was conducted by applying best environmental practices and stringent occupational health and safety measures. For more information on this process, which included drainage, dismantling, packaging, transport and storage of the PCB contaminated waste until loading of shipment for destruction in France, a short documentary can be found on YouTube under the title: Lebanon - PCB Management in the Power Sector - English Version (LEB PCB P122540 - Information on PCB project).

10.4.2.2 End-of-Life Vehicles

End-of-life vehicles are recognized as potential sources of POPs. Decommissioned buses are often cut in half to warrant that they are not reused and sold at auction to metal scrapyards, which smash them and export them to Turkey for recycling under HS code 81.01.97 in 2006. In addition, out-of-service cars are often sent to scrapping facilities, which crush them after the removal of engine, battery and lubrication oils and export them to Turkey for further processing under HS code 87.03.32.90 (MoE/UNEP/GEF, 2017b).

10.4.3 Integrated Pest Management

Lebanon's response to the excessive use of pesticides in the agriculture sector has been limited in the last decade to unsystematic activities that are not associated with an overall national policy. Through its extension agents, MoA as well as several NGOs, have focused their pesticide management efforts on organizing various seminars and events aimed at raising the awareness of farmers and building their capacities in IPM. However, these seminars are generally ad hoc and do not occur regularly enough to ensure that farmers have acquired the necessary skills and knowledge and are now committed to applying IPM in their fields. NGOs involved in these activities as part of internationally financed projects include the Mouawad Foundation, Fares Foundation, Safadi Foundation and Indevco. The MoA has also provided farmers with a limited amount of pesticide alternatives, including pheromones, traps and biopesticides. Nevertheless, this was not done as part of a larger program within the context of an IPM approach (Abou Zeid, 2020).

Under the World Bank-funded Lake Qaraoun Pollution Prevention Project, the MoA, Council for Development and Reconstruction (CDR) and Food and Agriculture Organization are implementing the project subcomponent: "Reduction of underground, Litani River and Qaraoun Lake water pollution through promotion and application of IPM-GAP by farmers in Upper Litani basin and Qaraoun Lake", which started in 2017 and is planned to end in 2021. The project beneficiaries are the MoA as well as West Bekaa and Zahlé farmers and its main outputs are to analyze and assess current practices and knowledge of farmers, upgrading the capacity of MoA, farmers and other stakeholders in IPM and GAP and testing and implementing these practices.

10.4.4 Asbestos Removal

As mentioned in Section 10.2.3.4, an inspection of the Jieh power plant in 2012 found that asbestos was present in various materials and at different locations onsite. As a result, the CDR was assigned through CoM Decision 19 of 18/04/2016 to secure funding for the complete dismantling of the plant in an environmental and secure way, including developing plans to treat the soil and remove the asbestos material from the site before construction a new power plant (CDR, 2018).

10.4.5 Reduction of ODS

As party to the Montreal Protocol, the GoL has taken substantial measures to phase-out ODSs under the Institutional Strengthening Project - National Ozone Unit in Lebanon, implemented by MoE and managed by UNDP. The project strove to build close partnerships with the private and public sectors, in addition to industries by helping them convert their manufacturing facilities to ozone-friendly production, enhance their products and technical expertise, create job opportunities and introduce their products to international markets.

Since 1998, the Institutional Strengthening Project included the conversion of 100 industrial enterprises that use CFCs into ozone friendly production, the establishment of a recycling center and the rehabilitation of refrigerant gases at the IRI, the provision of LCA with the necessary equipment to check refrigerants at all Lebanese crossings and ports and the provision of devices and equipment for automobile air conditioning maintenance workshops. In addition, several conversion projects to non-ODSs were implemented at 23 industries that use HCFCs in the RAC and rigid foam manufacturing sectors, the establishment of a vocational training center for RAC at the Dekwaneh Technical Institute and the provision of four other technical institutes with equipment and devices needed to train technicians on ozone-friendly alternative refrigerants and the development of a National Cooling Plan for Lebanon.

Currently, the Institutional Strengthening Project has achieved the adoption of ODS legislation, implementation of efficient and timely data collection and reporting whereby the ODS Report (2015 Data of imports and consumption) was submitted to the Multilateral Fund of the Montreal Protocol and Ozone Secretariats. In addition, the project has established coordination with other national agencies such as the collaboration with UNIDO for a pilot project for ODS destruction. Supervision of timely implementation of phase-out activities along with awareness raising and information exchange was also conducted under the current phase of the project.

Moreover, CFC phase-out actions were addressed through the National Phase-out Management Plan for Annex-A, Group-I Substances (CFCs) in Lebanon, which was approved in November 2004 as a performance-based agreement with annual consumption and phase-out targets and complete phase-out of all remaining consumption of Annex-A, Group-I Substances (CFCs) in Lebanon before 1 January 2009. Lebanon has also completely phased out consumption of Methyl Bromide by 2010. As for HCFC, the HCFC Phase out Management Plan Stage-I was prepared and approved in 2011 for achieving phase-out targets up to 2017. This was successfully implemented, and the country was at the final stages of implementation in 2019. HPMP Stage-II for achieving phase-out targets up to 2025 was approved in November 2015 (refer to Section 10.2.3.5).

The Kigali Amendment to the Montreal Protocol was ratified by the GoL and came into force on the 1st of January 2019. The country is in the process for updating its reporting mechanism to include HFCs. Lebanon will soon be in a position to monitor the imports, exports and uses of HFCs in the country through the functioning of the licensing system to include HFCs. The uses and imports of HFCs will be addressed in the phase-down plan of HFCs over the coming 20 years through the conversion of all industries in the different sectors that use HFCs, including the servicing of the RAC sector. (Figure 10-19).

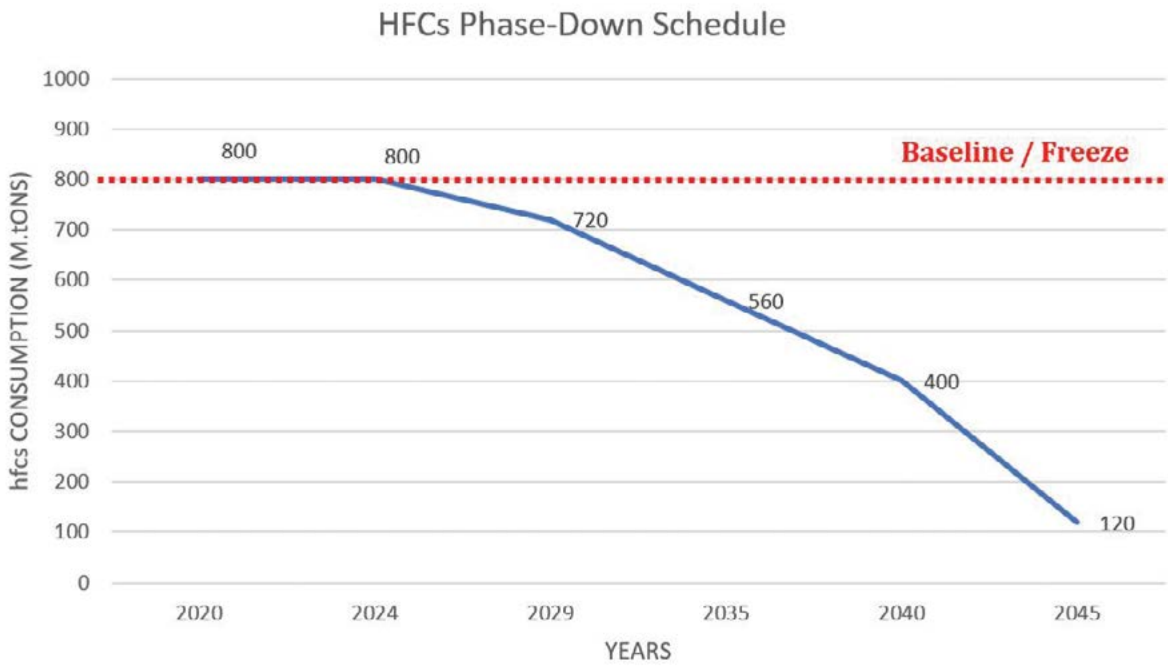

Figure 10-19 HFCs Phase-out Schedule
Source: Data from National Ozone Unit at MoE

10.5 Priority Recommendations and Future Outlook

Several challenges for chemical management exist in Lebanon such as inexistence of databases and monitoring infrastructure, absence of precise emissions data, lack of public awareness regarding threats caused by chemicals and insufficient financial resources to remove, control or reduce chemicals emissions. This section highlights priority recommendations for improving the management of chemicals in Lebanon.

10.5.1 Filling Legal and Institutional Gaps

The regulation of hazardous chemicals is already addressed in the Lebanese legislation; however, several legal gaps exist, particularly in terms of hazardous chemicals storage and disposal. Therefore, a specific decree on management of hazardous chemicals based on Law 444 should be prepared and endorsed to establish national environmental standards, procedures to regulate its implementation and fundamentals for assessing and safeguarding the environment from chemical contamination. In addition to strengthening the legal framework, other priority actions include institutional strengthening and capacity building, improving national infrastructure, raising awareness about risks associated with chemical management and the importance of proper treatment and disposal, promoting advanced technologies and practices, improving research in chemicals management and data management and properly managing hotspots and stockpiles through the establishment of a comprehensive national inventory for all chemical storage sites in an effort to prevent future disasters in the country, such as the one that occurred in Beirut Port on the 4th of August, 2020.

10.5.2 Heavy Metals

Focus in the coming decade should be on the assessment, reduction and monitoring of heavy metals, in particular mercury, releases into the environment. At the national level, a strategy to phase out the use of mercury should be put in place in line with the Minamata Convention and legislation developed to assess and reduce waste containing mercury in the country.

10.5.3 National Implementation Plan on POPs

The National Implementation Plan of 2017 presents in detail the way forward for Lebanon to reduce or eliminate POPs with the aim of safeguarding human and environmental health in line with provisions of the Stockholm Convention. All activities aimed at addressing the presence of POPs in the country should be guided by this plan. In addition to strengthening the legal and institutional framework, this includes managing the import and export, production, use, recycling and disposal of IPOPs through:

- Improving control of import and trade of IPOPs.
- Enhancing knowledge and capacity of industrialists, distributors and retailers to manage IPOPs and consider their risks.
- Identifying and managing IPOPs stockpiles and wastes/residues (current and future) in an environmentally sound and integrated manner.
- Identifying, assessing and remediating potential contaminated sites including water bodies.

Controlling and gradually reducing UPOPs can be done through identifying and managing UPOPs wastes/residues (current and future) in an environmentally sound and integrated manner and identify, assess and remediate potentially contaminated sites.

The plan's objectives were also to create a system for reporting on measures undertaken and their effectiveness in implementing the provisions of the Stockholm Convention. The POPs assessment conducted in 2017 is considered an initial assessment (Tier I) of current conditions. A preliminary inventory (Tier II) focusing on specific sectors is now required to better estimate national data that were missing in the initial (Tier I) assessment. Tier II is developed by conducting surveys and site visits. In addition, an in-depth inventory (Tier III) may also be required for certain POPs should the preliminary inventory (Tier II) conclude that they pose high human health and environmental risks in the country and more precise data are needed to prioritize risk reduction measures and to estimate their costs.

10.5.4 Lifecycle Management of Pesticides

Abou Zeid (2020) presented policy actions, to be supported through legislation that can be taken forward in the coming decade to address gaps in pesticide management in Lebanon. In addition to the current "command and control" tool of import banning, a more holistic approach is needed:

- Adopt one lifecycle management strategy and legislation for all types of pesticides (mainly agricultural and domestic). This will require inter-ministerial and institutional cooperation, with the potential establishment of a pesticide board that includes representatives from MoA, MoPH, MoE, MoI, Ministry of Labor, Ministry of Justice, LCA and focal points of all binding international instruments, to ensure effective management and jurisdiction overlap.
- Follow the precautionary principle and burden of proof when registering pesticides, introduce the concept of "restricted" pesticides, promote biopesticides and "natural enemies" and improve labeling to include recommended number and mode of applications and mode of disposal method.
- Develop and implement traceability methods to include farm-to-fork traceability and pesticide container management traceability system.
- Promote education and invest in compulsory training for all stakeholders that handle pesticides throughout its lifecycle through creating MoA professional training centers with curricula that result in certification of pesticide prescribers, applicators and IPM producers.
- Adopt a prescription system whereby only certified agricultural engineers are allowed to prescribe pesticides to certified pesticide applicators or trained farmers.
- Provide low interest loans for producers who are implementing IPM/GAP.
- Use import taxation to reduce the use of harmful pesticides such that it is high enough to increase their costs but not to the extent that illegal smuggling becomes more feasible.
- Establish twinning projects with an advanced country for cooperation on pesticides management and training.

10.5.5 Research and Monitoring

A common challenge with other sectors in Lebanon, chemical management is limited by lack of research and data availability. Published records of chemical pollution within different environmental media are restricted to projects and studies within constrained periods and areas. In addition, regular environmental monitoring and biomonitoring are nearly inexistent, often due to insufficient financial and technical resources and scientific expertise. Therefore, further research and environmental monitoring and biomonitoring studies are highly needed to improve knowledge about the negative impacts of hazardous chemicals. Risk assessment of hazardous chemicals in Lebanon is of priority but it requires previous measures such as hotspot identification, measurement of chemical levels in the environment and the identification of populations at risk. Additional studies about health impacts and potential economic costs of exposure to certain hazardous chemicals such as POPs or heavy metals can pinpoint social risks and economic repercussions serving as a basis for policy making. The establishment of a tracking system for transport of hazardous material and an emergency response system to deal with situations associated with transport or industrial accidents are also a priority (see Box 10-3).

Box 10-3 August 4 Beirut Explosion
On August 4, 2020, a large amount of ammonium nitrate caught fire and exploded at the port of Beirut, killing more than 200 people, wounding 10,000 others and leaving 300,000 residents temporarily homeless (UNDP, 2021). Ammonium nitrate is a chemical compound, a crystal-like white solid, used as a source of nitrogen for fertilizer and as an explosive. About 2,750 tons of this material had been stored at the Port of Beirut for 7 years awaiting further action. The explosion of ammonium nitrate releases toxic gases including nitrogen oxides and ammonia gas. The orange plume that was observed after the explosion is caused by the nitrogen dioxide, which is often associated with air pollution. The chemicals released into the environment as a result of the explosion can damage health, through direct exposure, or the environment through soil and water contamination. Chemical contamination of particles scattered by the explosion may become airborne again and could pose a new public health threat. In addition, the large amount of waste produced is expected to aggravate the existing municipal solid waste crisis in Beirut. The cost of cleaning up the environmental degradation resulting from the explosion has been estimated by the UNDP to be over $100 million (UN News, 2020).

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قوانين الاتفاقيات الدولية

نوع النص	الرقم	التاريخ	عنوان النص
قانون	١١٩	٢٠١٩/٣/٢٩	الموافقة للحكومة بالانضمام الى تعديلات كيغالي-روندا المتعلقة ببروتوكول مونتريال حول حماية طبقة الاوزون من المواد المستنفدة لها
قانون	٢	٢٠١٧/٠٢/٠٣	الموافقة على ابرام انضمام لبنان الى اتفاقية ميناماتا بشأن الزئبق
قانون	٢٩	٢٠١٥/١١/٢٤	الموافقة على الانضمام الى تعديل اتفاقية بازل بشأن التحكم في نقل النفايات الخطرة والتخلص منها عبر الحدود
قانون	٣٤	٢٠٠٨/١٠/١٦	الاجازة للحكومة الإنضمام الى اتفاقية لحماية البيئة البحرية والمنطقة الساحلية للبحر المتوسط وهي التعديلات التي طرأت على اتفاقية حماية البحر المتوسط من التلوث الموقعة في برشلونة بتاريخ ١٩٧٦/٢/١٦
قانون	٧٢٨	٢٠٠٦/٠٥/١٥	الاجازة للحكومة الانضمام الى اتفاقية روتردام بشأن تطبيق اجراء الموافقة المسبقة عن علم على مواد كيمائية ومبيدات آفات معينة خطرة متداولة في التجارة الدولية
قانون	٧٥٨	٢٠٠٦/١١/١١	الاجازة للحكومة الانضمام الى تعديلات بيجين المتعلقة ببروتوكول مونتريال بشأن المواد المستنفدة لطبقة الأوزون في الاجتماع المنعقد ما بين ٢٩/١١/١٩٩٩ و١٩٩٩/١٢/٠٣
قانون	٤٣٢	٢٠٠٢/٠٧/٢٩	الاجازة للحكومة الانضمام الى اتفاقية ستوكهولم للملوثات العضوية الثابتة
قانون	١٢٠	١٩٩٩/١٠/٢٥	الاجازة للحكومة الانضمام الى تعديلات كوبنهاغن المتعلقة ببروتوكول مونتريال حول حماية طبقة الأوزون من المواد المستنفدة لها
قانون	٣٨٧	١٩٩٤/١١/٤	الاجازة للحكومة ابرام معاهدة بازل بشأن التحكم في حركة النفايات الخطرة (المادتان ١ — ٢) الموقعة في بازل سويسرا عبر الحدود والتخلص منها بتاريخ ١٩٨٩/٠٣/٢٢
قانون	٢٥٣	١٩٩٣/٧/٢٢	الإجازة للحكومة الانضمام إلى معاهدتين متعلقتين بطبقة الأوزون
مرسوم اشتراعي	١٢٦	١٩٧٧/٠٦/٣٠	اجازة انضمام لبنان الى الاتفاقية المتعلقة بحماية البحرالابيض المتوسط من التلوث والبروتوكولين الملحقين بها
قرار وزاري	١/٤٠٤	٢٠١٩/٩/٢١	منع إستيراد وإستخدام مادة (HCFC-141b) في عمليات تنظيف المعدات والأجهزة في قطاعي التبريد والتكييف

القوانين والأنظمة

نوع النص	الرقم	التاريخ	عنوان النص
قانون	٧٨	٢٠١٨/٠٤/١٣	قانون حماية نوعية الهواء
قانون	٨٠	٢٠١٨/١٠/١٠	الإدارة المتكاملة للنفايات الصلبة
قانون	٢٨٩	٢٠١٤/٠٤/٣٠	تعديل بعض مواد المرسوم الاشتراعي رقم ٦٧/٥٠ تاريخ ١٩٦٧/٨/٥ المتعلق بنظام وتنظيم الدفاع المدني
قانون	٢٠	٢٠٠٨/٠٩/٠٥	تعديل القانون رقم ٦٤٢ تاريخ ١٩٩٧/٦/٢ (احداث وزارة الصناعة) لجهة اضافة مصلحتين اقليميتين جديدتين
قانون	٦٩٠	٢٠٠٥/٠٨/٢٦	تحديد مهام وزارة البيئة وتنظيمها
قانون	٤٤٤	٢٠٠٢/٧/٢٩	قانون حماية البيئة
قانون	٦٤٢	١٩٩٧/٠٦/٠٢	احداث وزارة الصناعة
قانون	٢١٦	١٩٩٣/٠٤/٠٢	احداث وزارة البيئة
قانون	٦	١٩٧٩/١٢/٢١	إلحاق الدفاع المدني بوزارة الداخلية
مرسوم اشتراعي	٣١	١٩٥٥/٠١/١٨	تحديد مهام وزارة الزراعة
مرسوم	٥٦٠٦	٢٠١٩/٠٩/١١	تحديد أصول إدارة النفايات الخطرة
مرسوم	٦١٧	٢٠١٧/٠٤/٢٥	انضمام لبنان الى تعديل اتفاقية بازل بشأن التحكم في نقل النفايات الخطرة والتخلص منها عبر الحدود
مرسوم	٣٢٧٧	٢٠١٦/٠٤/١٨	تعديل المرسوم رقم ٢٠٠٩/٢٦٠٤ تاريخ ٢٠٠٩/٩/١٧ المتعلق بالتحكم في المواد المستنفدة لطبقة الأوزون
مرسوم	٢٦٠٤	٢٠٠٩/٠٩/٢٤	التحكم في المواد المستنفدة لطبقة الاوزون
مرسوم	٨٤١	٢٠٠٨/١٢/٠٦	تنظيم مديرية حماية المستهلك وتحديد ملاكها وشروط التعيين الخاصة فيها
مرسوم	١١٨٠٢	٢٠٠٤/٠١/٣٠	تنظيم الوقاية والسلامة والصحة المهنية في كافة المؤسسات الخاضعة لقانون العمل
مرسوم	٩٧٦٥	٢٠٠٣/٠٣/١١	الرقابة والتدابير والعقوبات المتعلقة بالمؤسسات الصناعية
مرسوم	٥٢٤٣	٢٠٠١/٠٤/٠٥	تصنيف المؤسسات الصناعية
مرسوم	٤٤٦١	٢٠٠٠/١٢/١٥	قانون الجمارك
مرسوم	٥٢٤٦	١٩٩٤/٠٦/٢٠	تنظيم وزارة الزراعة وتحديد ملاكها وشروط التعيين في بعض وظائف هذا الملاك وسلسلة رتب ورواتب الموظفين الفنيين فيه
مرسوم	٦٨٢١	١٩٧٣/١٢/٢٨	تحديد مهام وملاكات وزارة الاقتصاد والتجارة
مرسوم	٥٠	١٩٦٧/٠٨/٠٥	نظام وتنظيم الدفاع المدني
مرسوم	٨٣٧٧	١٩٦١/١٢/٣٠	تنظيم وزارة الصحة العامة
قرار وزارة البيئة	١/٩٩٨	٢٠٢٠/٠١/٠٢	تحديد اجراءات واصول تطبيق الفصل الاول (المولد وموجباته) من الباب الثاني من مرسوم تحديداصول ادارة النفايات الخطرة (مرسوم رقم ٥٦٠٦ تاريخ ٢٠١٩/١١/٩)
قرار وزارة البيئة	١/٥٩	٢٠٢٠/٠١/٢١	تحديد إجراءات واصول تطبيق الفصل الاول (منشآت تخزين النفايات الخطرة) من الباب الثالث من مرسوم تحديد أصول إدارة النفايات الخطرة (رقم ٥٦٠٦ تاريخ ٢٠١٩/٩/١١)
قرار وزارة البيئة	١/٩٩٩	٢٠١٩/١٢/٢٤	تحديد إجراءات واصول تطبيق الفصل الاول (الناقل و موجباته) من الباب الثالث من مرسوم تحديد أصول إدارة النفايات الخطرة (رقم ٥٦٠٦ تاريخ ٢٠١٩/٩/١١)
قرار وزارة الزراعة	١/٣١٠	٢٠١٠/٠٦/٢٤	تنظيم تسجيل الأدوية الزراعية المستوردة والمحضرة في لبنان واستعمالها
قرار وزارة الزراعة	١/٣١١	٢٠١٠/٠٦/٢٤	تنظيم استيراد الأدوية الزراعية
قرار مجلس الوزراء	١٥	١٩٩٤/٠٨/٠٤	الموافقة على أن تصبح مديرية الدفاع المدني مديرية عامة

SECTION IV

THE OUTLOOK - TOWARDS 2030

CHAPTER 11 - The Decade Ahead

11 The Decade Ahead

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Abbreviations and Acronyms

AQMN	Air Quality Monitoring Network
CDR	Council for Development and Reconstruction
CoM	Council of Ministers
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GoL	Government of Lebanon
HCFC	Hydrochlorofluorocarbon
ICZM	Integrated Coastal Zone Management
ISWM	Integrated Solid Waste Management
MPA	Marine Protected Areas
LRA	Litani River Authority
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
NDC	Nationally Determined Contributions
NPMPLT	National Physical Master Plan for the Lebanese Territory
NIS	Non-Indigenous Species
NRW	Non-Revenue Water
ODS	Ozone Depleting Substance
POP	Persistent Organic Pollutant
PPP	Public Private Partnerships
RWE	Regional Water Establishment
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SOER	State of the Environment Report
SWI	Sea Water Intrusion

11. Future Outlook

The 2010 State of the Environment Report (SOER) closed on an exercise of building two scenarios for the decade 2010-2020, adapted from the scenarios developed in the Global Environmental Outlook. The two stylized scenarios in SOER 2010 of Market First vs Sustainability First are intended to broadly delineate the bounds of possible developments over the ensuing decade, while implicitly acknowledging that the course the country will tread would likely lie somewhere in between. Halfway through the past decade, in 2015, countries also committed to achieving a set of 16 Sustainable Development Goals (SDGs) by 2030. The first part of this chapter re-evaluates the scenarios in the last edition of the SOER, with the hindsight of the concluding decade: we are now in a position to check how the period between 2010 and 2020 measures up to the Market First and Sustainability First scenarios developed in the 2010 SOER for each sector. With the first 5 years of the SDG commitment already past, it is also an opportune occasion to evaluate progress towards those goals that are directly related to environmental policy and practice.

The second part of this chapter engages in a similar exercise of developing possible scenarios that help describe the possibilities for the coming decade up to 2030, the year of SDG maturity. In light of the significant progress in the development of national sectoral strategies, action plans, and legislation over the past decade, this section first maps the scope and content of these national efforts onto the 17 SDGs. The section then describes two scenarios to frame the possible outcomes in the decade to come: a scenario of Poor Enforcement and one of Robust Enforcement of the strategies and laws developed over the course of the last ten years.

11.1 Retrospective

This section looks back and traces the path that was trodden since 2010 in relation to the Market First and Sustainability First scenarios described in the previous edition of the SOER. It should be noted that at the time, the scenarios were developed assuming the decade would bring no serious military or political flareup. And while the country has not experienced any large-scale domestic military escalation, one major development that was not foreseen at the time the 2010 SOER was written, and that has had a serious impact on the country, has been the crisis in Syria. Towards the end of the decade, a sharp economic downturn steered the country towards austerity starting in 2017, and eventually put the country on the precipice of an economic collapse in the last quarter of 2019. The country also suffered a number of unforeseen crises in the year 2020, as the economic downturn accelerated, with the COVID-19 pandemic starting in March of 2020, and the explosion at the Port of Beirut on August 4, 2020, inflicting enormous human and material damage on the city.

The following subsections look at each of the main sectors included in the scenarios of the SOER 2010 to assess the developments in these sectors in relation to the expectations under the Market First and Sustainability First scenarios. This retrospective look shows that most sectors have diverged from some of the predictions of the Market First scenario, not because of a systematic prioritization of sustainability, but rather because of the country's accelerating economic downturn during the second half of the decade, and which by definition, meant that "market" forecasts and expectations were not met.

The section closes on a more cross-sectoral snapshot that evaluates progress towards select SDGs by reporting the value of some SDG indicators as well as the direction of change in these indicators in the first 5 years of the SDG countdown.

11.1.1 Environmental Governance

The recession starting in 2016 has meant that based on some of the basic measures used in the 2010 SOER as indicators of the state of environmental governance, the resources for governance, like most other public resources in times of austerity, have shrunk rapidly. According to the Institute of Finance, after a stagnant budget allocation in 2017 and 2018, the Ministry of Environment (MoE) budget was reduced by 12.9% in 2019 and then slashed by another 52% in 2020. While reduced funding can be expected during any recessionary period, the fact that the cuts to the budget for environmental protection, which was already very low, are disproportionately large is indication of a crisis culture that deprioritizes environmental and sustainability concerns.

However, the past ten years have not all been contractionary. Nor are ministerial budget allocations the only metric for assessing environmental governance. In fact, remarkable progress was made during the last decade on advancing sectoral strategies, national plans and programs, draft laws and proposed regulations across various sectors. The decade saw the adoption of a National Strategy for Air Quality Management, a National Biodiversity Strategy and Action Plan, a Policy for the Integrated Management of the Quarrying Sector, a Policy for the Integrated Management of Solid Waste, an update of the Policy Paper for the Electricity Sector, as well as a National Implementation Plan for Persistent Organic Pollutants and the development of a new National Water Sector Strategy (NWSS). Several important laws and decrees were adopted, including in 2014 the law for dedication of environmental prosecutors and sectoral laws such those relating to water, air quality and solid waste in 2018, as well the protected areas framework law in 2019. In 2012, three safeguard decrees were adopted tackling on strategic environmental assessment, environmental impact assessment, and environmental auditing. During the same year, the National Council for the Environment decree was also issued, leading to establishment of this council that had been meeting regularly until the start of the mass protests in October 2019 in response to the financial crisis. A draft law has been prepared for integrated coastal zone management (ICZM), maritime public domain, and illegal occupancy of maritime public property and another for organizing the quarrying sector.

The framing of the coming decade within the axes of the two possible scenarios of Poor Enforcement vs Robust Enforcement is precisely founded in the significant investment over the last 10 years in drafting and adopting national policies and strategies, as well as legislation and regulations. The future state of the environment, but also the soundness of the decade's large investment in developing and adopting strategies, plans, programs and laws hinges on the proper implementation of the rich set of drafting outcomes of the last 10 years.

11.1.2 Water Resources

Over the past 10 years, the water sector has seen major developments. Even though the improvements have fallen short of the targets set in the 2010 NWSS, its ability to deliver growth has been curbed by several legal, financial, procurement and political constraints. While the country has seen an increase in the volume of the surface and groundwater sources tapped, these have been offset by a significant increase in demand, mainly attributed to the population increase from the Syrian crisis. During the past 10 years, 4 new artificial lakes were completed, with a total static capacity of 3.35 MCMs. Additionally, construction works on six dams were initiated; however, the future of the largest of these dams (Bisri dam) remains uncertain. Meanwhile, groundwater resources remain under increased stress, with the Ministry of Energy and Water (MoEW) estimating that around 700 MCM/year are being extracted. Managed aquifer recharge projects aimed at reversing and/or stabilizing the decline in the water table and the acceleration of sea water intrusion (SWI) have not materialized, with the exception of a few pilot-scale projects. Efforts aimed at managing demand have remained weak, although several pilot projects have been initiated to introduce smart meters, SCADA systems, and non-revenue water (NRW) assessments.

Water quality over the past 10 years has not improved, with some freshwater and marine systems experiencing significant degradation in their water quality. Gains made in the pollution abatement have often been offset by new sources of pollution and the immergence of unforeseen events such as the increase in untreated wastewater as a result of the influx of the Syrian displaced. While it is hard to benchmark pollution levels today with those 10 years earlier due to the absence of a national water quality monitoring networks, using the Litani basin as a bellwether for river systems highlights the magnitude of degradation over time. Similarly, groundwater assessments have shown an intensification of SWI along the coastal aquifers and a worsening nitrate pollution in the inland aquifers. At the household level, E. coli contamination was found in 53% of all collected water samples. Meanwhile, large sections of the Lebanese coastal zone remain negatively impacted by several sources of pollution. Of the 31 beaches regularly assessed for water quality in Lebanon, 65% were found to be affected by biological contamination. At the level of domestic wastewater treatment, the country has increased its capacity of collected wastewater from 111,000 m3/day in 2010 to 824,664 m3/day by 2020. Yet, out of the current 78 existing WWTPs only 11 plants treat beyond the primary level. On the industrial level, the 133 dedicated industrial zones remain unequipped with WWTPs. In fact, the cost of environmental degradation of the current situation in the water sector has been estimated to be 1.1% of the country's gross domestic product (GDP).

At the institutional level, Regional Water Establishments (RWEs) have large financial and water deficits. At the same time, and with the exception of the Beirut Mount Lebanon Water Establishment, RWEs have been unable to break-even and recover their operation and maintenance costs as a result of the low percentage of subscribers to the total serviced population, the low collection rates, the reliance on flat rate tariffs, high energy expenditures, significant losses in terms of NRW, and more recently, the devastating impact of the Lebanese currency depreciation. Moreover, most establishments remain understaffed and heavily dependent on projects from international donors. The role of the RWEs continues to develop as they assume more functions that were originally part of MoEW and the Council for Development and Reconstruction (CDR). Overlaps between the RWEs and the Litani River Authority (LRA), local municipalities, and even international donors remains an issue. On the bright side, most RWEs have become mindful of the importance of NRW and the need to better manage demand.

11.1.3 Air Quality

Lebanon made some strides to reduce air pollution in the last decade, spearheaded by MoE efforts that were supported by several internationally-funded projects, by adopting a detailed, holistic, and integrated legal framework and the installation of spatially and temporally resolved monitoring to iterate on the effectiveness of the legal body governing air quality.

Lebanon signed the Paris Agreement in April 2016 and ratified it in February 2019 and pledged to take measures to reduce greenhouse gas (GHG) emissions. Additionally, the law on the protection of air quality was adopted in 2018 and the National Strategy for Air Quality Management adopted in 2020. Other laws and regulations established customs and registration reductions on hybrid and electric cars aiming to increase the use of fuel-efficient and hybrid vehicles, control of operation of electric generators in Lebanon, and the installation of catalytic converters in all gasoline vehicles. In 2017, Lebanon adopted a decree on income and custom tax reduction for all activities protecting the environment, whose application decisions were issued by the MoE in 2017 and the Ministry of Finance in early 2020.

In 2013, the MoE launched Phase 1 of the national Air Quality Monitoring Network (AQMN) with real time air quality monitoring through five stations in Lebanon, with the support of the Greek Government, the United Nations Environment Programme and UNDP. These stations used online analyzers connected to a supervisory control and Data Acquisition System located at the MoE. In 2017, Phase 2 of the AQMN was launched with support from the EU, marking completion of the network by installing ten additional stations to monitor criteria pollutants and eight weather stations, three PM stations and one calibration station. Those were also directly connected to the Department of Air Quality at the MoE where data could be requested by a letter and obtained for free. Moreover, an Air Quality index is made available on the home page of MoE website for several key cities. This data proved invaluable for academic research, environmental assessment studies and audits conducted during this period. However, on July 9, 2019 the MoE announced that the monitoring stations were to stop operating due to budgetary reasons. The Cost of Environmental Degradation Report of 2018 has estimated the cost of air pollution in Lebanon to be US$ 0.84 billion for premature mortalities and around US$ 0.1 billion for morbidities for a total of US$ 0.94 billion.

11.1.4 Ecosystems

The state of natural ecosystems in Lebanon has seen some positive developments since 2010; however, the deterioration far outweighs the modest improvements. The last decade has seen an active revision of the status of endemic and other species, efforts to enhance their conservation, the creation of corridors between areas significant for biodiversity and the management of forests. The scope of reforestation from methodology to tools, experience gained and areas reforested advanced systematically, and employed native species grown at local nurseries. Conservation of nature sites has become better regulated with the passing of the law for categorization and management of new reserves in 2019. The number of protected areas has almost doubled and many more sites are in the pipeline; the area under conservation though has increased by only 18% as conservation focused on the creation of micro-reserves.

On the other hand, the rate of degradation has increased and environmental pressures have augmented. Urban sprawl has consumed large natural areas, and the urbanization of the countryside remains entirely haphazard and uncontrolled, adding to the infringement on resources. Based on the Lebanon Country Report under the Global Evaluation of Forest Resources, the total forest cover in 2020 is assessed to be roughly the same. Forest fires invaded larger expanses of natural areas than in the previous decade with nearly 4000ha affected in 2020 alone. Firefighting proved highly inefficient and uncovered the loss of existing equipment (firefighting planes). Logging and chaotic charcoal production continues. The hunting law, adopted in 2004, went into implementation for the first time in 2017 after the completion of the required detailed decrees, ministerial decisions and memos. An automated system for hunting permits was also put in place, thus supporting the organization of the sector, protection of biodiversity and securing of substantial governmental revenues that were estimated in 2018 to reach 10% of MoE budget. Times of social, political and economic instability diminish proper enforcement leading to the resurfacing of hunting and bird massacres documented in social media. The impact of climate change has been better documented; however, mitigation and adaptation measures are still very shy. The decade has also seen multiple partnerships between the public and private sectors in this domain, often with increased effectiveness. However, partnerships are still largely limited to individual projects.

On the preservation of marine ecosystems, the decade also witnessed vigorous drafting activity of national strategies, monitoring programs and laws. For one, the MoE developed "Lebanon's Marine Protected Areas (MPA) Strategy," which proposed 18 sites for protection and resulted in the declaration in May of 2020 of the Abassieh Coast (South Lebanon) as an MPA. The Ministry also published the "National Monitoring Program for Marine Biodiversity in Lebanon". In collaboration with its partners, MoE initiated several missions in coastal and deep waters to assess the ecological characteristics of several sites. This resulted in the development of draft laws to declare Ras el Chakaa as an MPA and the Jounieh Canyon as a deep-sea nature reserve. Following the ratification of the ICZM Protocol, an ICZM draft law is now ready for a final submission to the Council of Ministers (CoM) before it is presented to Parliament.

A new draft law on fisheries and aquaculture was prepared by the Ministry of Agriculture (MoA), taking into consideration some of the new challenges in these sectors as well as the new scientific references and benchmarks for the sustainable management of marine resources and the wellbeing of fishing communities, in addition to the provisions of the international conventions ratified by Lebanon as related to biodiversity. The MoA has been collecting catch and effort data for commercial fisheries since 2013. Furthermore, a draft management plan for the purse seine fisheries based on the Ecosystem Approach to Fisheries of the Food and Agriculture Organization was developed in 2016 and awaits endorsement and implementation. The MoA also banned the fishing of 10 species of sharks and rays, while biological studies of several commercial species including non-indigenous species (NIS) have seen an exponential increase.

11.1.5 Land Resources

Land resources are increasingly at risk of additional degradation. The population of Lebanon increased from 4.2 million in 2010 to 6.8 million in 2020, and most of the increase was due to the Syrian crisis. However, this did not translate in a typical increase in demand for housing as many of the displaced Syrians lack conventional shelter and lack the means for consistent revenue. The country has therefore seen an increase in informal settlements encroaching on agricultural areas and water bodies. The total built-up area increased from 648 km2 in 2010 to 690 km2 in 2020. This lackluster growth is due more to the sluggish economic growth than to any efforts to curb unsustainable construction practices.

Despite adoption of the National Physical Master Plan of the Lebanese Territory in 2009, no progress was made on master plans as only 14.4% of the territory is planned and 4.3% partially planned by decree. Including plans not enforced by decree, this would amount to about 32% of the territory.

So far, a policy for the integrated management of the quarrying sector has been developed and adopted by CoM in 2019, which highlights the need to update Decree 8803/2002 and its amendments and reorganize the sector around a master plan. Although the text of the new decree has already been approved by CoM in September 2019, the master plan, an annex to the decree, is still under review, and accordingly the new decree has not been issued yet. Progress has been made on identifying and clearing minefields but, while it was expected to be completed by 2020 or 2021, significant work still needs to be done.

In 2018, it was estimated that the cost of land degradation in Lebanon is 1.1% of the GDP, with a lower bound of US$ 0.38 billion to an upper bound of US$ 0.83 billion. Most of these costs (1% of GDP) were attributed to degradation from quarrying activities.

11.1.6 Haphazard Urbanization

Urbanization remains uneven and incoherent despite a clear deceleration due to the economic downturn. At 8.91 million m2, total floor area of construction permits decreased almost by half since 2010. The housing market is at a near complete standstill, save for some limited real estate transactions in the wake of the banking crisis of 2019-2020. The urbanization rate remains at 88.6%, almost unchanged in years. The influx of displaced since 2011 was not properly managed, with many living in inadequate shelter and left vulnerable to predatory letting practices. There was no progress made on construction or housing legislation, and strategies for social housing remain a dire need.

Flagrant proofs of inappropriate decision-making include the temporary authorization to municipal powers to issue construction permits of 150 m2 on rural lands (and the subsequent extensions). This paved the way to the erection of residential constructions on agricultural lands. Such a stance from the Ministry of Interior and Municipalities received strong opposition from both the Ministry of Environment and activists and allowed the bypassing of construction regulation steps. In 2012, the Directorate General of Land and Maritime Transport of the Ministry of Public Works and Transport produced a report detailing occupation (legal and illegal) of the Maritime Public Domain and showing that only 20% of the shore is accessible to the public, while it counted around 1,068 transgressions amounting to over 5 million m2 of illegal sea-filling. Settlement of "Illegal Occupancy of Public Maritime Property" was put forward under two laws that set deadlines for violators to settle their violations or else the state may expropriate illegally built properties. Since then, constructions still sprouted on public domain, the most notorious being the Eden Bay Hotel on the Ramlet el Bayda coast in Beirut.

Urban design guidelines have yet to be updated in order to have buildings adapted to their surroundings and environment, while minimizing environmental degradation and pollution due to excavations and loss of green cover. Large cities do not have good natural lighting and ventilation. Infrastructure development (water, sanitation, and transportation) still cannot keep up with the needs of the urban population. In 2012, MoE proposed, as a direct implementation to the NPMPLT, to develop a masterplan to protect environmentally sensitive areas (mountains; protected areas; green sites; coastal zones and agricultural terrains) which was only approved in September 2019. The plan was set to be prepared by CDR in coordination with all stakeholders, but due to the financial crisis and currency devaluation, the funds that had been allocated in local currency are no longer sufficient to conduct the necessary studies. Administrative reform is necessary for better enforcement of urban planning regulations.

11.1.7 Solid Waste

While the last decade had witnessed several crises in the waste sector, progress has been made on several fronts. On the legal front, the Government of Lebanon (GoL) adopted Law 80/2018 on Integrated Solid Waste Management (ISWM), a major milestone for the sector, following the adoption of the ISWM policy in 2018. This was followed by the drafting of a national ISWM strategy, following a participatory approach that included most actors in the SWM sector in the country. Finalization and adoption of this strategy is pending preparation of a Strategic Environmental Assessment. In June 2019, a roadmap for attaining the objectives of the ISWM policy was prepared by MoE in 2019 and adopted by the CoM; it was later revisited by a committee appointed by the Presidency of the Council of Ministers in 2020 following the recent economic and financial developments.

After the solid waste crisis of 2015, the GoL managed to reduce the cost of solid waste collection and disposal services at US$ 74/ton (compared to US$ 124/ton paid until 2015), for more services including collection, sorting, composting, baling, landfilling and upgrading of facilities. While only 11 small-scale solid waste treatment facilities were in operation in 2010, today, there are more than 45. During the period 2010 – 2020, two major dumps in Saida and Bourj Hammoud were rehabilitated and three major ones in Tripoli, Ras el Ain and Bar Elias were closed, still to be rehabilitated. In addition, an estimated 28 inland dump sites were removed, and covered or rehabilitated. Health-care waste, only 55% of which was being treated by one NGO in 2010, is now mostly (85%) being treated by this NGO, Arc En Ciel while less than 10% at Abbassieh Facility and a similar amount treated on-site. The management of a key persistent organic pollutant (PCB) in the power sector project was launched, an action plan and an inventory were developed and 265 PCB-containing transformers (out of 1,129) have been disposed.

All these developments imply major improvements in the SW sector, namely in legislation, planning, the number of small-scale facilities and hazardous waste management. However, the lack of trust in authorities led to rejection of these developments by the public, political opposition and civil society, who focused on the negative impacts of expanding coastal landfills. In addition, the enhancements of the last decade have yet to yield any comprehensive and permanent solutions on the ground that ensure the stability of the solid waste sector as much work remains. In fact, the Rapid Cost of Environmental Degradation Report of 2018 estimated that the annual loss from the status quo in terms of poor treatment and poor disposal of solid waste to be USD 200 million in 2018, or 0.4% of GDP.

11.1.8 Climate Change and Energy

Lebanon experienced deviation in rainfall patterns, which has been attributed to increasing temperatures. Changes in rainfall patterns are affecting the frequency of intense rainfall events and altering catchments and drainage basins. Increased winter rainfalls lead to destructive flooding. About 10% of the Lebanese population is susceptible to drought.

Increased surface runoff coupled with reduced precipitation is likely to increase with rising temperatures, leading to increased drought severity. Higher temperature and drier conditions increased the severity and intensity of fires, severe drought conditions, the rise in the sea level and the depletion of groundwater supplies, currently under pressure from extraction for agriculture and industrial activities. The GoL joined the Paris Agreement in 2019 and had already presented its National Determined Contribution (NDC) in 2015 to the United Nations Framework Convention for Climate Change (UNFCCC). The NDC was updated in 2020 unconditional committing to a 20% GHG emission reduction, 18% of the power demand (i.e. electricity demand) and 11% of the heat demand (in the building sector) to be generated by renewable energy sources and a 3% reduction in power demand through energy-efficiency measures by 2030. In addition, Lebanon has fulfilled its reporting obligations to the UNFCCC through submitting its Second (2011) and Third (2016) National Communications and its First (2015), Second (2017) and Third (2019) Biennial Update Report. Much work was conducted in the last decade, including estimating the economic cost of climate change in Lebanon and proposing frameworks for derisking renewable energy investments and climate proofing the country's development plans. In these reports, Lebanon had assessed climate change vulnerabilities and proposed adaptation measures to be implemented. In July 2017, the country initiated its National Adaptation Process Development to prepare an integrated and comprehensive National Adaptation Plan (NAP). Furthermore, adaptation principles and priorities have been strengthened in the updated NDC of 2020.

Total Primary Energy Supply in Lebanon increased to 8,617 KTOE in 2020 (up from 5,400 KTOE in 2009). The energy mix did not change much in favor of cleaner and less expensive fuels. Lebanon's renewable energy production is still limited and under-exploited, including hydroelectricity, despite its recent rise in solar and wind energy. The environmental performance of Lebanon's electricity sector has worsened due to shortage of investments, aging of transmission and distribution infrastructure, and lack of consumer awareness for power utilization, in addition to the increase in consumption due to the inflow of displaced, as well as political deadlock. The 2010 Policy Paper for the Electricity Sector was only partially implemented and was later updated in 2019. Storage facilities for imported hydrocarbon fuels did not undergo a detailed environmental audit, unlicensed gas stations continue to operate, and the majority of storage tanks have escaped inspection.

Regarding oil and gas, in February 2020, the updated Strategic Environmental Assessment (SEA) for exploration and production activities for offshore petroleum resources in Lebanon was published by the Lebanese Petroleum Administration. The SEA aimed to ensure that impacts and their sources are identified, and that effective measures to manage these impacts are in place early on prior to the start of petroleum activities. Drilling of the first exploration well on Block 4, subject to an EIA that is published online, was completed on 26 April 2020 with plans to drill an exploration well in Block 9 at a later date Traces of gas were observed confirming the presence of a hydrocarbon system, but no reservoirs were encountered.

11.1.9 Chemical Management

Hazardous chemicals storage and disposal remain problematic despite the emphasis on the regulation of chemicals in the Lebanese legislation. This has led to accidents and safety incidents, most prominently the August 4 Beirut Explosion, which appears to be the direct result of inappropriate storage and mishandling of flammable material at the Port of Beirut over a long period.

Over the last decade, moderate to high levels of heavy metals have been detected in rivers, sediments, and marine water as a result of untreated industrial and residential wastewater effluents, coastal agricultural runoffs and dump leachates. In 2017, Lebanon joined the Minamata Convention on Mercury joining over 100 countries to protect human health and the environment from the adverse effects of mercury and controlling its release into the environment.

In terms of persistent organic pollutants (POPs), Lebanon has continued its commitment to the Stockholm Convention through issuing legislation that ban and restrict the import and of POPs. During the last decade, the MoE, with support from the international community, produced the Assessment of POPs Impacts and Management and Action Plan, Assessment of New Industrial Pops and Action Plan and Inventory of PCB Equipment in the Power Sector. As part of the implementation of this plan and emphasizing its commitment to the Convention, the MoE has so far collected about 389 tons of PCB equipment and oils and shipped them for proper off-site treatment and disposal in 2016 and in 2020.

Another challenge tackled by the GoL and its international partners during the last decade was the excessive use, potential smuggling, and the inappropriate storage and disposal of pesticides. This was done mostly by providing training and extension services to farmers on proper use of pesticides. The extent of the impact of these activities, however, is unclear.

As for ozone depleting substances (ODS), Lebanon has taken a proactive, forward-looking and targeted approach for its regulation, through the ODS quotas and licensing system. Since 2018, several ministerial decisions were amended with regards to the quota systems and quotas for importers, deadlines of submission of import licenses, HS codes for hydrochlorofluorocarbons (HCFCs), and enforcement of the general procedures for issuing imports licenses which include issued quotas versus actual quotas. As a result, Lebanon is on track to practically eliminate the use of ODS in the country by 2028.

11.1.10 Progress towards Select SDGs 2015-2019

The separate assessment for each sector over the last decade in comparison to the Market First and Sustainability First scenarios produces a valuable granular picture of sectoral evolution. However, the state of the environment is more than the sum of its parts, and the sectoral approach may obscure some of the intersectoral elements and cross-cutting aspects of development. The table below (Table 11-1) translates the overall effect of this evolution into outcomes, by showing the country's progress towards the achievement of select SDGs, as measured by levels and trends in certain development indicators.

Table 11-1 Relevant SDG Indicators for SOER

Indicator	Value	Rating	Trend
SDG3 – Good Health and Well-Being			
Age-standardised death rate attributable to household air pollution and ambient air pollution (per 100,000 population)	51		••
SDG6 – Clean Water and Sanitation			
Population using at least basic drinking water services (%)	92.3		↑
Population using at least basic sanitation services (%)	95.4		↑
Freshwater withdrawal as % total renewable water resources	33.3		••
Imported groundwater depletion (m^3/year/capita)	17.3		••
Anthropogenic wastewater that receives treatment (%)	N/A		••
Degree of implementation of integrated water resources management (%)	32		••
Mortality rate attributed to unsafe water, unsafe sanitation and lack of hy-giene (per 100,000 population)	0.8		↑
SDG7 – Affordable and Clean Energy			
Access to electricity (% population)	100		↑
Access to clean fuels & technology for cooking (% population)	N/A		••
CO_2 emissions from fuel combustion / electricity output ($MtCO_2$/TWh)	1.3		↑
Renewable electricity output (% of total electricity output)	2.6		↓
Energy intensity level of primary energy (MJ/2011$ PPP GDP, average of 5 years)	4.0		••
SDG9 – Industry, Innovation and Infrastructure			
Carbon dioxide emissions per unit of manufacturing value added (kilo-grammes of CO_2 per constant 2010 US$)	0.5		→

Indicator	Value	Rating	Trend
SDG11 – Sustainable Cities and Communities			
Annual mean concentration of particulate matter < 2.5 microns in diameter (PM2.5) (μg/m³)	30.6		↓
SDG12 – Responsible Consumption and Production			
E-waste generated (kg/capita)	11.1		••
Production-based SO_2 emissions (kg/capita)	N/A		••
Imported SO_2 emissions (kg/capita)	-1.4		••
Nitrogen production footprint (kg/capita)	21.4		••
Total municipal solid waste generated (kgs/year/capita)	364.1		••
Value realization score (Resource Governance Index)	N/A		••
Fossil-fuel pre-tax subsidies (consumption and production) per capita (current US$)	499.9		••
Compliance with multilateral environmental agreements on hazardous waste and other chemicals (%)	55.6		••
SDG13 – Climate Action			
Energy-related CO_2 emissions per capita (tCO_2/capita)	2.4		↑
Imported CO_2 emissions, technology-adjusted (tCO_2/capita)	1.1		••
People affected by climate-related disasters (per 100,000 population)	8,559		••
CO_2 emissions embodied in fossil fuel exports (kg/capita)	0.0		••
SDG14 – Life Below Water			
Mean area that is protected in marine sites important to biodiversity (%)	17.8		→
Ocean Health Index Goal-Clean Waters (100–0)	30.1		→
Ocean Health Index Goal-Fisheries (100–0)	41.6		↓
Fish caught by trawling (%)	10.0		••
SDG15 – Life on Land			
Mean area protected in terrestrial sites important to biodiversity (%)	13.1		→
Red List Index of species survival (1–0)	0.9		↑
Imported biodiversity threats (threats per million population)	4.2		••

Rating:

SDG achieved Challenges remain Significant challenges remain Major challenges remain Data unavailable

Trend:

↑ On track or maintaining SDG achievement ↗ Moderately improving → Stagnating ↓ Decreasing •• Data unavailable

Reference: UN (2019). 2019 Arab Region SDG Index and Dashboards Report

11.2 Scenarios for the Decade Ahead

The hallmark of the achievements of the past decade has been the substantial effort at developing, updating and planning strategies and legislation across all the various sectors. One of the important features of this effort is that when considered collectively, it has a wide reach and comprehensive scope. The table below (Table 11-2) produces a matrix mapping the different national strategies, plans and draft laws onto SDGs. A remarkable aspect of the matrix is that it shows that the last decade's planning and strategizing effort speaks to most of the 17 of the SDGs, although, naturally, to differing degrees. In principle, then, the country has already developed the roadmap, plans and rules to make good on its commitments for 2030.

However, in practice, the country is at a crossroads. Lebanon faces the COVID-19 pandemic while its economy is already in freefall because of economic and financial crises, with the fallout of the Beirut Port Explosion still unclear. The overlay of crises has created a great deal of uncertainty about the future. The disruptions since the start of 2020, whether resulting from the pandemic, the sudden stop of dollar inflows, the near collapse of the banking system, or the Port of Beirut explosion are all unprecedented, and suggest that the developments since the beginning of the economic downturn do not represent a typical evolution and cannot be used to project coming trends.

Instead, Lebanon finds itself at the precipice of a sharp depression that could seriously hinder the ability and will of any central authority to enforce regulation and honor commitments, including the SDGs. In terms of the state of the environment, and in light of the most notable achievements of the last decade, such a development can be characterized as a scenario of Poor Enforcement of the laws, decrees, national plans and strategies that were developed over the last ten years.

If on the other hand Lebanon is offered international support and assistance conditional on frontloading reforms, the promise of recovery could create an opportunity for improvements in governance, enforcement, and transparency. This scenario entails a Robust Enforcement of the past decade's vigorous planning, strategizing and legislating. And given the broad coverage of SDGs in the strategies and policies, this scenario would march the country steadily towards its 2030 goals. Instead of thinking of environmental governance as one of the outcome sectors, it is treated here as the lens through which to project the two scenarios for the decade to come.

The Poor Enforcement Scenario: The local financial, banking and economic crises, combined with the global recession resulting from the coronavirus pandemic, mean that the policy space is severely restricted in Lebanon. In this context, poor enforcement is not sector specific. Instead, it cuts across multiple spheres of decision-making, several institutional players, various structures of authority and different practices of governance, the most prominent of which are detailed here:

- **Enforcement procedures:** with weak commitment to the national plans, sector strategies and laws enacted in the last decade, no effort is made to develop and follow clear enforcement procedures, so that the inaction in implementing plans and strategies is also the result of the absence of any clear and verifiable mechanisms and channels for enforcement.
- **Administrative and civil service reforms:** good enforcement requires good enforcers, and so long as rules for the recruitment, retention and compensation of civil servants do not protect the service from abuse, inefficiency and poor competence, stalled administrative reform will also mean that even the most well thought out plans and policies will fail to get implemented fairly and systematically.
- **Automation:** putting in place the infrastructure for automation and services of e-government involves the front loading of high fixed costs. In a period of rapid economic contraction, such an investment is not a priority, in addition to resistance by civil servants as automation makes corruption more difficult, even though automation has been shown to improve the quality-of-service provision, the efficiency of procedures, and the transparency of enforcement.
- **Procurement law:** procurement has the potential to be a gateway to extensive abuse, corruption and conflict of interest. A loose, permissive and partial procurement law is one of the weaker links in public decision making. In a climate of poor enforcement, the currently proposed draft procurement law of February 2020 is either stalled, or passed but poorly implemented, exposing public interest to the predatory practices of the more powerful players.
- **Stakeholder engagement in applying the law:** the proper and consistent application of a law requires the participation of a multitude of stakeholders including regulatory authorities, auditors, law enforcers, the judiciary and the general

Table 11-2 Key National Environmental Policies, Strategies and Plans and Alignment with SDGs

Policy / Strategy / Plan (Relevant Chapter)	Date of Adoption/Launch	SDG1 - No Poverty	SDG2 - Zero Hunger	SDG3 - Good Health & Wellbe-ing	SDG5 - Gender Equality	SDG6 - Clean Water & Sanita-tion	SDG7 - Affordable & Clean Energy	SDG8 - Decent Work & Eco-nomic Growth	SDG9 - Industry, Innovation & Infrastructure	SDG11 - Sustainable Cities & Communities	SDG12 - Responsible Con-sumption & Production	SDG13 - Climate Action	SDG14 - Life Below Water	SDG15 - Life on Land	SDG16 - Peace & Justice Strong Institutions
National Water Sector Strategy (NWSS)* (Chapter 3 – Water Resources)	2012			■		■				■	■		■		
National Strategy for Air Quality Management (Chapter 4 – Air Quality)	2020			■			■			■	■	■		■	
Marine Protected Areas Strategy (Chapter 5 – Ecosystems)	2012												■		
Lebanon National Forest Program 2025–2015 (Chapter 5 – Ecosystems)	2015											■		■	
National Biodiversity Strategy and Action Plan (Chapter 5 – Ecosystems)	2018											■	■	■	
National Physical Master Plan of Lebanon (Chapter 6 – Land Resources / Chapter 7 – Haphazard Urbanization)	2009	■				■	■	■	■	■	■			■	■
Quarry Policy (Chapter 6 – Land Resources)	2019					■				■				■	
Policy for Integrated Management of Solid Waste (Chapter 8 – Solid Waste)	2018			■		■				■	■		■	■	
Lebanon's Nationally Determined Contribution to Climate Change (updated in 2020) (Chapter 9 – Climate Change and Energy)	2015	■	■	■	■	■	■	■	■	■	■	■	■	■	■
National Energy Efficiency Action Plan for Lebanon 2020–2016	2016						■			■	■	■			
Update of Policy Paper for Electricity Sector (Chapter 9 – Climate Change and Energy)	2019						■								
Renewable Energy Road Map (Chapter 9 – Climate Change and Energy)	2020						■			■					
National Implementation Plans for the Management of POPs (Chapter 10 – Chemical Management)	2018		■	■		■		■	■	■			■	■	
HCFC Phase-out Management Plan Stage I (2017 – 2011) and Stage II (2025 – 2016) (Chapter 10 – Chemical Man-agement)	& 2011 2016								■						
Ministry of Agriculture Strategy 2025–2020 (Chapter 10 – Chemical Management)	2020	■	■		■	■	■	■	■		■	■	■	■	

Adapted from: GoL (2018). Lebanon Voluntary National Review on Sustainable Development Goals
*Updated in 2020 awaiting adoption

public. For each one of these sets of players, the incentive to uphold the law is reinforced by the law-evincing behavior of the other players. A climate of weak confidence in the power of the law tends to be self-fulfilling.

- **No political interference:** one of the primary sources of pressure on all of the processes described above is political power. One of the main objectives of sound administrative rules and institutional reforms is to safeguard some of these decision-making arenas from undue political influence. A scenario where reforms continue to be stalled or weak is one in which decisions relating to public interest remain exposed to political agendas.
- **Responsible media:** information and messaging can shape stakeholder incentives. The media is also subject to capture by powerful interests. Therefore, without the proper enforcement of laws and regulations relating to information and privacy and the social responsibility of media, it can become a tool to further skew policy and decisions towards the private interests of certain players.

Some of the implications of such a scenario that are more relevant for the evolution of the state of the environment include:

- Drastic reduction in fiscal spending means extremely limited budgets for infrastructure, capital investments, staffing, enforcement, and maintenance. This affects the ability to:
  - o undertake priority projects to stop pollution: (1) building large scale priority environmental projects and properly operating and maintaining them, including wastewater treatment facilities, solid waste management facilities as well as operating and maintaining the Air Quality Monitoring Network; (2) environmental pollution abatement projects at the point source level (industries; other classified establishments; health care establishments; touristic establishments; quarrying sector)
  - o use land and water resources sustainably and conserve the natural capita.
- At the level of environmental outcomes and practices, the economic collapse comes with a de-prioritization of any agenda of environmental protection, or of efforts at mitigating further degradation. Sustainability is treated as a “luxury” and the national plans, strategies, decrees and laws are poorly and haphazardly enforced.

The Robust Enforcement Scenario: In response to the crisis, reforms are instituted to usher in foreign assistance and international aid for economic recovery. They span a variety of vital sectors, including fiscal, regulatory, administrative and judicial reform. Some of the more relevant implications of such a scenario for the evolution of the state of the environment include:

- **Enforcement procedures:** for the last decade’s investment in the development of national plans, sector strategies and laws to yield high returns, clear procedures and verifiable mechanisms and channels for enforcement are introduced.
- **Administrative and civil service reforms:** robust enforcement requires a civil service staffed with enforcers with the right set of competencies, operating in an institutional structure that protects them from abuse and influence, but also holds them accountable for their performance.
- **Automation:** technology offers several models of automation and e-government solutions today. The streamlining of procedures into automated processes relieves a substantial part of the enforcement, record-keeping, efficiency and delivery burdens that currently plague much of service provision.
- **Procurement law:** the draft procurement law of February 2020 is passed and implemented, leading not only to an improvement in transparency and efficiency of public contracts, but also in the promotion of priorities such as sustainability and gender equality in service provision.
- **Stakeholder engagement in applying the law:** a reformed civil service, automation, and a modern and sound procurement law go a long way in pushing other stakeholders, including enforcement, the judiciary and ordinary citizens to abide by the law.
- **No political interference:** administrative reform and clearer enforcement procedures contribute to raising legislation and regulation above the sphere of interests by political centers of power or business elites.
- **Responsible media:** information can go a long way in aligning stakeholder incentives. Beyond media’s traditional function of watchdog, in a general climate of reform, media’s advocacy role becomes paramount.

Some of the ways in which reforms play out across various sectors include:

- A fiscal restructuring that involves reforming the scope and provenance of government revenues. As part of the effort to increase government revenues, more licensing fees and taxes are collected through the proper enforcement of laws:

- o Cogent fiscal reform expands the fiscal space available to policy makers for capital investment in big infrastructural upgrades, and current expenditures for maintenance and monitoring; and
- o Fiscal reforms include the institution of fees and breaks to limit waste, incentivize conservation, and promote efficient use.
- Reforms in the electricity sector involve switching to cleaner fuels, closer control of fuel quality, deregulation of the tariffs for electricity and more consistent collection, which limits waste and incentivizes conservation.
- Judicial reform, which gives a blanket boost to law enforcement, including the "dedication" of environmental prosecutors and investigation judges as per Law 251/2014, the strict penalization of violations, which both limits the incentives to violate and increases government revenues through fines and indemnities.
- With exchange rate stabilization comes a new balance of trade that is less biased in favor of imports than before the crisis. This naturally creates incentives for the preservation, reuse and recycling of resources that pushes productive practices more towards a circular economy.
- The passing of competition law breaks down cartels and oligopolies, including cartels in sectors with serious environmental impact, such as cement. Reducing the concentration in markets creates employment, many of which can be directed towards greener more sustainable jobs, particularly with the reduced incentive to import.

Table 11-3 presents general assumptions for each scenario based on a set of drivers and sub-drivers.

Table 11-3 Overview of Drivers, Uncertainties, and Assumptions by Scenario

Driver and Sub-Driver	Poor Enforcement	Robust Enforcement
Governance		
Dominant actor and power balance	State capture by powerful individual interests (political and business) to the detriment of institutions and public interest	Regulators, the judiciary, civil society and rights groups
Level of public participation	Fragmentation and division	Public participation, scrutiny and investment
Priority	Powerful interests maximize short term capture and rent seeking	Reforms, respect for institutions and sustainability
Mainstreaming of social and environmental policies	Lost, in the failure to enforce policies	Championed, as incorporated in the policies and strategies
Economic Growth		
GDP growth	Negative	Positive
Diversification	Sharp recession leads to atrophy in some sectors	High, towards import substitution and services
Privatization	Crony privatization accelerates	As integrated in a reform plan
Demographic Growth		
Population growth rate	Negative	Stagnant
Migration (expatriates and labor force)	Severe brain drain, decrease in foreign labor	Stricter regulation and enforcement of labor law
Urbanization	Haphazard and uncontrolled	Planned, integrated with rationalized land use policy, housing policy and infrastructural upgrades
Human Development		
Level of investment in education and health	Deterioration in quality of education with the public sector experiencing the brunt of the effect	Reforming public education and health sectors
Environmental awareness	Receding, subordinated to private interests	Growing, integrated into regulatory policy
Regional Integration and Cooperation		
Type, level and rate	Further isolation due to a diminished rule of law, cooperation is largely humanitarian and politically driven	Reformed economy offers new opportunities for cooperation and integration

11.2.1 Poor Enforcement

11.2.1.1 Water Resources

Gains made in recent years with regards to improving the hydrological and water quality monitoring will be lost. Projects earmarked in the updated 2020 NWSS will not be implemented due to the lack of international funding resulting from the default of the GoL on its loans, and the deep proliferation of corruption and mismanagement. The existing water networks will further degrade, increasing transmission losses and pollution. These changes in the sector will lead to an increase in the number of unlicensed wells across the country, further accentuating SWI along the coast and further decreasing the water table inland. The number of people without access to a safe and improved water source will continue to increase, as well the incidence of water-borne diseases, which will further stress the local economy and increase the morbidity and mortality statistics for the highly vulnerable population.

The economic collapse will also lead to the de-prioritization of domestic and industrial wastewater treatment projects, especially those proposed under the updated 2020 NWSS. Meanwhile, the existing WWTPs will either stop operating or will downgrade their treatment levels. The percentage of raw sewage discharged into the environment will increase, causing further deterioration in river and coastal water quality. This will have a dramatic impact on the population's health and the tourism, fishing, and agricultural sectors. Demand management activities will not bear fruition. This will lead to increased conflicts between the sectors and across regions.

The poor enforcement scenario will restrict the introduction of meaningful and much needed policies and interventions foreseen for the sector in the Amended Water Code and the draft updated NWSS. The political deadlock will delay the issuance of the executive bylaws needed for the implementation of the amended Water Code (Law 192/2020). Moreover, the lack of sufficient funds will degrade the existing capabilities and capacities present at the MoEW, MoE, the RWEs and LRA. This will further erode the role and reach of the central government and the RWEs, thus resulting in a drop in the collection of subscriptions, a decrease in the dependability of the existing water sources, treatment systems, and distribution networks as well as an erosion in the ability to regulate the sector. These challenges will dissuade foreign investments in the sector and as a result PPPs will not be as successful as expected.

11.2.1.2 Air Quality

In the poor enforcement scenario, the worsening energy deficit in Lebanon further increases reliance on private, unregulated electricity generation that is a major source of air pollution and have been shown to emit 6.3 times more CO, 2.2 times more PM2.5, 1.5 times more PM10, and a comparable amount of NOx than the national power supplier, EDL. Actions to bolster public transportation do not materialize and vehicle fleet continues ageing due to lack of financial ability to renew it, thus leading to more traffic congestions and higher vehicular emissions. With the national Air Quality Monitoring Network shut down due to budget cuts, the air quality data available remains very segmented, non-homogeneous, and driven mostly by research agendas of the many academic institutions that collect it. This renders the data difficult to use as a monitoring tool for the success of the different efforts to reduce air pollution. Additionally, without detailed and reliable emission inventories, there is little opportunity to develop strategic plans of how to deal nationally or locally with air pollution problems and to monitor the effect of such plans, as well as bring scientific evidence of pollution and take the polluters to court on that basis.

11.2.1.3 Ecosystems

Poor enforcement will be reflected in further degradation of natural assets with heightened loss of significant habitats and increased levels of threat to endemic, rare and threatened species. Degradation to key biodiversity areas will inflict major losses to the value of the biodiversity of Lebanon. Uncontrolled hunting activities due to lack of enforcement of hunting laws will not only cause loss of species but will cast doubt on Lebanon's respect for its commitments on signed international treaties, agreements and conventions. The ability to counter forest fires will be diminished markedly, while the needs will augment exponentially.

The scenario will also not see Lebanon's 2012 National Marine Protected Area Strategy implemented and therefore the two draft laws for the declaration of Chakaa and Jounieh Canyon as MPAs will not likely be adopted. Furthermore, Lebanon's National Biodiversity Strategy and Action Plan, National Monitoring Programme for Marine Biodiversity in Lebanon and Action Plan Concerning Species Introductions and Invasive species in Lebanon will not be implemented leading to loss of marine and coastal biodiversity. Efforts for the identification of new NIS will be reduced. Without protection, vermetid (snail) platforms will be further disturbed and destroyed especially as chaotic sea-filling for the construction of ports and resorts continues. The poor enforcement scenario will also lead to poor management and planning of artificial reefs that create new habitats for marine species, leading to their destruction and the destruction of any habitats they create. In the absence of monitoring programs for climate change, climate change variables will make the coastal zone experience the full negative effects of anticipated weather events and other climate change impacts.

11.2.1.4 Land Resources

In this scenario, land degradation leads to a major national crisis. Lack of master planning maintains the meager 19% of newly planned territory with most of the new plans just developments from previous ones. Quarries continue illicit operations while pollution increases in their vicinity. The proposed decree to reform quarries is not adopted and neither is the masterplan for the preservation of environmentally sensitive areas. Land degradation spreads due to deforestation and unregulated constructions leading to more landslides and poorer soil. The efforts of the Lebanon Mine Action Center are hindered so that they are only able to attain total landmine clearance by 2030.

11.2.1.5 Haphazard Urbanization

The poor enforcement scenario sees the total population of Lebanon reduced to 6.5 million as much of the active population emigrates while some of the displaced Syrian population return to their home country as their situation deteriorates. The deep economic crisis drives out many tenants unable to pay rent. The increasing vacancy rate of buildings, combined with the emigration of the middle class and the return of numerous urban dwellers to their ancestral villages, leads to a reduction of the urban population from 88% to 85%. In urban areas, slums expand and more illegal buildings sprout, thus increasing the burden on the infrastructure and worsening sanitary conditions in struggling neighborhoods. The weak authority of the state makes it common for some administrations to disregard standard procedures and take decisions that serves political or private interests, paving the way for numerous new cases of encroachment on public domain, agricultural land and protected areas. Air pollution is constantly increasing in urban centers. With the oversupply of real estate leading to the downfall of short to mid-term speculative transactions, total floor area of construction permits amount to 6 million m2/year leading to a built-up area covering 720 km2 of the territory.

11.2.1.6 Solid waste

The poor enforcement scenario is characterized by insufficient adoption of application decrees and decisions of the ISWM Law 80/2018, leading to fragmented strategies and implementation plans, and delayed capacity building of national and local authorities, resulting in weak enforcement of the existing regulations. Limited resources associated with this scenario will lead to lack of a national, country-wide, decentralized solid waste infrastructure, and continuous dependence of the sector on ad hoc interventions with no sustainability path for adequate operation and maintenance. As a result, no tangible progress is achieved on the reduction, processing and disposal of municipal solid waste, potentially leading to waste crises similar to the one of 2015-2016 and more open dumping and burning. This will reduce ever further the public trust in government run SW facilities and continued rejection of sanitary landfills. Hazardous waste management remains unsatisfactory for several major streams. There is no major improvement in the reduction of the volume of generated marine litter and deviation of plastic waste from water streams. More than 50% of the construction and demolition waste generated in the country still ends in open dumps and landfills.

11.2.1.7 Climate Change and Energy

The poor enforcement scenario sees Lebanon facing environmental and sustainability challenges of an unprecedented scale and urgency. Sectors such as transport and energy, which are in need of urgent overhauling - especially Lebanon's electricity infrastructure – continue to deteriorate. With the country increasingly unable to meet local demand, rationing electricity will become more severe as citizens and businesses increase their reliance on private generators that will become more cost prohibitive and polluting due to aging equipment that cannot be easily replaced. As a result, Lebanon will not be able to meet its commitments in the National Determined Contribution as CO_2 emissions become more difficult to track. The scenario also sees limited adaptation measures adopted across the country while it experiences higher temperatures, changes in precipitation, and extreme weather events, such as storms. These will reduce agricultural productivity, adversely affect human health, cause flooding, and impose similar damage on different segments of Lebanon's economy and society. As for oil and gas, if reservoirs in Block 9 were found to be productive, this will boost the economy and may help the uphauling of the fragile infrastructure, but in an inefficient and untransparent manner. In addition, this development will be at the expensive of the environmental and natural resources as none of the safeguard decrees are implemented. If no productive wells are encountered, the economy will continue to plummet as a result of deterioration of the energy and transport sectors combined with the adverse impacts of climate change.

11.2.1.8 Chemical Management

This scenario will be marked by the absence of a national strategy to phase out the use of certain heavy metals, such as mercury, and the lack of assessment and monitoring will hamper the reduction of the release of heavy metals in the environment. It will witness the increase in import and use of cheaper chemicals as a result of the financial crisis, which may lead to smuggling of hazardous or banned substances. Lack of control will lead to discharge of these chemicals in the environment, including heavy metals and POPs. Social and economic costs of dealing with health impacts resulting from practices such as open waste burning and dumping of hazardous chemicals in municipal landfills will continue to be incurred. Given the local economic and political crises, the policy space is severely limited, leading to a lack of adherence to the National Implementation Plan on POPs, as well as lack of institutional strengthening and capacity building and weakening infrastructure due to limited budgets for investments, enforcement, maintenance, and infrastructure. The gaps that exist in the Lebanese legislation with regard to storage and disposal of chemicals, as well as the lack of centralized management of hazardous chemicals in the country remain. The lack of proper pesticides storage and disposal continue to be an issue, and the smuggling of pesticides remains uncontrolled, and likely increase due to decrease in purchasing power of farmers.

11.2.2 Robust Enforcement

11.2.2.1 Water Resources

Water supply augmented: The sector emerges from the economic crisis with a commitment towards increasing transparency, improving performance and oversight, reducing redundancies, embracing the One Water paradigm, augmenting revenues, engaging the private sector in developing the water sector, and investing in transformative technology. The MoEW launches a plan to implement a series of check-dams and rainwater harvesting initiatives that focus on increasing retention, recharge and reuse of water. By the same token, the Managed Aquifer Recharge projects that have been previously identified by the MoEW and UNDP in their 2014 study are executed to augment recharge. The revised set of dams retained in the 2020 NWSS are implemented after undergoing a long public participation process and the preparation and serious implementation of the ecological compensation/offsetting plans, and after a full transparent review of the construction and operational challenges that have plagued the existing dams. Public Private Partnerships (PPPs) are extended for the procurement of water from unconventional sources, especially desalination along coastal urban areas. The MoEW, LRA, and the RWE fully realize the importance of monitoring for effective resource management. As such, a state-of-the-art hydrological information system is rolled out nationally with the involvement of the private sector. Relevant data are made available online to ensure transparency and to engage the public in water conservation and pollution prevention.

Water quality improved: Recognizing the negative impact that water pollution is having on the local economy, the MoEW and the RWE embark on increasing wastewater treatment and ensuring that at least secondary treatment is ensured at all existing and new plants. As a result, the pollutant loads in the rivers decrease and the coast will experience a significant improvement in its water quality. Industrial wastewater is reduced by expanding on the Lebanon Environmental Pollution Abatement Project and by issuing PPPs based on performance to design and operate treatment plants within industrial zones. Meanwhile, all industries are asked to apply for a pollution discharge permit and charged based on their loads. In an effort to reduce O&M costs, the RWEs commit to investing in renewable energy to power their facilities and reduce their electricity and fuel consumption.

Legal and institutional framework strengthened: Significant efforts are directed towards issuing the needed executive decrees for the implementation of the Water Code. The focus of the MoEW and the RWE shifts from being heavily skewed towards augmenting supply sources to managing demand, reducing NRW, and lowering operation and maintenance costs. The RWEs engage in commissioning audits on all their resources to rank them based on their performance, sustainability, and resilience. Collected data is properly stored and analyzed in a centralized hydraulic information system. The RWEs also engage in campaigns to win over the trust of their subscribers. At the same time, efforts are made to regulate the informal water delivery sector. Moreover, investments are made through internationally-guaranteed, low-interest loans to help farmers change cropping patterns and irrigation methods in an effort to reduce water consumption. Current subsidies on the provision of agricultural water to farmers will start to be lifted and incentives are given to dissuade farmers from using blue water sources. As such, extension services at the RWE, MoA, and local universities are expanded and properly funded.

11.2.2.2 Air Quality

Reduction in pollutant emissions: For the transport sector, robust enforcement will manifest in actions taken to bolster public transportation and reduce the vehicle fleet age. In terms of public transportation, Lebanon's NDC for the transport sector are 36% stabilization of the share of annual passengers-kilometers driven using public transport as an unconditional target for 2030. This would manifest, at a minimum, in the revitalization and restructuring of the operation of public buses inside cities, the deployment of a Bus Transit System with dedicated lanes on Beirut north and south gates, commuting Jounieh to Jiyeh. As for the energy sector, EDL's generation capacity will increase to meet the country's demand, stopping all emissions from private generators. Furthermore, in such a scenario, EDL power plants would shift their main fuel source form heavy fuel oil and diesel to the less polluting natural gas. These changes in are estimated to likely "save" 8,629 lives per year in the Greater Beirut Area and would represent economic savings of around US$ 1.2 billion.

Improving assessment capacity: In the context of a robust enforcement scenario, air quality assessment capacity is improved through compilation of comprehensive baselines coupled with continuous and spatially distributed monitoring, and periodically updated inventory of emission sources by putting the AQMS back in operation and providing adequate resources to ensure its operation. Data is collected in a standardized manner as part of a national effort to reactivate air quality monitoring through low-cost sensors, such that the main results are shared with all systematically and free of charge. The technical capacities already available at the MoE are expanded to include the production and maintenance of an updated air pollution emission inventory.

11.2.2.3 Ecosystems

Terrestrial Ecosystem: Robust enforcement will support better conservation and management of natural assets. The number of reserves and the surface areas benefiting from protection measures will increase. Existing reserves will develop and implement rigorous management plans. Biodiversity monitoring will improve on methodologies, experience gained, scope and impact. Law enforcement will provide better chances for species and habitat conservation, as well as for maintaining the forest cover and preserving reforestation sites. International confidence in the value and impact of implementation will engender financial and other forms of support for biodiversity preservation efforts. Climate change mitigation and adaptation measure will expand to implementation processes that help reduce pressures on biodiversity.

Marine Ecosystem: With a robust enforcement, Lebanon's National Marine Protected Area Strategy developed in 2012 is fully implemented and the remaining 16 sites identified in the strategy in addition to Ras el Chakaa and the Jounieh Canyon will be declared as MPAs. Moreover, all national plans and strategies for the conservation of coastal and marine biodiversity (National Monitoring Programme for Marine Biodiversity in Lebanon and Action Plan Concerning Species Introductions and invasive species in Lebanon) are fully implemented, in addition to continuous efforts for the identification of new NIS. Remaining vermetid platforms and their habitats will be preserved, and restoration actions will be developed, tested and implemented. Also, permits for coastal development will be extensively limited while sea-filling will be prohibited. Moreover, a network of artificial reefs will be created based on scientifically sound approaches, with good management of the deployed reefs. This will lead to the declaration of properly-designed ones as MPAs. Finally, data series, analysis of meta-data sets and the establishment of long-term monitoring programs will lead to the identification and implementation of mitigation measures for climate change effects.

11.2.2.4 Land Resources

In the robust enforcement scenario, land in Lebanon is considered an important asset and any development is treated with caution and careful decisions. Improved administration and regulation lead to over 30% of the territory covered by master plans enforced by decrees, with more focused plans executed at the district and governorate level in the most critical areas. Protected areas are well maintained and some are expanded thanks to coordinated efforts between the central government, municipalities and local NGOs, all within the framework of the masterplan for environmentally sensitive areas which the CoM agreed to prepare in 2019. The quarrying master plan is adopted and implemented by

MoE to regulate quarrying activities, successfully closing and rehabilitating 35 sites. The dues to the national treasury from the quarrying sector are collected, including fees and penalties related to cost of environmental degradation, cost of rehabilitation, difference in fees to Ministry of Finance (based on actual volume) and working without a permit. New market regulations allow the import of material, further limiting quarrying. The land degradation rate considerably slows down. Sustained efforts of the Lebanese Mine Action Center lead to the clearance of all landmines and cluster bombs fields by 2025.

11.2.2.5 Haphazard Urbanization

An estimated 5.7 million people (excluding Syrian displaced, as their continued presence depends on the resolution of the conflict in Syria) now live in the country, as the mass emigration is averted. However, the deep economic crisis drives out many tenants unable to pay rent with the increasing vacancy rate of buildings, combined with the already occurring emigration of the middle class and the return of numerous urban dwellers to their ancestral villages, leads to a reduction of the urban population from 88% to 85%. In parallel, regional development focused more on villages while sustainable and fair agricultural practices have gained momentum, with livelihoods adequate to sustain rural households. Numerous interventions, including landscape design work, improved urban mobility, air quality and public spaces. Total floor area of construction permits 6 million m^2/year as the real estate sector becomes more focused on responding to actual demand than on speculative practices. For the same reason, total built up area is capped at 700 km^2.

11.2.2.6 Solid Waste

The Robust Enforcement scenario simulates the outcomes of a well-rounded SWM that provides adequate regulatory and administrative reform and allocates sufficient resources needed to develop the regulatory, economic, communicative and institutional instruments and implement the ISWM strategy in line with Law 80/2018. As a result, the targets of the ISWM strategy are achieved in terms of closure and rehabilitation of dumpsites (resulting in annual savings between US$33 and 92 million), noticeable diversion of waste from landfills, high recovery of materials from waste, and adequate management of construction and demolition waste. Hazardous waste streams are collected separately, stored, treated and recovered following well-structured national standards and regulations – along with systematic monitoring and data collection. Marine litter generation is considerably reduced and plastic discharge in water streams is strongly controlled.

11.2.2.7 Climate Change and Energy

Improved power sector: In anticipation of developing its prospective gas reserves and generating a new and potentially important stream of revenue, enhancing its energy security, and reducing air pollution by replacing fuel oil in power generation, Lebanon will rehabilitate its power plants to replace fuel oil in power generation and import natural gas in the short to medium-term. Considering that two thirds of GHG emissions originate from the energy sector, the country will move forward with a large-scale shift to energy efficiency and renewable energy programs. This leads to decreasing technical and non-technical losses and increasing EDL financial income, in addition to increasing generation capacity, improving efficiency and reducing costs by switching to natural gas. This will improve EDL services and allow it to increase electricity tariffs and attract private investment. Moreover, modernization of all EDL's core business areas and administrative processes will take place as the basis for improving EDL's operational and financial performance and as a foundation for attracting private sector participation. With the correct measures implemented, the cost of electricity could decrease from as high as US¢27/kWh (billed) today to around US¢16.4/kWh by 2030. Supply could increase to provide all customers with reliable 24 hours of electricity.

Climate Mitigation and Adaptation: Curbing the GHG emissions will help in mitigating the increase in average annual temperature and the decrease in annual precipitation and increase in sea level. Robust enforcement will also lead Lebanon to consider the impacts of climate change on its various sectors, implementing adaptive measures to protect coastal infrastructure, providing support and extension services to farmers to change cropping patterns and mainstreaming climate impacts into future developments.

11.2.2.8 Chemical Management

Hazardous chemicals legislation and strategy adopted: A specific decree on hazardous chemicals management based on Law 444/2002 is endorsed to establish the environmental national standards, the procedures to regulate implementation of the decree, and fundamentals of assessing the environmental status and safeguarding it. A national chemical management strategy is also adopted, with a particular focus on storage and disposal of chemicals and assessing and reducing hazardous waste at the local and national level, which leads to reduced chemical pollution in various environmental media and a reduced risk of accidents.

Capacity of national enforcement agencies enhanced: Reforming and capacity building of the Customs Authority, enhancement of quality and monitoring of water sources, and a comprehensive waste management strategy have a positive impact on the regulation of heavy metals, POPs and pesticides in the country.

NIP on POPs Implemented: Resources are dedicated to complete the National Implementation Plan on POPs, leading to the control of import/export of products containing POPs, the identification of contaminated sites for rehabilitation and remediation, and a reduction and monitoring of POPs release in the environment. In addition, more emphasis is placed on greener alternatives to replace POPs-containing products, especially in the PVC sector.

Holistic pesticide law adopted: A holistic law addressing all pesticides in Lebanon is adopted, leading to improved inter-ministerial cooperation and reduces the risk of harmful use and disposal of pesticides. The path to ODS elimination is maintained and the country manages to meet its commitments to the Montreal Protocol.

In conclusion, the scenarios described in this chapter present two stark possibilities for Lebanon's future. And while the challenges and crises faced in the last decade seem to forecast a grim one ahead, it should instead be seized as an opportunity to break the cycle of unsustainable practices, having learned that they will always take the country down the least desirable path.

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