2009/2010

National Human Development

REPORT

Climate Change in Moldova

Socio-Economic Impact and Policy Options for Adaptation

UNDP Moldova

The United Nations Development Programme (UNDP) is the UN's global development network, advocating for change and connecting countries to knowledge, experience and resources to help people build a better life.

We are on the ground in 166 countries, working with them on their own solutions to global and national development challenges. As they develop local capacity, they draw on the people of UNDP and our wide range of partners. In all our activities, we encourage the protection of human rights and the empowerment of women.

The analysis and policy recommendations of this report do not necessarily reflect the views of the United Nations Development Programme, its Executive Board or UN Member States. The report is an independent publication commissioned by UNDP. It is the result of a collaborative effort by a team of eminent consultants, advisors and authors coordinated by the Advisory Group.

The boundaries and names shown and the designations used on the maps presented in the report do not imply official endorsement or acceptance by the United Nations.

Cover design: **Lica Sainciuc**
Layout design: **Ion Axenti**
Printed by Nova Imprim in Chisinau, Republic of Moldova

TEAM FOR THE PREPARATION OF THE NHDR

Lead Authors/Coordinators

Alex Oprunenco, *Expert-Grup*

Valeriu Prohnițchi, *Expert-Grup*

Chapter Authors/Experts

Sergiu Budeşteanu	*Ecosystems*
Roman Corobov	*Climate, Climate Projections*
Grigore Friptuleac	*Health*
Rodica Iordanov	*Policy*
Eric Kirschner	*Adaptive Capacity*
Judith Köberl	*Risk Transfer*
Tamara Leah	*Agriculture*
Adrian Lupuşor	*Risk Transfer*
Alex Oprunenco	*Energy, Health*
Daniela Petruşevschi	*Policy*
Franz Prettenthaler	*Adaptive Capacity, Risk Transfer*
Valeriu Prohnițchi	*Human Development Analysis, Agriculture, Transport*
Igor Sîrodoev	*Water*
Elena Vâtcărău	*Statistics*

UNDP Project Coordinator

Nadja Vetters

Editor

Thomas Escritt

FOREWORD

The United Nations Development Programme's global and national Human Development Reports (NHDRs) have been putting people in the centre of the analysis of development since 1990. The key to building successful democracies with a market economy, social protection and equal opportunities is not only economic growth and wealth accumulation, but most importantly, an expansion of people's choices and a broadening of their horizon of opportunities. Such a holistic, sustainable approach to development has underpinned every NHDR for Moldova, starting with the first one published in 1995. NHDRs have become an important tool for formulating development policies and strategies and a culmination of inclusive consultations that have helped build consensus among national stakeholders.

This Report, which marks the 15th anniversary of the NHDRs in Moldova, focuses on the impact of climate change on Moldova's environment, society and economy. It discusses adaptation options and their potential synergies with the overarching development goals of the country. At the same time, the importance of mitigating future greenhouse gas emissions and climate change cannot be neglected, and, as underlined in the Report, adaptation has to go hand in hand with mitigation. Being the first of its kind, the Report will, we hope, contribute to the ongoing national effort to address the climate change challenge while promoting human development.

The Report is a call to action. It aims to inspire decision-makers and the general public to act now for the sake of current and future generations. By providing an unprejudiced and professional assessment of climate change impacts in the country, a comprehensive policy analysis, and recommendations on how to manage and minimise the negative impacts, maximise beneficial opportunities and avert their implications for human development, the Report hopes to be instrumental in the policy debate on climate change in Moldova. It highlights areas where action is needed in terms of adaptation to climate change, and explains the implications for sectoral and cross-sectoral development policies. It also convincingly demonstrates best practices and the experience of other countries in addressing some of the issues of concern presented in the Report.

Climate change is recognised as a priority challenge that humanity is facing in the 21st century, and it is no longer a distant prospect. Some of its consequences – like increased frequency and intensity of natural hazards – are already being felt. For Moldova it has meant, most recently, the catastrophic drought in 2007 and devastating floods in 2008. Reality is such that while all countries are and will be affected by climate change, developing countries will suffer most. They tend to be more vulnerable to the adverse impacts, have fewer resources with which to adapt and to recover losses caused by extreme weather events and are in general more dependent upon the environment for their citizens' livelihoods. As a result, climate change poses a serious threat to achieving the MDGs which Moldova has committed to. At the same time, climate change can create opportunities for transforming the economy in the direction of greater sustainability, thus paving the way towards poverty reduction and the achievement of the MDGs.

The Report was commissioned by UNDP, relying to a large extent on a group of national experts, and benefited from international know-how and extensive stakeholder consultations throughout its preparation. Its intended audience is policy makers at the national, regional and local levels, civil society and academia, donors and providers of technical assistance, and the general public. The Report emphasises the importance of individual behavioural changes that

are needed to support the national climate change agenda without incurring major costs, and therefore I hope that it will be used by everyone, not only by the expert audience.

While the global community is preparing for the United Nations Climate Change Conference (COP 15) to take place on 7-18 December 2009 in Copenhagen, we trust that the timing of the publication will allow us to contribute to the national preparation efforts and the debates that will take place to reach a new global climate change deal. I look forward to this Report generating discussions about the impact of climate change on Moldova, the role of government and individuals in addressing it and the proposed policy recommendations. I hope that such national dialogue will help the country achieve greater progress.

Kaarina IMMONEN

UNDP Resident Representative and UN Resident Coordinator

PREFACE

Global warming is the challenge of the millennium. This phenomenon is a threat to the environment and a deterrent to economic growth and global welfare. The Republic of Moldova is no exception. Climate change has become a threat to sustainable development and climate change mitigation and adaptation measures should become a priority of national policy.

Population growth and increased consumption of material goods lead to a growing impact on the environment. Excessive consumption of natural resources has resulted in increased GHG emissions, causing the warming of the Earth over the last century and, ultimately, could lead to the collapse of the global climate system. The scientific community faces the dilemma of finding a compromise between economic development and its effects on climate change. Finding such a compromise will ensure sustainable development for humankind. Studies show that the impact of global warming is directly proportional to the population's living standards and mostly affects people in poor countries, who have actually polluted the least.

The problem of climate change can only be tackled with the joint efforts of all states in the world. To this end, the United Nations Framework Convention on Climate Change (UNFCCC) was developed. Moldova signed this Convention on 12 June 1992 and ratified it on 16 March 1995. The first step under the UNFCCC was the development of the First National Communication of the Republic of Moldova on Climate Change, a document that reflected national aspects of vulnerability and adaptation, emissions generated by the economic sector and analysed climate trends in Moldova.

On 13 February 2003, the Republic of Moldova acceded to the Kyoto Protocol of the UN Framework Convention on Climate Change. As a non-Annex I country under the Kyoto Protocol, the Republic of Moldova is eligible for activities under the Clean Development Mechanism (CDM). In order to coordinate activities under the Clean Development Mechanism at a national level, a "National Commission for the enforcement and implementation of provisions of the UN Framework Convention on Climate Change and the mechanisms and provisions of the Kyoto Protocol" was established by Government Decision no. 1574 of 26 December 2003. Four projects are currently being implemented under the Clean Development Mechanism in the Republic of Moldova.

As part of UNFCCC, Moldova identified and presented its technological needs for the mitigation of GHG emissions in priority sectors – energy and processing industries – and implemented concrete activities to attract funding and implement projects for the refurbishment and use of renewable energy sources in the energy sector. The Ministry of Environment is constantly looking for new partners who would be willing to implement such projects. The implementation of the provisions of the UNFCCC and the Kyoto Protocol in the Republic of Moldova is coordinated by the Working Group established within the State Hydrometeorological Service, subordinated to the Ministry of Environment. The National Coordinator and members of the Working Group take active part in various national, regional and global activities.

The National Human Development Report on Climate Change, developed by UNDP Moldova, is a special report for Moldova. It aims to inform decision makers and the public about the impact of climate change on the environment, the key sectors of the national economy and the social sector.

Our country has set itself an ambitious goal in developing the National Climate Change Adaptation Strategy and we believe that a comprehensive scientific analysis and the climate change projections presented in this report will provide a solid basis for the development of this Strategy. We are confident that the findings and recommendations of the report will be an important issue on the agenda of decision makers at all levels and will be reflected in the Strategy. I also hope that this report will generate debate among different social groups and will eventually encourage citizens to contribute collectively to combating this phenomenon.

We take this opportunity to express our utmost gratitude to UNDP Moldova for assistance provided in the preparation, translation and publication of this report in the official language of our country.

Gheorghe ŞALARU

Minister of Environment

ACKNOWLEDGEMENTS

Throughout its preparation process this Report has benefited greatly from the generous support and valuable contributions received from the many individuals and organisations mentioned below. Many others contributed to the Report either directly, through feedback on drafts, discussions, background papers, or indirectly through their research. We are particularly grateful to UNDP's Bratislava Regional Centre for their professional and financial support for the development of this Report. The team offers special thanks to Kaarina Immonen, UN Resident Coordinator/UNDP Resident Representative in Moldova, and Matilda Dimovska, UNDP Deputy Resident Representative, for their intellectual advice and professional guidance. We would like to thank all those directly or indirectly involved in guiding the development of this Report, while retaining sole responsibility for any remaining errors.

Peer reviewers and Contributors

The conceptual framework and analysis greatly benefited from the guidance, international know-how and technical inputs received from different experts. UNDP and the authors also wish to gratefully acknowledge the helpful criticism, comments and contributions offered by national and international peer reviewers. In particular the team would like to thank

JOANNEUM RESEARCH Forschungsgesellschaft mbH
(Dorian Frieden, Eric Kirschner, Judith Köberl, Naomi Pena, Franz Prettenthaler)

Mac Callawy, Natalia Catrinescu, Thomas Otter, Elena Strukova

UNEP Regional Office for Europe (Mahir Aliyev, Gaetano Leone, Rie Tsutsumi)

Advisory Board and Consultations

Many individuals and colleagues who were consulted during the preparation of the report provided extremely useful comments and suggestions. The report team benefited greatly from rich discussions and consultations during the Advisory Board meetings and a Round Table discussion as well as from written feedback and contributions to the drafts of the Report, involving

Ludmila Andronic (Business Class Magazine), Ion Buza (Moldcargo SRL), Arcadie Capcelea, Anatol Gobjila (World Bank), Oleg Cara, Elena Vâtcărău (National Bureau of Statistics), Ion Comendant (I.C.S. Red Union Fenosa S.A.), Boris Gîlcă (UNFPA), Andrei Isac (REC Moldova), Sergiu Moldovanu, Tatiana Popovici, Ghenadie Rusu (Ministry of Economy), Maria Nagornîi, Inga Podoroghin (Ministry of Environment), Nicolae Opopol (State Medical and Pharmaceutical University), Pintilie Pîrvan (Ministry of Agriculture and Food Industry), Sergiu Polişciuc (Ministry of Construction and Regional Development), Diana Porubin (Academy of Sciences of Moldova), Vasile Scorpan (Climate Change Office, Ministry of Environment), Ylva Sörman Nath (Swedish International Development Cooperation Agency)

Alexei Andreev (NGO Biotica), Valentin Arion (Technical University of Moldova), Petru Bacal (Academy of Economic Sciences of Moldova), Valentin Ciubotaru (NGO BIOS), Ilya Trombitsky (Eco-TIRAS)

UNDP Support

Many colleagues within the UNDP system generously shared their experience, time, expertise and resources and guided the development of the Report with continuous constructive feedback and suggestions. The Report team wishes to specifically acknowledge the critical advice and support provided by

Anna Kaplina, Keti Chachibaia, Andrey Ivanov, Mihail Peleah (UNDP Bratislava Regional Center), Tim Scott and colleagues (UNDP HDRO, NHDR Unit), Bhujang Dharmaji and colleagues (UNDP BDP/EEG), Vasile Filatov (UNDP Moldova) and Sandra Vlašić (UNDP Croatia). Special thanks are owed to Nazik Abdiyeva (UNDP RBEC) for her dedicated support during the finalization and production stage of the Report.

Contents

List of tables

List of charts

List of boxes

List of human development-related annexes

List of climate change-related annexes

List of human development statistical appendixes

ABBREVIATIONS

AI – Aridity Index

AOGCM – atmosphere-ocean general circulation models

CA – conservation agriculture

CBD – Convention on Biological Diversity

CEE – Central and Eastern Europe

CHP – Combined Heat and Power

CIS – Commonwealth of Independent States

DSM – Demand Side Management

DO – dissolved oxygen

EDEP – equally distributed equivalent percentage

EEA – European Environmental Assessment

EG – Expert-Grup

EIA – Environmental Impact Assessment

EU – European Union

FSU – Former Soviet Union

GCM – general circulation models

GDI – Gender-related Development Index

GDP – Gross domestic product

GEF – Global Environment Facility

GEM – Gender Empowerment Measure

GHG – Greenhouse Gas

HDI – Human Development Index

HDRO – Human Development Report Office

HHI – Hirschman-Herfindahl Index

HIRHAM4 – Hamburg regional climate model

HIV/AIDS – Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome

HTC – Hydrothermical Coefficient

ICBE – Index of Climate Biological Effectivity

IMF – International Monetary Fund

IPCC – Intergovernmental Panel on Climate Change

ISCED – International Standard Classification of Education

MDG – Millennium Development Goals

MDL – Moldovan leu (*national currency*)

MoE – Ministry of Environment

NBM – National Bank of Moldova

NBS – National Bureau of Statistics

NCCAP – National Climate Change Adaptation Programme

NEN – National Ecological Network

NGO – non-governmental organization

NHDR – National Human Development Report

NPK – nitrogen, phosphorus, and potassium

NUTS – Nomenclature of Territorial Units for Statistics

OECD – Organization for Economic Cooperation and Development

PCA – Principal Component Analysis

PE – Potential Evaporation

PEEN – Pan-European Ecological Network

PPP – Purchasing Power Parity

RCC – Regional Cooperation Council

REDD – Reducing Emissions from Deforestation and Forest Degradation in Developing Countries

SADI – Small Area Deprivation Index

SEA – Strategic Environmental Assessment

SECE CRIF – South Eastern and Central Europe Catastrophe Risk Insurance Facility

SME – small and medium enterprise

SRES – Special Report on Emission Scenarios

SRL – societate cu răspundere limitată

UCTE – Union for Co-ordination of Transmission of Electricity

UNDP – United Nations Development Programme

UNECE – United Nations Economic Commission for Europe

UNEP – United Nations Environment Programme

UNFCCC – United Nations Framework Convention on Climate Change

USD – US dollar

VAT – value-added tax

WEF – World Economic Forum

WEO – World Economic Outlook (IMF publication)

WHO – World Health Organization

WMO – World Meteorological Organization

EXECUTIVE SUMMARY

Chapter 1. **Introduction**

Climate change is a truly unprecedented and unique challenge for mankind. Though it is global in nature, poor nations appear to be most vulnerable as many of them will be hit disproportionately and, at the same time, their adaptive capacity is much more limited. Therefore, immediate and concerted action on both international and national levels is required in order to mitigate climate change by reducing greenhouse gas emissions and help both developed and developing countries to adapt to those effects which are already inevitable. Unfortunately, in Moldova climate change is sometimes perceived of as a remote and irrelevant concept.

The authors of this report believe that the challenges of climate change should be fully introduced into the national policy agenda. If they are neglected and we proceed with business as usual – both in terms of allowing climate change to continue unabated and in terms of adapting to its impacts – the cost of inaction faced by current and future generations may be significant. Development policies, however, should also aim at advancing the interests of their intended beneficiaries – the people. Therefore, this report goes beyond an assessment of bio-physical impacts and applies a human development perspective throughout its analysis by trying to shed more light on the way climate change will affect Moldova's development trends and agenda and, ultimately, the hopes and opportunities of the Moldovan people.

Chapter 2. **Human development in Moldova – the background**

Human development basically means freedom of choice for all the people living in a given country or region. In order for people to make effective use of this freedom, they need enabling conditions such as adequate education, good health, material well-being, social participation, empowerment and inclusiveness and equitably distributed benefits of economic growth.

Human development is thus a multifaceted and complex phenomenon spanning many areas. One measure used to assess a country's development progress is the Human Development Index (HDI). From an HDI perspective, Moldova is one of the least advanced European and/or transition countries. In 2005, Moldova had the fourth lowest HDI in the group of 20 Central and Eastern European (CEE) and Commonwealth of Independent States (CIS) countries for which the HDIs were available. Moldova was also among the four transition countries which in 2005 were worse off in terms of HDI than in early transition, and its losses in terms of human development were the largest compared to all other countries. This decline was largely due to the economic collapse associated with lower enrolment in education and the population's poorer health status. As its economic growth model fundamentally influences a country's outcomes in terms of human development, it has to be said that in Moldova this growth has been narrowly based in geographical terms as well as socially inequitable. The decade-long increase in outward migration of labour is a symbol of Moldova's deficient economic growth model, which contributed to a weakened social fabric, family disintegration, domestic violence and a worsening demographic outlook.

Climate change influences human development in many ways. Global warming has already changed livelihoods in many parts of the world and the poor are suffering the most. Needless to say, developed countries have more financial and human resources available to implement the measures necessary to adapt and provide for human security even in the case of extreme weather events, while lower income countries lack these. Therefore, climate change, be it through heightened water insecurity, increased exposure to extreme weather events, environmental deterioration or loss of natural resources and ecosystems, may raise significant hurdles to improving Moldova's human development. Of particular concern are the impacts on agriculture, which is a major source of income in Moldova, where more than half the population lives in rural areas and about one third of the labour force is still employed in agriculture. Depending on how well long-term development strategies in Moldova will perform, this situation might change within the next two generations. There might be less agricultural employment and welfare dependency on rural income, a trend which could come hand in hand with demographic change, productive innovation

and climate change. Nevertheless, for the coming decades and until all the expected changes start to take place, the possibilities for human development in Moldova will be determined by the majority of the population's dependency on agricultural income and a rural way of life. In this respect, droughts have repeatedly reduced agricultural income in the past and their frequency and intensity is expected to increase in the future.

The whole extent of climate change's impact on Moldovan society itself depends in turn on future human development performance which has the potential to significantly reduce the negative impacts of climate change and take advantage of potential positive outcomes. This depends on the country's adaptive capacity, i.e. the ability or potential to respond successfully to climate variability and change, and includes adjustments in both behaviour and resources and technologies. Human and social capital are key determinants of adaptive capacity, as important as income levels and technological capacity, population development and governance structures (which may enhance but also decrease specific adaptation potentials). The four Moldovan regions investigated (North, Centre, South and Chisinau) do not belong to those region types that are presumed to have the lowest adaptive capacity. Chisinau's potential to adapt to climate change is the highest in Moldova – the capital has a high ranking, even compared to Romanian and Bulgarian regions of high adaptive capacity.

Chapter 3. **Climate change and its challenges for Moldova**

Moldova is located in a temperate continental climate zone, slightly modified by the proximity of the Black Sea and the intrusion of warm wet air from the Mediterranean. Climatic seasons are clearly defined with a short and soft low-snow winter and a long summer which can be very hot and dry. On the whole, Moldova is located in an insufficiently wet zone which results in a high frequency of droughts which negatively affect its economy. For example, between 1990 and 2007 alone, nine droughts were registered in the country.

The climate projections for Moldova in this Report are based on a range of recent coupled atmosphere-ocean General Circulation Models (GCMs). Such models are used as a research tool for studying and simulating the climate, and for operational purposes, including monthly, seasonal and inter-annual climate projections. The results of six GCM experiments based on the A2 and B2 marker scenarios of the Special Report on Emission Scenarios (SRES) for three time-slices (2010–2039; 2040–2069; 2070–2099) served as a basis for downscaling.

These models suggest that annual mean air temperature in Moldova will increase under both emission scenarios. By the end of this century the increase may amount, on average, to 4.1–5.4 °C. Depending on the GCM experiment, these values vary from 1 °C to 6 °C. Along with warming, a continuous annual fall in summary precipitations is expected, especially for the A2 emissions scenario.

Moldova expects maximum warming in winter and in transition seasons. By the 2080s, the baseline negative winter mean temperatures (-2.1 °C) could increase by up to 2 to 5.7 °C; the spring and autumn mean temperatures could increase by about 4 to 5 °C. The lowest relative warming is expected in the summer months: by 1 °C in the beginning and by about a 3 °C by the end of the century. Moderate increases in precipitation are expected in winter and spring, but the summer and autumn tendencies are mainly negative (20-30 per cent decrease by the 2080s). On the whole, Moldova will face warmer and wetter winters but hotter and drier summers and autumns. To use an analogy, Moldova can expect winters like in England and summers like in Greece or Spain.

In order to represent the new humidity conditions, which are particularly critical for the agricultural sector, separate temperature and precipitation changes should be incorporated into other, more complex indices. In this report, two indicators of new humidity conditions – *Potential Evaporation (PE)* and *Aridity Index (AI)* – were calculated. These indicators show that the annual decrease in precipitation, against a temperature increase, stimulates a strong humidity deficit. Potential Evaporation is likely to increase by 15-20 per cent over the first time horizon and practically double by the end of this century, with the A2 emissions scenario resulting in stronger climate change signals. The Aridity Index also shows that Moldova is moving towards a dryer climate, from insufficiently wet and wet subhumid zones to dry subhumid and semiarid zones. While in Moldova's baseline climate (1961-1990) only the end of summer and the beginning of autumn were semiarid, in the future significantly longer and more intense dry periods are likely.

Extreme weather events are likely to become more frequent in the future. Projections suggest that what were considered as extreme rare events for absolute maximum temperatures under the baseline climate (34-35 °C) will possibly become mean maximum summer temperatures. The observed and expected increase in night temperatures is especially important for human health because it results in unfavourable conditions for night relaxation.

The summer of 2007 may provide a glimpse of the shape of the future climate to come and a foretaste of some of the negative impacts that are likely in the distant future. The heat-wave of 2007 is clearly more closely related to what may be expected in the future climate than to contemporary climate conditions. Moreover, the summer of 2007 is also a signal for policy- and decision-makers that climate change and its impact are issues that should be given attention in the present and not be left for the future.

Chapter 4. **Climate change and water resources**

Water is a critical resource for human development and economic growth, being essential for the vital functions of all living beings, plants, for agricultural production as well as for many industrial processes. In general, Moldova's water supply-withdrawal balance is adequate with respect to the available resources. In spite of this adequacy, specific regions in the South already face water scarcity. Climate change is likely to affect the adequacy of water resources, and the water-deficient regions are likely to suffer the most. Addressing deficits in these regions will be critical for supporting a sustainable economic recovery. Due to climate change, Moldova is expected to experience increasing frequency of short-term water oversupply, particularly in the form of flash floods as well as seasonal droughts.

Moldova does not have enough financial resources to implement the primary technological adaptation measures needed to address the expected water variability, such as dams and dykes. Considerable external funding would be needed for these measures to be successful. Comprehensive and efficient implementation of Moldova's "Strategy on the modernisation and development of communal water supply and disposal systems in the settlements of the Republic of Moldova" and the "Concept of national water resources policy" would be an important first step towards addressing Moldova's water situation. The "Framework regulation on using communal water supply and disposal systems" needs to be improved in many ways, including establishing rules for up-stream and down-stream users and for force majeure situations.

Given Moldova's limited financial resources, introducing new crops and agricultural practices, together with reduced use of flood plains in crop production, would provide some relief from expected climate-related water stress.

Chapter 5. **Ecosystems: vulnerability assessment, climate change impacts and adaptation measures**

Agricultural ecosystems cover some 75 per cent of Moldova's land area, while natural ecosystems account for 15 per cent. Ecosystems in Moldova are currently threatened not only by climate change but also by socioeconomic conditions, poverty and a lack of political will to address these challenges. Practices such as overly intensive irrigation, heavy use of chemical fertilisers, pesticides and fungicides and use of heavy agricultural machinery, etc., lead to degradation, erosion, compaction, and depletion of the soil which, in turn, affects its capacity to sustain agricultural crops and human welfare. Unauthorised waste disposal, overgrazing, illegal tree felling, illegal hunting and fishing, and industrial and agricultural pollution are examples of other activities which have a substantial negative impact on the functioning of ecosystems.

The state of the agricultural ecosystems fundamentally influences Moldova's ability to support its economic and human development. Agricultural ecosystems are highly vulnerable to climate variability and extreme weather events which are expected to increase as climate changes. Some specific measures to reduce their vulnerability include rational land consolidation, promotion of ecological agricultural practices, improvement of soil fertility and efficient irrigation.

Natural ecosystems are also in a poor situation, with large portions being highly degraded and the number of endangered species climbing rapidly. Climate change is expected to have substantial negative impacts on forests and aquatic species, especially in the southern and eastern parts

of Moldova; these are currently semi-arid regions and as the climate changes they may turn arid. A number of proactive measures, including the extension and better protection of protected areas, need to be implemented in order to ensure biodiversity conservation.

Establishing new policies based on an integrated landscape approach to biodiversity protection under different climate change scenarios and on developing River Basin Management Action Plans for the sustainable use of water resources are some of the most important long-term adaptation measures that need to be implemented in order to meet the sustainable development objectives.

The projected climate changes are likely to have significant impacts on biodiversity from the level of species right through to the level of ecosystems or biomes. Rising temperatures will force many living organisms to migrate to cooler areas in the northern part of the country, while new organisms will arrive. Such movements might involve many species including plants and trees. However, some flora and fauna species could have low resilience to temperature and precipitation changes because climate systems will move more rapidly than they can follow.

Chapter 6. **Impact of climate change on the agricultural sector**

In general terms, Moldova has climate conditions and a relief favourable for agriculture. Soils are highly fertile in the northern region and have a medium level of fertility in the central and southern regions. However, in the transition period, Moldovan agriculture has suffered a dramatic decline, one of the deepest in the group of transition countries. This has had a significant impact on human development outcomes, as many rural inhabitants are migrating to urban areas or abroad and villages are losing their human capital.

The main causes of the agricultural decline in the last decade include low levels of investment in the sector, the inadequacy of the recent reforms and a number of institutional and regulatory obstacles affecting exports and domestic sales. However, as a result of poor technological development and a failure to adopt soil protection measures, natural calamities such as droughts, late spring frosts, hail, and floods frequently have had a destructive impact on harvests and on farmers' income. Despite the generally high level of soil fertility, agricultural productivity indicators in Moldova are very low. If the issue of soil protection is not pursued seriously and soils continue to deteriorate at the present rate, agricultural productivity and farmers' incomes will decline further still.

Climate change could seriously undermine Moldova's food security, as patently proven by the severe drought of 2007, when both the overall quantity and the composition of food available to rural inhabitants worsened. Large families, single-headed households and families with disabled members have been assessed as being the most vulnerable in conditions of drought. According to international estimates of the impact on ecology and agriculture, this drought was of catastrophic proportions. In the 20th century such a phenomenon was registered only once, in 1946-47. More than 90 per cent of the country's territory and 80 per cent of the rural population depending on agriculture was affected by the diminished harvest. The savings and income of the rural population were severely reduced, with total losses amounting to USD 1bn, according to official estimates. Output of cereal crops diminished by 70 per cent compared to 2006, and the wheat harvest fell by a factor of 10. Many households were not able to maintain their livestock because of the lack of fodder. Bovine livestock diminished by one quarter, pigs by almost 50 per cent, and sheep and goats by 10 per cent, and the number of poultry by 25 per cent. By January 2008, many families had had to liquidate their entire livestock resulting in a loss of foodstuffs. High inflation fuelled the deteriorating situation.

Projected climate changes are likely to have a negative effect on wheat production, which has a central role in providing food security. It is also likely that climate change will affect vineyards, which are economically very important. If no alternative economic occupations are provided, these trends will drive more rural families into poverty and further encourage the depopulation of rural areas. Small peasant farms, averaging 1.5 hectares, as well as farmers in the central hot semi-humid and south hot-arid zones are the most vulnerable to the types of extreme climate conditions expected to become more frequent and severe with climate change. The provision of irrigation in appropriate areas within these two zones would provide significant benefits even under current conditions, potentially increasing yields by 1.5 to 2 or more times as compared to yields without irrigation.

Even though climate change can induce some positive changes, the overall balance of the climate change effects projected for the next 100 years is not favourable for Moldovan agriculture. A rough economic assessment of the impact of climate vulnerability on wheat and corn in the period 1996-2008 suggests that net losses have so far exceeded net gains. In order to adapt Moldovan agriculture to changing climate conditions, a number of no regret measures are recommended, including using modern farming techniques, improving short-term weather forecasts and preventing soil erosion. At the same time, reforms should continue with the aim of adapting the agricultural system, implementing an efficient system of farmers' training and education and putting in place a developed agricultural infrastructure (including irrigation and hail protection).

Chapter 7. **Climate change impact on transport infrastructure**

The importance of the transport infrastructure for human development is hard to underestimate. First, it supports economic growth and thus poverty reduction efforts. Second, it helps with access to basic services which can significantly improve livelihoods and income opportunities. The importance of transport infrastructure is further underlined by the fact that Moldova is a small and landlocked country. Although the density of Moldova's road network is more or less on a par with regional standards, the very poor quality of these roads undermines their ability to fulfil their economic and social function. Little investment in road infrastructure has been made in the last two decades, significantly contributing to its vulnerability. The level of funding of road maintenance declined from about 80 per cent of total necessary funds in 1990 to less than 10 per cent in 2000. It rose to 20 per cent of needs by 2006, but this is obviously still inadequate. As a result of constant underinvestment, the road network has almost collapsed in terms of quality. Railroads, which also play an important role, are only in a slightly better shape.

There are several main effects climate change will have on the transport sector. First, lasting heat-waves can worsen or even destroy the asphalt pavement of national roads. Second, high temperatures during summertime can cause deformation of railroad lines which are already old; further they potentially accelerate the physical wear-out of metal parts in bridges and can even cause thermal deformation. Moreover, higher temperatures will underscore the need to use heat-resistant engines, while air-cooling will have to be more widely employed, leading to higher energy consumption. Still more critical, climate change is set to significantly constrain the development of naval transport envisaged also by the strategic framework for the development of the transport network. Besides higher temperatures, extreme weather events can also have a significant impact on transportation, both in urban and rural areas, with the risk of cutting off some rural communities where roads are especially poor.

There is a series of adaptation measures that can be taken into account in order to tackle climate challenges in the transport sector. A no-regret measure would be the incorporation of climate change considerations into the technical standards to be implemented throughout the sector. Thus, building higher-quality, weather-resilient roads would increase the competitiveness of the sector and road safety. In order to minimise the impact of heavy trucks on roads, their movement on sensitive roads should be limited during the day.

At the same time, warmer winters will allow for less rigorous requirements regarding the depth of the roadbed, thus freeing up resources that can be employed in improving road quality.

Chapter 8. **Climate change impact on the energy sector**

Access to energy is crucial for serving society's social needs, fuelling economic growth and promoting human development. The energy sector of Moldova exposes a series of vulnerabilities, such as limited production capacity, low energy efficiency and insecure supply. Thus, due to wear-out and lack of investment, the actual power generation capacity is half the original installed level, while energy imports cover almost all the country's energy needs.

Given the Republic of Moldova's external vulnerability to disruptions and price hikes in the foreign energy supply, it is hardly surprising that recent developments on the global energy markets hit Moldovan consumers particularly hard. During the last couple of years, prices for imported gas and electricity have risen significantly, especially for gas, as Russia has started to apply a new price policy toward CIS countries. Furthermore, rising prices appear to undermine state efforts aimed

at installing gas networks in rural Moldova, since exorbitantly high investment costs prohibit rural consumers from connecting to the networks, while increased prices make many people refrain from consuming gas even after being connected to the network.

The overall rise in prices for imported energy has resulted in growing tariffs for heat energy, putting strains on households as well as the public budget. Moreover, the date of the start of the heating season for social public institutions such as hospitals, schools and kindergartens has become an issue of heated debate.

Climate change will most likely affect the energy distribution infrastructure, patterns of demand and energy production capacities. The patterns of demand will change as winters become warmer, decreasing heat energy needs, while in summer, higher temperatures will push up demand for the electricity needed to power air-conditioning equipment. The energy infrastructure may suffer as result of more frequent and more violent extreme weather events, damaging supply grids, while growing demand in the summer time could cause transmission lines to sag. Further, climate change potentially puts Moldova's plans to enhance its domestic capacity to produce energy at risk, as water resources may become scarcer in coming decades.

Although climate change is set to pose significant challenges for Moldova's energy sector, it should be said that most of the solutions on the table would need to be implemented even if climate change were not taken into account. The main adaptation efforts should aim at changing consumer behaviour both through tariff stimuli and information campaigns, strengthening domestic energy efficiency by integrating the relevant standards into technical requirements and building codes, and spurring the development of renewable energy production. Emphasis should also be placed on the consolidation of infrastructure through technological modernisation, taking growing climate risks into account.

Chapter 9. **Climate change and human health**

The ability to live a long and healthy life is at the core of human development. At the same time, the impact of climate change on human health is significant and well-documented. The effects are passed on to human health through changing weather patterns (more frequent and severe extreme weather events) and indirectly through changes in water, air and food quality and quantity, ecosystems, etc. More specifically, the direct impacts of climate change include deaths from floods, low and high temperatures and other climate change-related disasters. Indirect impacts include rising numbers of infection bearers such as mosquitoes which swarm near flooded land and spread diseases and a larger tick population. Altogether, when temperatures are high enough, these bearers contribute to developing encephalitis and Lyme disease. Failure to supply the population with good-quality drinking water also increases the risk of infections spreading. This exacerbates the risks caused by water shortages that are already visible in some parts of the country, especially in the southern region. In fact, a direct link between the maximum frequencies of diarrheic diseases and salmonellas in the hottest months of the year is easy to observe. Thus, the entire population, especially children, are at risk during this period. Furthermore, heat-waves represent an enormous risk for the elderly population, as well as for those with chronic cardiovascular illnesses resulting from hyperthermia. Another important risk is increasing exposure to allergic diseases via aeroallergens in part as a result of changing pollen counts.

Overall, the rural population appears to be more vulnerable to climate change impacts as it has more limited access to medical services as well as to medical insurance coverage, is much more dependent on a non-centralised supply of water (which is of much lower quality), and has a higher share of the more vulnerable elderly population. Also, as climate change will significantly affect the agricultural sector, the risks of malnutrition will become particularly important for the rural population. The urban population, however, may be significantly affected by the creation of 'heat islands' in the cities, with critical effects for the vulnerable groups of the population.

The health risks stemming from climate change were already outlined in the First National Communication of the Republic of Moldova. Unfortunately, the conclusions and recommendations of this effort are not taken fully into account in the national health-related strategic framework.

Therefore, the national health policies should incorporate in a proper manner responses to the health risks posed by climate change. Other important measures include: introduction of

early warning systems with regards to extreme weather events, extending medical insurance to fill the gaps in the coverage of the poor and rural population, implementing sanitation and water-treatment projects to ensure rural communities and social institutions have access to quality water, and developing aeroallergen monitoring and asthma surveillance systems. At the same time, the development of electronic databases for relevant data collection from doctors and medical institutions and proper public information on climate change-related health risks should be put in place.

Chapter 10. **Towards a risk–resilient society**

Risk transfer represents an important instrument for managing the risk resulting from natural perils and can help mitigate or minimise disaster losses. A well-implemented plan for spreading economic risks from extreme events across society and/or transferring those risks from victims to the financial markets is a fundamental adaptation measure that crucially affects how the impact of climate change will ultimately affect a society. Although risk transfer does not prevent the damage climate change causes, it represents an effective mechanism for managing the hardship resulting from climate risks and quick recovery, especially of those climate risks which cannot be prevented by means of risk mitigation measures.

Furthermore, risk transfer can be seen as an effective instrument for helping reduce poverty. For example, access to these tools can help rural households stabilise their incomes, to safeguard their financial resources and to improve their access to credits by lowering the risk of lending and hence reduce the cost of borrowing. In Moldova, the insurance sector has developed dynamically in recent years. Nonetheless, it is still poorly developed compared to western European countries. For instance, the insurance depth (the share of gross written premiums in GDP) is about 1.3 per cent compared with 9.2 per cent in the EU-15. The low levels of development are mostly explained by the low income of the population, a lack of public risk information and the existence of public funds that also compensate victims.

It should also be mentioned that the insurance sector is even more poorly developed in rural areas. Despite the fact that the insurance of agricultural production is subsidised by the state, agriculture remains one of the most underinsured sectors. In order to build a proper risk transfer mechanism a set of conditions should be met. A non-exhaustive list of prerequisites includes: optimally coordinated risk partnership between insurers, state and citizens; generation of a risk collective of sufficient size to enable an effective balancing of risks; effective control of adverse selection and moral hazard; and generation of incentives with respect to collective and individual risk prevention.

Moreover, the development of such a risk transfer mechanism would require political efforts aimed at providing better risk zoning and mapping, encouraging ex ante insurance and joining regional risk transfer mechanisms.

Chapter 11. **Policy discussion: climate change realities in the country development agenda**

Despite the fact that climate change is a recognised fact of global importance, the national strategic framework lacks integrated measures for mitigating climate change or adapting to its effects. Some of the impacts are mentioned sporadically and in differing contexts, but the connection between them and climate change as well as the complex repercussions are mostly omitted. Based on an analysis of current strategies and the legal framework, it can be concluded that Moldova urgently needs to put forward adaptation measures that would reduce the potential negative impact of climate change on further development. To date, the topic of climate change is mostly a priority for the Ministry of Environment. However, efforts by this Ministry alone will not be enough to successfully adapt to climate change. It is an issue that needs to be incorporated into different policy areas – whether energy, transport, agriculture or industry, etc. Therefore, a timely elaboration of national adaptation strategies and the integration of climate change aspects into development cooperation as well as into the relevant national sectoral policies are of high importance.

These relevant policies should be designed and implemented by the government at many levels, under the pressure of severe financing constraints. Responding to climate change will require the integration of adaptation measures into all aspects of policy development and planning for poverty reduction. These government

efforts would require consistent international support, going beyond financing. Assistance will be needed for capacity development in areas like energy and water efficiency, organic and sustainable agriculture, alternative energy sources etc. While project-based support plays an important role, adaptation planning has to be part of national programmes and budgets. Furthermore, all adaptation efforts should be society-wide and engage all key actors. Public authorities, the private sector, civil society and individuals all have to be involved and take responsibility.

At the strategic policy level, for adaptation efforts to be successful they will require a climate change adaptation framework that ensures an effective adaptation of the country to climate change impacts. Otherwise, projected impacts could prejudice Moldova's development and worsen the situation in the economic and social realms. Moldova has to put in place sectoral adaptation strategies or amend the current strategies in order to incorporate necessary adaptation measures. This is important as each sector needs a specific approach, but at the same time all adaptation measures must be taken as a complex whole, to make sure a qualitative, effective and coherent climate change adaptation process takes place. A well-designed policy framework for climate change adaptation will ensure a timely response to climate change challenges, allowing the country and its citizens a progressive positive development.

All the proposed strategies could be part of an umbrella programme named the National Climate Change Adaptation Programme that would also include an Action Plan to implement adaptation measures, enforced also by a set of market-based instruments that would serve as economic stimulus. Part of the same programme should be a joint communication strategy that will provide for information access, public awareness, and public participation in the decision making process, cooperation between authorities at different levels and collaboration with academia in matters related to climate change adaptation for all sectors.

All in all, given the level of Moldova's economic development, the process of adaptation to climate change will not be easy. Our country will need to invest great efforts in order to ensure success in the adaptation of Moldova's development policies to climate change-related risks. However, all efforts made today will help ensure progress in human development for both current and future generations.

Chapter

1

Introduction

1. Introduction

1.1. Climate change as major human development risk

Humankind is in no way a complete stranger to major development risks. Indeed, over the period from the plagues of the Middle Ages to the Great Depression and the two world wars of the last century, human progress went hand in hand with major development risks. Moreover, the end of this decade has been marked by major financial and economic turmoil. This turmoil is far from over and may well result in a significant setback to human development for rich and poor countries alike. However, in the worst-case-scenario the outcome may be the wholesale dismantlement of the global economic and financial architecture laid down in the wake of World War II which was strengthened with the passing of the Cold War.

Nonetheless, one more challenge has been looming large for years. This existential challenge is as certain to happen, if the necessary action is not taken, as it is unpredictable in its dire consequences. This challenge is the immediate and longer-term negative impacts of climate change-related events.

Climate change has several distinctive features. First of all, it is truly global, as the main emitters of greenhouse gases will suffer along with underdeveloped or "green" economies. Second, the world's poor will be hit disproportionately as the majority of poor countries will be on the geographical frontline of climate change and perhaps will lack the resources required to implement sound adaptation policies. Third, the world is committed to climate change, i.e. greenhouse gases, once emitted, remain in the atmosphere for a long time. In other words, we can do very little about climate change effects that have already been locked in as a result of past and present emissions. What we can and must still do is avoid dangerous climate change by striving to cut emissions and embark on low-carbon development pathways in the interest of future generations,[1] while looking for win-win opportunities and a more sustainable development model. Finally, if we reach a certain threshold (2°C above preindustrial levels), these changes may become irreversible. As the UNDP 2007/2008 Human Development Report points out, unless changes are made to the business-as usual model, "we are edging towards 'tipping points'. These are unpredictable and non-linear events that could open the door to ecological catastrophes…that will transform patterns of human settlement and undermine the viability of national economies".[2]

For underdeveloped countries, climate change effects are seemingly double-edged: besides hitting them disproportionately there is fear that any significant mitigation and adaptation efforts may derail ongoing development and poverty-reduction efforts. This fear, however, appears to be vastly exaggerated. First, climate change mitigation and adaptation efforts are not necessarily at odds with development if we see development as an environment-inclusive phenomenon, not confined only to GDP growth per capita.[3] Indeed, growth in incomes may make little sense against a background of a sharp decline in the environmental conditions people live in. Second, there is sufficient evidence showing that climate change may eventually derail economic growth since it can lead to economic disruptions comparable to those provoked by world wars or the depression of the first half of the 20th century.[4] Thus, one of the conclusions of the Stern review[5] was that "…tackling climate change is the pro-growth strategy for the longer term, and it can be done in a way that does not cap the aspirations for growth of rich or poor countries".[6]

The imminent risks of climate change require an immediate and concerted action on both international and national levels. Unfortunately, in Moldova climate change is sometimes perceived as a remote and irrelevant concept. Indeed, while the country is still struggling to set itself firmly on a development path and struggling to complete the never-ending post-communist transition process, while labour migration remains the only solution for escaping the poverty trap and overall progress in human development is uneven, to consider climate change a policy priority may seem to be outlandish.

Nonetheless, it does not need to be so. There is no trade off between development policies and climate change policies. As everywhere in the world, climate change is going to pose significant challenges that may derail development and modernisation efforts in Moldova. Since these effects are no longer a distant prospect, the sooner

[1] UNDP Human Development Report 2007/2008.
[2] Ibid.
[3] Ibid..
[4] The Stern Review on the Economics of Climate Change is a comprehensive report released in 2006 by economist Lord Stern of Brentford for the British government. The Report discusses the effects of climate change and global warming on the global economy.
[5] Ibid.
[6] Ibid.

Moldova acknowledges these paramount risks and adjusts its policy agenda accordingly the better. Hence, although this Report has quite a wide audience, its main target is local policy-makers. At the same time, even the most carefully crafted policies cannot help without support of all elements of the population. Climate change requires a much broader society response and action, particularly given that many high-impact, but low- or no-cost behavioural measures to address climate change can be easily implemented by each citizen of the country. Certainly, as this Report was being written, Moldova was entering into a prolonged period of political turmoil aggravated by the economic impacts of the global financial crisis. However, as political animosities settle down and political actors start forming a governmental coalition, the new government should not get bogged down solely in addressing arduous, though short- or mid-term tasks on the economic and financial fronts. The long-term challenges should not be ignored and left for future generations, who might confront a situation where whatever they do at the national level is "too little, too late".

Therefore, we believe the climate change challenge should be fully introduced into the national policy agenda. The implementation of Moldova's development policies may not contribute significantly to the acceleration of climate change,[7] but, nonetheless, climate change will affect Moldova's prospects for accomplishing its development goals. The need is, then, to become aware of the risks posed to the goals and either re-adjust them or put forward such adaptation policies that would allow for a continuous pursuit of Moldova's development agenda. Even though the focus of this Report is on adaptation policies, the need for climate change mitigation cannot be neglected. Embarking on a low carbon development pathway, for example by promoting by 'win-win' solutions for effective emission reductions, green technologies, improved access to energy and energy efficiency, sustainable land management, and reduction of emissions from deforestation and forest degradation, will ensure that future development efforts do not contribute further to climate change. While adaptation and mitigation measures will require additional resources, they also considerably reduce the residual costs of climate change impacts. If we proceed with business as usual – both in terms of allowing climate change to continue unabated and in terms of adaptation to those changes that are already unavoidable – the cost of inaction will be significant.

At the same time, development policies are of little value if they fail to advance the interests of their intended beneficiaries – the people. In this report we address the human development perspective on the way climate change will affect Moldova's development trends and agenda and, ultimately, the hopes, aspirations and present and future opportunities of Moldovan people. Given the fact that climate change's impact on human development will be broad and multi-faceted, in this Report we focus on the areas (resources and economic sectors) where this impact will be most significant to human development in general and economic growth in particular. This is additionally the most sensitive area for human development in Moldova, since improvements in Human Development Index in recent years were driven by economic growth.

1.2. Guide to the report

The 2009 National Human Development Report consists of 11 chapters, including this introduction.

In the second chapter we introduce the human perspective that underlies the whole Report. We start with a review of human development dynamics in Moldova with a specific focus on the most vulnerable groups and on the key factors defining these dynamics. We also add regional comparative perspective to this review. Further, we look at the effects of climate change on human development and how they are relevant for Moldova.

The third chapter introduces the topic of climate change and the physical challenges it poses. The chapter offers a concise review of the global perspective on climate change, the observed effects on the global climate and looks at estimations of its future impact. It also outlines the main vulnerabilities and reasons for concern. Further, the chapter offers a brief overview of the Moldovan climate and a more detailed presentation of the likely changes to it that may result from climate change. The Report's climate projections are closely correlated with regional estimates and are specifically focused on future heat supply and humidity, changes to agro- and bio-climate conditions as well as the expected frequency of extreme weather events. Special attention is also paid to the interplay between adaptive capacity

[7] Currently Moldova contributes little in the way of GHG emissions and even those emissions are decreasing (see National Inventory Report, Greenhouse Gas Sources and Sinks in the Republic of Moldova 1990-2005, 2009).

to climate change and human development and the report puts this issue into a regional comparative perspective.

Further on, the fourth chapter contemplates the climate change impact on the vitally important resource of water. First, we evaluate the current situation with regard to water quality, its quantity, use and disposal. Second, the impact of climate change on water availability and quality is assessed. Finally, the chapter reviews available adaptation options: the feasibility of infrastructure solutions as well as passive and active policy options.

The next two chapters are focused on two 'microcosms' of critical importance for the future livelihood of a large share of the country's population. The first of these two is biodiversity. Ecosystems are highly vulnerable in the face of climate change and the chapter offers a comprehensive assessment of its future impact on ecosystems. It also reviews options available for ensuring conservation of ecosystems in different regions of Moldova. Since agricultural ecosystems cover around 75 per cent of Moldova's land area, climate change impacts on ecosystems are of extreme importance for the future of Moldovan agriculture.

Hence, the next chapter turns to the second 'microcosm' – agriculture. A concise review of the current situation in Moldovan agriculture is followed by an assessment of the economic impact of climate-related conditions as well as the available policy options for adaptation. Furthermore, as agriculture has enormous significance for the lives of more than half of Moldova's population this chapter pays special attention to this matter by bringing into the discussion the human development perspective.

The seventh chapter paves the way for a critically important sector for economic development: transport infrastructure. It provides an overview of the current state of the transport infrastructure in Moldova, which due to its poor condition imposes significant costs on economic development. Then, the possible impact of climate change on the transport infrastructure is examined. The chapter goes on to discuss tentative adaptation measures aimed at managing climate change impacts.

The energy sector is put in a wider perspective in chapter eight. The core of the analysis of the energy sector is an examination of the effects of climate change on the demand and supply sides, while less attention is paid to infrastructure issues. Following a review of the current state of the energy sector and its main vulnerabilities, the chapter provides an evaluation of the impact of climate change on energy supply, demand and infrastructure. This analysis is followed by a set of proposed adaptation measures.

The ninth chapter looks at another area of concern – human health. It starts with an analysis of the main effects of climate change on human health and the main transmission mechanisms of such effects as heat-waves, worsening water quality, and air pollution. At the same time, it outlines the outcomes of these changes from a human development perspective. The chapter concludes with a series of potential adaptation options.

The following chapter looks at the ways a sound insurance policy and insurance instruments can pave the path towards a risk-resilient society. The chapter starts with an explanation of the importance of risk transfer as part of adaptive capacity and then looks at current state of the insurance sector in Moldova with a special focus on property and agricultural insurance. It also tries to offer suggestions for the shape of a future transfer mechanism and concludes with policy recommendations on how to bring this mechanism into being.

The final chapter offers a venue for broad policy discussion. It reviews Moldova's development strategies from the perspective of climate change. In particular it focuses on development objectives that are likely to be thwarted if climate change is not taken into account. After summarising key development strategies, the criteria used to evaluate adaptation options will be explained and adaptation options that can assist in achieving development objectives identified. The chapter will stress realistic adaptation options from the perspective of their feasibility, advantages, and drawbacks, including consideration of adaptation strategy costs and the realities of the government's financial situation. The chapter concludes with recommendations for Moldova given the expected climate impacts and available adaptation strategies.

We do hope that this Report will accomplish its three-pronged mission: it will bring climate change discussion into the national policy agenda, it will contribute to elaboration of the national adaptation policies and it will add an important human development perspective to this issue.

Chapter 2

Human Development in Moldova - the Background

2. HUMAN DEVELOPMENT IN MOLDOVA - THE BACKGROUND

2.1. Summary

In terms of human development Moldova is one of the least advanced countries both in Europe and in the group of transition countries. Among other key indicators, Moldova's poor progress in human development is proven by the Human Development Index (HDI). In 2005 Moldova had the fourth lowest HDI in the group of 20 CEE and CIS countries for which the HDIs were available. Moldova was also among the four CEE and CIS countries which in 2005 were in a worse situation in terms of human development than in 1990, and its losses were the largest; that was because Moldova's Human Development Index slipped back in all its three constitutive elements, life expectancy, school enrolment and GDP per capita. Moldova's decade-long recession (1991–1999) was among the deepest and an economic recovery in 2000–2005 was followed by a series of external economic shocks in 2006-2008. The year 2009 has seen a harsh economic decline with a corresponding impact on GDP and the Human Development Index. Even if trends in 2000-2008 continue unaltered, Moldova will only reach a high Human Development Index (0.800), similar to Western European countries, by 2040. In order to achieve this level sooner, Moldova would need faster economic growth and constant improvement in life expectancy and education enrolment rates. Nevertheless, the overall concept of Human Development is much broader then the index, as will be shown later and there might be improvements in Human Development as a whole which are not reflected in the performance of the Human Development Index.

Climate change may raise significant hurdles to improving Moldova's human development unless significant intervention occurs, and this is mainly due to the connection between climate change and agricultural income and the impact of climate change on water resource quantity and quality. Nevertheless, even within a context which in general looks more problematic, some improvements can occur and show up new opportunities for working and income generation. As with every change, there will be winners and losers as well as more or less affected groups of people. Moldova's rural economy, dominated by agricultural employment, has remained stagnant as manufacture and services have grown rapidly since 2000. Even if this is a typical situation for economies in transition from agriculture-based production to more modern structures, agricultural income is highly relevant for Moldova's human development, since more than half of the population lives in rural areas and about one third of the labour force is still employed in agriculture. Depending on how well long term development strategies in Moldova will perform, this situation might change within the next two generations. There might be less agricultural employment and welfare dependence in rural income, a trend which could come hand in hand with demographic change, productive innovation and climate change. Nevertheless, for the upcoming decades and until all the expected changes start to take place, the possibilities for human development in Moldova will be determined by agricultural income and a rural way of life for the majority of population. In this sense, droughts have repeatedly reduced agricultural income in the past and drought frequency and their intensity are expected to increase in the future. As shown in the next chapter of the Report, temperatures that were regarded as extreme in the past may come to seem normal in the future. Temperature increases will go hand in hand with falling levels of humidity. It is likely that Moldova will move from being an insufficiently wet to wet sub-humid zone to being a dry sub-humid to semiarid zone, with the southern part of the country being most seriously threatened.

Some of the negative impacts of climate change have already been seen. The 2003 drought had a negative impact on the well-being of rural households and while final statistical data on poverty in 2008 are not yet available, indicators suggest that the much more catastrophic drought of 2007 will result in increased poverty particularly for families deriving the main part of their income from market-oriented or subsistence agriculture. For these families, small scale subsistence agricultural production was still sufficient to meet their own needs, but the failure of market access left farmers with a severely reduced income. In the last quarter of 2008, for example, agricultural income was 30% below the last quarter of 2007. As shown in the Chapter CLIMATE CHANGE AND ITS CHALLENGES FOR MOLDOVA, the year 2007 really provided a "shape of the future climate to come" and could be considered as a glimpse at some of the negative consequences of climate change that are likely in the not-so-distant future.

2.2. What is human development?

2.2.1. Evolving approaches to human development

Human development is a broad and evolving concept. In development economics those countries and regions are said to be developed where people have freedom of choice in areas such as career, education path, lifestyle and political freedom. As a process in time, human development means building, through policy measures, the enabling conditions for sustainable human development, such as adequate education, health, material well-being, participation, social empowerment and inclusiveness and an economic growth model that is equitable in social and geographic terms.

People are the real wealth of a nation. The basic objective of development is to create an enabling environment for people to enjoy a long, healthy and creative life. This may appear to be a simple truth, but it is often forgotten amid the immediate concern for the accumulation of commodities and financial wealth. For too long, we have been preoccupied with creating wealth and material opulence. In that pursuit, we have often forgotten that development is all about people. In our preoccupation with economic growth, we systematically pushed people more and more from the centre to the periphery of development debates and dialogues.

The publication of the first Human Development Report by United Nations Development Programme (UNDP) in 1990 was a modest attempt to reverse this trend. By introducing the concept of human development, constructing a composite measure for it and triggering a discussion of the relevant policy implications, the Human Development Reports have changed the way society looks at human progress.

Defining human development

Human development can be defined simply as a process of broadening the range of choices. Every day human beings make a series of choices – some economic, some social, some political, some cultural. The ultimate objective of development is not to create more wealth, or to achieve higher growth, but to broaden this range of choices for every human being. Human development is both a process and an outcome. It is concerned with the process through which the range of choices is broadened. And it also focuses on the outcomes of enhanced choices. Human development, thus defined, represents a simple notion, but with far-reaching implications.

First, the range of human choices is broadened when people acquire more capabilities and enjoy more opportunities to use those capabilities. Human development reflects a balance between the two and if there is a mismatch between the two, human frustration may result.

Second, according to the concept of human development, economic growth is just a means, albeit an important one, not the ultimate goal of development. Income makes an important contribution if its benefits are translated into human lives, but the growth of income is not an end in itself. The goal of development must be to enhance people's capabilities.

Third, human development, by concentrating on choices, implies that people must influence the process that shapes their lives. In other words, they must participate in various decision-making processes, the implementation of those decisions, and their monitoring.

Ultimately, human development is development of the people, development for the people, and development by the people. Development of the people refers to the building and strengthening of human capabilities through human resource development. Development for the people implies that the benefits of growth must be translated into the lives of people. And development by the people emphasizes that people must participate actively to influence the processes that shape their lives.

Human development is more holistic than other approaches. Human resource development emphasizes human capital only and treats human beings only as inputs in the development process, but not as its beneficiaries. The Basic Needs Approach talks of human beings' minimum requirements, but not about their choices. Human welfare looks at people only as recipients, and not as active participants in the processes that shape their lives. Human development, by encompassing all these aspects, represents a more holistic approach to development. Human development is closely linked with human rights, human security, gender equality, environmental sustainability and the Millennium Development Goals (MDGs). Human development and human rights are

closely linked as they have a common denominator – human freedom. Human development, by enlarging human capabilities and opportunities, enhances the freedom of choice. Human rights, on the other hand, protect that freedom. Human development and human rights are thus mutually reinforcing.

The concept of security has for too long been interpreted narrowly: as the security of a territory from external aggression, or the protection of national interests in foreign policy, or as global security from the threat of a nuclear holocaust. It has been related more to nation-states than to people. Forgotten was the legitimate concern of common people who sought security in their daily lives. For many of them, security symbolized protection from the threat of disease, hunger, unemployment, crime, social conflict, political repression and environmental hazards. For most people, a feeling of insecurity arises more from worries about daily life than from the dread of a cataclysmic world event. Human security is concerned not only with territorial security or security of nation-states, but it also encompasses security of people in their everyday lives. It may be termed as the freedom from certain deprivations as well as freedom from specific perceived fears. For example, freedom from income poverty and hunger refers to security in terms of actual deprivation, whereas the desire to be secure from violence or personal assault may imply security against perceived threats. Both are aspects of human security. The notion of human security should not be equated with human development. Human development is a broader concept – defined as the process of widening the ranges of people's choices. Human security means that people can exercise these choices safely and freely. There is, of course, a link between human security and human development: they are mutually reinforcing. Progress in one area enhances the chances of progress in the other, but failure in one area also heightens the risk of failure in the other.

Gender equality is at the core of human development, which emphasizes that development, if not engendered, is endangered. The human development framework firmly believes that any development strategy or effort which bypasses half of humanity cannot be sustainable. It believes in enhancing the capabilities of women so that gender gaps in capabilities are reduced. It also argues for equal opportunities for women in all spheres of life – economic, social, cultural and political. It is opposed to targeted discrimination against women, violation of their rights and specific threats to them – e.g. threats to their personal safety, the threat of domestic violence, or sexual abuse.

Human development focuses on the choices not only of the present generation, but also of future ones. The range of choices available for the present generation should be expanded, but not by limiting or destroying those available for future generations. All forms of capital and social assets – physical, human and environmental – should be replenished so that future generations have at least the same, and possibly better choices available. The issue of sustainability is, thus, key to human development.

In the year 2000 the world leaders adopted the United Nations Millennium Declaration, committing to a new global partnership to reduce extreme poverty and setting out a series of time-bound quantitative targets – the Millennium Development Goals (MDGs). Also Moldova has subscribed with full responsibility to achieving the MDGs and assuring sustainable human development and poverty reduction, environmental protection, good governance, democracy and human rights protection through a more efficient coordination of the economic and social policies by 2015.[8] The human development perspective provides a strong analytical framework for attaining the MDGs.[9]

[8] Government of the Republic of Moldova, 2005.

[9] For further details on the MDGs and targets and the possible climate change implications see Table 2 and Annex 2.10.

Table 1. Analytical linkage between human development and MDGs

Human development						
Directly enhancing human capabilities dimensions			Contextual dimensions			
Long and health life	Knowledge	Decent standard of living	Participation	Environmental sustainability	Human security	Gender inequality
MDGs 4,5,6	MDG 2	MDG 1		MDG 7		MDG 3
Child mortality Maternal mortality HIV/AIDS	Universal primary education	Extreme income poverty Hunger		Environmental sustainability		Gender inequality in primary education

Source: *Jahan, 2002.*

Even though MDGs are anchored in human development, there are two qualifiers that should be taken into account. First, the MDGs refer only to some basic dimensions of human development and do not cover all its dimensions. They do not reflect such human development dimensions as participation or human security, which, of course, are part of the broader Millennium Declaration. Second, even though anchored in the human development paradigm, for natural and obvious reasons, MDGs have a strong association with the deprivation side of human development, i.e. human poverty, though the other side of the coin, namely an expansion of opportunities is equally important.

Human poverty

Poverty manifests itself in the deprivation of the lives that people lead. Poverty involves not only the lack of the necessities for material well-being, but the denial of opportunities for living a tolerable life. Life can be prematurely shortened. It can be made difficult, painful or hazardous. It can be deprived of knowledge and communication. And it can be robbed of dignity, confidence and self-respect as well as the respect of others. All these are aspects of poverty that limit and blight the lives of many millions in the world today.

If human development is about enlarging choices, poverty refers to a situation where the opportunities and choices most basic to human development are denied. The concern for identifying people affected by poverty and the desire to measure it have at times obscured the fact that poverty is too complex to be reduced to a single dimension of human life. It has become common for countries to establish an income-based or consumption-based poverty line. Although income focuses on an important dimension of poverty, it gives only a partial picture of the many ways human lives can be blighted. Someone can enjoy good health and live a relatively long life but be illiterate and thus cut off from learning, from communication and from interactions with others. Another person may be literate and quite well-educated but prone to premature death because of epidemiological characteristics or physical disposition. Yet others, and especially women, may be excluded from participating in decision-making processes affecting their lives. None of these deprivations can be fully and effectively captured by the level of their income. Also, people perceive deprivations in different ways. Each person and community may differently define deprivation and disadvantages that affect their lives.

Poverty of lives and opportunities – or human poverty – in multidimensional in character and diverse content. The concept of human poverty was first introduced in the 1997 Human Development Report. In addition to being broader than income poverty, human poverty offers a different way of evaluating development. Human development focuses on advances made by all groups in each community – from the rich to the poor. In the hu-

man poverty perspective, development is judged by the way the poor and the deprived fare in each community.

So human development is an inherently complex issue and therefore it is extremely difficult to measure it in an objective and academically sound way. Obviously, human development analysis does not have to be based on the components of the Human Development Index or any other composite index. It should be assessed based on a wide range of disaggregated quantitative and qualitative data across all human development dimensions over time for different groups, particularly those marginalized. However, an inclusive and suggestive indicator is necessary to assess the evolution of the countries and to make possible international comparisons. For many decades the main indicator of development was GDP per capita. While still widely used, this indicator has obvious deficiencies because of its unilateral and narrow nature in capturing the full range of aspects of human development, but has the strength of being easily computed and understood, which is an important property for policy use.

Nowadays, one of the most widely used indicators of human development is the Human Development Index that has its origins in the United Nations Development Programme. It is particularly used at global level for the purposes of international and regional comparisons. The Human Development Index is calculated as the simple average of an Education Index, Life Expectancy Index and GDP Index. The Human Poverty Index, the Gender-related Development Index and the Gender Empowerment Measure are other composite indices developed by the UNDP, but for now the HDI is the most widely known and used. The first Human Development Report published in 1990 introduced with the HDI a new way of measuring development by combining indicators of life expectancy, educational attainment and income into a composite Human Development Index. The HDI sets a minimum and a maximum for each of the three dimensions (goalposts) and then shows where each country (or region) stands in relation to these goalposts, expressed as a value between 0 and 1 (see Annex 1.1).

This way of measuring the state and evolution of the human development has received some criticisms, such as "failing to capture the essence of the world it seeks to portray" or "being almost exclusively focused on national performance and ranking, but not paying much attention to development from a global perspective".[10] For example, the HDI does not account for the environmental and human rights situation in a given country or region and does not account for inequality, to give one of the most common criticisms of the index. However, it has to be said that for now there are no other indices that would be easily measurable, globally acceptable, informative and allow for international comparisons. And the most important feature of the HDI is that it focuses on people as ends of development rather than tools for achieving this development.

2.2.2. Links between the growth models and human development

An increasing number of representatives of modern development economics assert that human development rather than economic growth per se should be viewed as the final end of human activity and governmental policy.[11] The growth model characteristic for a given country fundamentally influences the country's outcomes in terms of human development. As a matter of fact, from a human development point of view, economic growth is in tension with social justice, environmental sustainability or equality of gender, but it is the source of general welfare in the sense of being the generative power for that provides the necessary resources for the development of all the other sectors and aspects of human development. The willingness of households to spend their income on services and goods enhancing human development depends very much not only on how large this income is, but also on how the income is distributed across and within households. All recent research proves that the more socially inclusive the economic growth is and the more empowered women inside the family are, the more likely households are to spend more on education, healthcare, clean water and safe food. At the same time, higher economic growth generates necessary governmental funds to invest in those economic and social assets that promote human development but which have a low or negative rate of economic return and which are of little or no interest for private investors (schools, roads, hospitals, water-running and sewage systems and so on). Obviously, it is important for these public goods to be universally accessible and geographically unbiased in their final distribution, avoiding exclusion. If not, only a small proportion of the population, mostly based in urban areas, will benefit, while the rest of the population will remain poor and will not be em-

[10] Ambuj D. Sagara and Adil Najam, "The Human Development Index: a Critical Review", Ecological Economics 25(3): 249-264.

[11] Ranis Gustav, Stewart Frances and Ramirez Alejandro, "Economic growth and human development".

powered to change their own lives. A human-oriented economic growth model is associated with job creation, including in rural areas, and with constantly rising levels of labour productivity. As such, a more equal distribution of economic opportunities will result in a more equal distribution of income across society and in higher human development outcomes. Some estimates show that if Brazil, which has a highly inegalitarian economic growth pattern, had an income distribution like Malaysia (a country with a lower level of inequality), the rate of enrolment of children from poor Brazilian families would be 40 per cent higher.

At the same time, the achievements, or the slippages, in the area of human development may consolidate or, correspondingly, undermine, the country's economic growth in the long run. There is sound statistical evidence that the better educated and healthier people are, the higher their productivity and contribution to the country's GDP. Furthermore, people's health and education are basic determinants of a country's ability to absorb and generate advanced technology, which, in the long run, builds up national competitiveness. As shown by Ranis et al. (1997), good conditions of health and primary education are critical for increasing the labour productivity of unskilled or low-skilled workers. Secondary and vocational education enhances lifelong learning capacities and stimulates the acquisition of managerial skills. Higher education supports the development of science and technology and is a basic ingredient in the development of efficient governmental institutions and regulatory environments.

Whether economic growth and human development interact to create a virtuous or a vicious circle depends largely on government policy. As shown in the 2006 National Human Development Report for Moldova, the high economic growth that Moldova has achieved since the year 2000 (with GDP undergoing total real growth of 46 per cent between 2000 and 2006) was not accompanied by equally impressive progress in human development.[12] Migration and associated remittances drove the economic growth which was geographically concentrated in a few urban areas and the growth was not labour-intensive. As result, even more people are now willing to migrate than was the case in the early 2000s, while more and more rural communities have become unattractive places to live and are losing their human capital. According to the National Bureau of Statistics, in 2001-2002 an average number of 200,000 people were estimated as "being abroad for reasons related to work," while in 2007-2008 this figure was already 335,000. More than two thirds of these people are from rural areas, most of them with an intermediate or higher education background.

2.2.3. How climate change influences human development

Climate change has an underlying influence on human development in many ways. As pointed out in the 2007/2008 Human Development Report, "climate-related risks are a major cause of human suffering, poverty and diminished opportunity". Global warming has already changed livelihoods in many parts of the world and the poor are suffering the most. Developed countries have more resources to take the necessary measures to provide for human security even in the case of extreme weather events, while the poorest countries do not. For instance, as the 2007/2008 Human Development Report shows, in Ethiopia and Kenya – two of the world's most drought-prone countries – children aged five or less face a risk of being malnourished that is 36 per cent and 50 per cent higher respectively if they are born during a drought. These children's health is likely to be affected permanently.

The channels through which climate change might have a negative impact on the human development process can be easily understood by remembering that reaching the Millennium Development Goals can be seen as the road map to human development. Table 2 shows that most of the MDGs become less attainable in the context of climate change.

[12] UNDP, 2006.

Table 2. Negative impact of climate change on MDGs and human development

Human development dimensions		MDG		Negative consequences of climate change on MDGs
Directly enhancing human capabilities dimensions	Decent standard of living	1	End poverty and hunger	• Reduced avialability of water • Less or more difficult access to health, housing and infrastructure. • Reduced economic growth with direct negative impact on poverty due to reduced opportunities for income generation. • Food security might be at risk.
	Knowledge	2	Universal primary education	• The possible loss of natural, environmental, physical, social, financial and human assets, natural disasters, displacement and migration of people will affect negatively peoples' opportunities to access education.
	Long and healthy life	4	Child health (mortality)	• Possible increase of health problems related to higher temperatures or change precipitation and humidity profiles. • Possible increase of prevalence of illnesses transmitted by vectors and higher vulnerability to illnesses related to climate change. • Less quantity and quality of water and a possible increase of nutritional problems in consequence of reduced environmental services and less food supply.
		5	Maternal health	
		6	Combat HIV/AIDS	
Contextual dimensions		3	Gender equality	• The possible loss of natural resources and agricultural productivity could increase the time used by women for working and in this way negatively affect their health status and limit at the same time their opportunities for participating in decision making and income generation. • There is evidence that natural disasters affect female-headed households disproportionately, given their general lower level of welfare.
		7	Environmental sustainability	• Further environmental deterioration, due to the loss of natural resources and ecosystems
	Participation			• General participation requires resources and the minimum possible level of exclusion. Both of these conditions would be likely to worsen.
	Human security			• Understanding human security as the absence of (armed) conflicts makes clear how the effects of climate change destroy resources and change and deepen existing structures of participation and exclusion which might lead to new conflicts and impact negatively on human security.

Source: *World Bank et al. Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation. 2003.*
Obs.: *Table in original source adapted for this report by the report team.*

Sustainability as one of the constitutive elements of an integral human development process; this will still be true within a worsening environment affected by climate change. Environmental sustainability has many facets and the concept is used from different approaches. Box 1 shows in more detail how the human development approach deals with the concept of sustainability.

The Intergovernmental Panel on Climate Change (IPCC) has found in its recent researches that the impact of the global warming will not be evenly distributed and will fall disproportionately on the poor and persons less capable of coping with weather changes. These countries will also face more severe adaptation challenges and this adaptation will only make life more difficult. As Moldova is still in a developing stage, its human development achievements remain highly vulnerable to global warming and the developments of the past decade confirm that poor people are particularly exposed to climate risks (see more on impact of extreme weather events on agriculture and health in the chapters IMPACT OF CLIMATE

Box 1. Sustainability and human development

It is not difficult to agree on that development ought to be "sustainable"; that is, "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This claim may be justified on different grounds, but from the standpoint of human development, sustainability is a matter of efficiency, freedom and, especially, of equity:

- Efficiency calls for the best time-allocation of productive resources, so that the sum total of well-being for different generations is maximized;
- Freedom requires that human choices be maximized within each generation;
- Equity implies that the choices available to future generations be not unfairly reduced by the current generation.

This form of stating the problem corresponds to the inner evolution of scientific thought on sustainability. In fact, the pioneers of the "green movement" were understandably dedicated to alert the world to the imminent risk of catastrophes derived from environmental abuse and the overexploitation of natural resources. If no "limits to growth" were set, "Mother Earth" would be depleted in a short time.

Hence, as conceived by human development, sustainability is a challenge neither conditioned by ecological catastrophe nor limited to the environment; it is a general problem of efficiency, freedom, and equity among human generations.

There is a two-way relationship between sustainability and human development:

1. Like economic growth, sustainability is a means to human development; it is to guarantee that our children will have a range of options at least as wide as the range we inherited.
2. But human development is also a means to sustainability, because the "potential" we must leave is not made only of natural resources but of any and all the different kinds of capital: the physical, the financial, the "human" and the "social capital". Investing, in particular, in the health and education of young people is one way to pay back for some of the natural resources we consume.

Finally, the human development view of sustainability has one more corollary worth stressing. There would be little consistency in striving for intergenerational justice without first ensuring intra-generational justice. We cannot defend the wealth of the unborn if we do not first defend the rights of the deprived.

Source: Extract from UNDP – Advanced course to Human Development, New York, 2007

CHANGE ON AGRICULTURAL SECTOR and CLIMATE CHANGE AND HUMAN HEALTH).

Climate change is one of the forces determining the prospects for human development.[13] Through its impact on different natural and social systems it affects all countries directly and indirectly, often resulting in human development setbacks. However, the impact of climate change on human development cannot be inferred automatically from global scenarios forecasts of key climatic variables. Climate change is global but the effects are local.

The interface between climate change and human development outcomes is shaped, among other factors, by the differences in localized weather effects, in social and economic coping capacities, and by public policy choices. People and countries on the whole vary in their vulnerability and capacity to manage incremental climate change risks (see Box 2 on climate change-related terms and definitions). Thus, dangers of climate change cannot be estimated from a set of scientific observations alone. The threshold for what is dangerous depends on value judgments over what is an unacceptable cost in social, economic and ecological terms at any given level of warming. For millions of people and for many ecosystems the world has already passed the danger threshold. Attempting to establish an acceptable upper-limit target for future global temperature increases raises fundamental questions about power and responsibility. The extent to which those facing the greatest risks are able to articulate their concerns, and the weight attached to their voice, matters a great deal.

Box 2. Climate change-related terms and definitions

Adaptation

Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned. Examples are raising river or coastal dikes, the substitution of more temperature-shock resistant plants for sensitive ones, etc.

Adaptive capacity

The whole of capabilities, resources and institutions of a country or region to implement effective adaptation measures

Climate

Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate change

Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes

[13] UNDP, 2007.

in the composition of the atmosphere or in land use. United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

Climate projection

A projection of the response of the climate system to emission or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Climate projections are distinguished from climate predictions in order to emphasize that climate projections depend upon the emission/concentration/radiative forcing scenario used, which are based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized and are therefore subject to substantial uncertainty.

Mitigation

Technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce greenhouse gas emissions and enhance sinks.

Mitigative capacity

A country's ability to reduce anthropogenic greenhouse gas emissions or to enhance natural sinks, where ability refers to skills, competencies, fitness and proficiencies that a country has attained and depends on technology, institutions, wealth, equity, infrastructure and information. Mitigative capacity is rooted in a country's sustainable development path.

Sensitivity

The degree to which a system is affected, either adversely or beneficially, by climate variability or climate change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise).

Vulnerability

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Source: *Excerpts from the Glossary of Terms used in the IPCC Fourth Assessment Report.*

Human development is about people. It is about expanding people's real choices and the substantive freedoms—the capabilities—that enable them to lead lives that they value. Choice and freedom in human development mean something more than the absence of constraints. People whose lives are blighted by poverty, ill-health or illiteracy are not in any meaningful sense free to lead the lives that they value. Neither are people who are denied the civil and political rights they need to influence decisions that affect their lives. Climate change will be one of the defining forces

shaping prospects for human development during the 21st century.

The starting point for any consideration of how climate change scenarios might play out is the human development backdrop. That backdrop includes some good news stories that are often overlooked. In general, since the inclusion of the concept of human development in the set of theories on development, there has been a worldwide improvement in general health and education conditions as well as in aggregated welfare. Even if Moldova had to face a fall in human development throughout the 1990s, since 2000 the trend has been positive again (mainly because of economic growth).

The bad news is that pre-existing and future forces resulting from climate change will be offset by deep and pervasive human development deficits, and by disparities that divide the 'haves' and the 'have-nots'. Trends and transmission channels can follow to a major or minor degree the structure shown in the table above.

Table 2 above mentions 13 different transmission channels by which climate change can affect human development. Of course, not all these 13 dimensions have the same scope or potentially negative impact.

Impact on human development will also vary since changes in climate patterns interact with pre-existing social and economic vulnerabilities. Nevertheless, the UNDP[14] identified five specific risk-multipliers or five human development 'tipping points' that are dangerous because they can engender human development reversals:

- Reduced agricultural productivity. Through impact on agriculture and food security, climate change could leave an additional 600 million people worldwide facing acute malnutrition by the 2080s.[15]
- Heightened water insecurity. By 2080, climate change could increase the number of people facing water scarcity around the world by 1.8 billion.[16]
- Increased exposure to coastal flooding and extreme weather events. For example, an increase in the extent of drought-affected areas could jeopardize livelihoods and compromise progress in health and nutrition.
- The collapse of ecosystems due to above-mentioned risks to unique and threatened systems.
- Increased human health risks at different levels.

These five drivers for major human development reversals cannot be viewed in isolation. They will interact with each other, and with pre-existing human development problems, creating powerful downward spirals. Moreover, these risks will intertwine to further weaken economies and societies through the direct impact on the jobs and livelihoods of different social groups. Obviously, not all of the human development costs associated with climate change can be measured in terms of quantitative outcomes. At a fundamental level, human development is also about people having a say in the decisions that affect their lives.

2.2.4. Links between climate change and human development in Moldova

Global warming influences directly and indirectly the level and depth of poverty in many countries. Some of these links are easily seen in Moldova as well. Long term projections for Moldova show that climate change may result in increased aridity, especially during periods of crop growth. Cultivation of the cereal crops that dominate the current structure of agricultural production will negatively affect yields in new agroclimatic conditions, and this is likely to be permanent. For example, winter yield may decrease by 18 to 39 per cent by 2020 and by 22 to 50 per cent by 2050. A lengthening of the dry period and a general aridification of the climate and more erratic precipitation will substantially affect the amount of and the territorial and seasonal distribution of water. The most vulnerable region is the southern part of the country, which already suffers from limited water resources, a small network of surface water distribution and smaller underground water reserves. The problem of water supply will be particularly severe for rural localities.

Extreme weather events cause big losses particularly to the poorest parts of society. Because of variations in rainfall, temperature and the poor state of irrigation and other relevant infrastructure, agricultural production in Moldova is very sensitive to weather conditions, while crop insurance is not a widespread practice. In 2008, the floods in the regions adjacent to the Dniester

[14] Ibid.
[15] Warren et al., 2006
[16] Ibid.

and Prut rivers destroyed about 600 rural houses and the harvest on many thousands of hectares. The total losses due to the floods are estimated at 300 million USD. In drought years, many Moldovan rural communities even have problems with water availability. As shown by the 2007 drought, climate change can also easily give rise to very serious problems with food security in Moldova, and public resources to deal with such a situation are quite scarce. In 2007, many Moldovan farmers would not have managed to maintain their production capacities without the support provided by international donors.[17]

Droughts, especially in the southern region, are a particular concern for Moldova. According to an official report, the drought in 2003 had a negative impact on the well-being of rural households in 2004 because of rising production costs which resulted in an increased incidence of extreme poverty in rural areas.[18] The much more catastrophic drought in 2007 mainly resulted in higher poverty rates in the following year because of the stocks of agricultural products available in many rural households. The quick reaction, technical assistance and the 20 million USD support provided by the international community brought some emergency and longer term relief. However, by the end of 2007 the stocks had vanished and the official expectations are that in 2008 the rural poverty will have worsened.[19] There are as yet no final data on poverty available for 2008 to check the extent to which rural poverty has increased. However, some indirect indicators suggest that poverty rose in 2008, especially for families deriving most of their income from commercial or subsistence agriculture. Indeed, as depicted in Chart 1, the income derived from agricultural activities in 2008 was much lower than in 2006-2007. The average annual income from agricultural activity in 2008 was 19 per cent lower than in the previous two years. The situation was deteriorating especially rapidly at the end of 2008: in the last quarter of 2008, income was 30 per cent below the level recorded in the last quarter of 2007.

Chart 1. Total income and income derived from agricultural activity in rural areas, MDL, 2006-2008, by quarter

Source: *NBS and EG calculations.*

There are no indicators as yet that show that climate change has affected education access and outcomes in Moldova. Indeed, the schooling infrastructure is not highly vulnerable to extreme weather events which are specific to Moldova. However, extreme weather events associated with climate change can, for instance, render inter-community roads impassable, preventing children from small villages from attending schools located in nearby villages or towns (see more in the chapter CLIMATE CHANGE IMPACTS ON TRANSPORT INFRASTRUCTURE). But the impact of climate on education is more likely to be indirect, mediated through impacts on agricultural productivity and poverty. Access to education and educational outcomes can suffer if droughts or floods result in persistent malnourishment of children and threaten the capacity of children to attend school. Increasing income poverty may force parents to deploy children in agricultural or domestic tasks instead of sending them to school or leave them with fewer resources to purchase textbooks, clothes, shoes or other items needed for their children's education.

International evidence suggests that health status can suffer very much as a result of climate change. Obviously, catastrophic events with great destructive power (such as floods) can result in massive damages, injuries, diseases or even deaths. But droughts, which are a more common problem for Moldova, apparently have a significant impact on health as well, with likely increases in the occurrence of circulatory, respiratory and other diseases. However, these conclusions are still quite uncertain. Even though both in 2003 and 2007 the prevalence of some diseases increased (par-

[17] Among the first assessments of crop and food security as a consequence of the drought in 2007 was a special report prepared by the United Nations Food and Agricultural Organization (FAO) and the World Food Programme (WFP) (see FAO/WFP, 2007).

[18] Ministry of Economy and Trade of Republic of Moldova, „Report on Poverty and Policy Impact 2004", Chişinău, November 2005.

[19] Ministry of Economy and Trade of Republic of Moldova, „Report on Poverty and Policy Impact 2007", Chişinău, November 2008.

ticularly that of circulatory disorders), because of the imperfect and short-term medical statistics it is difficult to disentangle the climate change effects from other effects.

The overall challenge that climate change represents for human development and other development processes nevertheless goes beyond the five major risks and the 13 transmission channels mentioned above. Keeping human development on track is not only about dealing with these threats but also about learning to live with them in the sense of gradually adapting to new and future living conditions. General population has a major role to play in this process. For example, broad public debate and provision of credible and digestible information will encourage residents to make responsible decisions, eventually helping them to better adapt to the impact of climate change on their communities and territories, socio-economic status, and health. Adaptation is always a learning process, a process of trial and error, and a process which requires additional resources. If the resources available today are barely sufficient to keep positive human development trends on track, the future threat regarding access to resources might be even much bigger.

2.3. Human development achievements and setbacks in Moldova

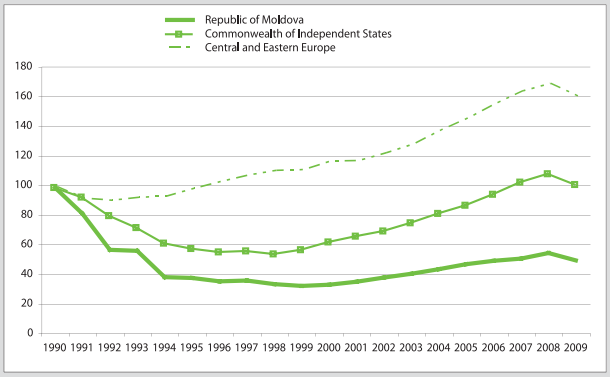
2.3.1. Economic growth – a key factor for Moldova's human development

Steep economic decline is the main cause of worsening human development in the early transition period in Moldova because transition brought with it a fall in the real income of the population. Hand in hand with this income decrease, opportunities for living a long and healthy life and for accessing education were curtailed as well. Participation and gender aspects were less affected by this setback but environmental degradation had already started to take place as the problems in agricultural production had shown. As shown in a later section, this deterioration was reflected by the falling Human Development Index.

Moldova started its transition from a less prosperous position than other countries in CIS and CEE and its decade-long recession (1991–1999) was among the deepest in the group of transition countries (only Georgia's was more severe). The only year with marginally positive economic growth was 1997, followed by the regional financial crisis that threw Moldova into an even deeper economic decline in 1998-1999. An economic recovery ensued in 2000–2005 with the GDP growing by an average of 6.25 per cent annually, leading to a slow convergence with the CIS and CEE income averages. However, a series of external shocks followed in 2006-2008. Although economic growth remained positive, the growth rate slumped to 4.1 per cent in 2006 and 3.0 per cent in 2007. Despite the impressive economic growth in 2008 (7.2 per cent), this was mainly recovery growth after the severe drought in 2007. As result, it is easy to see that the already large GDP gap between Moldova and other transition countries widened even more from 2007 onwards (Chart 2).

The year 2009 has seen a steep economic decline with corresponding effects on per capita GDP. Nor are Moldova's short-term prospects good, because the country was hard-hit by the second-round effects of the global financial crisis. Its first consequences were already visible in the final quarter of 2008 and were confirmed by bad statistical indicators in the first half of 2009.

Chart 2. Relative GDP growth, 1990=100



Source: *IMF WEO database and EG calculations.*

It has to be added that besides being relatively modest by regional standards, GDP growth has been also quite unequal in social and geographical terms. As shown in Table 3, the estimated GDP per capita for men is presently almost 60 per cent higher than GDP per capita for women. Inequality has shown positive trends in the last decade, with the Gini indicator declining from 0.40 on average in 1998-1999 to 0.30 on average in 2006-2007.[20] This trend is mostly explained by the growing number of families supported by migrants.

The economic growth is also quite restrained in geographical terms. Chişinău, Balti and a few

[20] Ministry of Economy of Moldova, Poverty Reports for various years.

other urban zones have grown rapidly as national or regional economic poles, while the rural economy dominated by occupations in agriculture has remained stagnant. In 2000-2008 the added value created by construction, services and industry sectors (mostly urban-based) has grown by about 270 per cent, 160 per cent and 45 per cent respectively. In the same period, the added value created in the agricultural sector has barely changed. This imbalance between rural and urban economic growth is highly relevant for Moldova where more than half of the population resides in rural areas and about one third of the labour force is employed in agriculture. It is also particularly relevant to climate change given the strong link between climate change and agricultural productivity. In 2007, the yields of the main crops collapsed because of the drought: there were only 11 quintals/ha of wheat (as compared with 21.1 in 2006), 7.8 quintals/ha of maize (28.8 in 2006), 6.7 quintals/ha of sun-flower (13.2) and 179 quintals/ha of sugar beet (278). As a result, many farmers were left with no resources for the next agricultural cycle and with very serious food security challenges. The economic problems triggered a massive emigration abroad of the rural population starting in the early 2000s. In fact, one can affirm that in the last 8 years the rural population has benefited more from migrants' remittances than from domestic economic opportunities.

2.3.2. Education as an enabler of human development

The situation regarding basic education in Moldova is reasonably good. Since Soviet times Moldova has preserved and even marginally increased its relatively high level of literacy, with almost 99.1 per cent of the adult population literate currently. There are no significant gender discrepancies as regards literacy level.

However, it is worth mentioning that the formal literacy rate may significantly differ from the functional literacy rate, meaning the ability to make use of one's knowledge and skills in order to improve one's own economic situation. Generally speaking, there are significant problems with the quality of education in Moldova.[21] Among the main causes of the poor quality of education are low-paid teaching staff, outdated curricula and old equipment used for practical training. This is particularly relevant in the case of vocational education, where employers are very dissatisfied with the level of competence of the young specialists graduating from Moldovan institutions.[22] As result of the poor training received, many youth have no chance of finding employment. Some of them remain unemployed, increasing the youth unemployment rate, which reached 15.4 per cent in the second quarter of 2009, the highest level of all the age groups. But most young people who cannot find jobs in Moldova prefer to leave the country and seek employment abroad.

Chart 3. **Evolution of the general gross enrolment rate in Moldova, 1993-2008**

Source: *NBS.*

The total gross enrolment rate developed in a quite complex way over the period for which statistical data are available (Chart 3). After a decline in 1993-1994 it continued growing until 1998. A steep decline followed again in 1999-2000 as result of the increasing poverty rate in the aftermath of the Russian financial crisis. Some moderate gains ensued in 2001-2005, but mainly in respect of the female enrolment in education, while male enrolment worsened almost continuously. After that, the enrolment rate started worsening again, and is currently at a record low level of 69.8 per cent. The underlying factor behind this trend has been the falling rate of male enrolment in education over the last decade. This could be explained to some extent by general poverty that forces many youngsters to start independent economic life as early as possible after completing general secondary education. Indeed, the gender gap is significant only for vocational and higher education, when many young men decide to leave the education system. The gender gap in the enrolment rate has constantly increased, favouring women, from 2.3 percentage points in 1999 to 6.6 points in 2008. The decreasing male enrolment rate is a warning sign highlighting shortcomings in schooling systems which do not help people access jobs permitting a decent standard of living, and highlights a growing shortfall in the creation of work

[21] ENPI 08-14 Black Sea Labour Market Reviews "Moldova country report", January 2009, available at www.expert-grup.org.

[22] Study conducted jointly by the Moldovan Chamber of Trade and the Koblenz Chamber of Craftsmen, Germany quoted by Eco-Magazine, issue. 194, 29 October 2008, in an article entitled "Vocational schools train unsuitable staff for Moldovan economy". All 120 surveyed employers in Moldova were unanimous in declaring that young people graduating from vocational schools have no elementary practical training.

or income generation opportunities, which are needed if people are to use the skills they acquire to enhance their own welfare, by earning income as a means of human development.

The falling level of enrolment in primary education (from 100 per cent in 2000/2001 to 94 per cent in 2007/2008, affecting girls and boys equally) is partly explained by the unofficial migration of children whose parents work permanently abroad, as well as by the financial difficulties that many families face when it comes to sending their children to school. After several years of gains registered in secondary education enrolment, in 2005-2006 this indicator started declining again, which should be viewed as a consequence of the decline in primary education enrolment which started sooner. Another cause of the worsening enrolment rate in the last two years were the changes in government education policies adopted in 2006/2007 that unsuccessfully aimed to divert more students from higher education to vocational and professional education and to colleges. In the event, however, more youths preferred to leave the education sector entirely. The number of university students has declined from 357 per 10 thousand inhabitants in 2006/2007 to 322 in 2008/2009. At the same time, the number of students enrolled in colleges and vocational institutions has grown marginally, from, respectively, 84 and 66 students per 10 thousand inhabitants in 2006 and 2007 to 92 and 68 in 2008/2009. This means that this policy decision was wrong because no attractive alternatives were provided by the vocational education establishments. While no statistical data are available so far, this decision seems to have affected both males and females equally.

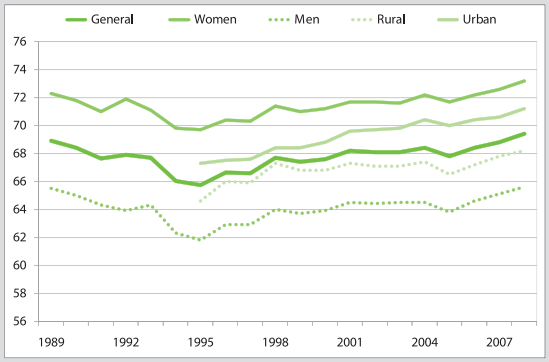
2.3.3. Health as a basic component of human development

Life expectancy is generally accepted as a key indicator of the overall state of a nation's health. In terms of life expectancy at birth Moldova, is presently in a slightly better position than in the pre-transition period. After a steep decline in the early transition period, average life expectancy started rising again, going from 65.8 years in 1995 to 69.4 years in 2008 (Chart 4). As in all countries, women's life expectancy at birth in Moldova is significantly higher than men's (73.2 as compared to 65.6 years). This gender difference has tended to increase over the last two decades, giving rise to a number of difficult policy issues. For instance, even though men in Moldova have lower life expectancy than women, according to the law they have to work longer than women in order to get the right to a pension (62 years for men and 57 for women).

At the same time, life expectancy in rural areas is significantly shorter than in urban ones (68.2 years and 71.2 years correspondingly). Men living in rural areas are the group facing the highest risk of a short life: in 2008 male life expectancy in rural areas was 64.6 years, as compared with 72 years for rural women and 65.6 years for urban men. These rural/urban differences can be explained by a constellation of factors: [23]

- rural inhabitants' lower level of access to health care institutions for geographical and transport reasons;
- differences in diet patterns: traditional diets in rural areas contain less protein and vitamin intake than in urban areas and contain more fats;
- poor water quality: on-site wells are traditional sources of water in villages, and a great majority of these sources do not meet basic hygiene standards;
- poverty incidence, which is much higher in rural areas than in urban ones, implying that people have fewer private resources to spend on their health;
- cultural factors, as rural inhabitants seem to be less inclined to report serious health disorders than urban ones;
- alcohol abuse: in rural areas the share of people consuming alcohol frequently is four times higher than in urban ones.[24]

Chart 4. **Evolution of life expectancy at birth in Moldova, 1995-2008**



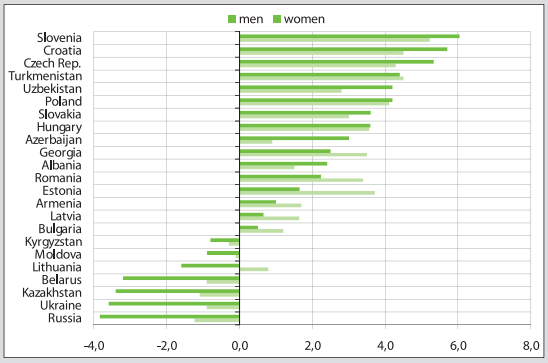
Source: *NHDR 2006 and NBS.*

[23] Other reasons for differences between life expectancies should be some cohort issues and demographic trends, including the infant mortality rate. There are no significant statistical differences between this indicator in rural and urban areas in Moldova. Under-five child mortality rates and some reproductive health care indicators, such as maternal mortality rate, have to be considered as well, but there are no such urban/rural disaggregated indicators in Moldova.

[24] NBS, Results of Survey of health status of population in the Republic of Moldova, Chişinău, 2006.

While the overall health conditions of the Moldovan population have tended to improve in the last decade or so, the comparative statistics show that the situation in most of the transition countries improved to a greater extent than in Moldova. As of 2006, in 16 out of the 23 transition countries for which statistical data are available the life expectancy was higher than in 1989 for both men and women (while in Lithuania only women's life expectancy was higher, while male life expectancy shortened). In 2006, Moldova was among the 6 countries were both women's and men's life expectancy was still worse than in the pre-transition period (Chart 5). The positive changes for Moldova started only in 2007-2008, but some preliminary data suggest that the situation also improved in most of the CIS and CEE countries. Therefore, the large gap between Moldova's performance and regional levels of life expectancy remains. Based on data for 2006, Russia and Kazakhstan seem to be the only transition countries where life expectancy is even shorter than in Moldova.

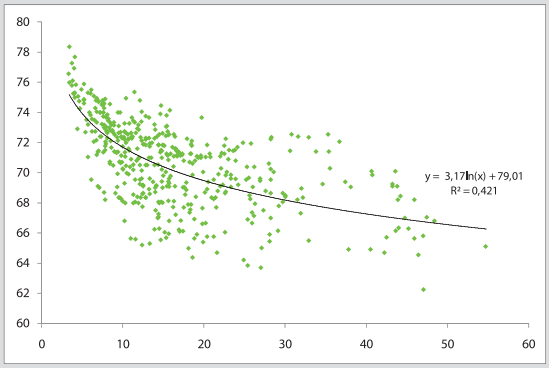
Chart 5. **Changes in women and men life expectancy, years, 2006/1989**



Source: *TransMoneeHigh. The general mortality rate is an important factor of short life expectancy. General mortality rate in Moldova has increased in the last two decades, from 9.8‰ on average in 1989-1991 to 11.2‰ in 1999-2001 and to 11.9‰ in 2006-2008. This mortality rate is similar to the Romanian indicator and is lower than in Ukraine (about 16‰).*

A key factor of the short life expectancy at birth is the high infant mortality rate. Indeed, as suggested by the available data for CEE and CIS transition countries for 1989-2006, about 40 per cent of the variation in life expectancy among these countries can be explained by differences in the infant mortality rate (Chart 6). In Moldova the infant mortality rate has been decreasing, from around 20 per mil on average in 1990-1994 to 11.5 per mil in 2005-2008.[25] This trend was accompanied by increasing life-expectancy at birth. However there is more work to be done in Moldova in terms of lowering infant mortality. Although the infant mortality rate in Moldova is currently somewhat lower than in Romania (11.8 per mil as compared with 13.9 per mil in 2006), this indicator remains high by regional standards (8.7 per mil in the western CIS, 9.8 per mil in all transition countries and 5.5 per mil in CEE and the Baltic countries).

Chart 6. **Correlation between life expectancy and infant mortality rate, cross-panel data, ECE and CIS countries, 1989-2006**



Source: *TransMonee, EG calculations.*

Because the statistical series on public health data are relatively short, it is difficult to attribute unequivocally the positive changes in infant mortality to any policy, cultural feature or other factor. To some extent, the positive changes can be explained by reforms implemented in the public health sector in the last decade, particularly due to improvements achieved in primary health care and emergency care. Prenatal care services have improved, with more women receiving folic acid and iron in the pre-natal period, and with primary level maternity clinics being endowed with better equipment and better trained staff. Mandatory health insurance was introduced in 2004, allowing for an increase in public and private spending for medical services. The health sector is also an important target for foreign development assistance. In 2000, as many as 20 international donors were working in Moldova's health sector with a total estimated project value amounting to 80 million USD.

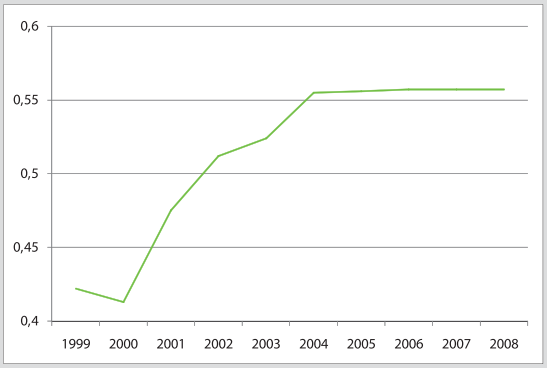
2.3.4. Gender dimensions of human development in Moldova

There are significant gender imbalances in Moldova's human development performance. As shown in previous sections, there is a significant

[25] In 2008 a methodological change was adopted in health statistics and births started to be registered based on the European standard of registering new-born babies weighing 500 g and more and from 22 weeks gestation period. Based on the new methodology, the infant mortality rate in 2008 was 12.7 per cent, while based on the old methodology it was 10.6 per cent.

gap between men and women in terms of life expectancy and educational enrolment. However, in many respects women's participation in social life has improved in the past decade, as captured by the evolution of the Gender Empowerment Measure (Chart 7).

Chart 7. Evolution of the Gender Empowerment Measure in Moldova



Source: *NBS.*

Most of the gains were achieved in 2001-2005 as result of the increasing number of Parliamentary seats occupied by women (7.9 per cent in 2000 and 22 per cent in 2005). This progress has been consolidated following the parliamentary elections of July 2009, following which women held 26 per cent of seats in parliament. The number of woman senior officials and managers as well as the number of women in intellectual and scientific occupations has increased as well over the past nine years, even though the increase is less convincing than in the case of legislators.

However, a significant constraint on achieving higher gender empowerment in Moldova is women's low level of access to economic resources. Even though women make up a larger share of the total population (52 per cent), their share in the economically active population is lower (49.4 per cent) and this ratio has tended to fall over the last five years. There is no significant progress on wage equality either. In 2002, women's wages were on average 70 per cent of men's and reached the record low level of 64 per cent in 2006. In 2007-2008 the indicator recovered to 70 per cent with no clear sign that the gap will narrow in the near future.

The growing economic and social role of women was reflected in demographic trends. The general fertility rate has decreased from 1.76 in 1995 to 1.21 in 2002 and after has marginally improved up to 1.28 in 2008 (due to the 1970s baby-boomers generation reaching childbearing age). The latter improvement is likely to be of short duration due to, among other factors, the intense outward migration of women (representing about 40 per cent of total migrants).

Domestic violence against women is one of the most serious gender problems in Moldova that has not yet been adequately addressed by policy. According to research, 18 per cent of Moldovan women have been victims of physical violence, 32 per cent victims of psychological violence, 43 per cent victims of social violence, 9 per cent of economic violence and 3 per cent victims of sexual abuse.[26] While some legal acts have been passed, the situation does not appear to have changed.

2.3.5. Trends in the Human Development Index

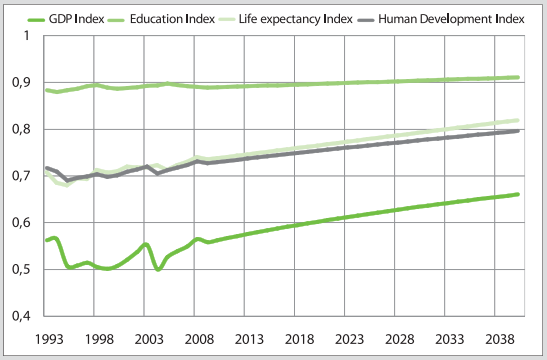
The Human Development Index is calculated as the simple average of the Education Index, Life Expectancy Index and GDP Index. Since 1993, the Education Index has been not only the highest (averaging 0.892 over the period from 1993 to 2008), but also the most stable component of Moldova's HDI. However, this index has also registered some slippages because of the falling enrolment rate. At the same time, the Life Expectancy Index evolved in a more complex way because economic and social difficulties were reflected more directly and with less of a lag in the health status of Moldova's population, especially in the early economic transition period (1991-1995). With life expectancy falling from 67.5 years in 1993 to 65.8 years in 1995 the Life Expectancy index fell correspondingly from 0.708 to 0.680. Afterwards, the Life Expectancy index improved more or less constantly. As outlined above, this is largely explained by the decreasing infant mortality rate in Moldova.

It is evident that Moldova's Human Development Index change was mainly driven by the evolution of the income index. Between 1993 and 2000, Moldova's HDI has followed a U-shaped path, starting at 0.719 in 1993, bottoming out at 0.692 in 1995 and then increasing to 0.706 in 1998 (Chart 8). In 1999 the HDI slipped back to 0.700 because of the fall in GDP associated with declining income in the aftermath of the Russian financial crisis. From 2000 onwards the HDI has grown almost constantly, except in 2004 when the HDI registered a fall due to changes in the methodology of estimating the GDP per capita in PPP terms (when it was estimated on the basis of the CIS Comparison Programme).

[26] "Women at risk in Moldova",http://www.info-sanatate.ro/index.php?l=ro&mode=articol&t=33&i=465.

Now, the HDI stands at 0.733, thus maintaining Moldova in the group of countries with medium human development. As compared with the lowest HDI level attained in 1995, by 2008 the Life Expectancy Index has gained 0.060 points, the GDP Index gained 0.058 points, while the Education Index only 0.007 points. Simulations conducted by the Expert-Grup have shown that if trends in 2000-2008 continue unaltered, Moldova will be able to reach a high Human Development Index (0.800) only by 2040. As shown in NHDR 2005/2006, in order to achieve this level sooner, Moldova would need first of all faster economic growth as well as constant improvement in life expectancy and enrolment rates. In the last three years, only life expectancy has grown fast enough. GDP per capita has evolved at a rate slower than that needed to achieve rapid HDI convergence, while the enrolment rate has even declined.

Chart 8. **Evolution 1995-2008 and forecast 2009-2040 of the HDI and its components in Moldova**



Source: *NBS, EG forecast (linear projections, conservative scenario, see more in UNDP, 2006).*

The Gender-related Development Index (GDI) has evolved in almost identical fashion to the HDI. In 2005, the difference between the HDI and the GDI was equal to +1, which means that gender inequality in terms of human development performance is relatively low. However, there are important internal differences: women live longer than men and have a significantly higher enrolment rate, whereas men command significantly larger economic resources.

In comparative terms, Moldova fares quite poorly in the rankings for current level of human development.[27] In 2005 Moldova was fourth from bottom in the group of 20 CEE and CIS countries for which Human Development Indices were available (Chart 9). Moldova was also among the group of four countries which in 2005 were still in worse situation in terms of human development compared with 1990 (Tajikistan, Ukraine and Russia were the other three) and its losses were also the largest. Two of Moldova's closest neighbours – Romania and Bulgaria – in this period of time moved from the group of countries with medium human development to the group with high human development, while Ukraine registered quite an opposite dynamic.

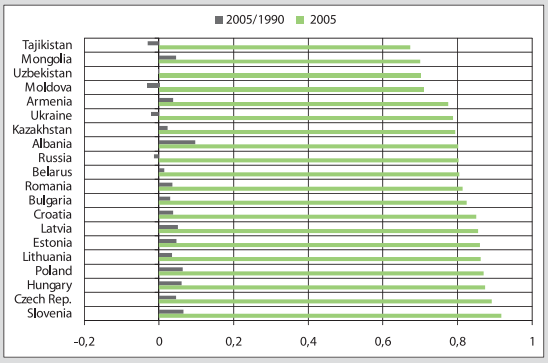
Table 3. Components of the Gender-related Development Index in Moldova

	2004	2005	2006	2007	2008
Life expectancy	68.4	67.8	68.4	68.8	69.4
Women	72.2	71.7	72.2	72.6	73.2
Men	64.5	63.8	64.6	65.1	65.6
Adult literacy rate (%)	98.9	99.0	99.0	99.1	99.1
Women	98.3	98.4	98.4	98.5	98.5
Men	996	99.6	99.6	99.7	99.7
Total gross education enrolment rate (%)	70.9	71.7	71.2	69.9	69.8
Women	74.0	74.8	74.3	73.2	73.2
Men	67.9	68.7	68.2	66.8	66.6
GDP per capita (USD at PPP)	2,028	2,362	2,561	2,715	2,986
Women	1,597	1,909	1,881	2,118	2,335
Men	2,499	2,855	3,296	3,357	3,690
Gender-related Development Index	0.705	0.711	0.718	0.723	0.731

Source: *NBS.*

[27] In this paragraph analysis is based on statistical data from the HDR 2007/2008. There are differences between Moldova's HDI level as reported in NHD2007/2008 and the level reported by National Bureau of Statistics in Moldova.

Chart 9. **HDI in 2005 and absolute changes 2005/1990 in some transition countries**



Source: *HDR 2007/2008.*

2.4. Human development as adaptive capacity

2.4.1. Measuring adaptive capacity

This chapter has so far dealt with human development in Moldova and the potential impact climate change will have and already has had on human development. However, the exact impact of climate change on Moldovan society itself depends on future human development performance which has the potential to significantly reduce the negative impacts of climate change and take advantage of potential positive outcomes. So it is this reversed perspective, i.e. the impact that human development has on the potential impact that climate change will have on Moldova, to which we now turn.

"Societies have an inherent capacity to adapt to climate change,"[28] and both nations and regions perpetually adapt their economic, but also their institutional framework. The ongoing structural change is nothing other than continuous adaptation – but it is not free, it is costly, in terms of resources and capital. Fresh knowledge, innovative processes and innovative organisational structures have to be applied. Adaptation to climate change is of great importance not because it is something new or unique – it "is of great importance, since the direct effect of adaptation is to reduce social vulnerability",[29] but it "also enables sectors and institutions to take advantage of opportunities or benefits from climate change, such as longer growing seasons or increased potentials for tourism".[30]

As the definition in Box 2 states, "adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both, behaviour and in resources and technologies,".[31] Human and social capital are key determinants of adaptive capacity at all scales, and they are as important as levels of income and technological capacity[32] and other social factors such as human capital, population development and governance structures (which may enhance but also decrease specific adaptation potentials).

Like the responsibility for climate change and the vulnerability to its impacts, adaptive capacity is also unequally distributed among poor and rich countries. "In rich countries, coping with climate change to date has largely been a matter of adjusting thermostats, dealing with longer, hotter summers, and observing seasonal shifts",[33] whereas adaptation in developing countries implies saving lives. In this sense also the Stern Report[34] and the fourth assessment report of the IPCC (2007) conclude that necessary structural changes to adapt to climate change imply high costs and efforts which are easier to carry for richer countries, whereas less developed countries face governmental and individual financial as well as structural and socio-economic constraints.

Such a broad and demanding concept renders the measurement of adaptive capacity a difficult task. The problem is to find appropriate indicators to measure all those capacities. In order to be able to operationalise a specific regional assessment of adaptive capacity, indicators have to be defined and tested to measure the concept and to produce data on it.

Adaptive capacity is an artificial concept per se, hence it is simply not possible to measure adaptive capacity directly and therefore a set of so called "proxy indicators" must be identified. The rationale for this concept is quite simple: Because a single indicator cannot measure adaptive capacity on its own, a set of indirect variables is taken into account.

To outline a method of measuring adaptive capacity, four basic assumptions are formulated. To put it simply, adaptive capacity is causally related to the following four areas of human development:

(1) First, the demographic structure and the number of people living in a country. The level of education, the age structure, but also migration and immigration have the biggest influence on adaptive capacity.

[28] Adger, 2004.
[29] Ibid.
[30] IPCC, 2007.
[31] Brooks and Adger, 2005.
[32] IPCC, 2007.
[33] Watkins, 2007.
[34] Stern, 2008.

(2) Second, the wealth that is created. The wealth of nations is usually measured by their Gross Domestic Product (GDP). Obviously, adaptation is not cost-free; the question is how much adaptation is affordable? In general, richer nations or regions face more favourable conditions than poorer nations.

(3) Third, the structure of the economy. It is not only the wealth within a nation or a region that matters. The question of how wealth is created is of utmost importance. The degree to which an economy is able to absorb a certain shock heavily depends on the diversity of the socio-economic system.

(4) Finally, adaptive capacity depends on the regional distribution of all the factors mentioned above. Since climate change makes its impact on a very regional level, adaptive capacity matters at the very place where the changes take place. Nations cannot be analyzed as homogeneous constructs. Regional disparities often exceed national disparities.

To go into detail, the first and most prominent set of indicators can be derived from the people living in Moldova. The availability or the endowment of human and civic resources is a strong determinant of adaptive capacity. However, it is not merely the population itself that matters, but rather the evolution of the demographic structure. In other words: how many people are living in the country and how will the situation look in the long term? Therefore, the number of residents, the population density and also population projections for the year 2025 constitute the first proxy indicators. A decline in population usually accompanies aging; besides, the participation rate of elderly residents, which is the share of a certain age group that actively participates in the labour market, is relatively low. A stable population is therefore a prerequisite for high levels of adaptive capacity. Besides, the level of education is of particular interest. For example, better educated citizens are far more willing to apply new technologies. On the other hand, low levels of education constitute crucial barriers to human development. So, to conclude, the proportion of highly educated citizens is seen as one good indicator for adaptive capacity. Higher levels of education indicate higher levels of adaptive capacity.

As already mentioned, economic well-being measured by variables such as Gross Domestic Product, or more generally by economic variables and their evolution over time constitute the second factor influencing adaptive capacity. Consequently, regional GDP per inhabitant at Purchasing Power Parity (because of differences in the price levels, when including regions in other countries) was taken into account. Besides, a second proxy indicator for economic well-being was taken into account – the growth rate of GDP during a five year period. As a result, not only today's wealth but also future prosperity was estimated. Advanced growth results in high levels of GDP later on.

Concerning the structure of the economy, the ability of a homogeneous society dependent on agriculture to adapt, for example, is extremely limited compared to knowledge-intensive economies. Climate change and in particular the impact of climate change on human societies does not harm the whole economy, but certain sectors, e.g. tourism and agriculture. Therefore, adaptive capacity rises with increasing diversity. The diversity of the economy is estimated by a bundle of proxy variables, including sectoral employment shares, value added shares and sectoral productivity. The distribution of a region's total employment in the agricultural, industrial and the service sectors gives a first rough overview of the importance of a certain sector within a nation or region. To make the picture complete, sectoral value added shares are incorporated into a further assessment. Hence, different levels of sectoral productivity can be compared. In sum, we know how much value is added by a single employee in agriculture, industry and services respectively.

The reason for including these factors has been partly explained already in section 2.3.1, which highlights the important role economic growth plays in human development. Therefore, it is natural to have a closer look especially at those sectors of the economy which generate growth more than others. More details on the theoretical rationale for this focus on structural variables are given in the technical Annex 2.1.

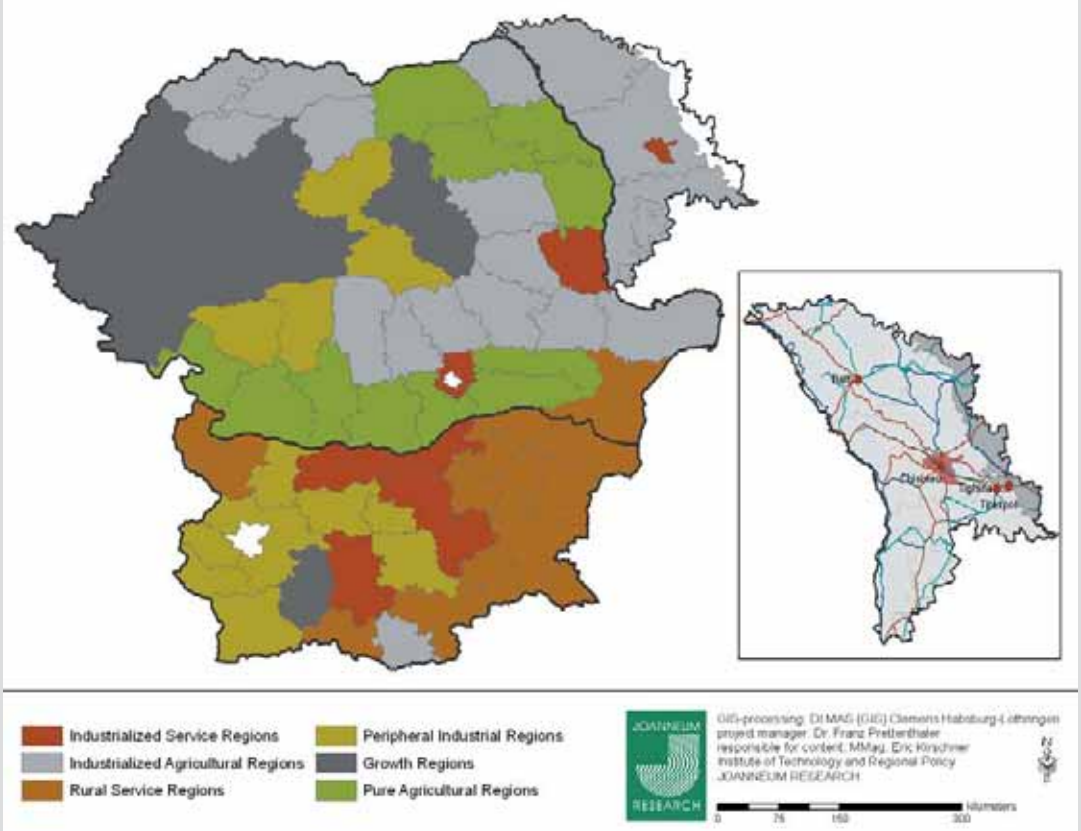
An ongoing concentration process, specialization and also geographic conditions mean regional disparities often exceed national disparities. In other words, nations might be hardly comparable in terms of GDP, population or any other indicators, but several regions within a certain country are comparable to regions of other countries. Hence, the challenges of competitiveness, but

also levels of adaptive capacity, are unequally distributed among regions. A precondition for a successful transition from a planned economy to a market economy, for example, is to overcome inadequate market mechanisms – especially for regions depending on inefficient state-owned industries. Hence, adaptive capacity is unequally distributed among regions and some economic sectors have a particular need to adapt (such as energy supply, health, water management, agriculture, tourism and transport). Consequently, an estimate of adaptive capacity has to take into account interregional disparities rather than international disparities. Therefore, regions have to be compared and analysed, not on a country by country basis, but on a region by region basis. The next problem is establishing which regions should be taken into account. In order to ensure a representative sample of comparable regions, first the Moldovan regions used for statistical purposes were chosen.[35] The set of regions was enriched by including the Romanian and Bulgarian NUTS 3 regions in the sample. By excluding the capital regions Bucharest and Sofia, because of their special role as metropolitan areas, different levels of adaptive capacity were estimated by clustering 72 regions.

2.4.2. Region types of similar adaptive capacity in Moldova, Romania and Bulgaria

The next question for an appropriate assessment of adaptive capacity was how to integrate all this relevant information to finally learn more about whether Moldova has particularly low adaptive capacity. We thus looked at the neighbouring regions in Romania and Bulgaria and looked for those regions that have a comparable adaptive capacity to the regions of Moldova. All the regions that are similar in this respect were selected to form region types that can then be described and compared to the other region types. The aim in this case really is to compare Moldova's adaptive capacities to similar regions that also face a similar climatic regime and similar risks from climate change.

Chart 10. **Region types with similar adaptive capacity when comparing 72 regions in Moldova, Romania and Bulgaria**



Source: *Calculations by JOANNEUM RESEARCH.*

[35] Due to a lack of data, the Transnistria region had to be excluded from the quantitative analysis.

The classification is performed by utilising the explorative instruments of factor and cluster analysis[36] (see the technical appendix for a description of these methods). Utilising these five factors in a hierarchical cluster analysis (Ward, squared Euclidian distance as a proximity measure) resulted in 6 distinct clusters of region types, representing a specific set of structural characteristics as well as the cluster-specific endogenous factor endowments explained above, hence representing a specific type of adaptive capacity: (1) Industrialized Service Regions, (2) Industrialized Agricultural Regions (3) Rural Service Regions (4) Peripheral Industrial Regions (5) Growth Regions and (6) Pure Agricultural Regions.

As can easily be seen from Chart 10 and Table 4, the four Moldovan regions investigated belong to only two cluster types and they do not belong to those region types that are presumed to have the lowest adaptive capacity. While region type 1 is at the upper end of the adaptive capacity scale, cluster type 2 is at the lower end.

With these results on the comparative regional adaptive capacity of Moldova's regions and its neighbours (see Table 4), the not-so-pessimistic conclusion that its regions do not belong to the region type with the lowest adaptive capacity has to be qualified by two more remarks:

First, if we were to compare the entire countries, the neighbours will likely fare better for two reasons: the current analysis did not include the two

Table 4. Regional adaptive capacity by region type

Region Type	Adaptive Capacity:	Demography	Wealth	The structure of the economy
INDUSTRIALIZED SERVICE REGIONS (Chisinau)	**rather high**	**(+) (+)** Stable population, densely populated	**(+)** Wealthy but GDP growth below average	**(+) (–)** Diverse but high employment in agriculture
RURAL SERVICE REGIONS	**low**	**(–)** People are leaving (overaging), low population destiny	**(–) (+)** Poor in terms of GDP but growing	**(–)** Missing an industrial base, depending on tourism
INDUSTRIALIZED AGRICULTURAL REGIONS (North, Center, South)	**rather low**	**(+) (–)** Stable population but low level of education	**(–) (+)** Poor but GDP growth far above average	**(–)** Unproductive secondary sector, moderate concentrations
PERIPHERAL INDUSTRIAL REGIONS	**average**	**(–)(+)** Declining population rapid over aging but well educated	**(+)** Average in terms of GDP and growing	**(–) (+)** Given industrial base, high employment in agriculture
GROWTH REGIONS	**high**	**(–) (+)** Average decline in population, educational level is above average	**(+) (+)** Fast growing and high regional GDP	**(+) (+)** Service sector is developing, economy is extremely diverse
PURE AGRICULTURAL REGIONS	**very low**	**(+) (–)** a relatirely stable population educational level is below average	**(–)** lowest GPD, growth rates under average	**(–) (–)** homogenous economy, driven by agriculture

Source: *Calculations by JOANNEUM RESEARCH.*

[36] In order to avoid multicollinearity, the first step was to undertake a principal component analysis. Subsequently, five factors were extracted from the described set of data. These are not a perfect choice, but are still suitable for a principal component analysis, with a Kaiser-Meyer-Olkin measure of sampling adequacy of 0.6 (which still is feasible).

capitals Sofia and Bucharest with their outstanding adaptive capacities for the entire country, whereas Chişinău was not a (positive) outlier in the relevant data.

Second, many variables were measured in terms of relative numbers compared to the national average. This allows for a better understanding of the role a region plays in the national context and helps a region to be realistic with regards to its own potential. This may be a motivating factor for regions, that they actually are comparable to regions with a higher development level. It should not lead us to disregard the fact that a region which has reached its potential level may still be well below other regions of the same type.

Chişinău's potential to adapt to climate change is the highest in Moldova – the capital has a high ranking, even compared to Romanian and Bulgarian regions of high adaptive capacity. The population is stable, which is a remarkably positive situation compared to most other regions. The region is rich compared to the national average, whereas growth rates are below average. Nevertheless, this is not unusual for rather wealthy regions. The economy itself is diverse; knowledge intensive services' share of employment, for example, is relatively high, which can be interpreted as a precondition for research and development. On the other hand, agriculture still plays an important role and tourism is underrepresented. Furthermore, industry is underperforming, which is one of the major hindering factors in terms of adaptive capacity. Obviously, structural change is ongoing, and while much has been done, much still remains to do.

Industrialized agricultural regions, which include the three remaining regions of Moldova, face different problems. Poor regions have to catch up. Growth rates in terms of GDP were high and stable (at least until 2007, before the crisis hit the world's economy). The regional economy strongly depends on industry, at least in terms of employment, while the productivity of the secondary sector is underperforming but developing. Still, too many people are employed in an unproductive primary sector, while tourism barely exists. New and - more important still - better jobs[37] have to be created, especially in the service sector – in particular by fostering touristic activities (as is happening in several Romanian and Bulgarian regions of this type).

In general, the degree of endogenous regional adaptive capacity, as analyzed within this chapter, determines a region's ability to adapt gradually and continuously to climate change. An element of adaptive capacity that has not been considered so far is the question of resilience after catastrophes, i.e. how fast a society recovers after it has been hit by a sudden climate change event (a natural disaster). This resilience particularly depends on the national risk transfer scheme, in which the state, the insurance industry and individuals usually share the risk and make sure that the productivity can quickly recover after a catastrophe. These issues are studied in detail in the chapter TOWARDS A RISK RESILIENT SOCIETY.

[37] The notion of 'more and better' jobs stems from the EU's Lisbon Strategy for Growth and Jobs (http://ec.europa.eu/growthandjobs/index_en.htm) which is aiming at stimulating growth and creating more and better jobs while making the economy greener and more innovative. The quality in work comprises characteristics of the job like intrinsic job quality and skills, life-long learning and career development next to the work and wider labour market environment.

Chapter

3

Climate Change and its Challenges for Moldova

3. CLIMATE CHANGE AND ITS CHALLENGES FOR MOLDOVA

3.1. What do we know from current global and relevant regional climate models?

3.1.1. The global picture

Earth's climate is changing, raising many concerns for scientists, policymakers and the general public (Box 3). People have come to realize that they are responsible for the anthropogenic component of observed climate change and that this process will have significant effects on the well-being of future generations. The main conclusion of the Forth Assessment Report of the Intergovernmental Panel on Climate Change is: "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level".[38] There is also growing awareness that even if greenhouse gas (GHG) emissions are stabilized today, global warming will continue for many decades, leading to associated impacts, to which countries will need to adapt.

The general consequences of climate change include an increased risk of climatic extremes (e.g. floods and droughts), losses of biodiversity, threats to human health, and damage to economic sectors such as energy, forestry, and agriculture. In some places and some sectors new opportunities may occur at least for a certain time (for example, cultivation of more heat-tolerant crops in agriculture), although over a longer period and with increasing temperatures the effects are likely

Box 3. Key messages on observed global and European climate change

Air temperature

- The ***global*** (land and ocean) average temperature up to 2007 was 0.8 °C above the pre-industrial levels (1850–1899 average). The average for land only was 1 °C higher.
- The rate of global warming has increased from 0.1 °C per decade over the past 100 years to 0.2 °C in the last decade.
- The best estimates of projected global warming during the current century for scenarios assuming no further/additional action to limit emissions show a further rise in average temperature between 1.8 and 4.0 °C.
- ***Europe*** has warmed more than the global average. Up to 2007, European annual average temperature was 1.2 °C above pre-industrial levels for its land area, and 1 °C – for the combined land and ocean area. Eight of the 12 years between 1996 and 2007 were among the 12 warmest years since 1850.
- In the 21st century the annual European temperature is projected to rise by 1–5.5 °C (best estimate) with the largest warming over eastern and northern Europe in winter and over south-western and the Mediterranean – in summer.

European precipitation

- Annual precipitation in the 20th century showed 10-40% increase in northern Europe and a decrease (up to 20%) in some parts of southern Europe.
- Mean winter precipitation has increased in most of western and northern Europe (20 to 40%); southern and parts of central Europe were characterized by drier winters.
- Increased precipitation is projected in winter in Northern Europe, whereas many other parts may experience dryer summers. However there are uncertainties regarding the magnitude and geographical details of the changes.

Source: *European Environmental Assessment (EEA, 2008).*

[38] IPCC, 2007a: 5.

to be adverse worldwide if no action is taken to reduce emissions or to adapt to climate change consequences.[39]

Progress in understanding how climate is changing in space and time has been gained through improvements and extensions of numerous datasets and data analyses, broader geographical coverage, better understanding of uncertainties and a wider variety of measurements.

3.1.2. Observed effects of global climate change

Evidence from across the globe over the past decade shows that many natural systems are being affected by regional climate change, especially by temperature increases. Many of them are relevant to Moldova, as shown below.

In particular, it is possible to assert with ***high confidence***[40] that:[41]

- There are clear effects on water systems that are manifested in increased runoff and earlier spring peak discharge in many snow-fed rivers, and warming of surface waters with effects on their thermal structure and water quality.
- There are terrestrial biological systems which are strongly affected, with changes including earlier timing of spring events (leaf-unfolding, bird migration, egg-laying, etc.) and shifts to the north and higher elevations of plant and animal habitats being seen. Since the early 1980s there has been a trend towards earlier 'greening' of vegetation linked to longer thermal growing seasons caused by recent warming.
- The observed changes in marine and freshwater biological systems are associated with rising water temperatures, as well as with related changes in ice cover, salinity, oxygen levels and circulation. There have been increases in algal and zooplankton abundance in high-latitude lakes and changes in the range and timing of fish migrations in rivers.

With ***medium confidence*** the effects of temperature increases have been documented in the following managed and human systems:

- Agricultural and forestry management at higher latitudes, caused by crops being planted earlier in the spring and alterations in disturbances of forests due to fires and pests.
- Some aspects of human health, such as excess heat-related mortality and changes in the vectors of infectious disease in different parts of Europe; earlier onset of and increases in seasonal production of allergenic pollens in high and mid-latitudes.

The most severe effects of climate change are expected in the second half of the century, although the associated time scales and hazards remain uncertain even over the next 20 years.

3.1.3. Key vulnerabilities and "reasons for concerns"

The IPCC has formulated five *"reasons for concerns"*, which are based on the observed relationships between global warming and the emergence of a series of new and stronger pieces of evidence for its adverse impacts.[42] In short, these concerns can be summarized as follows:

Distribution of impacts and vulnerabilities. The sharp differences in the projected regional patterns and regional impacts of climate change are unavoidable. Those in the weakest economic position, including the specific groups such as the poor and elderly, are often the most vulnerable and the most susceptible to climate-related damages, especially when they face multiple stresses. The challenge is therefore to better identify particularly vulnerable systems, sectors and regions.

Aggregate impacts. Whereas some initial net market-based benefits from climate change are projected, peaking at a lower magnitude of temperature increase, for larger magnitudes greater damages are *likely* and the net costs of the impacts are projected to increase over time. The aggregate impacts are *likely* to adversely affect hundreds of millions of people through increased coastal flooding, reductions in water supplies, increased malnutrition and health disorders already in this century.

Risks to unique and threatened systems. Continuing climate change will have increasingly adverse consequences for these systems. Various locations can be identified which are prone to irreversible losses, and if these locations become

[39] IPCC, 2007; EEA, 2008.

[40] Hereinafter, for the communication of uncertainty, the terminology of the IPCC is used. In particular, high, medium and low confidence of a statement signify, correspondingly, about 8, 5 and 2 chances in 10 of a forecast being correct.

[41] IPCC, 2007.

[42] IPCC, 2007.

unsuitable for their present occupants or disappear, many plant and animal species will be unable to find suitable alternatives, and this may result in their extinction. The severity of climate change effects varies among species, implying that some plant and animal communities will disappear, resulting in disruptions to ecosystems. With a *medium confidence*, approximately 20-30 per cent of plant and animal species assessed so far are likely to be at an increased risk of extinction if rises in global average temperature exceed 1.5-2.5°C compared to 1980-1999 levels. If this increase exceeds about 3.5°C, the model projections suggest 40 to 70 per cent of species around the globe will become extinct.

Risks of extreme weather events. Droughts, heatwaves and floods are likely to grow in frequency and their impact to become more severe in many regions and this effect will be mostly adverse. Responses to some recent extreme weather events show that levels of vulnerability in both developing and developed countries have risen.

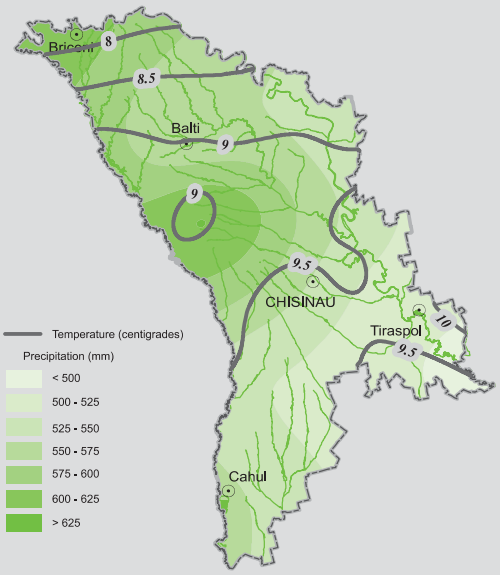
Risks of large-scale singularities. There is a risk that certain climate-related changes, for example rising sea levels, may be larger than earlier projected, even on century time scales. Such large-scale consequences of climate change could lead to mass migration of population from danger zones in many regions and countries, including Moldova.

3.2. Current climate of Moldova: general description, observed trends and variability

Climate, along with soils, is the main natural resource of Moldova, determining its agricultural productivity and ecosystems services, which in turn support the livelihoods of about half of Moldova's population, especially in the conditions of its transition economy and current world economic and financial crisis.

The country is located in a temperate continental climate zone, slightly modified by the proximity of the Black Sea and the intrusion of warm wet air from the Mediterranean. At times, there are northern cold-air surges. Climatic seasons are clearly defined with a short and soft low-snow winter and a long summer, sometimes very hot and dry. Annual mean air temperature for the country as a whole averages 9.3 °C, ranging across the country's territory from 7.8 to 9.9 °C. Being rich in warmth, Moldova has limited precipitation, which decreases from 615 to 485 mm from northwest to southeast (Chart 11, Annex 2.2).

Chart 11. **Baseline (1961-1990) mean annual temperature and precipitation in Moldova**

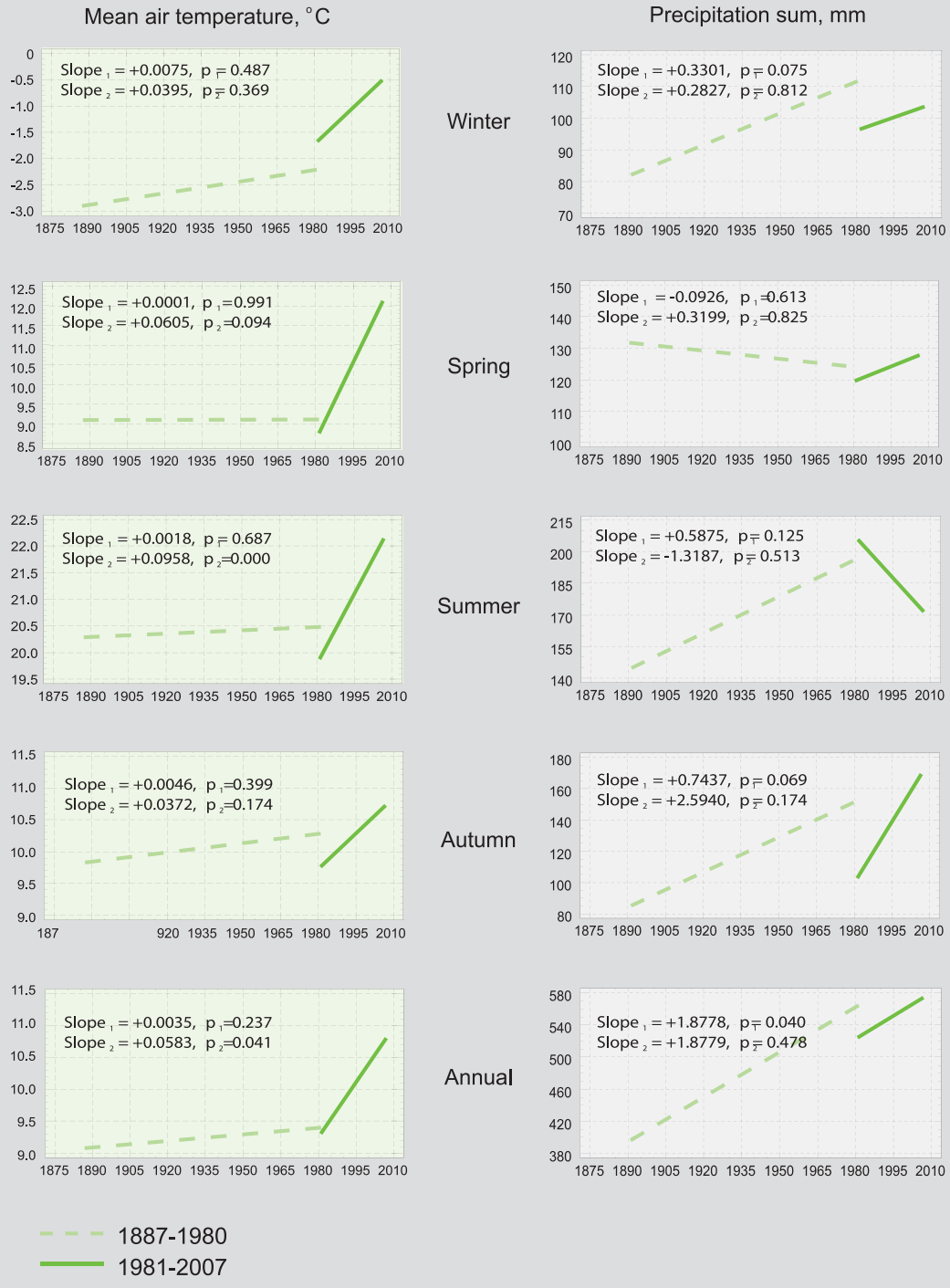


Source: *NHDR team.*

On the whole, Moldova is located in an insufficiently wet zone which results in a high frequency of droughts, which negatively affect its economy. For example, only between 1990 and 2007, nine droughts were registered in the country. A record catastrophic drought, which affected 75-80 per cent of the country area and had very severe consequences for national economy, was observed in 2007 (Annex 2.3).

The character of observed changes to Moldova's climate is identified through the trends and variability of individual climatic variables. Because the early 1990s are usually taken as a 'benchmark' for global warming, the seasonal and annual temperature and precipitation at Chişinău weather station (the longest series of instrumental observations) have been studied and compared for two periods: 1887-1980 and 1981-2008 (Chart 12). A change is real if the parameters of the trends are statistically significant.

Chart 12. **Comparisons of air temperature and precipitation trends for 1887-1980 (*1*) and 1981-2008 (*2*) Chisinau weather station**



Note: *Slope – coefficient of trend (change per year, °C); p-value – significance of change.*

Source: *NHDR team.*

As one can see from Chart 12, some growth in annual air temperature in Moldova observed before the 1990s (0.035 °C per decade) is followed by a sharp increase (about 0.58 °C per decade). Moreover, compared to the first period, the temperature trends in last three decades are statistically significant for summer and annual temperatures – at a 95 per cent confidence level, and for spring – at a 90 per cent level. Further evidence of the acceleration of regional warming can be seen in the

fact that seven years among the ten warmest in the history of instrumental observations in Moldova have been in last two decades.

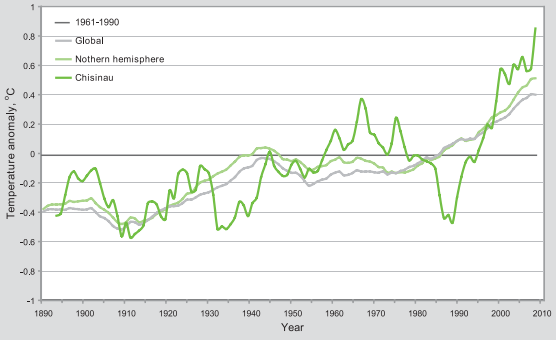
The precipitation picture is more complex. There is a change in the direction of some trends: from a decrease to an increase in spring, and from an increase (about 6 mm per decade) to a decrease in last thirty years (above 13 mm per decade) – in summer. For autumn-winter and annual precipitation the previous slight increase is continuing.

As to differences in air temperatures and precipitations between two periods (see Annex 2.2), it can be said with *high confidence* that the mean seasonal (except autumn) and annual temperatures in last three decades are different from the previous years. The variability of air temperature remains practically the same. The changes in the precipitation regime are not significant in their quantity; however there is evidence of an increase in their variability in transition seasons.

3.3. Necessity to study the regional climate change

The practice of environmental management increasingly recognizes the importance of scale and cross-scale dynamics in understanding and addressing global challenges. Changes in climate, economies, populations or institutions ultimately converge in localities, prompting a growing interest in obtaining regional-scale data as a response to demands for policy-relevant information that can be used at local and regional levels. Using cross-scale assessments, scientists are attempting to understand how mitigation and adaptive actions on one scale might constrain or provide opportunities on another.[43] Climatic changes are regional in their manifestation, not in their origin.[44] Chart 13 demonstrates the relationships between the last 120 years of global and planetary surface air temperature anomalies and the analogous series for Moldova.

Chart 13. **Anomalies (as to baseline 1961-1990 climate – zero line) of annual air temperatures, smoothed with 11-year running average**



Source of initial information regional – http://meteo.ru; global – http://www.cru.uea.ac.uk/cru/info/warming/.

It is evident that overwhelming part of regional climate variability is caused by local factors. The coefficient of simple correlation *(r)* between global and regional anomalies is equal to 0.405. Thus, proceeding from the coefficient of determination *(r^2),* expressed in percentiles, the global climatic processes explain only 16.4 per cent of air temperature variability in Moldova. The dependence of Moldova's climate on the large-scale circulation processes in the northern hemisphere ($r = 0.457$) stands at about 20.1 per cent.

However, the problem is not only how to downscale the global modelling results, but also how to make them more suitable for the specific applications when information about future change of primary climatic variables is not enough. Scenarios of future climate change can be considered user-oriented if they are constructed for the concrete requirements of climate impact studies and with appropriate spatial and temporal resolutions. For instance, in case of Moldova, it is particularly important to have scenarios for the evolution of the agro-climatic conditions. Such scenarios are a key component of any climate change impact assessment, and their construction is one of the greatest challenges for national researchers. Experience shows[45] that for sound assessment at least three types of information are necessary:

- The climate change projections for a country on the whole *(country-scale projections)*;
- The expected climate changes in any place within a territory *(local projections)*;
- Information satisfying the demands of particular researches *(user-oriented projections)*.

A comprehensive scientific understanding of climate change and its impacts on national and local scales show where the possible adaptation options can be in the best way developed and deployed.

[43] Adger et al., 2005; Joáo, 2002; Therivel & Ross, 2007.
[44] IPCC, 2007.
[45] Corobov, 2008; Corobov & Nicolenco, 2004.

3.4. Projections of Moldova's climate in the 21st century

3.4.1. Country-scale projections of air temperature and precipitation

These projections are based on a suite of the most recent coupled atmosphere-ocean general circulation models (AOGCM; hereafter abbreviated as GCM). The **General Circulation Model** is a numerical representation of the climate system based on the physical, chemical, and biological properties of its components, their interactions and feedback processes, accounting for all or some of its known properties. GCMs are applied as a research tool to study and simulate the climate, and for operational purposes, including monthly, seasonal and inter-annual climate predictions.[46] The results of six GCM experiments based on A2 and B2 marker scenarios of the Special Report on Emission Scenarios (SRES)[47] for three time-slices (2010–2039; 2040–2069; 2070–2099) served as a basis for downscaling (i.e. deriving local- to regional-scale information from larger-scale models or data analyses). In terms of cumulative GHG emissions, *SRES* A2 and B2 scenarios are considered as "high" and "medium low", respectively. They are both more economically than environmentally oriented; however the first is oriented towards global integration, the second toward regional solutions (Annex 2.2). The selected GCM experiments are documented in Annex 2.6. In most cases, the temperature and precipitation multi-model ensemble averages from six experiments were used (Table 5).[48]

Table 5. Projections of annual mean air temperature (T) and precipitation (P) changes in Moldova in comparison with baseline values (the first line) and averaged by six GCM, for three time horizons and two SRES emission scenarios

Time horizon	T, °C		P, mm	
	A2	*B2*	*A2*	*B2*
1961-1990	*9.2*		*555*	
2010-2039	1.7	2.0	-9	-17
2040-2069	3.4	3.2	-38	-11
2070-2099	5.4	4.1	-64	-23

Note: *Projections derived from each experiment are shown in Annex 2.3.*

Source: *Authors' calculations.*

Table 6. Ensemble-averaged projections of seasonal air temperatures and precipitation relative changes (%) in comparison with baseline climate

Season	Emission scenarios	Mean air temperature, °C				Precipitation sum, mm			
		Time horizons							
		1961-1990	2010-2039	2040-2069	2070-2099	1961-1990	2010-2039	2040-2069	2070-2099
Winter	SRES A2	-2.1	1.9	4.0	5.7	107	7.5	11.4	10.4
	SRES B2		2.2	3.5	4.4		8.5	13.6	15.5
Spring	SRES A2	9.5	13.2	26.8	43.2	130	4.4	6.0	5.5
	SRES B2		18.6	25.3	32.7		6.4	12.3	11.6
Summer	SRES A2	19.8	9.3	19.7	32.9	207	-7.8	-19.3	-30.2
	SRES B2		11.8	18.3	23.8		-13.2	-16.7	-22.6
Autumn	SRES A2	9.8	17.8	34.3	55.4	110	-6.07	-16.0	-17.6
	SRES B2		19.3	34.0	42.3		-6.2	-6.1	-6.8

Note: *Winter changes in temperatures are given in absolute values (°C).*

Source: *Authors' calculations.*

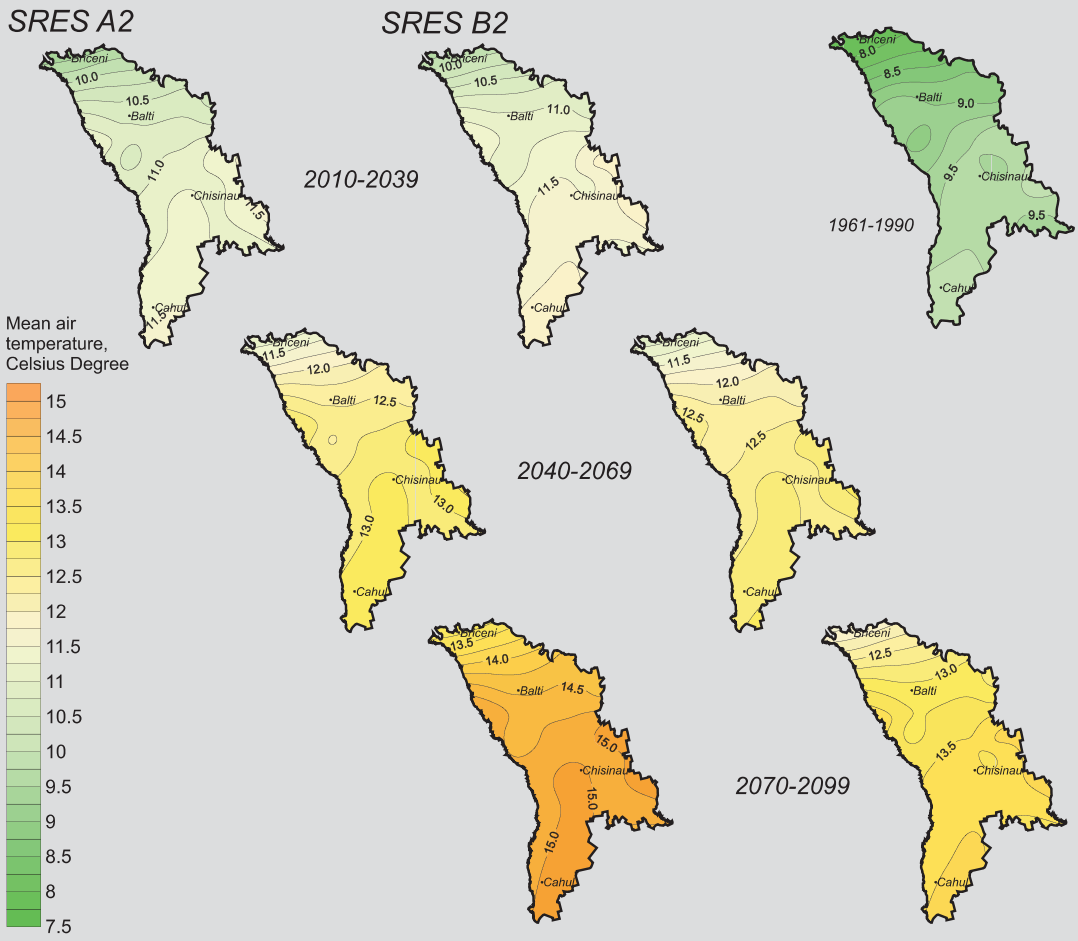
[46] IPCC 2007: 872.
[47] Nakicenovic & Swart, 2000.
[48] Corobov and Overcenco, 2007.

Annual air temperature in Moldova will increase in both emission scenarios. By the end of this century the increase may amount, on average, to 4.1–5.4 °C. Depending on the GCM experiment, these values vary from 1 °C to 6 °C and are in the range of temperature change estimations for Europe.[49] Along with warming, a continuous annual decrease of summary precipitations is expected, especially for A2 emissions.

Relative seasonal changes in temperature and precipitation, expressed in percentages against 1961-1990, are shown in Table 6. Moldova expects maximal warming in winter and transition seasons. By the 2080s, the baseline negative winter mean temperatures (-2.1 °C) could increase to up to +2-4 °C; the spring and autumn mean temperatures could increase by about 40-50 per cent. Minimal relative warming is expected in the summer months: by 9-12 per cent in the beginning and by about a third by the end of the century. Some increase in precipitation is expected in winter and spring time, but the summer and autumn tendencies are mainly negative (20-30 per cent decrease by the 2080s). On the whole, Moldova will face warmer and wetter winters but hotter and drier summers and autumns. To use an analogy, Moldova can expect winters like in England and summers like in Greece or Spain. Thus, like to observed tendencies, the expected changes in Moldova climate (further aridization) are unfavourable for the country.

Projected changes in annual mean air temperature for different parts of Moldova are shown in Chart 14. The southernmost isotherm of the baseline climate (10 °C) is likely to increase (depending on the scenarios) to 11.5-12.0 °C in the first modelling period and to 14-15 °C in the last period.

Chart 14. Likely future spatial distribution of annual mean air temperature in Moldova by three time horizons according to two emission scenarios



Source: *Authors' calculations/NHDR team.*

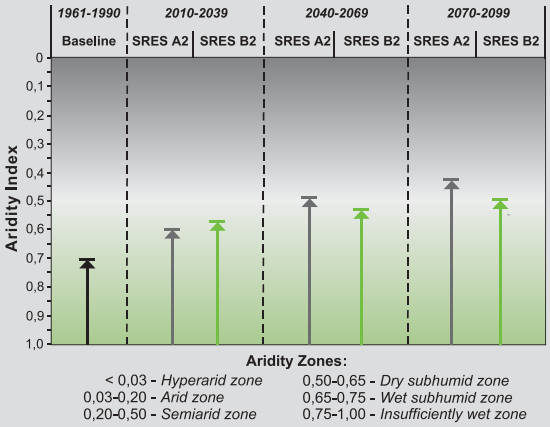
[49] IPCC, 2007

3.4.2. Likely changes in humidity conditions

Usually, separate consideration of temperature and precipitation change is insufficient to represent new humidity conditions and the two should be incorporated into certain complex indices. Indicators of new humidity conditions – *Potential Evaporation (PE)* and *Aridity Index (AI)* – were calculated and expressed, using statistical and graphical approaches (see chapter 6.3).

According to both scenarios, Moldova faces a change for the worse in its territory's humidity conditions (Table 7). Annual decrease of precipitation, against a temperature increase, stimulates a strong humidity deficit. PE is likely to increase by 15-20 per cent over the first time horizon and practically twice – by the end of this century, with the harder climate change expected for A2 emissions scenario.

Chart 15. Possible change of the aridity of Moldova's territory in new climatic conditions



Source: *Authors' calculations.*

Table 7. Projections of absolute (Abs) and relative (%) changes in humidity conditions

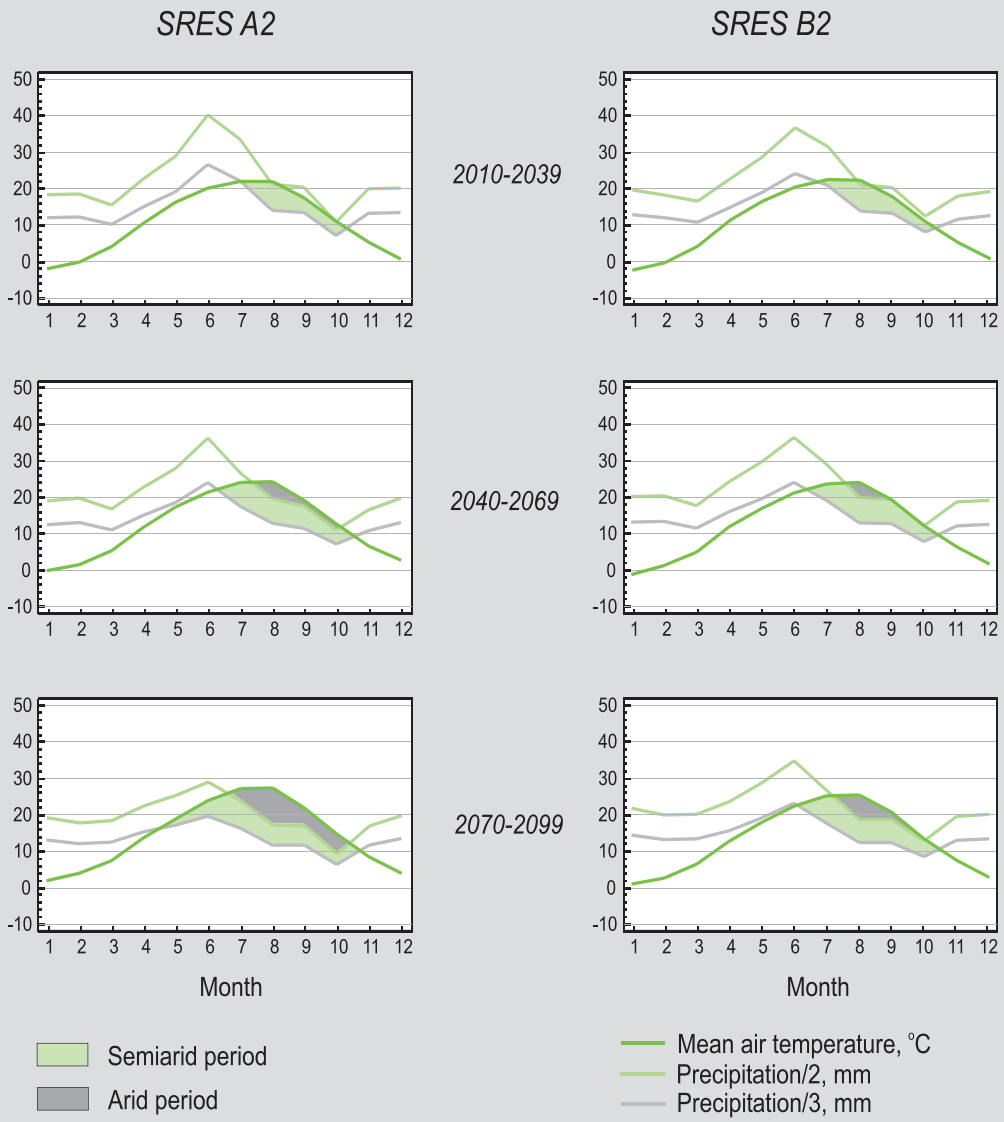
Parameter		Time horizon and emission scenario						
		1961-1990	2010-2039		2040-2069		2070-2099	
			A2	B2	A2	B2	A2	B2
Anual								
Potential evaporation	Abs, mm	787	126	158	258	238	420	307
	%		16.0	20,1	32,6	30,2	53,1	38,9
Aridity Index	Abs, mm	0.71	-0,11	-0,14	-0,22	-0,18	-0,30	-0,22
	%		-15,5	-19,7	-31.0	-25,3	-42,2	-31,0
Vegetation Period								
Potential evaporation	Abs, mm	686	105	135	221	205	366	266
	%		15,3	19,7	32,2	29,9	53,3	38,8
Aridity Index	Abs, mm	0.55	-0,10	-0,12	-0,19	-0,16	-0,27	-0,20
	%		-18.2	-21.8	-34.5	-29.1	-49.1	-36.4

Source: *Authors' calculations.*

The dynamic of changes in humidity conditions over the century, expressed in the Aridity Index, is shown in Chart 15. It is evident that Moldova is moving towards a dryer climate, from insufficiently wet and wet subhumid zones to dry subhumid and semiarid zones.

The change of temperature/precipitation ratio over a year (Chart 16) shows that if in Moldova's baseline climate only the end of summer and the beginning of autumn were semiarid, in the future there would likely be significantly longer and deeper dry spans.

Chart 16. Diagrams of likely aridisation of Moldova's climate in the 21st century



Note: *The half and third precipitation curves under the temperature curve show respectively the duration and intensity of dry and semiarid periods.*

Source: *Authors' calculations.*

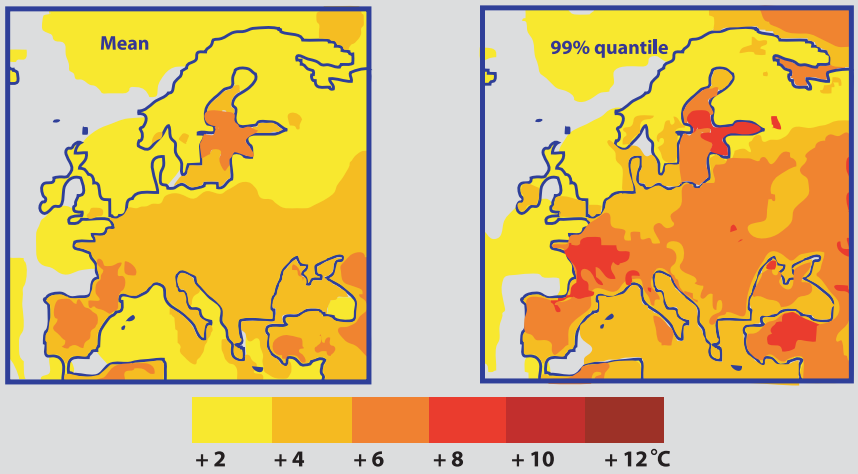
3.5. Projections of changes in frequency and severity of extreme meteorological events

3.5.1. European projections

Extreme weather events are projected to increase in frequency and intensity, and the number of people at risk is also expected to grow. However, predicting the future effects of extreme events remains difficult because of the increasing level of exposure caused by changes in economic development as well as changes in the value and density of human and physical capital. Disaster losses are likely to rise more rapidly than average economic growth, thus emphasising the importance of risk reduction.[50]

[50] Bouwer et al., 2007; EEA, 2008; IPCC, 2007.

Chart 17. **Differences in summer Tmax between the future "greenhouse gas climate" for the period 2071-2100 and the baseline climate period (1961-1990) according to the HIRHAM regional climate model with 50-km resolution**



Source: *Beniston, 2004.*

Extreme high temperature events across Europe, along with the overall warming, are projected to become more frequent, intense and longer.[51] For example, the high resolution Hamburg regional climate model (HIRHAM4) estimates changes in maximum temperatures averaged over June–July–August (hereafter referred to as summer Tmax) for Central and South-East Europe of +4-6 °C in their mean values and of +6-8 °C – in their 99% quintiles (Chart 17). It is also expected that there will be an increase in the number of days with very high temperatures. In particular, the frequency of days with temperatures above 30°C, simulated by the HIRHAM4 model for the period 2071–2100 in Moldova, may reach 60 to 90 days a year, compared to 10 to 30 before the 1980s.

Likewise, night summer temperatures are also projected to increase considerably, leading to additional health problems, at least partly compensated for by reduced mortality in winter.[52] Geographically, the maximum temperature during summer is projected to increase far more in central and southern Europe.

Heavy rainfall (intense showers), on average, will become (with 66 per cent probability) more frequent.[53] In summer, the frequency of wet days is projected to decrease, but the intensity of extreme events is projected to increase. Episodes of heavy rainfall could become more frequent, either in absolute terms or as a proportion of total precipitation. In southern Europe, a higher proportion of the rainfall may fall on very wet days, although the absolute number of days of high rainfall will decrease. These changes in heavy rainfall events have implications for flash flooding, urban drainage, water management, erosion, slope stability and ground water recharge.

The combination of higher temperatures and reduced mean summer precipitation is expected to increase the frequency and intensity of droughts, with evident increase in the number of consecutive dry days defined as those with precipitation below 1 mm. In southern Europe, where the maximum number of dry days is likely to increase most substantially, the longest dry period within a year may be prolonged by one month by the end of the century. Regions that are now dry are projected to become more vulnerable.

In linking this prediction of a higher future level of vulnerability of today's dry regions with the concept of human development and the knowledge about human development levels and spatial distribution, it is important to bear in mind the following issues. Even if a detailed estimation of regional differences in the Human Development Index inside Moldova is not yet available, we can be quite sure that such a map would coincide widely with overall welfare distribution and / or the SADI index for rural communities, since HDI performance and HDI levels are closely correlated with GDP per capita. Welfare mapping shows the centre and southern regions to be the regions of

[51] Beniston et al., 2007; Tebaldi et al., 2006.
[52] Halsnæs et al., 2007; Sillman and Roekner, 2008.
[53] EEA, 2008; IPCC, 2007.

low income and consumption levels. Given that these areas might also suffer a disproportionate impact from climate change, we will have to consider the possibility of them being more fragile in human development terms.

3.5.2. Moldovan projections

The IPCC Glossary[54] defines *an extreme weather event* as "an event that is rare within its statistical reference distribution at a particular place". Criteria of "rarity" vary from place to place and are normally calculated as rare as (or rarer than) the 10th or 90th percentile[55] values.

Following this criterion, in the Chişinău baseline climate 27.1°C could be considered as an extreme mean summer maximum temperature *(Tmax)* and 33.9 °C – as extreme absolute maximum temperature (Table 8). Since the 1980s, these thresholds have increased to 28.2 °C and 35.3 °C, respectively, and while in 1961-1990 the mean summer Tmax never exceeded its 99% extreme threshold (28.4 °C), this has been already exceeded in the current climate (30.2 °C) and is likely to be exceeded on several occasions in the future. In particular, by the end of the 21st century *Tmax* could increase by 6.4 °C on average for two emissions. The last figure is close to the upper limit of European regional estimations for Moldova (Chart 17).

As to extremes with different probabilities, by the 2080s the 99% quintile of mean summer Tmax in Chişinău is likely to reach 35 °C, or to exceed the baseline value by 7 °C. This figure is also in the range of European estimations (6-8 °C) and signifies that by the end of the century mean Tmax may reach the values of baseline absolute Tmax (32 °C). Similarly, what were considered as extreme rare events for absolute temperatures at or beyond the 90th percentile under the baseline climate (34-35 °C) will become possible for mean summer temperatures. The observed and expected increase in night temperatures is especially important for human health because it results in unfavourable conditions for night relaxation during heat-waves.

It is instructive to compare these projections with the elevated temperatures observed in the summer of 2007 in Moldova (Annex 2.3), a year that provided a glimpse at the "shape of the future climate to come," and a foretaste of some of the negative impacts resulting from climate change that are likely in the distant future. The heat-wave of 2007 is clearly more closely related to what may be expected in the future A2 climate rather than contemporary climatic conditions. Moreover, the summer of 2007 is also a signal showing policy- and decision-makers issues that should be given appropriate attention in the present.

Table 8. Mean values and different probabilities of observed and projected summer (June-July-August) maximum temperatures at Chisinau weather station

Period	Mean maximum						Absolute maximum					
	Range			Percentile, %			Range			Percentile, %		
	Mean	Max	Min	90	95	99	Mean	Min	Max	90	95	99
1961-1990	25.6	28.1	23.6	27.1	27.6	28.4	32.0	29.0	34.1	33.9	34.4	35.5
1981-2008	26.4	30.2	23.6	28.2	28.6	29.6	32.9	29.2	38.0	35.3	36.0	37.2
2010-2039	28.0			29.8	30.3	31.2	34.7			37.0	37.7	40.0
2040-2079	29.9			31.7	32.2	33.1	36.8			39.2	39.8	41.1
2070-2100	32.0			33.8	34.3	35.2	39.1			41.5	42.2	43.4

Source: *Authors' calculations.*

[54] IPCC, 2007: 875.

[55] The pth percentile of data set is a value below which approximately percentages of observations in this set fall.

Chapter

4

Climate Change and Water Resources

4. CLIMATE CHANGE AND WATER RESOURCES

4.1. Summary

Water resources are among the most critical for human and economic development in general, because they are essential for the vital functions of all living beings, plants, for agricultural production as well as for many industrial processes. The availability of Moldova's water resources depends in particular on the country's geographical position within the contact zone of central and eastern European climatic influences. Currently, Moldova's national-level water supply-withdrawal balance is adequate with respect to available resources. This adequacy is largely attributable to Moldova's steep economic decline in the recent past. In spite of this adequacy, specific regions within the country already face water scarcity.

The most populated and economically important regions are the most vulnerable to expected climate change. Some of these regions are already facing water shortages. Addressing deficits in these regions will be critical for supporting a sustainable economic recovery. Due to climate change, Moldova is expected to experience increasing frequency of short-term water oversupply, particularly in the form of flash floods as well as seasonal droughts. Successful adaptation measures should combine supply-side and demand-side solutions.

Moldova does not have the financial capacity to implement the primary technological means to address the expected water variability, i.e. dams and dykes. Considerable external funding would be needed for these measures to be successful. Accelerated, comprehensive implementation of Moldova's "Strategy on modernization and development of communal water supply and disposal systems in the settlements of the Republic of Moldova" and "Concept of national water resources policy (2003-2010)" would be important first steps toward addressing Moldova's water situation. The "Framework regulation of using communal water supply and disposal systems" needs to be improved in many ways, including establishing rules for up-stream and down-stream users and for force majeure situations.

Given Moldova's limited financial resources, the introduction of new crops and agricultural practices, together with reduced use of flood plains in crop production, would provide some relief from expected climate-related water stress.

4.2. Current state of water resources

4.2.1. Water quantity

The Republic of Moldova withdraws water for economic use from both surface and underground sources. At present, the volume of water withdrawn from surface sources exceeds the volume from underground sources (mainly contained in confined aquifers); the latter have a share that has varied in the past decade between 13 per cent and 18 per cent. Both types of sources, but surface ones especially,[56] are vulnerable to climate variability. However, within the past twenty years, economic circumstances have had a much stronger influence on water supply dynamics than natural factors.

Surface waters

The surface water bodies of the Republic of Moldova are contained within the Black Sea basin and occupy about one percent of the country's total area. There are two major river basins in the Republic of Moldova: the Dniester (the largest) and Prut (the second largest) river basins. Their stream flow amounts to 98 per cent of total surface water resources in Moldova. In addition to these two major rivers, there are numerous smaller rivers out of which only nine have a length of about or exceeding 100 km (Annex 2.8). Internal surface water resources account for 1.2 km^3/year. The entire river network consists of about 3,600 water streams totalling about 16,000 km in length.

The natural water regime of both large and small rivers has been changed by the construction of dams and reservoirs, designed to prevent floods, trap sediment, provide water for agricultural, industrial and household consumption as well as for fish farming. There are about 3,500 small and medium reservoirs and ponds with a total surface area of more than 300 km^2 and total storage capacity of about 1.5 km^3. About 100 reservoirs have a storage capacity of over 1m m^3 each. In addition to these, there are two big reservoirs in Moldova: Costeşti-Stînca on the Prut River (the largest; 678m m^3), jointly operated by Romania and the Republic of Moldova and Dubăsari (235m m^3) on Dniester River.[57]

[56] The relationship between the water table depth of unconfined aquifers and precipitation in the same area is quite weak. In the case of confined aquifers this relationship is almost imperceptible. See more in: Лалыкин Н.В., Сыродоев, И.Г., 2004: Некоторые подходы к оценке воздействий изменения и изменчивости климата на водные ресурсы. В: Р.М. Коробов (ред.). Климат в Молдове в XXI веке.проекции изменений, воздействий, откликов. Кишинэу , стр. 176-212; Гидрогеологическая карта СССР масштаба 1:200 000. Лист L-35-XVII. Объяснительная записка. Киев, 1977.

[57] There is another reservoir at Novodnestrovsk (Ukraine) that also affects Dniester River's hydrological regime.

Reservoirs have different functions depending on their position. Reservoirs in the northern and central part of the country play the role of seasonal regulation of water, while in the south they mainly serve for inter-annual distribution due to the region's greater water deficiency. Among the biggest reservoirs, 74 serve for seasonal distribution and 52 are designated for inter-annual flow regulation.

There are about 50 natural lakes with a total surface slightly exceeding 60 km^2. They are floodplain lakes, intimately linked to neighbouring rivers. Their storage capacity, compared to artificial lakes', is insignificant. However, they play a leading role in conserving biodiversity and contributing to the extension of wetlands. Such lakes, with large wetlands, are concentrated in the lower course of the Prut and Dniester Rivers.

Natural wetlands, especially, on medium rivers' floodplains, have been significantly transformed through drainage in favour of agriculture and irrigation and by the construction of levees to protect land and settlements against floods.

Ground waters

Ground waters for centralized household and industrial use are withdrawn from ten aquifer complexes. The main ground water reserves are located in the deep confined aquifers of Middle Miocene deposits. They, especially the Lower Badenian-Sarmatian aquifer, a regional aquifer that underlies the entire country, are a major ground water source. There are approximately 7,000 boreholes for ground water withdrawal; their total debit (annual groundwater resources) accounts for approximately 1.3 km^3, including 0.7 km^3 of drinking water. These waters have a water table depth that is not exposed to climate variability, being much more stable than in the case of unconfined aquifers. Confined aquifers in the Republic of Moldova may not have any recharge area at Earth's surface, or they recharge from the territories outside the country (Western Ukraine, North-Eastern Romania). In the latter case, taking into consideration the general trend of a likely decline in ground water recharge in Eastern Europe,[58] one can only reach speculative conclusions about a decrease in ground water resources in the Republic of Moldova. Ground waters from perched and unconfined aquifers are used locally in rural areas in the absence of a centralised water supply system. Because these aquifers are able to receive water from the surface and have their water table surface free to fluctuate up and down, they are highly vulnerable to climate variability and human impact.

Due to their weak connection with Earth's surface, the natural recharge capacity of the confined aquifers is limited, and there is a risk of overexploitation. In some areas, signs of depletion are appearing: in perched and unconfined aquifers on the flood plain and on low terraces in the lower course of Dniester River and in the Badenian aquifer in the valleys of Lopatinca, Draghişte, and Ciuhur rivers in the northern part of the country.

Taking into consideration different sources of water and various usage restrictions (agreements on transboundary rivers, ecological water resources etc.), we can conclude that the total economically available water resources in the Republic of Moldova amount to 5.6 km^3, including 4.3 km^3 of surface waters and 1.3 km^3 of ground waters.

4.2.2. Water quality

Since 1990, because of economic decline, the decline of heavy industry and falling water use in industry and agriculture, the quality of **surface water** resources has improved. For instance, currently, up to 84 per cent on average of the waters to be treated are actually being purified, comparing to 67 per cent in the 1980s. The majority of rivers belong to the third class of water pollution, i.e., medium pollution level. Regarding big rivers, water quality in the Dniester and Prut Rivers is usually classified as "relatively good" to "moderately polluted". However, the level of pollution differs in different river sectors, being at its highest immediately downstream of the inflow of tributaries and of urban water discharges (the Bîc downstream of Chişinău, the Răut downstream of Bălţi, the Dniester downstream of the Bender-Tiraspol agglomeration, the Prut downstream of Ungheni). Nevertheless, the water quality of the two big rivers is considered suitable for drinking and irrigation purposes. The quality of small inner rivers belongs, in general, to the class of "polluted" or even "very polluted". In addition, some of the inner rivers, especially in the southern part of the country, cross-cut rock masses with high salt content that makes their waters unsuitable for direct use.

The quality of **ground water** is influenced by both natural and human factors. Natural and man-made pollutants in the *unconfined aquifers* consist of nitrates, pesticides, sulfates and other

[58] Eitzinger J. et al., 2003: A simulation study of the effect of soil water balance and water stress in winter wheat production under different climate change scenarios. Agriculture and Water Management 61: 195-217.

chemicals. Water quality in wells does not comply with the national standard for drinking water; often, water hardness in wells exceeds the standards by 2 to 5 times and more. Furthermore, almost 90 per cent of the samples taken from unconfined aquifers exceed the maximum permitted concentration for nitrate. Investigations indicate a strong correlation between groundwater quality in unconfined aquifers and land use. Continuous degradation of drinking water quality is attributed to increased livestock growing in households.

Water quality in the *confined aquifers* is influenced, mainly, by local geological conditions, especially by fluorine, selenium, and strontium geochemical anomalies. However, there are signs that the human factor plays an increasingly significant role in polluting water in these aquifers as well, through infiltration of polluted water and through abandoned boreholes. Man-made pollution results in an increasing number of polluted water withdrawal sources that threaten centralised water supply systems in several towns.

4.2.3. Water use

Economic decline has had a beneficial impact not only on the quality of water resources, but on the intensity of water use as well. In 1990, the year of the highest water withdrawal rate, about 70 per cent of available water resources were withdrawn. The intensity of withdrawing surface water was higher – 77 per cent, while in the case of ground water this figure was below 50 per cent. As a result of the deteriorating economy, just 16 per cent of available water resources are withdrawn at present: 18 per cent of surface waters and 10 per cent of the groundwater reserves are used.

However, economic decline has had a different impact on unconfined aquifers. Due to the uncontrolled use of water from wells and short boreholes for crop watering in households and small farms, the water table depth in these aquifers has increased drastically, leading to depletion of the aquifer, in many regions of the country (the case of Lower Dniester flood plain was cited above).

Total water consumption in the past decade represents slightly more than 20 per cent of the water use in the past (Table 9). The decline is more evident in the cases of agricultural water use (especially for irrigation) and water consumption for production needs (mainly industrial). According to the estimates, the structure of water use has changed as well. Currently, about 65 to 70 per cent of total water is used in industrial heating and cooling and hydro-energy production, 15 to 20 per cent for drinking and domestic purposes and 5 to 8 per cent for irrigation. Compared to average figures for 1980s, the share of household consumption has doubled in the structure of water use, while the same figure for irrigation has fallen to a third of the earlier level.[59] Transporta-

Table 9. Average water use by decades

	Average water use, mil. m³			Change (%), comparing to 1980s	
	1980s	1990s	2000s	1990s	2000s
Water withdrawal	3,651	2,000	864	-45	-76
Total water use	3,550	1,920	849	-46	-76
Non-drinking water supply for production needs	2,463	1,227	588	-50	-76
Drinking water supply for production needs	101	45	21	-55	-79
Irrigation	649	317	46	-51	-93
Water supply in agriculture	118	88	57	-25	-51
Drinking water supply for households	220	232	146	5	-33
Transportation losses	57	87	64	53	12
Recycled water	755	604	369	-20	-51
Water losses in irrigation, mil. m³	28	20	12	-29	-57
Using water for 1 ha irrigated land, m³	2309	961	141	-58	-94

Source: *Calculated using statistical yearbooks and National Bureau of Statistics' website: http://www.statistica.md.*

tion losses, although higher in the past 20 years, still remain at the acceptable level of 8 per cent.

4.2.4. Water disposal

Economic decline has also brought benefits to water disposal, which has been falling in the past 20 years. In the 2000s, about 690m m^3 were discharged in surface waters each year; this figure represents a 75 per cent decrease compared to the 1980s. Another positive result of the decline consists in reduced pollution: the volume of the polluted water discharged in surface waters has diminished by 74 per cent; however, in the structure of disposed waters, polluted ones have the same proportion as in the past – 3 per cent.

Taking into consideration the impact of the economic transition on the intensity of water resource usage (highly diminished water use and disposal), to date, economic dynamics have had a much greater impact on the water supply than climate variability. Taking into account just the generalized figures for the entire country, it seems that there still are enough water resources for economic development. However, regional analyses suggest different situations, and some regions would be threatened by water scarcity, if today's consumption levels remained unchanged.

4.3. Potential climate change impact on water resources

Water resources in the Republic of Moldova are sensitive to climate change with regard to their quantity and quality. GHG emission scenarios and climate modelling provide different projected values for future water quantity and quality in the Republic of Moldova; however, they agree with regard to the sign of the expected changes, which will be negative in any case.

According to our estimates (see detailed methodology in Annex 2.9), available surface water resources will diminish by 16 to 20 per cent already in the 2020s (Table 10). Thus, according to the water-intensive target of national economic development (Box 4), secure supply for all water users will be threatened by climate-related change in water resources already in the 2020s, when the intensity of surface water use will be close to 100 per cent. However, taking into consideration ground water supply as well, the point when water scarcity will become a brake to development will set in after 2030. In designing the national development goals, water resources and climate change were not taken into consideration. If this target is selected as the supreme goal of national economic policy, Moldova's economic and human development will be threatened within 20 years regardless of the GHG emission scenario. At the same time, if the business-as-usual scenario of water use is followed, depletion of water resources will not occur at least until the end of the century.

The natural water regime of the big and small rivers will change. According to our estimates (see Annex 2.9), the coefficient of variation of the stream flow will rise, leading to an increase in the instability of annual flow and an increase in spring and flash floods (the severest flash flood in August 2008 seems to confirm these assessments). Furthermore, the outcomes of climatic modelling[60] show that droughts will become longer and more severe (the drought in 2007 is characteristic in this regard). These results are confirmed by European assessments as well:[61] flash floods on the big rivers will increase as an extension of the

Table 10. Projected relative changes of available surface water resources in the Republic of Moldova (%)

Scenario	Time-slice	Dniester and Prut Rivers catchments
SRES A2	2020s	-15.9
	2050s	-36.0
	2080s	-57.7
SRES B2	2020s	-20.3
	2050s	-29.2
	2080s	-38.9

Source: *Authors' estimates.*

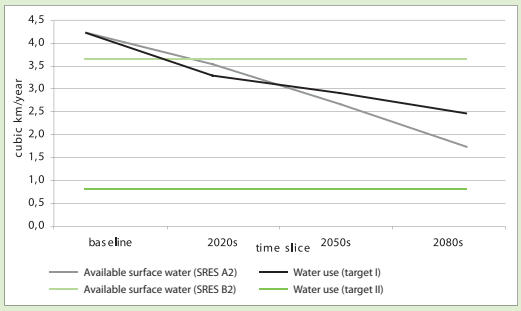
[59] Since 2006, official statistics have not provided data on water volumes used for irrigation, but one can estimate it as about 50m m^3 in 2008. For comparison, in 1990 about 900m m^3 of water was used for irrigation. Economic decline has caused an 18-fold decrease. The inappropriateness of the current irrigation system for such a reduced amount of water has led to growing relative water losses in irrigation from 4 per cent in 1990 to 25 per cent in 2006.

[60] Climatic modelling conducted for present report. Moreover, other assessments show that in July semi-desert meteorological conditions set in over the entire country. Thus, conclude the authors, desertification process has already started in Moldova (Constantinov T., Nedealcov M., 2008: Evaluarea fenomenelor climatice nefavorabile. In: T.Constantinov (ed.). Republica Moldova. Hazardurile naturale regionale. Chişinău, p. 57-68 (in press)).

[61] Bates B., Kundzewicz Z.W., Wu S., Palutikof J. (eds.), 2008: Climate change and water. Technical paper of the Intergovernmental Panel on Climate Change. IPCC secretariat, Geneva, 210 p.

Box 4. Targets of economic development

Chart 18. Availability of water resources and possible water use according to the targets of economic development [62]



Source: *Authors' estimates.*

In order to assess whether the national economy will be threatened by expected water scarcity or not, we selected from the past economic evolutions of the country two targets, to which projected amount of available water resources will be compared. The first target (water-intensive) represents the state of national economy in 1990, the year when the intensity of water use was at its highest. The second target (water-indifferent) represents the average state of national economy in the 2000s, when water supply was remaining stagnant. The intensity of water use will serve as threshold criterion: when projected water availability will become equal to the volume of water supply (100 percent water use intensity) according to one of the selected targets, then it will be possible to state that further economic development will be threatened by water scarcity.

Central European trend; water stress will grow as a trend common to South-Eastern Europe.

Water quality is also threatened by degradation due to natural, non-pollution, factors. Thus, an increase in air temperature will lead to an increase of the temperature of the surface waters and diminishing dissolved oxygen (DO) level. DO level lowering, in combination with the increase in water temperature, could affect the ecosystem composition by allowing the invasion of new thermophilic species and dangerous bacteria. Changes in the annual averages of these indicators are relatively small, but the seasonal effect of this process is expected to be striking. Winter and, especially, transitional months will be the most affected by water temperature increases. Already by the 2020s, water temperature increases in the Dniester River could exceed 65 per cent in March (under SRES B2 scenario). Summer months (especially August) are the most vulnerable to DO level change. The expected diminishing of the DO level could be about 10 per cent by the 2020s (regardless of the SRES scenario). Such a change in these indicators will lead to a change in ecosystems, to degradation of the ecosystem services to the population, and will require additional treatment of water for drinking purposes.

The effects of water-related aspects of climate change on tourism include changes in the availability of water, which could be positive or negative.[63] Warmer climates can contribute to emergence of an exotic environment (palm trees) in Moldova as well as to making living conditions in the urban environment less comfortable due to heat stress. These factors could contribute to the development of tourism (both internal and external) in the country. Droughts and the extension of an arid environment might discourage tourists (in the case of foreign ones) and will increase the human impact on remaining surface water bodies. In general, expected climate change might increase the percentage of local people involved in touristic fluxes that undoubtedly will contribute to the development of this branch of the national economy. At the same time, the human impact on water resources will certainly grow.

Two issues are particularly important with respect to regional disparities in water resources distribution. Although big rivers constitute the main source of water, not all the population has equal access to them. The biggest distance between a settlement and the closest water body in Moldova is about 6 km. If we take this 6 km zone as certain threshold, we will see that about one quarter of the population (1.03 m. people) live in the 6 km buffer zone of the Dniester and Prut Rivers; this zone constitutes one fifth of national territory and contains 23 per cent of the settlements. The rest of the country and population (about 3m people) have to rely on various supply systems designed to transfer water from big rivers or on local resources of poorer quality.

The other issue consists in the unequal distribution of available water resources and natural moistening. The northern part of the country (and the central part to some extent) are, currently, more or less secured from this point of view, while the southern part suffers from a natural

[62] These "targets" do not represent projections of future water use, but only the extreme limits of the capacity of the Moldovan economy for using water. The idea of the box is to compare projected water availability with water use in the absence of water use projections.

[63] Bates B., Kundzewicz Z.W., Wu S., Palutikof J. (eds.), 2008: Climate change and water. Technical paper of the Intergovernmental Panel on Climate Change. IPCC secretariat, Geneva, 210 p.

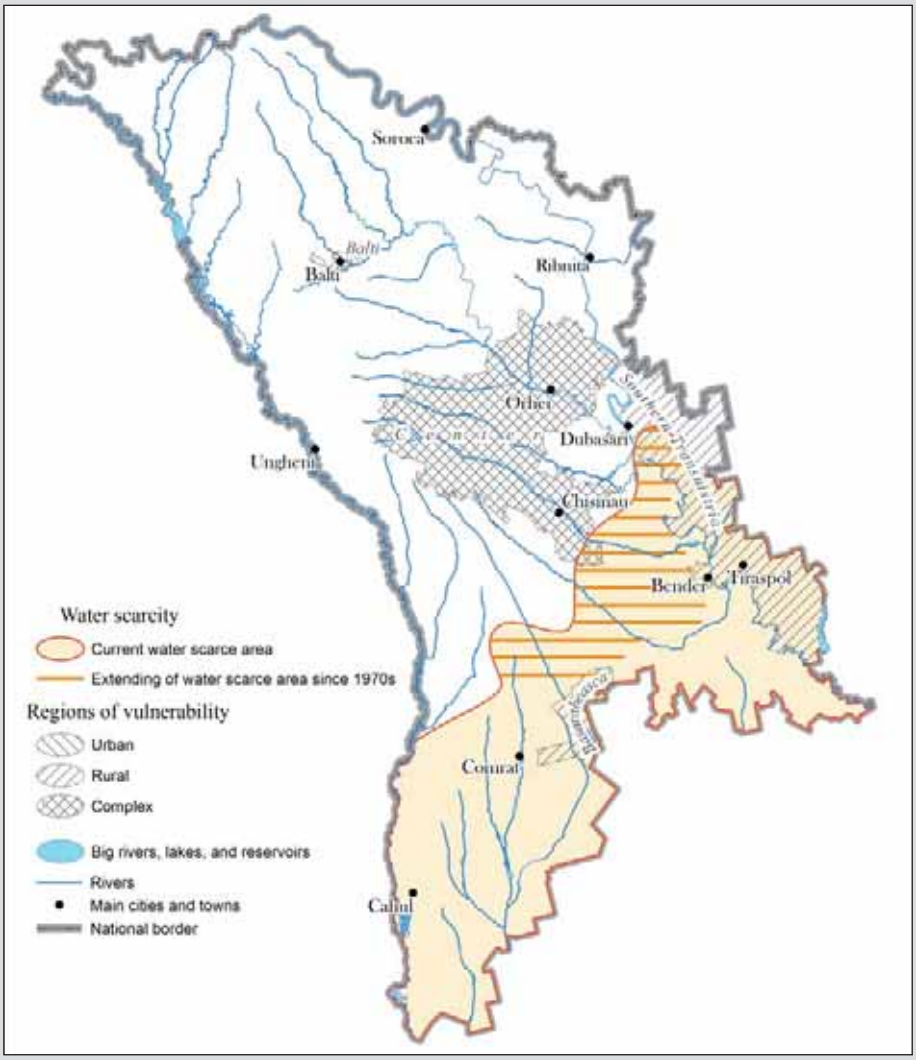
water deficit (Chart 19). At the same time, medium and long distance water transfer systems are almost non-existent in the south. This region is among the most exposed to water shortages. Moreover, local surface water resources in the south (and, less frequently, in the central part of the country) are exposed already today to depletion in drought years (like in 2007, when several reservoirs on the Işnovăţ River dried up).

In such a way, the geographical location of water users will play the most decisive role in the future in ensuring access to a secure water supply.

The water scarcity area, has, as it extends northwards (Chart 19), already reached the most populated areas, which place the biggest load on water resources and are most intensive in water use.[64] The expected impact of diminishing water resources likely to occur in the near future will be differentiated into three types of areas, depending on human and economic activity within the affected regions:

- Traditionally water deficient zones. In these areas climate change will put pressure on current economic activity, but water scarcity will not be a new phenomenon for the area and its inhabitants;
- Areas with vulnerable, mainly rural, populations. These are areas, especially the southern Transnistria region, which

Chart 19. **Potential vulnerability to water scarcity**



Source: *Sîrodoev I.G., Knight C.G., 2007: Vulnerability to Water Scarcity in Moldova: Identification of the Regions. Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţele vieţii 3(303): 159-166 with changes.*

[64] Sirodoev I.G., Knight C.G., 2007: Vulnerability to Water Scarcity in Moldova: Identification of the Regions. Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţele vieţii 3(303): 159-166.

are already experiencing water shortages as well as decreasing water table depth in unconfined aquifers due to overexploitation;

- Central Moldova. This part of the country is exposed to the complex impact of likely diminishing water resources on both rural and urban populations.

Southern Transnistria and the Central region are the most vulnerable to the expected changes. This is especially important for future water policies because of the concentration of population (up to 40 per cent of the total) and the main productive activities (Chişinău, Bender and Tiraspol are the Moldova's principle industrial centres). Thus, the most economically active areas are expected to be affected by water scarcity in the near future.

Taking into consideration the territorial unevenness of the population and of economic activity distribution, as well as a spatially varied climate change impact, we can expect that a significant part of the Republic of Moldova will approach the threshold of water overexploitation earlier than suggested by the models' outputs, i.e., earlier than 2030.

4.4. Policy discussion and recommendations

Current development strategies and plans

There is a set of legal documents (laws, development policies and programmes) linked directly or indirectly to water resources; none of them goes beyond 2025 in their timeframe and planning (see Annex 2.11). These documents do not take into consideration modifications likely to result due to expected climate change. At the same time, the impact of climate change will not significantly threaten the attainment of their goals. However, there is a strong need to incorporate specific adaptation measures into the existing development strategies and plans in order to mitigate the impact of climate change in a longer-term perspective.

The main shortcomings of the laws, development policies and programmes in question are the following: they do not take into account the likeliness that water resources may be depleted either in the entire country or in certain region; although mentioned, the role of systemic measures to protect water resources is weakly emphasised; the documents make no provision for water distribution in the case of water shortages and force majeure situations.

The documents contain adequate technical measures proposed for rational use that may achieve good results. Recommendations to improve current legislation focus on implementing and enforcing what has already been planned. Additionally, attention should be paid to extending a systemic approach to water saving policy (through interventions in ecosystems and society); to establishing water-use rules that would take into consideration the interest of both up-stream and down-stream users.

The implementation of the policies adopted faces serious problems. Not long ago, the state agency Apele Moldovei (Moldovan Waters) was the only organization responsible for water management, with the efficiency of the management being quite low. Regulatory and operational functions were not separated. The new government subordinated Apele Moldovei to the Ministry of Environment with the aim of creating EU-style management structures. However, this process is very slow and suffers from both a lack of skilled personnel and a shortage of financial resources. Because of the absence of experience in new water management, not all the structures created are adequate for local conditions. The absence of full financial support leads to a lack of necessary technical equipment. In order to solve these problems, there is a need to train a skilled labour force as well as for additional financing in order to develop new management structures not just at the national level but at the regional one as well. Besides increasing tariffs for end-users and installing water-meters, no other financial tools have been employed so far to promote water use efficiency.

The Republic of Moldova has adhered to and ratified the following international conventions in the water sector: The Helsinki Convention of the Protection and Use of Transboundary Watercourses and International Lakes (in force since 1994), The Sofia Convention on Cooperation for the Protection and Sustainable Use of the Danube River (in force since 1999), and The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat (in force since 2000). These conventions serve as a framework for integration in regional communities and for cooperation and negotiation with neighbouring countries in the

water sector. According to the assumed liabilities, the national government makes efforts to develop measures and instruments to support activities related to the Conventions, including small grant programmes for civil society, seminars and discussions to increase public awareness and protection of the wetlands (3 Ramsar sites proposed and approved up-to-date).

The water policies of neighbouring countries are important for Moldova in the case of the big transboundary rivers – the Dniester and Prut. These rivers serve as sources of water for urban water supply (Odessa in Ukraine and Iași in Romania). The main difficulties with transboundary cooperation relate to the exchange of urgent information about flood waves and in the discharging of

Box 5. Beyond scarcity - power, poverty and water use

Water, the stuff of life and a basic human right, is at the heart of a daily crisis faced by countless millions of the world's most vulnerable people—a crisis that threatens life and destroys livelihoods on a devastating scale.

Overcoming the crisis in water and sanitation is one of the great human development challenges of the early 21st century. Additionally, considering climate change for regions and nations who already had solved most of this problem the challenge is to avoid backstops regarding water and sanitation levels.

Ultimately, human development is about the realization of potential. It is about what people can do and what they can become—their capabilities—and about the freedom they have to exercise real choices in their lives. Water pervades all aspects of human development. When people are denied access to clean water at home or when they lack access to water as a productive resource their choices and freedoms are constrained by ill health, poverty and vulnerability. Water gives life to everything, including human development and human freedom.

The availability of water is already a concern for some countries. But the scarcity at the heart of many existing water crises is rooted in power, poverty and inequality, and not in physical availability. Issues of power, poverty and inequality regarding access to water will become more critical in the way real availability of water will decrease.

Water security is an integral part of this broader conception of human security. In broad terms, water security is about ensuring that every person has reliable access to enough safe water at an affordable price so as to lead a healthy, dignified and productive life, while maintaining the ecological systems that provide water and which also depend on water. If these conditions are not met, or if access to water is disrupted, people face acute human security risks transmitted through poor health and the disruption of livelihoods.

"The human right to water", declares the United Nations Committee on Economic, Social and Cultural Rights, "entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use." These five core attributes represent the foundations for water security. But the issues behind water security – that is, how to provide this security, at what cost and who pays this cost – are at risk or are changing hand in hand with climate change.

One of the possible risks coming out of predicted future water scarcity is that poor people might be more likely to get reduced access to water but could also face a situation where they pay higher prices for this water than wealthier people. These problems occur when market forces are allowed to intervene and regulate access and prices. Policy action and governance will play a crucial role in ensuring that the threat that is implied by reduced availability of water availability in future for human development would not be exacerbated by issues of power and inequality.

Source: *Extract of Global Human Development Report 2006 (edited for this report).*

polluted and cold waters that lead to the extinction of fish species in the Dniester River. That is why Moldova, Ukraine and Romania are actively working on developing a common water policy in order to satisfy all the countries concerned. However, these policies do not provide for measures designed to mitigate climate change impact or procedures to regulate water withdrawal quotas in the case of force majeure situations.

Possible adaptation measures and recommendations

As was shown above, on Moldova's territory two different types of climate change consequences will alternate leading to the combination of short-term overabundance of water and longer-term deficits. This trend suggests that water policy may play an important role in adjusting supply to demand. Such a policy can focus on supply-side and demand-side solutions.

Supply-side solutions are based on high-cost infrastructural projects like dam building, the construction of dykes and stream channelization. In the case of the Republic of Moldova, none of these on their own are an optimal solution. Older dams and dykes can actually increase the risk of extreme flooding rather than serve to control or prevent flooding. Stream channelization will reduce the infiltration of surface water into confined aquifers, thereby reducing ground water storage. Thus, solutions that combine supply-side and demand-side approaches should be considered.

Dams and reservoirs

Dams and reservoirs represent the main option for adapting to climate change in the water sector in Europe.[65] Being deficient in natural lakes and with abundant intermittent streams, Moldova has already developed a large network of ponds and reservoirs for inter-seasonal and inter-annual redistribution of water. Existing dams and reservoirs, as well as additional ones could help in redistributing precipitation between seasons, serving as an important object for both water storage and diminishing flash flood risk.

However, in the context of Moldova using and even extending the network of reservoirs as the main adaptation solution is problematic because:

(1) a lack of maintenance work in the case of older dams (as well as dykes) will certainly lead to dam breaks and an increased risk of extreme flooding. The Chişinău experience several years ago is very significant in this regard (Box 6);

(2) it is expected that the efficiency of building dams for water storage will diminish (especially in the south) compared to present situation due to a decrease in stream flow on the rivers that feed certain dam lakes and because of an increase in potential evapotranspiration (as projected by the models). However, detailed economic analysis is needed in each case in order to establish whether this adaptation measure is efficient or not.

Box 6. Grătieşti dam break in August 2005

On August 18 and 19, 2005, within 36 hours, 65 mm of precipitation, which exceeds monthly average, fell on the territory of Chişinău. As a result, the water level in Grătieşti reservoir increased in a very short time by 4 m over the normal level. The dam broke and a section of Chişinău downstream of the dam was flooded: more than 60 houses were damaged, about 150 people were evacuated. According to the officials, the dam crashed because of heavy rains and a lack of maintenance works. As of today, the dam has not been repaired.

Source: *mdn.md.*

Because dam building does not represent a solution secure enough to provide a safe water supply, this adaptation measure should be applied only after a thorough analysis of all possible alternatives. It is especially important in the case of Moldova, where, due to economic decline, the probability of dam breaks is quite high.

Dykes and stream channelization

Dykes represent a solution to prevent flooding in the lower courses of the rivers. However, in the Republic of Moldova dykes are old and have not been properly maintained in the last 20 years. Their water retaining capacity has decreased. Furthermore, the recent extreme flood serves as a good example of the limited utility of dykes (Box 7). They played their role on the limit of their capacity.

[65] Bates B., Kundzewicz Z.W., Wu S., Palutikof J. (eds.), 2008: Climate change and water. Technical paper of the Intergovernmental Panel on Climate Change. IPCC secretariat, Geneva, 210 p.

Box 7. Floods in July-August 2008

Because of heavy rains, especially in the northeastern part of the Carpathians, Romania, Ukraine and the Republic of Moldova suffered from a flash flood that in some places reached the historical maximum. In the Republic of Moldova, the biggest flash floods occurred on the main Dniester and Prut rivers, as well as, locally, on several small inner rivers. The Dniester River flash flood caused the most significant damage. According to official evaluations, the total damages resulting from the flash flood amount to 120 mil. USD, of which 20 per cent resulted from damage to road infrastructure, 15 per cent to agricultural lands and 65 per cent to real estate. Real estate was mainly affected in the northern (living houses) and central (touristic infrastructure) parts of the country, while in the lower course of Dniester River, damage to agriculture dominated.

Source: *moldova.org.*

Although dykes play a decisive role in protecting agricultural lands located at floodplains from flooding, taking into consideration the combination of the two contradictory trends likely to be more intensive in the future, the dyke strategy may be less wise than the reservoirs and dams. Due to increasing water scarcity there will be a need to store as much water as possible instead of helping water to flow away as fast as possible.

Furthermore, the efficiency of dykes as an adaptation measure to a changing climate is questionable for the same reason as in the case of dams: economic circumstances will not allow to maintaine them in the appropriate condition and will increase the risk of extreme flooding.

The majority of small rivers have been channelized in order to gain floodplain territories with very fertile soils for agricultural purposes, as well as to reduce flood risk. Frequently, channelization is followed by the construction of dykes. In many cases, channelized courses make up a significant part of the total river length, especially in the cases of the following rivers: Botna, Cogîlnic (Cunduc), Ichel, Răut (in many sectors), Cula, Ialpug etc.

Considered as an adaptation measure, stream channelization has similar effects as the dykes. In addition to accelerating stream flow, stream channelization reduces infiltration and soil moisture. Given the expected changing climate trends in the Republic of Moldova, this is the least preferable adaptation measure.

The negative consequences of the last two infrastructural solutions, dykes and stream channelization, can be avoided through more flexible combinations of supply-based and demand-based strategies. Infrastructural solutions (especially dykes) should be combined with such systemic adaptation measures as a change in land use in the floodplains that would allow natural ecosystems to return to these territories through the rehabilitation of naturally flooded areas. This approach will not just increase soil moisture and the recharging of local ground waters, but will contribute to an extension of natural ecosystems, enriching ecosystem services and conserving biodiversity.

Cultural values

Moldovan people have appreciated water for a long time, being conscious of its important role in their lives. This is confirmed by customs and traditions kept by many generations, which created their own, particular, attitude towards water in general, and particularly toward water sources – wells and springs (Box 8). Water underpins the human life cycle and its symbols can be seen in customs linked to people's birth, marriage and funerals.[66]

Box 8. Wells as cultural values

Water is a vital necessity in the Moldovan tradition. Funeral processions on their way to the cemetery makes a stop at each well and the procession places money behind the well as an expression of gratitude for the water used by the deceased and in the hope that he will not lack for water in the other world. This popular belief has contributed to the appearance of Moldova and has contributed to the maintenance even today of the custom of building bridges, wells or, at least, of repairing, cleaning and restoring old wells and springs.

Source: *Overcenco A., Mihailescu C., Bogdevici O., Gîlcă G. Fîntîni şi izvoare: Atlas ecologic. Ştiinţa, Chişinău, 2008, 208 p.*

[66] Overcenco A., Mihailescu C., Bogdevici O., Gîlcă G. Fintîni şi izvoare: Atlas ecologic. Ştiinţa, Chişinău, 2008, 208 p.

Such traditions have great potential for protecting water resources and promoting water-saving policy if encouraged among the population of local communities, especially among the younger generation and in areas with centralised water supply.

The degree of success of adaptation policy

In the near future, we can predict that about half of the country's territory, its population and economic potential will be exposed to the risks of water deficit.[67] Solid investments will be needed for the equal distribution of available water; otherwise human development in many regions of the Republic of Moldova will be threatened by excess water demand over water supply capacity. Under these conditions, the degree of success of any adaptation measure will depend on demand-side solutions.

Adaptation policies based on a demand-side approach should not just provide recommendations on what is to be done, but also take into account people's receptiveness to things that are new to them. They have to classify adaptation measures depending on their impact on people and their mode of life. Thus, two types of adaptation should be considered: passive and active adaptation.

Passive (autonomous) adaptation is the result of the natural evolution of traditional practices (Box 9). This type of adaptation can be recommended in the southern part of the country traditionally experiencing deficit and poor quality water resources, because their practices and way of life have evolved under water scarce conditions. However, the long-term impact of passive adaptation measures is quite doubtful, as shown in Box 9.

Active (planned, deliberative and proactive) adaptation is intended directly to intervene in people's mode of life. It is more water-efficient; however, it is cost-intensive and needs substantial investments. It gives better results in the longer term, but it is much more efficient if implemented in a way that exceeds certain threshold conditions. In relation to the social impact of likely changes, it is worth emphasising *socially active* adaptation as the most radical, because it requires change, sometimes very dramatic, to people's traditional occupations. For instance, introducing completely new crops or agricultural techniques, which people are not familiar with or relocating industry due to water use restrictions.

Box 9. Passive adaptation in Moldova

As an eloquent example we can cite the current situation in the southeastern part of the country. The unconfined aquifer in the villages is becoming depleted due to diminishing recharge capacity and overexploitation; people are experiencing a lack of water for watering vegetable gardens – the activity traditionally practiced over the years. A solution was found in breaching the upper (unconfined) aquifer with a pipe and pumping water from the lower (confined) one The result: the depletion rate of the upper aquifer has increased, there still is enough water for watering so far, and nothing has changed in agricultural practices and people's way of life; just the rate of the depleting unconfined aquifer has grown.

Source: *Sîrodoev I.G., Knight C.G., 2008: Vulnerability to Water Scarcity in Moldova: Likely Threats for Future Development. Present environment and sustainable development 2: 7-15.*

The vulnerability of the population increases due to both global environmental change and policy measures, especially when they are applied in anticipation of future conditions that are not yet obvious to the locals. In addition to direct financial costs, it creates tension among inhabitants, it is emotionally fraught, and, if these indirect costs are translated into financial terms, total costs can be even higher than initially planned. But in a long-term perspective, if properly implemented, it promises the best results.

Active adaptation is more risky and more difficult to implement, but it is more recommended in vulnerable regions. It is especially important, because this type of adaptation, in order to be efficient, must embrace all aspects of people's everyday life. The best (but not fast) way for implementing such a policy is to start with education and encompass all water-related aspects of people's everyday life and economic activity. Implementation of active adaptation through the entire water-scarce region, especially in vulnerable regions, will result in increasing efficiency of water policy, eliminate an important brake on Moldova's economic development, and will con-

[67] Sirodoev I.G., Knight C.G., 2008: Vulnerability to Water Scarcity in Moldova: Likely Threats for Future Development. Present environment and sustainable development 2: 7-15

tribute to consolidating the base for the country's sustainable development.[68]

Another important aspect of the demand-side policies consists in searching for good practices to be adapted to local conditions. Useful approaches are more likely to be borrowed from the regions that currently face problems, which, in the case of the Republic of Moldova, are projected to occur in the near future. Such practices can be found, for example, in Central Turkey or the United States Midwest.

Policy recommendations

Recommendations, in order to be successful, should not just focus on direct water use, but should also consider activities indirectly related to the water sector. Special attention should be paid to the social flexibility of the measures being proposed.

One of the first would be a recommendation to have a new and ***functioning*** National Adaptation Strategy for the Water Sector, which would have established mechanisms and instruments to be used to ensure its correct and timely implementation.

Or, the existing Strategy for the development of the Water Sector could be amended with a new Chapter on Adaptation to Climate Change, mechanisms and instruments to implement the adaptation measures, as well as modifications of other related provisions and existing regulations in order for them to be in total compliance with respective adaptation measures.

These changes should be developed by the responsible Ministry, in conformity with international agreements and conventions, signed and ratified by the Republic of Moldova, under the supervision of the Inter-ministerial Adaptation Commission. This Commission would control the process of elaborating this framework and would ensure the all sector-related strategies were connected and exclude the possibility of conflicting provisions.

In order to have proper adaptation measures included, the responsible Ministry should perform a cost–benefit analysis of possible measures and also assess the cost of inaction. It should also ensure a close cooperation with academia and other related institutions, as well as with neighbouring countries with whom Moldova shares water bodies.

The following are further high priority recommendations to be taken into account:

- Attention in national and regional economic planning should be paid by the Government to the vulnerability of the economy and local communities to water supply;
- The state agency Apele Moldovei in water use planning should assume from "quasi-natural" diminishing of available water resources due to expected climate change. The current practice, whereby this effect is disregarded, is not acceptable;
- Apele Moldovei should create scenarios for water use under severe drought and water shortage conditions, and it should prioritise water use (focusing on drinking water and irrigation) under these conditions;
- The national government, in cooperation with Apele Moldovei, should consider establishing strategic water reserves. In this respect a regulation on efficient water use could be devised, incorporating new sustainable methods, like the rain water and snow collection for irrigation purposes;
- The Ministries of Industry and of Agriculture and the Food Industry, in cooperation with the Apele Moldovei, should make efforts to adjust existing water supply systems to the current needs of national economy in order to diminish losses of water in transportation networks and irrigation facilities;
- Apele Moldovei should be responsible for assessing the balance between preserving capacity and potential losses when considering adaptation measures such as building new dams etc.

Systemic recommendations (to be implemented continuously):

- Climate change should be considered among the factors that influence water availability and quality in Moldova, and, therefore, specific adaptation measures should be applied to control and improve it;

[68] Sirodoev I.G., Knight C.G., 2008: Vulnerability to Water Scarcity in Moldova: Likely Threats for Future Development. Present environment and sustainable development 2: 7-15.

- There is a need to increase the self-regulatory function of water bodies in both water quality and quantity. This can be achieved by diminishing the human impact on existing water bodies;
- Adaptation approaches should be carefully differentiated by type, region and by social groups; no single solution fits everywhere; adaptation measures and priorities should be publicly debated;
- Special attention should be paid to reassessing national traditions that affect water use and the search for new approaches to the consolidation of a water-saving culture and ethic; the Ministries of Education, Culture and Environment should jointly provide for the measures promoting such traditions;
- Design and prepare permanent emergency plans for extreme weather events and water scarcity with traditional approaches (humanitarian aid) and design and prepare complementary emergency plans supporting demand for education and health in order to ensure the continuity of capacity development in the young population;
- Public awareness and information campaigns, including training sessions for authorities, the general public and the private sector regarding water and sewage solutions should be performed on a continuous basis. Local authorities should cooperate closely with the community and monitor the implementation of these solutions;
- Strengthen governance in order to avoid governance problems with future lower availability of water.

Further, a list of concrete solutions to be taken into consideration by the responsible authority is presented:

- an Action Plan to gradually repair, renew and adapt the water supply infrastructure and water treatment facilities to climate change;
- Establishment of special commissions for each of the big river basins (Prut and Dniester). These commissions should cooperate in order to exclude work overlaps and their activity should be performed based on a specific regulation;
- Training authorities and informing the public on nutrient run-off problems and consequences, as well as teaching about solutions to solve these issues.

To make sure of the water quality, several testing procedures should be carried out each year. In places where water does not correspond to quality norms, the population should be offered filters or they should be informed on methods for cleaning their water. These activities should be performed in joint action with health authorities.

Chapter

5

Ecosystems: Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

5. Ecosystems: vulnerability assessment, climate change impacts and adaptation measures

5.1. Summary

Agricultural ecosystems cover some 75 per cent of Moldova's land area. Intensive agricultural practices such as the use of pesticides and fertilizers, use of heavy machinery, and excessive irrigation, etc. have led to degradation, erosion, and compaction of Moldova's most valuable natural resource, its black soils. The condition of these soils and agricultural ecosystems more broadly are closely tied to Moldova's ability to support economic and human development. These ecosystems are highly vulnerable to droughts, floods and extreme weather events, all of which are expected to increase with climate change. Land consolidation, the promotion of ecological agricultural practices, improvement of soil fertility and irrigation are specific measures to reduce the continuous degradation of the agricultural ecosystems and increase their resilience to future climate changes.

Natural ecosystems cover some 15 per cent of Moldova's land surface. Significant portions are highly degraded and the number of endangered species has climbed dramatically from 55 to over 180 in the last 30 years. Climate change is expected to result in southern and eastern Moldova, currently semi-arid regions, becoming arid. This can be expected to have substantial negative impacts on forests and aquatic species. Under such conditions, proactive measures need to be taken to implement biodiversity conservation strategies through the expansion and consolidation of the protected areas in the central and northern parts of the country. Rehabilitation of irrigation systems in the southern and eastern parts along with the introduction of drought resistant crops could increase the resilience of the agricultural ecosystems to help them maintain their services.

Establishing new policies based on an integrated landscape approach for biodiversity protection under different climate change scenarios and developing River Basin Management Action Plans for sustainable use of water resources are some of the most important long-term adaptation measures necessary to implement in order to meet the sustainable development objectives.

5.2. Current status of the main ecosystems in Moldova

At present, some of the most valuable ecosystem services directly used by humans are food, timber and water supply, drought and flood regulation services as well as recreation and tourism (Box 10).

Moldova's long-term targets related to ecosystem functioning are provided in The First National Report, Millennium Development Goals in the Republic of Moldova (June 2005). Goals include:

- Increasing the surface of forested land from 10.3 per cent in 2002 to 11 per cent in 2006, to 12.1 per cent in 2010 and to 13.2 of the total surface area of the country in 2015;
- Increasing the surface of protected natural areas for the conservation of biological diversity from 1.96 per cent in 2002 to 2.1 per cent in 2006, to 2.2 per cent in 2010 and to 2.4 per cent of the total surface area of the country in 2015.

Goal 7 in the most recent Annual Report on progress towards the Millennium Development Goals[69] includes "significantly reducing the rate of biodiversity loss by 2010".

The variety and vulnerability of Moldova's biodiversity is influenced by several factors. Due to the republic's geographical position near the Carpathian Mountains, the Black Sea and the East European Plain there is a confluence of three main eco-regions: central European leafy forests, the Mediterranean forest steppe and the Euro-Asiatic steppe. This confluence of eco-regions provides conditions for high biodiversity. However, ecosystems strongly affected by human use constitute approximately 75 per cent that are agricultural ecosystems and 10 per cent urban ecosystems. Natural ecosystems cover approximately 15 per cent of the country.

Over past decades, human activities have threatened the country's biodiversity through fragmentation of the natural areas, resulting in reduced ecological functioning of these areas and the ongoing loss of habitats and species. In particular,

[69] The Millennium Development Goals Report 2008, UN, New York 2008.

Box 10. Biodiversity and its services

Biodiversity is the source of many ecosystem goods that sustain human development. Protecting biological species and their habitats also improves people's quality of life and living standard. Changes in biodiversity can influence the supply of ecosystem services. These are provisioning, regulating, cultural and supporting ecosystem services that sustain our lives and impact human development (*Table 11*).

Table 11. Supply of basic ecosystems services

Provisioning	Regulating	Cultural
• Diverse food products • Timber and fuel • Textiles • Medicinal products • Water supply	• Regulate the climate • Control floods • Pollinate crops • Purify water • Absorbs CO_2 gases • Stops erosion	• Beautiful landscapes • Spiritual • Cultural heritage • Healthy environment • Recreation and tourism
Supporting		
• Nutrient cycling • Primary production • Soil formation		

Source: *Millennium Ecosystem Assessment.*

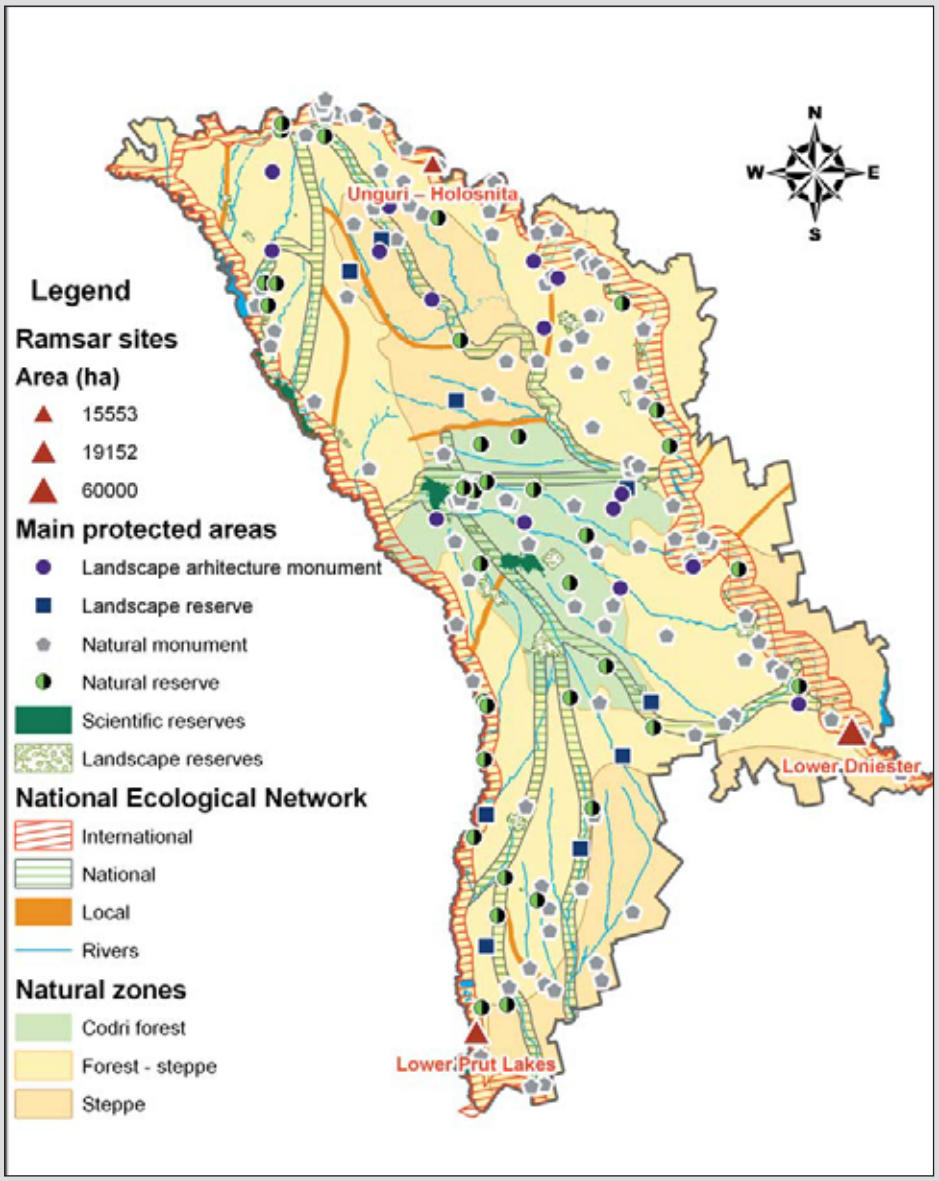
biodiversity of the steppe zones of the republic has been more adversely affected by overgrazing, soil erosion and landslides, soil salinization as a result of intensive irrigation of flood plains and pollution of surface waters. This has resulted in a non-uniform distribution of biodiversity.[70,71] Moreover, the observed climate changes have affected various local species of flora and fauna that in turn had a significant impact on ecosystem composition and resulted in degradation of ecosystem services to local inhabitants.

The territory of the Republic of Moldova is comprised of two main natural zones: forest steppe and steppe (Chart 20). The forest steppe zone is located in the northern and central parts of the country and represents a hilly plain with an alternation of plains and plateaus. The steppe zone is situated in the south and south-eastern part of the republic.

[70] National Strategy and Action Plan on Biodiversity Conservation of the Republic of Moldova (2001).

[71] USAID/Moldova FAA 119 Biodiversity Analysis. 2007.

Chart 20. The National Ecological Network and the main protected areas of the Republic of Moldova

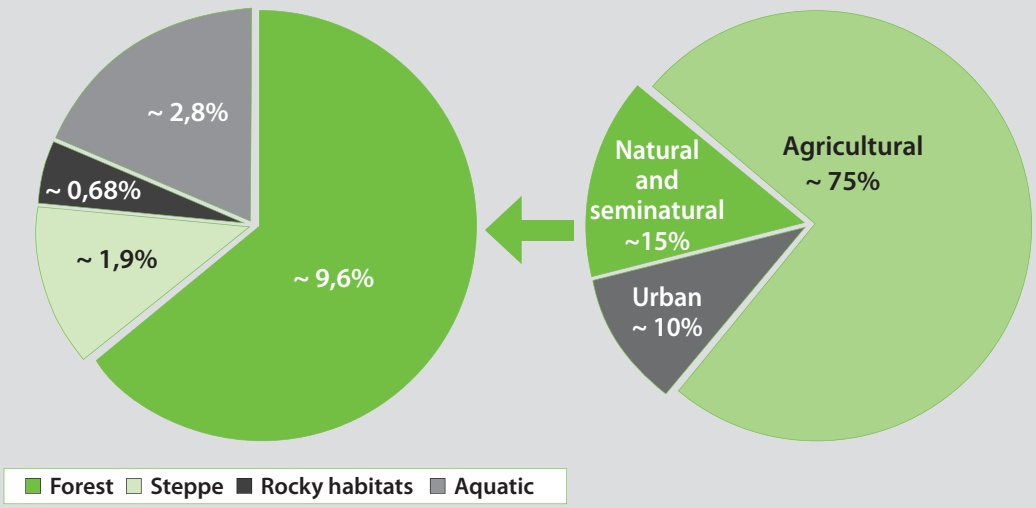


Source: *Cazanteva O., Sirodoev Gh., et al., 2001.*

The National Ecological Network (NEN)[72] in green stripes in Chart 20 provides a link between Moldova's different ecosystems and habitats. As observed from the Chart, NEN represents a landscape level approach that links the main protected areas, considered as core areas in the NEN structure, through corridors, restoration and buffer zones to ensure the continued functioning of ecological processes. Presently there are 12 categories[73] (8 according to the International Union for Conservation of Nature criteria and 4 according to national criteria) of protected areas in Moldova that cover approximately 4.65 per cent of its land. Two categories of protected areas, Landscape reserve and Scientific reserve, constitute the largest coverage with 52 per cent and 29 per cent of the protected areas respectively. As shown in Chart 20, the National Ecological Network links Moldova's local and national protected areas with the Pan-European Ecological Network (PEEN), shown in red stripes along Prut and Dniester rivers. This link should also ensure a

[72] Climenco V., Trombiţki I., Andreev A. Reţeaua ecologică: Calea spre protejarea naturii în Moldova. – Chişinău: Biotica, 2002. – 144 p.
[73] Law on State Protected Areas Fund, #1538-XIII, 25/02/1998.

Chart 21. The Main Ecosystems of Moldova



Source: *Ministry of Environment and National Resources, National Report on Implementation of the Convention of Biological Diversity, 2005.*

favourable conservation status for the three wetlands of international importance (Ramsar list) and connect them with Europe's key ecosystems, habitats, species and landscapes.

As can be seen in Chart 21, agricultural and urban ecosystems cover about 85 per cent of the country with natural and semi-natural ecosystems covering approximately 15 per cent of Moldova. Significant portions of the natural and semi-natural ecosystems are highly degraded. The main natural ecosystems of Moldova are: forest, steppe, rocky habitats or petrophyte and aquatic. Moldova's forests, which cover approximately 9.6 per cent (some sources say 10.7 per cent) of the country, protect water, lands, and soil and provide opportunities for recreation and scientific research. Steppe ecosystems occupy 1.9 per cent of the total area of the country an d are located in the northern (Balti steppe) and southern (Bugeac steppe) natural zones.

Native steppe and steppe associated with meadows have been systematically converted to cropland and pastures in the past. Due to fragmentation, most of the wet meadow vegetation communities are strongly degraded and are often occupied by steppe vegetation. In the past five decades the surface area of meadow and steppe ecosystems has been considerably reduced. This has had an adverse impact on biodiversity due to the worsening reproduction conditions of many vertebrate animal and bird species. Rocky habitats or petrophyte ecosystems are unique relief forms (limestone) of vegetation located in the northern part of the republic and presently cover approximately 0.68 per cent of the country. Aquatic ecosystems, such as rivers, lakes and ponds, cover approximately 2.8 per cent of the total area of the country.

The plant life of Moldova includes 5,513 plant species composed of 1,989 species of vascular plants and 1,200 non-vascular species.[74] During the last 50 years, 31 flora species have disappeared from the Republic of Moldova. Ecological analysis of species has established that 77 per cent of the plant species lost were dependent on wet habitats.[75] The loss of natural vegetation in Moldova has contributed to a substantial decline in fauna species.

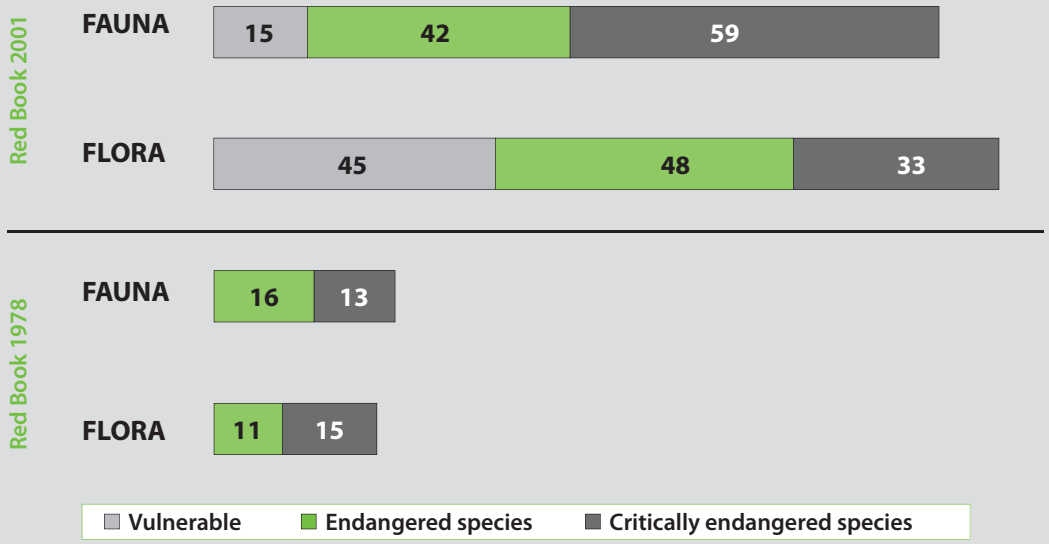
Moldova's fauna includes 14,800 species of animals, including 461 species of vertebrates. The number of animals as well as some species of birds, reptiles, fish and insects which have an important role in natural ecosystem functioning such as the ground squirrel, European mink, Greater Spotted Eagle and Corncrake, has declined due to extensive cultivation of the steppes. The degree of degradation of natural ecosystems can be indicated by the number of critically endangered and endangered rare species.[76] Comparing the current number of animal species and plants which are vulnerable, endangered, and critically endangered with that of 20 to 30 years ago, one can conclude that many natural ecosystems have become critically degraded (Chart 22).

[74] Republic of Moldova. Third National Report on the Implementation of the Convention of Biological Diversity. 2005.

[75] Izverskaya Tatiana (2000). Climate changes influence on floral biodiversity (including rare, endangered and assailable species) of the Republic of Moldova. Climate change: Research, studies, solutions. Chişinău, 2000. p. 38-41.

[76] Red Book of the Republic of Moldova, First Edition (1978) and Second Edition (2001).

Chart 22. Evolution of the number of endangered and critically endangered flora and fauna species in the Republic of Moldova



Source: *Red Books of the Republic of Moldova.*

Chart 22 shows findings from two editions of the Red Book of the Republic of Moldova. The first edition (1978) of the Red Book showed 29 species of animals and 26 species of plants as endangered or critically endangered. The most recent edition (2001) shows 81 species of plants and 101 species of animals in these categories. Due to the fact that no species were considered vulnerable in 1978, the first edition did not have the category 'vulnerable' that was introduced in the second edition. Hence, only a comparison between endangered and critically endangered categories is provided here. The increasing number of endangered and especially critically endangered species is due to mainly human activity. The considerable difference between the two editions highlights the need to undertake urgent and effective actions to protect biodiversity and to identify adaptive measures that will enable these species to cope with climate change impacts at local and national levels.

5.3. Potential climate change impact on ecosystems in Moldova

Since climate change may become a major threat to ecosystem functioning in the longer term, ecosystems in Moldova are currently primarily threatened and degraded not only by human activities but also by socioeconomic conditions, poverty and a lack of political will. Practices such as intensive irrigation, the use of chemical fertilizers, pesticides and fungicides and the use of heavy agricultural machinery, etc., is leading to degradation, erosion, compaction, and depletion of the soil organic matter of the most valuable natural resource Moldova has – its black soil. Depletion of this most valuable resource impacts the capacity of soil to sustain agricultural crops and consequently human welfare. Other human activities that affect and disrupt ecosystem services include unauthorized waste disposal, overgrazing, illegal tree felling, illegal hunting and fishing, industrial and agricultural pollution, which have a negative impact on the cultural functioning of ecosystems to a great extent (see Box 11).

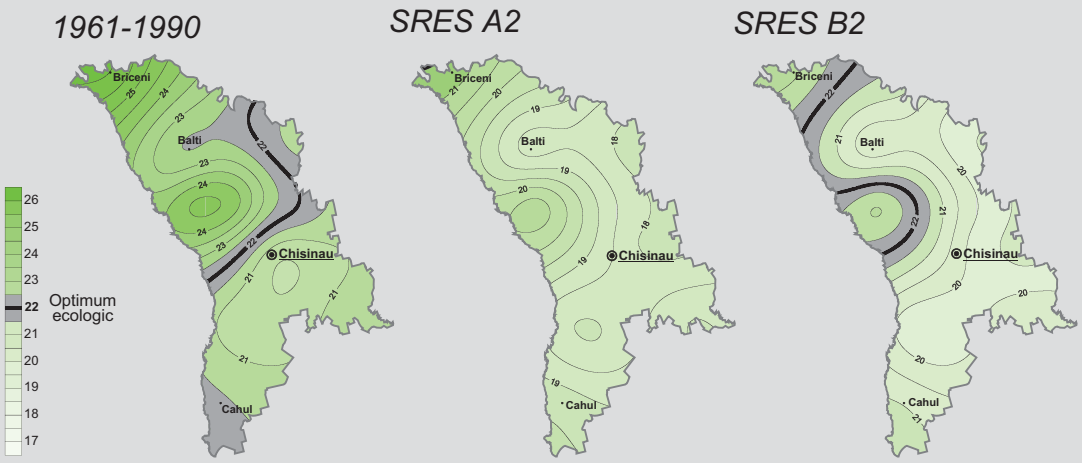
Box 11. Limiting factors and threats to vulnerable, endangered and critically endangered flora and fauna species in the Republic of Moldova

FLORA	FAUNA
• Tree felling (leads to forest degradation, changes in hydrothermal and light regimes, changes in habitats etc.)	• Economic activity
• Inadequate forest management	• Atmospheric pollution
• Atmospheric pollution	• Introduction of new lands into the economic circuit
• Intensive grazing	• Industrial pollution of water basins
• Haymaking	• Braconage (hunting & fishing)
• Intensive land use for agriculture	• Draining of natural marshes and lakes
• Flower gathering	• Cutting of woods along the river banks
• Amelioration works, hydrotechnical constructions	• Habitat loss and degradation
• Weak natural regeneration	• Recreation pressure and human disturbance
• Destruction of the cultivation areas because of economic activity (disappearance of medicinal plants)	• Surface water level fluctuations as a result of pressure to satisfy socio-economical needs (drinking water supply, irrigation, etc)
• Drainage and pollution of the water basins	• Decrease of food resources in the food chain
• Intrinsic factors (such as poor recruitment, limited dispersal, low population size, slow growing rates and natural fluctuations)	• Intrinsic factors (such as poor recruitment, limited dispersal, low population size, slow growing rates and natural fluctuations)
• Land slides and soil erosion	• Disease
• Reclamation of slopes	• …
• Unorganized tourism	
• Limited ecological proportions of species	
• Stone mining	
• Recreation pressure and human disturbance	
• Invasion of alien species	
• Disease	
• …	

Source: *Red Book of the Republic of Moldova (1978 & 2001 editions).*

The assessment of the potential impact of climate changes on ecosystems is based on recent climate projections for Moldova, which predict an increase in mean air temperature and a significant decrease in precipitation by the end of the 21st century (see CLIMATE CHANGE AND ITS CHALLENGES FOR MOLDOVA). A change for the worse in humidity conditions leads to a worsening of ecological-climatic characteristics for plant growing. Most significant regional differences in their quality on the upper taxonomic level are well characterized by the Index of Climate Biological Effectivity (ICBE) that in the zone of the ecological optimum, according to different studies, equals 22. The national projections (Chart 23) show that if by the end of this century, according to the climatologically softer B2 scenario, only a north-west shift in the ecological optimum is possible, then the realization of A2 scenario could result in the total disappearance of natural habitats that are optimal for Moldova's current vegetation.

Chart 23. **Baseline and likely spatial distribution of the Index of Climate Biological Effectivity (ICBE) by 2070–2099**



Note: *ICBE = HC *∑T>10°C, where CH – Coefficient of Humidity; ∑T>10°C – sum of air temperatures >10°C; Grey – ecological optimum.*

Source: *Authors' calculation.*

Climate change of this magnitude is likely to have significant impacts on biodiversity from the level of the individual right through to the level of the ecosystem or biome. Under the above-mentioned projections the climate of Moldova will change from semi-arid to arid, especially in the southern and eastern part of the country. Rising temperatures will force many living organisms to migrate to cooler areas in the northern part of the country, while new organisms will arrive. Such movements might involve many species including plants and trees. However, some flora and fauna species could have low resilience to temperature and precipitation changes because climate systems are moving more rapidly than they can follow. Some oak species such as Eastern black oak, English oak and Sessile oak in the western and northern parts of the country have high adaptation capacities and would be able to adapt to dry conditions in the central and northern parts of the country. Some species will seek higher altitudes in the central part (in the Codrii forested area), others will move further to the northern part of Moldova. Steppe plants are generally well adjusted to high temperatures although some species could suffer reduced populations due to overgrazing and become extinct. Landscape fragmentation and human activity are likely to increase the vulnerability to changes in climatic conditions of steppe species with limited dispersal capacity such as arrow broom.

As seen from GCM scenarios, water availability in Moldova which is important not only to human development but also to sustaining the functioning of the ecosystem is sensitive to climate change. As a consequence, the hydrological regimes of large and small rivers will change substantially (see CLIMATE CHANGE AND ITS CHALLENGES FOR MOLDOVA). According to the A2 and B2 scenarios, the available surface water resources for the Dniester and Prut river basins will fall by about 16 to 20 per cent already in the 2020s and by up to 39 to 58 per cent for the B2 and A2 scenarios by the end of the 21st century. The aforementioned chapter outlines the increase in the frequency of spring and flash floods due to the instability of annual flow. Also, besides floods, droughts will become longer and more severe. This will have a substantial effect on forests and aquatic biodiversity[77] since many habitats, protected areas and the Ramsar wetlands are located in the vicinity of the Dniester and Prut rivers. Droughts result in a shorter-duration presence of water on floodplains and intensify the soil salinisation processes. These changes could have a significant impact on meadow species through an extension of the areas of halophyte plants well adapted to salt and drought conditions and a reduction of the area occupied by plants tolerant of floods such as sedges. Generally, forest ecosystems are more resistant to droughts; however some species of oak in the southern and central

[77] Lazu S., Vulnerability and adaptation of the meadow ecosystems to climate change impact. Climate change: Research, studies, solutions. Chişinău, 2000. – p. 49-52.

parts of the country could dry out in the case of a massive invasion of insects.[78,79,80]

Floods and droughts or other extreme climatic events (storms, hail, etc.) also affect human welfare by causing losses to ecosystems on which human welfare depends. Ecosystems provide food and water, with human health dependent on quality of both food and drinking water. Forest ecosystems provide, among other benefits, timber for construction, the wine industry, and heating. Timber for heating is essential for many rural areas that are without centralised gas supplies, as well as for poor, elderly and disadvantaged people who cannot afford to pay high natural gas prices. The number of people employed in the wine industry was 14,472 in 2008, which was an increase of 3,181 employees compared to the year 2006. Annually, the forest ecosystems provide approximately 360,000 to 380,000 m^3 of timber from which 45,000 m^3 is used for construction, 290,000 m^3 as firewood and 30,000 to 50,000 m^3 for other purposes.[81] According to the National Bureau of Statistics in Moldova, there are 634,300 people receiving pensions with approximately 20 per cent of them due to disability. The majority of retired and disabled people are living in rural areas. In 2008 almost 160,000 people – disabled people, war veterans, families with more than four children, etc. – received benefits for purchasing firewood and charcoal.[82] Losses to forests through illegal felling and agricultural lands deteriorating through soil erosion, salinisation, compaction and depletion of the organic matter content are particularly closely connected to human welfare in rural areas that depend strongly on agricultural crop production.

Urgent action plans are needed for the consolidation of the protected areas, creation of national parks and further development of the local and national ecological network, adopting strategies for the integrated management of water resources at the river basin level supported by awareness-raising campaigns in order to increase the resilience of natural and agricultural ecosystems. In this respect, more studies are necessary to understand the complex implications of regional temperature changes and changes in the amount of precipitation for individual species that can disrupt the ecosystem functioning.

5.4. Policy discussion and recommendations

Policy Framework

Moldova's biodiversity loss will likely continue and even escalate unless adaptation measures are adopted and integrated into environmental and other policy areas. Although climate change is occurring on a global scale, national and local actions are essential to stemming ecosystem degradation in Moldova. While it is recognized that adaptation challenges are greatest for developing countries such as Moldova due to their low per capita income, weak institutions, and limited access to technology, Moldova's economy strongly depends on its ecosystems, particularly its forest and agriculture systems, both of which are highly sensitive to the climate (see IMPACT OF CLIMATE CHANGE ON THE AGRICULTURAL SECTOR). In Moldova, the primary responsibility for policies and actions to conserve biodiversity lies with the Ministry of Environment (MoE). The State Forestry Service – Moldsilva – is responsible for the management of nature and forest areas. The Ministry of Agriculture and Food Industry is responsible for nature protection and conservation in its respective fields and local public authorities are responsible mainly for the management of natural monuments. These and other state organizations have cooperated in devising laws to ensure biodiversity conservation and rational use of natural water, forest and soil resources are incorporated into development plans and strategies.

In 1995, the Republic of Moldova signed up to the Convention on Biological Diversity (CBD) and committed itself to achieving the objectives of the convention. According to the provisions of the convention, Moldova elaborated the *National Strategy and Action Plan on Biodiversity Conservation of the Republic of Moldova* (Government Decision 112-XV, April 27 2001). The overall goal of the Strategy is the conservation, restoration, and sustainable use of biodiversity and landscapes in order to ensure social and economic sustainable development of the Republic of Moldova. The Strategy also includes particular goals, objectives, main directions of biodiversity conservation activity, biodiversity conservation strategy components, principles of biodiversity conservation, and terms of strategy implementation.

[78] Postolache Gh., Natural ecosystems. Vulnerability and adaptation to climate change. Climate change: Research, studies, solutions. Chişinău, 2000. – p. 42-48.

[79] Sabanova G., Izverskaia T., Sensitivity of natural vegetative communities of Moldova to climate changes. Climate of Moldova in the 21st century. Chişinău, 2004. p. 98-149.

[80] Izverskaia T., Sabanova G., Forecast of floral behaviour under climate change conditions. Climate of Moldova in the 21st century. Chişinău, 2004. p. 151-175.

[82] Casa Nationala de Asigurari Sociale: http://www.cnas.md/libview.php?l=ro&idc=176&id=404.

[81] Institutului de Cercetari si Amenajari Silvice: www.icas.com.md.

Furthermore, the document comprises eleven action plans, which start with the General Action Plan on the biodiversity conservation, and continue with the action plans on:

- creating a National Ecological Network;
- protection of forest ecosystems;
- protection of the steppe ecosystem;
- protection of the aquatic ecosystem;
- protection of rocky habitats;
- protection of agricultural ecosystems biodiversity;
- protection of biodiversity in urban ecosystems;
- species protection;
- biodiversity conservation outside natural habitats.

Implementation of the National Strategy's Sustainable Development of the Forest Sector programme resulted in Moldova's forest area reaching 435.4 thousand ha (12.9 per cent of total area) as of 2007.[83] The government of Moldova is committed to increasing the surface area of natural protected areas through the consolidation of the dispersed areas and establishment of a few national parks that will be linked with the National Ecological Network to address all aspects of biodiversity conservation. Moldova has also joined many other international treaties and conventions that guide its domestic policies (Table 12).

Table 12. International treaties and conventions to which the Republic of Moldova has signed up

Biodiversity-related treaties and conventions	• Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar, 1971); • Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 1979); • Convention on Biological Diversity (Rio de Janeiro, 1992); • Pan-European Biological and Landscape Diversity Strategy (Sofia, 1995); • Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 1979); • Agreement on the Conservation of African-Eurasian Migratory Species (Hague, 1995);
"Horizontal" treaties which refer to various environmental aspects, including biodiversity	• Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, 1992); • Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus, 1998);
Treaties and documents at ministerial level related to biodiversity conservation	• World Nature Charter (New York, 1982); • Action Programme on Sustainable Development "Agenda XXI" (Rio de Janeiro, 1992); • Convention on Cooperation for the Protection and Sustainable Use of the Danube River (Sofia, 1994); • The United Nations Convention to Combat Desertification in those Countries Experiencing Serious Droughts and/or Desertification, Particularly in Africa (Paris, 1994); • European Landscape Convention (Florence, 2000).

Source: *Environmental Legislation of the Republic of Moldova, Volumes I, II and III. Eco-TIRAS. Chisinau 2008.*

[83] Ministry of Ecology and Natural Resources (MENR) Institutional Development Plan 2009-2011, Chişinău, 2008.

For most international agreements and conventions, working groups and focal points were identified. However, due to the lack of financial support from internal sources these working groups have no legal power, and lack clearly identified plans. This substantially limits the implementation of the conventions. The centres and offices that were created with international support in the framework of different projects do not have long-term plans and are not sustainable without post-project support.

In the implementation of conventions on climate change, on combating desertification and on wetlands of international importance, there are different ministries involved with no clear focus on land degradation issues. Lack of knowledge and lack of willingness to apply sustainable practices make compliance with these conventions very difficult.

Access to and exchange of environmental information among different state institutions, research organizations and NGOs is difficult and in most cases the information is very costly and impossible to obtain for different reasons. Each ministry has its own data collection network which is inconsistent and incompatible with other institutions' data collection and storage formats.

The EU-Moldova Action Plan ratified by Parliament in February 2005 aimed at promoting and adjusting national environmental policy objectives to consider social and economical changes in the country and incorporate regional and global programmes and trends in order to prevent further degradation of the environment. Since then, new legislation and policies were adopted and many were oriented towards EU standards. However, due to institutional and financial constraints, in some key areas like the water sector, the adaptation of national legislation and policies proves to be more challenging. Further, less progress has been made regarding the practical implementation of legislation, programmes and agreements. Although there were considerable results obtained, it is mainly due to external support through different projects and international programmes and with less local support. One of the main obstacles for adjusting the national legislation to the EU standards is the lack of expertise and training of governmental officers. The administrative structures and procedures and institutional capacities need further improvement. Financial mechanisms for implementation are often missing. The capacities for environmental management at the local level are rather low and the implementation of different national and local strategies also lacks financial support, the strategies focusing on attracting international funds.

Currently, the legislative framework of the Republic of Moldova is quite adequate, favourable and sufficient to achieve the target goals of international conventions in the field of protection and conservation of biodiversity (see Table 13).

The Ministry of Environment (MoE) and Apele Moldovei are currently drafting several laws and regulations which will have a significant impact on biodiversity conservation. The MoE is drafting a Law on Environmental Protection and a Law on Wastes which are now available for public review. Apele Moldovei is at its final stages with regard to the new Water Law which is supposed to replace the old Water Code. These laws are oriented towards EU standards to ensure sustainable use of natural resources and protect them for future generations.

Possible adaptation measures and recommendations

However, although there are many policies for biodiversity protection, which have been developed and implemented continuously, there are currently no climate change adaptation measures included in any national legislation. Given that even highly developed countries such as the USA and many EU countries do not have yet adaptation measures in their national policies, this is not surprising. There are just a few EU countries who have adopted such measures (Germany, Hungary, the Netherlands, etc.).

At the EU level, member countries have concluded that in order to reduce biodiversity vulnerabilities there is a need to develop and implement new conservation approaches, such as the creation of national parks, water resources management and sustainable agricultural practices, focusing on integrating landscape management into development strategies on national and local scales. National governments are also encouraged to support climate change and biodiversity research because only with accurate information can policy makers formulate corresponding strategies to ensure the long term sustainability of adaptive measures.

Table 13. Republic of Moldova's national legislation on biodiversity protection

Laws regulating biodiversity	• Animal Kingdom Law: No. 439-XIII from 27.04.95 • Law on Zones and Strips for Rivers and Water Basins Protection: No. 440-XIII from 27.04.95 • Forest Code: No. 887 from 21.06.96 • Concept on Hunting Property Development • Law on State Protected Natural Areas: No. 1538-XIII from 25.02.98
"Horizontal" laws which refer to various environmental aspects, including biodiversity	• Environmental Protection Law: No. 1515-XII from 16.06.93 • Law on Ecological Expertise and Environmental Impact Assessment; No. 851 from 29.05.96 • Natural Resources Law: No. 1102-XIII from 06.02.97 • Law on Environmental Pollution Payment: No. 1540-XIII from 25.02.98 • Law on Green Spaces of Urban and Rural Localities: No.591-XIV from 23.09.99 • Law No.29-XV from 13 February, 2003 regarding joining of the Republic of Moldova to Kyoto Protocol of the UN Framework Convention on Climate Change (UNFCCC)
Laws at ministerial level which deal with biodiversity conservation	• Law on Monuments Protection: No.1530-XII from 22.06.93 • Law on Principles of Urbanistics and Territorial Development: No. 835-XIII from 17.05.96 • Law on the Red Book of the Republic of Moldova: No. 325 from 15.12.2005 • Law on the piscicultural fund, fishery and conservation of the aquatic biological resources: No. 149 from 08.06.2006 • Law on the National Ecological Network: No. 94-XVI from 05.04.2007 • Law on the zoological gardens No. 136-XVI from 14.06.2007
National Strategies and Action Plans	• National Strategy and Action Plan on Biodiversity Conservation of the Republic of Moldova (Government Decision 112-XV, April 27 2001) • National Programme on Setting Up of the National Ecological Network for 2003-2010 • National Plan to ensure Ecological Security for 2007-2015 (Government Decision 304, 17.03.2007) • National Action Plan to Combat the Desertification (NAPCD). (Government Decision 367, 13.04.2000) • Strategy for Sustainable Development of Forest Sector of the Republic of Moldova (Government Decision 350, 12.07.2001) • State Programme for regeneration and afforestation of forest fund lands for the years 2003-2020. (Government Decision 737, 17.06. 2003)

Source: *Environmental Legislation of the Republic of Moldova, Volumes I, II and III. Eco-TIRAS. Chisinau 2008.*

Generally, the poorer the nation is the more severe the impact on natural ecosystems and human development. The major challenge facing governments in poor countries such as Moldova is to decrease the number of poor and disadvantaged people and increase incomes, especially in rural regions. In this context, the adaptation measures shown in Table 14 need to be considered by policy makers at the national and local level. The most important may be establishing new policies based on an integrated landscape approach for biodiversity protection under different climate change scenarios and developing River Basin Management Action Plans for the sustainable use of water resources in order to meet the long-term sustainable development objectives of Moldova.

Table 14. Proposed adaptation measures

Adaptation measures	National	Local
• Prepare action programmes on national and local levels for maximum conservation of natural ecosystems, endangered species and their habitats	+	+
• Support and promote, acknowledge and implement interdisciplinary climate change research agendas involving a wide range of research and stakeholder communities	+	
• Establish new policies based on the integrated landscape approach for biodiversity protection under climate changes. Develop strategies to increase ecosystem resistance and resilience.	+	
• Creation of new biodiversity conservation centres that will monitor and take immediate actions to protect biodiversity in its natural state	+	
• Further develop and link the local ecological network to the national and international networks as well establish of national parks	+	+
• Possible transfer of rights to own and manage ecosystem services to private individuals. Examples from different countries show that the private sector can make significant contributions to biodiversity conservation.		+
• Use drought resistant species in the improving of forested ecosystems	+	+
• Develop sustainable restoration plans for steppe ecosystems	+	+
• Develop River Basin Management Action Plans for sustainable use of water resources and protection of meadow ecosystems	+	+
• Limit overgrazing of steppe pastures and river valleys in the southern and eastern parts of Moldova which are more vulnerable to the increasing occurrence of droughts (a specific example from a village in Moldova where such practice was introduced in 2009)	+	+
• Establish protective measures against invasive species	+	+
• Promote sustainable agricultural practices	+	+
• Limit all activities in protected wetlands and marshes. At the national and local level there are few activities underway to protect these areas which are considered to be in a critical conditions	+	+
• Establish a new systemic inventory and monitoring of endengered species and elaborate methodologies for their protection	+	
• Increase public awareness to protect environment and natural ecosystems. There is an urgent need to inculcate good ecological sense in people to protect the environment for future generations.	+	+
• Increase the capacity of the state and local budgets in order to adequately finance the required measures for the conservation and restoration of biological diversity	+	+
• Develop tools to facilitate communication within and between sectors, ministries and institutions, and especially between climate change and biodiversity research and policy communities	+	+
• Introduce payments for environmental services to protect biodiversity and carbon in agricultural landscapes	+	+

Source: *Authors' evaluations.*

Implementation of adaptation measures may be constrained by the following factors:

- Low institutional capacity development and insufficient integration of biodiversity conservation measures into local development plans;
- Low level of technical expertise of governmental officers;
- Political instability and lack of political will in adopting different regulations, laws, strategies;
- Low level of responsibilities on the part of national and local public authorities;
- Poor coordination of activities among different institutions and organisations;
- Lack of financial support to conduct research studies on climate change impact on ecosystems;
- Budgetary constraints to implementing policies at national and local levels;
- Weak development of the Protected Area System as part of the National Environmental Network;
- Low level of management capabilities within the Protected Areas System. Here, with support from UNDP and GEF a project on "Improving coverage and management effectiveness of the Protected Area System in Moldova" is being implemented starting June 2009;
- Poor ecological education;
- Lack of willingness to apply sustainable development practices in soil protection, water use and protection, etc.;
- Low enforcement with low fines for environmental damage caused by different economic activities as well as the wasteful attitude of most people with respect to forest, water, soil, etc.;
- Absence of a unified monitoring and information system.

Good governance is critical for ensuring that political objectives are effectively delivered on, especially for those that involve integrated actions across sectors. Due to weak state institutions in Moldova, international institutions can play an important role in providing guidance for the development and implementation of climate change scenarios. However national adaptation and mitigation programmes should involve all interested stakeholders in order to address local characteristics and specific challenges and opportunities.

In this respect a specific policy recommendation would be to include the ecosystem dimension in the National Adaptation Strategy for the Environmental Sector. The strategy in question could be developed to implement climate change adaptation measures for ecosystems and it could also include mechanisms that will ensure a successful implementation of respective provisions.

These provisions should be also reflected in other sector strategies that can directly or indirectly affect the environment and its ecosystems. In this respect the use of the Strategic Environmental Assessment (SEA) instrument for all relevant Strategies and Programmes would help in finding the best possible sustainable solutions or even a compromise to ensure further development of the country based on sustainable development principles and respecting MDGs.

Chapter

6

Impact of Climate Change on the Agricultural Sector

6. IMPACT OF CLIMATE CHANGE ON THE AGRICULTURAL SECTOR

6.1. Summary

Since most of Moldova is located in the sub-humid zone with frequent droughts during the plant vegetation period, it is critical to undertake measures to adapt Moldova's agriculture to the changing climate.

Due to its overwhelming dependence on climate conditions, agriculture is the most vulnerable sector of the Moldovan economy to climate change. Climate volatility is one of the main causes of unstable harvests and is an inherent risk of Moldovan agriculture. However, a number of macroeconomic and structural evolutions have also determined the current depressed state of agriculture. Among these factors the most important are: the growing share of subsistence farming at the expense of commercial farming; an inefficient system of agricultural subsidies; lack of investment funds; excessive division of farming land; and a destroyed irrigation system.

Climate, landscape and land are the basic natural conditions influencing agricultural yields. Generally, Moldova has favourable climate conditions and relief. The country's soils have a high level of fertility in the northern region and a medium level of fertility in the central and southern regions. However, natural calamities such as droughts, late spring frosts, hail, and floods frequently have a destructive impact on harvests. Furthermore, many land parcels are losing their natural fertility and require rehabilitation. If the soil protection issue is ignored and soil deterioration proceeds due to continued use of outdated farming techniques and a failure to adopt practices that protect against destructive effects of changing climate, agricultural productivity can be expected to face further serious declines.

Projected climate changes are likely to negatively affect wheat production, which has a central role in providing food security. It is also likely that climate change will affect the vineyards which are economically very important. If no alternative economic occupations are provided, these trends will drive more rural families into poverty and further encourage the depopulation of rural areas.

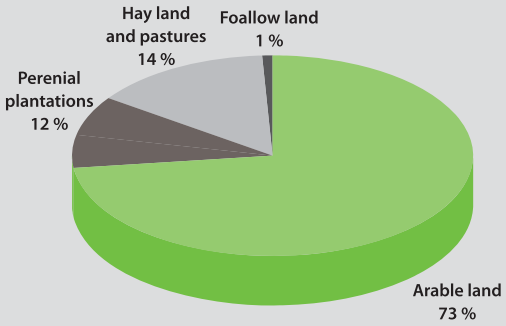
6.2. The current situation in Moldovan agriculture

From 1994 to 2006 Moldovan agriculture registered one of the most dramatic declines of output of all CIS and CEE countries. Declines in livestock production have been particularly acute. Collapsing agricultural output has resulted in rural inhabitants migrating to urban areas or abroad. The main causes of the decline include low levels of investment in the sector and inadequacy of recent reforms. Although tariff and non-tariff trade barriers present hurdles, the main obstacles to developing Moldova's agriculture lie within its national borders. Small peasant farms, averaging 1.5 hectares, as well as farmers in the central hot semi-humid and south hot-arid zones are the most vulnerable to the types of extreme climate conditions expected to become more severe with climate change. Provision of irrigation in appropriate areas within these two zones would provide significant benefits even under current conditions, increasing yields by 1.5 to 2 or more times as compared with yields without irrigation.

The total land area in the Republic of Moldova constitutes 3,385m hectares, including 2,506m hectares (74 per cent) representing agricultural land. As shown in Chart 24, the total share of arable land is 73 per cent, which is one of the highest levels in Europe. Nowadays, the Government owns 23.1 per cent of total agricultural land including 100 per cent of pastures; local public administrations have 21.5 per cent, with private ownership dominating the land structure at 55.4 per cent of the total.

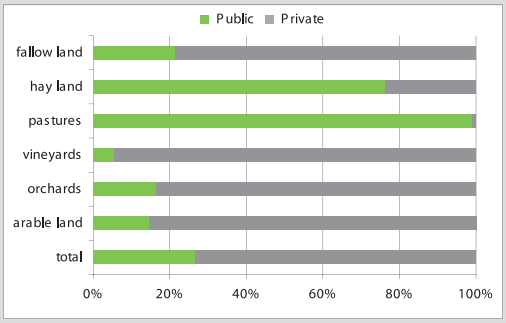
A variety of agricultural entities are active in this sector. On January 1, 2008, 259 farm cooperatives were registered, owning 7.9 per cent of total agricultural land; 109 joint stock companies (1.7 per cent of agricultural land); 1,344 limited liability companies (31.6 per cent); and 386,200 small peasant farms (28.4 per cent). Depending on the average area of tilled land, two major groups of entities can be identified. The first group includes large and very large farm estates and the second one includes small and very small ones. The middle-sized farm estates, which are considered the

Chart 24. Shares of land by destination as of 01.01.2008



Source: *Republic of Moldova Land Registry as of 01.01. 2008. Chisinau, 2008.*

Chart 25. Shares of agricultural lands by type of ownership as of 01.01.2008



Source: *Republic of Moldova Land Registry as of January 1, 2008. Chisinau, 2008.*

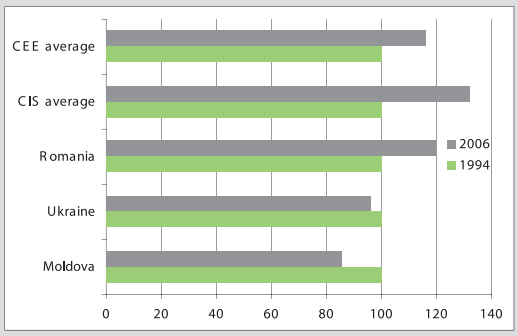
backbone of agriculture in most European countries, are almost absent in the national economy.

The average surface of land owned by farm cooperatives is 607 ha, by the joint stock companies 539 ha, and by the limited liability companies 466 ha.[84] The majority of these companies appeared as a result of the agricultural reforms in 1990s. In most cases only names were changed, while the same old farming techniques and management structures were retained. As a result, labour remuneration remains low and often takes the form of products not money. Peasant farms consist of small cultivated areas of land, averaging 1.5 ha, which are often divided into 3 to 4 plots,[85] and are mainly used for subsistence farming. Most of the peasant farms do not meet the conditions necessary to preserve the soil's fertility – crop rotations, fertilizers, and conservation works – and as a result the soils lose significant fractions of their fertility. These peasant farms are the most exposed and the most vulnerable to extreme climate conditions and to climate change.

The role of agriculture in Moldova's economy has declined in the past two decades. Without the subsidies and guaranteed access to the market that it enjoyed in the Soviet period, the sector has seen its production shrink, together with its share of GDP and the total labour force. Between 1994 and 2006, Moldovan agriculture registered one of the most dramatic declines of output of all CIS and CEE countries (Chart 26, Chart 27). Collapsing agricultural output has been reflected in the income of the rural population and many rural inhabitants found migration to urban area or abroad to be the best option.

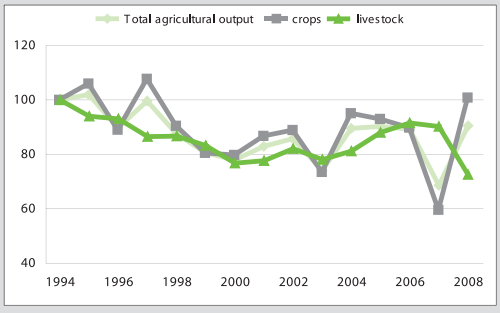
It is no surprise that agriculture has drastically declined as a share of GDP and of the total labour

Chart 26. Comparative analysis of agricultural harvest, 1994=100%



Source: *CIS Department for Statistics, EBRD, EG estimations*

Chart 27. Evolution of agricultural harvest in Moldova, 1994 =100%



Source: *Republic of Moldova Land Registry as of January 1, 2008. Chisinau, 2008.*

[84] Anuarul Statistic al Republicii Moldova 2008. Chişinău, 2008. p.315-358.
[85] Activitatea agricolă a micilor producători agricoli în Republica Moldova (rezultatele cercetărilor statistice). Chişinău, 2008.

force: in 1998, the agricultural sector contributed 26 per cent of the GDP and used 46 per cent of the country's labour force; in 2008 these shares were 11 per cent and 31 per cent respectively.

The declining competitive advantages of the agricultural sector and the diminishing income of the farmers were manifested by shrinking output of high value-added agricultural products such as apples, tomatoes, grapes and meat; and by an expansion of the areas sewn with wheat and sunflower. Between 1995 and 2007, the total area of orchards decreased by 30 per cent and that of vineyards by 20 per cent, while the area of lands sewn with grains increased from 50 per cent of the total area of crops in 1994 to 65 per cent in 2004. These developments are a consequence of farmers' diminishing incomes, since they cannot finance needed investments in higher value-added crops. The high value-added crops require more sophisticated technologies and better protection against unfavourable climate conditions. It should be noted that the increasing area of land sewn with grains and industrial crops (sunflower and sugar beet) was accompanied by unstable yields per hectare, as shown in Table 15. Yields of winter wheat, seed corn and sunflowers have fluctuated over the years, with 2008 yields of sugar beets considerably higher than previously. This suggests that yields have varied at least partly with climate conditions. The recovery of the crops sector in 2008 was paralleled by a further fall in animal husbandry. On average, the yields obtained in Moldova's agriculture between 1996 and 2008 are rather close to the levels registered in 1960s. This is an underlying indicator showing the depth of the current crisis in Moldovan agriculture.

The livestock sector experienced a downward trend from 1994 to 2000. Following a partial recovery between 2001 and 2006, a steep decline started in 2007. Between 1995 and 2006, cattle livestock decreased by 56 per cent, pigs by 41 per cent, and sheep and goats by 32 per cent. A fall in livestock numbers (Table 16) was the consequence of inefficient restructuring of large animal and bird farms as well as natural disasters which required mass slaughtering of animals and also the consequence of a lack of investment funds (livestock is more capital-intensive than crops). In fact, the current size of Moldova's livestock is even below one century-old indicators (except in the case of birds).

Livestock production in Moldova is very sensitive to climate changes as well, even though the reaction comes usually with a 6 to 9 month lag. The main channel of influence is a lack or shortage of fodder. In 2008, meat production across all farms fell by 23.1 per cent compared to the previous year, milk production by 10.3 per cent, egg production by 23.2 per cent. The steep 2008 decrease in animal products is the consequence of a decreased livestock population due to the severe drought in 2007. Most rural families raise cattle and depend to some extent on associated products. This means that more than half of the rural population is significantly exposed to the likely negative impact of climate change on livestock growing conditions.

Over the last decade cattle and pig livestock have moved from the large corporate farms to the peasant farms and households, where livestock is raised mostly for subsistence and not for commercial ends. Big agricultural entities have almost entirely abandoned the cattle and sheep industry; today they produce only 13 per cent of meat, 3 per cent of milk and 3 per cent of wool. A different situation is seen in the poultry sub-sector, where large companies produce 34 per cent of eggs and meat. This is probably the only livestock branch where Moldovan companies have a strong competitive advantage, but mostly on domestic markets. On the foreign markets, Moldovan meat and dairy products are not competitive because Moldova has not yet implemented the necessary institutional infrastructure that would guarantee that these products meet international health and safety standards. The main reasons for shrinking animal production are the small sizes of areas for grasing and forage plantations which result in an inability to achieve the economies of scale needed to be competitive on international markets, and low investment levels. It is interesting to note that in contrast to the decrease in most forms of livestock the population of horses and donkeys in peasant farms doubled over the period from 1996 to 2004, revealing the very low level of development of farming in Moldova and agricultural technologies which are used (horses and donkeys are used for ploughing and other agricultural works and for transporting the harvest).

A number of necessary but belated reforms were implemented in the agriculture of the Republic of Moldova in the 1990s: farm land privatisation,

Table 15. Evolution of key crop yields in Moldova, quintals/hectare

Years	Winter wheat	Seed corn	Sunflower	Sugar beet
1963-1965	15.8	27.7	15.1	192
1966-1970	20.3	33.8	16.4	256
1971-1975	33.7	35.8	17.6	279
1976-1980	34.9	35.7	16.5	278
1981-1985	34.2	36.1	18.1	246
1986-1990	37.9	39.3	19.6	287
1991-1995	34.6	27.1	13.6	248
1996	21.4	29.1	14.0	234
1997	32.4	39.7	8.7	221
1998	26.7	31.0	8.5	181
1999	23.5	28.3	11.9	152
2000	19.6	23.4	11.8	151
2001	27.2	23.7	12.2	182
2002	25.1	26.7	12.4	227
2003	5.0	25.5	11.1	174
2004	27.5	30.7	12.4	261
2005	26.1	32.7	12.0	290
2006	23.4	28.8	13.2	278
2007	13.1	7.8	6.7	179
2008	31.3	34.5	16.3	389

Source: *Informational system regarding the soil layer in Moldova, Pontos, Chisinau, 2000.*

Table 16. Livestock population in all farms, thousand heads

	Cattle	Pigs	Sheep and goats	Birds
1993	870	1,311	1,331	13,678
1994	816	1,015	1,420	11,826
1995	751	946	1,483	11,775
1996	644	910	1,394	11,965
1997	570	866	1,344	11,423
1998	485	724	1,209	11,613
1999	469	860	1,120	12,088
2000	423	683	1,030	12,575
2001	394	447	938	13,041
2002	405	449	947	14,119
2003	410	508	956	14,955
2004	373	446	938	15,756
2005	331	398	942	17,522
2006	311	461	938	22235
2007	299	532	947	22,531
2008	232	299	853	17,157

Note: *The table does not include Transnistrian region.*
Source: *Statistical Yearbooks of the Republic of Moldova.*

abolition of the central control system and price planning, free foreign trade etc. Nevertheless, these reforms did not contribute to a strong and sustainable economic development of agriculture. Total agricultural output in 2008 constituted 90 per cent of its 1994 level (Chart 27). Even the abundant harvest in 2008 after the drought from 2007 did not contribute to improving the situation but only recovered the pre-drought level. The key reasons for sluggish agricultural development are a lack of investment, insufficient company restructuring, and the government's controversial agricultural policy.

Land consolidation has been one of the Moldovan government's main policy objectives since 2001. The main argument was that small plots of land are a key factor behind the economic inefficiency of agriculture in Moldova. However, available evidence shows that small farms in Moldova are more efficient than the bigger ones,[86] including in production of high value-added vegetables and fruits. The current system of agricultural subsidies is another area of concern. This system is not only inefficient, opaque and complex, but also socially unfair as it clearly penalises individual companies and peasant farms and favours big companies. While dominant in terms of number, worked land and produced output, the share of these small farmers in total agricultural subsidies has decreased from 23 per cent in 2006 to 13 per cent in 2007-2008. Hidden taxation and prices policy is another key issue. In order to implement its social protection goals, the Government closely monitors wheat and flour prices in order to maintain low bread prices. This generates distortions in the distribution of added value along the production chain with farmers receiving the smallest part of the added value. In fact, farmers are forced to sell products at low prices in order to subsidise the consumption of urban dwellers.

Unfavourable climate conditions have had a negative impact on agriculture as well. However, climate risk could be mitigated by timely interventions for conducting proper agricultural works.[87] There are still several obstacles in the way of Moldovan agricultural export to key foreign markets (EU, Russia, Ukraine), such as tariff and non-tariff trade obstacles. However, the main trade obstacles for developing agriculture are those behind the national borders and are mainly related to inefficient agricultural and trade policy.

6.3. Potential impact of climate change on Moldova's agriculture

Food security and climate change

Climate change has the potential to seriously undermine Moldova's food security. Usually, there is no shortage of basic food in Moldova, and in ordinary years Moldova has the necessary means to ensure basic food for its population. A constant problem, though, is the unbalanced and even unhealthy diet that many Moldovans prefer for economic or cultural reasons. Indeed, as some research suggests, the diet of many Moldovans, especially those living in rural areas, is unbalanced and poor in necessary vitamin and protein intake (see HUMAN DEVELOPMENT IN MOLDOVA - THE BACKGROUND).

However, in times of drought and other extreme weather events, many problems with basic food availability can emerge as well, as patently proven by the severe drought of 2007. According to international estimates of the impact this phenomenon has had on ecology and agriculture, this drought was of catastrophic proportions.[88] In the 20th century such a phenomenon was registered only once in 1946-47.

In the catastrophic drought in 2007, 90 per cent of the country's territory and 80 per cent of the rural population depending on agriculture was affected by the diminished harvest. The savings and income of the rural population were lost, with total losses amounting to USD 1 billion, according to official estimates. Output of cereal crops diminished by 70 per cent compared to 2006, and the wheat harvest fell by a factor of 10. Many households were not able to maintain their

Table 17. Evolution of prices of basic food, MDL

	January 2007	January 2008	January 2009
Rice	9.8	13.0	24.7
Wheat flour	7.2	10.8	10.4
Sunflower oil	23.0	25.5	21.2
Corn flour	17.9	21.5	18.5
Canned pork meat	25.3	25.3	29.4

Source: *NBS.*

[86] World Bank, "Moldova Agricultural Policy Notes: Agricultural Land", December 2005.

[87] Productivitatea Rurală în Moldova– Gestiunea Vulnerabilității Naturale, BM, 2007.

[88] UNPD Europe and CIS, "Drought in Moldova is of catastrophic proportions", http://europeandcis.undp.org/home/show/C9199CF1-F203-1EE9-BE30A716AA49B88E.

livestock because of the lack of fodder. Bovine livestock diminished by one quarter, pigs by almost 50 per cent, and sheep and goats by 10 per cent, and the number of poultry by 25 per cent. By January 2008, many families had to liquidate their entire livestock resulting in a loss of food sources.

As result of the drought in 2007, both the overall quantity and the composition of food available to rural inhabitants worsened. Large families, single-headed households and families with disabled members have been assessed as being the most vulnerable in conditions of drought.[89] These groups faced an increased risk of malnutrition due to the acute food shortage, depleted winter reserves, and the slaughter of their livestock in order to have necessary cash or simply because of a lack of fodder. High inflation and low pensions and social allowances fuelled the deteriorating situation.

Poverty significantly increases the risk of malnutrition due to a rapid growth in prices accompanying and/or following droughts (Table 17). Increased food prices resulted in an increasing share of food expenditure in households' budgets, which were already strained as a result of increases in tariffs for electric energy, which were raised in three rounds in 2007 and in tariffs for gas which were raised in two rounds as a consequence of increased prices of energy resources imported from Russia and Ukraine. Together, these increases raised the cost of living, with the minimum subsistence budget increasing by 23.8 per cent in the first quarter of 2008 as compared with the first quarter of 2007. The population's disposable income in the first quarter of 2008 covered only 83.2 per cent of the subsistence minimum, as compared to 88.8 per cent in the first quarter of 2007.

In 2008, many families in Moldova were exposed to famine risk because of depleting stocks and rising prices. The Moldovan government was not ready to deal with the challenges presented by the drought in 2007 and many families main-

Box 12. Climate change as an opportunity for broader renewal in the country

Taking sound action against climate change means gradually introducing profound changes in the use of natural resources, production technology, energy, generation capacity and daily ways of live. These changes should not only be understood as a necessary strategy of protection against adverse climate trends but as an opportunity to provide the framework for other pending changes in Moldovan society and economic structure. Even if climate change as such might not be seen as a positive issue, it can serve as a driver for other changes that need to take place. A second driver for these changes is the demographic trend of an aging population which is getting steadily older with a lower proportion of young people.

Subsistence agriculture or subsistence agriculture combined with some market access is not a productive model for a long-term future in a modern society integrated in a European context and will most probably disappear within the next one or two generations, as happened in the last century in western European countries. Additionally, precisely the climate change effects make subsistence agriculture ever less feasible.

On the other hand, having access to fresh water, being able to produce food and having access to renewable sources of energy seem to be three of the most important present and future assets for development, considering the long-term trends of increasing demand for all three of these.

The possibility of taking advantage of the fact that there are resources available for food production in Moldova and that a midterm change in production technology could make this feasible even within a context of climate change, looks more promising if not implemented based on small-scale farming. Additionally, small-scale farming will not provide production surplus in the future that is sufficient to feed the country, considering demographic change in Moldova. So there is a need and an opportunity to start facing required changes now, within the context of climate change.

Source: *Authors' evaluations.*

[89] International Federation of Red Cross and Red Crescent Societies, "Moldova: Food Insecurity", DREF operation n° MDRMD001, Glide No. DR-2007-000175-MDA, 4 February 2008, http://www.ifrc.org/docs/appeals/08/MDRMD001.pdf.

tained their level of consumption only thanks to the external assistance received by the government. The prompt and decisive response by the United Nations and the international community mobilised funding, expertise and resources and contributed to reducing the losses, saving livelihoods as well as to recovering from the effects of the drought. The Food and Agriculture Organization and the World Food Programme have provided expertise, seeds, fertilizers and fuel. Financial support was provided by many bilateral agencies, including those from the Netherlands, Norway, Switzerland, Sweden, and Austria. Food parcels valuing in total USD 6 million were provided for pregnant women and nursing mothers via the European Commission's Humanitarian Aid Office and UN Population Fund.

The drought showed that Moldova has a shortage of human resources and equipment necessary to deal with such major events. The government's capacity to coordinate large-scale relief operations and to channel and distribute humanitarian aid to people most in need is also rather weak. The drought did force the Government to start, in August 2007, the elaboration of a Strategy for Sustainable Development of Agriculture. In April 2008, the development of a Food Security Strategy started as well. However the two documents were developed in a rather non-transparent environment and without much public consultation.

It has to be added that climate change can also affect crops (and consequently food security) in other ways, not only via temperature/moisture extremes. According to some research, climate change is a contributing factor to the occurrence and gravity of biotic diseases attributed to organisms such as fungi, bacteria, viruses and insects.[90] While such episodes are often registered in Moldova, their impact on food security has not been adequately studied so far.

At the same time, climate change can exert a significant impact not only on raw agricultural production but also on food manufacturing as an industry and on the food trade, with negative consequences for human development (see Box 12). A lack or shortage of agricultural raw materials can lead to increases in final prices for the food reaching the market. Also, hazards emerging in primary production related to climate change can influence the design and management of the food safety systems required to effectively control those hazards and ensure the safety of the final product. Finally, increasing average temperatures could increase hygiene risks associated with storage and distribution of food commodities.[91]

Exposure and vulnerability of national agriculture to climate factors

Current climate conditions in Moldova are quite favourable for growing a number of thermophile plants, even though there is a shortage of humidity in the country. At the same time, climate conditions have become increasingly volatile in the past two decades. Over this period, the agricultural sector of the Republic of Moldova has suffered severely because of droughts, soil erosion and wind, thunder storms and heavy rain falls, hail, spring frosts and floods; as modern research in climate change shows, these phenomena are significantly associated with global warming. In Moldova, these weather extremes primarily affected rural areas, where a majority of population practice low-performance farming and depends almost entirely on climate conditions. The national and international climate projections for the 21st century in Moldova, including the agro-climate parameters, are quite pessimistic from the perspective of their impact on agriculture.

Undoubtedly, agriculture is one of the managed systems most vulnerable to climate and the weather. For a correct assessment of climate change impacts on agrotechnology and crop growth, the projections of air temperature and precipitation should be transformed into some specific parameters of plants' heat and water supply. Some assessments rely heavily on *spatial user-oriented information* that can be extracted from the projections of key variables.

New conditions of heat supply (see Table 18) are estimated as changes in the duration of periods with daily temperatures above 0, 5, 10 and 15 °C as well as the degree-days sum of these temperatures. In Moldova, the transition of temperature over these thresholds denotes respectively the commencement/ending of spring, vegetation and active vegetations periods, and summer. The estimations were based on the good correlation of these indicators with mean monthly temperatures.[92]

In the future climate, due to earlier springs and longer autumns, it is expected that there will be a significant increase in the duration of the warm period both on the whole and by individual temperature gradations. For example, the duration of

[90] Lee-Ann Jaykus and others, „Climate Change: implications for food safety", FAO,

[91] Ibid.

[92] Corobov and Nicolenco, 2004.

Table 18. Possible heat supply change in Moldova under SRES emission scenarios

Characteristics	Time horizon						
	1961-1990	2010-2039		2040-2069		2070-2099	
		A2	B2	A2	B2	A2	B2
Transition of mean air temperature over 0 °C							
Beginning	60*	47	45	37	38	24	31
Ending	340*	353	355	367	364	377	369
Duration, days	278	305	310	330	326	353	337
Degree-days, °C	3,680	4,108	4,209	4,548	4,500	5,096	4,731
Transition of mean air temperature over 5 °C							
Beginning	82	75	72	68	68	60	64
Ending	314	321	322	327	327	335	330
Duration, days	232	249	253	264	263	283	272
Degree-days, °C	3,533	3,986	4,100	4,465	4,416	5,054	4,659
Transition of mean air temperature over 10 °C							
Beginning	106	101	97	94	93	87	91
Ending	290	297	297	304	303	313	307
Duration, days	184	196	201	210	209	225	215
Degree-days, °C	3,174	3,592	3,717	4,056	4,018	4,628	4,246
Transition of mean air temperature over 15 °C							
Beginning	134	129	127	122	124	115	121
Ending	266	277	278	287	287	301	293
Duration, days	132	148	152	166	164	187	173
Degree-days, °C	2,510	2,916	3,006	3,365	3,304	3,927	3,537

Note: * *- days from the beginning of year; durations of periods were calculated independently from dates of transition; close coincidence of the estimations (direct and trough the dates of transition) indicates validity of the method.*

Source: *Authors' calculations.*

warm temperatures may increase by 3 to 4 weeks in the 2020s and by more than two months in the 2080s. Periods of vegetation will also lengthen significantly. Increases in the seasons' duration are accompanied by a corresponding increase in degree-days. So, during this century, according to the SRES A2 scenario, the sums of active temperatures (above 10 °C) – most important for agricultural crop growth – may increase sequentially by about 13, 28 and 46 per cent.

Chart 28 presents an estimate of spatial distribution of Moldova's heat supply in the first third of the century. If, in the baseline climate the degree-days of active vegetation changed across the territory from 2,800 to 3,300 °C, then in the next three decades these figures could rise to 3,400 – 3,800 °C.

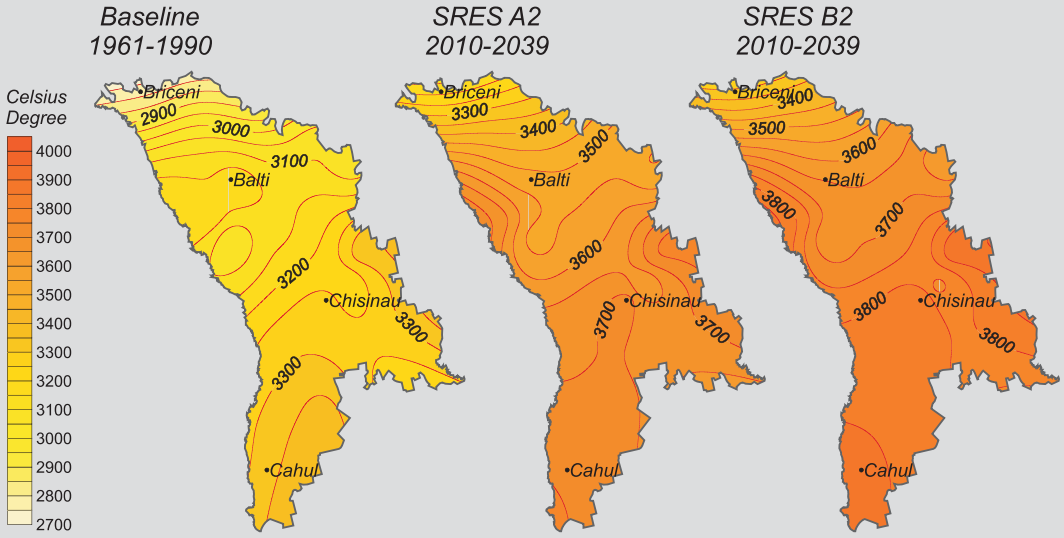
Of special interest for agroclimatic projections is the well-known Selianinov Hydrothermical Coefficient *(HTC)* because it characterizes humidity conditions in a vegetation period. Chart 29 demonstrates clearly the gradual aridisation of Moldova's territory, including in its northern areas, which today are still sufficiently wet.

Temperature and humidity are critical for agriculture, particularly for the crops subsector; as some authors suggest, in Moldova, the joint influence of temperature and humidity explains about 75 per cent of the variations in wheat harvests and about 40 per cent of variation in corn harvests.[93]

Some future trends associated with climate change could be positive for agriculture, such as a higher concentration of CO_2 in the atmos-

[93] Corobov R., Cealic S and Buiucli P., „Assessment of crop production sensitivity to likely climate change", in Corobov R. (ed.) "Moldova's Climate in XXI century: the projections of changes, impacts and responses", Chișinău, 2004 (in Russian).

Chart 28. **Sum of active temperatures (∑T > 10 °C), expected in Moldova by the 2020s in comparison with the baseline period**



Source: *Authors' calculations.*

phere, an increase in the duration of warm temperatures, an increase in solar radiation and an increase in the sum of active temperatures. These trends may accelerate plants' growth, lengthen the periods of vegetation, and increase the yields of the plants. For instance, it has been shown that doubling the concentration of CO_2 can increase the yields of wheat by about 28 per cent (a phenomenon known as the so-called CO_2-fertilization).[94] Higher temperatures and lower precipitation in the ripening period could increase the concentration of the sugar in grapes and improve the quality of the wines, especially of sparkling wines. Such trends alone would be beneficial for the Moldovan economy in which the winemaking sector plays a major role.

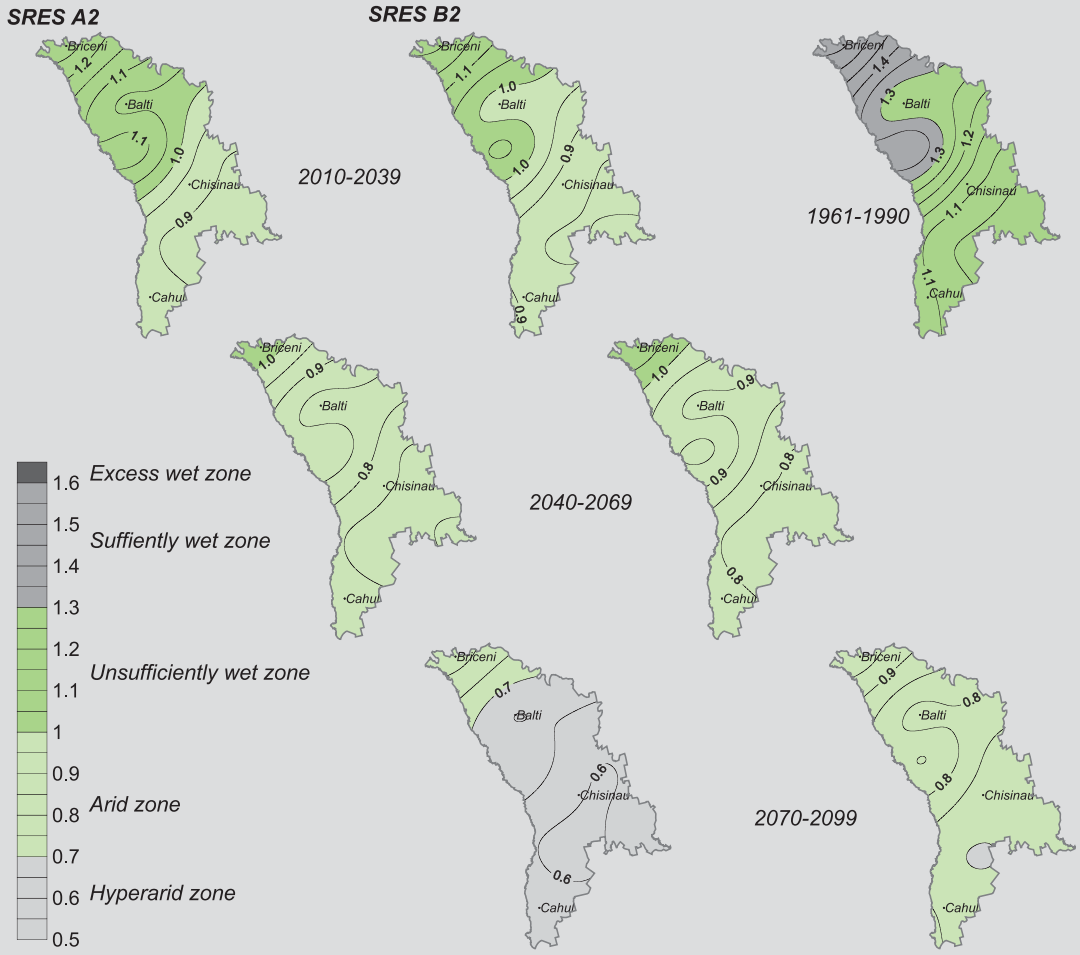
However, the leading experts in Moldova believe that overall balance of the climate change effects projected for the next 100 years is not favourable for Moldovan agriculture.[95] A rough economic assessment of the impact of climate vulnerability on wheat and corn in the period 1996-2008 suggests that net losses have so far exceeded net gains by far (Box 13).

Even a high concentration of CO_2 can actually lead to an opposite effect when associated with extremely high temperatures in the flowering period. Also, while increasing the yields, a high concentration of CO_2 results in lower crop quality. Higher temperatures associated with lower levels of precipitation raises the sugar concentration in grapes but at the same time can reduce the total yields, meaning the net outcome is very difficult to predict.

As compared with the animal subsector, the crop subsector is directly dependent on climate conditions. But the degree of harvest exposure and capacity to adapt to climate factors depend on the agropedoclimatic zone. An agropedoclimatic zone is a geographical region characterised by specific climate factors and land characteristics. Moldova is divided into three agropedoclimatic zones and some sub-zones[96] (Table 19). As shown in the table, the second sub-zone from the central zone and the whole southern zone are the most vulnerable to climate change. As national climatic projections show, these regions belong to those parts of the country where the aridity index is expected to increase the most in the next 100 years. Currently, the humidity coefficients in these areas have small values both in relative and absolute terms. In the first sub-zone, 2 to 3 droughts may occur per decade, while in the second one, the number of droughts may reach 3 to 4 during a decade. From past experience, a drought may harm 80 to 90 per cent of the grain harvest in Moldova. At the same time, soil is less fertile in these regions compared to the other

[94] Ibid.
[95] Ibid.
[96] Eroziunea solului. Esența, consecințele, minimalizarea și stabilizarea procesului. Pontos. Chișinău, 2004 și Sistemul informațional privind calitatea învelișului de sol al Republicii Moldova (Banca de date), Pontos, Chișinău, 2000.

Chart 29. **Baseline and projected spatial distribution of Selianinov Hydrotermic Coefficient (HTC) for three time horizons**



Note: *HTC = Pwp / 0.1 ∑T>10°C, where: Pwp – precipitation sum of warm period; ∑T >10°C – sum of air temperatures >10°C.*

Source: *Authors' calculations.*

zones, which further increases potential losses from the expected climate changes.

Soils may either intensify or protect plants from the impact of global warming depending on their quality and fertility. Over 65 per cent of Moldova's fertile soils have been negatively affected by ero sion, landslides and other degradation processes. Chernozem is the most important soil in Moldova, and is found on 2.510m ha, or 78 per cent of arable land. Such an asset is conducive to the development of conservation agriculture (Box 14). National food security depends on the quality and fertility of these soils. At the beginning of 1970, the average annual rating of soil quality across Moldova's arable lands was 70 points (on a scale from 1 to 100). According to the data from the 2008 land registry, the current average annual soil rating is 63 points (primary factors that influence the rating are fertility, soil structure, etc.). This decrease is the outcome of a range of soil degradation processes including soil erosion, landslides, decrease in humus, deterioration of the soils' structure through compaction, increase in soil salinity and soil droughts.[97] These processes break biological cycles, upset the balance of nutrients and humus, and diminish soil fertility. Poor soil structure and low fertility increase the vulnerability of agriculture to climate factors. This occurs because poor soil structure and low humus levels diminish water-retention capacity and lower plant resilience.

[97] Leah T., Cerbari V. Eroziunea solurilor – factor de intensificare a consecințelor secetelor// Secetele: pronosticarea și atenuarea consecințelor. Chișinău, 2000.

Box 13. Estimates of the economic impact of the climate change on production of wheat and corn

Because of the scarce statistical data, estimates of the losses/gains incurred by agricultural producers are very approximate. Estimates shown in the table below are based on regression equations describing the relationship between wheat and corn yields, respectively, and monthly characteristics of temperature and precipitation in the critical phases of crop growth (see more in Corobov R. (ed.), 2004). These regression coefficients were estimated using data for the baseline period 1960-1990.We assume that the coefficients are still valid. Based on the deviations of the reference monthly temperature and precipitations and baseline dependencies, we have computed the percentage contribution of the meteorological conditions in the vegetation period to the total variation in yields as compared with expected yields. Net losses/gains have been computed proceeding from the total area sewn with the respective crops and their average production costs (in USD/tonne).

Year	Winter wheat						Corn					
	Yield, t/ha	Winter wheat response, %	Yield losses as to baseline, t/ha	areas sown with wheat, thousand hectares	wheat production costs, USD/ tone	net income, million MDL	Yield, t/ha	Corn yield response, %	Yield losses as to baseline, t/ha	areas sown with corn, thousand hectares	corn production cost, USD/ tone	net income, million MDL
1996	2.14	-6.7	-0.2	335.0	74.3	-4.9	2.91	-4.9	-0.17	339.4	83.0	-4.8
1997	3.24	36.0	1.05	355.4	60.1	22.5	3.97	-12.0	-0.42	431.2	67.5	-12.3
1998	2.67	12.1	0.35	356.2	58.4	7.3	3.1	8.6	0.3	399.5	79.1	9.5
1999	2.35	8.3	0.24	340.0	42.3	3.5	2.83	-7.7	-0.27	403.2	54.4	-5.9
2000	1.96	-20.6	-0.6	369.9	58.2	-12.9	2.34	-11.1	-0.39	441.5	72.5	-12.5
2001	2.72	17.4	0.51	433.9	45.9	10.1	2.37	-12.6	-0.44	471.3	73.8	-15.4
2002	2.51	-7.2	-0.21	442.7	44.6	-4.2	2.67	-11.3	-0.4	446.7	76.0	-13.5
2003	0.5	-17.8	-0.52	202.0	147.9	-15.6	2.55	-20.5	-0.72	553.5	78.2	-31.1
2004	2.75	5.5	0.16	310.8	67.9	3.4	3.07	2.1	0.07	584.3	66.9	2.9
2005	2.61	6.2	0.18	401.2	67.9	5.0	3.27	2.3	0.08	455.9	79.1	2.8
2006	2.34	-18.2	-0.53	290.2	74.4	-11.5	2.88	-0.9	-0.03	459.3	91.1	-1.3
2007	1.31	-39.2	-1.14	307.1	151.4	-53.2	0.78	-19.3	-0.68	466.2	233.5	-73.7
2008	3.13	-1.5	-0.04	412.9	118.9	-2.2	3.45	-7.3	-0.26	427.2	125.1	-13.7
Total for 1996-2008						**-52.6**						**-168.9**

Note: **- plant relative response (% loss/gain as to expected) to a growing season weather conditions.*

Source: *NHDR team estimates.*

Year-to-year variations can be explained both by climate variability and poor quality of today's agriculture statistics in the country due to transition reforms in agriculture. Generally speaking though, the negative trends in losses/gains due to weather conditions support our general projections that observed changes in regional climate are unfavourable for Moldova's cereals. As shown in the table above, in some years, climate conditions resulted in positive gains for farmers, but for the entire period both wheat and corn producers seem to have suffered net losses. The years 2003 and 2007 stand out as years where losses are particularly high. In 2003, weather conditions in the vegetation period were adequate, but yields were lost due to difficult conditions in the winter and late spring frosts. The year 2007 was the one when a catastrophic drought led to a collapse of the agricultural sector. In fact, in 2007, losses were apparently bigger as the model used is not able to properly capture the impact of abnormally wide variations in climate conditions.

Table 19. Climate and soil parameters in the climate zones of Moldova

Indicator	North (moderately hot, semi-humid)		Centre (hot semi-humid)		South (hot-arid)
	Sub-zone1 The Plain of Northern Moldova	Sub-zone2 The Plain of Northern Moldova, front Dniester hills	Sub-zone1 The Plain of Central Moldova and Codrii region	Sub-zone 2 Terraces of the Dniester, Prut, Raut, Bic, Botna etc. rivers	The Plain of Southern Moldova, terraces of the inferior Prut and Dniester Rivers
Sum of t°>10°C	2750-2850	2750-3050	3000-3150	3000-3250	3100-3350
Average annual T °C	7-8°C	8-8,5°C	8,5-9°C	9-9,5°C	9,5-10°C
Annual amount of rainfalls, mm	550-630	550-600	550-600	500-550	450-550
Potential evaporation, mm	650-700	700-800	800-820	800-850	850-900
Moisture coefficient, K	0,7-0,9	0,65-0,8	0,7-0,8	0,6-0,65	0,5-0, 6
No. of droughts in 10 years	≈1	1-2	1-2	2-3	3-4
Altitude	200-300 m	100-300 m	200-400 m	50-200 m	50-200 m
Main types of soils	Brown soils, levigated Chernozem	Typical and levigated Chernozem, brown soils	Brown and grey soils	Casual chernozem	Casual chernozem carbonated and southern varieties
Soil match to agricultural crops	Seed bearing orchards, sugar beet, tobacco, potato, vegetables, grains, fruits, rape, soy	Seed bearing orchards, nuts, sugar beet, tobacco, vegetables, grains, sunflower, fruits, rape, soy	Vineyards, orchards, walnuts	Vineyards, orchards, walnuts, fall grains, sunflower, vegetables for irrigation, fruits, rape	Vineyards, kernel orchards, fall grains, vegetables for irrigation, aromatic and oily plants
Restrictions for some plants	Wine	Wine (only in ecologic niches at <200 m altitudes)	Weeding plants (erosion)	Sugar beet, soy, spring grains	Sugar beet, spring grains

Source: *Drought and methods of minimizing its negative impact, Chisinau, 2007 (in Romanian).*

According to some estimations, the negative impact on the national economy from soil degradation (direct and indirect annual losses) amounts to 4.801bn Moldovan lei (MDL) made up of 2.073bn MDL due to loss of agricultural output; 1.850bn MDL due to irreversible soil losses from slope erosion; and 878.3m due to losses from landslides and excavations for social needs; losses due to fertility destruction during the past 30 years amount to approximately 3.319bn USD.[98]

[98] Instrucţiune privind evaluarea prejudiciului cauzat resurselor de sol, nr.381 din 16.08.2004. Act al Ministerului Ecologiei şi resurselor naturale al RM. (MO al RM nr. 189-192 (1543-1546), 22 Octombrie 2004.

Table 20. Degree of exposure and adaptation of crops by areas

Area	Drought	Decrease of harvest	Rainfalls	Increase of t°C	Degree of exposure	Degree of adaptation
North	Weak -1 in 10 years	Up to 20%	70-80% from normal	By 1-1,5°C	Low	High
Centre	Strong - 1 in 5-6 years	20-50%	60-70% from normal	By 2°C	Moderate	Average
South	Very strong- 1 in 3 years	> 50%	< 50% from normal	By 3-4°C	High	Small

Source: *Drought and methods of minimizing its negative impact, Chisinau, 2007 (in Romanian).*

Corn and especially wheat are the most vulnerable to unfavourable climate conditions. Some regressions show that if the structure of crop species and agricultural techniques do not change in the future, under the projected increase in temperatures and reduction in amount of precipitations, the wheat yields may decrease by 25 per cent of the 1960-1990 baseline in 2010-2039, by 45 per cent in 2040-2069 and by 75 per cent in 2070-2099.[99] CO2 fertilization will not compensate completely for these losses in wheat production, but it is likely to offset the losses in corn production.

The changing climate conditions will affect the animals subsector in a direct, but more in an indirect way. In a direct way, high temperatures and lower humidity will increase the physiological stress and probably affect animal growth. The indirect impact will come via weather impact on grasing lands and forage plants – which are already in a dire situation in Moldova due to improper use of land – and will contribute to unfavourable evolutions in the animals subsector. Climate change can be expected to exacerbate this situation, contributing to a continuation in the unfavourable evolution of the animal sector and a reduction in the number of animal breeds. It is likely that the number of cattle will decrease while that of goats and donkeys in the southern part of the country will increase due to their greater tolerance for heat and their ability to subsist on more drought-tolerant forage. On the other hand, there may be more favourable development conditions for the animals subsector in the northern region of the country.

6.4. Policy discussion and recommendations

Policy framework

National strategy for sustainable development of the agro-industrial complex of the Republic of Moldova in 2008-2015

This strategy was adopted by the Government decision No. 282 from 11.03.2008. The purpose of this strategy is to create favourable conditions for sustainable growth of the agro-industrial sector and improve the quality of life in rural areas by improving the competitiveness and productivity of the sector. The need for adopting this strategy derives from many social and natural factors, including "excessive exposure of agriculture to natural conditions which are reflected in abruptly decreasing harvests in years with extreme weather events". According to the strategy, decreasing the degree of exposure of agriculture to natural factors can be accomplished by means of different measures and policies such as organisational measures; special measures preventing soil erosion, drought, flood and other destructive climate factors. Insurance services may constitute important support for diminishing the impact of climate factors on food security, especially in the case of hail, drought and frosts.

The main obstacles to implementing the strategy in 2008-2009 were internal limitations such as a lack of state support in rural areas, insufficient managerial and organizational skills, and a lack of financial support for implementing the strategy. At the same time, the strategy envis-

[99] Corobov R., Cealic S and Buiucli P., „Assessment of crop production sensitivity to likely climate change", in Corobov R. (ed.) "Moldova's Climate in XXI century: the projections of changes, impacts and responses", Chișinău, 2004 (in Russian);

ages a sophisticated mechanism based on additional programmes to be adopted for a number of sectors and regions which have to be further elaborated to accomplish the Action Plan itself. This can be seen as an important drawback because the original Strategy does not incorporate concrete measures to be taken for improving the situation.

National programme for preventing desertification

The Government adopted the National programme for preventing desertification with decision No. 367 on April 13, 2000. The purpose of this programme is to maintain and enhance soil fertility in the dry regions affected by desertifica-

Box 14. Conservation agriculture – a feasible method for facing climate change effects

Conservation agriculture (CA) is an application of modern agricultural technologies to improve production while simultaneously protecting and enhancing the land resources on which production depends. Application of CA promotes the concept of optimising yields and profits while ensuring provision of local and global environmental benefits and services.

CA is gaining acceptance in many parts of the world as an alternative to both conventional agriculture and to organic agriculture. Although the practice of conservation agriculture on a large scale emerged out of Brazil and Argentina, similar developments were occurring in many other areas of the world, notably in North America with zero tillage, and Africa and Asia with technologies such as agroforestry. Conservation agriculture is based on the principles of rebuilding the soil, optimising crop production inputs, including labour, and optimising profits. In deference to other approaches, conservation agriculture promotes a series of principles to achieve conservation objectives, rather than a particular technology. This is in recognition of the fact that global agriculture is practiced in many different ecosystems, and that technologies have to be carefully tailored to be successful.

CA is not 'business as usual', based on maximising yields while exploiting the soil and agroecosystem resources. Rather, CA is based on optimising yields and profits, to achieve a balance of agricultural, economic and environmental benefits. It is based on the idea that the combined social and economic benefits gained from combining production and protecting the environment, including reduced input and labour costs, are greater than those from production alone. With CA, farming communities become providers of more healthy living environments for the wider community through reduced use of fossil fuels, pesticides, and other pollutants, and through the conservation of environmental integrity and services.

Conservation agriculture is the integration of ecological management with modern, scientific, agricultural production. Conservation agriculture employs all modern technologies that enhance the quality and ecological integrity of the soil, but the application of these is tempered with traditional knowledge of soil husbandry gained from generations of successful farmers. This holistic embrace of knowledge, as well as the capacity of farmers to apply this knowledge and innovate and adjust to evolving conditions, ensures the sustainability of those who practice CA. A major strength of CA is the step-like implementation by farmers of complementary, synergetic soil husbandry practices that build to a robust, cheaper, more productive and environmentally-friendly farming system. These systems are more sustainable than conventional agriculture because of the focus on producing with healthy soils.

Conservation agriculture promotes minimal disturbance of the soil by tillage (zero tillage, direct sawing), balanced application of chemical inputs (only as required for improved soil quality and healthy crop and animal production), and careful management of residues and wastes. This reduces land and water pollution and soil erosion, reduces long-term dependency on external inputs, enhances environmental management, improves water quality

and water use efficiency, and reduces emissions of greenhouse gases through reduced use of fossil fuels. Conservation agriculture, including agroforestry, intercropping, specialty crops, and permanent cropping systems, promotes food sufficiency, poverty reduction, and value-added production through improved crop and animal production, and production in relation to market opportunities. Reduced tillage leads to lessened human inputs, in both time and effort – this is generally attractive overall.

Successful experiences in implementation of CA from Asia, Africa and South America show that CA provides good results at small scale and at huge scale farming and that it is adaptable to climate change problems such as lower rainfalls. For example, since when implementing CA technologies like direct sawing, the ground is permanently covered by green fertilizer plants, soil retains humidity better and provides higher productivity with less precipitation. Of course, even a CA farm with higher precipitation performs better than one with less precipitation, but after all within a context of reduced water availability, a CA farm performs better than one which implements traditional technology.

CA allows increasing soil productivity, even while needing less labour than traditional methods. Higher outputs provide higher income; even if market access conditions or crop prices remain the same (do not improve). Since smallholders are among the poorest in Moldova, they would benefit widely from such an increased income.

Source: *Extract of Dumanski, J., et al, 2006; The Paradigm of Conservation Agriculture, United Nations Economic and Social Comission for Asia and the Pacific (edited for this report).*

tion processes. Generally speaking, one can affirm that due to insufficient financial support, the programme was only partially implemented.

According to the programme, in order to enhance soil fertility, it is necessary to identify the factors which contribute to dry land expansion, undertake preventive measures against it, reduce the impact of the drought, and better set out the responsibilities of the government, local communities and land owners. The programme identifies climate change as one of the two major factors contributing to dry land expansion (the second factor is anthropogenic influence).

The programme targets lands which are not yet fully degraded or have already started to dry out. It is expected that the programme will contribute to consolidating climatological, meteorological and hydrological capacities to make timely weather forecasts. Another purpose of this programme is to consolidate institutional cooperation at all levels between donors, government and local administrations. To successfully implement the programme and elaborate and implement proper land-use decisions, it is necessary to involve the population and nongovernmental organizations on the local, national and regional level.

The Action Plan of the Programme was financed in the limits of the approved budget, but also from private resources of the agricultural companies, from the governmental and local ecological funds and by international organizations.

National programme for exploring new lands and increasing soil fertility in 2003-2010

This programme has significant potential to protect and improve Moldova's agricultural soils. However, due to financial and organisational limitations, the programme's stipulations are being implemented only slowly and partially.

This programme consists of two parts. The first part, the "Complex programme for improving degraded soils" was set out in government decision No. 1027-402 dated 04.05.1998. The purpose of this programme is to protect national soils from erosion and recover damaged soils. The programme stipulates required measures and allocated expenditures by regions, in some cases – by groups of communities. It includes the list of priority anti-erosion works which need to be done first during 2003-2010. The programme is being executed within the limits imposed by very scarce financial resources.

The second part of the programme, "Complex programme for increasing soils fertility" was elaborated by government decision No. 728 dated June 16, 2003. The purpose of the programme is

to contribute to preserving and/or increasing the fertility of both degraded soils with low productive potential and those less affected, by rational use of fertilisers, crops rotation, irrigation and other regeneration measures for providing food security.

The programme includes a number of objectives:

- Evaluating the current degree of soil fertility using research on humus losses;
- Taking a quantitative and qualitative inventory of resources needed for increasing soil fertility, including required amounts of organic and industrial fertilizers;
- Soil fertility conservation through the use of sound crop rotation, best-practice for plant-bed preparation; and application of fertilizers according to national standards;
- Increasing irrigated soil fertility by establishing quality indicators for water sources and their suitability to irrigation purposes.

For financial and organisational reasons, the programme provisions are being slowly and partially implemented. Some actions have been implemented according to schedule, but most are lagging behind the plan. A lack of proper cooperation between central and local authorities and lack of private and public funds for the implementation of costly actions are the main barriers.

National programme on ecological food production

The programme was adopted by government decision No. 149 dated 10.02.06. The programme states that ecological products may contribute to sustainable development of agriculture, by helping find efficient social, ecological and economic solutions. Ecological food production is defined as a sustainable way of obtaining food products without using such chemical components as mineral fertilisers, insecticides, herbicides and fungicides. Ecological food production is based on maintaining a productive soil through the use of organic fertilisers, proper crop rotation and balanced crop structures, as well as by fighting crop diseases and pests through biological methods. The programme contains certain basic objectives, including environment and soil protection; increasing soil fertility; elaborating and using proper animal raising models; protecting natural resources.

The government has provided relatively small sums of money for the implementation of the programme's measures: 2 million MDL in 2007, 4 million in 2008 and 5 million in 2009, which is only 11 million USD in 3 years. However, the basic progress indicators seem to have been met, according to recent information. Currently, about 32,000 hectares are part of the ecological food production system (1.2 per cent of total agricultural land), a three-fold increase compared with the situation in 2006. The programme set the target of reaching 31,000 hectares of land under ecological cultivation by 2010. However, it is clear that global warming and smaller amounts of rain may have negative consequences for ecological produce and harvest collection, particularly in the flowering period, depending on the intensity and length in time of the factor. These trends may undermine further enlargement of the ecological sector in Moldovan agriculture.

National Programme "Moldovan Village" (2005-2015)

This programme was elaborated as part of the National Strategy for Economic Growth and Poverty Reduction and represents the political framework for sustainable rural development in the Republic of Moldova between 2005 and 2015. According to the programme the natural environment in the rural area is continuously degrading due to irrational use of natural resources, over-intensive exploitation of farm lands, use of harmful technologies, and water and air pollution. To some extent, this programme takes into account the changing climate and its impact on rural development. According to the programme in order to adapt to changing climate, it is necessary to increase the forestation level, by planting and regenerating the protective forest stripes around agricultural land, including by using carbon credit resources for achieving this goal. The programme also stipulates a range of measures for improving weather monitoring and the forecasting system. However, there is not enough information regarding the implementation and monitoring of this programme. The last governmental decision assessing the implementation of the programme dates back to 2006, and at that

time the government warned ministries, governmental agencies and local public administration to "speed up" its implementation.

Adaptation measures and recommendations

Land irrigation as adaptation strategy: how feasible it is?

Moldova is located in an insufficient wet zone which results in a high frequency of droughts, particularly in summer. Low amounts of precipitation constitute the main natural factor which contributes to the insufficiency of humidity. The amplitude of the negative impact that droughts can exert on the agriculture of the Republic of Moldova was shown in 2000, 2003 and, the most recent and severe episode, in 2007. The only solution for offsetting insufficient rainfall is artificial land irrigation, but it is not universally applicable in the whole country. Even more, as shown in the chapter CLIMATE CHANGE AND WATER RESOURCES, in this century the global warming may significantly contribute to a reduction in the quantity of water available for irrigation.

The most widespread irrigation systems in Moldova are irrigation by canals, by sprinkler and the drip irrigation. These systems are used for field crops, vegetables, orchards and vineyards. Drip irrigation has introduced to modern agriculture the concept of combining fertilisation with irrigation, using the irrigation water to distribute the fertiliser. Although considered the most efficient system for orchards and vegetable plantations, dripping irrigation is not widespread in Moldova.

During the Soviet period, there were about 100 centralised irrigation systems which were used to irrigate 310,000 hectares of land (including 110,000 hectares on the left bank of the Dniester and 200,000 on the right bank). The Dniester and Prut rivers were used as water sources for these irrigation networks in the past. However these systems were inefficient, heavily energy-intensive and were designed only to suit the needs of the large collective farms. According to recent assessments, some parts of the former irrigation network (50,000-55,000 ha) can no longer be repaired, because of the high costs of pumping water and their remote placement. The total land area in Moldova which can be cost-effectively restored for irrigation constitutes about 145,000 hectares. At the same time, about 400 artificial and natural lakes can be used for irrigation purposes but only to a limited scale due to the poor quality of the water.[100] These sources can provide water for irrigation of about 36,000 ha.

In the 1990s the irrigation system gradually became useless. Out of the 145,000 hectares of land with irrigation potential on the right-bank of the Dniester, only 4,000 hectares were irrigated in 2001. This indicator can be explained by the degradation of the irrigation systems, frequent electric power cuts in the 1990s and changing land ownership. Since 2001, investments have increased the total irrigated area to 35,000 hectares in 2008. Some international donors contributed to renovating the irrigation system in the country. In 2005-2006 the National Agency Apele Moldovei received a 32 million MDL grant from the European Commission which was used to extend the irrigation area by 11,000 hectares and renovate 15 water pumping stations.

The drought of 2007 had a significant impact on farmers' and the government's approach to irrigation, as they realised that high-performance agriculture in Moldova is impossible without irrigation. Apele Moldovei, which manages national water resources, devised a programme for improving the use of national water resources between 2008 and 2015. The government, however, has not yet adopted the programme. According to the programme, it is necessary to irrigate a total of 300,000 hectares of land in order to ensure food security and a stable harvest of the main crops. At the same time, the programme states that irrigation capacity could potentially increase to 500,000 hectares. According to the programme, the latter objective will become possible after renovating efficient irrigation networks, building new irrigation systems and implementing the "small irrigation concept". When restoring former irrigation networks it is necessary to take into consideration not only economic efficiency but also the protection of soil and other environmental features.

The objective of enlarging the irrigated area may be unfeasible in the long run if current climate projections are confirmed and water resources become scarce. Therefore, it is much more important to examine how to increase the efficiency of the renovated irrigation network rather than simply to extend the network. Experts emphasise that drip irrigation would be the most efficient and could generate high revenues for farmers if used in orchards, vineyards, and in vegetable growing. Some best practice suggests that investment in

[100] THVA project.

this type of irrigation could be recovered in one year. The outcome of drip irrigation varies according to the agropedoclimatic zone of the country. In the north, irrigation may contribute to 30 to 40 per cent increase in harvest yields; in the centre by 1.4-1.8 times and in the south by 1.8 to 2.5 times. Irrigation thus provides the greatest benefits in zones already experiencing water scarcity and which are expected to face the more severe deficits under conditions of climate change.

However, not all lands in the country are suitable for irrigation and if not applied properly, sodium and salts may harm the soil, diminishing the humus layer and destroying soil structure, compacting it, and resulting in ponding, and in some instances marsh-type conditions. According to some estimates, out of 2,682m hectares of arable lands, only 1,237m are suitable for irrigation. Suitability is limited by both land and water characteristics, and degradation processes have further reduced the land areas which can be irrigated.[101] The degree to which land is suitable for irrigation depends on a range of factors, such as: landscape factors (only arable lands with a 2 degree slope can be irrigated); soil type (only full profile soils can be irrigated); level of ground waters (deeper than 2 m for plain soils).

The soils of the Republic of Moldova are quite complex. Over 65 per cent of fertile soils are affected by erosion, landslide and other processes. These destructive factors diminish the land areas which can be irrigated.[102]

The extension of irrigation to the central part of the country represents a dangerous factor in conditions of uneven relief and frequent landslides. In the south of the country where the salinization risk is higher, it is necessary to make a careful selection of soils which are suitable for irrigation. In the north of the country underground waters are situated 4-7 m under the surface, which constitutes a risk for marsh formation.

There are also concerns related to water quality. In the north of the country, waters have a lower salt content, while in the centre and south of the country water used for irrigation has a higher degree of mineralisation. Water from the Danube, Dniester and Prut rivers meets quality indicators and its use for irrigation does not contribute to soil degradation. In smaller national rivers, the water is of good quality in the upper reaches. In the middle and lower reaches, the quality of the water is not suitable for irrigation. There is also high salt content in lakes (the mineralisation degree ranges between 1,0 and 3,0 g/l) as well as other chemically dangerous contents. Using such water in irrigation may lead to the soil becoming over-saturated with salt. There are only 3 national water basins (Costesti, Ulmul and Cahul) which store good quality water for irrigation.

Adaptation strategies

Given that most part of the country is located in the sub-humid zone, with frequent droughts during the plant vegetation period, it is crucial to undertake measures to adapt national agriculture to the changing climate. These measures include improving weather forecasting capabilities, protecting soil fertility, extending efficient irrigation systems and ensuring proper crop structure. To achieve a positive outcome for the adaptation programmes, it is necessary to devise sustainable action plans for the sector at both national and local levels.

In order to limit the dramatic consequences of drought and other extreme weather events for Moldovan agriculture it is necessary to use the land according to its soil and climate conditions potential in each agropedoclimatic zone of the country. At the same time it is clear that climate change will in any case dramatically affect the national economy and agriculture. In order to reduce the climate change-related risks and the anthropogenic factor causing climate change it is necessary to introduce new sustainable resource management systems.

There are several options for adaptation, starting from technical ones to an individual approach, including weather forecasts, improved risk management, crop insurance and biodiversity conservation for reducing the impact of climate on people. To achieve a positive outcome for the adaptation programmes, it is necessary to elaborate sustainable sector specific national and local action plans.

There are certain obstacles when attempting to adapt agriculture to the changing climate. Specifically, it is necessary to elaborate regional models and climate scenarios for each agropedoclimatic zone to provide information on the frequency and duration of droughts and frosts and to diminish the uncertainty rate. Once such information is available, it is necessary to elaborate and implement appropriate good practices in agriculture in all farms. Further, coordination and cooperation on

[101] Recomandări pentru prevenirea degradării cernoziomurilor irigate. Chișinău și 1996 Seceta și metode de minimalizare a consecințelor nefaste. Chișinău, 2007.30 pag.

[102] Recomandări pentru prevenirea degradării cernoziomurilor irigate. Chișinău și 1996 Seceta și metode de minimalizare a consecințelor nefaste. Chișinău, 2007.30 pag.

the national and international level is needed to obtain and allocate sufficient resources. A number of general and specific measures can be elaborated for adapting agriculture to climate change.

No regret measures

- **Drought**. Risks resulting from drought can be diminished by using modern farming methods, by adapting plants to climate conditions, by achieving optimal soil irrigation, and improving weather forecasting. It is crucial to improve the drought forecasting capacity of the National Weather Forecast Service in Moldova, by providing access to European forecasts and EUMetsat satellite data. Improved weather forecasts and early warning systems would give farmers the necessary time to take precautionary measures. In this regard, it is necessary to identify the most drought-prone zones at a micro-level in order to develop more specific adaptation measures. Such detailed analyses have not been done in Moldova so far, however necessary in order to adopt measures that are tailored to micro-level conditions.

- **Soil erosion**. Soil erosion may be prevented by specific agricultural measures, better selection of crops and better use of efficient irrigation, by using proper growing and harvesting techniques, slope forestation, and slope water collection. A key precondition for this is better education of individual farmers and managers of the big agricultural entities. Soil erosion may be controlled by the use of engineering interventions. However, the most cost-effective method for preventing soil erosion is planting trees on affected land. Moreover, it is necessary to improve the soil erosion monitoring system and draw up maps that indicate levels of soil risk. Many studies and much research on this issue have already been done, but for these efforts to continue more and better targeted financial support is necessary from the central and local budgets. Equally important, a better monitoring of the use of these funds should be established.

- **Convection factors.** Large harvest losses are also caused by convection factors in the May-August period and by late spring frosts in May. Weather storms are frequent from May to August. Hail, heavy rainfall and storms contribute to small rivers overflowing. Weather forecast bureaus also need special micro-climatic maps in order to make timely warnings against spring frosts. Using an anti-hail missile system is expensive while its benefits are uncertain and its extension is not recommended. It is reasonable to introduce anti-hail radar detection, which may contribute to providing higher-resolution weather forecast data.

Policy recommendations

Moldova is a country with a soil resource that represents a way of living for the more than 30 per cent of the population[103] that depends on agriculture. Still, agriculture only contributed 10.9 per cent of Gross Value Added in 2008. To reflect this issue and adapt agricultural development to climate change a National Adaptation Strategy for the Agricultural Sector could be developed and/or amendments should be made to the current agricultural development programme.

These changes should be advanced by the Ministry of Agriculture and the Food Industry, in conformity with international agreements and conventions signed and ratified by the Republic of Moldova, under the supervision of the Inter-ministerial Adaptation Commission. This Commission would control the process of elaboration and will ensure that all sector strategies are linked and exclude the possibility of conflicting provisions.

The same adaptation strategy and/or amendments could provide for provisions on public awareness and information regarding sustainable development, new techniques and technologies in the agricultural field.

Priority Recommendations:

- It is particularly important for Moldova to have scenarios for agro-climate development. These projections, along with a suitable information system, would enable the community to respond and/or adapt in time to possible threats to climate. The proposed Adaptation Strategy for the Agricultural Sector or

[103] www.statistica.md National Bureau of Statistics, Distribution of employment by sector of economy chart, 2000-2007. Last consulted on August 2, 2009.

specific amendments to the current National strategy for the sustainable development of the agro-industrial complex could include specific provisions regarding collaboration among authorities, academia and interested organizations (the Climate Change Office, the Institute of Geography, Hidrometeo, etc.) for the establishment of such an information system. If this liaison could be established, it would involve scientists and experts in the process and ensure the release of comprehensive information to all interested stakeholders, thus increasing the level of understanding of existing problems.

- The existing consulting service on agricultural matters should be improved, to ensure a correct use of available information and monitor the evolution of applied methods. Nevertheless, it will teach the general public the correct ways of producing and using fertilisers. Performing a reorientation of the agricultural development so that it would take into account not only existing environmental problems, but also possible climate change impacts could be a way of raising standards of living in Moldova.
- Applying no-regret measures would be a first step toward boosting Moldova's development, specifically in the agricultural sector. These measures should be identified by the experts in the field, with the involvement of the Ministry of Agriculture and the Food Industry, and promoted through a wide public information and awareness campaign.
- Connecting agriculture to regional development, which in Moldova are separate, would positively influence further development.
- Development of an agricultural market system in rural areas would have a beneficial impact on the national economy and on rural human development. The market could be developed by improving local level and national level communication between authorities through an informational system, by supporting private agricultural (including livestock) producers, and establishing state subsidies for this economic sector. The Ministry of Agriculture and the Food Industry, with the participation of the Ministry of Economy, could establish the structure and a regulatory framework for the agricultural market system.

Concrete solutions to be considered by the Government:

i. Agricultural restructuring

- Provide favourable conditions for a functioning agricultural land market in order to increase the minimal size of peasant farms and promote farm enterprise models which have sufficient agricultural equipment for conducting land works;
- Improve national standards and legislation according to the CEE Directive nr.209/91 on ecologic agriculture;
- Introduce a 4-7 year crop rotation in order to protect soil structure and fertility;
- National authorities should promote single-farmer agricultural management and control systems;
- Producers should agree to establish a minimal area of 10 hectares to use for appropriate crop rotation methods and agricultural equipment;
- Establish a viable economic mechanism which would improve price, credit and tax policies and contribute to implementing a sustainable agricultural system;
- Provide governmental support for implementing a sustainable agricultural system in all types of farm enterprises, with no regard to the economic or geographical dimension;
- Develop a preferential financial support programme for eco product farmers;
- Approve in the state budget the necessary financial resources for conducting annual soil researches on a 200,000 hectare area and developing

standard "Set of measures for increasing soil fertility" in various farm enterprises at all levels;

- Speed up reimbursement of VAT to farmers when purchasing fertilisers and chemical merchandise for plant protection;
- Adopt a new crop structure more adapted to climate change.

ii. Education and outreach programmes for farmers

- Create the necessary training and educational infrastructure for further promotion of the sustainable agricultural system;
- Promote with governmental support the best models of agricultural exploitation for small, medium and large farms in the 3 pedoclimatic zones of Moldova (North, Centre and South);
- Launch sustainable agricultural practices in these farm enterprises and work toward their gradual implementation across the country;
- Introduce modern land tillage practices, with a preliminary testing phase in 2-3 farm enterprises and further improvement and adjustments to the climate conditions of Moldova;
- Improve the national research system for conducting required land zoning works in order to enhance the land and environmental conditions according to sustainable agricultural system requirements;
- Identify in national and international collections the genotypes which are best adapted to expected climate change and introduce them in the national selection process;
- Introduce and promote agrotechnical measures enabling the conservation of the water in the soil in the drought period;
- Implement crop rotation with a mandatory perennial plant share of 20-25 per cent;
- Provide scientific support to agriculture and to ecological food production.

iii. Developing agricultural techniques and infrastructure

- Improve the crop rotation system and accumulate biological nitrogen in the soil by increasing the share of vegetable plantations to 20-25 per cent; enrich the soil with chemical and organic nutrients;
- Increase the plants' drought-resistance by introducing phosphor and potassium fertilisers in the sewing period and introducing phosphor, calium, borium and microelements in the flowering period;
- Optimise the nutrition regime of the soil by administering 10-12t/ha of organic fertilizers annually and 200-220 kg/ha of active NPK;
- Develop a biological agricultural register (product range and ecological classification);
- Develop a corresponding infrastructure for achieving technical and material endowment of the sustainable agricultural system (machines, seeds, fertilizers, fuels, pesticides etc.);
- Periodic checking of the quality of water used for irrigation;
- Conduct agrochemical and soil research for checking soil quality;
- Respect tillage methods on irrigated soils;
- Establish Irrigation Water Consumer Associations;
- Establish national laboratories with modern equipment for conducting agricultural product quality certification;
- Develop infrastructure for collecting, storing, processing and selling on of agricultural products;
- Ensure integrated plan protection from weeds, diseases and harmful agents;
- Implement the production techniques of conservation agriculture.

Chapter 7

The Impact of Climate Change on Transport Infrastructure

7. THE IMPACT OF CLIMATE CHANGE ON TRANSPORT INFRASTRUCTURE

7.1. Summary

Moldova's roads are perceived as the worst in the transition country group and the worst in Europe. Many actions envisaged for infrastructure development in the Strategy for Land Transport Development for 2008-2017 will indirectly or directly help the sector deal with challenges related to the climate change. However, the Strategy contains no explicit mention of specific imperatives imposed by climate change on roads and railroads; and strengths, weaknesses, opportunities and threats (SWOT) analyses fail to identify climate change as a main threat. The poor condition of roads is already a significant constraint to economic growth and poverty alleviation in remote areas. The negative impact of climate change on roads could further marginalize those isolated communities that already suffer from a lack of access to the national labour and product markets.

7.2. The current condition of the transportation system

Roads

Transport infrastructure is a critical precondition for inclusive economic and human development (see Box 15). But roads are of particular importance for the economic and social development of Moldova. Being a geographically small and landlocked country, a decent network of national and local roads is the optimal solution for transporting both freight and passengers inside the country and for middle distance international transportation. Presently 95 per cent of passengers and 30 per cent of freight is transported by road.[104] International roads are also vital for Moldova's integration into the regional economy. The Pan-European ninth transport corridor (Helsinki-Alexandroupolis) crosses Moldova's territory, as well as four other important international

Box 15. Transport infrastructure as a necessary condition for growth – a means for human development

The positive relationship between infrastructure and economic growth is well known, and requires little further elaboration. Ironically, however, the links between infrastructure and human development are often less well recognised and are not enunciated in terms relevant to policy.

It is obvious that infrastructure contributes directly to conditions of life not only by increasing labour productivity, but also by providing a range of amenities that are either necessary or desirable for human existence. The crucial role played by infrastructure development in creating better conditions of life has been highlighted again and again. Transport and communications infrastructure is important in terms of providing access to basic health services and thereby improving conditions of health and life, particularly for women and female children.

Infrastructure affects human development in two ways: first, it supports the processes of growth on which much poverty reduction depends; and second, it helps the poor access basic services which can improve their lives and income opportunities. At its best, infrastructure can draw poverty reduction, service provision, and growth into a self-reinforcing virtuous cycle. Infrastructure also has an important impact on human development and poverty through growth. It is also an intermediate input into production. Without power and water, all but the most basic production would grind to a halt. It raises the productivity of factors of production by generating the power that allows factories to mechanize, by allowing workers to get to work quicker, or by providing the networks through which information on health can pass electronically. Infrastructure connects goods to markets, workers to industry, people to services, and the poor in rural areas to urban growth centres. Infrastructure lowers costs, enlarges markets, and facilitates trade.

Source: *NHDR team.*

[104] National Bureau of Statistics, "Passengers and cargo transport in 2008", http://www.statistica.md/newsview.php?l=ro&idc=168&id=2486

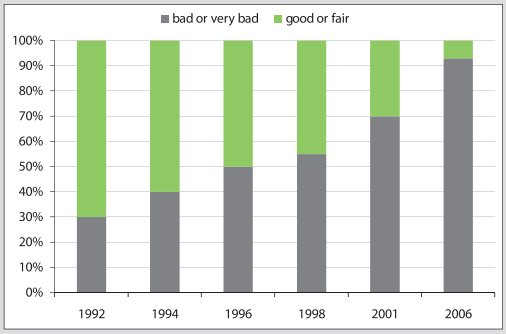
highways. It is no surprise that, as shown in a recent research, the poor condition of the roads is a critical constraint to Moldova's economic growth.[105] Obviously, this has negative implications for human development and economic and social equity as well, because economic growth is limited only to big urban areas whereas rural areas remain depressed.

With regard to density of the total road network, Moldova is in line with regional standards, with a road density indicator (37.6 km/100 sq. km.) quite close to that of Bulgaria (39.7) and Ukraine (28.1). While a few new road projects may be proposed in the future, the existing infrastructure is not expected to expand significantly in the near future. In fact, the road network would be enough for the current degree of economic development provided that these roads were of high quality. However, a number of indicators reveal a very low development standard and a poor quality of the roads. Only 5,800 km of a total of 10,500 km of roads have any capital pavement (either concrete or asphalt). The rest have a so-called "light pavement" and represent mainly the local roads. About 750 km of roads have bitumen pavement, 3,422 km are paved with gravel and 527 km are without any pavement.[106] The latter tw o categories are of particular concern, partly because of their vulnerability to climate instability. As shown in a World Bank report, due to the inadequate condition of the road network, about 40 settlements have no year-round access to the national road network and, during the rainy and winter seasons, are virtually isolated from the rest of the country.[107]

Little investment has been made in roads in the last two decades or so, significantly contributing to their vulnerability. The level of funding of roads works declined from about 80 per cent of total necessary funds in 1990 to less than 10 per cent in 2000. It rose to 20 per cent of needs by 2006, but obviously this is still inadequate. As result of constant underinvestment, the road network has almost collapsed in terms of quality (Chart 30). While in 1992 about 70 per cent of the total roads network was assessed as being of good or satisfactory quality, in 2006 only 7 per cent received this qualification. The quality of the local roads is even poorer. Taking into account their physical parametres as described in the paragraph above, only 2 per cent of the total length is of fair or good quality. As shown in the official documents, the total economic losses caused by underinvestment in roads over the past 15 years are four times larger than the money "saved" due to underfunding.

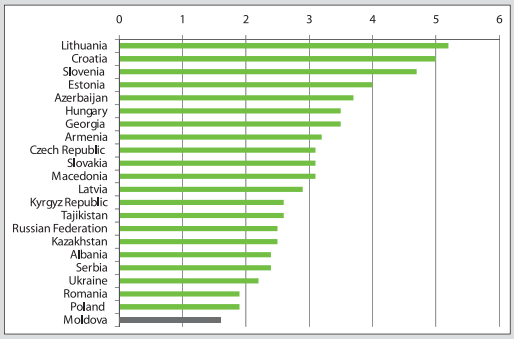
Given these statistics, it is no surprise that Moldova's roads are currently perceived as the worst in the group of transition countries and in Europe as well (Chart 30). According to some estimates "about 78 per cent of the national roads and 88 per cent of the local roads have reached the end of their economic life and are technically outdated".[108] Such a situation may in the long run undermine the human development of the country by diminishing the returns from economic growth to the poorest part of the society living in remote or isolated rural areas.

Chart 30. Evolution of the quality of the roads in Moldova



Source: *Strategy for Land Transport Development 2008-2017.*

Chart 31. Quality of road infrastructure in the transition countries (1=underdeveloped, 7= extensive and efficient by international standards)



Source: *WEF, Travel&Tourism Competitiveness Report 2009.*

[105] Bozu Valentin, Caragia Dumitru and Gotisan Iurie, "Final Analysis of Constraints to Economic Growth", available athttp://ksghome.harvard.edu/~drodrik/Growth%20diagnostics%20papers/Moldova%20CA_Bozu,Caragia&Gotisan.pdf.

[106] Expert-Grup, „State of the Country Report", 2008.

[107] World Bank, "Moldova: transport strategy update with emphasis on the road sector", December 2002.

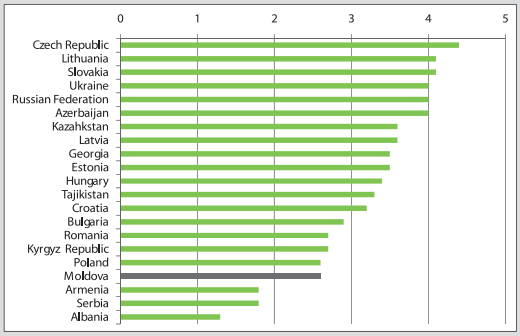
[108] World Bank, http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/ECAEXT/EXTECAREGTOPTRANSPORT/ 0,,contentMDK:20647585~pagePK:34004173~piPK:34003707~theSitePK:571121,00.html.

Railways

Railways are important for the Moldovan economy due to their central role in cargo transportation, particularly in long-distance international transport towards Russian and other eastern markets. Rail transport to Western countries is constrained by railway gauge incompatibility. The Soviet 1,520 mm standard is used in Moldova and its Eastern neighbours, whereas the European 1,435 mm standard is used in Romania, Moldova's neighbour to the West. In 2008, railway transportation accounted for 68 per cent of the total transported cargo in Moldova.[109] Long-distance cargo is in fact the main profit centre of the incumbent state-owned operator ("Caile Ferate ale Moldovei" – "Moldova Railways"), which also maintains some non-profitable operations like domestic passenger transportation and even some non-core assets (construction, electricity, telecommunications, health and other divisions). Presently about 80 per cent of the Moldova Railways' income is derived from international cargo transport. In a number of Moldova's local communities – such as Basarabeasca, Ocnita - the economic well-being of the people depends significantly on railway traffic and associated services.

Generally, railways are in a slightly better condition compared to the roads, however they are not radically better (Chart 32). While some repair works have been carried out recently (such as the repair of Chişinău train station) and the network was even extended by building the Giurgiulesti – Cahul branch, the main infrastructure continues to deteriorate because Moldova Railways does not have the necessary resources to fund urgent maintenance works. The company operates only Diesel locomotives. These move at a very slow speed both because they are old and also because of the poor infrastructure. Only 100 km out of a total of 1,318 km of the railway system is electrified and only 140 km is double track. All the rolling stock has been inherited from the USSR and is in a very poor condition.

Chart 32. Quality of railway infrastructure in the transition countries (1=underdeveloped, 7= extensive and efficient by international standards)



Source: *WEF, Travel&Tourism Competitiveness Report 2009.*

Air transportation

Air transportation has become increasingly important over the past decade, with the number of transported passengers more than doubling between 1996 and 2008. Still, the capacity of air transportation in Moldova is underused, both for passengers and freight.[110] While air transportation is currently not important for cargo transportation, the situation may change in the future if Moldova manages to make use of its central geographical position between East and West. In the Republic of Moldova there are 5 airports currently, but only Chişinău airport is regularly used for flights and is completely functional. Marculesti airport is expected to enter into regular service soon as a Free Economic Zone and will be used for mid-range cargo transport. A significant part of the fleet is formed of technically outdated Soviet models and should be replaced with modern aircraft. Airport infrastructure needs to be modernised as well.

Naval transportation

Moldova is a landlocked country and does not have direct access to the sea. However, it can use to a limited extent its internal waterways – the lower Prut and Dniester rivers and its narrow gateway to the Danube shore (800 m) - to receive small seagoing vessels. There is one maritime port and four river ports in Moldova (including three under the effective jurisdiction of the Transnistrian authorities).

Despite rapid growth in cargo transportation in 2006-2008, currently the internal waterways have a negligible role in passenger transportation and a minor one in freight transportation (about 1.3 per cent of total in 2008). The Government has some plans regarding this mode of transport, as shown by a recent Governmental decision regarding the approval of a development plan for river transportation in Moldova.[111] The prospects for this mode of transportation are, however, significantly constrained by the conflict with the breakaway Transnistrian region which stretches

[109] National Bureau of Statistics, "Passengers and cargoes transport in 2008", http://www.statistica.md/newsview.php?l=ro&idc=168&id=2486.

[110] World Bank, Moldova: Transport Strategy Update with Emphasis on Road Sector, December 2002.

[111] Government of Republic of Moldova, decision no.453 of 24/03/2008 regarding the approval of the Concept of development of river transportation in Moldova.

along the Dniester river and by the completely worn-out boat fleet. The Dniester and Prut rivers are navigable only partially because of accumulated mire, inadequate use of dams, and a lack of dredging equipment for ensuring the necessary depth for free vessels' traffic. It is clear that because of its negative impact on water resources, the changing climate conditions can impose even more hurdles on the objective of developing a river transportation system. This will impede the rural and urban communities located along the rivers' valleys to diversify local economies and increase number of jobs.

7.3. Potential climate change impact on transportation system

Potential impact of high temperatures

Higher maximum temperatures that are projected due to climate change will significantly influence the highways, even though there are no sufficient data to quantify the effect.

Long-lasting heat-waves can worsen or even destroy the asphalt pavement of the national roads. This phenomenon has already been witnessed both in 2003 and 2007, when longer periods of high temperatures were registered. The most serious damage was to the Chişinău-Balti highway. Even on the newly rebuilt Chişinău-Leuseni national highway, long portions of the road were deformed. The roads from Rabnita and Rezina were almost completely destroyed by trucks carrying cement from the local factories.

High temperatures in the summertime can also cause deformation of the railroad lines which are already old and worn-out, can accelerate the physical obsolesce of metallic parts in bridges, and even cause thermal deformation. In all cases, significant limits to traffic speed and load weight can be necessary, as well as restricting transportation of heavy loads to the night time. The need for such restrictions applies both to road and railroad transportation and will cause additional economic losses for operators using both systems.

Higher temperatures will require stronger and more heat-resistant engines in road and railway vehicles and it will be necessary to use on-board air conditioners more frequently and intensively. Both the stronger engines and increased use of air conditioning will further raise fuel consumption. All these will significantly raise the costs of both capital investment and operation and maintenance costs in land transportation systems.

High temperature is also likely to influence air transportation, both aeroplanes and ground infrastructure. Hotter air is less dense and requires increased portability and power from the aircraft, reducing in relative terms the useful weight of cargo and requiring longer runways. Warmer weather will also influence runways in a similar way to automobile roads, making them softer and more liable to deformation. The only positive effect is that due to higher temperatures the costs of deicing planes and removing of snow and ice from the runways may fall substantially, but on balance the money saved will be outweighed by the additional expenses.

Potential impact of changes in precipitation

Drier and hotter weather is likely to have a positive influence on highways as it will be associated with reduced humidity of the roadbed, especially in spring and autumn. Reduced humidity will likely reduce the risk of landslides and soil erosions which presently affect many national roads in Moldova. Also, less precipitation and higher temperatures in the winter mean fewer costs for snow and ice control measures on the roads. However, a change in precipitation patterns is very likely to negatively affect local roads which are not covered with an asphalt surface and have shallow roadbeds. As winters in the 21st century in Moldova become warmer and wetter, many local roads are likely to become impracticable due to moisture and mud. As a result, many more rural communities will become virtually separated from the rest of the country during the winter season or in rainy periods (there are about 40 such communities at present).

Dry conditions in the summer are very likely to affect the level of the water in the Prut and Dniester rivers. This may undermine the development of the river transportation plans presently being nurtured by the Moldovan government. Lower levels of water would first of all impair the circulation of the vessels and involve significant engineering works for the adaptation of the port infrastructure. Lower water levels also mean that ships will not be able to carry as much cargo (which is presently already significantly limited by the shallowness of the Dniester and Prut rivers) and the operational costs will increase significantly. Lower water levels will also significantly constrain the flow of the river traffic, possibly

even requiring additional engineering works to allow for two-way traffic.

Potential impact of extreme weather

Heavy local rains associated with storms and hail, frequently coming after periods with extremely high temperatures, will likely have the most detrimental effects on transportation. This is a special area of concern for urban transport. Heavy summer rains almost stopped vehicular circulation in downtown Chişinău in 2005, 2008 and 2009. Violent rainfall also caused additional damage to the pavement of city streets, pavement which is already in a poor condition. The rainfall water collection system is outdated and unable to accommodate heavy rain episodes. The dependency of the urban transportation system in Chişinău on crossing the downtown area exacerbates its vulnerability.

7.4. Possible adaptation measures and recommendations

While climate change projections are made for quite long time periods (up to 2099), some of the negative consequences of global warming are already being felt by the Moldovan transportation sector. Even though managers in the transport sector can today take the position that future managers will be responsible for facing climate challenges and designing adaptation measures, the capacity of the next generation of managers very much depends on what today's managers do. This is mainly because of the long-lasting effects of infrastructure decisions. Therefore, today's decision makers should at the very least adopt no-regret measures. A general no-regret measure would be to incorporate climate change considerations into the technical standards guiding the design of the transportation infrastructure in all transportation modes. This will have systemic effects in long term.

Priority Recommendations

A solution to reduce the negative impact of climate change on transportation would be the creation of a National Adaptation Strategy for the Transportation Sector or preparing respective amendments in the existing sector strategy that will cover all types of transport and the road infrastructure.

These changes should be developed by the Ministry of Transport, in conformity with international agreements and conventions, signed and ratified by the Republic of Moldova, under the supervision of the Inter-ministerial Adaptation Commission. This Commission will control the process of elaboration and will ensure all sector strategies are inter-linked and exclude the possibility of conflicting provisions.

- The Republic of Moldova could sign up to the Pan-European Transport Corridor network. It would help spur economic growth, offering transportation networks that link the country to European regions, as well as freedom of movement for goods, persons and services.[112]
- In air transportation, reducing the exposure and vulnerability of the sector to weather conditions constitutes a no-regrets option and would improve sector performance regardless of the magnitude of climate change. This is because bad weather is currently the main cause of route delays or flight cancellations. One specific no-regrets measure, which is also a "win-win" measure, is to replace weak runways with stronger runways. In addition to helping meeting climate chance challenges, this measure will also enable Moldovan airports to receive bigger planes, thus reducing the relative operational costs.
- In road transport, building higher-quality, more weather-resilient automobile roads will lead to higher performance of the sector, fewer accidents and reduced economic costs for operators. This is a no-regrets measure because new materials and new road technologies are necessary in any case in Moldova where the poor quality of roads poses a critical constraint to economic growth.

Some more specific recommendations related to climate change follow below:

- As winters in Moldova will become warmer, it would be reasonable to soften requirements regarding the depth of the roadbed and to use the resources saved to improve the quality of the surface, through use of thicker layers of asphalt and less viscose materials.

[112] http://ec.europa.eu/transport/infrastructure/basis_networks/basis_networks_en.htm last checked on October 30, 2009.

- Bridges have to be inspected more carefully and at regular intervals, particularly with the aim of discovering thermal deformations and replacing parts that are too soft with harder metal.
- To minimize the impact of the heavy trucks on roads surface, amendments to the Road Circulation Codes need to be adopted prohibiting the circulation of heavy trucks in midday in summer.
- A similar recommendation to that above is needed in the case of railroad freight transportation.
- In the railroad sector, the electrification of the railway and replacement of Diesel locomotives with electrical engines is necessary in any case in order to save money and accelerate circulation. This is a "win-win" option because locomotives with electrical engines will be less vulnerable to future higher temperatures.
- In the short term, in order to adapt Moldova's emerging river transportation to global warming, it is necessary to deepen the traffic routes in the lower Dniester and Prut rivers and make corresponding improvements to the existing ports.
- However, in the longer term, Moldova's plans to rehabilitate the river transportation system may be completely undermined by decreasing rainfall and the associated reduction of the water level in the Dniester and Prut rivers. However, it is not clear to what extent this might be counterbalanced by rising sea levels expected in the next 50-100 years. A more detailed and scientifically-sound assessment is necessary in this regard.

Chapter

8

Climate Change Impact on the Energy Sector

8. CLIMATE CHANGE IMPACT ON THE ENERGY SECTOR

8.1. Summary

Climate change will have a range of effects across the energy sector. Energy supply, demand and infrastructure will all be affected as climate-related risks will take their toll. Moreover, these risks are set to heighten the already quite salient vulnerabilities of Moldova's energy sector. Since Moldova's strategic framework does not fully take into account climate change risks to the development of energy sector, it may well happen that climate-related evolution will put a question mark over the feasibility of the ambitious goals.

8.2. The current situation in Moldova's energy sector

Moldova's energy sector displays a series of vulnerabilities, which mostly stand to be magnified by climate change effects. The vulnerabilities can chiefly be observed in areas such as *production capacity, energy efficiency* and *security of supply* and are to a certain extent determined by the interplay of historical and geographical factors.

Thus, Moldova has only very limited energy production capacities, limited mostly to electric-

Box 16. Access to energy and human development

Access to modern energy services is fundamental to fulfilling basic social needs, driving economic growth and fueling human development. This is because energy services have an effect on productivity, health, education, safe water and communication services. Modern services such as electricity, natural gas, modern cooking fuel and mechanical power are necessary for improved health and education, better access to information and improved agricultural productivity.

When looking at linkages between energy services and human development in low income countries, empirical evidence shows that a threshold level of modern energy services is required to achieve growth and improvement in human development in developed and developing countries. Higher energy consumption in low income countries is frequently linked to higher levels of greenhouse gas emission, since usually no modern or ecologically less damaging energy sources are available. Addressing the energy needs of developing and low income countries requires a combination of strategies and actions, including the following:

- Developing country governments should commit to expanding access to modern energy services by making it a national development priority;
- Strategies for rural electrification should be based on decentralised power generation. Decentralisation has the potential to assist with technology transfer, increased equity in distribution and consumption, and increased participation of local people in the supply of energy services;
- The realities of poor people's economic means should also be borne in mind in any energy reform. There should be a wide range of energy technology options to ensure that poor people can make a choice based on their income and be able to switch fuel in response to price fluctuations.

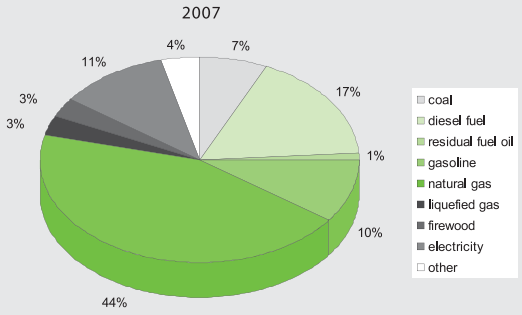
Source: *Extract of Amie Gaye, 2007, Access to Energy and Human Development, HDRO Occasional Paper 2007/25.*

ity production by 3 co-generation power plants (CHPs, producing both electricity and heat) and one hydro power plant. Most of the production capacities were constructed in period 1950-80, while the plant with the highest generative capacity is Cuciurgan power plant, which is situated in the break-away region of Transnistria and is therefore beyond control of the Moldovan authorities. Although the joint production capacity of electricity in the Republic of Moldova (Transnistria included) was estimated at 3,000 MW in 1990, more recently (as of 2006)[113] it was estimated at 1,200 MW due to infrastructure having become worn out. Furthermore, since 80 per cent of the total capacity is in the Transnistrian region, the actual production capacity is much lower. Currently, due to wear-out the actual power generation capacity in right-bank Moldova is less than half the original installed capacity, estimated initially at 435MW.[114] At the same time, since domestic energy is produced at worn-out plants and a large part of the energy infrastructure (especially thermal energy infrastructure) is obsolete, energy efficiency is very low in Moldova: energy intensity is estimated to be three times higher than in the EU.[115]

Given the limited domestic energy generation capacities, Moldova relies heavily on imports to satisfy its energy needs: imports made up almost 90 per cent of the total in 2007.[116] Limited domestic market liberalisation and a lack of diversification in the supply of natural gas (the Russian state-owned company Gazprom is the only supplier) exacerbates still further Moldova's vulnerability to interruptions of foreign energy supplies. This dependency is also magnified by historical factors. Since Moldova's energy sector was designed as an integral part of the Soviet Union's integrated system, it was and still is deeply integrated into fSU power system. Thus, Moldova's power grids are mostly connected (15 interconnects) and actually integrated with the Ukrainian power grid system and much less so with Romania (with which it has 4 interconnects), while natural gas pipelines go only an east-west direction, transporting Russian gas to the Balkans, while no reverse connection has been established. For example, the impaired gas transportation system resulted in the fact that Moldova duly became a collateral victim of the Russian-Ukrainian gas dispute last winter.

The main energy resources consumed are natural gas, petrol and electricity (see Chart 33).

Chart 33. Main types of the energy resources, %



Source: *Statistical Yearbook, NBS, 2008.*

Households and industry are the main consumers of electricity and gas (which is also used for heat production). At the same time, energy consumption has fluctuated significantly over the past 20 years. In the wake of Moldova's independence energy consumption fell almost five-fold between 1990 and 2000 following a dramatic contraction of the economy and a steep decline in personal incomes as the domestic economy embarked on a transition path. As economic growth resumed and personal incomes started to grow, energy consumption started to pick up as well, increasing by 20 per cent between 2000 and 2006.[117] According to the National Energy Strategy, energy consumption is expected to more than double by 2020. Use of renewable energy remains quite limited so far, being estimated at 3 per cent to 4 per cent of the total (hydro and firewood, see more in Box 17).[118]

Given the external vulnerability of the Republic of Moldova towards disruptions and price hikes in the foreign energy supply, it is hardly surprising that recent developments on the global energy markets have hit Moldovan consumers particularly hard. Over the past few years, prices for imported gas and electricity have risen many times over, especially for gas, as Russia has started to apply a new price policy toward fSU countries. Furthermore, rising prices appear to undermine state efforts aimed at installing gas networks in rural Moldova, since exorbitant gas prices prohibit rural consumers from connecting to the networks.

[113] National Energy Strategy of Moldova (2007-2020).
[114] Report on National Policies in Energy Efficiency and Renewable Energy Sources, Ministry of Ecology and Natural Resources, June, 2009.
[115] National Energy Strategy of Moldova (2007-2020).
[116] Statistical Yearbook of the Republic of Moldova, NBS, 2008.
[117] NBS.
[118] Report on National Policies in Energy Efficiency and Renewable Energy Sources, Ministry of Ecology and Natural Resources, June, 2009.

Box 17. Renewable energy potential in the Republic of Moldova[119]

The following renewable energy sources can be employed in the Republic of Moldova: biomass, solar, wind, hydro and geothermal energy. Overall, the technical potential of these energy sources (excluding geothermal) is estimated at 2,500 tonnes of oil equivalent (toe).

Solar energy potential is estimated at 1,200 toe. The National Programme for developing renewable energy sources envisages a three-fold use of solar energy: drying agro-products, water heating and electricity production in photovoltaic installations. The Programme envisages three separate projects for each type of resource that would have estimated costs of 8m, 8.4m and 0.2m Euros respectively. The energy produced would substitute for 38.5, 11.5 and 0.5 toe respectively and would reduce GHGs by 38.5, 11.5 and 0.5 thousand tonnes, respectively.

Biomass energy potential is estimated at 2,700 toe. The biomass, mostly firewood and wasted wood, is envisaged to be used for house heating and cooking through modern installations with effective power of not less than 75-80 per cent. Overall costs for woods, biogas and biofuel energy production would be 7.6m Euros, resulting in 117 thousand toes of annual fuel substituted and a 258 thousand tonne GHGs reduction.

Wind energy potential is estimated at 0.7 toe. Wind energy is envisaged to be used for electricity production at stations with general installed power capacity of 8MW. According to the Programme, an investment of 5.5m Euros is required, which would result in a substitution of 5 toe of fossil fuel energy and a reduction of GHGs emissions of 16,900 tonnes.

Hydraulic energy potential is estimated at 0.3 toe. In order to use it, several mini-plants were envisaged to be constructed with power of 200-400 kW and flux mini power plants with total power of 100 kW on the Dniester, Prut and Raut rivers. This energy is expected to be used for small-scale irrigation. Implementation of the planned activities would require 10m Euros investment, leading to annual fuel substitution of 23,800 toe and GHGs reduction of 13,000 tones.

Source: *National Programme for developing renewable energy sources (2003-2010).*

Tariffs for heat energy also started growing as a result of rising gas prices and the complicated situation in the heat generation sector in Chişinău, Moldova's capital, which put painful strains on households as well as the public budget. Even the date of the start of the heating season for such social public institutions as hospitals, schools and kindergartens is often a bone of contention, without even mentioning the exceptional situation of last winter when a cut-off in the gas supply endangered the normal functioning of many important social institutions in Moldova.

Both energy scarcity and its expensiveness (relative to low population incomes) can have significant impacts on human development. Such socially important institutions as hospitals, schools and kindergartens are vitally dependent on energy supplies. While electricity supply is very reliable, the heat supply, whether centralised as in Chişinău, or autonomous, as in towns and rural areas, is not. In Chişinău, the main cause of disruptions is high tariffs set in a non-transparent manner by the bankrupt heat provider. These disruptions are further exacerbated by political meddling and an inefficient bill compensation policy for the vulnerable population, while in previous years, city hall subsidised heat provision for the whole population of Chişinău. At the same time, the centralised heat provision infrastructure is obsolete and loss-making, while the heat provider is facing a bankruptcy procedure.

In towns (where centralised heating has either not been maintained or is absent altogether) and rural areas public authorities and the population rely mostly on coal, to heat socially important buildings, and firewood, to heat dwellings. These methods, however, even if slightly cheaper, are much less efficient and healthy ways to heat.

Hence, if only indirectly, spillovers from the energy sector may significantly affect human development in Moldova.

[119] There is also potential for energy production from urban waste, however, its potential has not been properly estimated so far.

8.3. Possible impact of climate change

The possible effects of climate change are set to have a marked impact on the Moldovan energy sector, being sometimes exacerbated by the vulnerabilities outlined above.

The impact of climate change is most likely to be felt in the energy distribution infrastructure, and in changing patterns of energy demand and energy production capacities (supply).

- Impact on distribution infrastructure. More frequent and more violent extreme weather events such as storms or lightning strikes could damage supply grids and present a threat to electricity transmission and distribution.[120] In Moldova, recent extreme weather events, such as the floods of 2008, caused serious disruptions to power supply in the affected locations. At the same time, other weather calamities, such as strong winds and heavy rains, reportedly caused local power supply disruptions in different Moldovan regions in July 2009. Almost 300 localities suffered power supply disruptions in January 2009 because of strong winds and related events.

- At the same time, the Report's climate projections (see CLIMATE CHANGE AND ITS CHALLENGES FOR MOLDOVA) envisage increases in the maximum mean and absolute temperatures, which are associated with an increased frequency of extreme weather events, meaning the increased strain on the country's power distribution networks can easily be anticipated.

- Furthermore, if a warmer climate results in growing energy demand, then extra power demand could cause transmission lines to sag, lowering the effectiveness and efficiency of the distribution system.[121]

- Changing patterns of energy demand. Overall, climate change is associated with rising temperatures which can result in a lower demand for heating during winter and higher energy demand through summer due to a surge in the use of air conditioning. The rise in energy demand due to hotter summers will take place across southern Europe and the Mediterranean region.[122] Moldova will be no exception. The Report's climate projections show that temperature increases will be observed throughout all annual seasons.

  Thus, it is expected that springs will begin earlier and autumns will last longer, while in aggregate the duration of the warm period may increase by 3-4 weeks in the 2020s and by over two months by the 2080s. The anticipated rise in the number of days with temperature over 10°C will mean that building heating will be required on a smaller number of days (in Chişinău centralized heating season starts when daily temperature is below 8°C).

  At the same time, the Report's projections show that summers and autumns are expected to become hotter and drier. Therefore, demand for the electricity required to ensure air cooling in the buildings is likely to surge. Even without taking climate change effects into consideration, electricity consumption is expected to grow by over 15 per cent over the period from 2006 to 2020.[123] Taking into the equation climate change effects on demand could push demand for electricity still higher.

- Climate change can also affect energy supply. Although Moldova currently mostly covers its energy needs through imports, the National Energy Strategy envisages strengthening local production capacities by modernising and enhancing the existing CHPs (I, II and North) as well as constructing new mini-CHPs. Another focus of efforts will be boosting production from renewable sources, such as biomass, solar and wind energy. However, climate and water availability projections show that some of these plans may be put at risk when climate change effects start making themselves felt.

[120] German Strategy for Adaptation to Climate Change, 2008.
[121] Colombo et al, quoted in The Impacts and Costs of Climate Change Report, Paul Watkiss et al., 2005, Commissioned by European Commission DG Environment.
[122] Energy and Environment Report, European Environment Agency, 2008.
[123] The National Energy Strategy (2007-2020).

Thus, currently 65 per cent to 70 per cent of total water is used in industrial heating and cooling and hydro-energy production (see CLIMATE CHANGE AND WATER RESOURCES). However, as has been shown, water quantity in Moldova is quite sensitive to climate change effects. Thus, water scarcity will start adversely affecting national development goals by 2020 if only surface water is taken into account. If ground water is added then water scarcity will become a development obstacle by 2030. Furthermore, one of the climate change effects on water supply will be growing instability in annual water flows: growing short-term oversupply due to spring and flash floods and scarcity due to longer and more severe droughts. Hence, growing water scarcity may become the main obstacle to enhancing local hydro- and cogeneration power production.

Furthermore, the climate projections (see CLIMATE CHANGE AND ITS CHALLENGES FOR MOLDOVA) show that the anticipated worsening of humidity conditions and growing aridisation may result in a deterioration of the ecological-climatic conditions for plant growing towards the end of the century. In the longer run it represents a serious threat to energy production from biomass.

8.4. Policy discussion and recommendations

Policy framework

Moldovan authorities are fully aware of the main challenges facing the country's energy sector. Some governmental documents tackle these challenges as a group, others focus on only one of them.

The most comprehensive document to date is the National Energy Strategy (2007-2020). The strategy correctly traces the main problems for Moldova's energy sector. It outlines as the main objectives ensuring the security of the energy supply, promoting energy conservation and efficiency, and making greater use of renewables in order to satisfy domestic energy demand. Thus, it sets the ambitious target of making renewable energy sources achieve 10 and 20 per cent shares in the energy balance by 2010 and 2020, respectively. On conservation and efficiency, it envisages a revitalization of the National Agency for Energy Conservation and implementation of the National Plan for Energy Conservation (2003-2010).

It also seeks to boost local production capacity by setting up small hydro power plants that would decrease the country's dependence on external energy supplies. Another step in this direction is the privatisation of CHPs with the aim of modernising them. At the same time it emphasises policy and institutional alignment with EU legislation, rules and practice. It also envisages Moldova joining UCTE and the Energy Treaty Community and consolidation of the transit capacity of Moldova's power grids and better inter-connection with Romanian power networks.

However, the strategy has little to offer in the sense of diversifying gas supply to the country and given the distribution network constraints the current dependency is set to persist for some time to come.

It is worth mentioning that this is the third energy strategy adopted in Moldova over the decade from 1997 to 2007. All strategies had more or less similar objectives, and both earlier strategies achieved very little with no proper assessment conducted of the reasons for their failure. If history is any guide, the implementation of the current strategy will be a tall order. So far, less than 0.1 per cent of the funds envisaged for the 2007-2020 period was actually invested in the implementation of the strategy's objectives. At the same time, the schedule set for harmonization with the EU acquis communautaire in the energy sector is also not being respected and adoption of the respective amendments has been lagging.[124]

Progress has also been very uneven in meeting the relevant goals set out in the EU-Moldova Action Plan. Among the most significant failings are: a lack of funds to support the implementation of many infrastructure and legislative actions; tariff distortions have been reduced but still persist; efforts on energy efficiency and renewable energy have been limited; privatization in the sector stagnated while the situation in the thermal energy area remains notoriously poor.[125]

Adaptation options and recommendations

Although climate change is set to pose significant challenges for Moldova's energy sector, it should be said that most of the solutions on the table need to be implemented even if climate change were not taken into account. However, the risks stemming from climate change are set to heighten the existing challenges even further.

[124] Free Trade Agreement between the Republic of Moldova and European Union: Feasibility, perspectives and potential impact, Expert-Grup, 2009.

[125] See for more details: EU-Moldova Action Plan as capacity test for Moldovan Government: Screening implementation of the Plan's economic provisions, Expert-Grup, 2008.

At the same time, it would be wrong to ignore the fact that most of the steps to be taken are already in the most important development documents of the country, although climate change-related challenges are not explicitly taken into consideration. Nonetheless, progress in implementing these measures has been very sluggish at best. There are several reasons for this state of affairs amongst which we can mention:

- Energy issues are rarely on the top of the government's agenda, save in outright crisis situations like last winter's;
- The challenges of climate change are rarely reflected in the country's development policy, and even more so within strategic thinking on energy;
- The government has lacked a long-term strategic vision regarding development of the energy sector and has not ensured proper monitoring and assessment of the process (recall here the situation with the three national energy strategies, implementation of which has been never properly ensured);
- Proper financing of the activities envisaged was never ensured, although activities that have been carried out were implemented with the support of the international donor community.

Given the fact that most of the adaptation efforts represent either 'no-regret' or 'win-win' solutions we think it is worth stressing the most important of them as well as outlining their importance for the economic and human development of the country.

- ***Flatenning consumption curve***. Given rising energy prices as well as the eventual strain on the development of local power production (due to the climate change effects discussed above), rationalisation of energy consumption is needed. Since electricity is mostly consumed during day hours and much less so during night hours, an eventual rebalancing of consumption would mean more efficient use of the electricity produced during night hours through Demand Side Management (DSM) measures. One of the major incentives would be the introduction of a tariff difference for the consumption in peak and non-peak hours for industry consumers. Overall, the result would be a general reduction in the tariffs paid by consumers.
- ***Changing consumer behaviour***. There is a need for technological modernisation with regard to energy consumption that would induce the implementation of energy saving lighting and equipment in households, industry and in all sectors of the national economy. A public awareness campaign and relevant tariff incentives (higher tariffs for high energy use) may be important steps in this direction.
- ***Energy efficiency and renewable energy sources***. The National Energy Strategy sets very ambitious targets on both accounts. However, the record of implementation of previous strategies and of National Programme for Energy Conservation (2003-2010) is dismal. The main reasons are probably a lack of consistency in public policies. Several steps could help re-launch efforts in this direction:
  - The introduction of technology standards for energy efficiency (equipment, buildings, etc.);
  - The promotion of a tariff policy that supports 'energy-savers';
  - Educational and information campaigns that would encourage efficient energy use;
  - Modernisation of current energy production capacities in order to make them more efficient. Possible water scarcity due to climate change should also be taken into account in this respect;
  - Support consumers' efforts aimed at thermal insulation of buildings; here again, tariff incentives can play an important role.

  The development of renewable energy sources in Moldova is just at the beginning. At the same time, some important

steps were taken in 2009, including most of all the development and adoption of a methodology for calculating tariffs for renewable energy and adopting a regulation on the origins of renewable energy.

All in all, the importance of renewables should not be underestimated. First of all, their development is an inherent part of the international efforts at climate change mitigation and the promotion of the 'green' economy. Secondly, in Moldova, the development of renewable energy sources could have important impact on the development of rural regions given the fact that most projects can be implemented on the community level. This means renewable energy can ensure a more secure supply of energy to small rural communities and allow them to diversify their energy supply, which has become more and more costly and often imposes additional costs for connecting to centralised networks (especially in the case of the gas systems). Furthermore, the production of energy from biomass presents new opportunities for rural farmers who are already involved in rape growing. Development of processing plants will also mean better energy supply for rural communities (including for heating schools, kindergartens, etc.) and a greater source of income for the biofuel sold. In this respect, however, attention should be paid to the growing aridisation risks resulting from climate change.

Initial investments are needed, however, for the development of renewable energy sources in Moldova. Thus, the government should seek more support from the donor community for the development of such projects as well as create proper conditions for foreign investor interest in the production of renewable energy in Moldova. At the same time, renewable energy development can provide a favourable venue for public-private partnerships.

Most of the important measures needed to promote the development of renewable energy sources in Moldova are already in the National Energy Strategy and the Law on Renewable Energy. Among those it is worth outlining critical measures:[126]

- Harmonisation of the national legislative and regulatory framework with the European one;
- Guarantee the openness of the power grid network for the selling and distribution of the electricity produced from renewable energy sources;
- Ensure that renewable energy sources are granted obligatory acquisition quotas by the energy providers;
- Promote research on the potential and development of renewable energy sources in Moldova (such as Wind Atlas, Land Register, Solar Radiation Atlas, Available Wastes Catalogue (for combustion wood, agricultural and wooden wastes, zoo-cultural residues) or small rivers hydro-energetic potential).

- *Consolidation of infrastructure and adaptation to climate change risks.* Given the growing risks of the extreme weather events that can impair the operational capacities of power transportation, consolidation of existing networks is needed with a focus on wind-proofing of cables, emergency water connections for power plants, etc.[127] At the same time, the relevant state agencies' capacity to respond in an emergency situation should be enhanced.

Policy Recommendations

In-depth sector-specific assessments should be carried out to establish vulnerabilities and concerns related to climate change, such as high energy demands, a low water level that may hamper electricity production, extreme weather events, etc. These assessments will underscore the need to rethink and restructure energy supplies, develop renewable energy sources such as wind and solar power, and strengthen the electricity grid to cope with greater fluctuations in demand [128] and will serve as arguments, baseline information and incentives for authorities to actually achieve the National Energy Strategy objectives.

Priority Recommendations

- A cost-benefit analysis of all adaptation options in order to establish the financial capacity of the government and the

[126] The Renewable Energy Law (no. 160, of 12.07.2007); see also http://courseweb.stthomas.edu/moldova/energy_appendix.htm.
[127] German Strategy for Adaptation to Climate Change, 2008.
[128] EU action against climate change. Adapting to climate change. European Communities, 2008.

volume of financial resources needed to implement them would also be very welcome.

- Objectives, set out in the National Energy Strategy should be reassessed in order to determine the feasibility of their achievement in the time given. Instead, objective targets and deadlines should be proposed.

- The National Energy Strategy should be amended with a chapter providing for climate change adaptation measures. These measures should be prepared after research in the field. In this respect, close cooperation between authorities, academia and international organizations would be desirable.

These amendments should be developed by the Ministry of Economy, which is responsible for the Energy sector, in conformity with international agreements and conventions signed and ratified by the Republic of Moldova, under the supervision of the Inter-ministerial Adaptation Commission. This Commission will control the process of elaboration and will ensure the inter-relation of all sector strategies and exclude the possibility of conflicting provisions.

- The strategy could provide for measures and incentives for efficient use of alternative energy resources and at the same time reduce energy costs. Low levels of energy efficiency are currently a threat to climate change adaptation efforts. Raising efficiency levels could transform that threat into an opportunity, also generating gains for human development.[129] Gradual evolution and progress towards **efficient use of available energy resources** and use of renewable sources of energy, on personal and/or country level should be supported. At the same time there is a need to inform the people and to offer access to information on **alternative energy resources and energy efficiency**, tailored based on national and local needs of the population. Additionally, mechanisms and incentives in this respect are necessary and cooperation of authorities with scientist in the field should be encouraged by means of awards and empowerment. It could also be based on already existing experiences; for example it could support the implementation of technologies that produce biogas by using manure from farming activities and organic wastes.

In the short run these measures will need strong support from authorities, including a financial effort for a plan to manage the resultant biogas, train people in this field and organise manure and organic waste collection. But in the long run these measures could pay for themselves. In order to ensure that this process develops appropriately, authorities should cooperate with international organisations and private investors for knowledge and experience transfer, especially with those who have already had pilot projects in this field in Moldova and also start collaborating with local private companies in the field to ensure the transparency of the process.

- The quality of energy supplied to the population and companies must urgently be improved. An Action Plan would provide for special measures in the case of emergencies and natural disasters and a means for the population to get involved as a watch-dog for the quality of services provided. In this respect there must be easier ways for the population to get involved and express its opinion, but the population must also be offered access to information related to the specific requirements of energy security and reliability.

[129] Human Development Report 2007/2008.

Chapter 9

Climate Change and Human Health

9. CLIMATE CHANGE AND HUMAN HEALTH

9.1. Summary

Climate change has a significant impact on human well-being (Box 18). The consequences of climate change include a rising morbidity rate and general human morbidity due to infection and diseases (diarrhoea, dysentery, salmonellas) and non-transmissible illnesses (cardiovascular and respiratory illnesses and tumours). Health may be at risk from high temperatures or other changes in the environment, including air and water pollution. Therefore, it is necessary to devise correspondingly effective measures to diminish the harmful effects of climate change on human health.

Box 18. Climate change, health and human development

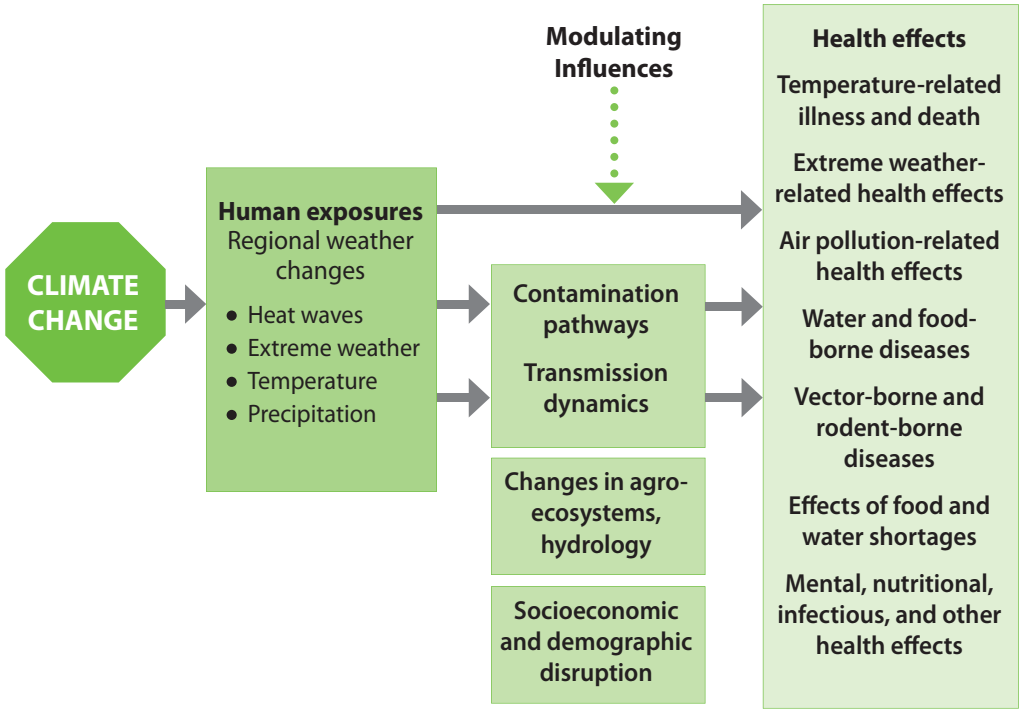
To be able to live a long and healthy life is one of the core elements of human development. In upcoming years to live a long and healthy life might be more difficult and unsecure, due to climate change.

Human beings are exposed to climate change through changing weather patterns (for example, more intense and frequent extreme events) and indirectly through changes in water, air, food quality and quantity, ecosystems, agriculture, and economy. At this early stage the effects are small but are projected to progressively increase in all countries and regions.

Main health effects are expected in the following areas:

- Direct Temperature Effects
- Extreme Events
- Climate-Sensitive Diseases
- Air Quality
- Water availability and water quality
- Indirect impacts via welfare changes
- Indirect impact via changes in ecosystems

Chart 34. Pathways by which climate change affects human health



Source: *Climate Change and Human Health - Risks and Responses, WHO, WMO, UNEP, 2003.*

9.2. The current state of public health in the light of climate change

Today there are more frequent cases of health disorders caused by the changing climate at the global level. Therefore it is necessary to outline specific factors which have harmful effects on health and elaborate necessary prevention measures. Using international[130] and national[131] sources of reference it may be concluded that human health depends on climate change and how disease is spread. Changes in weather can have direct and indirect impacts on human health. Direct impacts include deaths from floods, low and high temperatures and other climate change-related disasters.[132] Indirect include rising numbers of infection bearers such as mosquitoes which swarm near flooded land and spread diseases and a larger tick population. Altogether when temperatures are high enough these bearers contribute to developing encephalitis and Lyme disease. Failure to supply the population with good-quality drinking water also increases the risk of an infection spreading. This exacerbates the risks caused by water shortages that are already visible in some parts of the country, especially in the southern region (see the chapter CLIMATE CHANGE AND WATER RESOURCES). Indeed, there is a direct correlation between the maximal frequencies of diarrheic diseases and salmonellas in the hottest months of the year. In fact, the entire population, especially children, are at risk during this period.

Furthermore, heat-waves and growing air pollution represent an enormous risk for the elderly population, as well as for those with chronic cardiovascular illnesses resulting from hyperthermia. Another important risk is increasing exposure to allergic diseases via aeroallergens in part as a result of changing pollen counts, with allergic rhinitis (hey fever) and asthma (aeroallergens are not cause but trigger for this illness) being diseases mostly associated with this risk.

Nonetheless, climate change can also bring one positive effect for human health: as winters grow warmer the number of cold deaths (hypothermia) is set to decline.

Thus, global warming is not a virtual threat anymore. Rather, it is a reality with 300,000 deaths per year or a destructive power equivalent to the tsunami of 2004.[133] At the same time in 2003, 12 European countries reported more than 70,000 excess deaths compared to the averages for the preceding five years.[134] Higher temperatures lead to a drop in agricultural yields and more limited water access, which implicitly may lead to increases in poverty. In developing countries, the poverty level strongly depends on environment protection measures. According to research, 325m people around the world suffer because of frequent natural calamities, such as floods, cyclones or a polluted environment.

At the same time, at the regional and European level the following trends are anticipated as the climate change-related risks:[135]

- increased heat-wave-related health impacts;
- cold-related health effects in particular in populations with a lack of access to energy;
- increased flood-related health impacts;
- increased malnutrition in areas already affected;
- changed food-borne disease patterns;
- changed distribution of infectious diseases which potentially contribute to the establishment of tropical and subtropical species in Europe;
- increased burden of waterborne diseases, in populations where water, sanitation and personal hygiene standards are already low;
- increased frequency of respiratory diseases due to higher concentrations of ground-level ozone in urban areas and changes in pollen distribution related to climate change.

This situation, which is relevant for the Republic of Moldova as well, has not been considered in drafting necessary policies, strategies or recommendations. It has to be mentioned that warnings about the potential negative impact on human health have been included in the First National Communication of the Republic of Moldova,[136] elaborated as part of the United Nations Framework Conventions on Climate Change, of which the Republic of Moldova is part. However, the basic principles and priorities have not been taken into account in the corresponding documents and have therefore not been implemented.

[130] Б.А.Ревич.Изменение климата и угроза здоровью населения России. Россия в окружающем мире, 2004. www.rus-stat.ru.

[131] N. Opopol, R. Corobov şi a. Schimbările climatului şi potenţialul impact al acestor fenomene extremale asupra sănătăţii. Curier medical, 2003; V. Stancu. Studiu privind impactul schimbărilor climatice asupra răspândirii ascaridozei. Schimbarea climei: cercetări, studii, soluţii (culegere de lucrări). Chişinău, 2000.

[132] N. Opopol, R. Corobov şi a. Schimbările climatului şi potenţialul impact al acestor fenomene extremale asupra sănătăţii. Curier medical, 2003.

[133] US Global Change Research Program, 2007.

[134] Protecting Health in Europe from Climate Change, WHO Europe, 2008

[135] Ibid.

[136] The First National Communication of the Republic of Moldova, elaborated in the framework of the UN Convention on Climate Change, Chişinău, 2000.

9.3. Potential impact of climate change on human health

In order to determine the impact of climate change on health, it is necessary to determine relevant health indicators, which can be dependent on climate variations. This analysis will allow us to outline the health issues which are determined by climate change, general health issues across the country and to provide arguments and suggest measures for diminishing these consequences. The changes in public health indicators depend largely on climate changes (*see Table 21*).

When general mortality data is taken into consideration (official data of the Ministry of Health) we

Table 21. Climate factors which determine and contribute to the spread of disease

Factor	Direct consequences	Indirect consequences	Direct non-transmissible consequences
Increasing air temperature	Heart attack	Growing mosquito population and potential spread of malaria. Increasing number of vector-borne diseases spreading Lyme disease Tumaur	Severe circulatory diseases: hypertensive disease, Ischemia, myocardial infarction. Severe respiratory disease (bronchial asthma, pneumonia).
Floods	Drowning, injuries, diarrhoeal diseases, vector-borne diseases	Damage to infrastructure for health care and water and sanitation	Circulatory illnesses
Polluted drinking water		Frequent cases of diarrhoea, dysentery, typhoid fever	Increasing number of digestive system sicknesses (gastric ulcer, cholecystitis malfunctions); Urinary-genital system (urinary lithiasis), Bone articulations (arthritis, polyarthritis)

Source: *NHDR team.*

Table 22. Morbidity rate from infections, per 100,000 cases (according to annual statistical data provided by the National Center for Preventive Medicine)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Salmonella	15.9	21.3	21.9	22.4	23.5	21.2	32.13	28.12	18.36
Bacillary dysentery	34.0	17.4	17.8	48.5	38.3	54.1	46.04	34.0	20.8
Typhoid fever	-	-	-	-	0.2	0.05	0.03	0.03	0
Intestinal infections from undetermined and wrongly assumed infection agents. toxic food poisonings	-	212.2	232.6	264.2	289.2	367.7	236.4	263.8	230.0
Hepatitis A	-	124.1	213.7	214.4	83.6	30.7	9.88	5.54	2.83
Malaria	-	-	-	0.68	0.14	0.55	0.42	1.31	1.23
Ascaridiasis	-	-	-	180.6	186.6	182.8	196.1	202.2	177.5
Enteritis, colitis, gastroenteritis, food poisonings caused by identified pathogens	-	-	93.6	98.4	95.9	127.7	149	175.6	179.8

Source: *Starea sanitaro-igienică şi epidemiologică, indicii de activitate a serviciului sanitaro-epidemiologic de stat (SSES) conform rapoartelor statistice a organelor şi instituţiilor SSES pe a.2002. Chişinău, 2003-2008., National Center for Preventive Medicine.*

see that there is a growing trend towards mortality from circulatory diseases, tumours, digestive illnesses, traumas and poisonings, and respiratory disorders. The total mortality rate of the population is on the rise as well. Similarly, it is important to compare the infection and non-infection morbidity indicators from the past years. This information is further displayed in Table 22 and Table 23.

According to the data in Table 22, an increase in the prevalence of intestinal infections can be identified over past years, which are caused by undetermined or wrongly identified infection agents, food poisonings, malaria or helminthes. There are some instances of malaria which however remain largely imported. Nonetheless there is a certain risk for local cases in the future. A decline in the number of cases of hepatitis A is due to fluctuating evolution of this malady.

Changes have also been recorded in the development of non-transmissible diseases (Table 23). The data for Table 23 serves as a proxy showing a trend towards increases in instances of illnesses related to climate change: malignant tumour, circulatory and respiratory system diseases.

Interconnection between evolution of health indicators, climate and environment changes

Changes to health indicators may take place only under the direct influence of climate change on the human organism and through indirect environmental factors. Two very important transmission mechanisms, for which the necessary data is available, are growing temperatures, leading to heat- waves and declining drinking water quality.

One of the most important factors is rising temperatures. According to temperature estimates and projections conducted as part of this Report, the average annual air temperature analysis in the Republic of Moldova during 1990-2007, which is compiled using regression calculation, shows an annual temperature increase of 0,0589°C (see chapter CLIMATE CHANGE AND ITS CHALLENGES FOR MOLDOVA). It means that on average temperature has annually increased during these years by 1,06°C. The year 2007 was the hottest year out of the last 120 years. The average annual air temperature was above the normal level of 2-2.6°C and reached 10.1-12.3°C. The following year, 2008, was the second hottest year in the reference period. The average annual temperate was 9.7-11.8°C, which is higher by 1.2-1.9°C than the norm. Air temperatures maximums registered in 2006-2008 were: + 36 °C (August, 2006), +41.5 °C (July, 2007) and +39.1 °C (August, 2008). The minimum temperatures registered in Moldova since 2006 are on the rise. The minimum temperature in 2006 was -30 °C, while in 2007 it was -24.1 °C and -20.5 °C in 2008.

The projections also show that mean and absolute summer maximum temperatures are set to grow in the forthcoming decades, while higher mean temperatures increase the likelihood of extreme weather events. No less importantly, night temperatures are also expected to grow magnifying health risks stemming from heat-waves still further.

Table 23. Morbidity rate from non-infectious diseases, per 100,000 inhabitants

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Malignant tumour	152.6	163.1	167.8	176.6	190.1	193.4	205.3	209.7	212.7
Psychological disorders	291.0	311.2	352.5	438.4	338.0	349.1	415.5	405.5	
Respiratory system diseases	11,750	10,737	11,192	11,611	10,578	11,035	10,195	9,958	
Diabetes	65.0	89.0	106.0	150.0	167.0	178.0	190.0	193.0	
Circulatory system diseases	1,010	1,297	1,248	1,426	1,843	2,429	2,125	1,972	
Hypertensive disease	-	-	-	-	1,061.0	1,635.0	1,425.0	1,295.0	
Overall diseases	33,773	33,832	35,233	36,117	36,047	36,674	33,440	32,547	32,330

Source: *National Center for Preventive Medicine.*

In summer 2007 the Republic of Moldova experienced a heat-wave. Then, at the start of the heat-wave, emergency departments recorded increases in the number of calls related to cardiovascular and chronic diseases, and a rise in the number of calls relating to the elderly and infants. However, over the course of the summer, it was noticed that people had somewhat adapted to the heat. This development is in line with the findings of European research projects on the health effects of heat and heat-waves.[137]

Currently, there are no criteria for identifying and recording deaths from heat-related illnesses in the Republic of Moldova, although the Ministry of Health does provide guidance on how best to protect health during a heat-wave. Although the early warning system is considered extremely important, funding has been lacking.[138]

Besides adversely influencing human health though a rising incidence of cardiovascular and respiratory diseases, rising temperatures also create favourable conditions for a worsening of other elements of the environment: underground and surface water quality (see chapter CLIMATE CHANGE AND WATER RESOURCES), air, soil, crops and even food (see chapter IMPACT OF CLIMATE CHANGE ON THE AGRICULTURAL sector). While the chapters discuss a worsening situation in the water sector in more detail, we focus here on the consequences of this state of affairs for human health. Table 24 below displays examples of how underground water quality changed during 2003-2008.

Data analysis shows that chemical, sanitary and microbiological indicators describing water quality in wells have been in steep decline throughout the past six years. Thus, it is possible to trace how the quality of the wells' drinking water has evolved over time. In 2003, 82 per cent of water in drinking wells failed to meet health standards. This share went up to 84.8 per cent in 2008. If this trend goes on unabated we can expect that throughout following 5 years that share of below-standard drinking water will reach 86.7 per cent. A worsening of microbiological indicators for this type of water was also observed: the share of below-standard water went up from 30 per cent up to 38.4 per cent in 2008. If this tendency continues, the share of water that fails to comply with microbiological standards may reach 44.1 per cent in 2012.

Although, as was noted elsewhere, the quantification of the health consequences of climate change will be difficult, given their lack of specificity,[139] it is still possible to use as a proxy some extrapolations based on the average annual data for previous years. For example, if no measures are taken to adapt the population to climate changes, then it is highly likely that the mortality rate will increase sharply in the short term (up to five years), the mid-term (5-20 years) and long term (over 20 years).

Similar consequences may be valid for morbidity of the population. Specifically, in the short run (5 years), the population morbidity with intestinal infections will increase from 230 cases per 100,000 inhabitants in 2008 to 246 cases per 100,000 inhabitants in 2012. Morbidity with circulatory system illnesses is expected to rise from 1,972 to 2,855 cases. Given such developments, it is possible that the general morbidity increase may also be driven by other diseases which result directly from climate variations.

Obviously, extreme weather events stemming from climate change do not hit different population groups in the same manner: some groups are obviously more vulnerable than others. It appears that as far as health issues are concerned the rural population (especially the poor) will suffer most.

First of all, the health care services infrastructure is much less accessible in rural areas, which means still more pain for the rural population. Furthermore, the rural population has a much higher share of persons who are not registered with family physicians (62 per cent of the total non-registered) as well as a much higher share of those not holding obligatory medical insurance (27.3 per

Table 24. Share of drinking water samples from drinking wells which are not hygienically suitable (%)

	2003	2004	2005	2006	2007	2008
Chemical and sanitary indicators	82,0	83,0	84,0	86,3	82,1	84,8
Microbiological indicators	30,0	31,0	32,0	29,7	31,1	38,4

Source: *National Center for Preventive Medicine.*

[137] Assessment of health security and crisis management capacity in the Republic of Moldova, WHO Europe, March 2008.
[138] Ibid.
[139] Jonathan M. Samet, Adapting to Climate Change in Public Health, RFF Report, 2009

cent of the rural population vs. 19.9 per cent of the urban population). Moreover, every third person who does not hold medical insurance is from the fifth poorest quintile. Given the higher prevalence of poverty among Moldova's rural population it seems the rural poor come out less prepared for coping with the health risks stemming from climate change.

Secondly, the rural population (around 60 per cent of the total) is much more dependent on the non-centralised supply of water than the urban population. Hence, the decline in the quality of water that we outlined earlier will disproportionately affect the rural population. No less important, one of the groups most vulnerable to intestinal diseases is children, and in this way rural children will be particularly affected. This is quite a worrying prospect as it risks adversely affect human development as well as future educational and employment opportunities for these children. Ill-health might divert households' resources away from ensuring proper education, which could otherwise lead to the promise of better employment opportunities and higher living standards in the future. This effect may be further magnified by the higher incidence of poverty among rural households than among their urban compatriots.

Furthermore, the growing number of hot days is especially dangerous for the elderly and people with chronic diseases. Here again, the rural population is set to bear the brunt of the negative effects, since rural areas have almost twice as many people of pensioner age as urban areas.

Another important vulnerability is the risk of malnutrition. This vulnerability may appear as a confluence of two factors: first, an important share of the rural population is dependent on smallholder subsistence agriculture and, second, the agriculture sector seems to be poised to suffer a significant impact from climate change. In the absence of adaptation policies, severe climate events, such as droughts, floods and hails may ruin crops, leaving small farmers with no food and no income, meaning that rural children will face serious nutrition risks. It is worthwhile mentioning that already in the recent years, approximately 37 per cent to 40 per cent of children have been suffering from iodine deficiencies, poor nutrition and anaemia.

Thus, any consistent adaptation policy should look at specific measures that would ensure relevant protection and health care for rural citizenry. Certainly, this does not mean that urban populations are immune to the health risks stemming from climate change. It just means that they have a better chance of coping with these effects.

9.4. Possible adaptation measures and recommendations

A number of measures are suggested for preventing the negative impact of climate change on human health and adapting the public health system to weather conditions. These measures mostly lie in the field of responsibility of the Ministry of Health, though some of them will require support from other relevant Ministries and civil society organizations.

- national health policies incorporate only to a limited extent the risks posed to human health by climate change; hence, these issues should be further introduced into the national health policy agenda;
- the national health legislation of the Republic of Moldova should be adjusted to the UN Framework Convention on Climate Change and international progress in this respect;
- the Ministry of Health should update the National Health Action Plan in order to adequately tackle the relevant risks stemming from the climate change;
- measures for combating the consequences of climate change in the Health section of the National Action Plan in relation to the environment;
- have the Ministry of Health elaborate standards concerning preventive measures for protecting humans from climate change as well as procedures and guidelines, such as treatment guidelines for crush injuries, guidelines for emergency surveillance procedures during an earthquake or flood, guidelines for the collection and transportation of laboratory and environmental samples, etc.[140]

Practical measures:

- Introduction of an early warning system with regards to extreme weather events, such as heat, and water quality trends posing serious health risks;

[140] Assessment of health security and crisis management capacity in the Republic of Moldova, WHO Europe, March 2008.

- Specifically, for managing negative effects of heat-waves authorities should develop capacities for implementing globally renowned approaches, such as model heat watch systems, based on the identification of weather conditions historically associated with increased mortality in a particular location and then the prospective issuance of a warning when such conditions arise;[141]
- Extending further medical insurance to fill the gaps in the coverage of the poor and the rural population;
- Implementing sanitation and water-treatment projects, including with donor support, in order to ensure large rural communities and important social institutions have quality water access;
- Organisation of information campaigns for targeted vulnerable groups of the population ;
- During the hot period of the year, provide public transport, work places, hospital areas, institutions for disabled people with air coolers, ventilation systems and medical kits;
- Provide family doctors and ambulances with diagnostic equipment and medical aid kits in case of serious climatic events;
- Examine patients for hypertension illness and other disorders of the circulatory system, intestinal infections and diseases which depend on climate conditions;
- Improve sanitary management in order to improve human health, especially that of pregnant women; coordinate actions between family doctors and specialised consultants;
- Improve preventive treatments for people sensitive to climate conditions in order to diminish the negative impact of extreme climate conditions;
- Develop an aeroallergen monitoring system (currently there is a total absence of data and effort in this area) and asthma surveillance;
- Introduce air quality regulations and ensure the proper implementation of relevant guidance (such as WHO guidance) in this area of concern;
- Develop broad public dialogue involving general public, civil society, and international community emphasising that climate change requires a simultaneous change in behaviour of millions. Government undoubtedly has the responsibility to protect its citizens from the adverse effects of climate change; however, it is also the responsibility of the individuals themselves. Focus on promoting healthy lifestyle though such public health campaigns.

Policy Recommendations

Implementing adaptations for facing climate change impacts will increase the ability of the population to have a decent quality of life in healthy conditions. Measures such as improved health care, better building design and insulation, and the installation of early warning systems, improved emergency preparedness and disaster relief, and a host of other preventative strategies will help alleviate the health risks and impact of climate change, particularly those associated with extreme weather events. These could be included in a National Adaptation Strategy for the Health Sector or as amendments to the existing sector strategy.

These amendments or the Strategy should be developed by the Ministry of Health, which is responsible for the health sector, in conformity with international agreements and conventions, signed and ratified by the Republic of Moldova, under the supervision of the Inter-ministerial Adaptation Commission. This Commission will control the process of elaboration and will ensure the inter-relatedness of all sector strategies and exclude the possibility of conflicting provisions.

- Specific attention should be paid to the health care system, improve its work by building capacity through professional training for medical workers on climate change impacts, new possible diseases, complication of already known diseases, etc.

[141] Ibid.

- Changes should be made to the system of health data collection from doctors, which currently is paper based and time consuming. Often data are lost or arrive too late due to the inefficient data collection. First, an assessment should be made to determine all gaps; second, administrative changes should be proposed that would increase the efficiency of data collection and analysis, ensuring the lowest rate of data loss.
- In order to keep track of health development in the country an electronic system of data collection from doctors should be developed. Health centres, hospitals and clinics should be supplied with computers and the necessary software. Doctors should be trained on how to use the system and on the available techniques.
- There should be provisions made for extreme weather events, including a regulation for extreme weather cases, by the common efforts of medical and municipal authorities that would provide for climate change-related health emergency prevention measures. For example: in the case of high temperatures there could be places to offer drinking water for free. Also, appropriate amendments should be made to the work security requirements. For example in cases of extremely hot weather, working hours could be changed.
- A public information and awareness campaign should be prepared and implemented on a continuous basis, in order to prepare and inform the population on the possible health impacts of climate change and also provide adaptation measures to reduce possible negative results.

Chapter

10

Towards a Risk Resilient Society

10. Towards a risk resilient society

10.1. Summary

Risk transfer on the one hand represents an element of disaster risk management and thus an instrument to adapt to climate change, whereas on the other hand it can also help to reduce poverty. However, the Moldovan mechanism currently in place to transfer the risk of natural hazards shows various limitations. The interplay between the public sector and the private insurance industry, which forms an important aspect of a functioning risk transfer scheme for natural hazards, does not work well. As a result, insurance depth is low and most damages resulting from natural hazards have to be borne by individuals, especially the rural poor. Suggestions concerning the reform of the current risk transfer mechanism regarding property insurance include e.g. the provision of better risk zoning and risk mapping by the public and a redesign of the conditions of public ex-post compensation so that they encourage also ex-ante insurance. Regarding the agricultural risk transfer scheme, the introduction of alternative instruments such as index-based insurance could help to improve the accessibility to small farmers and reduce the public sector's burden.

10.2. Why is risk transfer a key issue for adaptive capacity?

Risk transfer, which is defined as a shifting of the burden of disaster loss to another party (for instance by means of insurance), represents an important instrument for managing the risk resulting from natural perils and can help in mitigating or minimising disaster losses. A well implemented plan for spreading economic risks from extreme events across society and/or transferring those risks from victims to the financial markets is a fundamental adaptation measure that crucially affects how the impacts of climate change will finally disturb a society. Although risk transfer does not prevent damages from climate change, it represents an effective mechanism for managing the hardship resulting from climate risks, especially of those climate risks which cannot be prevented (cost effectively) by means of risk mitigation measures. Moreover, adequately designed risk transfer mechanisms even have the potential to generate incentives for individuals as well as the collective to actively engage in risk reduction.

However, risk transfer does not only represent an element of disaster risk management and thus an option to adapt to climate change, but also a mechanism that can help to reduce poverty.[142] Variability in weather and climate constitutes a risk that can significantly limit the options of the rural poor and hence restrict human development. Risk transfer tools designed in such a way that their accessibility and affordability is ensured for poor rural households therefore positively affect human development. Access to financial risk transfer tools increases the range of opportunities available to poor rural households. The threat of weather shocks, which have the potential to totally destroy their goods and assets, reduces their creditworthiness and prevents them from investing in innovations and technological changes that could stimulate productivity growth in the long run. Access to financial risk transfer tools on the other hand can help rural households to stabilise their incomes, safeguard their financial resources and improve their access to credit by reducing lending risk and hence reducing the cost of borrowing. In other words, accessible risk transfer mechanisms facilitate sustained growth by helping poor rural households to escape the classic poverty trap that is caused by shock losses resulting in difficulties with carrying on with production in the subsequent season.

10.3. Status quo of risk transfer in Moldova

Although the insurance sector in Moldova has been growing in recent years (see Chart 35), it is still poorly developed compared to Western European countries. In 2008, the 33 registered insurance companies generated gross written premiums in the amount of 54.4 million Euros,[143] which represents an increase of 24.8 per cent in nominal terms compared to 2007. However, an insurance depth[144] of only about 1.3 per cent compared to 9.2 per cent within the EU-15, makes it clear that the Moldovan insurance sector is at an early stage in its development. Claims paid by insurance companies amounted to 17.6 million Euros in 2008, which corresponds to an increase of 24.2 per cent compared to the previous year.[145]

With a lack of participation by the population in the insurance market, the public sector – besides

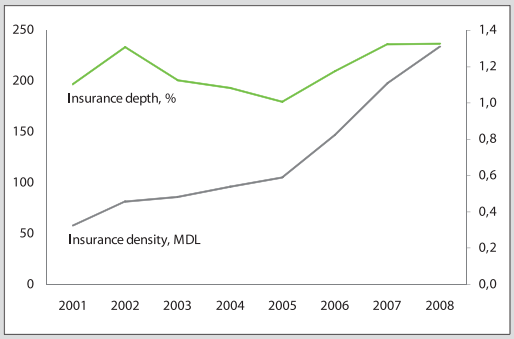
[142] See e.g. International Research Institute for Climate and Society, 2009.

[143] Calculated at the average exchange rate according to the Moldovan National Bank.

[144] The insurance depth is defined as the share of gross written premiums in GDP.

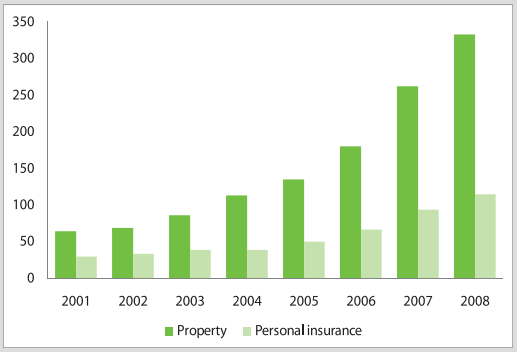
[145] http://insurance.1asig.ro/25-growth-for-the-insurance-in-the-Republic-of-Moldova-in-2008-article-2,3,117-29727.htm (as in September, 2009).

Chart 35. The evolution of insurance depth[146] (%) and insurance density[147] (MDL)



Source: *National Commission of Financial Markets.*

Chart 36. The evolution of property and personal insurance (mil. MDL)



Source: *National Commission of Financial Markets.*

institutions of the civil society such as charities – is the only remaining provider of (ex-post) risk transfer that provides financial support to victims of extreme weather events. There are two cases in which the Moldovan government provides compensation:[148]

- Physical as well as indirect losses resulting from earthquakes are partially compensated by the government through the mobilisation of exceptional funds.
- Central and local government keeps back a reserve fund each year in order to be able to provide disaster relief in the case of localised extraordinary events such as floods or extreme climatic events.

However, ex-post disaster relief by the government again weakens the incentive to participate in the insurance market. On the other hand, the Moldovan government also subsidises agricultural insurance (see sub-chapter AGRICULTURAL INSURANCE for further details). Nevertheless, most damages resulting from natural hazards are borne by individuals, especially the rural poor.[149]

10.3.1. Property insurance

The private sector provides 100 per cent coverage for natural catastrophes but the low insurance depth suggests that either the prices are not considered affordable or that the risk is underestimated by the population. A lower level of demand for insurance in general is natural for poor countries, since insurance demand grows disproportionately to GDP, and this fact can partially explain low level of insurance penetration.

Since there are no data available on the risk mapping of natural hazards in Moldova, we cannot prove but have to assume that a third possible reason for low insurance depth, namely that the risks from natural perils actually *is* lower than in comparable countries, is unlikely. This lack of risk mapping information however entails another problem: there is only asymmetric information on the Moldovan property insurance market. The two consequences of asymmetric information, i.e. moral hazard and adverse selection, both drive down the amount of insurance that is sold. For an explanation of this effects see Box 19.

The dysfunctional interplay between the public sector, whose duty should be the provision of risk information about natural hazards to the public, and the private sector, which then can provide efficient coverage of the identified risks, is the fourth possible reason for high prices and a resulting low quantity of insurance demanded. This certainly is a more important effect than the above mentioned possible underestimation of the risk. The sixth possible reason for low demand is that if the state is trusted to use the above mentioned reserve funds to compensate individual victims of natural hazards, this will also drive down insurance demand, as mentioned above. So, to conclude, there seem to be three remaining plausible reasons for low insurance depth in Moldova:

- Low income
- Lack of public risk information
- Existence of public funds that also compensate victims

[146] Share of gross written premiums in GDP.
[147] Gross written premiums per capita.
[148] World Bank, 2007.
[149] Ibid.

Box 19. Two consequences of asymmetric information: adverse selection and moral hazard

Adverse Selection

Adverse selection is a consequence of asymmetric information between the insurance company and the insured party (e.g. the home owner). The potential insurance client has more information on the risk he is facing than the insurance company. Thus, the insurance company faces a difficulty in properly classifying the risk its customers represent and has to offer the same contract to clients bearing different risks. However, such contracts are more attractive to people with higher risks, leading to higher damage payments. Consequently, to avoid losses, the insurance company has to increase the premium. Unfortunately, this measure only exacerbates the problem and ends in a vicious circle, because only those facing very high risks will buy at this price. The result is low levels of insurance penetration.

Obviously, the Moldovan property insurance market suffers from this problem since in the case of natural hazards this problem can only be solved if some institution makes information on risk zones publicly and easily available. This usually is a task of the State, especially if the market is small.

Moral Hazard

Moral hazard is also related to asymmetric information and refers to the inability of the insurance company to monitor the behaviour of the insured party. Moral hazard occurs after the conclusion of the insurance contract and refers to a change in the behaviour of the insured party that leads to a higher risk than considered when setting up the contract. As efforts for avoiding damages represent costs to the insured party, it faces an incentive to take less care. Taking agricultural insurance as an example, an insured farmer tends to reduce his usage of fertilisers and pesticides or cultivate riskier kinds of crops after contract formation.

With moral hazard in place, providing sustainable insurance becomes virtually impossible in the agricultural sector, as the phenomenon leads to a costly cycle of losses. To reduce the inefficiencies due to moral hazard, there has to be continuous investment into a monitoring system, which imposes higher costs on the insurance company. The solution to moral hazard problems in agricultural insurance is the introduction of weather index based insurance. The alternative solution is that the government subsidises agricultural insurance and in this way compensates the insurer for the additional cost. This results in an overall dead weight loss to the economy, however.

Source: *NHDR Team.*

10.3.2. Agricultural insurance

As already mentioned, the Moldovan insurance sector is poorly developed, which is especially true for rural areas. In Moldova, the insurance of agricultural production is subsidized by the state.[150] Despite the introduction of this subsidy, which caused a pronounced upward trend in gross written premiums starting with 2005 (see Chart 37), agriculture remains one of the most underinsured sectors. In 2008, gross written premiums from agricultural insurance amounted to about 3 million Euros. Thus, the share of agricultural insurance in the insurance market is extremely low, representing only 5.4 per cent of the total gross written premiums.[151] Moreover, only two insurance companies (out of 33) were underwriting agricultural risks in 2008, namely "Moldasig" SRL and "Moldcargo" SRL.

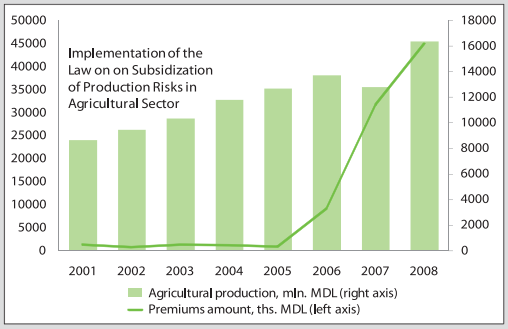
Chart 38 illustrates the evolution of the loss ratio of agricultural insurers, which represents the ratio between the total claims paid and the premiums collected. According to the graph, the drought-year 2003 was the most unprofitable year for Moldovan agricultural insurers within the analyzed period.

Policies cover agricultural risks including drought, torrential rains, hail, floods and different types of

[150] Law on the Subsidization of Production Risks in the Agricultural Sector, no. 243-XV from 08.07.2004.

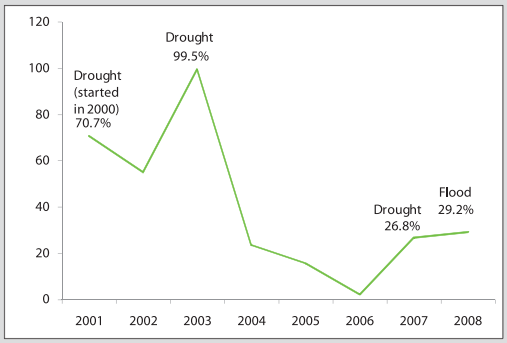
[151] http://social.moldova.org/news/government-to-appropriate-25-mln-lei-for-farmland-insurance-196057-eng.html (as in September 2009).

Chart 37. Evolution of agricultural production and gross written premium.



Source: *National Commission of Financial Markets.*

Chart 38. The evolution of the loss ratio (%) of agricultural insurers compared to the occurrence of natural hazards



Source: *National Commission of Financial Markets.*

frost. Premiums vary by type of crop and by type of risk covered and on average amount to 3 to 5 per cent of the sum insured. Regarding "Moldasig" SRL, compensation in the case of damage amounts to the full insured loss minus about 20 per cent. Insurance clients are mainly formed of large-scale farmers.[152]

As already mentioned, the Moldovan agricultural insurance scheme is heavily subsidised by the government. Premium subsidies compensate for the risk of drought, hail, floods, storms and frost as well as the forced slaughter of animals and poultry. The subsidised goods include sugar beet, corn, sun flower, tobacco, vegetables, wheat, fall rape, barley, vines, orchards, grapes, fruit crops and animals.[153] Table 25 outlines the extent of premium subsidisation as well as the amount budgeted for these subsidies for the years 2006, 2007 and 2009. If agricultural insurance gains in popularity among farmers, the current design of the Moldovan agricultural risk transfer scheme will impose ever larger costs on the government.

Besides subsidising agricultural insurance premiums, the Moldovan government also provides ex-post disaster assistance. In 2008, for instance, the Government allocated MDL 15.3 million (around 1 million Euros) to compensate agricultural land owners for crop losses due to a flood that affected 4,832 hectares of agricultural land.[156] However, besides being expensive for the state, ex-post disaster relief also leads to poor incentives as it does not encourage individuals to engage in risk reduction and prevention.

To sum up, the current design of the Moldovan agricultural risk transfer scheme has the following drawbacks:

- The scheme is (or has the potential to become) expensive for the state due to governmental premium subsidies and ex-post disaster relief;
- The governmental ex-post disaster assistance is likely to provide poor incentives;
- Agricultural insurance seems not to be affordable for poor farmers.

The Bulgarian and Romanian agricultural risk transfer schemes, which are briefly described in Box 20, show similar limitations to the Moldovan one.

Table 25. Governmental subsidization of agricultural insurance

	2006	2007	2009
Subsidy (in % of premium costs)	50% - 60%[154]	80%	70%
Amount budgeted for subsidies (in million MDL)	3.7	15	25

Source: *World Bank (2007) and Moldova.org.*[155]

[152] World Bank (2007) and http://economie.moldova.org/news/government-to-pay-crop-insurance-premiums-23900-eng.html (as in September 2009).
[153] http://social.moldova.org/news/government-to-appropriate-25-mln-lei-for-farmland-insurance-196057-eng.html (as in September 2009).
[154] 60% in the case of perennial plantations, sugar beet and vegetables and 50% in the case of other crops and animals.
[155] http://social.moldova.org/news/government-to-appropriate-25-mln-lei-for-farmland-insurance-196057-eng.html, http://economie.moldova.org/news/government-to-pay-crop-insurance-premiums-23900-eng.html and http://economie.moldova.org/news/government-to-increase-financing-agriculture-risks-42057-eng.html (as in September 2009).
[156] http://economie.moldova.org/news/farmers-that-lost-crops-as-a-result-of-floods-will-receive-compensations-145160-eng.html (as in September 2009).

Box 20. Case study – agricultural risk transfer schemes in Bulgaria and Romania

Bulgaria

In Bulgaria, agricultural insurance is private and not subsidised by the state.[157] Currently, single as well as combined risk insurance is available whereas products such as yield or index-based insurances are not provided at the moment. Although the agricultural insurance market has been developing in recent years, insurance is still unpopular and not widely used[158]. Agricultural insurance is mainly purchased by larger farmers, which possess the financial means to insure agricultural assets. In addition, purchasing insurance represents a precondition for having access to certain subsidies and low interest rate credits. Since big farms are the main recipients of these loans and grants, they buy insurance in order to get the financial support. Smaller farms often have no access to insurance due to low income. In addition, insurance companies try to avoid dealing with small farms since their size leads to higher transaction costs and lower profits.[159] Due to the low level of insurance penetration, the state often provides ex-post aid in the case of natural disasters. However, ex-post disaster assistance is expensive for the public sector and moreover leads to wrong incentives.

Romania

Agricultural insurance in Romania is private, but was partially subsidised by the state until 2007.[160] Currently, single-risk as well as combined risk insurance is available, whereas no yield or index-based insurance products are provided at the moment. Although the Romanian agricultural insurance market has been growing rapidly in recent years, compared to countries of Western Europe it is still small. The great majority of the agricultural insurance contracts undertaken stem from large farms. Most small producers ignore agricultural insurance due to a lack of money or information about the significance of risk management tools.[161]

The role of the state within the Romanian agricultural risk transfer mechanism is regulated by Law 381/2002 concerning the granting of indemnities in the case of natural calamities in agriculture.[162] According to this law, the government indemnifies those agricultural producers for damages caused by natural calamities who have insured their agricultural crops, livestock, fowls, bees and/or fish with insurance companies that are approved by the Ministry of Agriculture. Thus, the condition for being indemnified by the state in case of a natural calamity is the existence of an optional insurance contract for the damaged good. In order to receive indemnity it suffices to possess even a simple insurance product like that against hail, which is the cheapest one.[163] In summary, the insured loss of agricultural producers is either compensated by insurance companies or the state. If losses arise due to "standard risks" (insurable risks), compensation is paid by the insurance company whereas if the damage arises due to natural calamities as defined by Law 381/2002, the compensation of the agricultural producer, insured for "standard risks", is carried out by the state.[164]

As Law 381/2002 acts as a disaster aid in the case of significant losses, farmers rely on it and have no incentives to think about other risk management alternatives. Besides, indemnity payments by the Ministry of Agriculture are considerable, thus the Romanian Government is searching for a solution in order to stop paying full indemnities for insured crops in the case of natural calamities alone.[165]

Source: *NHDR Team.*

10.4. What properties should a risk transfer mechanism have?

Although the concrete design of a country's risk transfer mechanism depends on the goals pursued and the desired incentive effects, there are some general aspects that need to be considered when designing an efficient and working risk transfer scheme.[166]

[157] Bielza et al., 2006.
[158] Panciu and Doronceanu, 2007.
[159] Bachev and Nanseki, 2008.
[160] Bielza et al., 2006 and Ionete, 2009.
[161] Mitu, 2008.
[162] LAW 381/2002 regarding the granting of indemnities in case of natural calamities in agriculture, Official Gazette of Romania, 1st Part, no 442, 24 June 2002.
[163] Mitu, 2008.
[164] Bielza et al., 2006, ANNEX 21.
[165] Bielza et al., 2006.
[166] see also Prettenthaler, Albrecher (2009)

Optimally coordinated risk partnership between insurers, the state and citizens:

A well-coordinated and active partnership between public institutions and the private insurance sector is the best way to manage the adverse effects that climate change has on extreme weather events. The private insurance sector knows best how to identify and analyse risks, create sustainable financial solutions and stimulate risk-reducing behaviour. However, due to some specific features certain types of natural hazards show – e.g. the potential of causing catastrophic damages as large areas are affected at the same time – it might be difficult or even impossible for the private insurance sector to provide comprehensive insurance coverage efficiently for the whole population on its own. The state, on the other hand, has the power to establish a framework that helps in meeting the insurability conditions with respect to natural hazards, as it decides on land-use planning, construction codes, prevention measures, etc. Thus, active public-private partnerships have the potential to improve the insurability of risks from natural hazards, which brings benefits to the government, the public as well as the insurers.[167]

Bulgaria, which currently faces similar problems regarding the insurance of natural hazards as Moldova, is for example considering participating in a regional catastrophe insurance programme facilitated by the World Bank, which builds on cooperation between public authorities and the private insurance sector. Box 21 provides more detailed information on the situation in Bulgaria.

Generation of a risk collective of sufficient size to enable an effective balancing of risks:

An effective balancing of risks requires a risk collective of sufficient size. However, some natural hazards, such as floods or droughts, are characterized by the fact that they tend to occur at the same place over and over again. Thus, if insuring oneself against such kinds of natural perils is voluntary, coverage will be demanded mainly in areas that show an above average likelihood of suffering damage. In other words, only a particular part of the population, namely that at (greatest) risk, may want to purchase insurance, a phenomenon called adverse selection (see Box 19 above). If insurance companies have difficulties in screening clients and/or are not able or allowed

Box 21. Case study – Bulgarian risk transfer scheme with respect to natural hazards

In Bulgaria, insuring property against natural hazards is voluntary. Insurance companies offer coverage for most natural hazards either within or as an additional endorsement to the standard homeowner/fire policy, depending on the type of hazard and the insurance company. Premiums, except those for earthquakes, tend to be flat and deductibles are rather uncommon. Due to long and complicated procedures there exists little confidence in the private insurance market. Thus, catastrophe insurance penetration for natural hazards is quite low. Only about 7 per cent of Bulgarian homeowners are insured against damages arising from natural disasters. Because of the low insurance penetration, the Bulgarian government has provided financial assistance to uninsured homeowners following floods in recent times. However, this is a strategy the Bulgarian state cannot actually afford, since the financial preparedness to cope with major disasters is in any case quite low. Thus, several proposals for reforming the risk transfer scheme have recently been made. The most recent development is that Bulgaria is committed to establishing the South Eastern and Central Europe Catastrophe Risk Insurance Facility (SECE CRIF) – a regional catastrophe insurance programme facilitated by the World Bank together with the United Nations International Strategy for Disaster Reduction (UN ISDR) and the Regional Cooperation Council (RCC) – along with five other countries, namely Albania, Bosnia and Herzegovina, Croatia, Montenegro and Serbia.[168] The SECE CRIF will be set up as a regional catastrophe risk pool ***owned by the governments*** of the participating countries and ***managed by the private sector***. The aim of the SECE CRIF is to "*facilitate the development of a catastrophe insurance market in South East Europe and thereby provide access for homeowners and SMEs to affordably priced (but not subsidised!) catastrophe insurance*".[169] This would help reduce the budgetary outlays of governments for reconstruction after disasters.[170]

Source: *NHDR Team.*

[167] For more detailed information on the role of public-private partnerships in reducing the impacts of natural catastrophes see CEA (2007).
[168] Radev, 2009.
[169] Regional Cooperation Council, 2009.
[170] See e.g. Gurenko et al., 2008 for a more detailed description of the South Eastern and Central Europe Catastrophe Risk Insurance Facility.

to charge risk-based premiums, adverse selection becomes a problem that leads to a reduced risk collective. A lack of risk awareness among potential clients as well makes the creation of a risk collective of sufficient size difficult.

Actions that can be taken in order to increase the size of the risk collective include the bundling of several types of natural hazards, which enlarges the number of potential insures at risk with regard to one of the perils in the bundle and thus increases the demand. Further possible measures include risk-based premiums, campaigns to inform the population about their exposure and the introduction of compulsory insurance.

Control of adverse selection and moral hazard:

The phenomena of adverse selection and moral hazard have already been described in Box 19. There are several measures available for reducing the problems associated with these two phenomena. One of the measures insurance companies can use to limit the problem of moral hazard is the introduction of deductibles, i.e. before being entitled to compensation by the insurer the insured has to bear a certain portion of the insured loss on his own. Risk-based premiums present a measure for reducing adverse selection. However, risk based premiums presuppose the existence of risk zoning information. Using premiums that vary with the degree of risk can also help to reduce problems related to moral hazard. With several types of natural perils the choice of the building site and the building materials is already related to some kind of moral hazard. Given that the insurance conditions for the different risk groups are known and society is aware of the exposure of different locations, risk-based premiums are likely to reduce construction work in high risk areas, for which no or only limited/expensive insurance coverage is available. A further possibility for combating adverse selection is making insurance compulsory.

Explicit rules for the handling of objects with very high damage frequency:

The introduction of effective risk transfer mechanisms is a special challenge for countries which have had malfunctioning risk zoning instruments in the past, failing to prohibit construction activities in high risk zones. On the one hand, offering buildings in such zones insurance at affordable premiums is one of the main purposes of government intervention. On the other hand, a strong cross subsidisation from other risk zones to these zones creates incentives to build in such places. Therefore, such buildings should be included, but in case of damages a strict prohibition of reconstruction at the same place for objects with very high damage frequency is indispensable.

Control of the accumulation risk caused by correlated risks, precautions for catastrophic loss events:

Individual damages resulting from natural hazards such as floods or droughts generally do not occur independently from each other, but affect large, connected areas. In other words, several types of natural hazards can lead to catastrophic loss events by having the potential to affect a huge number of (insured) people at the same time. Such excessive losses may exceed an individual insurer's reserves. Possible measures for overcoming this risk include the introduction of liability limits, reinsurance, the use of catastrophic risk-transfer bonds (cat bonds), the development of a risk pool for natural catastrophes or the involvement of the state as insurer of last resort.

Creation of a socially acceptable premium for 100%-coverage (apart from deductibles):

In general, risk transfer schemes that simultaneously provide universally available coverage and affordable premiums in risk zones as well can be classified as socially acceptable. This will usually involve a certain amount of cross subsidisation from good risks to bad risk. Setting the desired/justifiable extent of cross-subsidisation is not an easy task, and this is why self-selecting tariffs for premiums are a good instrument: good risks will rather accept a system, in which they have a choice between a combination of either higher premiums with low deductibles on the one hand or lower premiums and higher deductibles on the other hand.

Generation of incentives with respect to collective and individual risk prevention:

Whereas tools such as governmental ad-hoc aid or compensation funds, which finance economic losses after the occurrence of the catastrophe, do not encourage individuals to reduce risks, insurance solutions, which on the contrary finance the possible economic losses before the disaster takes place, create incentives for individuals to engage in risk mitigation and prevention. This is especially true if the insurance solution makes use of deductibles and/or risk-based premiums. Another important design element for creating

incentives for individual and collective risk mitigation and prevention is the prohibition of new buildings in risk zones. Of course, the development of risk maps represents a precondition for such a measure.

Planning security regarding the financial involvement of the public sector:

While the state as the largest possible risk collective for any given territory will always have to play some role in controlling and bearing the correlated risks typical for natural catastrophes, its budgetary boundaries should not be overstretched. Thus, the state should always also at least partly rely on the private sector, a transfer to the international financial markets, e.g. by cat bonds or build up public reserves for at least avoiding budgetary instability after disasters.

Creation of a legal framework for schemes with obligatory elements:

Obligatory coverage extensions and compulsory insurance represent possible methods for solving problems such as adverse selection or insufficient demand. At the same time the advantages of an insurance solution bring maximum benefit to society as a whole. If a country intends its risk transfer mechanism to incorporate obligatory elements, the creation of a legal framework is necessary. One example of a country that is currently working on the introduction of a risk transfer mechanism with obligatory elements is Romania (see Box 22).

10.5. Suggestions for policy reform

The above section provides a wide range of ideas for the policy maker who really wants to design a balanced risk transfer mechanism in Moldova. However, there are some obvious points that should be highlighted as a conclusion:

Suggestions concerning the risk transfer mechanism regarding property insurance:

- any reform has to start with better risk zoning, risk mapping and making this information as easily available to the public as possible;
- the conditions of public ex-post compensation of damages need to be redesigned so that they also encourage ex-ante insurance;
- given the size of Moldova and the transaction cost of the implementation of a new system, joining SECE CRIF might be worth considering.

Box 22. Case study – Romanian risk transfer scheme with respect to natural hazards

In Romania, a reform process regarding the financial risk transfer mechanism with respect to natural hazards is in progress at the moment. A national catastrophe insurance pool supported by insurance companies is in the process of being established. The new system for household insurance against natural risks, that is regulated by Law 260/2008[171] and expected to enter into force in January 2010, introduces compulsory insurance coverage for all residential dwellings owned by natural persons or legal entities and covers earthquakes, landslides and floods if they are manifest as natural phenomena.

According to Law 260/2008 and the corresponding norms, the mandatory premiums will only vary with the building material, but not with the degree of risk. Regarding social households or persons who are beneficiaries of social aids, the mandatory premiums will be subsidised by the state. The new mandatory insurance system against natural catastrophes is conceived as a chain relation between the insured persons, the insurance companies represented by the catastrophe insurance pool, the reinsurers as well as the state. In the case of a natural catastrophe that leads to insured damages exceeding the compensation potential of the national catastrophe insurance pool, the state will pay the difference. Thus, the whole system of mandatory household insurance is guaranteed by the state. However, at the moment there are still some unresolved problems with respect to the new system, which could delay its implementation.

Source: *NHDR Team.*

[171] Law 260/2008 regarding the mandatory household insurance against earthquakes, landslides and floods, Official Gazette of Romania,1st Part, no 757, 10 November 2008.

Suggestions concerning the agricultural risk transfer mechanism:

- the accessibility of the system to small farmers needs to be improved;
- given the considerable budgetary strain caused by the increasing sums being spent on subsidising insurance premiums, premium-reducing instruments should be considered;
- e.g. Index-based insurance should be promoted (see Box 23).

According to a study assessing the feasibility of index-based insurance in Moldova,[172] the country seems to be well suited for this alternative risk transfer mechanism. Moldova has a high density of weather stations (weather data is collected in 82 locations) and the government as well as the insurance industry are strongly interested in the product. Index-based insurance could help to reduce the systemic risks the country faces (catastrophic events occurred in 2000, 2003, 2006, 2007 and 2008) and contribute to solving certain insurance problems such as the lack of access to international reinsurance markets or portfolio diversification.

The recommendation of the World Bank with respect to agricultural risk transfer mechanism in Moldova:

- "Piloting of a privately run index-based weather insurance for broad-based threats like drought and frost; and
- Traditional, private sector insurance products for localized threats like hail." [173]

Box 23. Alternative risk transfer mechanisms – Index-based insurance

Index-based insurance

Index-based insurance products represent an alternative insurance form, where payments are based on certain indices rather than farm yields. Those indices represent variables that are exogenous to the insured person, but strongly correlated to farm-level losses. Index-based insurances can e.g. be developed on the basis of a weather index (weather index insurance) or on the basis of the average regional yield (area-yield insurance). The index is measured by government agencies or other third parties. In contrast to traditional crop insurance products, such as single or multi-peril crop insurance, no data about individual yields is needed. Index-based insurances only require the historical values of the weather index (e.g. temperature, precipitation, etc.) or the regional yield.[174]

Advantages

Index-based insurances offer several advantages compared to traditional crop insurance. First of all, there is less adverse selection since the indemnities and premiums are independent of the individual risk of the insured group. Furthermore, the problem of moral hazard is reduced as individual farmers cannot influence the basis (i.e. the index) of the payment. Thus, compared to traditional crop insurance index-based insurances sometimes offer better risk protection as deductibles are not needed. In the case of index-based insurances neither underwritings nor inspections of individual farms are required, thus administrative costs are low. Moreover, the contracts could be sold in small units, making them appealing for poor people. Due to their availability and negotiability, index-based insurances can be traded easily on derivative markets. This allows the risk to be spread among a wider range of parties. Thus, index-based insurances could be used for reinsurance as well.[175]

Challenges

There are also several challenges related to index-based insurances including the minimisation of the basis risk. The basis risk refers to the risk that a single farmer suffers losses and is not (sufficiently) compensated or is overcompensated for the loss. Thus, the basic risk depends on the degree of the correlation between the index and the losses of the insured person. If there is not enough correlation, index-based insurance is ineffective. However, by carefully designing the index insurance policy parameters (coverage period, trigger, measurement site, etc.) it is possible to reduce the basis risk. Furthermore, accurate and secure measurement and distribution of the index data has to be guaranteed. Since unfamiliarity with the concept of index-based insurances represents another potential disadvantage, it is important to provide potential users with enough information. A further challenge is the absolute need for strong reinsurance. Therefore, effective arrangements between local insurers, international reinsurers and national governments have to be forged.[176]

Source: *NHDR Team.*

[172] Shynkarenko, 2008.
[173] World Bank, 2007, xiii.
[174] See e.g. Prettenthaler et al., 2006 or Skees et al., 2005.
[175] See e.g. Skees, 2003 or Hazel and Skees, 2006.
[176] See e.g. Skees, 2003 or Bielza et al., 2006.

Chapter

11

Policy Discussion: Climate Change Realities in the Country Development Agenda

11. POLICY DISCUSSION: CLIMATE CHANGE REALITIES IN THE COUNTRY DEVELOPMENT AGENDA

11.1. Introduction

This Report provides a comprehensive overview of climate change projections for Moldova that show considerable impacts across the whole country which were described in detail in the preceding chapters.

Although climate change is a recognized fact of global importance, none of the assessed strategies has integrated measures for prevention of its effects or adaptation to them (Annex 2.12). The factors responsible for this major global problem are sporadically and separately mentioned, but the links between them as well as their obvious complex effects are missed. Based on the analysis of current strategies and the legal framework (Annex 2.12), it can be concluded that Moldova urgently needs to put forward adaptation measures that would reduce the negative impacts of climate change on further development. Without early action, the costs of inaction can be significant.

Climate change is mostly the priority of the Ministry of Environment. But efforts by this Ministry alone will not be enough to adapt to climate change. It is an issue that needs to be incorporated into different policy areas – whether energy, transport, agriculture or industry.[177]

In this respect, each chapter of the Report provides a detailed analysis of the current situation in each respective economic sector and provides for a series of recommendations to be taken into account, and issues that would need to be reflected in sector strategies and policies. Several adaptation solutions are proposed, including for policy options, chosen to respond to climate change in the context of the current economic and financial crisis faced by the Republic of Moldova.

This chapter takes this discussion further. First, it puts the sectoral adaptation options into a broader context and attempts to put forward the transversal policy framework needed to tackle successfully the challenges posed by climate change at the national level. Secondly, it looks in more detail at such pre-requisites of efficient adaptation as the different stakeholders' involvement, the need for more awareness and public participation, education and training, and so on.

11.2. Adaptation options in support of development goals

The Republic of Moldova, being an economy in transition and a less developed country, is most vulnerable to the adverse impacts of climate change. Because of its poverty level and low capacity, associated with the demographic structure, the wealth, structure of the economy and the regional distribution of all these factors (see HUMAN DEVELOPMENT AS ADAPTIVE CAPACITY), Moldova's adaptive capacity is limited. A timely elaboration of national adaptation strategies and the integration of climate change aspects into development cooperation as well as into relevant national sectoral policies are of high importance. ***Climate change adaptation should not be done in competition with, but in addition to other management measures***.[178]

It should be noted that as was previously shown in this Report, climate variability and change will lead to wide ranging impacts across different sectors and regions of Moldova and current and future economic development is affected by climate change which directly affects the country's human development efforts. Given the current situation (see HUMAN DEVELOPMENT AS ADAPTIVE CAPACITY) the country should make the necessary efforts in order to adapt to climate variability and climate change impacts. Without early policy action on adaptation, the Republic of Moldova may be forced into sudden and reactive measures in response to increasingly frequent crises and disasters. If climate change and its potential impacts are not taken into account in decision making today, the costs of inaction can be significant. This will not only prove much more expensive than planning ahead, but will also harm the economy, social stability and security. Policy making on sound adaptation to climate variability and change has to be informed by estimates of the damage costs that are likely to appear if business as usual will be followed. As funds are limited, in the first place attention will naturally be given to win-win measures, i.e. adaptation options that are justifiable even without taking climate change into account. However, by applying the precautionary principle in the face of uncertainty, the potentially high costs

[177] Policies for a Better Environment. Progress in Eastern Europe, Caucasus and Central Asia. OECD, 2007.

[178] Draft guidance on water and climate change adaptation, UNECE, WHO, July 2008.

of inaction should be taken into account when assessing the benefits of adaptation measures.

Previous sector-specific chapters (4, 5, 6, 7, 8 and 9) presented adaptation options and policy recommendations which are briefly summarised and presented below:

In the **water sector,** adaptation options are related to the poor state of the water supply infrastructure, poor quality of drinking water and the need for more efficient use of water. It is recommended to have a National Adaptation Strategy for the water sector or respective amendments to the existing strategic documents, providing specific adaptation solutions based on scientific research and cooperation with other sector-specific authorities. (See CLIMATE CHANGE AND WATER RESOURCES CHAPTER for more details)

Recommendations in the **Ecosystem chapter** provided for the inclusion of the ecosystem dimension in a National Adaptation Strategy for the Environmental Sector or respective amendments to the existing strategic documents, but also in other sector strategies that can directly or indirectly affect the environment and its ecosystems. Strategic Environmental Assessment is recommended as an instrument to ensure sustainable development principles are respected in existing and future policies, strategies and programmes. (See ECOSYSTEMS: VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES for more details)

The **agriculture sector** is one of the sectors most vulnerable to climate change and the proposed recommendations emphasise the need to subsidise agricultural activities in order to modernise and improve the quality of irrigation, and emphasise the promotion of newly available techniques like conservation agriculture. It is also recommended to develop a National Adaptation Strategy for the agriculture sector that would reflect climate change impacts and provide for viable adaptation solutions. (See IMPACT OF CLIMATE CHANGE ON THE AGRICULTURAL SECTOR for more details)

The **transportation sector** is at the base of current economic development. It was recommended to develop a National Adaptation Strategy for the transportation sector or respective amendments to the existing strategic documents that would cover all types of transport, including also the road infrastructure, and which would aim at improving road infrastructure, prepare the country's transportation network for a shift to the Euro-2 or higher standards in a gradual fashion, and prepare an action plan for transportation in case of natural emergencies. (See THE IMPACT OF CLIMATE CHANGE ON TRANSPORT INFRASTRUCTURE for more details)

The **energy sector** is a sector with great dependency on external factors. It is one of the most vulnerable economic sectors of the country given Moldova's dependence on foreign electricity and gas. That is why main ideas of these policy recommendations are related to the efficient use of available energy resources and promotion of alternative energy resources. The National Energy Strategy should be amended to incorporate adaptation measures, and it should provide for an improvement in the quality of energy services, including infrastructure, ways to involve the general public and create a dialogue for a better result. (See CLIMATE CHANGE IMPACT ON THE ENERGY SECTOR for more details)

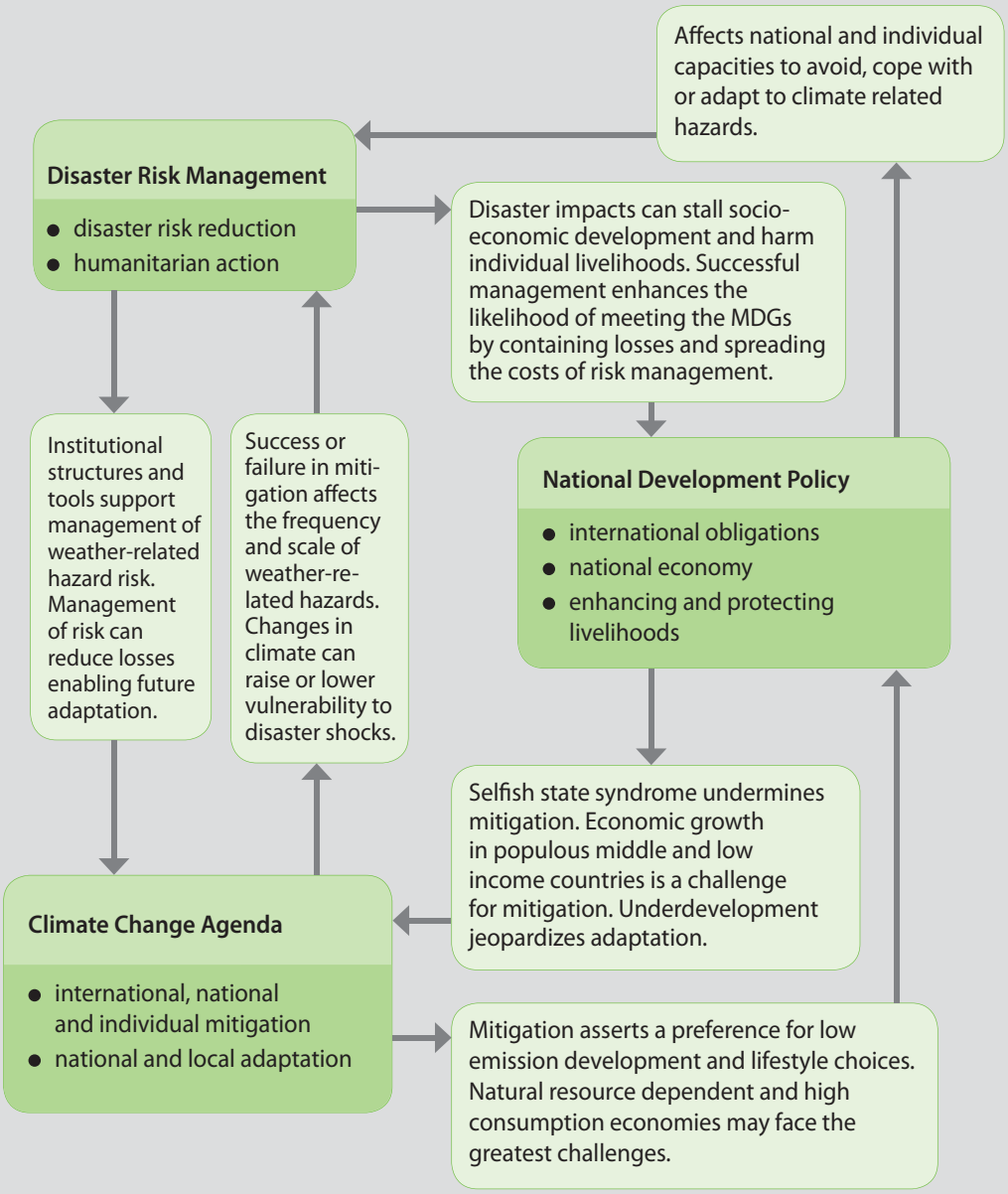
The sector the most linked to human development, the **health sector**, is the one that should reflect adaptation measures to prepare and inform the population for possible negative climate change impacts, ranging from risks stemming from heat-waves and the deterioration quality of water to natural emergencies and disasters. As an imperative solution it is proposed that the health care system be improved by training medical workers on climate change impacts, on new possible diseases, on complications that could result to already known diseases, etc. It is important that the system be supplied with needed equipment and that it be used properly. There should be a National Strategy that would provide for measures to be taken in case of natural emergencies and disasters. For example, in cases of extremely hot weather, working hours could be changed to evening hours, places could be arranged where drinking water could be offered for free, etc. (See CLIMATE CHANGE AND HUMAN HEALTH for more details)

While each sector has its own specific recommendations, the success of their implementation relies on the inter-relatedness of economic sectors and the synergy of the adaptation measures' implementation. By involving all climate change adaptation processes under the same umbrella programme, as shown further in 11.4, an attempt is being made to control the action and ensure a high-quality result.

The NHDR comes as a first baseline report, but more targeted research is needed at the sectoral level as a basis for better national policy adaptation. Special emphasis should be placed on risk management measures, given the nature of climate change impacts. In this case, the procedure of hazard identification, as well as the risk assessment requires a comprehensive approach, regardless of the qualitative nature of the analysis. In other words, vulnerability should be assessed even if quantitative or detailed data about future conditions are missing.[179] Chart 39 illustrates the relationship between disaster risk management, climate change adaptation, and national development.

The challenges that are faced by our country have to be met by the government at many levels, under the pressure of severe financing constraints. Responding to climate change will require the integration of adaptation measures into all aspects of policy development and planning for poverty reduction. However, planning and implementa-

Chart 39. Relationship between disaster risk management, climate change adaptation, and national development policy



Source: *Schipper and Pelling, 2006.*

[179] Adapting to Climate Change in Europe and Central Asia, World Bank, 2009.

tion capacity is limited, and must be improved along the following lines:

Information. Moldova needs the capacity and the resources to assess climate change impacts, risks and costs. In this respect authorities at all levels should be informed, trained and involved in the process of public information and awareness campaigns on climate change issues and adaptation solutions and/or alternatives. Collaboration with scientists and experts in the field should be developed as more targeted research in the climate change field is needed.

Infrastructure. In climate change adaptation, as in other areas, prevention is better than cure.[180] Moldova lacks the financial resources required for infrastructure adaptation. Beyond disaster prevention, the development of community-based infrastructure may reduce vulnerability and empower people to cope with climate risks.

Insurance (for social protection). Climate change is generating incremental risks in the lives of the poor. Social protection programmes can help people cope with those risks while expanding opportunities for employment, nutrition and education.[181] Additionally, attention should be paid to well-designed climate risk transfer mechanisms (see TOWARDS A RISK RESILIENT SOCIETY). Insurance companies could take a role in developing and promoting tailor-made insurance products for different parts of society taking into consideration the climate change risks.

International support for adaptation has to go beyond financing.[182] Current international efforts will be needed for capacity building in areas like energy and water efficiency, organic and sustainable agriculture, alternative energy sources etc. While project-based support is playing an important role, adaptation planning has to be part of national programmes and budgets.

It should be borne in mind that adaptation measures will not reduce climate change, but they can reduce vulnerability to the impacts of climate change. This report presents a list of principles and approaches that should guide the process of designing and implementing adaptation measures and policies[183] (see Box 24). However, without the political will for a change, the support of the central and local authorities and public empowerment, all proposed alternatives will not be successful in practice.

Box 24. Adaptation suggestions based on UNECE guidance[184]

1. The following **overarching principles** should apply to any adaptation policy framework:
   - Adaptation to short-term climate variability and extreme events is a basis for reducing vulnerability to longer-term climate change;
   - Adaptation policy and measures should be assessed in a socio-economic development context;
   - Following the principles of sustainable development, adaptation policy and measures should take social, economic and environmental concerns into consideration and ensure that the needs of the present generation are met without compromising the needs of future generations;
   - Adaptation policies/strategies should be elaborated at different levels in society, including the local level;
   - Effective crossborder cooperation should be ensured at all relevant stages of decision-making, planning and implementation.

2. The **precautionary principle** should be applied and preventive actions should be taken even if some cause and effect relationships are not yet fully scientifically proven. According to the precautionary principle, uncertainty about the damage to be incurred should not serve as an argument to delay action. In the face of great uncertainty, a precautionary approach might even result in a more stringent emission-reductions target and/or adaptation response, meaning the authorities should maximize the deterrent effect of their activities.[185]

3. **Strong inter-ministerial and inter-sector cooperation** with the involvement of all relevant stakeholders should be a precondition for decision-making, planning and implementation. (a) The national development strategy could be modified in order to develop a partnership be-

[180] Human Development Report 2007/2008.
[181] Human Development Report 2007/2008.
[182] Human Development Report 2007/2008.
[183] See Draft guidance on water and climate change adaptation, UNECE, WHO, July 2008.
[184] See Draft guidance on water and climate change adaptation, UNECE, WHO, July 2008.
[185] The precautionary principle is prescribed to protect the environment. But in practice, its scope is much wider, and specifically where preliminary objective scientific evaluation, indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen for the Community. EU's Communication on Precautionary Principle, Brussels, 2000. http://www.gdrc.org/u-gov/precaution-4.html

tween the authorities and the community. (b) A close, continuous interactive collaboration should be established with scientists on climate change issues and newly available technologies in the field.

Effective cooperation should successfully integrate both *top-down and bottom-up approaches*. It is essential that these different administrative levels share their experience from early action and results from research. Adaptation will require solidarity between neighbouring countries so that poorer regions and those hit hardest by climate change can respond accordingly.

4. **No-regret and low-regret options should be considered as a priority**, as they can be designed to provide net benefits regardless of climate change. No-regret options are investments in such developments that would help society to adapt to climate change. In these cases, exact projections of climate change may not be necessary to justify these kinds of adaptations. The simple knowledge and awareness that climate is changing can be enough.[186]

5. Public awareness campaigns at national, regional and local levels and information campaigns to promote methods of climate change adaptation should be performed in order to inform the public, **establish a basis for cooperation and increase the community's level of trust in the authorities**.

6. The impacts of climate change are locally specific. However, the level of specificity of knowledge at the local level is limited and needs to be downscaled. **Any policy or measure should be developed for and applied at appropriate level** (national, regional and local).

7. Climate change has a high level of uncertainties and risks relative in particular to the magnitude, timing and nature of changes, uncertainties and risks which are unusual for decision makers when dealing with other issues. In order to cope with this situation, various methods should be used like **sensitivity and risk analysis, simulation and scenario development**. Authorities should **perform assessments of possible damages and analyse the *"cost of inaction"***. These costs should be compared to the costs of adaptation measures and based on that should an adaptation plan should be elaborated.

8. Measures to cope with the effects of climate change have to be taken into account at different scales, both in space and in time. The **setting of time horizons** should be considered when defining a strategy, policy, or measure, and also for monitoring the implementation of an adaptation strategy. Generally, strategies would be long-term in nature, and policies would targeted at the medium to long term. Measures may have an implementation time of any length, but are expected to have sustained results. Prioritisation – mostly of measures, but in some cases also of (alternative) policies – should take the whole period into account.

9. Estimating the costs of a measure is a prerequisite for ranking it and including it in the budget or in a wider adaptation programme. **The four major methods used for prioritising and selecting adaptation options are cost-benefit analysis, multi-criteria analysis, cost-effectiveness analysis and expert judgment**. The costs of non-action that could lead to a number of environmental and socio-economic effects (e.g. lost jobs, population displacement, and pollution) should also be considered.

10. **Preparing the country for climate change impacts should become a political priority.** Programmes should be devised that aim to: (a) insulate human activities from the influence of weather and climate conditions, most probably extremes in precipitation (rain or snow), in drought and in temperature (both heat and cold waves); and (b) reduce the exposure of weather- and climate-sensitive activities to climate-related hazards.

11. **New legal documents or/and amendments to the existing legal framewor**k should be drawn up, as well as policies, which should include assessment and management of environmental risks. These would also include the risks posed by climate change impacts. These documents should also include maps of areas that might present a significant risk, showing the

[186] Integrating climate change adaptation into development co-operation. OECD, 2009.

possible consequences of extreme weather events. Such maps should be updated every 2 to 3 years, based on geographical, social and economic changes, thus enabling progressive adaptation to climate-related risks as knowledge improves.

12. All new measures should take into account the possible impacts of climate change and the best available technology should be used as far as possible. **Innovative sustainable approaches and technologies should also be taken into account.** In this respect a close cooperation should be established between local authorities and scientists.

13. Mitigation and adaptation strategies should be developed and implemented in an integrated manner aimed at minimising harm to humans and the environment and should take into consideration the adaptive capacity of a system. **The health risk of climate change adaptation options should be assessed before adopting any strategy.** Any scenarios and related methodologies and measures to deal with adaptation to climate change might have side-effects to their implementation. These side effects should be taken into account when selecting strategies.

14. Branch strategies of transport, energy, environment, agriculture, forestry, water, waste, construction and other affected sectors should include respective changes that would provide for adaptation measures in each sector. **All strategies should provide for incentives to promote energy efficiency, sustainable development, decreases in GHG emissions and carbon release, efficient water use** etc. The incentives could be based on awards and price/tax reduction.

15. In order to have policies, programmes and laws that respond to climate change challenges the government should **apply political instruments like Strategic Environmental Assessment**, which have been proven to identify weaknesses and offer proper solutions to help implement sustainable development at all levels.

16. **Work groups should be created that are formed of experts from different fields**, including young specialists and invited stakeholders, to elaborate innovative policies and strategies and involve the general public and NGOs in public debates.

Source: *Draft guidance on water and climate change adaptation, UNECE, WHO, July 2008.*

11.3. Main Actors

Innovative policies and approaches are the ones to make a difference, but these policies and approaches cannot accomplish the tasks on their own. Involvement of civil society, the private sector, nongovernmental sector and individuals is imperative as these are the actors to undertake adaptation. Authorities should take the first step as they are the custodians of public assets, providers of public services and establish the rules of the game. Sustainable solutions will require all these actors to internalise climate risks in their diverse decisions, while being mindful of possible related uncertainties.[187]

Public authorities

Cooperation among local level authorities is a prerequisite for coordinated and constant development. Horizontal collaboration between authorities should be supported and facilitated by offering means and instruments for collaboration. The top-down model of coordination should guide general activities and give the possibility to make decisions at local level – decisions that would best suit the specific situation.

In this respect, authorities should start information campaigns for the general public. Being most familiar with local conditions, local authorities have a key role to play in enabling people to adapt to climate change on the ground.[188] At the same time, central authorities should create incentives for the general public to increase its interest in energy and water-efficient equipment and techniques, alternative energy, efficient water use, waste disposal, etc.

Programmes on climate change should be included in the education system and this knowledge

[187] Integrating Climate Change into Development Cooperation. OECD 2009.
[188] Ibid.

should be promoted in appropriate ways at all appropriate levels of education.

Local authorities should use requirements for spatial planning, land use and land-use change, with respect to adaptation, and could play a key role in raising awareness of the need for adaptation among decision-makers, economic actors and the public. Technical guidance documents, exchange of case studies and sharing of good practice could prove useful tools in this regard.[189]

It should be emphasized that authorities should not create administrative and/or financial obstacles for individuals and private sector, and should ensure no obstacles are created by other economic agents regarding sustainable alternatives for energy, water, fertilisers etc. Public authorities should take into consideration and develop regulations on issues related to authority liability.

The existence of such problems as weak institutions and policy-making capacities, corruption, an inconsistent and unenforceable legal framework, and a lack of qualified personnel is well known and constantly criticised by society. Addressing these issues will result in an increased level of trust on the part of the general public and a higher level of public interest and participation in decision making process. An informed public is an important means for achieving development goals.

Private sector

The economic and political crisis faced by the Republic of Moldova has reduced the country's budget and beside the international financing programmes, a workable solution could come from the involvement of the private sector in activities related to climate change adaptation.

Across all economic sectors, private companies play a very important role in adaptation. Agribusiness will ensure the supply of food. The engineering and construction sector will be responsible for climate-proofing of infrastructure. Risk communication and monitoring will be the responsibility of the media, IT and telecommunication sectors. While the banking sector will be responsible for financing investments in adaptation, the insurance sector will provide the coverage of risks.[190]

Business

Climate change will also influence the activity of companies in all sectors, this being a reason also to support their adaptation to climate change. At the same time, the number of new opportunities to offer new products and services increases.[191] For example, there are new technologies for recycling, biogas production, and new techniques for fertiliser production. Authorities should support and facilitate this new direction on the market and create appropriate incentives for businesses to become sustainable and be promoters of sustainability, in other words to become partners. The private sector, on the other hand, should understand and accept regulations and practices that, while more costly for the private sector in the short run, will ensure better adaptation in the long run.

Insurance

The insurance sector could develop new products for reducing risks and vulnerability before extreme weather events happen. Insurance premiums anticipating climate change could provide incentives for private climate change adaptation measures.[192]

Adaptation measures are not only those measures that can be adopted by authorities, but also measures that are applicable to the general public. In developing countries, where the level of corruption is high, facing an economic and political crisis, the main actors are people – the general public. In this respect the report offers a list of actions that can be applied by individuals, as well as public associations and NGOs.

Individuals

Each adaptation measure has to be understood and implemented by society, which needs to be informed and familiar with the issues if it is to be responsive.

Adaptation is the key to protecting one's existence and property and to ensure a decent future. The process starts with a decision that will further influence one's life, whether it is a decision on where to build a house, or a decision to invest in an irrigation system. In their search for economically enticing deals, people could reorient their daily activities toward efficiency in energy, water use etc.

Informed and educated people have the power to make a change, to be part of a decision and to understand their responsibilities. This could be the path towards rebuilding trust in authorities and a partnership for further sustainable development.

[189] Ibid.

[190] Economics of Adaptation to Climate Change, OECD 2009.

[191] EU action against climate change. Adapting to climate change. European Community, 2008.

[192] Ibid.

11.4. Adaptation policy strategy

It is of crucial importance for the Republic of Moldova to have a Climate Change Adaptation Programme that would ensure an effective adaptation of the country to climate impacts. If not, projected impacts (CLIMATE CHANGE AND ITS CHALLENGES FOR MOLDOVA and the impacts presented in the preceding chapters) could prejudice Moldova's development and worsen the current state of economic and social sectors.

An effective strategy to adapt to climate change should ideally meet a number of core requirements (see Annex 2.12):

- Comprehensiveness both in terms of addressing the impact of climate change and in engaging the largest possible number of sectors, organisations and people.
- Political will of public authorities on national and local level.
- Empowerment of local public authorities, individuals and the private sector.
- Capacity building of authorities to help clearly identify vulnerabilities and formulate efficient responses to adaptation challenges.
- Informed and trained stakeholders and authorities.
- Cooperation and exchange of knowledge at national and international levels.
- Timely public awareness campaigns and involvement of the interested public.
- A transparent and open dialogue between authorities, stakeholders and academia.
- Taking into account human development criteria.

As mentioned in the policy recommendations of chapters 4 – 10, it is recommended to have sectoral adaptation strategies or current strategies should be amended with adaptation measures. This is important as each sector needs a specific approach, but at the same time all adaptation measures must be taken as a complex whole, to make sure a qualitative and effective climate change adaptation process takes place. A well-designed policy framework for climate change adaptation will ensure a timely response to climate change challenges, allowing the country and its citizens a progressive positive development.

All the proposed strategies (adaptation strategies, or amended strategies with adaptation provisions) could be part of an umbrella programme named the **National Climate Change Adaptation Programme** (NCCAP) that would also include an **Action Plan** to implement adaptation measures, enforced by a set of **Market Based Instruments** that would serve as economic stimulus.

Part of the same programme should be a joint communication strategy that will provide for information access, public awareness, and public participation in the decision making process, cooperation between authorities at different levels and collaboration with academia in matters related to climate change adaptation for all sectors.

Sectoral Adaptation Strategies and amendments should be developed by the respective ministries, in conformity with international agreements and conventions, signed and ratified by the Republic of Moldova, under the supervision of an Inter-ministerial Adaptation Commission. This Commission could consist of designated representatives from each sector, but also invited relevant specialists and stakeholders in order to have an effective and transparent process. The main purpose of this commission will be to control the process of adaptation measures elaboration, to ensure the inter-relatedness of all sectoral political documents, to exclude the possibility of conflicting provisions and verify the existence of implementation mechanisms in a real time-frame.

Responsibility for programme monitoring should belong to the Ministry of Environment. Nevertheless the Ministry will need a strong programme for capacity building and an increase in staff to ensure a high-quality result. The ministry could also involve external experts in the monitoring process and could use the non-governmental sector in the usual watch-dog role. This will ensure the transparency of the process and increase public support and trust.

The NCCAP should be oriented toward the following:

- The legal framework
- The institutional framework

- Framework for actions in the development sector (Agriculture, Industry, Water, Energy, Ecosystems and Health)
- Social development
- Information and public awareness aspects (which will include all 3 elements of the Aarhus Convention and education)

Climate change adaptation is a costly process that has to be well targeted, and has to be based on research and cost-benefit analyses. There is evidence that even in the absence of financial and environmental constraints, the potential benefits of climate change adaptation could be significantly reduced by imperfect information and a sub-optimal decision-making process.[193]

The Action Plan should prioritise the fields to be focused on and the actions to be taken at national and regional levels and offer advice for the local level actions. Based on the conclusions of the working group, a set of measures should be laid out, for each development sector, after a thorough risk analysis and a financial review of the action applied. The same action plan should provide for follow-up actions. The results obtained should be used as experience for further actions.

In order to have a positive outcome, this programme would need to have the full support of the authorities, as the main changes are needed in the planning and decision-making process, based on a continuous and open dialogue between the authorities and society. In this context, the government should prioritise policies that have a positive impact on development, but also improve its adaptive capacity. The main elements that the government should focus on in the short term are:

- Implementing reforms to ensure a transparent, equitable, and effective decision making process. Requirements for an ex-ante analysis of draft decisions, which would also include a demand for an analysis of the environmental impact of policies and consultations with the Ministry of Environment, should be gradually introduced, at least for the most important public policies. Moreover, all policy decisions, on all levels of government, should be published and discussed with the relevant stakeholders. This will ensure that policies are anticipatory, consensual, and public. Plans for such a reform already exist. The State Chancellery has developed a draft regulation and a guide for a redesigned decision-making process, but significant efforts are needed to train public servants in applying it.
- Continued public service reform, particularly the reform of the remuneration system for public servants. As long as low pay and limited opportunities for growth do not allow for attracting and retaining good public servants, the capacity to analyse possible climate change scenarios and promote correct adaptation policies will remain very limited. Strong political will is the key to achieving progress on this reform.
- Creating a mechanism for regular collection, analysis and wide distribution of climate change-related data. This will allow continuous improvements and refinement of projections on the specific effects of climate change, which will both improve the credibility of advocacy efforts, and inform the behaviour of companies, organizations, and the general public.
- Raise the profile and strengthen the capacities of the authorities responsible for meteorological monitoring, emergency response and disaster management. Specific attention should be paid to the capacity of these authorities for anticipating and preparing for certain events, as well as for leading interdepartmental coordination on issues related to climate change. Whatever authority is selected to lead in this process, it should create, maintain, and monitor a detailed risk map, elaborate various scenarios and response procedures and build awareness within and outside government regarding the consequences of climate change.
- Decentralise local public finances, so as to allow local public authorities to take the lead on community responses to climate change. Central government

[193] Economic Aspects of Adaptation to Climate Change, OECD 2009.

can often hinder the development of adaptive capacity at the local level. Proper decentralisation could ensure that adaptive measures most relevant to the community and the region are taken.

It has to be acknowledged that the Republic of Moldova already has over 200 strategic documents that are not implemented or only partially implemented. Therefore, the proposed programme should not become just another adopted document, with no proper enforcement and with half-hearted implementation efforts. Several additional Strategies could make the situation even more difficult, as it will create the need to adapt and amend many other legal and policy documents to match the provisions in these Adaptation Strategies. This work will demand great efforts. Meanwhile the institutional capacity of authorities to perform the respective work needs considerable improvement.

Substantial help could be provided through public information and involvement in the climate change adaptation process. Informed stakeholders understand current vulnerabilities, the starting point for understanding future adaptation needs, and often have good ideas on how to reduce them. Involving stakeholders also increases the chances of successfully implementing the adaptation plan and mainstreaming adaptation concerns.[194]

That is why separate attention is paid to the social aspects of adaptation: shaping public opinion, promoting public participation, educating and training civil society and fostering human solidarity.

11.4.1. An informed public is an important ally

An informed public understanding of why climate change is such an urgent priority can create the political space for governments to introduce radical reforms.[195] A massive media awareness campaign should be enacted to raise awareness of climate change issues, create public debates and offer the public access to information on the costs of actions applied and offer appropriate explanations.

Media policy should be completed with provisions supporting public service advertisements on TV or radio. Political support should be provided by imposing a lower price or by subsidising partially or totally the costs of the specific adverts. The Communication Strategy on climate change could provide the basis and offer support for the preparation of quality shows, interviews, information for news, comments. National and other TV and radio advertising can be used to inform people on what is going on and what might happen. The media can inform the population about climate change solutions.

There are exclusive, qualitative and informative movies on climate change, which are distributed for free like "HOME"[196] or "The 11th Hour"[197], or others. These movies can be broadcast and become instruments of Climate Change Adaptation.

11.4.2. Paving the way towards public participation

Public participation is an instrument of democracy and transparency that should be used more often. Dialogue with civil society, private and nongovernmental sectors, is not only a source of information, but also a means of education. Knowing that their opinion is taken into account increases the level of trust in and responsibility for the actions taken and this is exactly what our society lacks.

"In addition, stakeholder involvement in the planning process increases the chance that they will "own" and support the ensuing adaptation plan. More importantly, by involving stakeholders and local decision makers at all levels in an adaptation plan, governments (local or national) improve prospects that society will incorporate climate change concerns in future investment and management decisions."[198]

The government should ensure the implementation of the Aarhus Convention's provisions. Being a signatory, Moldova is obliged to ensure access to information, public participation in the decision making process and access to justice. Introducing mechanisms and/or instruments that would increase the involvement of the public, including the vulnerable parts of society could have a positive impact on human development in the country.

More local experts and interested stakeholders should be involved in actions related to human development and climate change. Given the fact that a political leader is not always a professional in the field of climate change, the opinion of experts and public discussions could be the instrument needed to achieve consensus and gain public confidence in the correctness of the decision taken, and as result the support and trust of the public during implementation.

[194] Adapting to Climate Change in Europe and Central Asia, World Bank, June 2009.
[195] Human Development Report 2007/2008.
[196] HOME – a movie by Yann Arthus - Bertrand. http://www.ho-me-2009.com/us/index.html
[197] http://www.leonardodicaprio.org/
[198] Adapting to Climate Change in Europe and Central Asia, World Bank, 2009.

11.4.3. Education and training – answering the questions

Education and training are important as most of the stringent climate change impacts will be felt by the next generation. Generations to come will be the ones who confront the consequences of our past and present mistakes. To survive and to develop sustainably they need to be prepared for the changes to come, they need to understand the situation and take action.

The current Educational Programme should be amended with an element providing education on climate change issues. The educational programmes starting from school to universities should include information on climate change and sustainable development, preparing the new generation for the upcoming changes and orienting them towards sustainable development.

The education and training of the population is also a crucial factor determining the adaptive capacity of the Republic of Moldova. National Adaptation Strategies related to the issue should follow an approach that focuses on enhancing adaptive capacity to current climate variability and extremes, as this will help address the negative impacts of climate change.[199]

The Education Programme should also offer sector-specific trainings on climate change issues. The same programme should create a large database of information on mitigation methods and case-studies, as well as provide for extensive experience exchange with other countries. District authorities also should be trained and should in their turn provide special training for the population on climate change adaptation and mitigation including environmental protection and sustainable development measures; the training process should involve academic world and also international experts who could share their knowledge.

11.4.4. Fostering human solidarity

Discussing the impacts of climate change on the population, one could observe three social aspects as the most vulnerable: the gender dimension, social assistance and poverty, and human mobility.

As it is presented in GENDER DIMENSIONS OF HUMAN DEVELOPMENT IN MOLDOVA, the pressure on women increases along with lower incomes, reduced economic opportunities (especially in rural areas) and other factors like domestic violence, etc. Current national policies should be amended and new strategies should include provisions on increasing the economic and social role of women and achieving a higher level of gender empowerment. Although women's participation in social life has improved in the past decade, gender equality is at a low level in Moldova.

Women have a special role in the response to the crisis. When men are absent, gender roles are open to change. These circumstances can increase women's economic independence, their ability to provide for their families, decision-making skills, and social prominence.[200] In order to help women develop these qualities, specific training programmes should be developed relating to peace negotiations, planning and implementation of reconstruction projects and decision-making structures. Women's participation helps develop an economic, social, and legal environment propitious for women's success.

Social assistance and poverty are issues that directly affect the capacity of society to adapt to climate change impacts. It is recommended that provisions be reviewed, amended and/or adopted to improve social assistance, reflecting possible health and other implications caused directly or indirectly by climate change. As can be observed, the poorer the population, the more vulnerable it is to climate change impacts. This is why poverty reduction programmes should go hand in hand and be coordinated with climate change adaptation.

Human mobility related to climate change is characterised by the migration of people from high risk areas, often leading to interrupted livelihoods, migration and temporary displacement. Long term displacement of people and permanent migration from damaged residences goes hand in hand with lower living standards and increased vulnerability.[201]

People are moving in search of economic opportunities, and a changing climate already influences and will continue to influence the economic decision to migrate.

To respond to these challenges, the government will need the help of international organizations and the public. Assessments should be performed of current migration trends and a strategy should be developed that would have as its objective reducing migration levels by offering local opportunities (especially in rural areas) for development and solutions to existing problems. This can be achieved by promoting income diversification and capacity building, including for local

[199] Economic Aspects of Adaptation to Climate Change, OECD 2009.
[200] http://www.ilo.org/public/english/employment/crisis/about/dimension.htm consulted on September 5, 2009
[201] Adapting to Climate Change in Europe and Central Asia, World Bank, June 2009.

civil society and governmental institutions so that they can provide better support to communities, households and individuals in their adaptation efforts; reducing the disaster risk impacts of hazards, particularly on vulnerable households and individuals as well as providing advocacy and social mobilisation to address the underlying causes of vulnerability, such as poor governance, lack of control over resources, or limited access to basic services.[202] Social reintegration options should also be included for people who have been trafficked or were victims of violence.

11.4.5. Climate change and human rights

The impact of climate change is that it increases people's vulnerability to poverty and social deprivation. Populations whose rights are poorly protected are likely to be less equipped to adapt to climate change impacts.[203]

The government should provide support to society in order to improve its capacity to adapt to the impact of changing conditions. Human rights could be protected indirectly by focusing adaptation measures on the following issues:[204]

- Ensuring that homes are resistant to extreme weather conditions protects the right to life;
- Offering quality/alternative water access protects the right to water;
- Offering health-related information and education and providing proper sanitation protects the right to health;
- The right to a healthy environment are protected by reducing environmental degradation and pollution, etc.

Not all human development costs associated with climate change can be measured in terms of quantitative outcomes. At a fundamental level, human development is also about people having a say in the decisions that affect their lives. Climate change is a profound denier of freedom of action and a source of disempowerment.[205]

11.4.6. Adaptation finance

The Republic of Moldova faces a serious budgetary and economic crisis. But even after the crisis effects fade away and economic growth resumes, the budgetary resources available for climate change adaptation will remain limited and thus special emphasis should be placed on development and employment of market based instruments.

Any climate change adaptation measure will require financial resources and the implementation of certain mechanisms. Depending on the level and magnitude of change to be applied, the alternatives offered can be of low or high cost. In any case, following are some suggestions that could have a positive effect:[206]

- Develop and supply products and services for the new markets which will come with integrated adaptation e.g. at micro-level, and for ecological services.
- Recognise the reality of climate change and mainstream it into all business processes. It should be a decision factor for business planning and strategies, portfolio management and at individual transaction level.
- Ensure that contingency plans consider "worst case" scenarios.

A wide range of technological options are needed to keep climate change adaptation costs low, and beside that there is a need for a mix of policy instruments in order to implement a cost-effective strategy.

The following considerations and instruments may help to effectively encourage wider country buy-in for adaptation actions:[207]

- Synchronising political will and climate benefits of policies.
- Decreasing energy dependence.
- Facilitating technology transfers.
- Applying and being open to international financing programmes for climate change mitigation and adaptation actions, including through the Clean Development Mechanism[208] and REDD.[209]

[202] Climate Vulnerability and Capacity Analysis, Handbook, http://www.careclimatechange.org. Last checked on September 10 2009.

[203] http://cpd.org.au/article/climate-change-and-human-rights, Climate Change and Human Rights, John Von Doussa, published on June 13, 2008. Last consulted on August 9, 2009.

[204] Ibid.

[205] Human Development Report 2007/2008.

[206] http://www.caribank.org/titanweb/cdb/webcms.nsf/AllDoc/E6F380BA51977179042575F5006CE100/$File/KLeslieCCregionaldev.pdf Presentation for the CDB Seminar: Advancing the Climate Change Agenda, July 6, 2009. Last checked on August 9, 2009.

[207] Adapted from Climate Change. What do we do? OECD 2008.

[208] The Clean Development Mechanism (CDM) under the Kyoto Protocol is designed to help encourage private financing for mitigation action in countries like Moldova, where there is lack of capacity or financing to implement these actions without support.

[209] UN Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries.

In a discussion on environmental policy integration, OECD (2003) recommended a further use of market-based instruments, such as the implementation of Environmental Fiscal Reform and full-cost pricing of services such as water and waste, better inter-ministerial cooperation and further use of strategic environmental assessments.[210] Although these instruments are mostly known as mitigation measures, they may also be used as adaptation solutions.

Below are some market-based instruments, already addressed in the environmental literature (see bibliography) that we considered as important in Moldova's path towards climate change adaptation:

a. *Environmental taxation* is one of the main tools for moving towards sustainable development. It has positive effects on the environment and thus on development by stimulating innovations and efficiency; external benefits of natural resources have to be given a market value,[211] for example. **Tax differentiation** is a good fiscal tool for favouring cleaner products over traditional ones. Taxes can be lowered for eco-labelled goods and can be raised on polluting products. Environmental taxation, from an adaptation point of view, can be used to internalise adaptation benefits to ecosystems.

b. *Subsidy reform.* First of all, current subsidies should be assessed in order to determine if there are any harmful subsidies[212] and if any of the provided subsidies are not reducing incentives to move away from activities that become less viable under climate change scenarios.[213] Subsidies should be created that offer a "win-win" scenario by helping the environment adapt to climate change, and increasing economic efficiency.[214] A good example is the subsidy provided by the government of Moldova for agricultural terrains afforested with walnut trees. Improvement of resources allocation towards adapting the sectors for climate change impacts can eventually even compensate for some short-term sector losses.[215]

c. "Insurance has a dual role with respect to adaptation. Access to insurance payouts can lessen the net adverse impact of climate events on policy holders. At the same time, insurance is also an instrument for incentivising adaptations aimed at climate risk reduction"[216] (refer to chapter TOWARDS A RISK RESILIENT SOCIETY)

The indirect and direct impacts of climate change can be spread through the insurance industry if necessary policies will not be undertaken by a series of decision-making institutions. As a result of the decrease in the affordability of insurance products and increasing insurance gaps, the social and economic costs of climate change will significantly increase.

In the Republic of Moldova, the fundamental barrier for the development of the insurance sector lies in the population's negative perception of insurance products. As a result, around 70 per cent of all insurance premiums collected in 2008 were subjected to mandatory insurance, which means that people and businesses resort to insurance generally only when the law requires it.

Therefore, mandatory insurance products should be used by policy makers to increase levels of confidence in this sector, which indirectly will influence the popularity of insurance products related to climate change risk transformation. Thus, the policy implications should be concentrated on two main issues related to the insurance sector: credibility and affordability of insurance products.

In order for the climate change concerns to be taken into account, these must be incorporated into the planning system. And we are not talking only about the Ministry of Environment's planning system, but the central planning system, so that climate change concerns can be integrated into all sectors of development.

11.5. Conclusions for policy makers

Climate change will be one of the defining forces shaping prospects for human development dur-

[210] Environmental Policy Integration: Theory and practice in the UNECE region, May 2003.

[211] Economic Aspects of Adaptation to Climate Change, OECD 2009.

[212] For example, subsidies to the production and consumption of fossil fuels exist in a wide variety of forms, including direct budgetary transfers, tax exemptions, and price controls. Although subsidies are often justified as having an overall benefit for social welfare, research has found that many fossil fuel subsidies have a net negative effect, both nationally and internationally. Fossil fuel subsidies distort the market, resulting in a host of negative impacts, including potentially greater greenhouse gas emissions, high costs imposed on government budgets, and reduced incentives for energy efficiency and conversion to alternatives energy sources. (www.globalsubsidies.org).

[213] Economic Aspects of Adaptation to Climate Change, OECD 2009.

[214] Environmental Policy Integration: Theory and practice in the UNECE region, May 2003.

[215] Ibid.

[216] The economics of Climate Change Adaptation. OECD, 2009.

ing the 21st century. Through its impact on ecology, rainfall, temperature and weather systems, global warming will directly affect all countries.[217]

Taking into consideration the impacts of climate change and their costs, one can conclude that mitigating and adapting would be the best solutions for ensuring continuing human development.

In order to have an understanding of the real costs of climate change, Moldova's key vulnerabilities should be identified and a common environmental and economic analysis and evaluation of the benefits of adaptation should be performed on the basis of a comparison with the evaluated costs of inaction. A number of climate change scenarios should be defined (and researched on a continuous basis by a selected team of experts) and based on the detailed results a decision should be taken on which solutions best suit the respective situations. The action will be an incentive for the government to apply those adaptation options that are more beneficial for the development of the country and also a means to determine the time horizons for these actions. The adaptation strategy for climate change proposed above is based not only on expert knowledge in specific fields and international experience, but also on personal level perceptions of development in the Republic of Moldova. It should be noted that it is concentrated mostly on developing cooperation and collaboration between authorities among them top-down and bottom-up, as well as horizontally, collaboration with scientists, NGOs, the private sector, as cooperation among people is a prerequisite for coherent human development.

The start of an adaptation process relies on public awareness. Having an informed society will ease the adaptation process, making it clearer, by commonly adopted priorities and values related to climate change. But there must be solutions and alternatives offered that would satisfy as many members of society as possible and offer decent living conditions and education. Achievement of any results is primarily based on the level of education, access to information, participation in decision-making, access to justice and transparency, thus conditioning the success of human development and adaptation to climate change.

It should be noted that although all recommendations offered are divided by sector, their success relies in their synergetic interconnectedness, cooperativeness and the transparency of the process. For example, water solutions must go along with agricultural, ecosystem, industry and health solutions. This is why cooperation between sectors and with the scientific community is of great importance.

Political will is essential to all aspects of development. This is why increased attention should be paid towards the spheres of monopoly or increased influence (like energy, water sectors). This will enable private owners to get involved and invest in infrastructure and alternative sources.

Establishing insurance schemes, setting up market based instruments, developing sector specific adaptation strategies are a challenge for the development of Moldova. Much more work is needed to improve concepts and define details. It will be necessary to make sure there is qualitative local climate information, and that some preparatory work is carried out on building institutional and technical capacity and opening a clear dialogue with the public.[218]

The process of adaptation to climate change in Moldova's economic, social and political conditions will be a difficult and time-consuming one. The republic will need to invest great effort, including financial, into its development that should be adapted to possible climate change impacts in order to be successful. Depending on the state of Moldova's financial development, authorities can choose the most viable solution for the expected results. One should remember that any effort done today for mitigation and adaptation to climate change is a step towards sustainable development, to a better future for current and future generations.

[217] Ibid.
[218] The economics of Climate Change Adaptation. OECD, 2009.

Annexes

HUMAN DEVELOPMENT-RELATED ANNEXES

Annex 1.1. Human Development Index Methodology

HDI is a synthesis of the human development based on three major goals of development:

- Longevity – as expressed by life expectancy at birth.
- Education – computed as weighted arithmetic average of the adult literacy rate (with a share of two thirds) and of global gross enrolment rate (one third).
- Living standards – estimated as GDP per capita expressed in US dollars at Purchasing Power Parity.

Based on minimum and maximum values (goalposts) established by UNDP for each indicator, the specific index for each of the three dimensions is computed as follows:

$$I_s = \frac{V_{real} - V_{\min}}{V_{\max} - V_{\min}}$$

where:

I_s –specific index;

V_{real} – actual value of indicator;

V_{min} – minimal value;

V_{max} – maximal value.

The GDP index is calculated as difference between logarithmic values.

The extreme goalposts and the actual values for the Republic of Moldova used for calculating the HDI are the following:

Indicator	Maximum value	Minimum value	Actual value
Life expectancy at birth, years	85	25	69.4
Adult literacy rate (%)	100	0	99.1
Global gross enrolment rate (%)	100	0	68.9
GDP per capita at PPP, US dollars	40,000	100	2,986

HDI is calculated as arithmetic average of the specific indices:

$$HDI = \frac{I_{LE} + I_E + I_{GDP}}{3}$$

Below there is an illustration of the calculation of the HDI for the Republic of Moldova in 2008.

a. Life expectancy index (I_{LE})

$$I_{LE} = \frac{69.4 - 25}{85 - 25} = 0.740$$

b. Education index (I_E)

b.1. Alphabetisation index (I_A)

$$I_A = \frac{99.1 - 0.0}{100.0 - 0.0} = 0.991$$

b.2. Index of the global gross enrolment index (I_{GER})

$$I_{GER} = \frac{69.8 - 0.0}{100.0 - 0.0} = 0.698$$

By combining the two education indices with the corresponding weights one gets:

$$I_E = \frac{2I_A + I_{GER}}{3} = 0.893$$

c. The GDP index (I_{GDP})

$$I_{GDP} = \frac{\log 2986 - \log 100}{\log 40000 - \log 100} = 0.567$$

As result, the Human Development Index

$$HDI = \frac{0.740 + 0.893 + 0.567}{3} = 0.733$$

Annex 1.2. Gender-related Development Index (GDI)

GDI adjusts the level of human development to the gender differences in the three major areas of human development. The calculation of the GDI involves three stages:

a. Calculation of the gender disaggregated specific indices (I_F; I_M), according to the general formula:

$$I_{F/M} = \frac{V_{real} - V_{\min}}{V_{\max} - V_{\min}}$$

where:

$I_{F/M}$ – specific index for women / men;

V_{real} – actual value of indicator;

V_{min} – minimal value;

V_{max} – maximal value.

b. The female and male indices are combined in a way that the differences between achievements in each dimension are perceived as negative factors and penalised. The resulting index, referred to as Equally distributed index (I_{EDI}), is calculated according to the following general formula:

$$I_{EDI} = (P_F * I_F^{1-\varepsilon} + P_M * I_M^{1-\varepsilon})^{\frac{1}{1-\varepsilon}}$$

where:

I_{EDI} – equally distributed index;

P_F and P_M – shares of females / males in total population;

ε – a measure of aversion to inequality. For GDI the UNDP has established the ε=2 for which the general formula transforms in a simple harmonic average of the indices calculated for men and women:

$$I_{EDI} = \frac{1}{\frac{P_F}{I_F} + \frac{P_M}{I_M}}$$

c. GDI is calculated as simple arithmetic average of the equally distributed specific indices:

$$GDI = \frac{I_{LEEDI} + I_{EEDI} + I_{GDPEDI}}{3}$$

where:

I_{LEEDI} – equally distributed life expectancy index;

I_{EEDI} - equally distributed education index;

I_{GDPEDI} - equally distributed income index.

d. Calculation of the equally distributed income index is rather complex. For its calculation the following data are necessary:

Total number of population;

GDP per capita, US dollars at PPP;

W_f/W_m – ratio of the female wage to male wage in non-agricultural activities;

E_F – share of women in economically active population;

E_M - share of men in economically active population;

S_F – contribution of women to total income;

Y – total GDP calculated in US dollars at PPP;

N_f – total number of women;

N_m – total number of men;

Y_f – estimated income received by women (US dollars at PPP);

Y_m - estimated income received by men (US dollars at PPP);

The extreme and actual values of the Republic of Moldova (except GDP which is computed below) used for GDI are included in the table below:

Indicator	Maximum value	Minimum value	Actual value
Women life expectancy at birth, years	87.5	27.5	73.2
Men life expectancy at birth, years	82.5	22.5	65.6
Women alphabetisation rate (%)	100	0	98.5
Men alphabetisation rate (%)	100	0	99.7
Global gross enrolment rate of women (%)	100	0	73.2
Global gross enrolment rate of men (%)	100	0	66.6
GDP per women, US dollars, PPP	40,000	100	
GDP per men, US dollars, PPP	40,000	100	

Other indicators used for calculation are:

- GDP per capita at PPP: 2,986 US dollars
- Total population: 3,570.1 thousand

Women: 1,853.9 thousand

Men: 1,716.2 thousand

- Share in total population of (%):

Women: 51.9

Men: 48.1

- Share in economically active population of (%):

Women: 49.4

Men: 50.6

- Ratio of women wage to men wage in non-agricultural activities (%): 70.1.

Based on the data above the following specific indices are calculated:

a. Equally distributed life expectancy index (I_{LEEDI})

a.1. Gender disaggregated life expectancy indices:

Women:

$$I_{LEF} = \frac{73.2 - 27.5}{87.5 - 27.5} = 0.762$$

Men:

$$I_{LEM} = \frac{65.6 - 22.5}{82.5 - 22.5} = 0.718$$

a.2. Equally distributed life expectancy index:

$$I_{LEEDI} = \frac{1}{\frac{0.519}{0.762} + \frac{0.481}{0.718}} = 0.740$$

b. . Equally distributed education index (I_{EEDI})

b.1. Gender disaggregated alphabetisation indices:

Women

$$I_{AF} = \frac{98.5 - 0.0}{100.0 - 0.0} = 0.985$$

Men

$$I_{AM} = \frac{99.7 - 0.0}{100.0 - 0.0} = 0.997$$

b.2. Gender disaggregated enrolment indices:

Women

$$I_{GERF} = \frac{73.2 - 0.0}{100.0 - 0.0} = 0.732$$

Men

$$I_{GERM} = \frac{66.6 - 0.0}{100.0 - 0.0} = 0.666$$

b.3. Gender disaggregated education indices:

Women

$$I_{EF} = \frac{2I_{AF} + I_{GERF}}{3} = \frac{2*0.985 + 0.732}{3} = 0.901$$

Men

$$I_{EM} = \frac{2I_{AM} + I_{GERM}}{3} = \frac{2*0.997 + 0.666}{3} = 0.887$$

Equally distributed education index:

$$I_{EEDI} = \frac{1}{\frac{0.519}{0.901} + \frac{0.481}{0.887}} = 0.894$$

c. Equally distributed income index (I_{GDPEDI})

c.1. Index of females contribution to total income (S_f)

$$S_F = \frac{\frac{W_f}{W_m}E_f}{\frac{W_f}{W_m}E_f + E_m} = \frac{0.701*49.4}{0.701*49.4 + 50.6} = 0.406$$

c.2. Gender disaggregated income:

GDP per women:

$$Y_f = \frac{S_F * Y}{N_F} = \frac{0.406*106603186}{1853.9} = 2{,}335 US\ dollars$$

GDP per men:

$$Y_m = \frac{Y - S_F * Y}{N_F} = \frac{10660318.6 - 0.405*10660318.}{1716.2} = 3{,}690 US\ dollars$$

c.3. Gender disaggregated income indices:

Women

$$I_{GDPF} = \frac{\log 2335 - \log 100}{\log 40000 - \log 100} = 0.526$$

Men:

$$I_{GDPM} = \frac{\log 3690 - \log 100}{\log 40000 - \log 100} = 0.602$$

Equally distributed income index:

$$I_{GDPEDI} = \frac{1}{\frac{0.519}{0.526} + \frac{0.481}{0.602}} = 0.560$$

Applying the simple arithmetic average, the Gender-related Development Index is:

$$GDI = \frac{0.740 + 0.894 + 0.560}{3} = 0.731$$

Annex 1.3. Gender Empowerment Measure

The Gender Empowerment Measure is calculated based on explicitly defined variables measuring the opportunities (capabilities) women have for participating in political and economic decisions and for controlling their economic resources:

1. The distribution of seats in Parliament by gender is used as an estimate for degree of participation in political decisions;

2. For illustrating women's participation in economic life the following ratios are used:

- Share of women out of total number of managers and senior officials in public administration and socio-economic units;
- Share of women out of total number of professionals employed in intellectual and scientific occupations.

3. Women's control over economic resources is estimated based on gender disaggregated GDP per capita (unadjusted).

For each of the three dimensions an equally distributed equivalent percentage is calculated (EDEP), using the following formula:

$$I_{EDEP} = (P_F * \%I_F^{1-\varepsilon} + P_M * \%I_M^{1-\varepsilon})^{\frac{1}{1-\varepsilon}}$$

where:

P_F and P_M – the shares of females/males in total population;

$\%I_F$ and $\%I_M$ – the gender indices for every of the three dimensions.

To adjust the respective dimension of development to gender disparities, as in the case of the GDI, a weighted formula is used with the aversion index $\varepsilon = 2$.

For the first two dimensions the EDEP is indexed by dividing them by 50. The indexation is based on the hypothesis that in an ideal society women's participation in decision making is equal to that of the men.

Besides the data used for calculating the GDI, other indicators used for calculating the GEM are:

- Share in Parliament (%):

Women: 21.8

Men: 78.2

- Managers and senior officials in public administration and socio-economic units (%):

Women: 37.9

Men: 62.1

- Professionals employed in intellectual and scientific occupations (%)

Women: 63.4

Men: 36.1

Calculation of the GEM involves three steps:

a. The EDEP for participation in political decision making is calculated based on female and male shares in total population and in Parliament seats (IDP):

$$EDEP = \frac{1}{\frac{P_F}{\%M_F} + \frac{P_M}{\%M_M}} = \frac{1}{\frac{0.519}{21.8} + \frac{0.481}{78.2}} = 33.38$$

where $\%M_F$ and $\%M_M$ is share of women and, respectively, share of men in Parliament seats

IDP = Indexed EDEP for parliamentary representation = EDEP : 50 = 0.668

b. The index for participation in economic decision making and economic life is calculated as follows:

b.1. for manager and senior officials in public administration and socio-economic units (IC):

$$EDEP = \frac{1}{\frac{P_F}{\%C_F} + \frac{P_M}{\%C_M}} = \frac{1}{\frac{0.519}{37.9} + \frac{0.481}{62.1}} = 46.64$$

where $\%C_F$ and $\%C_B$ are expressions of the female and male shares in this group of occupations

IC = Indexed EDEP for positions as managers and senior officials = EDEP : 50=0.933

b.2. for professionals with intellectual and scientific occupation (IS):

$$EDEP = \frac{1}{\frac{P_F}{\%S_F} + \frac{P_M}{\%S_M}} = \frac{1}{\frac{0.519}{63.4} + \frac{0.481}{36.6}} = 46.89$$

where $\%S_F$ and $\%S_B$ are the shares of women and men in this group of occupations

IS = Indexed EDEP for intellectuals and scientists = EDEP : 50 = 0.938.

The average of the indices referring to these two groups of occupations represents the degree of participation of women in economic decision making and economic life (I_{DE})

$$I_{DE} = \frac{I_C + I_S}{2} = 0.936$$

c. The equally distributed income (I_{GDPED}).

The gender disaggregated equally distributed income indices (I_{GDPF} and I_{GDPM}) are calculated based on unadjusted GDP per women and per men (no logarithmic values).

Women:

$$I_{GDPF} = \frac{2335 - 100}{40000 - 100} = 0.056$$

Men:

$$I_{GDPM} = \frac{3690 - 100}{40000 - 100} = 0.090$$

I_{GDPED} is calculated according to the same algorithm as the GDI.

$$I_{GDPED} = \frac{1}{\frac{P_F}{I_{GDPF}} + \frac{P_M}{I_{GDPM}}} = \frac{1}{\frac{0.519}{0.056} + \frac{0.481}{0.090}} = 0.068$$

The GEM is calculated as simple arithmetic average of the three equally distributed indices

$$GEM = \frac{0.668 + 0.936 + 0.068}{3} = 557$$

CLIMATE CHANGE-RELATED ANNEXES

Annex 2.1. Methods used for the comparative adaptive capacity analysis

Indices used in other analyses of adaptive capacity

"The selection of indicators and the measurement process represent a theoretical reasoning and prediction. One of the main challenges that indicator studies face is that of finding reliable data" (Adger 2004). National level studies usually use proxy indicators for economic capacity, human and civic resources and environmental capacity (see for example Adger 2004; Brooks 2005; Füssel 2005 or Klein 2002): Economic well-being corresponds to proxy variables such as GDP per capita, Gini Index, Debt repayments or more generally to economic values and competing demands etc. Proxies for health and nutrition are education expenditure (Percent of government expenditure or Percent of GNP) or the literacy rate (Percent of population over 15). Geographical and demographic factors are related to population, population development and population density, but also to accessibility. A dependence on agriculture can be measured in terms of agricultural employees, rural population, sectoral value added shares or agricultural exports. Alberini and Chiabai (2005) determine adaptive capacity of two hypothetical countries by a vector system of seven attributes, including per capita income, inequality in the distribution of income, measures of the health status of the population, the health care system, and access to information. Based on expert judgments, coefficients on these rankings were used to construct an index of countries with highest to lowest adaptive capacity.

Rationale for focusing on indicators on the regional economic structure

The justification for extensively using variables describing the sectoral composition of the regional economy is – partly – provided by classical growth theory [explicitly in the Cambridge view of classical growth theory]. The core idea of the classical theory is that a surplus is the determinant of growth (an idea that was brought up again in John von Neumann's work). While early in economic theory, growth was usually seen as an ongoing industrialisation, Schumpeter argued in his Theory of Economic Development that there are – in general – no diminishing returns to innovation; therefore a growing economy is characterized by alternating changes in the economic environment. Consequently, growth leads to economies of scale and may lead to permanently high industrial concentration and high profits (Schumpeter 1934 /1997) which results in growth again. But even Schumpeter mentioned limiting factors, such as a lack of credit or a lack of human resources (which is broadly spoken nothing else than a lack of "entrepreneurs").

Following Kaldor, productivity encourages increased competitiveness which in turn leads to an additional increase in demand, with the manufacturing sector being the driver of growth. Kaldor's first law states that the manufacturing sector is the engine of growth. It exhibits higher productivity increases due to increasing returns to scale and can incorporate technological progress more easily, thereby inducing growth in the rest of the economy. In Kaldor's second law a positive relationship between labour productivity in the industrial sector and output productivity is hypothesised, while the third law claims a positive relationship between the labour productivity of the total economy and of manufacturing production (see Aumayr Ch. 2008). Based on the classical demand-driven growth models, the Kiel school focused on technological change as the big crucial variable that is constantly leading to increases in the rate of return on capital and thus higher investment.

Another important contribution was made by Lewis and Singer: again growth is driven by industry, but industrialisation strongly depends on social development as a whole. Therefore human capital, education and demographic developments are not seen "just" as limiting factors in theoretical considerations but as necessary pre-requisites which have to be applied to the framework of growth theory. As a result, structural issues were incorporated into the theory, namely urbanisation, agricultural transformation, education, health, unemployment, inequality or population changes. Additionally, the stage theory of economic development suggests that underdeveloped economies develop institutions and standards of living over time and catch up in different stages of development.

Recent work proves empirical evidence to support the classical ideas; Rowthorn/Ramaswamy (1997) – for example (for an overview of recent literature see Aumayr 2008) – present a 3-sector closed economy model which illustrates the hypothesis that deindustrialization is a "natural" consequence of the process of development, because productivity in the manufacturing sector expands faster than that in the service sector. They claim that it is not the decline in demand for manufacturing products that serves as a major explanation for the secular decline of manufacturing employment after the mid 60s in the US, Japan and Europe, but essentially productivity differentials between services and industry (Rowthorn 1997).

Box 25. Indicators used to measure adaptive capacity on the regional level

DEMOGRAPHY: Regionalized Population Projections 2025: This indicator illustrates the forecasted number of inhabitants in each of the analysed regions for the year 2025. The population of 2001 serves as a basis and is set to 100. All regions average on a population projection of 84. Therefore the studied area as a whole is characterised by depopulation.

Education Level [ISCED3_6] in relation to the average of all regions: The regional education level is measured according to the ISCED (International Standard Classification of Education). Different ISCED levels represent different levels of education, reaching from the pre-primary level of education to the second stage of tertiary education. Unfortunately the ISCED comparisons between different countries are difficult because schools in different countries that are classified at the same ISCED level may not provide the same programmes or have the same function. The indicator used in the cluster analysis gives the education level of a certain region in terms of the average of all regions, which is set to 100. For the regions considered in the cluster analysis the mean of this indicator amounts to 96.

WEALTH: Growth rate of Regional GDP per habitant/pps 2001-05: For measuring economic growth generally the growth rate of the regional gross domestic product per capita is taken. Since national statistical offices usually provide the (regional) GDP in national currency and differences in the price levels have to be taken into account, Purchasing Power Standards are implemented. The indicator used in the cluster analysis gives the rate at which the regional GDP per capita, measured in purchasing power standards, grew between the years 2001 and 2005. The regional GDP growth rate of all regions included in the cluster analysis averages at 138 per cent.

Ratio of Regional GDP per habitant/pps in terms of national average: The regional GDP per capita is an indicator of a region's total production. Therefore it can be used to measure and compare the degree of economic development of different regions within a country. This proxy indicator allows for further consideration of regional disparities on the national level. The indicator used in the cluster analysis gives the per capita GDP of a region measured in Purchasing Power Standards in terms of the national average. Values below 100 indicate that the region's per capita GDP is below the national average whereas values above 100 indicate that the region has a GDP per inhabitant that lies above the national average.

THE STRUCTURE OF THE ECONOMY: Regional Employment Shares: Regional employment shares indicate the regional proportion of employees in the population of working age.

Sectoral Employment Shares: The sectoral employment shares indicator illustrates the distribution of a region's total employment in the agricultural, industrial and service sectors. Within the regions included in the cluster analysis, the agricultural sector on average accounts for 35 per cent of total employment, whereas the industrial and service sectors on average show employment shares of 29 per cent and 36 per cent respectively.

Sectoral Value Added Shares: The indicator regarding the sectoral value added shares measures the contribution of each of the three sectors (agriculture, industry, service) to the total production of a region. The agricultural sector contributes on average 19 per cent to total

production whereas the industrial and service sectors exhibit value added shares of 31 per cent and 50 per cent respectively.

Sectoral Productivity Indicators: The sectoral productivity indicators measure the productivity (value added per employee) of one of the three sectors (agriculture, industry, service) compared to the total productivity of a region. If the sectoral productivity indicator exceeds the value 100, the industry under consideration is more productive than the total economy of the respective region.

PART 3b Hirschman-Herfindahl Index (HHI) aggregates of regional employment shares: The HHI is a concentration measure. For the purpose of this cluster analysis it indicates the degree of sectoral concentration. Based on available data, regional employment shares are divided into six branch-aggregates (a_b representing agriculture; c_e including producing branches; f representing construction; g_h_i representing services including trade and tourism; j_k including knowledge intensive branches and l_to_p including public services and education). The HHI is calculated by summing the squares of the regional employment shares of the sectors mentioned. The normalised HHI ranges from 0 to 1. Therefore, having the same employment shares in each branch mentioned above equals 0 on the Hirschman-Herfindahl Index. Generally a HHI below 0.1 indicates that the sectoral concentration is very diverse or in other words, that the economy is unconcentrated. A HHI between 0.1 and 0.18 points at moderate concentration, whereas a HHI above 0.18 indicates high concentration.

The average normalised HHI is 0.12. Certainly, an optimal concentration ratio does not exist. Nevertheless, negligible employment shares in construction (f) are a sign of a missing stock of capital or indicate an old stock that is not maintained anymore. Furthermore, the service branches j to k include knowledge intensive employment, hence research and development. A diverse economy is characterised by small employment shares in agriculture, substantial employment shares in construction and manufacturing (branches f and c to e) and by having a relatively diverse service sector including the service braches j to k (employment shares in those branches are almost never equally distributed). Conversely, a concentrated regional economy, hence a HHI above 0.18 points, has a disproportionately high level of employment in agriculture as well as excessively low levels of employment in construction as well as missing employment in the service branches j to k.

Methods used to form region types

Structured data analysis is carried out primarily by using two statistical methods: (1) Cluster Analysis to discover primarily structural coherences and to order data into meaningful structures and (2) Principal Component Analysis to reduce multidimensional data sets to lower dimensions for analysis.

The Cluster Analysis is a method of multivariate data analysis with the purpose of dividing a data set into subsets (clusters), where the data in each subset share some common trait. Variables need to be uncorrelated. For the cluster analyses the analysed objects are considered as random variables and displayed as points in a vector space for which the characteristics build the dimensions. The accumulation of points (scatterplot) is called a cluster. To quantify similarities between objects, a measurement of proximity (dependent on the scale level of the characteristics) is chosen to quantify distances between points or the variance within a cluster. The starting point of the cluster logarithm is then the construction of a distance and similarity matrix, which aims at the aggregation of the objects. To group the given objects a broad spectrum of algorithms is available. Those algorithms set up how the distance between a cluster and a single point should be calculated. They are chosen according to the number of variables which are regarded in the process of merging (monothetic and polythetic) and according to the selected procedure of merging. Concerning the procedure one can distinguish the hierarchical procedure (the number of clusters is reduced stepwise, either to the desired number of clusters or as long as the groups melt in to one

remaining group) and the partitional procedure (based on a given group the single elements are switched between different groups until the objective function reaches an optimum). (cf. Backhaus et al 2000, 329-349; cf. Prettenthaler 2003, 7-9).

The Principal Component Analysis (PCA) is a vector space transformation which is used to extract significant linear combinations (principal components) from the whole set of statistical variables, to lower dimensions for further analyses. For that reason an orthogonal linear transformation is used to transform the data to a new coordinate system, whereas the greatest variance by any projection of the data comes to lie on the first coordinate (called the first principal component), the second greatest variance on the second coordinate, and so forth.

The first step of the PCA is to choose relevant variables and test them for correlation. To control the correlation matrix for its adequacy the "measure of sampling adequacy" (Kaiser-Meyer-Olkin-Kriterium) is the best procedure (others are the significance level of the correlations, the inverse correlation matrix, the "Bartlett-Test" and the "Anti-Image-Covariance-Matrix"). The "Kaiser-Meyer-Olkin-Kriterium" indicates to what extent the base variables belong together. The results range from 0 to 1, where a result smaller than 0.5 indicates that the correlation matrix is not adequate and results from at least 0.8 are appreciable. If the variables are dependent and able to group (according to the mentioned tests), the factors need to be extracted from the variables. According to the fundamental theorem therefore the correlation matrix needs to be replicated through the loads on the factors and the correlations between the factors. In the next step the part of the whole variance of one variable which should be explained through all factors has to be set. To choose the number of extracted factors afterwards, the "Kaiser-Kriterium" is used: Therefore all factors with eigenvalues (the sum of the squared load of the factors over all variables; benchmark for the variance which is explained through the factor) greater than 1 will be extracted. To interpret the chosen factors, variables with high loadings on 1 factor are gathered and a collective name is identified. This step needs specific knowledge of the subject. In the last step the values of the factors are calculated to identify which values the objects gain concerning to the generated factors (cf. Backhaus et al 2000, 253-299).

The usage of the composite factors as described above instead of single variables on the one hand blurs the "borderlines" between single clusters (when analyzed in terms of single variables) and makes interpretation more difficult, but on the other hand backs the classification of a single region into one particular type by taking into account the influence of several variables measuring along similar dimensions:

The first or "Industrial Factor" loads high on the value added share in industry and indicates a high employment share in this sector; a high level of education as well as an unproductive service sector characterise this factor. The second factor, the "Agricultural Factor" loads high on the Hirschman-Herfindahl Index, indicating high sectoral concentrations; especially in agriculture as the negative values in secondary and tertiary employment prove. Overall, employment shares are high and agriculture dominates the economy. The third factor, the "Tertiary Employment Factor" characterises relatively rich and fast growing regions with a high share of tourism which goes hand in hand with a high employment share in a productive service sector. The "Population Factor" constitutes the fourth factor and is characterized by a high decrease in the population and a low population density. An economy below average with negative growth rates constitutes this factor as well as a high employment share in agriculture and a low employment share in industry. Finally, the "Growth/Disparity Factor" indicates high population and a growing economy above the average. Growth is led by industry and tourism, which is confirmed by the above mentioned Theories of Economic Development.

Industrialized service regions

Industrialized Service Regions have a relative diverse economy and a productive service sector, whereas the key driver of the economy - the industrial base - is given. Therefore, adaptation potentials are given and exceed the average of all regions presumably slightly.

The first cluster type contains eight regions that are characterized by a relatively high population development (in 2025 95 % of the population in 2001) and a high population density (172 people per square kilometres). The growth rate of regional GDP per habitant (131 %) is slightly below the average of

the 72 regions (138 %) and the ratio of regional GDP per habitant to the national average lies with 93 % above the average of the regions under investigation (83 %). The regions of this Cluster are characterised by a tertiary sector with a very high employment share – a mean of 48 % compared to the average of 37 % that results from all investigated regions in Romania, Bulgaria and Moldova. With 57 % these eight regions under consideration show a mean tertiary share in value added that exceeds the average value of investigated regions (50 %). Nevertheless, this regions are characterized by a – compared to other regions – unproductive tertiary sector (119 %) and an agricultural sector whose productivity (73 %) is above the average (58 %). The secondary sector contributes on average 30 % to total value added, whereas the contribution of the agricultural sector accounts for 13 %. The same manner is found for the employment share of these sectors: Industry 30 %, agriculture 22 %. As the number of beds per thousand inhabitants – a mean of 6.9 compared to an average of 18.6 of all regions – shows, there is virtually no tourism in these regions. The Hirschman-Herfindahl Index (0.07) lies below average and indicates that the economy is very diverse. These regions are furthermore characterized by an educational level (95.7) slightly below the average of all investigated regions (96.3).

Industrialized agricultural regions

A stable population comes along with a low level of education which is typical for rural areas that face low accessibility. Productivity of the tertiary sector of these regions is strongest; industry is – on a low level – developing.

The second cluster type includes 17 regions, which are characterized by the highest population development (93 %) and the lowest educational level (91 %) of all Clusters and a population density accounting for 82 people per square kilometre. The growth rate of regional GDP per habitant (149 %) accounts – beside the fifth Cluster – for the highest of all Clusters, whereas the ratio of regional GDP per habitant to the national average (78 %) accounts for the second lowest value. Employment of the population (40 %) is below the average of all analysed regions. Concerning the economic structure the second Cluster shows the following manner: in terms of value added share and productivity the tertiary sector of these regions is strongest (value added share 47 %; productivity 144 %), followed by the secondary sector (value added share 31 %; productivity 108 %). The agricultural sector accounts on the one hand for the highest employment share (38 %) – the employment share of the secondary sector accounts for 28 % and of the tertiary sector for 33 % – whereas, on the other hand, its contribution to the value added share (22 %) as well its productivity (57 %) are weak. The Hirschman-Herfindahl Index accounts for 0.12, which indicates a moderate sectoral concentration.

Rural service regions

Rural Service Regions miss an industrial base, agriculture is dominating the economy – economic progress is happening mainly due to tourism. Adaptive Capacity is limited, besides the regions are highly vulnerable – tourism but also agriculture are per se exposed to climate change.

Rural Service Regions represent the third Cluster, which consists of 13 regions. The Cluster accounts for the lowest population development (75 %) and population density (58 people per square kilometre) of all regions under investigation, whereas the educational level (95 %) lies only slightly below average. The growth rate of regional GDP per habitant accounts for 131 % and the ratio of regional GDP per habitant to the national average for 79 %. Employment of the population is 41 %. Concerning the sectoral concentration of the economy, the regions of the third Cluster are characterized by a strong tertiary sector: employment share (42 %), value added (56 %) and productivity (135 %) are higher than other sectors and above the average of all analysed regions (except productivity). This numbers are confirmed by the fact, that also the number of beds per thousand inhabitants (59) in these regions is highest of all Clusters. The employment share of agriculture accounts for 36 % and of the secondary sector for only 22 %. Since also value added of the secondary sector accounts only for 23 %, the secondary sector of the regions of this Cluster is, in the sense of employment share and vale added, below the average. Value added of agriculture amounts for 21 % and its productivity for 57 % (productivity of industry 102 %). The Hirschman-Herfindahl Index accounts for 0.12, which indicates an average sectoral concentration.

Peripheral industrial regions

A declining population indicating rapid over aging but also a low population density characterized peripheral industrial regions. The employment shares in agriculture are high, whereas productivity is low. Tourism is underrepresented. Adaptation in these regions is limited.

The fourth Cluster includes twelve regions, which are characterized by a population development (75 %) and a population density (65 people per square kilometre) below average. The educational level is, with 105 %, the highest of all regions of investigation. The growth rate of regional GDP per habitant amounts for 131 % and the ratio of regional GDP per habitant to the national average for 93 %. Employment of the population of the regions of the fourth Cluster accounts for 42 % and is therefore slightly above the average. The structure of the economy shows that the secondary and tertiary sector of these regions are, in terms of sectoral employment shares (secondary sector 35 %; tertiary sector 37 %), value added shares (secondary sector 42 %; tertiary sector 45 %) and productivity (secondary sector 122 %; tertiary sector 123 %) almost equal, whereas the agricultural sector lies below the average of all analysed regions: employment share 28 %; value added share 13 %; productivity 48 %. Since the number of beds per thousand inhabitants accounts only for 15, it seems that the tertiary sector is not mainly driven by tourism. The Hirschman-Herfindahl Index amounts for 0.09 and indicates therefore moderate to low sectoral concentration.

Growth regions

Structural change is ongoing in these regions. The service sector is developing, the economy is extremely diverse. Agriculture is productive, hence employment shares are low. The adaptation capacity in Growth Regions is assumed to be the highest of all cluster types.

Growth Regions represent the fifth Cluster, which consists of eleven regions. Results of the Cluster indicate that it doesn't extremely stand out from the other regions of investigation. Concerning population development, the regions of the fifth Cluster amount for a population development of 81 % until 2025 compared to 2001, whereas the population density of the regions amounts for 68 people per square kilometre. The educational level (99 %) is slightly above the average of the investigated regions. The growth rate of regional GDP per habitant is, with a value of 149 %, beside the second Cluster, the highest of all Clusters and also the ratio of regional GDP per habitant to the national average (100 %) is above average. The employment share of the population accounts for 41 %. Sectoral employment shares of the secondary sector (38 %) are highest of all Clusters, whereas the employment share of agriculture (23 %) is – after the first Cluster – the lowest of all Clusters. Employment of the tertiary sector accounts for 38 %. Value added shares show the following structure: tertiary sector 50 %, secondary sector 34 %, agriculture 16 %. Concerning the productivity of the sectors, results indicate that the agricultural sector of the regions (71 %) of this Cluster belongs to the most productive agricultural sectors, whereas the secondary sector (89 %) is the least productive secondary sector. Also productivity of the tertiary sector (131 %) lies below the average of the analysed regions. The number of beds per thousand inhabitants amounts for 15 and the Hirschman-Herfindahl Index indicates, with a value of 0.08, that the sectoral concentration in these regions is very diverse.

Pure agricultural regions

High overall employment shares, a relative stabile population and a homogenous economy, driven by agriculture – this is what Pure Agricultural Regions are about. Besides, the GDP of these regions is the lowest of all regions and so is the adaptive capacity.

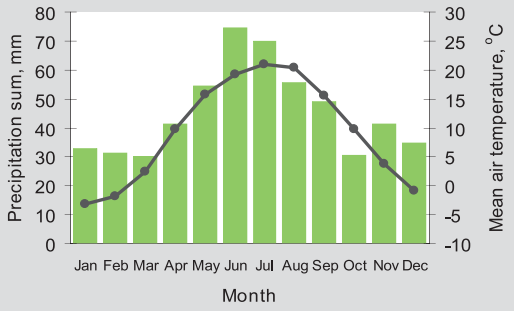
Pure Agricultural Regions constitute the sixth Cluster which comprises eleven regions. Regions of this Cluster stand out from other regions in several characteristics. Concerning population development, the regions of the sixth Cluster are marked by a development above average (89 %). Also population density lies, with a value of 88, above the average of the analysed regions. The educational level amounts for 95.8 % and is therefore slightly below average, as well as the growth rate of regional GDP per habitant, which accounts for 131 %. The ratio of regional GDP per habitant to national average accounts for 64 % and is therefore the lowest of all Clusters. On the contrary, employment of the population is the highest of all

Clusters and amounts for 48 %. Concerning the economic structure of the regions of the sixth Cluster, the Hirschman-Herfindahl Index indicates, with a value of 0.24, highest sectoral concentration of all Clusters. The agricultural sector of the Cluster accounts for – concerning employment shares (57 %) as well as value added shares (27 %) – highest values of all Clusters, whereas in contrast, the productivity of this sector (46 %) is the lowest of all Clusters. Furthermore, productivity of the secondary sector (155 %) and the tertiary sector (187 %) is the highest for these regions of the sixth Cluster, whereas employment share is lowest (secondary sector 19 %, tertiary sector 24 %) of all Clusters. Value added shares of both sectors (secondary sector 29 %, tertiary sector 45 %) are below the average of all regions of investigation. Concerning tourism, also the number of beds per thousand inhabitants is, with a value of 4.7, the lowest of all Clusters.

Annex 2.2. Main characteristics of current climate and observed changes in Moldova

In the coldest month (January) mean air temperature ranges from -2.8 to -5.3 °C (Chart 40), however its coldest values can go down to -27–30 °C. The highest mean monthly temperature is observed in July (19.0–22.0 °C). Practically every year there are days with temperatures up to 30°C; in some years temperature can amount to 38–41 °C. The period with positive temperatures is lasting about 300 days; the duration of annual sunshine changes on average from 1900 hours in the North to 2180 hours in the South. Moldovan springs are not stable, but autumns are usually warm and long, with the so-called *Indian summers*.

Chart 40. Diagram of Moldova's monthly precipitation (bars) with a super-imposed curve of mean air temperatures



Precipitations fall mainly in the warm period as short-term heavy showers with maximum in June-July. Because of the hilly and heavily billowy terrain, the heavy rains often cause erosion, flash floods and silting. Minimal precipitations take place in February-March and October (about 30 mm a month). Solid winter precipitations (snow) average only about 10% of their annual value. Long dry spells are usual, especially in the summer.

Annex 2.3. Meteorological description of droughts in Moldova: example of drought of 2007

The duration of droughts in Moldova varies from a few days to a few months and even to 3 years (e.g. droughts of 1945, 1946 and 1947). In 1990, 1992 and 2003 the droughts lasted the whole vegetation period (April-September). Some characteristics of the extremely hot warm period and the record catastrophic drought of 2007 are shown in Box 26.

Box 26. Meteorological description of 2007 drought in Moldova

2007 was the warmest in the history of instrumental observations in Moldova. Air temperature records were broken in winter, spring, and especially in summer. The warm period was extremely hot and dry. Practically all temperature records have been exceeded while precipitation shortage was all-round (see table below).

Weather records of 2007

Date		Record description
Air temperature		
Winter 2006-2007		Winter 2006-2007 was the warmest for all period of instrumental observations. Average air winter temperature over the territory amounted 0.9-2.8°C, or 4.1-4.6°C above the norm.
Spring		Seasonal mean air temperature in Moldova: 11-13°C or by 2-3°C higher than normal.
23-24 May		*Mean daily* temperature: 24.1°C in Briceni and 27.5°C in Făleşti (23.05) – by 1-4°C higher than observed maximums for this day; 21.9°C (Ceadîr-Lunga) and 27.5°C (Soroca, Rîbnița) – 1-5°C higher than observed maximums for 24.05 in central and north regions. *Maximal* daily temperatures: 31.5°C (Briceni) and 35.5°C (Rîbnița, Bravicea) – here and in other places (Camenca, Bravicea, Corneşti) reached or exceeded by 0.7-1.0°C the May absolute maximum temperatures for all observation period.
25-27 May		*Mean daily* temperatures in the Centre and South were registered between 21.9°C (Briceni) and 26.6°C (Făleşti) – by 1.6°C higher than abs historic values for these days. *Maximal daily* air temperature: 30°C in Briceni and 36°C in Dubăsari; in Dubăsari it has reached and in Rîbnița exceeded by 0.5°C the abs maximal temperature in May
Summer		Seasonal mean air temperature over the territory amounted up to 21.0–24.7°C, exceeding the 'normal' value by 2.4-3.8°C. On the most part of territory such temperatures were observed for the first time. May-July period was by 3-4°C higher the norm – ***record.***
June 1st decade		*Mean decadal* temperature in Moldova amounted 19.9-23.5°C, or 2.7-4.3°C higher than normal; in some places (Soroca, Bravicea, Bălțata, Chişinău, Tiraspol, Dubăsari) it exceeded record values for all period of observation.
15-17 June		*Daily mean* temperature in Moldova reached 21.5-27.2°C – an absolute record. *Maximum* temperatures in some regions (Camenca, Bravicea, Dubăsari, Ştefan-Vodă, Tiraspol) were 34-35°C, or 0.2-0.4°C above absolute maximum for 2nd decade of June.
26 June		Absolute maximum of this day temperature in Moldova (39.5°C, Făleşti) – 1.5°C higher than previous value. In the South (33.2°C in Ceadîr-Lunga and 37.7°C in Leova – 0.1-1.9°C more that the highest absolute maxima for June.
19 July		Maximal temperature – 41°C (Tiraspol, Ialoveni) – new absolute maximum for Moldova.
21 July	The hottest period	Maximal temperature – 41.5°C (Camenca) – new absolute maximum for Moldova.
20-23 July	The hottest period	*Maximal* temperatures (39.5-41.1°C) in Făleşti, Rîbnița, Corneşti, Bravicea, Dubăsari, Tiraspol, Ştefan-Vodă, Comrat – 0.4-2.1°C higher than their absolute summer maxima.
23 July	The hottest period	The highest July minimal air temperature – 26.5-26.7°C (Chişinău, Ceadîr-Lunga).
24 July	The hottest period	*Degree-days sum*, accumulated for continuous period without precipitation, amounted 10000-15 000°C – the highest for all observations period.
July		***The warmest month for all period of instrumental observations in Moldova.*** Mean monthly temperature amounted 24.0-26.0°C, or above 3.7-4.8°C above the normal.
25 August		Maximal temperature – **40.5°C** (Tiraspol) – absolute maximum for August in Moldova.
Season		*Duration of days with heat*: ≥30°C – 45-60, or 3-4 times higher than the norm; ≥35°C – 15-22 against 1 (norm); ≥40°C – 5 (for the first time).
Precipitation		
May-June		6-50**%** of normal values
April-June		48-68 days of relative humidity ≤30%: for the first time and 3-4 times less than norm.
Season		*Precipitation sum*: mainly 35-170 mm, or 35-80% of the norm. *Duration of rainless period (days):* in the North – 30-75; in the South – 80-110 days; mean unbroken duration – 20-40 days that is observed one time per 20 years, maximal – 52 days in the South.
Unfavorable weather events		
Season		Practically over all territory there were observed squalls (up to 24 m/s), hail (up to 20-30 mm in diameter), heavy rains and thunderstorms.

Source: *Bugaeva T. & T. Mironova, 2007: Caracterizarea condițiilor meteorologice şi agrometeorologice din vara anului 2007. Available at:* ***http://www.meteo.md/newsait/vara07.htm; Recorduri meteorologice din 2007. Available at: http://www.meteo.md/newsait/nsrecord.htm.***

Annex 2.4. Storylines of SRES A2 and B2 emission scenarios

Features	A2 storyline	B2 storyline
World	Differentiated	Local solutions
Economy	Regionally oriented	Intermediate growth
Population	Continuously increasing	Continually increasing at lower rate than A2
Governance	Self-reliance with preservation of local identities	Local and regional solutions to environment protection and social equity
Technology development	Slowest and most fragmented development	More rapid than A2; less rapid, more diverse than A1/B1

Source: *Parry et al., 2007a.*

Annex 2.5. Projections of annual mean air temperature (T) and precipitation (P) changes in Moldova based on six GCM experiments

Table 26. GCM experiments and modelling centres

Experiment	Modelling Centres
HadCM3	UK Hadley Center for Climate Prediction and Research
CSIRO Mk2	Australian Commonwealth Scientific and Industrial Research Organization
CGCM2	Canadian Center for Climate Modelling and Analysis
ECHAM4	German Climate Research Centre Deutsches Klimarechenzentrum
GFDL-R30	US Geophysical Fluid Dynamics Laboratory
CCSR-NIES	Center for Climate System Research/National Institute for Environmental Studies

Source: *IPCC DDC: http://ipcc-ddc.cru.uea.ac.uk.*

Table 27. Projections of annual mean air temperature (T) and precipitation (P) changes in Moldova for different time horizons and emission scenarios

Time horizon	Experiment	T, °C		P, mm	
		A2	B2	A2	B2
2010-2039	CGCM2	1.3	1.5	-16	-41
	CSIRO Mk2	1.3	1.8	23	10
	HadCM3	1.4	2.3	-31	-17
	ECHAM4	2.4	2.5	-12	-1
	GFDL R-30	1.3	1.2	5	-12
	CCSR-NIES	2.4	3.0	-22	-41
	Ensemble average	1.7	2.0	-9	-17
2040-2069	CGCM2	3.1	2.2	-51	10
	CSIRO Mk2	2.4	2.5	-12	17
	HadCM3	3.2	3.0	-32	-17
	ECHAM4	3.6	3.7	-28	14
	GFDL R-30	2.6	1.9	1	29
	CCSR-NIES	5.8	6.0	-104	-117
	Ensemble average	3.4	3.2	-38	-11
2070-2099	CGCM2	4.2	3.1	-38	-32
	CSIRO Mk2	4.6	3.3	-45	29
	HadCM3	5.3	3.9	-64	-8
	ECHAM4	5.7	4.6	-64	-8
	GFDL R-30	3.4	2.4	18	3
	CCSR-NIES	9.5	7.3	-189	-119
	Ensemble average	5.4	4.1	-64	-23

Source: *IPCC DDC: http://ipcc-ddc.cru.uea.ac.uk.*

Annex 2.6. Approaches and indicators used for evaluation and representation of new humidity conditions

Statistical approach – calculation of Potential Evaporation and Aridity Index for assessing the change in annual and seasonal humidity conditions, using following equations:

Ivanov potential evaporation (PE):

$$PE = 0.0018\ (25+T)^2 - (100-a),$$

where: *T* – mean monthly air temperature, °C; *a* – relative air humidity, %

Aridity index (AI):

$$AI = P/PE,$$

where: *P* – precipitation sum, mm; *PE* – potential evaporation, mm;

Graphical approach is based on construction of climatic diagrams to show the possible temporal dynamic of change in humidity conditions.

Annex 2.7. Methods used for estimation of temperature extremes

A statistical view on weather extremes reveals that the higher mean air temperatures, the more extremely warm events are likely. Moreover, there is a linear correlation between average summer maximum temperature *(Tmax)* and its extreme values. This correlation can be extrapolated on projections[219] and be used with a high degree of confidence as an empirical predictor of the type of extremes that may occur.

The simple linear regression of summer maximal temperatures on mean temperatures showed that in 1981-2008 each degree of mean summer warming in Chişinău is accompanied by statistically-significant increase in mean summer maximal temperatures by 1.14 °C and in absolute summer temperatures – by 1.27 °C. Based on such dependencies there were calculated projections of these variables (see chapter CLIMATE CHANGE AND ITS CHALLENGES FOR MOLDOVA, discussed in main text. In particular, by the end of the 21st century, along with the likely increase of mean summer temperatures – respectively by 6.5°C and 4.7°C in comparison with baseline climate according to *SRES A2 and B2* scenarios – the mean maximal temperatures can increase by 7.4 °C and 5.4 °C (by 6.4 °C on the average for two emissions).

Table 28. Mean values, standard deviations (σ) and probabilities of observed and projected summer (June-July-August) temperatures at Chisinau weather station

Period	Mean							Absolute						
	Mean and range			σ	Percentile, %			Mean and range			σ	Percentile, %		
	Mean	Max	Min		90	95	99	Mean	Min	Max		90	95	99
Maximal summer temperature, °C														
1961-1990	25.6	28.1	23.6	1.19	27.1	27.6	28.4	32.0	29.0	34.1	1.50	33.9	34.4	35.5
1981-2008	26.4	30.2	23.6	1.37	28.2	28.6	29.6	32.9	29.2	38.0	1.86	35.3	36.0	37.2
2010-2039	28.0			1.37	29.8	30.3	31.2	34.7			1.86	37.0	37.7	40.0
2040-2079	29.9			1.37	31.7	32.2	33.1	36.8			1.86	39.2	39.8	41.1
2070-2100	32.0			1.37	33.8	34.3	35.2	39.1			1.86	41.5	42.2	43.4
Minimal summer temperature, °C														
1961-1990	15.3	16.6	13.8	0.69	16.2	16.4	16.6	10.2	12.0	7.3	1.11	11.6	11.8	12.0
1981-2008	16.5	18.8	15.0	0.86	17.6	18.2	18.8	11.1	13.5	8.4	1.41	12.9	13.4	13.5
2010-2039	16.9			0.86	18.0	18.3	18.9	11.8			1.41	13.6	15.0	16.3
2040-2079	18.1			0.86	19.2	19.5	20.1	13.9			1.41	14.1	15.5	16.9
2070-2100	19.5			0.86	20.6	21.0	21.5	14.5			1.41	15.1	16.5	17.8

Source: *IPCC DDC: http://ipcc-ddc.cru.uea.ac.uk.*

Although there is an assumption that any change in temperature means is accompanied by corresponding change in the variances, our results do not confirm this hypothesis (Table 28). Therefore, the current variability of high temperatures was used to estimate the probabilities of future extremes.

[219] Beniston,2004; Beniston and Stephenson, 2004.

Annex 2.8. Hydrographical characteristics of the main rivers of Moldova

River	Length, km	Catchment area, thou. km²	Mean stream flow, km³/year
Danube *	about 0.8	8.3	203
Prut * (Danube's tributary)	695	8.0	2.9
Ciuhur (Prut's tributary)	97	0.7	0.02
Dniester *	657	19.1	10.7
Răut (Dniester's tributary)	286	7.8	0.3
Căinar (Răut's tributary)	113	0.8	0.05
Cubolta (Răut's tributary)	100	0.9	0.06
Bîc (Dniester's tributary)	155	2.0	0.09
Botna (Dniester's tributary)	152	1.5	0.03
Ichel (Dniester's tributary)	101	0.8	0.02
Ialpug *	135	3.2	0.09
Cogîlnic *	125	1.0	0.06

Note: ** Transboundary rivers; length and area are given within Moldova's territory.*

Annex 2.9. Modelling water resources quantity and quality

Surface and ground water features depend on a series of variables, but only a part of them is climate-related and can be reliably modelled in the context of changing climate. The following models were developed using climatic variables of the baseline period of 1961-1990 (1970s) in their relationship with hydrological parameters. For prognosis, the outputs of Global Circulation Models downscaling were used as primary inputs into the hydrological models. There were taken three standard future time-slices: 2010-2039 (2020s), 2040-2069 (2050s) and 2070-2099 (2080s) and two scenarios (SRES A2 and B2) of greenhouse gas emissions. Projections for the following water resources parameters are provided:

1. Projections for **big rivers' stream flow**, the cases of Dniester and Prut rivers, were obtained through multiple regression analysis. Regression parameters were calculated using statistical modelling for specified catchments.[220]

Table 29. Multiple linear regression parameters for big rivers' stream flow modelling

River	R	*p-value*	constant	Regression coefficients	
				temperature	*precipitations*
Dniester	0,517	0,0002	277,6	-17,12	0,36
Prut	0,502	0,0001	79,8	-6,40	0,11

2. For projecting climatic norm of **small rivers' run-off**, the method of water-heat balance by V.S. Mezentsev were used:[221]

$$\overline{Q}_p = \left(\overline{P} \pm \Delta\overline{P}\right) - \overline{E}_m\left(1+\frac{\varepsilon\Delta\bar{t}}{100}\right)\left\{1+\left[\frac{\overline{E}_m\left(1+\frac{\varepsilon\Delta\bar{t}}{100}\right)}{\overline{P} \pm \Delta\overline{P}}\right]^n\right\}^{-1/n} \quad (1)$$

where, $\overline{Q}_p$ – projected climatic norm of small rivers' run-off (mm): $\overline{P}$ and E_m – baseline climate's averages for precipitation (mm) and evaporativity (mm), accordingly; $\Delta\overline{P}$ and $\Delta\bar{t}$ – expected changes in annual precipitations (mm) and temperature (°C); ε and *n* – constants, equal to 4.44 and 2.45, accordingly, in the particular cases of the Republic of Moldova.[222]

[220] Лалыкин Н.В., Сыродоев, И.Г., 2004: Некоторые подходы к оценке воздействий изменения и изменчивости климата на водные ресурсы. В: Р.М. Коробов (ред.). Климат в Молдове в XXI веке: проекции изменений, воздействий, откликов. Кишинэу, стр. 176-212.

[221] Мезенцев В.С., 1976: Расчеты водного баланса. Омск: ОСХИ.

[222] Коробов Р.М., Николенко А., 2004: Новые проекции антропогенного изменения климата Молдовы в XXI столетии. Р.М. Коробов (ред.). Климат Молдовы в XXI веке: проекции изменений, воздействий, откликов. Кишинэу, стр. 54-97.

Table 30. Baseline values (mm) and projected relative changes of Dniester (at Bender) and Prut (at Ungheni) rivers' stream flow and small rivers' run-off (%)

Scenario	Time-slice	Dniester	Prut	Small rivers
baseline	1970s	323	88	73
SRES A2	2020s	-10.0	-13.2	-16.9
	2050s	-22.8	-29.9	-38.7
	2080s	-36.5	-48.0	-55.5
SRES B2	2020s	-12.9	-16.9	-22.7
	2050s	-18.4	-24.6	-27.1
	2080s	-24.5	-32.7	-36.5

3. Monthly distribution of the small rivers' run-off was obtained using general version of the water-heat balance:[223]

$$q_m = p_{m+} W_{m0} - W_{m1} - e_m \quad (2)$$

where, q_m, p_m and e_m – average monthly norms of stream flow, precipitations, and evaporativity (mm); W_{m0} and W_{m1} – humidity within the 1 m soil depth at the beginning and at the end of the month (mm).

Table 31. Baseline values (mm) and projected relative changes of monthly Răut River run-off (%) (at Jeloboc)

Scenario	Time -slice	Months											
		I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*	*XI*	*XII*
baseline	1970s	2.7	2.4	4.2	7.9	6.4	2.3	3.0	3.3	1.8	1.7	2	2.5
SRES A2	2020s	16.7	16.7	0.0	1.6	-34.8	-56.7	-60.6	-27.8	-41.2	-60.0	-56.0	-18.5
	2050s	20.8	16.7	1.3	-46.9	-17.4	-66.7	-66.7	-33.3	-41.2	-50.0	-60.0	-3.7
	2080s	4.2	11.9	-54.4	-53.1	-60.9	-86.7	-90.9	-72.2	-11.8	-45.0	-68.0	3.7
SRES B2	2020s	33.3	-2.4	-3.8	0.0	8.7	-66.7	-69.7	-50.0	-52.9	-70.0	-64.0	18.5
	2050s	29.2	0.0	-8.9	-6.3	0.0	-50.0	-54.5	-16.7	-17.6	-60.0	-40.0	37.0
	2080s	50.0	28.6	1.3	-1.6	-43.5	-76.7	-66.7	-38.9	-52.9	-55.0	-60.0	18.5

4. Coefficient of variation of annual stream flow was calculated using two different approaches depending on river size. In the case of big rivers, statistical linear regression was used (Dniester case study):[224]

$$C_v = -0.0002 * Q_{an} + 0.3531 \qquad r = 0.729;\ p = 0.000 \quad (3)$$

In the case of small rivers, another equation, obtained for Moldovan rivers,[225] was used:

$$C_v = 1.03 - 0.0117 * Q_{an} \quad (4)$$

In each of the equations C_v represents coefficient of variation of annual stream flow and Q_{an} means annual stream flow (mm).

[223] Лалыкин Н.В., Сыродоев, И.Г., 2004: Некоторые подходы к оценке воздействий изменения и изменчивости климата на водные ресурсы. В: Р.М. Коробов (ред.). Климат в Молдове в XXI веке: проекции изменений, воздействий, откликов. Кишинэу, стр. 176-212.

[224] Ibid.

[225] Лалыкин Н.В., Собченко, А.П., 1998: Водные ресурсы рек Молдовы и пути их определения. In: Resursele funciare şi acvatice. Valorificarea superioară şi protecţia lor. Conferinţa ştiinţifico-practică. Chişinău, стр. 142-153.

Table 32. Baseline values (%) and projected relative change of annual stream flow coefficient of variation (%)

Scenario	Time-slice	Dniester (at Bender)	Small rivers
baseline	1970s	29	17
SRES A2	2020s	2	32
	2050s	5	51
	2080s	8	65
SRES B2	2020s	3	37
	2050s	4	41
	2080s	6	49

5. **Spring flood** projections were obtained by combining multiple regression method[226] and the method of analogue years.[227]

Table 33. Multiple linear regression parameters for spring flood modelling

Variables	R	p-value	constant	Regression coefficients			
				annual flow layer	share of spring flood flow in the annual flow	flood flow layer	flood duration
Flood flow layer	0,971	0,000	-41.8	0.27	1.51		
Maximal discharge	0,848	0,000	935.2			26.0	-14.74

Note: *Input values of the share of spring flood flow and flood duration for the three future time-slices (2020s, 2050s, and 2080s) were obtained through selecting among historical records 5-8 years having annual stream flow similar to projected; it was assumed that years with the stream flow similar to projected have other characteristics similar as well. Thus, median values of the selected historical records were used as input parameters in the model.*

Table 34. Baseline values of flood run-off (mm) and maximal discharge (m^3/s) and projected relative changes of Dniester River flood parameters (%) (at Bender)

Scenario	Time-slice	Flood run-off	Maximal discharge
baseline	1970s	46	1374
SRES A2	2020s	-13.5	-31.5
	2050s	8.1	-17.2
	2080s	-44.3	-59.1
SRES B2	2020s	27.1	3.4
	2050s	12.1	-13.8
	2080s	-33.4	-49.7

6. Expected **summer-autumn low water** was calculated by means of simple linear regression:[228]

$$Q_{min} = 0.56 * Q_a - 11.1 \qquad r = 0.745; p = 0.000 \qquad (5)$$

where, Q_{min} and Q_a – minimal and annual water discharge (m^3/s).

[226] Лалыкин Н.В., Сыродоев, И.Г., 2004: Некоторые подходы к оценке воздействий изменения и изменчивости климата на водные ресурсы. В: Р.М. Коробов (ред.). Климат в Молдове в XXI веке: проекции изменений, воздействий, откликов. Кишинэу, стр. 176-212.

[227] Kundzewicz Z.W., Somlyody L., 1997: Climatic change impact on water resources in a system perspective. Water Resources Management 11: 407-735.

[228] Лалыкин Н.В., Сыродоев, И.Г., 2004: Некоторые подходы к оценке воздействий изменения и изменчивости климата на водные ресурсы. В: Р.М. Коробов (ред.). Климат в Молдове в XXI веке: проекции изменений, воздействий, откликов. Кишинэу, стр. 176-212.

Table 35. Baseline value (m^3/s) and projected relative changes of the Dniester River low water stream flow discharge (%) (at Bender)

Scenario	Time-slice	Low water stream flow
baseline	1970s	150
SRES A2	2020s	-7.61
	2050s	-18.40
	2080s	-30.06
SRES B2	2020s	-10.01
	2050s	-14.69
	2080s	-19.91

7. There are four categories of **water resources** in the Republic of Moldova: natural, real, ecological, and available resources:[229]

- Natural water resources are formed under natural conditions and are conditioned by natural factors of annual stream flow;
- Real water resources represent really formed river flow as a result of human activity that changes catchment surface characteristics (agriculture, forestry etc.);
- Ecologic water resources – resources needed for maintaining present environmental state of floodplains and neighbouring areas;
- Available water resources are those available for economic use.

Only the latter can be used without harming natural and human ecosystems.

More than 98% of the natural water resources are being formed within Dniester and Prut river catchments; therefore, assessment of water resources is worthy of being made just for these two catchments. Taking in consideration that Dniester and Prut are transboundary rivers and their resources should be shared equally among neighbouring states (Romania and Ukraine), obtained projections are divided by two, in order to show Moldovan share of the resources.

Available water resources were calculated according to the following schema:

$$W_{av} = W_{rea} - W_{ecol} \quad (6)$$

$$W_{real} = W_{nat}(1-\varphi) \quad (7)$$

where, W_{nat} – natural water resources, W_{real} – real water resources, W_{ecol} – ecological water resources, W_{av} - available water resources, φ - constant.

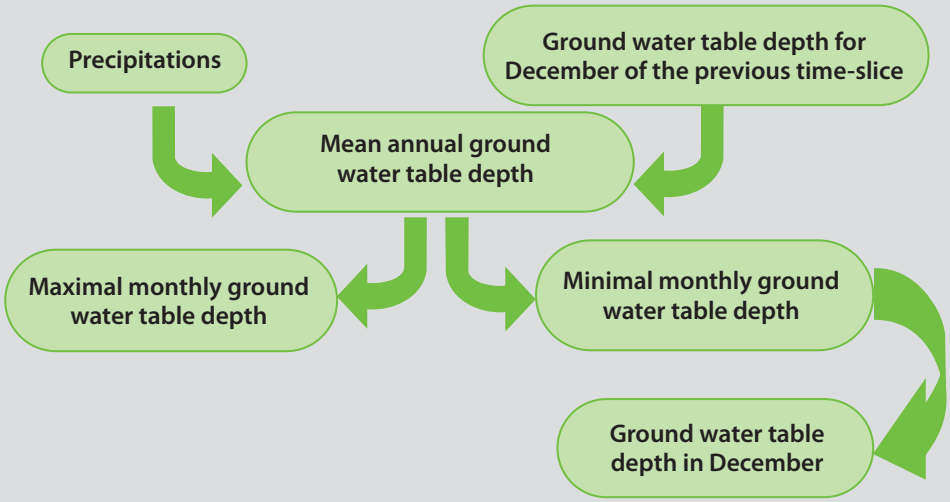
Table 36. Baseline value (km^3) and projected relative changes of available water resources in the Republic of Moldova (%)

Scenario	Time-slice	Dniester and Prut Rivers catchments
baseline	1970s	4.3
SRES A2	2020s	-15.9
	2050s	-36.0
	2080s	-57.7
SRES B2	2020s	-20.3
	2050s	-29.2
	2080s	-38.9

[229] Лалыкин Н.В., Собченко, А.П., 1998: Водные ресурсы рек Молдовы и пути их определения. In: Resursele funciare şi acvatice. Valorificarea superioară şi protecţia lor. Conferinţa ştiinţifico-practică. Chişinău, стр. 142-153.

8. Ground water depth parameters were calculated according to the following schema (Chart 41):

Chart 41. **Sequence of the ground water table parameters calculation**



Source: *Лалыкин Н.В., Сыродоев, И.Г., 2004: Некоторые подходы к оценке воздействий изменения и изменчивости климата на водные ресурсы. В: P.M. Коробов (ред.). Климат в Молдове в XXI веке: проекции изменений, воздействий, откликов. Кишинэу , стр. 176-212.*

Input parameters into the model were obtained as follows: mean annual ground water table depth estimated using graphical method (Chart 42); for other variables (extreme ground water table depths and the depth in December) regression method was used:

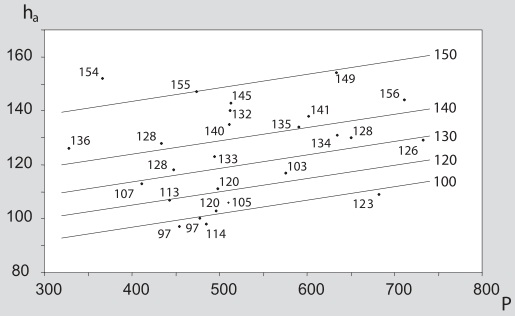
$$h_{max}=0.84*h_a+31.1 \qquad r=0.946;\ p=0.000 \qquad (8)$$

$$h_{min}=1.3*h_a-51.1 \qquad r=0.973;\ p=0.000 \qquad (9)$$

$$h_{dec}=0.65*h_{min}+57.3 \qquad r=0.901;\ p=0.000 \qquad (10)$$

where, h_a; h_{max}; h_{min} and h_{dec}– values of ground water table depth (mm): annual average, maximal, minimal and for December, accordingly.

Chart 42. **Dependency of mean annual ground water table depth (h_a) on annual precipitations (P) and mean water table depth in December previous year** (*indicated by points*)



Source: *Лалыкин Н.В., Сыродоев, И.Г., 2004: Некоторые подходы к оценке воздействий изменения и изменчивости климата на водные ресурсы. В: P.M. Коробов (ред.). Климат в Молдове в XXI веке: проекции изменений, воздействий, откликов. Кишинэу , стр. 176-212.*

Table 37. Baseline values (mm) and projected relative changes of ground water table parameters (%) (*at Bălțata*)

Scenario	Time-slice	Ground water table depth (mm)			
		Average	Highest	Lowest	in December
baseline	1970s	121	133	104	121
SRES A2	2020s	-7.4	-5.9	-9.1	-1.9
	2050s	-10.7	-8.4	-14.1	-4.7
	2080s	-13.2	-10.3	-17.9	-6.8
SRES B2	2020s	-8.3	-6.5	-10.4	-2.6
	2050s	-9.9	-7.8	-12.9	-4.0
	2080s	-10.7	-8.4	-14.1	-4.7

9. Mean annual and monthly distribution of **water temperature** were obtained using a series of simple linear regressions describing relationship between air temperature and water temperature for year as a whole and by months, separately.[230] As examples, there can be shown two equations used in the modelling, to obtain annual value of water temperature (eq. 11) and for one of the months (eq. 12):

Annual average: $T_w = 1.04 * T_{air} + 0.49$ $r = 0.981; p = 0.000$ (11)

November average: $t_w = 0.7 * t_{air} + 3.07$ $r = 0.835; p = 0.000$ (12)

where, T_w and t_w – mean annual and monthly water temperature, accordingly (°C); T_{air} and t_{air} – mean annual and monthly air temperature, accordingly (°C).

Table 38. Baseline values (°C) and projected relative changes of the Dniester River monthly and annual water temperature (%) (at Bender)

Scenario	Time-slice	Months												Year
		I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*	*XI*	*XII*	
baseline	1970s	0.7	0.5	2.2	9.4	16.6	21.1	23.1	22.7	18.7	12.5	6.1	2.0	11.3
SRES A2	2020s	13.4	27.2	56.0	10.3	3.1	2.9	4.6	5.3	5.7	10.0	22.3	7.7	33.7
	2050s	30.7	50.7	104.5	21.7	8.5	7.7	11.3	12.0	12.1	19.2	37.5	87.7	64.2
	2080s	46.1	80.9	187.1	34.3	14.1	14.7	20.0	19.6	20.7	30.5	56.5	144.8	103.5
SRES B2	2020s	13.1	30.7	67.5	17.6	4.6	4.2	6.2	6.9	7.0	10.1	23.0	23.4	39.6
	2050s	24.1	50.6	97.2	22.9	6.7	6.7	10.3	11.5	12.9	17.2	37.9	58.1	59.7
	2080s	36.3	61.9	140.9	27.0	9.2	9.5	14.1	14.5	16.2	21.9	45.0	82.2	76.4

10. Mean annual and monthly distribution of **dissolved oxygen (DO) level** were obtained using simple linear regression model:[231]

$DO = -0.28 * t_w + 14.45$ $r = -0.882; p = 0.000$ (13)

where, DO – dissolved oxygen level (mg/l); t_w – water temperature (°C)

[230] Sirodoev I.G., Corobov, R.M., 2005: An approach to the modelling of some river water quality parameters. Gh. Duca (ed.). The third international conference "Ecological chemistry". Latest advances. Book of proceedings. Chișinău: Tipogr. Acad. Șt.,p. 242-248.

[231] Ibid.

Table 39. **Baseline values (°C) and projected relative changes of the Dniester River monthly and annual DO level (%) (at Bender)**

Scenario	Time-slice	Months												Year
		I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*	*XI*	*XII*	
baseline	1970s	14.7	14.5	14.2	11.8	9.8	8.5	8.3	8.6	9.8	11.4	13.1	14.3	11.6
SRES A2	2020s	-3.2	-1.5	-4.9	-2.2	-1.3	-1.7	-7.3	-9.8	-9.0	-7.1	-5.6	-3.2	-4.5
	2050s	-3.5	-1.7	-6.9	-4.7	-3.9	-5.0	-12.6	-14.7	-12.4	-9.9	-7.6	-6.3	-6.9
	2080s	-3.7	-1.9	-10.4	-7.6	-6.5	-9.9	-19.3	-20.3	-17.0	-13.4	-10.0	-8.5	-9.9
SRES B2	2020s	-3.2	-1.5	-5.4	-3.8	-2.0	-2.6	-8.6	-10.9	-9.6	-7.1	-5.7	-3.8	-5.0
	2050s	-3.4	-1.7	-6.6	-5.0	-3.0	-4.3	-11.8	-14.3	-12.8	-9.3	-7.6	-5.1	-6.6
	2080s	-3.5	-1.8	-8.5	-5.9	-4.2	-6.3	-14.7	-16.6	-14.6	-10.8	-8.5	-6.1	-7.9

Annex 2.10. Overview of Millennium Development Goals and targets and possible climate change implications

Goal	Target	Possible Climate Change Implications
Goal 1: Eradicate Extreme Hunger and Poverty	**Target 1.** Halve, between 1990 and 2015, the proportion of people whose income is less than $1 a day **Target 2.** Halve, between 1990 and 2015, the proportion of people who suffer from hunger	• Economic security given increase in weather extremes • Loss of biodiversity and less access to natural resources • Diminished crop yields • Changing soil structure (erosion, compactation, salinization, etc)
Goal 2: Achieve Universal Primary Education	**Target 3.** Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	• Change of lifestyle: more time to ensure food, water and cash income, this reduces time for education • Possible ill-health impacts and follow up of calamities as barriers to attending classes
Goal 3: Promote Gender Equality and Empower Women	**Target 4.** Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015	• Women's greater reliance on subsistence and natural resources for income
Goal 4: Reduce Child Mortality	**Target 5.** Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate	• Health impacts on children and mothers as they are particularly vulnerable to disaster-related, water quality and hunger related diseases • Health impacts on people already living with diseases as they have an increased vulnerability to climate change • Increases in heat related mortality and illness associated with weather extremes (hot waves especially)
Goal 5: Improve Maternal Health	**Target 6.** Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio	
Goal 6: Combat HIV/AIDS, Malaria and other diseases	**Target 7.** Have halted by 2015 and begun to reverse the spread of HIV/AIDS **Target 8.** Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases	

Goal 7: Ensure Environmental Sustainability	**Target 9.** Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources **Target 10.** Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. **Target 11.** Have achieved by 2020 a significant improvement in the lives of at least 100 million slum dwellers	• Increased water shortages as a result of changes in rainfall patterns, greater periods of drought • biological diversity and ecosystems loss, and environmental degradation due to variations in temperature and precipitations
Goal 8: Develop a Global Partnership for Development	**Target 12.** Develop further an open, rule-based, predictable, nondiscriminatory trading and financial system (includes a commitment to good governance, development, and poverty reduction? both nationally and internationally) **Target 13.** Address the special needs of the Least Developed Countries (includes tariff- and quota-free access for Least Developed Countries' exports, enhanced program of debt relief for heavily indebted poor countries [HIPCs] and cancellation of official bilateral debt, and more generous official development assistance for countries committed to poverty reduction) **Target 14.** Address the special needs of landlocked developing countries and small island developing states (through the Program of Action for the Sustainable Development of Small Island Developing States and 22nd General Assembly provisions) **Target 15.** Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term **Target 16.** In cooperation with developing countries, develop and implement strategies for decent and productive work for youth **Target 17.** In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries **Target 18.** In cooperation with the private sector, make available the benefits of new technologies, especially information and communications technologies	• Dealing with costs of weather related disasters that could affect the Gross Domestic Product, the level of indebtedness, state of public finances, and investments

Source: *http://www.unmillenniumproject.org/goals/gti.htm Last checked on August 1, 2009.*

Annex 2.11. Analysis of current strategies and legal framework

Domain	Title and date of issue	Climate change provisions
General	The National Strategy on Development for 2008 – 2011	In the SWOT analysis of the actual situation in the Republic of Moldova it is also mentioned that while the effects of climate change will intensify, the frequency and severity of natural disasters, like draught, hail, as well as soil erosion will increase. It also states that the worsening of the environmental situation in the Republic of Moldova has a negative impact on human health, as well as on rural development and agricultural production. The MDGs, among which is MDG 7 Ensure Environmental Sustainability, are emphasized. Based on these objectives, the Strategy proposes five main general objectives. Only the last one – regional development – implies working with the environment but it does not respond to any of the issues on which climate change is based.
	Action Plan on Improvement of National Capacities in the Field of Global Environmental Management According to Country's Obligations under Rio de Janeiro Conventions (2005-2010)	Based on Action Plan the following activities should be realized till 2010: elaboration of National Action Plan on adaptation to climate change and strengthening capacities of Climate Change Office according to provisions of the UN Framework Convention on Climate Change; elaboration of national strategy and branch programmes on reduction of GHS emissions; inclusion of requirements on GHS emissions inventory in branch programmes and strategies (energy, transport, household sector, public sector, industry, agriculture, forestry, waste management, etc). A number of obligations regarding adjustment of legal and normative act were identified as well.
Water	Law on Environment Protection, 16.06.1993	There are no issues specifically related to climate variability and change.
	Water Code of the Republic of Moldova, 22.06.1993	There are no issues specifically related to climate variability and change.
	Law on Rivers' and Reservoirs' Water Protection Zones and Belts, 27.04.1995	There are no issues specifically related to climate variability and change.
	Law on Natural Resources, 06.02.1997	There are no issues specifically related to climate variability and change.
	Law on Drinking Water, 10.02.1999	There are no issues specifically related to climate variability and change.
	Government decision on Framework Regulation of Using Communal Water Supply and Disposal Systems, No. 656, 27.05.2002	There are no issues specifically related to climate variability and change.
	Concept of National Water Resources Policy (2003-2010), No. 325-XV, 18.07.2003	There are no issues specifically related to climate variability and change.

Domain	Title and date of issue	Climate change provisions
	Programme of Water Supply and Disposal in the Settlements of the Republic of Moldova till 2015, No. 1406, 30.12.2005	There are no issues specifically related to climate variability and change.
	Strategy on Water Supply and Disposal in the Settlements of the Republic of Moldova, No. 662, 13.06.2007	There are no issues specifically related to climate variability and change.
	National Programme on Environmental Security for 2007-2015, No. 304, 17.03.2007	There are no issues specifically related to climate variability and change.
Energy	Law on Renewable Energy, No. 160-XVI, 12.07.2007 (Official Monitor No. 1, 2007)	There are no issues specifically related to climate variability and change.
	Energy Strategy of the Republic of Moldova until 2020, approved by Government Decision No.958 of 21.08.2007 (Official Monitor No. 141-145/1012,07.09.2007)	There are no issues specifically related to climate variability and change.
	Methodology of Tariff Determination for the Energy Obtained from Renewable Sources (approved by Decision of National Agency for Energy Regulation, 25.02.2009 - ANRE, 2009)	There are no issues specifically related to climate variability and change.
	Energy Conservation Programme for the period 2003-2010. (Official Monitor No. 200-203/1133, 19.09.2003)	There are no issues specifically related to climate variability and change.
Transportation	Land Transportation Development Strategy for 2008-2017	There is nothing explicit about the specific imperatives imposed by the climate changes on roads and rail-road building technologies.
	Concept of Development of the River Transport in the Republic of Moldova, March 2008	There are no issues specifically related to climate variability and change.
	Strategy for Development of the Civil Aviation in 2007-2012	There are no issues specifically related to climate variability and change.
Biodiversity	National Strategy and Action Plan on Biodiversity Conservation of the Republic of Moldova (Government Decision 112-XV of 27.04.2001)	There are no issues specifically related to climate variability and change.
	The National Action Plan to Combat the Desertification (NAPCD). (Government Decision 367 of 13.04.2000)	There are no issues specifically related to climate variability and change.
	The Strategy for Sustainable Development of Forest Sector of the Republic of Moldova (Government Decision 350 of 12.07.2001)	There are no issues specifically related to climate variability and change.
	State Programme for regeneration and afforestation of Forest Fund Lands for 2003-2020. (Government Decision 737 of 17.06.2003)	There are no issues specifically related to climate variability and change.

Domain	Title and date of issue	Climate change provisions
Agriculture	National Strategy for Sustainable Development of Agricultural Complex of the Republic of Moldova for 2008-2015 (Government Decision No. 282 of 11.03.2008. Official Monitor No. 57-60, 21.03.2008)	One of the reasons to elaborate this Strategy was the excessive vulnerability of the agricultural sector to natural conditions, expressed by sudden reduction of crops in the years with various natural calamities. The Strategy provides that climate change can affect food security by erosion, droughts and floods, resulting in dramatic reduction or collapse of agricultural production because of natural disasters. Thus, it is needed to increase the reservoir system, rehabilitate existing dams in flood areas, enhance efficiency of the irrigation system, implement agro-systems in order to increase resistance to erosion, improve soil quality, identify plant species adapted to the Republic of Moldova's conditions (high temperatures and low humidity). The decrease of the vulnerability of agriculture to risk factors and risk control can be promoted by various mechanisms and policies. General measures (organizational); special measures on erosion control, against droughts, to diminish flood risks, devastating weather events.
	Strategy for Agricultural Sector Development during 2006-2015 (Government Decision No. 1199 of 17.10.2006. Official Monitor No. 170-173/1312,03.11.2006)	There are no issues specifically related to climate variability and change.
	National Programme "Moldovan Village"(2005-2015)	There are no issues specifically related to climate variability and change.
	National Action Programme to Combat Desertification (Government Decision No. 367 of 13.04.2000)	There are no issues specifically related to climate variability and change.
	National Complex to Increase Soil Fertility (No. 591, 20.06.2000)	There are no issues specifically related to climate variability and change.
	Programme of Recovery of New Land to Increase Soil Fertility during 2003-2010. Chisinau, 2004	There are no issues specifically related to climate variability and change.
Health	National Health Policy of the Republic of Moldova (Government Decision No. 886 of 06.08.2007)	There are no issues specifically related to climate variability and change.
	Law No. 10 of 03.02.2009 on the Supervision of State Public Health (Official Monitor No. 67, 03.04.2009)	There are no issues specifically related to climate variability and change.
	Health System Development Strategy for 2008-2017 (Government Decision No. 1471 of 24.12.2007)	There are no issues specifically related to climate variability and change.

Domain	Title and date of issue	Climate change provisions
	Strategic Development Plan of the National Health Information during 2008-2017 in the Republic of Moldova. Chisinau, 2007. Approved by Common Order of the Ministry of Health, Ministry of Information Development, National Bureau of Statistics, National Health Insurance Company Nr. 412/127/125/185-A on 06.11.2007	There are no issues specifically related to climate variability and change.

Annex 2.12. Explanation of criteria used for selection of adaptation options

Criteria used for selection considering highest-priority development goals include five specific risk-multipliers for human development reversals, identified in the HDR 2007/2008:

- Agricultural production and food security (Reduced agricultural productivity): It is closely related to poverty reduction. People with low income are the most directly and severely affected by disasters that affect agricultural production. Reducing their vulnerabilities and addressing poverty as a root cause of disasters should be identified as a key priority.
- Water stress and water insecurity (Heightened water insecurity): Water supply, quality and availability are a prerequisite for a normal development of the country, population and environment.
- Exposure to climate disasters (Increased exposure to extreme weather events): Disaster risk reduction and climate change adaptation must be closely linked to development and must address local needs. Climate information must capture the complexity and uncertainty in supporting adaptation and disaster risk reduction.
- Ecosystems and biodiversity (The collapse of ecosystems): Climate change is already transforming ecological systems. While some animal and plant species will adapt, for many species the pace of climate change is too rapid and many species could face extinction.
- Human health (Increased health risks): Rich countries are already preparing public health systems to deal with future climate shocks, such as the 2003 European heat-wave and more extreme summer and winter conditions. However, the greatest health impacts will be felt in developing countries because of high levels of poverty and the limited capacity of public health systems to respond. Major killer diseases could expand their coverage.[232]
- These five drivers do not operate separately. They interact with wider social, economic and ecological processes that shape opportunities for human development. Inevitably, the precise mix of climate change and human development factors varies across and within the country. Additionally there are large areas of uncertainty. What is certain is that dangerous climate change has the potential to deliver powerful systemic shocks to human development. Many of the human development impacts (like lost opportunities for health and education, diminished productive potential, loss of vital ecological systems) are likely to prove irreversible.[233]
- Costs: Any adaptation option will necessitate some costs, but these could be low cost options (an affordable/small financial and/or social effort) or options that will be high cost and could be implemented only if there is external support (including financial)

Proposed measures should include both structural and non-structural measures as well as the financial means and the institutional changes necessary to implement successful adaptation processes. They should be based on participatory processes, prioritising the potential reforms and investments taking into account the financial, institutional resources and other means and knowledge available to implement them. These options should ensure the step-wise implementation of the adaptation strategy, in accordance with determined priorities, including coping measures from the individual to the State level.[234]

[232] Human Development Report 2007/2008.
[233] Human Development Report 2007/2008.
[234] Draft guidance on water and climate change adaptation, UNECE, WHO, July 2008.

Climate change is global but the effects are local. Physical impacts will be determined by geography and microlevel interactions between global warming and existing weather patterns. Human development impacts will also vary as changes in climate patterns interact with pre-existing social and economic vulnerabilities.[235]

The shape of the interplay between climate change and human development outcomes will be defined the type of local climate effects, by the specific social and economic coping capacities, and by public policy choices, among other factors. What is important in the context of climate change is that Moldova being one of the vulnerable countries starts preparing adaptation strategies in order to reduce *Income poverty and Child mortality, improve Nutrition and Health*.

HUMAN DEVELOPMENT STATISTICAL APPENDIXES

Information was provided by National Bureau of Statistics of Republic of Moldova. Data do not cover the Trans-Dniester region and the Bender municipality, except for the mentioned cases when calculations are made for the entire country.

[235] Human Development Report 2007/2008.

Annex 3.1. Human Development Index (HDI)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GDP per capita:																
Moldovan lei. current prices	505	1,313	1,798	2,167	2,441	2,498	3,379	4,402	5,247	6,227	7,646	8,890	10,475	12,483	14,937	17,602
US dollars at Purchasing Power Parity *	2,935	2,975	2,105	2,128	2,207	2,087	2,033	2,112	2,300	2,533	2,765	2,028	2,362	2,561	2,715	2,986
Adult literacy rate (%)	97	97.2	97.4	97.5	97.7	97.9	98.0	98.2	98.3	98.5	98.7	98.9	99.0	99.0	99.1	99.1
Gross global enrolment ratio (%)	71.7	70.2	71.1	71.8	72.9	73.4	71.2	70.3	70.4	70.7	71.0	70.9	71.7	71.2	69.9	69.8
Life expectancy at birth (years)	67.5	66.1	65.8	66.7	66.6	67.8	67.4	67.6	68.2	68.1	68.1	68.4	67.8	68.4	68.8	69.4
Indexes:																
GDP	0.564	0.566	0.509	0.510	0.516	0.507	0.503	0.509	0.523	0.539	0.554	0.502	0.528	0.541	0.551	0.567
Education	0.886	0.882	0.886	0.889	0.894	0.897	0.891	0.889	0.890	0.892	0.895	0.896	0.900	0.897	0.894	0.893
Longevity	0.708	0.685	0.680	0.695	0.693	0.713	0.707	0.710	0.720	0.718	0.718	0.723	0.713	0.723	0.730	0.740
Human Development Index (HDI)	0.719	0.711	0.692	0.698	0.701	0.706	0.700	0.703	0.711	0.716	0.722	0.707	0.714	0.720	0.725	0.733

** Estimated based on results European Comparison Program of 1996.*

Annex 3.2. Gender-related Development Index (GDI)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Life expectancy	67.4	67.6	68.2	68.1	68.1	68.4	67.8	68.4	68.8	69.4
Women	71.0	71.2	71.7	71.7	71.6	72.2	71.7	72.2	72.6	73.2
Men	63.7	63.9	64.5	64.4	64.5	64.5	63.8	64.6	65.1	65.6
Adult literacy rate (%)	98.0	98.2	98.3	98.5	98.7	98.9	99.0	99.0	99.1	99.1
Women	96.9	97.1	97.4	97.6	97.9	98.3	98.4	98.4	98.5	98.5
Men	99.3	99.3	99.4	99.5	99.5	99.6	99.6	99.6	99.7	99.7
Gross global enrolment rate (%)	71.2	70.3	70.4	70.7	71.0	70.9	71.7	71.2	69.9	69.8
Women	72.4	71.9	72.3	72.8	73.5	74.0	74.8	74.3	73.2	73.2
Men	70.1	68.7	68.5	68.7	68.5	67.9	68.7	68.2	66.8	66.6
GDP per capita USD at PPP	2,033	2,112	2,300	2,533	2,765	2,029	2,362	2,560	2,714	2,986
Women	1,579	1,665	1,823	2,042	2,150	1,597	1,909	1,881	2,118	2,335
Men	2,527	2,598	2,819	3,067	3,434	2,499	2,855	3,296	3,357	3,690
Gender-related Development Index (GDI)	0.697	0.700	0.709	0.715	0.720	0.705	0.711	0.718	0.723	0.731

Annex 3.3. Gender Empowerment Measure (GEM)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Parliamentary participation (%)	7.9	7.9	12.9	15.8	17.5	22.0	22.0	21.8	21.8	21.8
Managers and high officials in public administration and social and economic units (%)	36.6	33.2	37.5	40.2	39.4	39.0	38.8	38.9	40.2	37.9
Women with intellectual and scientific occupation	61.3	63.1	62.4	60.3	62.9	62.2	62.9	62.1	64.4	63.4
Percent of women in total population	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.0	51.9	51.9
Percent of women in economically active population	49.3	50.0	50.1	50.8	50.4	51.0	51.5	49.1	49.5	49.4
Ration of women to men average wage in non-agricultural activities. (%)	…	…	…	70.0	66.9	66.8	68.5	64.1	69.3	70.1
GDP per capita USD at PPP	2,033	2,112	2,300	2,533	2,765	2,028	2,362	2,561	2,715	2,986
Gender Empowerment Measure (GEM)	0.422	0.413	0.475	0.512	0.524	0.555	0.556	0.557	0.557	0.557

Annex 3.4. Demographic profile

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Population. Entire country. January 1 (thousand people)	4,347.9	4,334.4	4,320.0	4,304.7	4,293.0	4,281.5	4,264.3	4,247.7	4,228.9	4,208.5	…	…	…	…
Population. Trans-Dniester region and Bender municipality not included (thousand people)	3,678.4	3,671.8	3,663.7	3,655	3,649.3	3,643.5	3,634.5	3,627.2	3,617.7	3,606.8	3,599.8	3,589.9*	3,581.1*	3,572.7*
Annual rate of population growth (%)	0.8	0.5	0.7	0.4	-0,7	-1,1	-1	-1,7	-1,8	-1	-1,9	-1.5	-1.4	-0.9
Birth rate (per 1,000 inhabitants)	13.0	12.0	12.5	11.3	10.6	10.2	10.0	9.9	10.1	10.6	10.5	10.5	10.6	10.9
Mortality rate (per 1,000 inhabitants)	12.2	11.5	11.8	10.9	11.3	11.3	11.0	11.6	11.9	11.6	12.4	12	12	11.8
Rate of natural increase (per 1,000 inhabitants)	0.8	0.5	0.7	0.4	-0.7	-1.1	-1	-1.7	-1.8	-1	-1.9	-1.5	-1.4	-0.9
Life expectancy at birth (years)	65.8	66.7	66.6	67.8	67.4	67.6	68.2	68.1	68.1	68.4	67.8	68.4	68.8	69.4
Marriage rate (per 1,000 inhabitants)	7.5	6.0	6.1	6.0	6.5	6.0	5.8	6.0	6.9	7.0	7.6	7.6	8.2	7.5
Likelihood of not surviving the age of 60 years (%)	…	…	…	…	…	…	12.2	13.0	13.0	13.4	13.6	12.5	11.0	10.4
Rate of divorce (per 1,000 inhabitants)	3.4	3.1	2.8	2.8	2.4	2.7	3.0	3.5	4.1	4.1	4.0	3.5	3.9	3.5
Infant mortality rate (per 1,000 newborns alive)	21.2	20.2	19.8	17.5	18.2	18.3	16.3	14.7	14.4	12.2	12.4	11.8	11.3	12.2
Mortality rate:														
0-4 years aged (per 1,000 newborns alive)	27.4	26.2	25.9	22.9	23.9	23.3	20.3	18.2	17.8	15.3	15.7	14.0	14.0	14.5
Maternal (per 100,000 newborns alive)	40.8	40.2	48.3	36.3	28.6	27.1	43.9	28.0	21.9	23.5	18.6	16.0	15.8	38.4
Share of underweighted newborns alive (%)	6.1	6.1	6.3	6.4	7.2	4.3	4.7	4.4	4.7	4.6	4.8	4.9	5.0	5.3
Conjectural rate of fertility	1.76	1.60	1.66	1.49	1.37	1.29	1.25	1.21	1.22	1.26	1.22	1.23	1.26	1.28
Number of abortions per 1 newborn alive	1.0	0.9	0.7	0.7	0.6	0.7	0.4	0.4	0.5	0.5	0.5	0.4	0.4	0.4
Share of population aged 0-15 years (%)	28.6	28.1	27.6	27.4	26.7	25.7	24.8	23.8	22.7	21.8	20.8	20.1	19.9	19.2
Share of population aged 65 years of age and above (%)	9.0	9.0	9.1	9.3	9.4	9.4	9.5	9.6	9.8	9.9	9.9	9.8	10.3	10.3
Demographic dependency ratio** (%)	60.1	59.1	57.9	58	56.3	54.1	47.6	45.6	43.9	42.1	40.6	39.2	39.8	38.7
Number of emigrants (thousand people)	5.4	4.7	5.5	4.8	6.3	9.1	6.4	6.6	7.4	7.2	6.8	6.7	7.2	7.0
Share of emigrants aged 20-34 years in total number of migrants	…	…	…	…	…	…	…	…	40.7	42.4	41.2	43.3	44.5	44.2

** Stable population.*

Annex 3.5. Health

	1995	1996	1997	1998	1999	2000	2001*	2002	2003	2004	2005	2006	2007	2008
Mortality rate (per 100,000 inhabitants) by causes:														
Circulatory system deceases	568.62	576.56	612.43	575.63	623.41	631.99	618.14	654.78	679.58	653.71	700.14	671.37	675.95	657.4
Tumours	131.81	134	130.9	131.89	127.36	126.55	129.94	134.72	138.53	141.54	145.75	153.41	152.62	157.4
Respiratory deceases	78.3	70.37	72.91	65.93	71.17	69.44	64.61	74.34	79.01	69.3	79.15	72.88	72.13	68.9
Infant mortality rate (per 1,000 newborns alive)	21.2	20.2	19.8	17.5	18.2	18.3	16.3	14.7	14.4	12.2	12.4	11.8	11.3	12.2
Maternal mortality rate (per 100,000 newborns alive)	40.8	40.2	48.3	36.3	28.6	27.1	43.9	28	21.9	23.5	18.6	16	15.8	38.4
New cases of active tuberculosis (per 100,000 inhabitants)	54.5	58.8	58.9	67.9	61.8	59.9	83.1	83.6	87.5	91.5	105.7	103.0	99.0	92.7
AIDS incidence (per 100,000 inhabitants)	0.05	0.02	0.2	0.1	0.1	0.1	0.2	0.5	1.0	1.0	2.0	2.4	5.3	2.3
Number of population per medical doctor	252	250	261	263	273	281	282	283	286	287	286	283	281	282
Number of population per medical assistant	96	100	102	105	119	124	131	132	135	129	139	130	129	130
Hospitals beds (per 1,000 inhabitants)	12.2	12.1	11.6	11.2	8.2	7.6	6.9	6.8	6.7	6.4	6.4	6.3	6.1	6.1
Public expenditures for health and social assistance. % of GDP	6.4	7.4	11.1	8.3	6.7	6.8	5.5	6.4	6.1	14.4	15.4	16.2	17.3	18.0
Persons in hospitals:														
total, thousand	939	858	831	786	647	585	533	586	610	588	593	598	615	636
per 100 inhabitants	21.6	19.8	19.3	18.3	15.1	13.7	14.7	16.2	16.9	16.3	16.5	16.7	17.2	17.8
Visits to medical doctors:														
total. thousand	35	36	36	36	25	23	23	25	23	20	22	22	22	22
per inhabitant	8.2	8.3	8.4	8.3	5.9	5.3	6.2	6.8	6.4	5.6	6.1	6	6.2	6.3
Number of private sanitary units:														
ambulatory or policlinic units providing medical assistance to the population	30	13	11	10	216	310	326	338	341	372	379	437	458	496
hospitals	-	-	1	4	5	8	10	15	9	12	13	11	10	10
medical offices	1	4	7	12	9	16	14	18	25	13	16	66	60	56
pharmacies	18	344	371	431	423	553	941	1,058	978	1,053	1,088	806	814	861

** Starting 2001, data are not including Trans-Dniester and Bender municipality.*

Annex 3.6. Formal education

	1995/ 1996	1996/ 1997	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009
Institutions, total	1,674	1,696	1,706	1,737	1,746	1,760	1,780	1,778	1,766	1,749	1,722	1,704	1,696	1,679
School population, thousand	766.5	778	786.5	788.1	770.9	753	746.7	738	726	709.4	697.2	675.4	641.5	608
Teaching personnel, thousand	57.1	55.3	55.2	54	53.1	51.9	52.2	51.1	52.4	51.2	51.6	51.2	49.5	48.1
Schools, gymnasiums, lyceums														
Day schools, gymnasiums, lyceums	1,515	1,530	1,536	1,549	1,558	1,566	1,577	1,580	1,576	1,570	1,551	1,539	1,534	1,519
Pupils, thousand	642.8	649.5	652.7	650.7	643.1	629.3	618.4	603.4	578.7	546.6	517	491.5	461	434.3
Teaching personnel, thousand	46.5	44.8	45	44.8	43.2	42.3	42.5	41.6	42.6	41	40.9	40	38.6	36.9
Evening schools	11	10	9	7	7	7	7	7	7	7	7	7	7	7
Pupils, thousand	3.1	2.9	2.7	2.5	2.1	1.9	1.9	1.8	1.8	1.9	2.0	2.0	1.8	1.8
Teaching personnel, thousand	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Institutions of secondary vocational education														
Number of educational institutions	78	81	80	87	81	80	82	83	83	81	78	78	75	75
Students, thousand	34.8	34	32.7	32.5	23	22.8	23	22.6	22.8	22.7	25	23.7	24.5	24.3
Teaching personnel, thousand	3.5	3.4	3.2	2.0	2.5	2.3	2.3	2.2	2.2	2.3	2.4	2.5	2.4	2.3
Colleges														
Number of colleges	50	51	53	56	57	60	67	63	60	56	51	49	49	47
Students, thousand	31	33.3	32.8	29.7	25.4	19.9	17.0	15.2	18.7	23.6	27.1	30.2	31.3	32.7
Teaching personnel, thousand	2.6	2.5	2.3	2.4	2.2	1.9	2.0	1.7	1.8	1.9	2.0	2.0	2.0	2.4
High education institutions														
Number of institutions	20	24	28	38	43	47	47	45	40	35	35	31	31	31
Students, thousand	54.8	58.3	65.6	72.7	77.3	79.1	86.4	95	104	114.6	126.1	128	122.9	114.9
Teaching personnel, thousand	4.3	4.4	4.6	4.7	5.1	5.3	5.3	5.5	5.7	5.9	6.2	6.6	6.4	6.4
Per 100,00 inhabitants														
School pupils	1,794	1,813	1,796	1,790	1,770	1,737	1,710	1,671	1,607	1,522	1,438	1,372	1,289	1,222
Students in vocational institutions	97	94	89	89	63	63	63	63	63	63	70	66	69	68
Students in colleges	86	93	90	81	70	55	47	42	52	65	75	84	88	92
Students in universities	152	162	180	199	212	217	238	262	288	318	351	357	344	322
Gross enrolment rate (%) in:														
preschool education (3 – 6 years)	…	…	50.5	49.4	44.1	44.1	47.6	57	61.1	66.1	69.7	70.1	72.6	74.4
primary education	98	99	98.8	100	100.1	99.4	99.5	99.5	99.8	97.9	93.7	94.4	94	93.6
lower secondary education	94	93	88.8	88.3	90.7	90.2	91.1	92.3	92.2	92.5	90.5	90.5	90.1	89.3
Public expenditures, as % of :														
GDP	8.9	10.3	9.9	7.0	4.7	4.5	4.9	5.5	5.4	6.8	7.2	8.1	8.0	8.2
Consolidated public budget	24.2	28.3	24.7	21.2	16.4	16.8	21.4	23.9	24.3	19.3	19.4	20.1	19.0	19.8

Annex 3.7. Population enrolment in education

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Rate of education young early leavers	17.4	20.7	22.8	23.6	22.6	21.8	22.6	23.6	21.0	20.1
Rate of youth education (%)	82.7	79.4	78.1	75.9	76.8	77.2	76.1	75.5	77.7	78.5
Rate of adult population education (%)	100	100	100	100	100	100	100	100	100	100
Low level education	19.8	20.4	20.2	20.4	19.5	18.6	18.8	18.4	18.3	17.4
Medium level education	67.8	67.0	66.8	66	66.3	66.4	66.3	64.0	65.1	65.6
High level education	12.4	12.6	13	13.6	14.2	15	14.8	17.6	16.6	17.0
Participation to lifelong education	0.5	0.4	0.4	0.5	0.5	0.4	0.5	0.9	0.82	0.85

Annex 3.8. Labour force employment

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Employed population (above 15 years of age), thousand people	1,495	1,515	1,499	1,505	1,356	1,316	1,319	1,257	1,247	1,251
- women	755	767	762	774	696	685	689	629	626	622
Rate of employment (%)	54.5	54.8	53.7	53.3	47.5	45.7	45.4	42.9	42.5	42.5
- women	51.8	52.2	51.4	51.7	46	44.9	44.8	40.5	40.5	40.1
Rate of employment of population aged 15-64 years (%)	59.4	59.6	58.5	57.7	52.3	50.2	49.7	47.1	47.1	47.3
- women	57.5	57.8	57.3	57.2	51.8	50.5	50.4	45.7	46.2	46
Youth employment rate (aged 15-24 years) (%)	32.8	30.6	27.9	26.8	20.1	18.1	17.7	18.9	17.7	18.5
- women	30.9	28.3	26.4	26.4	18.6	17.3	16.8	16.7	15.3	16.1
Share of population employed in private sector* (%)	66.8	69.9	71.1	71.6	68.8	68.1	67.9	66.2	67.1	69.7
Distribution of employed population by sectors (%):										
agriculture, total,	49.8	50.9	51.0	49.6	43.0	40.5	40.7	33.6	32.8	31.1
Including in private sector	90.7	93.2	96.2	98.4	98.5	98.2	98.0	96.9	97.6	98.2
manufacture, total,	10.7	10.6	11.0	11.4	12.1	12.3	12.1	12.8	12.7	13.1
Including in private sector	49.8	50.0	53.7	55.6	62.6	60.2	61.0	65.0	67.7	69.2
constructions, total,	2.9	2.9	2.9	3.1	3.9	4.0	3.9	5.4	6.1	6.6
Including in private sector	55.7	64.8	69.1	75.8	81.5	84.4	85.2	93.3	94.6	94.2
services, total,	37.6	35.2	35.1	35.9	41.0	43.3	43.3	48.2	48.5	49.3
Including in private sector	33.8	38.7	40.1	41.4	43.4	43.7	43.9	46.9	48.5	48.7
Share of population employed in public sectors (%):										
health	5.4	4.9	4.7	4.5	4.7	4.8	4.7	5.0	5.1	5.3
education	9.2	6.7	6.7	8.2	9.1	9.4	9.4	10.0	10.0	10.0
public administration	3.3	4.2	4.4	4.0	4.3	4.4	4.4	4.6	4.6	4.6
Number of wage-employed, thousand	932	951	899	892	868	841	831	843	832	850
Share of wage-employed in total employed population (%)	62.3	62.8	60.0	59.3	64.0	63.9	63.0	67.6	66.7	68.0
Share of wage-employed of private sector in total population employed in this sector (%)	48.7	45.6	43.7	43.4	49.2	48.0	46.8	51.9	52.3	54.1
Share of women in total wage-employed (%)	49.8	49.9	50	51.2	52.1	52.6	53.2	51.3	52.4	52.0
Share of population employed in informal sector (% of total employed)	…	…	…	…	14.5	12.7	12.1	10.0	10.4	10.9
Share of population informally employed (% of total employed)	…	…	…	…	38.0	34.6	33.4	35.1	33.6	31.1

Source: *Labour Force Survey. Statistical surveys of enterprises.*

** Private sector– according to the official Classificator of propriety.*

Annex 3.9. Labour participation

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Share of economically active population aged 15 years and above in total population of this age (%)	61.3	59.9	57.9	57.2	51.6	49.7	49.0	46.3	44.8	44.3
women	56.9	56.3	54.6	54.7	49.1	47.9	47.7	43.0	42.2	41.5
Rate of participation of population of age 15-64 years (%)	67.2	65.4	63.3	61.1	57.0	54.8	53.8	50.9	49.7	49.4
women	63.4	62.6	61.0	60.8	55.5	54.1	53.7	48.5	48.1	47.7
Rate of participation of youth (aged 15-24 years) (%)	42.2	36.4	33.3	31.6	24.6	22.6	21.8	22.8	20.7	20.8
women	37.8	33.2	30.7	30.2	22.4	21	20.5	19.8	17.7	18.4
Rate of labour participation of population above 50 years of age (%)	41.7	45.0	45.6	47.5	42.3	42.4	43.8	40.3	39.2	38.2
women	34.4	38.4	38.3	40.2	35.5	36.6	38.2	34.0	32.9	31.9
Structure of active population by professional status* (%)										
total	100	100	100	100	100	100	100	100	100	100
wage-employed	66.8	63.2	60.2	59.2	63.1	62.6	61.5	65.5	65.5	67.2
employers	0.5	0.5	0.5	0.7	0.6	0.6	0.6	0.9	0.9	1.0
self-employed	22.6	27.1	29.1	30.5	31.1	32.5	33.5	27.4	29.0	27.9
other categories	7.0	6.9	7.9	7.2	2.4	1.0	1.0	2.8	2.2	2.3
Economic dependency ratio (‰)	1443	1408	1428	1413	1671	1745	1733	1855	1871	1857
Labour replacement rate (%)	120.0	113.8	107.5	101.2	95.2	89.3	84.5	80.3	80.0	76.7

Source: *Labour Force Survey.*

** Classification of unemployed was made based on their professional status at the last job.*

There were not included the unemployed that never worked or stopped working 8 years ago.

Annex 3.10. Registered unemployment *

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of unemployed (persons)	24,543	23,426	27,973	32,021	34,918	28,873	27,646	24,019	19,666	21,018	21,717	20,358	18,898	17,833
Out of which, women	16,077	15,872	17,728	19,012	21,569	16,955	14,041	12,262	9,393	9,310	10,421	10,783	10,636	10,536
Unemployment rate (%)	1.4	1.5	1.5	1.9	2.1	2.1	2.0	1.9	2.0	1.8	2.0	1.9	1.9	1.6
Share of those receiving unemployment benefits in total registered unemployed (%)	32.5	29.8	26.7	25.2	32.6	23	19.7	14.6	9.5	5.1	6.7	9.3	10.5	11.6
Ratio of average unemployment benefit and average wage per economy (%)	37.9	34.2	37.3	31.7	33.2	29.4	24.6	24.6	19.2	23.1	38.9	28.0	26.6	26.1
Number of unemployed in retraining programs	2,139	3,356	3,506	4,244	2,640	3,532	1,482	3,470	2,008	2,461	2,142	2,428	2,046	2,250

Source: *National Agency for Labour Force Employment. End of year.*

Annex 3.11. Unemployment*

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of unemployed. (thousand persons)	187	140	118	110	117	116	104	100	67	52
Unemployment rate (%):										
total	11.1	8.5	7.3	6.8	7.9	8.1	7.3	7.4	5.1	4.0
men	13.3	9.7	8.7	8.1	9.6	10	8.7	8.9	6.3	4.6
women	8.9	7.2	5.9	5.5	6.4	6.3	6	5.7	3.9	3.4
Young unemployment rate (%) (15-24 years)	22.3	15.8	16.3	15.2	18.1	19.7	18.7	17.1	14.4	11.2
Share of young unemployed (15-24 years) in total unemployed (%)	31.8	26.4	30.2	29.2	26	26.5	27.5	27.3	30.5	30.2
Share of young unemployed (15-24 years) in total young population (%)	9.4	5.8	5.4	4.8	4.5	4.4	4.1	3.9	3.0	2.3
Incidence of long-term unemployment (share in total unemployed) (%):										
6 months and more	92.0	91.8	73.7	71.2	61.7	60.5	62.6	54.8	52.3	47.1
men	92.1	92.7	72.8	70.7	62.4	61.0	60.4	54.4	51.0	42.1
women	91.8	90.5	75.1	72.0	60.7	59.8	65.6	55.4	54.5	53.9
12 month and more	74.2	77.8	58.0	59.6	48.3	44.8	48.9	38.1	35.5	31.3
men	74.8	80.7	57.9	59.5	49.5	44.9	48.5	39.6	34.4	27.8
women	73.2	74.0	58.2	59.8	46.6	44.7	49.4	35.7	37.4	36.0
24 months and more	41.1	48.2	38.8	39.9	34.4	29.8	30.3	25.0	20.8	17.7
men	41.9	51.2	40.5	41.2	35.0	29.2	30.1	24.8	20.5	15.7
women	39.9	44.1	36.4	38.0	33.4	30.7	30.7	25.2	21.4	20.5
Incidence of youth long-term unemployment (share in total young unemployment) (%)										
6 months and more	62.4	61.4	58.1	59.3	45.3	48	50.6	46.2	35.2	30.3
men	63.9	67.6	60.1	59.2	47.7	48.8	50.2	48.1	37.7	24.2
women	59.9	53.0	55.0	59.4	42.0	46.8	51.2	43.3	31.6	36.8
Share of underemployed population in total active population (%)	0.4	5.5	5.5	5.4	3.8	3.3	3.7	7.8	7.6	6.7
women	0.5	5.1	5.2	5	3.5	3.2	3.5	7.4	7.1	6.4
Share of discouraged population in total active population (%)	5	5.5	5.9	4.8	5.1	5.7	5	4.3	2	1.4
women	4.7	5.2	6.1	4.7	5.2	5.5	4.7	4.2	1.9	1.3

Source: *Labour Force Survey.*

** - According to the International Labour Organisation definition.*

Annex 3.12. Female human potential

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Life expectancy at birth (years)	69.7	70.4	70.3	71.4	71.0	71.2	71.7	71.7	71.6	72.2	71.7	72.2	72.6	73.2
Year 1994 = 100%	99.9	100.9	100.7	102.3	101.7	102.0	102.7	102.7	102.6	103.4	102.7	103.5	104.0	104.8
Conjectural rate of fertility	1.76	1.60	1.66	1.49	1.37	1.29	1.25	1.21	1.22	1.26	1.22	1.23	1.25	1.28
Year 1994 = 100%	90.3	82.1	85.1	76.4	70.3	66.2	64.1	62.1	62.6	64.6	62.6	63.1	64.1	65.6
Maternal mortality rate (per 100,000 newborns alive)	40.8	40.2	48.3	36.3	28.6	27.1	43.9	28.0	21.9	23.5	18.6	16.0	15.8	38.4
Gross enrolment ratio (%):														
Primary	97.0	98.9	98.0	99.8	99.6	99.4	99.2	99.3	99.6	97.2	96.1	93.6	93.0	92.7
Lower secondary	93.8	92.2	88.9	88.0	91.0	90.7	91.7	92.9	92.9	92.5	93.4	90.1	89.8	88.8
Evolution of the gross rate of enrolment (1994=100%):														
Primary	100	102	101	103	103	102	102	102	103	100	99	96	96	96.0
Lower secondary	101	99	96	95	98	98	99	100	100	99	100	97	97	96.0
Students per 100,000 inhabitants (women)*:														
Number	1,595	1,702	1,894	2,102	2,280	2,349	2,619	2,859	3,196	3,638	3,903	3,987	3,901	3,583.0
1994 = 100%	111	118	132	146	158	163	182	199	222	253	271	277	271	249.0
Adult women illiterate rate. %	4.1	3.9	3.6	3.4	3.1	2.9	2.6	2.4	2.1	1.7	1.4	1.6	1.5	1.5

** High education.*

Annex 3.13. Disparities between men and women

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Life expectancy at birth (years)	65.8	66.7	66.6	67.8	67.4	67.6	68.2	68.1	68.1	68.4	67.8	68.4	68.8	69.4
Women	69.7	70.4	70.3	71.4	71.0	71.2	71.7	71.7	71.6	72.2	71.7	72.2	72.6	73.2
Men	61.8	62.9	62.9	64.0	63.7	63.9	64.5	64.4	64.5	64.5	63.8	64.6	65.1	65.6
Gross rate of enrolment in lower secondary education (gymnasium) (%):														
Women	93.8	92.2	88.9	88.0	91.0	90.7	91.7	92.9	92.9	92.5	93.4	90.1	89.8	88.8
Men	92.6	92.8	88.6	88.5	90.5	89.7	90.5	91.6	91.5	92.5	92.5	90.9	90.3	89.8
Unemployment rate (%):														
Women	…	…	…	…	13.3	9.7	8.7	8.1	9.6	10.0	8.7	5.7	3.9	3.4
Men	…	…	…	…	8.9	7.2	5.9	5.5	6.4	6.3	6.0	8.9	6.3	4.6
Average wage in non-agricultural activities. September (Moldovan lei)														
Women	…	…	…	…	…	…	…	679	833	998	1,191	1,529	1,859	2,134
Men	…	…	…	…	…	….	…	969	1,245	1,495	1,739	2,383	2,384	2,910

Annex 3.14. Structure of disposable income by categories of households

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Income from wage												
Total households	36.4	34.7	35.4	37.3	37.8	37.0	37.3	40.5	43.7	41.6	41.4	42.9
Households with:												
Employed	48.5	47.0	48.6	54.0	56.1	58.5	59.3	62.9	67.0	66.7	68.4	69.2
Farmers	11.3	10.0	10.5	10.3	14.8	8.6	8.8	11.2	12.2	14.1	14.5	17.7
Pensioners	9.9	7.7	6.3	5.7	6.9	5.7	6.5	8.3	9.5	14.7	14.8	17.8
Others	22.6	12.5	8.8	7.0	11.4	8.9	6.9	3.3	7.5	12.9	8.4	7.7
Income from individual agricultural activity												
Total households	35.6	39.4	38.5	34.5	31.9	29.9	28.9	23.1	20.2	18.6	15.1	10.5
Households with:												
Employed	30.2	32.6	30.7	25.5	22.4	19.3	16.3	12.5	10.4	11.1	9.1	6.3
Farmers	75.2	76.5	76.5	72.5	65.2	70.1	70.8	63.0	62.0	46.1	35.4	31.9
Pensioners	42.0	49.5	50.0	44.3	38.6	34.0	34.2	26.9	23.3	24.3	21.2	14.1
Others	15.9	24.4	14.5	8.7	7.1	4.6	4.0	2.6	2.0	8.8	7.2	5.7
Income from individual non-agricultural activity												
Total households	4.6	3.7	3.7	3.2	3	2.7	4.5	4.2	3.2	7.8	6.4	7.5
Households with:												
Employed	5.2	4.6	4.9	4.5	4.3	4.3	6.8	6.0	5.1	3.4	2.2	3.1
Farmers	3.7	2.1	1.2	0.7	1.6	1.1	0.9	0.8	0.1	2.1	1.6	3.5
Pensioners	2.5	1.6	0.8	1.1	0.7	0.8	1.4	1.8	0.7	2.3	2.2	2.6
Others	14.7	1.9	5.1	0.3	1.0	0.5	3.0	4.7	1.7	40.7	33.5	32.8
Social transfers												
Total households	10.4	10.1	8.3	9.6	10.9	14.1	14.0	15.2	18.0	13.2	13.6	14.9
Households with:												
Employed	3.5	4.1	3.2	2.7	3.5	4.3	4.8	4.8	4.8	5.0	5.1	5.7
Farmers	3.1	5.5	3.9	3.9	4.8	6.0	5.2	7.5	7.7	9.3	9.5	5.4
Pensioners	31.5	29.2	25.7	29.9	33.9	38.9	43.0	47.3	55.0	43.2	44.6	46.6
Others	4.1	6.7	2.7	1.8	2.4	2.2	2.4	2.6	3.5	4.2	3.3	3.6
Other income												
Total households	13	12.2	14.2	15.3	15.9	16.3	15.3	17.1	14.8	18.9	23.5	24.2
Households with:												
Employed	12.5	11.7	12.6	13.3	13.8	13.7	12.9	13.9	12.7	13.9	15.2	15.4
Farmers	6.8	5.9	7.8	12.6	13.6	14.2	14.3	17.4	18.0	28.4	39.0	41.2
Pensioners	14.1	12.0	17.1	19.0	20.0	20.6	15.0	15.7	11.5	15.6	17.2	18.8
Others	42.8	54.5	68.9	82.2	78.0	87.1	83.8	86.7	85.4	33.4	47.7	49.7

Annex 3.15. Structure of consumption expenditure by categories of households

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Food and alcoholic beverages												
Total households	67.9	69.7	68.9	67.5	64.2	62.0	60.0	59.5	56.9	47.1	46.4	42.1
Households with:												
Employed	65.2	67.2	66.0	62.9	59.8	57.3	54.1	54.1	51.7	43.9	44.0	39.5
Farmers	77.4	75.6	79.4	76.0	70.8	69.8	69.8	69.3	67.4	53.6	51.1	45.5
Pensioners	73.3	75.3	76.5	77.2	72.0	69.4	68.8	67.5	64.4	54.2	52.2	47.8
Others	59.5	68.3	49.7	59.5	53.1	47.1	39.4	43.0	35.4	40.0	40.1	38.2
Clothes and footwear												
Total households	9.3	7.1	6.6	7.3	7.6	8.2	8.4	8.1	7.9	11.9	12.0	12.7
Households with:												
Employed	10.9	8.5	8.3	8.8	9.0	9.9	10.5	9.8	10.0	12.6	12.5	13.6
Farmers	7.2	8.7	5.0	7.6	7.8	8.0	7.1	7.5	6.8	12.2	13.4	14.4
Pensioners	5.1	2.9	2.6	2.5	3.9	4.3	3.9	4.0	4.2	8.3	8.7	9.5
Others	14.3	4.9	4.6	9.1	10.3	8.1	16.1	11.0	7.7	14.4	13.7	14.1
Housing and house maintaining												
Total households	11.4	9.9	11.8	12.1	13.5	14.8	15.3	15.4	17.2	18.4	18.3	21.1
Households with:												
Employed	11.7	10.3	12.2	12.8	14.0	15.0	16.5	16.0	17.6	16.9	17.4	18.6
Farmers	8.4	7.5	6.9	8.4	11.8	12.6	12.5	12.7	14.3	19.0	19.8	23.5
Pensioners	11.7	9.6	11.3	12.2	12.8	15.2	15.2	15.6	18.8	19.2	19.4	24.1
Others	9.3	9.9	20.7	10.8	18.0	19.3	11.6	17.8	15.1	20.9	18.2	22.4
Medical care and health												
Total households	3.0	3.3	3.7	3.3	3.9	4.0	4.4	3.9	3.6	5.3	5.4	5.6
Households with:												
Employed	2.6	2.9	3.1	3.2	3.6	3.6	3.7	3.5	3.4	4.8	4.4	4.9
Farmers	0.9	2.0	3.0	1.9	2.7	3.3	2.8	2.3	2.4	4.4	5.1	4.6
Pensioners	4.4	4.9	5.0	4.3	5.4	6.0	7.0	5.6	5.4	8.1	8.3	7.9
Others	3.0	4.9	9.7	3.0	4.2	3.0	4.8	5.3	2.3	3.7	4.5	4.6
Transport and telecommunications												
Total households	4.4	5.1	4.4	5.0	5.2	4.9	5.3	6.3	7.2	9.0	9.2	9.8
Households with:												
Employed	4.8	5.5	5.1	6.3	6.1	6.3	6.8	7.6	8.0	11.0	10.5	11.8
Farmers	3.7	2.7	2.7	3.1	3.7	3.4	3.3	5.3	5.7	6.2	6.3	7.7
Pensioners	3.3	4.6	2.1	2.2	3.4	2.5	2.9	3.6	3.5	5.4	6.8	5.9
Others	7.8	5.9	8.7	8.5	7.9	8.7	10.2	9.5	24.2	11.0	11.8	11.2
Agreement and education												
Total households	1.8	2.1	1.9	2.4	3.1	2.6	3.3	3.5	3.2	2.4	2.5	2.5
Households with:												
Employed	2.4	2.5	2.3	3.1	3.9	3.4	4.1	4.9	4.0	3.4	3.0	3.3
Farmers	1.6	1.9	1.7	1.2	1.4	1.5	2.9	1.1	1.7	1.2	1.3	1.2
Pensioners	0.6	1.0	0.6	0.4	1.1	0.9	0.7	1.9	1.2	1.2	1.5	1.6
Others	1.8	2.4	2.7	5.2	2.2	6.8	12.3	6.8	9.3	2.7	3.2	2.6
Diverse												
Total households	2.2	2.7	2.7	2.7	2.4	3.5	3.3	3.3	4.0	5.9	6.2	6.2
Households with:												
Employed	2.5	3.1	3.1	2.9	3.5	4.7	4.3	4.2	5.3	7.4	8.2	8.3
Farmers	0.9	1.8	1.4	1.9	1.9	1.5	1.6	1.7	1.7	3.4	3.1	3.2
Pensioners	1.5	1.7	1.8	1.2	1.5	1.8	1.6	1.9	2.7	3.6	3.1	3.3
Others	4.4	3.6	4.0	4.0	4.3	7.0	5.5	6.7	6.0	7.3	8.1	6.9

Annex 3.16. Structure of disposable income by quintiles and residence

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Income from wage												
Total population												
Quintile I	27.6	20.2	22.0	29.5	30.4	27.1	35.9	40.0	36.0	34.7	35.0	35.3
Quintile V	42.5	43.1	43.5	46.8	47.1	44.5	41.5	46.1	50.8	44.9	47.5	49.4
Urban area												
Quintile I	49.0	52.3	46.4	52.9	54.4	59.3	57.7	68.9	70.9	49.4	54.2	48.2
Quintile V	60.5	58.9	59.0	62.4	63.6	60.6	55.8	56.9	63.1	57.0	58.6	59.5
Rural area												
Quintile I	20.9	12.2	14.4	15.1	18.9	16.0	26.0	28.7	23.2	27.2	27.2	31.6
Quintile V	18.9	20.2	15.1	21.0	24.7	20.8	22.1	25.1	24.0	25.3	27.9	27.1
Income from individual agricultural activity												
Total population												
Quintile I	50.3	59.8	59.5	42.1	40.3	42.0	35.2	32.7	31.4	25.2	23.8	17.9
Quintile V	25.4	26.3	23.9	22.1	21.1	20.3	20.1	11.9	11.2	12.4	8.7	4.4
Urban area												
Quintile I	9.0	14.4	19.8	16.0	8.8	7.3	5.5	4.5	4.1	3.8	3.8	2.5
Quintile V	4.2	4.4	3.2	2.5	1.9	1.5	1.5	1.2	1.0	1.6	1.2	0.7
Rural area												
Quintile I	63.1	71.2	71.8	58.2	55.3	54.0	48.6	43.8	41.4	36.0	32.0	22.3
Quintile V	53.1	57.8	61.5	54.7	47.0	48.0	45.3	32.8	33.6	29.8	21.9	12.7
Income from individual non-agricultural activity												
Total population												
Quintile I	2.1	0.9	1.3	0.9	1.0	1.2	0.9	1.0	0.6	4.7	4.7	6.7
Quintile V	6.0	5.6	5.9	5.5	3.7	3.7	6.7	7.2	4.6	10.7	6.9	7.9
Urban area												
Quintile I	5.7	2.4	3.7	2.1	1.7	3.1	2.0	3.2	2.7	7.0	8.2	7.5
Quintile V	7.5	7.9	7.5	7.1	4.2	4.6	9.7	7.5	4.7	12.0	7.7	7.4
Rural area												
Quintile I	1.0	0.6	0.6	0.1	0.7	0.5	0.4	0.2	0.0	3.6	3.3	6.4
Quintile V	4.2	2.2	2.9	2.8	2.9	2.2	2.5	6.4	4.3	8.6	5.3	9.0
Social transfers												
Total population												
Quintile I	11.7	9.6	7.4	12.9	18.7	18.4	20.3	20.9	26.3	22.6	21.5	22.4
Quintile V	8.5	9.7	7.9	6.0	6.0	7.8	8.2	8.0	9.8	7.6	8.4	9.4
Urban area												
Quintile I	21.6	14.4	15.1	15.9	22.6	21.1	23.3	17.0	17.0	27.3	20.6	24.2
Quintile V	7.2	8.3	7.7	4.6	5.0	7.3	6.8	7.0	8.3	7.0	7.5	9.6
Rural area												
Quintile I	8.6	8.4	5.0	11.0	16.8	17.4	18.9	22.4	29.6	20.2	21.8	21.8
Quintile V	10.2	11.8	8.1	8.3	7.3	8.6	10.1	10.0	13.0	8.7	10.1	8.9
Other income												
Total population												
Quintile I	8.4	9.5	9.8	14.6	9.7	11.3	7.8	5.4	5.8	12.8	15.0	17.8
Quintile V	17.6	15.4	18.9	19.7	22.2	23.7	23.5	26.9	23.6	24.4	28.5	28.9
Urban area												
Quintile I	14.7	16.6	15.0	13.1	12.6	9.2	11.6	6.4	5.4	12.5	13.1	17.6
Quintile V	20.6	20.5	22.5	23.5	25.3	26.1	26.2	27.5	22.9	22.5	25.0	22.9
Rural area												
Quintile I	6.4	7.7	8.2	15.6	8.4	12.1	6.1	5.0	6.0	13.0	15.8	17.9
Quintile V	13.6	8.0	12.4	13.3	18.1	20.3	19.9	25.7	25.1	27.6	34.8	42.3

Annex 3.17. Structure of consumption expenditures by quintiles and residence

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Food and alcoholic beverages												
Total population												
Quintile I	88.1	90.7	89.7	87.7	85.1	81.9	80.4	81.7	80.7	60.4	58.2	55.5
Quintile V	56.3	56.4	54.8	53.1	49.3	48.5	44.8	44.9	41.9	38.7	38.4	32.2
Urban area												
Quintile I	85	86.9	86.8	83.9	83.2	76.1	73.7	75.1	71.8	54.4	53.6	51.1
Quintile V	49.7	51	49.1	46.8	44.5	43.3	40.9	41.7	40.5	35.6	37.4	32.6
Rural area												
Quintile I	89	91.7	90.6	89.7	86	83.8	83	83.9	83.1	63	59.9	56.7
Quintile V	65	63.9	65.6	63.8	55.1	55.5	49.4	50	44.7	43.2	39.8	31.4
Clothes and footwear												
Total population												
Quintile I	2.9	1.9	1.5	1.5	1.8	2.5	2.1	1.8	1.8	9.1	11.1	11.2
Quintile V	12.3	10.5	9.9	11.4	11.1	12	12.6	11.8	11.2	12.5	11.8	12.6
Urban area												
Quintile I	2.8	1.7	1	1.7	1.6	2.2	1.9	1.6	1.5	6.6	8.1	7.9
Quintile V	14.8	12.3	10.2	12.6	11.8	12.2	13.2	12.3	12.7	12.9	11.9	12.3
Rural area												
Quintile I	2.9	1.9	1.7	1.5	1.9	2.6	2.1	1.9	1.9	10.2	12.1	12.1
Quintile V	9	8.1	9.3	9.4	10.3	11.8	11.9	11	8.4	11.9	11.6	12.9
Housing and house maintenance												
Total population												
Quintile I	5.1	3.9	5.5	6.7	8.4	9.7	10.4	10.1	10.7	17.9	17.9	19.7
Quintile V	15.5	13.1	16.5	15.8	17.3	18.2	19.5	19	21.1	19.8	19.8	24.1
Urban area												
Quintile I	5.8	5.1	7	8.6	9.6	13.2	14.5	14.2	16.8	21.8	21.1	24.3
Quintile V	15.3	15.4	18.6	15.5	17.6	18.1	19	18.2	17.3	17.8	16	19.6
Rural area												
Quintile I	4.9	3.6	5	5.8	7.8	8.6	8.7	8.7	9.1	13.2	16.8	18.5
Quintile V	15.7	9.9	12.3	16.2	16.8	18.3	20	20.4	28.1	22.5	25.6	32.4
Medical care and health												
Total population												
Quintile I	1.4	1	1	1.1	1.5	1.6	2	1.1	1.4	4	3.5	3.5
Quintile V	3.9	4.4	5.4	4.6	5.8	5.2	5.9	5	4.6	5.8	6.1	6.4

Urban area												
Quintile I	1.9	1.9	1.5	1.8	1.4	1.5	2.2	1.1	2.3	5.2	3.9	4.9
Quintile V	4.5	4.6	5.7	5.1	5.1	5	5.5	5	3.9	5.6	6	6.3
Rural area												
Quintile I	1.2	0.7	0.8	0.8	1.6	1.7	1.9	1.1	1.2	3.4	3.3	3.1
Quintile V	3.1	4.2	4.7	3.6	6.6	5.6	6.5	5	5.9	6	6.2	6.4
Transport and telecommunications												
Total population												
Quintile I	1.1	1.3	1	1.5	1.5	1.9	2.6	3.1	3.1	4.6	5.2	6.1
Quintile V	6.2	8	6.4	7.5	7.6	6.5	7	8.3	9.7	11.7	11.8	12
Urban area												
Quintile I	2	2.1	1.4	2.2	2.2	3.8	3.8	4.6	3.7	6.4	7.6	6.5
Quintile V	8	6.9	7.9	9.5	8	8	8.2	9.3	10.9	13.3	13.4	13.1
Rural area												
Quintile I	0.8	1.1	0.9	1.1	1.2	1.3	2.1	2.6	3	3.8	4.4	6
Quintile V	3.7	9.5	3.7	4.2	7	4.5	5.5	6.6	7.3	9.6	9.3	10
Agreement and education												
Total population												
Quintile I	0.5	0.4	0.4	0.5	0.6	0.8	1.2	0.8	0.7	1.2	1	0.9
Quintile V	2.8	3.6	3.2	4.1	4.8	4.2	5.6	6.3	5.4	3.5	3.7	4.1
Urban area												
Quintile I	0.9	0.9	0.7	0.6	0.8	1	1.8	1.5	1.2	2.1	1.8	1.6
Quintile V	3.2	4.5	3.7	5.9	7.1	6	6.6	7.1	6.3	4.6	4.4	5
Rural area												
Quintile I	0.3	0.2	0.3	0.5	0.6	0.7	0.9	0.6	0.5	0.7	0.7	0.7
Quintile V	2.3	2.3	2.1	0.9	2	1.8	4.5	5.1	3.6	1.9	2.6	2.2
Diverse												
Total population												
Quintile I	1	0.9	1	0.9	1	1.6	1.5	1.5	1.6	2.9	7.8	3.1
Quintile V	3.1	4	3.9	3.7	4.2	5.4	4.6	4.8	6.2	8	8.5	8.7
Urban area												
Quintile I	1.6	1.4	1.6	1.4	1.3	2.3	2.1	2	2.6	3.4	3.9	3.7
Quintile V	4.4	5.3	4.8	4.7	5.9	7.4	6.7	6.5	8.4	10.2	10.9	11
Rural area												
Quintile I	0.8	0.7	0.7	0.7	0.9	1.4	1.2	1.3	1.3	2.7	2.7	2.9
Quintile V	1.3	2.1	2.3	2	2.2	2.6	2.2	1.9	2	4.8	4.9	4.4

Annex 3.18. GDP by production and use

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GDP (million MDL, current prices)	6,480	7,798	8,917	9,122	12,322	16,020	19,052	22,556	27,619	32,032	37,652	44,754	53,430	62,840
Share in GDP of the added value derived in (%):														
agriculture	29.3	27.5	26	25.8	24.9	25.4	22.4	21.0	18.3	17.6	16.4	14.5	10.0	8.9
manufacture and constructions	28.5	26.9	25	19.9	20.3	19.0	21.8	20.2	20.5	20.5	19.1	18.7	19.1	19.5
services	33.1	37.9	38.8	43.8	49.7	45.5	46.1	48.1	48.7	50.1	50.5	52.8	56.3	56.3
Share in GDP of:														
final consumption, total	82.9	94.3	97.4	100.9	90.0	103.1	101.1	103.3	110.3	103.9	109.9	113.9	113.5	113.8
households	55.8	67.2	67.5	75.4	74.2	87.6	86.0	82.0	89.5	87.8	92.2	92.4	92.1	92.2
public administration	25.9	26.0	28.8	24.7	15.3	14.7	14.4	20.3	19.7	14.9	16.4	20.0	19.9	20.3
private administration	1.2	1.1	1.1	0.8	0.5	0.8	0.7	1	1.1	1.2	1.3	1.5	1.5	1.3
gross fixed capital formation	16.0	19.8	19.9	22.1	18.4	15.4	16.7	16.3	18.6	21.2	24.6	28.3	34.1	34.1
exports	60.1	55.3	53.2	45.0	52.3	49.6	50.1	52.5	53.3	51.2	51.2	45.3	45.6	40.7
imports	67.9	73.9	74.4	71.8	65.2	76.6	74.4	77.4	86.8	81.5	91.9	91.9	97.2	91.5
Gross savings, million Moldovan lei	1,206	1,031	930	513	2,385	2,106	3,223	3,617	4,624	7,612	8,564	9,333	11,611	
Total revenue of the National Public Budget*, million MDL	2,002	2,074	2,942	2,722	3,100	4,102	4,325	5,084	6,620	11,408	14,528	17,827	22,292	25,517
Total expenditures of the state budget**, million MDL	1,409	1,472	2,725	2,322	2,853	3,364	2,938	3,556	4,255	6,652**	8,482**	11,019**	14,257**	16,466
Share of private sector in GDP (%)	56	58	56	53	56	60	57	51	51	49	50	51	51	…

** - 1995-2003 Consolidate Budget (state + local administration).*

*** - all components (core resources. special means. special funds. investment projects).*

Annex 3.19. Social revenues, consumption and expenditures

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
GDP per capita														
MDL, current prices	1,798	2,167	2,441	2,498	3,379	4,402	5,247	6,227	7,646	8,890	10,475	12,483	14,937	17,602
USD, PPP	2,105	2,128	2,207	2,087	2,033	2,112	2,300	2,533	2,765	2,028	2,362	2,561	2,715	2,986
Share in GDP of the households disposable income (%)	69	70	69	65	67	74	77	83	90	92	94	95	89	…
Average nominal monthly wage, Moldovan lei:	143.2	187.1	219.8	250.4	304.6	407.9	543.7	691.5	890.8	1,103.1	13,18.7	1,697.1	2,065	2,529.7
public propriety	150.3	203	234.4	263.9	297.6	380.3	506.2	663.8	856.6	1048.7	12,56.4	1,658.8	1,949.2	2,387.8
private propriety	122.4	151	174.3	194.4	256.6	374.1	467	585.3	740.3	949.6	1,141	1,445.6	1,840.5	2,278.5
mixed propriety (public and private)	207.8	280.9	354.8	432.7	525.1	692	817.6	993.8	1,360.8	1,699.8	1,855.5	2,247.3	2,691.2	3,163.1
mixed propriety (with foreign capital)	238.2	342.7	361.3	572.7	763.4	864.8	1,061.6	1,295.4	1,599.2	1,863.6	2,190.8	2,597.9	3,300.6	3,867.1
Index of real wage (%):														
1998=100%					87.3	89.1	108.3	131	151.1	166.5	177.9	203.2	220	239.1
Previous year=100%	101.7	105.6	105	105.6	87.8	102.3	121.2	120.9	115.4	110.1	106.8	114.2	108.4	108.7
Minimal wage (Moldovan lei)	18	18	18	18	18	18	100	100	100	100	200	200	400	400
Share of public expenditures for law enforcement, as % of:														
GDP	3.6	4.8	5.5	4.7	4.3	4.1	4	4.7	4.4	5.1	5.2	5.4	5.7	5.5
National Public Budget*	9.8	13.2	13.6	14.2	15	15.5	17.6	20.3	19.5	14.5*	14.1*	13.5*	13.6*	13.2
Share of public expenditures for education, as % of:														
GDP	8.9	10.3	9.9	7	4.7	4.5	4.9	5.5	5.4	6.8	7.2	8.1	8.0	8.2
National Public Budget*	24.2	28.3	24.7	21.2	16.4	16.8	21.4	23.9	24.3	19.3*	19.3*	20.1	19.0	19.8
Share of public expenditures for health care and social assistance, as % of:														
GDP	6.4	7.4	11.1	8.3	6.7	6.8	5.5	6.4	6.1	14.4	15.4	16.2	17.3	18.0
National Public Budget*	17.6	20.3	27.5	24.9	23.6	25.4	24.2	27.7	27.2	41	41.7	40.4	41.2	43.2
Annual average consumption per inhabitant, (kg):														
Food and products thereof	23	25.3	25	26.7	24.5	23.6	24	26.6	26.5	31.6	40.4	38.3	36	…
Milk and dairy	165.2	161.4	154.5	155.4	145	152.8	154.6	167.3	164.4	166.2	173.9	177.3	175.4	…
Eggs, items,	107	116	121	122	132	133	139	158	158	162	177	168	177	…
Bakery	135	126.9	134.9	133.9	133.1	133.9	139.4	140.6	132.8	145.5	141.9	136.2	119	…
Potatoes	67.8	71	68.8	65.1	61.5	53.4	65.4	67.7	69.2	62.9	74.9	87.6	58.8	…
Vegetables	86.3	64.8	69	112.5	109	83.1	103.5	99.4	106.6	88.1	101.1	131.9	75.8	…
Fruits	59.7	59.3	77.5	47.7	27.2	31.8	33	38	43	38.4	37.1	38.8	27.9	…

** - 1995-2003 Consolidate Budget (state + local administration).*

Annex 3.20. Evolution of economic results

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Annual GDP growth rate (%)	98.6	94.1	101.6	93.5	96.6	102.1	106.1	107.8	106.6	107.4	107.5	104.8	103.0	107.2
Annual GDP per capita growth rate (%)	98.8	94.2	100.1	93.5	96.8	102.3	106.4	108.1	106.9	107.6	107.8	105.1	103.2	107.4
Annual average inflation rate (%)	30	24	12	8	39	31	10	5	11.6	12.4	11.9	12.7	12.3	12.7
Exports, % of GDP	60.1	55.3	53.2	45	52.3	49.6	50.1	52.5	53.3	51.2	51.2	45.3	45.6	40.7
Public budget revenues*, % of GDP	30.9	26.6	33	29.8	25.2	25.6	22.7	22.5	24	35.6	38.6	39.8	41.7	40.6
Public budget balance*, % of GDP	-5.8	-9.7	-7.5	-3.4	-3.2	-1	0	-0.5	1.6	0.5	1.5	-0.3	-0.2	-1.0

** - 1995-2003 Consolidate Budget (state + local administration).*

Annex 3.21. Revenues and expenditures of the National Public Budget*

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Revenues, total, million MDL	2,002.0	2,074.2	2,941.7	2,721.9	3,100.3	4,102.4	4,324.8	5,084.4	6,620.5	11,407.6	14,527.7	17,827.2	22,292.0	25,516.9
Share in total revenues, %:	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Corporate profit tax rate	19.9	17.3	8.3	6.6	7.5	6.7	8.1	8.4	8.7	6.8	6	6.1	6.2	2.8
Physical persons income tax rate	10.1	10.6	9.6	8.2	7.1	6.4	8	9.2	9.4	7	5.5	6.3	5.9	5.8
Land tax	4.6	5.6	4.3	3.1	4.5	3.9	3.8	3.7	2.5	1.7	1.3	1.1	0.8	0.8
Real estate tax	0.6	0.7	1	0.8	0.8	0.7	0.6	0.6	0.5	0.3	0.3	0.2	0.2	0.3
VAT	28.8	29.6	32.3	41.3	30.3	32.7	34.6	40	42.2	30	31.8	34.7	34.0	35.6
Excises	9.5	9.5	13.6	13.8	14.3	16	15.7	12.9	13.4	18	8.1	6	6.3	6.2
External economic activity revenues	2.6	4.6	4.3	4	7.4	5.6	5.4	6.6	7.2	4.3	4.7	4.7	4.1	4.5
Other	23.9	22.1	26.6	22.2	28.1	28	23.8	18.6	16.1	41.9	42.3	40.9	42.5	44.0
Share of total revenues in GDP, %	30.9	26.6	33	29.8	25.2	25.6	22.7	22.5	24	35.6	38.6	39.8	41.7	40.6
Expenditures, total, million MDL	2,376	2,827	3,608.4	3,027.1	3,495.3	4,268.8	4,325.8	5,194.1	6,183.4	11,256	13,949.3	17,973.9	22,415.6	26,146.9
Share in total expenditures, %:	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Economic expenditures	6.8	8.7	8.1	9.3	8.8	8.6	7.4	8	8.5	12	14.1	15.1	16.7	13.4
External economic activities expenditures	4.7	…	1.1	1.2	1.6	1.6	1.8	1.9	2	1.4	1.8	1.3	1.3	1.0
Social expenditures, total,	47.6	54.9	55.4	48.8	42.5	44.2	47.7	54.2	54.2	62.6	63.3	63.3	62.6	65.4
Including:														
Education	24.2	28.3	24.7	21.2	16.4	16.8	21.4	23.9	24.2	19.3	19.3	20.1	19.0	19.8
Health care	15.8	18.4	14.9	13	10.2	11.1	12.5	15.2	15.1	11.9	11.3	11.8	11.7	13.0
Social assistance	1.8	1.9	12.6	11.9	13.3	14.4	11.7	12.4	12	29	30.4	28.7	29.4	30.2
Expenditures for law enforcement bodies and public administration	9.8	13.2	13.6	14.2	15	15.5	17.6	20.3	19.5	14.5	14.1	13.5	13.6	13.2
Other expenditures	31.1	23.2	21.8	26.5	32.1	30.1	25.5	15.6	15.8	9.5	6.7	6.8	5.8	7.0
Share of total expenditures in GDP, %	36.7	36.2	40.5	33.2	28.6	26.6	22.7	23	22.4	35.1	37	40.2	42.0	41.6
Surplus (+), deficit (-) (million MDL	-374	-752.8	-666.7	-305.2	-395	-166.4	-1	-109.7	437.1	151.6	578.4	-146.7	-123.6	-630.0
As % of GDP	-5.8	-9.6	-7.5	-3.3	-3.2	-1	0	-0.5	1.6	0.5	1.5	-0.3	-0.2	-1.0

** - 1995-2003 Consolidate Budget (state + local administration).*

Annex 3.22. Rural / urban disparities

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Share of rural population, %, entire country	53.6	53.8	53.8	53.8	54	54	54.6	54.7	54.7	54.8	…			…
Share of rural population, %, Transnistria and Bender municipality not included	...	...	57.8	57.9	58	58	58.7	58.6	58.6	58.6	58.6	59.1	58.7	58.7
Life expectancy at birth (years):														
Total	65.8	66.7	66.6	67.8	67.4	67.6	68.2	68.1	68.1	68.4	67.8	68.4	68.8	69.4
Rural	64.6	66	65.9	67.3	66.8	66.8	67.3	67.1	67.1	67.4	66.5	67.2	67.8	68.2
Urban	67.3	67.5	67.6	68.4	68.4	68.8	69.6	69.7	69.8	70.4	70	70.4	70.6	71.2
Share of population aged 0-15 years (%):														
Rural	30.5	30.1	29.6	29.4	28.6	27.8	26.7	25.8	24.7	23.8	22.9	22.1	22	21.3
Urban	26.3	25.7	25.1	24.7	23.9	22.9	22	21	19.9	18.9	18	17.2	16.9	16.2
Share of population aged 65 years and more (%):														
Rural	10.7	10.7	10.8	10.9	11	11	11.1	11.1	11.1	11	10.9	10.8	11.7	11.6
Urban	7	7	7.1	7	7.1	7.1	7.6	7.6	7.9	8.1	8.4	8.5	8.4	8.5
Demographic dependency ratio (%):														
Rural	70.1	69.1	68	67.6	65.6	63.3	60.5	58.3	55.8	53.4	51	45	46.6	45.2
Urban	49.9	48.7	47.4	46.4	44.8	42.9	41.4	39.9	38.4	37.1	35.7	31.6	31	30.4
Birth rate (‰):														
Total	13	12	12.5	11.3	10.6	10.2	10	9.9	10.1	10.6	10.5	10.5	10.6	10.9
Rural	14.9	13.8	14.2	12.8	11.9	11.4	11.2	10.8	11.2	11.5	11.5	11.4	11.6	11.8
Urban	10.8	9.8	10.1	9.3	8.7	8.4	8.4	8.5	8.6	9.4	9.1	9.2	9.3	9.7
Fertility rate (‰):														
Total	1.8	1.6	1.7	1.5	1.4	1.3	1.2	1.2	1.2	1.3	1.2	1.2	1.2	1.3
Rural	2.2	2	2.1	1.8	1.6	1.5	1.4	1.3	1.4	1.4	1.3	1.4	1.5	1.5
Urban	1.3	1.2	1.2	1.1	1	1	1	1	1	1.1	1.1	1	1	1
Infant mortality rate (‰):														
Total	21.2	20.2	19.8	17.5	18.2	18.3	16.3	14.7	14.4	12.2	12.4	11.8	11.3	12.2
Rural	22.3	21.1	21.3	16	16.9	17.8	16	14.4	14.6	12.3	12.1	11	11.8	12.7
Urban	19.5	18.7	16.8	20.5	20.7	19.3	16.9	15.1	13.4	12	13	13	10.3	11.2
Average housing surface per inhabitant (m^2):														
Total	19.9	20.1	20	20.4	20.7	20.8	20.9	21	21.3	21.3	21.4	21.5	21.8	22.0

Urban	16.9	17	17.3	17.7	18.2	18.8	18.9	19	19.1	19.1	19.2	19.3	19.7	20.1
Rural	22.2	22.4	22	22.4	22.4	22.3	22.3	22.5	22.9	22.9	23	23.1	23.2	23.3
Unemployment rate:														
Total	...	...	...	...	11.1	8.5	7.3	6.8	7.9	8.1	7.3	7.4	5.1	4.0
Urban	...	...	...	...	19.1	15.7	13.8	12.1	12.2	11.9	11.2	9.2	6.9	5.5
Rural	...	...	...	...	5.4	3.4	2.7	3	4.5	5	4	5.8	3.6	2.7
Gross educational enrolment ratio (%)														
Pre-primary														
Total	…	…	…	…	…	44.1	47.6	57	61.1	66.1	70.7	70.1	72.6	74.4
Urban	…	…	…	…	…	63.8	65.6	75.5	80.4	84.8	89.2	87.2	88.8	90.8
Rural	…	…	…	…	…	34.2	38.6	47.7	51.3	56.4	61	61	63.6	65.2
Primary														
Total	…	…	…	…	…	99.4	99.5	99.5	99.8	97.9	96.7	94.4	94	93.6
Urban	…	…	…	…	…	101.3	101.3	101.7	104	102.8	102.4	100.5	100.9	101.6
Rural	…	…	…	…	…	98.3	98.5	98.3	97.7	95.5	93.7	91.4	90.5	89.4
Secondary														
Total	…	…	…	…	…	90.2	91.1	92.3	92.2	92.5	93	90.5	90.1	89.3
Urban	…	…	…	…	…	95.6	95.1	95.9	95.6	96.6	97.7	95.4	95.4	95.1
Rural	…	…	…	…	…	86.7	88.5	90	90.1	90.1	90.3	87.9	87.3	86.3

Annex 3.23. Demographic indicators in regional profile 2008

	Population as of 01.01.2009 (thousand persons)	Average annual population growth rate (%) 2003-2008	Birth rate (per 1,000 inhabiants)	Mortality rate (per 1,000 inhabitants)	Infant mortality rate (per 1,000 newborns alive)	Proportion of populations aged 0-14 years (%)	Proportion of population aged 65 years and more (%)	Dependency rate
Republic of Moldova	3,567.5	-0.23	10.9	11.8	12.2	17.1	10.2	37.6
Mun. Chişinău	785.6	0.12	10	8.1	9.4	13.8	7.7	27.4
North	1,013.7	-0.45	10.1	13.8	12.8	16.7	13.9	44.2
m. Bălţi	148.1	-0.28	9.9	10.5	11.7	14.2	9.5	31.0
Briceni	76.2	-0.51	10.1	15.8	11.8	16.5	17.3	51.1
Donduşeni	45.9	-0.70	8.5	17.6	5.1	15.6	18.6	51.9
Drochia	91	-0.72	10.2	14.6	11.4	16.5	16.9	50.1
Edineţ	83.6	-0.61	10.6	14.7	16.2	16.1	16.7	48.8
Făleşti	93.1	-0.44	11.1	14.4	16.3	18.8	12.4	45.5
Floreşti	91	-0.57	10.2	14.9	13.9	17.0	13.6	44.1
Glodeni	62.5	-0.54	9.7	13.8	11.5	17.7	13.8	46.1
Ocniţa	56.5	0.09	9.5	15.3	3.9	14.6	15.1	42.1
Rîşcani	70.9	-0.41	9.8	14.6	15.9	16.8	16.4	49.7
Sîngerei	93.8	-0.45	11.5	11.5	16.7	20.3	10.9	45.4
Soroca	101.1	-0.31	9.4	12.9	11.6	17.0	12.9	42.8
Center	1,065.2	-0.27	11.9	12.4	13.4	18.8	9.1	38.8
Anenii Noi	83.1	-0.16	11.9	12.1	12.3	18.0	8.6	36.1
Călăraşi	79.3	-0.47	10	13.3	10	18.1	10.5	40.0
Criuleni	72.8	0.00	13.6	13	8.1	19.4	8.1	37.8
Dubăsari	35.2	-0.32	12	12.4	11.9	17.8	8.8	36.3
Hînceşti	123.2	-0.50	10.7	11.9	12.6	19.3	8.9	39.4
Ialoveni	98.3	0.60	13.6	11.4	13.5	19.1	7.1	35.5
Nisporeni	67.2	-0.32	11.9	12	12.5	20.0	8.5	39.9
Orhei	125.9	-0.65	11.8	12.6	14.2	17.7	9.1	36.7
Rezina	53	-0.37	11.3	13.7	30.1	17.6	9.8	37.8
Străşeni	91.5	-0.05	12.7	12.6	14.7	18.6	8.6	37.2
Şoldăneşti	43.8	-0.59	10.4	14.9	10.9	19.5	12.5	47.1
Teleneşti	74.7	-0.33	11.7	11.8	11.5	20.6	9.8	43.6
Ungheni	117.2	-0.36	12.4	11.9	14.5	19.3	9.8	41.0
South	543.1	-0.33	11.1	12	11.8	18.8	9.5	39.4
Basarabeasca	29.5	-0.17	10	11.4	10.2	18.1	9.2	37.4
Cahul	124.4	-0.24	11.2	10.5	8.1	18.3	9.4	38.5
Cantemir	63.2	-0.36	11.7	11.7	16.1	20.3	8.3	40.1
Căuşeni	92.7	-0.16	11.6	13.2	9.3	19.0	9.5	39.8
Cimişlia	62.6	-0.66	8.4	12.7	9.5	18.5	9.3	38.5
Leova	53.8	-0.42	11.5	12.1	12.9	19.0	9.0	38.8
Ştefan Vodă	72.4	-0.34	12.4	12.5	19	19.6	9.9	41.9
Taraclia	44.5	-0.40	10.6	13.2	10.6	17.1	11.3	39.7
ATU Găgăuzia	159.9	0.10	12.4	10.9	11.7	18.0	9.4	37.8

Annex 3.24. Health indicators in regional profile, 2008

	Infant mortality rate (per 1,000 newborns alive)	Mortality rate of children under 5 years of age (per 1,000 newborns alive)	Maternal mortality rate (per 100,000 newborns alive)	Rate of mortality because of medical causes (per 100,000 inhabitants)	
				Circulatory system deceases	Tumours
Republic of Moldova	12.2	14.5	38.4	657.4	157.4
Mun. Chişinău	9.4	10.5	25.5	422.2	156.6
North	12.8	15.0	48.6	824.4	174.1
m. Bălţi	11.7	13.7		551.6	193.1
Briceni	11.8	14.3	130.2	1,051.1	138.8
Donduşeni	5.1	7.6		1,183.2	218.9
Drochia	11.4	11.8	107.1	780.3	176.5
Edineţ	16.2	16.2	112.6	960.1	160.0
Făleşti	16.3	18.3		844.1	167.1
Floreşti	13.9	16.2		910.7	211.5
Glodeni	11.5	11.5		805.5	172.3
Ocniţa	3.9	3.9		891.4	194.2
Rîşcani	15.9	20.2	144.3	839.7	188.5
Sîngerei	16.7	18.6		751.2	134.3
Soroca	11.6	18.8	104.7	752.2	152.0
Center	13.4	16.3	39.5	671.0	145.4
Anenii Noi	12.3	13.1		641.4	185.3
Călăraşi	10.0	10.0		689.7	139.7
Criuleni	8.1	9.1		714.3	167.6
Dubăsari	11.9	21.4		707.3	110.8
Hînceşti	12.6	17.5	152.2	564.3	142.7
Ialoveni	13.5	15.7	74.9	618.5	144.7
Nisporeni	12.5	17.5		616.7	133.8
Orhei	14.2	18.1		716.4	151.7
Rezina	30.1	33.2	166.1	826.7	118.6
Străşeni	14.7	17.3		667.8	142.1
Şoldăneşti	10.9	15.3		896.4	138.8
Teleneşti	11.5	12.6		688.4	151.1
Ungheni	14.5	16.5	68.8	616.0	134.8
South	11.8	14.8	49.9	670.2	153.1
Basarabeasca	10.2	13.6		576.3	159.3
Cahul	8.1	10.8		585.0	144.2
Cantemir	16.1	21.6	135.0	592.4	150.1
Căuşeni	9.3	11.2	93.2	737.1	162.7
Cimişlia	9.5	15.2		647.0	157.8
Leova	12.9	16.2		685.3	143.0
Ştefan Vodă	19.0	19.0	111.1	753.6	153.2
Taraclia	10.6	14.8		819.2	163.8
ATU Găgăuzia	11.7	14.1		602.0	147.1

Annex 3.25. Day schools, gymnasiums and lyceums in regional profile

	Number of institutions					Number of pupils				
	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009
Total	1,570	1,551	1,539	1,534	1,519	546,615	517,029	491,482	460,951	434,320
Mun. Chişinău	188	178	174	174	168	109,401	101,796	96,177	90,618	85,853
North	502	497	495	494	493	144,249	137,838	131,963	123,969	117,571
m. Bălţi	31	30	30	30	30	19,099	17,984	17,243	16,119	15,403
Briceni	34	34	34	34	34	10,861	10,458	10,042	9,577	9,043
Donduşeni	27	27	27	27	27	5,779	5,454	5,273	5,001	4,741
Drochia	41	41	41	41	41	13,156	12,571	11,963	10,956	10,379
Edineţ	44	44	44	44	44	11,166	10,777	10,259	9,761	9,376
Făleşti	51	51	51	51	51	14,688	14,045	13,549	12,739	12,095
Floreşti	56	56	56	56	56	14,113	13,513	12,726	11,946	11,314
Glodeni	28	28	28	28	28	9,537	9,187	8,890	8,404	8,076
Ocniţa	30	30	30	30	30	6,510	6,193	5,917	5,589	5,221
Rîşcani	41	41	41	41	41	10,029	9,612	9,174	8,440	7,903
Sîngerei	54	52	51	51	51	14,876	14,414	13,823	13,267	12,609
Soroca	65	63	62	61	60	14,435	13,630	13,104	12,170	11,411
Center	548	545	540	537	534	172,663	163,182	154,726	144,877	135,937
Anenii Noi	38	37	36	36	36	12,918	12,291	11,744	11,008	10,195
Călăraşi	42	42	42	42	42	12,289	11,467	10,666	9,893	9,268
Criuleni	34	34	34	34	34	12,108	11,603	10,888	10,287	9,615
Dubăsari	13	13	13	13	13	5,381	5,172	4,862	4,450	4,221
Hînceşti	57	56	55	54	54	20,949	19,546	18,559	17,232	16,041
Ialoveni	38	38	38	38	37	16,022	15,313	14,581	13,829	13,184
Nisporeni	38	37	37	37	37	11,061	10,570	10,072	9,391	8,804
Orhei	65	65	65	65	65	18,701	17,298	16,465	15,437	14,412

Rezina	40	40	40	40	40	8,609	8,196	7,827	7,108	6,725
Străşeni	42	42	40	40	39	14,511	13,749	12,952	12,360	11,671
Şoldăneşti	32	32	31	31	31	7,147	6,843	6,512	6,211	5,812
Teleneşti	43	43	43	43	43	13,138	12,423	11,853	11,006	10,351
Ungheni	66	66	66	64	63	19,829	18,711	17,745	16,665	15,638
South	271	270	269	268	264	89,051	84,789	80,560	75,400	70,581
Basarabeasca	11	11	11	11	11	4,741	4,418	4,234	3,976	3,627
Cahul	62	62	60	60	58	20,095	19,225	18,203	17,010	15,887
Cantemir	40	40	40	39	38	10,681	10,084	9,565	8,909	8,326
Căuşeni	39	38	38	38	37	15,085	14,230	13,447	12,493	11,966
Cimişlia	34	34	34	34	34	10,784	10,271	9,687	9,122	8,276
Leova	34	34	34	34	34	8,821	8,530	8,154	7,662	7,125
Ştefan Vodă	30	30	30	30	30	12,211	11,711	11,072	10,438	9,927
Taraclia	21	21	22	22	22	6,633	6,320	6,198	5,790	5,447
ATU Găgăuzia	55	55	55	55	54	27,640	26,279	25,080	23,322	21,972
Teritorial-administrative units on the left bank of the Dniester river and mun. Bender*	6	6	6	6	6	3,611	3,145	2,976	2,765	2,406

** - subordinated to the Minister of Education and Youth of the Republic of Moldova.*

Annex 3.26. Vocational education institutions in regional profile

	Number of institutions					Number of pupils				
	2004/05	2005/06	2006/07	2007/08	2008/09	2004/05	2005/06	2006/07	2007/08	2008/09
Total	81	78	78	75	75	22,696	25,005	23,656	24,506	24,270
Mun. Chişinău	24	21	21	19	19	7,690	8,151	7,759	7,812	8,044
North	29	29	29	28	28	7,816	8,636	7,998	8,554	8,495
m. Bălţi	7	7	7	6	6	3,143	3,497	3,311	3,681	3,625
Briceni	2	2	2	2	2	204	174	208	185	175
Donduşeni	2	2	2	2	2	278	320	177	185	159
Drochia	2	2	2	2	2	426	493	464	442	466
Edineţ	2	2	2	2	2	636	729	757	836	861
Făleşti	1	1	1	1	1	162	164	143	131	128
Floreşti	4	4	4	4	4	1,188	1,248	1,208	1,183	1,222
Glodeni	2	2	2	2	2	353	410	348	328	300
Ocniţa	1	1	1	1	1	161	202	154	202	169
Rîşcani	1	1	1	1	1	331	407	403	434	441
Sîngerei	2	2	2	2	2	453	498	372	415	368
Soroca	3	3	3	3	3	481	494	453	532	581
Center	15	15	15	15	15	4,012	4,616	4,336	4,398	4,158
Anenii Noi	1	1	1	1	1	185	180	132	130	122
Călăraşi	1	1	1	1	1	350	409	340	342	370
Criuleni	2	2	2	2	2	565	607	601	666	627
Dubăsari	—	—	—	—	—	—	—	—	—	—
Hînceşti	3	3	3	3	3	535	578	626	654	573
Ialoveni	2	2	2	2	2	458	608	603	578	507
Nisporeni	1	1	1	1	1	399	433	344	356	353
Orhei	2	2	2	2	2	572	691	648	685	630
Rezina	1	1	1	1	1	227	275	265	262	246
Străşeni	—	—	—	—	—	—	—	—	—	—
Şoldăneşti	—	—	—	—	—	—	—	—	—	—

Teleneşti	1	1	1	1	1	215	280	244	230	197
Ungheni	1	1	1	1	1	506	555	533	495	533
South	10	10	10	10	10	2,558	2,880	2,888	3,006	2,916
Basarabeasca	—	—	—	—	—	—	—	—	—	—
Cahul	2	2	2	2	2	702	762	857	976	986
Cantemir	1	1	1	1	1	154	162	126	135	138
Căuşeni	2	2	2	2	2	474	581	516	587	458
Cimişlia	1	1	1	1	1	285	335	291	289	280
Leova	1	1	1	1	1	353	350	337	306	327
Ştefan Vodă	2	2	2	2	2	506	599	611	566	580
Taraclia	1	1	1	1	1	84	91	150	147	147
ATU Găgăuzia	3	3	3	3	3	620	722	675	736	657

Annex 3.27. Colleges in regional profile

	Number of institutions					Number of pupils				
	2004/05	2005/06	2006/07	2007/08	2008/09	2004/05	2005/06	2006/07	2007/08	2008/09
Total	56	51	49	49	47	23,618	27,060	30,223	31,307	32,683
Mun. Chişinău	28	25	23	22	21	14,643	16,744	18,572	19,034	19,822
North	17	15	15	15	15	5,115	5,712	6,311	6,612	6,928
m. Bălţi	6	6	6	6	6	2,704	3,054	3,303	3,518	3,548
Briceni	2	1	1	1	1	301	327	392	391	412
Donduşeni	1	1	1	1	1	330	381	442	447	437
Drochia	–	–	–	–	–	–	–	–	–	–
Edineţ	1	1	1	1	1	149	174	201	196	217
Făleşti	–	–	–	–	–	–	–	–	–	–
Floreşti	–	–	–	–	–	–	–	–	–	–
Glodeni	–	–	–	–	–	–	–	–	–	–
Ocniţa	1	1	1	1	1	167	177	220	246	295
Rîşcani	1	1	1	1	1	363	427	478	510	532
Sîngerei	–	–	–	–	–	–	–	–	–	–
Soroca	5	4	4	4	4	1,101	1,172	1,275	1,304	1,487
Center	6	6	6	7	7	2,133	2,693	3,165	3,410	3,616
Anenii Noi	–	–	–	–	–	–	–	–	–	–
Călăraşi	1	1	1	1	1	274	351	418	437	431
Criuleni	–	–	–	–	–	–	–	–	–	–
Dubăsari	–	–	–	–	–	–	–	–	–	–
Hînceşti	1	1	1	1	1	340	418	456	535	631
Ialoveni	–	–	–	–	–	–	–	–	–	–
Nisporeni	–	–	–	–	–	–	–	–	–	–
Orhei	2	2	2	2	2	1,016	1,241	1,440	1,468	1,426
Rezina	–	–	–	–	–	–	–	–	–	–
Străşeni	–	–	–	–	–	–	–	–	–	–
Şoldăneşti	–	–	–	–	–	–	–	–	–	–
Teleneşti	–	–	–	–	–	–	–	–	–	–

Ungheni	2	2	2	3	3	503	683	851	970	1128
South	3	3	3	3	2	1,084	1,230	1,433	1,515	1,490
Basarabeasca	—	—	—	—	—	—	—	—	—	—
Cahul	2	2	2	2	2	923	1,106	1,331	1,495	1,490
Cantemir	—	—	—	—	—	—	—	—	—	—
Căuşeni	—	—	—	—	—	—	—	—	—	—
Cimişlia	—	—	—	—	—	—	—	—	—	—
Leova	—	—	—	—	—	—	—	—	—	—
Ştefan Vodă	—	—	—	—	—	—	—	—	—	—
Taraclia	1	1	1	1	—	161	124	102	20	—
ATU Găgăuzia	2	2	2	2	2	643	681	742	736	827

Annex 3.28. High education institutions in regional profile

	Number of institutions					Number of students				
	2004/05	2005/06	2006/07	2007/08	2008/09	2004/05	2005/06	2006/07	2007/08	2008/09
Republic of Moldova	35	35	31	31	31	114,552	126,132	127,997	122,939	114,865
mun. Chişinău	28	28	25	25	25	99,110	109,274	111,279	107,498	100,449
mun. Bălţi	3	3	2	3	3	9,613	10,898	10,958	10,615	9,552
Cahul	2	2	2	1	1	3,374	3,250	3,043	2,117	2,246
Taraclia	1	1	1	1	1	94	201	275	328	313
ATU Găgăuzia	1	1	1	1	1	2,361	2,509	2,442	2,381	2,305

Annex 3.29. Unemployed registered at territorial agencies of labour employment

	Number of unemployed registered over the year. Total persons			Of which, women			Unemployed placed in jobs over the course of the year. Total persons			Of which, women		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
Total	51,837	48,396	46,230	24,498	24,325	23,973	23,858	23,367	22,185	12,780	13,030	12,151
Mun. Chişinău	6,108	5,013	6,286	3,479	2,883	3,721	2,666	2,619	2,448	1,489	1,527	1,469
North	17,412	15,719	14,869	8,467	8,392	7,948	8,587	7,680	7,529	4,669	4,482	4,091
m. Bălţi	4,218	3,971	3,418	2,368	2,406	2,057	2,528	2,347	2,096	1,333	1,463	1,221
Briceni	563	493	523	228	221	269	533	469	401	188	185	185
Donduşeni	608	550	625	185	143	243	362	356	379	168	115	142
Drochia	1,614	1,365	1,420	724	671	735	574	603	623	340	381	340
Edineţ	1,544	1,326	1,208	702	648	589	636	311	470	347	201	235
Făleşti	1,438	1,323	1,209	826	787	725	738	737	741	520	510	477
Floreşti	1,733	1,401	1,522	683	694	776	584	490	609	294	261	292
Glodeni	1,140	906	913	578	482	514	560	435	423	314	257	252
Ocniţa	790	569	532	351	255	242	408	318	227	178	129	91
Rîşcani	715	769	748	214	297	359	348	302	286	162	172	167
Sîngerei	842	825	688	402	513	403	300	356	332	169	267	250
Soroca	2,207	2,221	2,063	1,206	1,275	1,036	1,016	956	942	656	541	439
Center	16,859	15,606	13,597	6,766	6,644	6,131	6,564	6,824	6,409	3,313	3,540	3,423
Anenii Noi	775	780	647	400	433	381	402	452	364	216	230	224
Călăraşi	1,439	1,439	1,333	743	659	571	858	1,058	908	463	509	367
Criuleni	565	558	493	253	236	289	224	222	207	110	118	140
Dubăsari	1,090	887	460	577	432	225	180	216	185	91	123	108
Hînceşti	1,279	1,158	1,003	436	407	412	275	282	285	181	148	159
Ialoveni	1,220	911	848	506	388	443	592	595	500	287	335	266
Nisporeni	699	702	686	266	258	330	246	254	299	146	127	198

Orhei	2,640	2,301	2,024	780	648	692	1,112	1,127	1,130	463	421	491
Rezina	924	1,052	843	432	521	404	492	522	501	248	239	224
Străşeni	1,168	1,033	976	455	493	480	562	598	535	275	326	303
Şoldăneşti	893	924	748	366	384	296	313	181	206	116	66	128
Teleneşti	1,332	1,220	1,226	251	404	387	261	304	306	112	213	182
Ungheni	2,835	2,641	2,310	1,301	1,381	1,221	1,047	1,013	983	605	685	633
South	9,035	8,939	8,679	4,328	4,437	4,417	5,041	5,086	4,819	2,612	2,620	2,437
Basarabeasca	728	725	683	329	370	331	273	301	262	89	92	72
Cahul	2,584	2,489	2,298	1,081	1,067	1,116	1,734	1,734	1,601	810	745	775
Cantemir	886	1,020	859	415	587	431	464	542	487	261	355	285
Căuşeni	1,443	1,439	1,716	676	645	826	890	902	903	453	428	423
Cimişlia	963	781	704	549	425	409	484	443	450	352	325	299
Leova	476	463	688	192	245	372	171	167	212	96	112	122
Ştefan Vodă	931	947	879	460	473	431	631	642	641	299	342	309
Taraclia	1,024	1,075	852	626	625	501	394	355	263	252	221	152
ATU Găgăuzia	2,423	3,119	2,799	1,458	1,969	1,756	1,000	1,158	980	697	861	731

Annex 3.30. Indicators of economic growth in regional profile

	Industrial output growth rate. previous year= 100%			2008 industrial output. 2005=100%	Net number of employed in the course of the year. % average number of employed		Fixed capital investment growth rate. previous year= 100%		Wage growth rate. previous year= 100%	
	2003	2004	2005		2007	2008	2007	2008	2007	2008
Total	95.2	98.7	101.5	95.4	2.4	2.1	121.9	101.7	121.7	122.5
Mun. Chişinău	95.8	100.5	97.3	93.7	3.6	3.3	119.4	105.4	121.5	121.0
North	103.1	95.1	111.8	109.6	1.7	1.2	105.5	106.3	120.0	125.2
m. Bălţi	98.5	110.5	103.2	112.3	4.8	3.1	87.3	108.6	122.3	122.9
Briceni	130.5	109.8	83.0	118.9	0.0	1.1	102.7	110.1	122.3	122.5
Donduşeni	114.3	109.4	101.0	126.3	-2.6	1.6	144.0	122.0	117.3	124.7
Drochia	100.4	96.6	141.6	137.4	-1.3	-0.7	77.4	113.4	112.9	125.3
Edineţ	104.3	84.8	105.5	93.3	9.1	2.6	144.9	103.8	123.4	119.8
Făleşti	119.8	55.3	206.4	136.7	-3.3	-2.4	84.7	96.5	116.1	126.1
Floreşti	99.8	90.0	109.3	98.2	0.3	0.9	102.3	85.7	117.1	123.2
Glodeni	107.8	49.4	202.7	107.9	0.8	0.4	121.0	78.8	116.6	126.9
Ocniţa	162.1	135.2	76.2	167.0	-1.1	-2.4	171.7	91.2	119.4	127.2
Rîşcani	108.9	92.6	116.5	117.5	-2.0	-1.1	125.0	134.8	117.8	130.8
Sîngerei	102.1	32.0	127.8	41.7	1.5	-0.2	125.0	108.0	117.0	126.7
Soroca	117.6	101.0	114.1	135.6	2.7	3.2	151.6	116.0	117.0	126.0
Center	92.2	101.9	93.2	87.5	0.7	1.2	151.1	84.0	119.9	123.0
Anenii Noi	96.9	111.4	100.2	108.2	1.6	3.3	210	52.0	122.1	120.1
Călăraşi	113.4	111.4	87.3	110.3	0.0	1.4	84.9	106.8	114.7	121.0
Criuleni	116.0	85.3	100.5	99.5	-0.9	-0.5	97.3	113.5	120.4	124.9
Dubăsari	106.4	71.3	107.8	81.8	2.8	-0.8	210	154.3	121.9	122.8
Hînceşti	83.9	65.9	71.2	39.4	-0.5	-0.7	155.7	66.3	121.9	125.3
Ialoveni	66.6	71.6	97.6	46.5	-1.2	0.1	144.1	78.2	122.9	120.7
Nisporeni	53.5	70.0	113.8	42.6	3.2	1.8	174.1	52.5	116.6	124.1
Orhei	86.3	122.6	92.0	97.4	1.3	2.0	146.0	119.7	116.7	125.7
Rezina	131.7	108.3	94.8	135.2	1.8	3.1	320	59.9	122.0	120.2
Străşeni	65.1	100.6	94.5	61.9	2.8	1.2	154.8	74.7	117.6	123.6
Şoldăneşti	59.7	80.6	166.6	80.2	2.0	-1.5	171.8	82.1	122.2	120.1
Teleneşti	78.8	94.7	102.1	76.2	-3.6	0.5	101.2	138.7	112.3	127.9
Ungheni	128.2	120.6	87.2	134.8	2.1	3.1	83.5	142.0	122.3	120.8
South	75.4	89.0	109.2	73.3	0.9	0.3	129.8	101.0	120.1	122.0
Basarabeasca	77.6	68.0	97.5	51.5	1.5	-0.2	97.0	62.0	126.0	119.4
Cahul	79.3	95.9	98.8	75.1	2.6	2.8	142.9	135.6	120.4	120.3
Cantemir	43.1	47.0	196.7	39.9	2.8	0.5	86.8	104.3	119.9	122.9
Căuşeni	68.5	91.5	103.2	64.7	0.2	0.0	80.0	121.5	117.3	119.1
Cimişlia	70.1	74.0	102.3	53.0	-0.6	0.1	260	44.4	118.9	123.2
Leova	122.9	57.0	80.4	56.3	1.4	-1.2	116.8	64.2	116.1	122.1
Ştefan Vodă	74.8	71.4	121.4	64.8	-1.5	-2.2	118.8	96.5	121.9	124.0
Taraclia	94.6	129.6	116.5	142.9	-0.1	-0.4	163.5	96.8	117.9	129.3
ATU Găgăuzia	77.8	89.6	111.3	77.6	3.4	1.2	95.3	130.0	119.8	118.7

References

- Adger W. N., Arnell N. W., Tompkins EL, „Successful adaptation to climate change across scales", Global Environmental Change, 2004.
- Adger, W. N., Brooks N., Bentham G., Agnew M., Eriksen S., New indicators of vulnerability and adaptive capacity: Tyndall Centre for Climate Change Research Technical Report 7, 2004.
- Alexandrov, V., Vulnerability and adaptation of agronomic systems in Bulgaria: CLIMATE RESEARCH Clim Res, Vol. 12, 1999.
- Ambuj D. Sagara and Adil Najam, „The human development index: a critical review", Ecological Economics, Volume 25, Issue 3, June 1998.
- Angie Dazé, Kaia Ambrose and Charles Ehrhart "Climate Vulnerability and Capacity Analysis", a Handbook, prepared for CARE International, 2009.
- Aumayr Ch., European Region Types in EU-25. In: The European Journal of Comparative Economics, Jg. Vol. 4, n. 2., 2008.
- Bachev H., Nanseki T., "Risk Governance in Bulgarian Dairy Farming", presented at the International Congress of the European Association of Agricultural Economists, 26-29 August 2008, Ghent, Belgium, 2008.
- Backhaus Klaus et al., Multivariate Analysemethoden: Eine anwendungsorientierte Einführung (9. überarbeitete u. erw. Auflage), Berlin/Heidelberg/New York, 2000.
- Bates B., Kundzewicz Z.W., Wu S., Palutikof J. (eds.), „Climate change and water. Technical paper of the Intergovernmental Panel on Climate Change", IPCC secretariat, Geneva, 2008.
- Beniston M., „Entering into the "greenhouse century": Recent record temperatures in Switzerland are comparable to the upper temperature quintiles in a greenhouse climate", Geophysical Research Letter 34, 2007.
- Beniston, M., „The 2003 heat wave in Europe: A shape of things to come? An analysis based on Swiss climatological data and model simulations", Geophys., 2004.
- Bielza M., Conte C., Dittmann C. et al., "Agricultural Insurance Schemes", Final Report, December 2006, Modified February 2008, European Commission, 2006.
- Bouwer, L. M., R. P. Crompton, E., Faust, P., Höppe, and R. A. Jr. Pielke, „Disaster management: Confronting Disaster Losses", Science 318 (5851): 753, 2007.
- Bozu V., Caragia D. and Gotisan I., "Final Analysis of Constraints to Economic Growth: Republic of Moldova", Chişinău, 2007, available at http://ksghome.harvard.edu/~drodrik/Growth%20diagnostics%20papers/Moldova%20CA_Bozu,Caragia&Gotisan.pdf.
- Brooks N., Adger W.N., Kelly P.M., "The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation: Global Environmental Change", 2005.
- Brooks, N.; Adger, W. N., "Assessing and enhancing adaptive capacity. In: Burton, Ian; Lim, Bo; Spanger-Siegfried, Erika, et al. (Eds.). Adaptation policy frameworks for climate change - Developing strategies, policies, and measures", 2005.
- CEA, "Reducing the Social and Economic Impact of Climate Change and Natural Catastrophes Insurance Solutions and Public-Private Partnerships", Brüssel, 2007.
- Climenco V., Trombiţki I., Andreev A., "Reţeaua ecologică: Calea spre protejarea naturii în Moldova", Chişinău, 2002.
- Constantinov T., Nedealcov M., "Evaluarea fenomenelor climatice nefavorabile". In: T.Constantinov (Ed.). "Republica Moldova. Hazardurile naturale regionale", Chişinău, p. 57-68, 2008.

- Corobov R. (Ed.), "Moldova's climate in XXI century: the projections of changes, impacts, and responses", Chişinău, Elan Poligraf (in Russian), 2004.
- Corobov R., "Regional Climate and Environmental Change: Moldova Case Study" in: P.Ya. Groisman P.Y. and S.V. Ivanov (Eds.). "Regional aspects of climate-terrestrial-hydrologic interactions in non-boreal Eastern Europe", NATO Science Series, p. 79-86, 2008.
- Corobov R., Cealic S. and Buiucli P., „Assessment of crop production sensitivity to likely climate change", in Corobov R. (Ed.) "Moldova's Climate in XXI century: the projections of changes, impacts and responses", Chişinău, 2004 (in Russian).
- Corobov R., Cealic S. and Buiucli P., „Assessment of crop production sensitivity to likely climate change", in Corobov R. (Ed.) "Moldova's Climate in XXI century: the projections of changes, impacts and responses", Chişinău, 2004 (in Russian);
- Corobov R., Nicolenco A., "New projections of Moldova's climate change in XXI century" In: Corobov R. (Ed.) "Moldova's climate in XXI century: the projections of changes, impacts, and responses", Chişinău, Elan Poligraf, 2004.
- Corobov R., Overcenko A., "Use of climate modelling outputs for regionalization of global climate projections" in: "Problems of Ecological Monitoring and Ecosystem Modelling", Vol. XXI, St. Petersburg, Gidrometeoizdat, 122-145, 2007.
- Duca Gh. et al,. "Seceta şi metode de minimalizare a consecinţelor nefaste", Chişinău, 2007.
- Eitzinger J. et al., "A simulation study of the effect of soil water balance and water stress in winter wheat production under different climate change scenarios", Agriculture and Water Management, 2003.
- Environmental Policy Integration: Theory and practice in the UNECE region, May 2003.
- European Commission, "Winning the battle against global climate change", Commission Communication of 9 February 2005, COM(2005) 35 - Official Journal C 125 of 21 May 2005.
- European Communities "EU action against climate change: Adapting to climate change", Luxemburg, 2008.
- European Environment Agency, "Climate change: the cost of inaction and the cost of adaptation", Technical report No 13/2007, http://reports.eea.europa.eu/technical_report_2007_13/en/Tech_report_13_2007.pdf, last update on 05/12/2007, last checked on 04/09/2008.
- European Environment Agency, "Energy and Environment Report", 2008.
- European Environment Agency, "Impacts of Europe's changing climate - 2008 indicator-based assessment", EEA Report No 4/2008.
- European Environment Agency, "Vulnerability and adaptation to climate change in Europe: EEA Technical report No 7/2005", 2006.
- European Training Foundation, "Black Sea Labour Market Reviews Moldova country report", January 2009, ENPI 08-14.
- Expert-Grup, "EU-Moldova Action Plan as capacity test for Moldovan Government: Screening implementation of the Plan's economic provisions", Chişinău, 2008.
- Expert-Grup, "Free Trade Agreement between the Republic of Moldova and European Union: Feasibility, perspectives and potential impact", Chişinău, 2009.
- Expert-Grup, "State of the Country Report", Chişinău, 2008.
- FAO/WFP, "FAO/WFP Crop and Food Supply Assessment Mission to Moldova: Special Report, 25 September 2007", Chişinău, 2007.
- Füssel H.-M. and Klein R., "Climate Change Vulnerability Assessments: An Evolution Of Conceptual Thinking on Climatic Change", Volume 75, Number 3 / April, 2006.

- Füssel, H. -M., Coevolution of the Political and Conceptual Frameworks for Climate Change Vulnerability Assessments, in: Biermann F., S. Campe, and K. Jacob (Eds.): Proceedings of the 2002 Berlin Conference on the Human Dimensions of Global Environmental Change "Knowledge for the Sustainability Transition. The Challenge for Social Science", Global Governance Project, Amsterdam, The Netherlands, pp. 302–320, 2004.
- Füssel, H. -M., Vulnerability in climate change research: a comprehensive conceptual framework, in: University of California International and Area Studies, 6, Breslauer Symposium (http://repositories.cdlib.org/ucias/breslauer/6), 2005.
- German Strategy for Adaptation to Climate Change, 2008.
- Government of the Republic of Moldova, "National Energy Strategy of Moldova (2007-2020)", Chişinău, 2008.
- Government of the Republic of Moldova, "The First National Report. Millennium Development Goals in the Republic of Moldova", June 2005, http://www.undp.md/publications/doc/Millenium_ENG.pdf, Chişinău, 2005.
- Gurenko E.N., Itigin A., Dumitru D., "Bulgarian Catastrophe Insurance Initiative: Feasibility Study", Project Report, World Bank, 2008.
- Hazel P., Skees J.R., "Insuring against Bad Weather: Recent Thinking", in: Radharishna, R., Rao S.K., Mahendra Dev, S., Subbarao, K. (Eds.) India in a Globalising World: Some Aspects of Macroeconomy, Agriculture, and Poverty, ew Delhi: Academic Foundation and Hyderabad: Centre for Economic and Social Studies (CESS), 2006.
- Hilpert K., Mannke F., Schmidt-Thomé P. "Towards Climate Change Adaptation in the Baltic Sea Region", Geological Survey of Finland, Espoo, 55 p. (ASTRA-Project), 2007
- Houghton J.T., Ding Y., Griggs D. J. et al. (Eds.), Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge: Cambridge University Press, 2001.
- Intergovernmental Panel on Climate Change, "Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change" (Parry ML, Canziani OF, Palutikof J.P et al (eds)]. Cambridge University Press, Cambridge, UK, 2007.
- International Federation of Red Cross and Red Crescent Societies, "Moldova: Food Insecurity", DREF operation n° MDRMD001, Glide No. DR-2007-000175-MDA, 4 February 2008, http://www.ifrc.org/docs/appeals/08/MDRMD001.pdf.
- International Research Institute for Climate and Society (IRI), "Index insurance and climate risk: Prospects for development and disaster management", 2009.
- Ionete A., "2009 – Another unfavorable year for the development of agricultural insurance?" Article published in XPRIMM Newsletters on 16 February 2009. Last consulted in September 2009, http://insurance.1asig.ro/2009-Another-unfavorable-year-for-the-development-of-agricultural-insurance-article-2,3,100-29633-0.htm.
- IPCC: IPCC Fourth Assessment Report. Working Group II Report "Impacts, Adaptation and Vulnerability". Published for the Intergovernmental Panel on Climate Change (Hg.). New York, Melbourne, Madrid, Cape Town, Singapore, São Paolo, Delhi: Cambridge University Press, 2007.
- IPCC: McCarthy J., Canziani O., Leary N., Dokken D., White K. (eds.) Climate Change 2001: Impacts, Adaptation, and Vulnerability Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, IPCC, Cambridge University Press, 2001.
- Izverskaia T., Sabanova G., "Forecast of floral behaviour under climate change condi-

tions" in Corobov R. (ed.) "Moldova's Climate in XXI century: the projections of changes, impacts and responses", Chişinău, 2004 (in Russian).

- Izverskaya T., "Climate changes influence on floral biodiversity (including rare, endangered and assailable species) of the Republic of Moldova" in Climate change: Research, studies, solutions. Chişinău, 2000.
- Jaykus L.-A. et al., „Climate Change: implications for food safety", FAO.
- Joáo E., How scale affects environmental impact assessment. Environmental Impact Assessment Review 22:289–310, 2002.
- Klein, R., coastal vulnerability, resilience and adaptation to climate change: Kumulative Dissertation, Mathematisch-Naturwissenschaftliche Fakultät of the Christian-Albrechts-Universität, Kiel, 2002.
- Kundzewicz Z.W., Somlyody L., Climatic change impact on water resources in a system perspective. Water Resources Management 11: 407-735, 1997.
- Lazu S., "Vulnerability and adaptation of the meadow ecosystems to climate change impact" in Climate change: Research, studies, solutions. Chişinău, 2000.
- Leah T., Cerbari V., "Eroziunea solurilor – factor de intensificare a consecinţelor secetelor", in proceeding of the National Conference "Secetele: pronosticarea şi atenuarea consecinţelor", Chişinău, 2000.
- Leslie K., "Presentation for the CDB Seminar: Advancing the Climate Change Agenda", July 6, 2009, Barbados. Last checked on August 9, 2009. http://www.caribank.org/titanweb/cdb/webcms.nsf/AllDoc/E6F380BA51977179042575F5006CE100/$File/KLeslieCCregionaldev.pdf
- Long S., "Changing the future of the world's poor?", Friends of the Earth Australia, 2003.
- Masure, P., Variables and indicators of vulnerability and disaster risk for land-use and urban or territorial planning, IDB/IDEA Programme of Indicators for Disaster Risk Management, National University of Colombia, Manizales, http://idea.unalmzl.edu.co/, 2003.
- Metzger M. J., Leemans R., Schroter D., A multidisciplinary multi-scale framework for assessing vulnerabilities to global change, International Journal of Applied Earth Observation and Geoinformation 7, pp. 253-267, 2005.
- Ministry of Ecology and Natural Resources of the Republic of Moldova "Report on National Policies in Energy Efficiency and Renewable Energy Sources", June, 2009.
- Ministry of Ecology and Natural Resources of the Republic of Moldova, "Institutional Development Plan 2009-2011", Chişinău, 2008.
- Ministry of Ecology and Natural Resources of the Republic of Moldova "Third National Report on the Implementation of the Convention of Biological Diversity", Chişinău, 2005.
- Ministry of Economy and Trade of the Republic of Moldova, „Report on Poverty and Policy Impact 2004", Chişinău, November 2005.
- Ministry of Economy and Trade of the Republic of Moldova, „Report on Poverty and Policy Impact 2007", Chişinău, November 2008.
- Ministry of Environment and Territorial Development of the Republic of Moldova, "First National Communication of the Republic of Moldova", elaborated in the framework of the UN Convention on Climate Change, Chişinău, 2000.
- Ministry of Environment and Territorial Development of the Republic of Moldova "National Strategy and Action Plan on Biodiversity Conservation of the Republic of Moldova" Chişinău, 2001.
- Mitu N.E., "Market Niche in Agricultural Insurances", 2008. Last consulted in September 2009, http://steconomice.uoradea.ro/anale/volume/2008/v3-finances-banks-accountancy/063.pdf.

- Nakicenovic N, Swart R (Eds.) "Special Report on Emission Scenarios", Cambridge University Press, Cambridge, UK, 2000.
- National Bureau of Statistics of Republic of Moldova, "Passengers and cargoes transport in 2008", Chişinău, 2009, http://www.statistica.md/newsview.php?l=ro&idc=168&id=2486
- National Bureau of Statistics of the Republic of Moldova, "Distribution of employment by sector of economy chart, 2000-2007. Last consulted on August 2, 2009.
- National Bureau of Statistics of the Republic of Moldova, "Resident Population by sex 1959-2008 chart", consulted on August 1, 2009, www.statistica.md.
- National Bureau of Statistics of the Republic of Moldova, "Results of Survey of health status of population in the Republic of Moldova", Chişinău, 2006.
- National Bureau of Statistics, "Statistical Yearbook 2008", Chişinău, 2008.
- National Bureau of Statistics, „Activitatea agricolă a micilor producători agricoli în Republica Moldova", Chişinău, 2008.
- Nour D. (Ed.) "Eroziunea solului. Esenţa, consecinţele, minimalizarea şi stabilizarea procesului", Pontos, Chişinău, 2004
- O´Brian et al., Vulnerable or Resilient - A Multi-Scale Assessment of Climate Impacts and Vulnerability in Norway: Climatic Change 64: 193–225, 2004.
- Opopol N., R. Corobov and others "Schimbările climatului şi potenţialul impact al acestor fenomene extremale asupra sănătăţii", Curier medical, 2003.
- Organization for Economic Cooperation and Development, "Policies for a Better Environment. Progress in Eastern Europe, Caucasus and Central Asia", 2007.
- Organization for Economic Cooperation and Development,„Climate Change Mitigation. What do we do?", 2008.
- Overcenco A., Mihailescu C., Bogdevici O., Gîlcă G., "Fîntîni şi izvoare: Atlas ecologic", Ştiinţa, Chişinău, 2008.
- Panciu V., Doronceanu O., "Dynamic and Potential – Bulgarian and Romanian insurance markets", Powerpoint decoument presented at the sixth Russian Insurance & Reinsurance Rendez-Vous, November 2007, St. Petersburg, 2007.
- Postolache Gh., "Natural ecosystems. Vulnerability and adaptation to climate change" in "Climate change: Research, studies, solutions", Chişinău, 2000.
- Prettenthaler F., Albrecher H., (Hg.) Hochwasser und dessen Versicherung in Österreich, Verlag der Österreichischen Akademie der Wissenschaften, Wien, 2009 (in German).
- Prettenthaler F., Regionalökonomische Analysen von 77 Regionen Zentral- und Südosteuropas. Ein strukturorientierter gemeinsamer Typisierungsversuch innerhalb eines heterogenen Wirtschaftsraumes, InTeReg Working Paper No. 13-2003,, Graz, 2003 (in German).
- Prettenthaler F., Strametz S., Töglhofer C., Türk A., "Anpassungsstrategien gegen Trockenheit: Bewertung ökonomisch-finanzieller versus technischer Ansätze des Risikomanagements", Wissenschaftlicher Bericht Nr. 8, Graz: Wegener Center Verlag, 2006(in German).
- Radev E., "SECE CRIF", Powerpoint document presented at the SEEDRMAP Conference, June 2009, Geneva, 2009.
- Ranis G., Stewart F. and Ramirez A., "Economic growth and human development", Yale Economic Growth Center Discussion Paper No. 787, 1997.
- Red Book of the Republic of Moldova, First Edition (1978) and Second Edition (2001).
- Regional Cooperation Council, "Annual report of the secretary general of the Regional Cooperation Council on regional co-operation in South East Europe", 2009. Last consulted in September 2009,

http://www.rcc.int/download.php?tip=docs&doc=Report+of+the+Secretary+General+to+RCC+Board-140509+-final.doc&doc_url=3877c45fc85e63a963400508eb74ec6f

- Rowthorn B., Deindustrialization. Its causes and implications. Washington DC: International Monetary Fund (Economic issues, 10), 1997.
- Sabanova G., Izverskaia T., "Sensitivity of natural vegetative communities of Moldova to climate changes" in Corobov R. (ed.) "Moldova's Climate in XXI century: the projections of changes, impacts and responses", Chişinău, 2004 (in Russian).
- Samet J. M., "Adapting to Climate Change in Public Health", RFF Report, 2009.
- Schumpeter, J., Theorie der wirtschaftlichen Entwicklung. Eine Untersuchung über Unternehmergewinn, Kapital, Kredit, Zins und den Konjunkturzyklus. 8. Aufl., unveränd. Nachdr. d. 1934 erschienenen 4. Aufl /9. Aufl., unveränd. Nachdr. der 1934 erschienenen 4. Aufl. Berlin: Duncker & Humblot, 1934 /1997 (in German).
- Shynkarenko R., "Opportunities for Introduction of Index-Based Insurance in Moldova, Ukraine and Russian Federation", Presentation at the East Agri 2008 Annual Meeting in Paris, 2008.
- Sirodoev I.G., Corobov R.M., An approach to the modelling of some river water quality parameters. Gh. Duca (Ed.). The third international conference "Ecological chemistry". Latest advances. Book of proceedings. Chişinău: Tipogr. Acad. Şt.,p. 242-248, 2005.
- Sirodoev I.G., Knight C.G., "Vulnerability to Water Scarcity in Moldova: Identification of the Regions", Buletinul Academiei de Ştiinţe a Moldovei. Ştiinţele vieţii 3(303): 159-166, 2007.
- Sirodoev I.G., Knight C.G., "Vulnerability to Water Scarcity in Moldova: Likely Threats for Future Development. Present environment and sustainable development" 2: 7-15, 2008.
- Sistemul informaţional privind calitatea învelişului de sol al Republicii Moldova (Banca de date), Pontos, Chişinău, 2000.
- Skees J.R., Barnett B., Hartell J., "Innovations in Government Responses to Catastrophic Risk Sharing for Agriculture in Developing Countries", Paper prepared for the Commodity Risk Management Group, Agricultural and Rural Development Department, ESW, The World Bank, Washington, DC, 2005.
- Skess J.R., "Risk Management Challenges in Rural Financial Markets: Blending Risk Management Innovations with Rural Finance", Thematic Paper presented at Paving the Way Forward for Rural Finance: An International Conference on Best Practices, 2-4 June 2003, Washington, DC, 2003.
- Smit B., Burton I., Klein R., Street R.,The science of adaptation: a framework for assessment, Mitigation and Adaptation Strategies for Global Change 4, pp. 199–213, 1999.
- Stancu V., "Studiu privind impactul schimbărilor climatice asupra răspândirii ascaridozei" in "Schimbarea climei: cercetări, studii, soluţii (culegere de lucrări)", Chişinău, 2000.
- Stern N., "The Economics of Climate Change", UK, 2006.
- Stern, N., The economics of climate change. The Stern review. 4th. print. Cambridge: Cambridge Univ. Press, 2008.
- Tebaldi C., K. Haynoe, J.M. Arblaster and G.A. Meehl, "Going to the extremes: An intercomparison of model-simulated historical and future changes in extreme events". Climatic Change 79: 185–211, 2006.
- Therivel R., Ross B., "Cumulative effects assessment: Does scale matter?" Environmental Impact Assessment Review 27:365–385, 2007.
- Transmonee Database, http://www.unicef-irc.org/databases/transmonee/.
- UNDP Moldova "2006 National Human Development Report: Quality of Economic

Growth and its Impact of the Human Development", United Nations Development Programme, Chişinău, 2006.

- UNDP, "Fighting Climate Change: Human Solidarity in a Divided World", Human Development Report, 2007/08. United Nations Development Programme, 2007.
- UNEP, Assessing Human Vulnerability due to Environmental Change: Concepts, Issues, Methods and Case Studies, UNEP/DEWA/RS.03-5, United Nations Environmental Programme, Nairobi, Kenya, 2002.
- United Nations, "Millennium Development Goals Report 2008", New York, 2008.
- UNPD Europe and CIS, "Drought in Moldova is of catastrophic proportions", http://europeandcis.undp.org/home/show/C9199CF1-F203-1EE9-BE30A716AA49B88E, 2007.
- US Global Change Research Program, Climate Change Impacts on the United States, US Climate Change Science Programme / US Global Change Research Program, Suite 250, 1717 Pennsylvania Ave, NW, Washington. Impact of Climate Change on Human Health, Last consulted on September 29, 2009. http://www.climate.org/topics/health.html.
- Von Doussa J., „Climate Change and Human Rights", published on June 13, 2008. Last consulted on August 9, 2009. http://cpd.org.au/article/climate-change-and-human-rights.
- Warren R., N. Arnell, R. Nicholls, P. Levy and J. Price, "Understanding the Regional Impacts of Climate Change". Research Report Prepared for the Stern Review on the Economics of Climate Change. Research Working Paper No. 90, Tyndall Centre for Climate Change, Norwich, 2006.
- World Bank et al., "Poverty and Climate Change: Reducing the Vulnerability of the Poor through Adaptation", 2003.
- World Bank, "Moldova Agricultural Policy Notes: Agricultural Land", December 2005.
- World Bank, "Moldova: Transport Strategy Update with Emphasis on Road Sector", December 2002.
- World Bank, "Rural Productivity in Moldova – Managing Natural Vulnerability", 2007.
- World Bank/ United Nations Food and Agriculture Ogranization, "Rural productivity in Moldova: Managing natural vulnerability", 2007.
- World Health Organisation, „Assessment of health security and crisis management capacity in the Republic of Moldova", March 2008.
- World Health Organization, "Protecting Health in Europe from Climate Change", 2008.
- World Health Organization, United National Economic Commission for Europe, "Draft guidance on water and climate change adaptation", July, 2008.
- Б.А.Ревич, "Изменение климата и угроза здоровью населения России", Россия в окружающем мире, 2004.
- Коробов Р.М., Николенко А., 2004: Новые проекции антропогенного изменения климата Молдовы в XXI столетии. Р.М. Коробов (ред.). Климат Молдовы в XXI веке: проекции изменений, воздействий, откликов. Кишинэу, стр. 54-97.
- Лалыкин Н.В., Собченко, А.П., 1998: Водные ресурсы рек Молдовы и пути их определения. In: Resursele funciare şi acvatice. Valorificarea superioară şi protecţia lor. Conferinţa ştiinţifico-practică. Chişinău, стр. 142-153.
- Лалыкин Н.В., Сыродоев, И.Г., 2004: Некоторые подходы к оценке воздействий изменения и изменчивости климата на водные ресурсы. В: Р.М. Коробов (ред.). Климат в Молдове в XXI веке: проекции изменений, воздействий, откликов. Кишинэу, стр. 176-212.
- Мезенцев В.С., 1976: Расчеты водного баланса. Омск: ОСХИ.