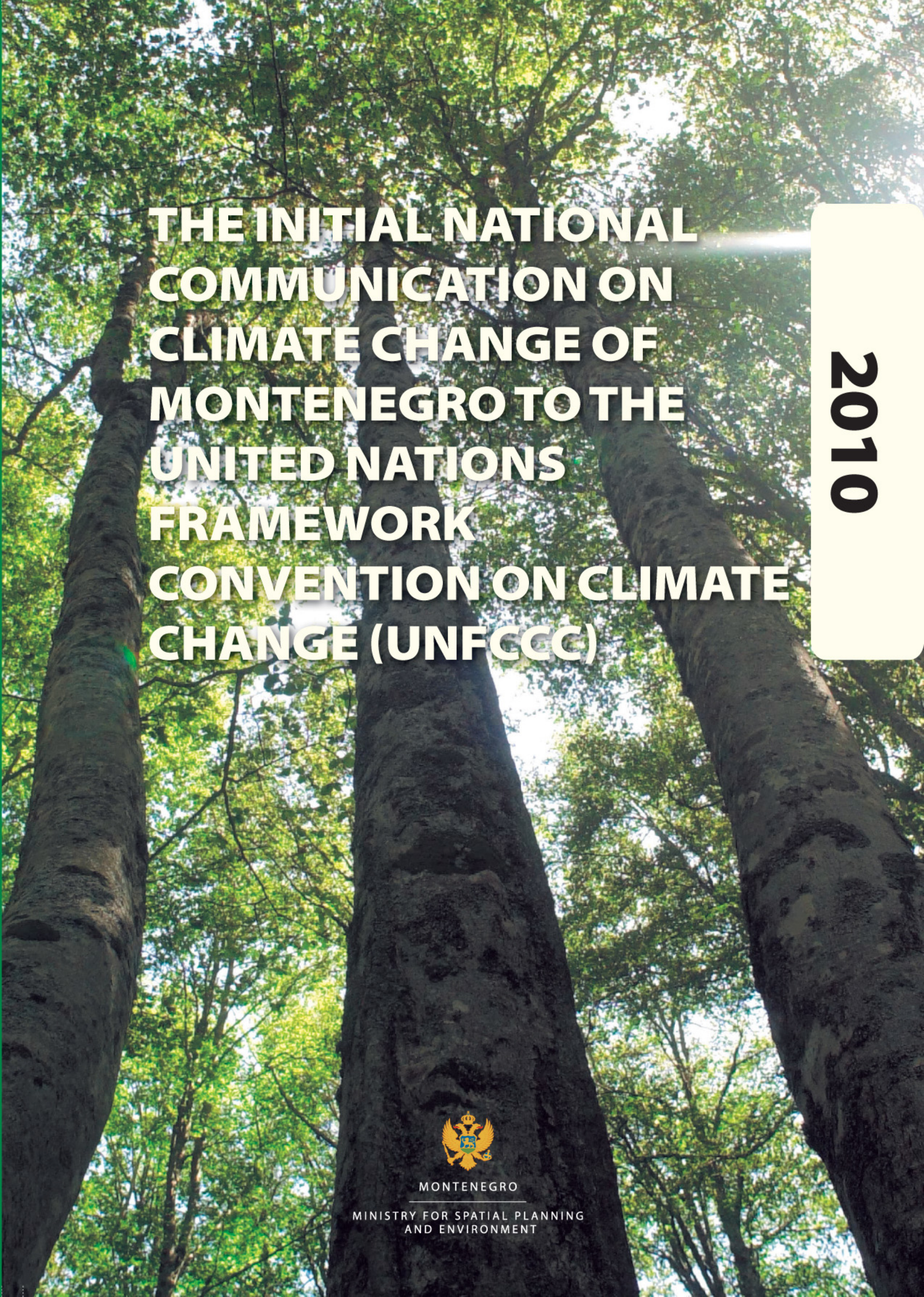

THE INITIAL NATIONAL COMMUNICATION ON CLIMATE CHANGE OF MONTENEGRO TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

2010

MONTENEGRO

MINISTRY FOR SPATIAL PLANNING
AND ENVIRONMENT

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Podgorica, May 2010

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Ministry for Spatial Planning and Environment

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EXECUTIVE SUMMARY

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1. EXECUTIVE SUMMARY

Introduction

Montenegro ratified the United Nations Framework Convention on Climate Change (UNFCCC) by succession in 2006, thus becoming a member of the Convention as a Non-Annex Party on 27 January 2007. The Kyoto Protocol was ratified on 27 March 2007 (the Ratification Law was published in the Official Gazette of the Republic Montenegro 17/07), so that Montenegro became its member as a "Non-Annex B" country on 2 September 2007. Having ratified the UNFCCC and Kyoto Protocol, Montenegro joined the countries that share concerns and play an active role in international efforts to identify the solutions to the problems of climate change. The Council for Clean Development Mechanism (performing the function of the Designated National Authority) was established on 5 February 2008.

The preparation of this Communication was supported by the Global Environment Facility (GEF), within the Project "Enabling Activity for the Preparation of Montenegro's Initial National Communication to the United Nations Framework Convention on Climate Change - UNFCCC" of the Government of Montenegro and UNDP/GEF. The Project was approved in April 2008 and implemented by a large number of experts in various areas, as well as through involvement of relevant ministries, scientific and professional institutions, UNDP, civil society and business sector who participated in the work of the Advisory and Steering Committees. The Communication has been prepared in line with the guidelines for development of Initial National Communications and it represents an important strategic document for sustainable development of Montenegro.

1.2 National Circumstances

1.2.1 Country Profile

General Information
Montenegro is a mountainous country in the Southeast Europe which regained its independence in 2006. The total length of its land borders is 614 km. The section of the Adriatic Sea coast in the country is 293 km long. The total surface of the state territory is 13,812 km^2, and of the territorial sea approximately 2,540 km^2.

Geographic Characteristic
The northern part of the country is dominated by high mountains, descending through a karst segment in the central part with large depressions/plains, to a coastal plain varying in width from several hundreds of meters to several kilometers. The lowest part of the central inland area are the valleys of the Zeta River and the lower Moraca River, comprising the Zeta-Bjelopavlići plain with the Lake Skadar, the largest lake in the Balkans. The mountain ranges in the north include 37 peaks with heights above 2,000 meters. The deepest canyon in Europe, the Tara River Gorge with a depth of up to 1,300 m, is also located in the northern mountainous region.

Climate
The southern region of Montenegro and the Zeta-Bjelopavlići plain have Mediterranean climate, with long, hot and dry summers and relatively mild, rainy winters. The central and northern regions of the country have certain characteristics of mountain climate, although the influence of the Mediterranean Sea is also evident. The continental climate in the far north is characterized by large daily and annual temperature ranges, in addition to low annual precipitation, rather evenly distributed over all months.

The average annual air temperatures vary from approximately 15.8^0 C in the south to 4.6^0 C in Žabljak. The duration of the sunny periods varies from 2,400 to 2,600 hours per year on the coast, i.e. from 1,600 to 1,900 hours in the mountains. Annual precipitation is very uneven, ranging from approximately 800 mm in the far north to about 5,000 mm in the far south. On the slopes of Mount Orjen, at the village of Crkvice (940 m above the sea level), precipitation may even reach 7,000 mm in record years.

Land Use
Agricultural land covers approximately 5,145 km², which is 37% of the total country area; about 6,225 km² or 45% is covered by forests, while the settlements, roads, rocky areas and other categories encompass the remaining 2,442 km² or 18% of the total territory.

Water Resources
The water resources distribution and abundance vary significantly in Montenegro. Generally speaking, with an average annual runoff of 624 m^3/s (i.e. the volume of 19.67 billion m^3), the territory of Montenegro falls among the water rich areas.

Forests
Forests occupy approximately 620,000 hectares or 45% of the total land area, while non-overgrown forest land takes up another 123,000 hectares (9%). The forest cover ratio is 0.9 ha/person. An overall timber stock is estimated to about 72 million m^3, out of which 29.5 million m^3 or 41% are conifers, and 42.5 million m^3 or 59% are deciduous trees.

Coastal Area
The coastal zone (six coastal municipalities) encompasses approximately 11% of the national territory. This region includes a zone designated as special purpose coastal area (public maritime domain – "*morsko dobro"),* which is a narrow coastal belt with the surface of approximately 60 km^2, including inland waters and the territorial sea covering altogether approximately 2,540 km^2.

Environment
Significant sources of air pollution are the main industrial and energy complexes using old technologies, which as a rule apply no adequate mitigation measures. The transport-related air pollution is increasing, especially in city centers. The air quality, evaluated from the aspect of global indicators, is satisfactory. For particular pollutants and at particular locations, it is necessary to take some pollution prevention measures.
In addition to communal wastewater (which is mostly discharged into the natural recipients without prior treatment), untreated industrial wastewater and inadequately disposed waste also make a significant contribution to the pollution of water bodies. The quality of surface waters is generally assessed to be good, with occasional non-compliance with the prescribed standards.

Montenegro has a very rich flora and fauna, as well as diverse ecosystems. With approximately 3,250 plant species, the country is viewed as one of the floristically most diverse regions of the Balkan Peninsula, whereas the species-to-area ratio of vascular plants is very high, amounting to 0.837. The total share of protected areas in the national territory is 9.21%, and it mainly refers to the five national parks.

The data on the generated, collected, treated and disposed volumes of waste, as well as on specific waste streams, are either incomplete or entirely missing, so the planning of waste management is still largely based on estimates. The extent of communal waste recycling is low, while only one sanitary landfill is operated at the moment (for the Municipalities of Podgorica, Cetinje and Danilovgrad).

1.2.2. Economy and Development Priorities

General Information

In 2008, the gross domestic product amounted to 3.09 billion euros, i.e. 4.908 euros *per capita*. For the same year, the service serctor's share in GDP was 77.2%, while the contribution of agriculture and industry (with mining) to the gross domestic product amounted to 9.3% and 13.5%, respectively. The electric power generation, mining, and metal processing make up approximately 70% of industrial production.

Energy

In 2008, the total primary energy consumption amounted to 47.26 PJ, i.e. approximately 1,800 kg of oil equivalent per capita. During the period 1997 – 2008, an average annual growth rate of primary energy consumption was 3.1%. Over the last ten years, the degree of energy self-sufficiency varied between 44% and 58%.

Fossil fuels have a dominant position in the consumption of energy accounting for as much as 70% of the total. Solid and liquid fuels are almost exclusively in use. The solid fossil fuels (mostly lignite) needs are fully met from own sources. The structure of liquid fossil fuels consumption is dominated by motor petrol, diesel and oil fuel (the needs are fully met by imports).

Local electricity generation takes place at the hydro power plants of Piva and Perućica (with a total installed capacity of 649 MW), and the thermal power plant of Pljevlja (210 MW).

Between 27 and 46% of the country's primary energy production originates from renewable sources, whereas 21% to 37% comes from hydro power (almost exclusively generated by large hydro power plants), and 6 % to 10% from firewood.

The sector with the largest energy consumption is industry, followed by general consumption and transport. In 2004, the losses in energy conversion processes amounted to 24.5% of the total consumption.

Final energy consumption went up from 29.33 PJ in 1990 to 30.58 PJ in 2004. Electricity had the largest share (ranging from 41% to 47%) in the total consumption, recording an annual growth of 2.9% in the observed period.

In comparison with the EU, the consumption of primary energy per capita in Montenegro is considerably lower than in the twenty seven EU countries, whereas its electricity consumption per capita is above the EU average. The existing energy intensity and energy efficiency data (although not calculated systemically and on a continuous basis) indicate that there is a considerable room for the introduction of energy saving measures and energy efficiency.

Industry and Mining

The processing industry share in GDP has recently varied between approximately 10% in 2005 and 7% in 2008. The contribution of mining during the same period was under 2%. Obsolate technologies characterized by high levels of emissions are dominantly used by the industrial plants. The largest industrial facilities are in the branches of extractive metallurgy and metal processeing. Recently, the structure of industrial production has somewhat changed due to a more significant presence of food and beverages industry, as well as an introduction of chemical production.

Transport
During the period 2005 – 2008, the share of transport (including the storage andcommunication) in GDP approximately amounted to 11–12%. The road transport is the dominant form of transport, with approximately 5.5 million passengers and 2.5 million tons of freight transported in 2008. The density of main roads equals 13 km per 100 km^2, while the number of regustered passenger cars is somewhat under 190,000. The total length of railways in Montenegro is 250 km.

Tourism
Tourism is a significant branch of economy which is regarded as one of the key development priorities. The number of tourists almost doubled during the period 2003 – 2007 (from approximately 0.6 to 1.1 million), while the number of overnight stays, during the same period, went up for more than 80%. In 2008, the country was visited by approximately 1.2 million tourists, with 7.8 million overnights. The visits/overnights realized in the coastal region prevail in the total tourism turnover

Agriculture
The share of primary agricultural production in GDP for the period 2005 – 2008 remained on the level of approximately 9 % to 10%. The agricultural land structure is predominated by pastures and meadows (approximately 87%), whereas arable land and gardens make up less than 10% of the total agricultural land. Animal husbandry is the most important branch of agriculture, with a share of 60% in the total new value. During the period 1992 – 2004, a relatively stable number of heads was registered in the cattle and hog breeding, while the number of sheep and horses evidently went down. During the 1990s, the poultry numbers slightly went down, whereas a positive trend of growth has been recorded since 2000.

1.2.3 Characteristics of Social Development

Population
According to the last census from 2003, total population of Montenegro was 620,145. The rate of natural increase was nearly halved during the nineties, from 9.7 (per 1,000 inhabitants) in 1991 to 5.5 in 2001, and continued going down until 2007, when it was only 3. In 2003, population density was 44.9 inhabitants per km^2. Approximately 61% of the population lives in urban areas. As for the regional population distribution, the highest level of urbanization is recorded in the central region with more than 78%, whereas approximately 62% and 41% of the population live in urban centers on the coast and in the northern region, respectively.

Education
Based on 2003 census data, approximately 13% of the population in Montenegro holds post secondary education degrees (college and university degrees), out of which 7.5% hold university degrees. Most of the population (approximately 49%) completed secondary education, while 37% completed primary education (fully or several grades) or had no education (4% of the population was in the last category). The illiteracy rate, according to the same census data, was 2.35%. The primary school enrollment rate was approximately 97%.

Healthcare
The life expectancy at birth is 71.2 for men and 76.1 years of age for women. In 2007 and 2008, infant (up to one year of age) mortality rates were 7.4 and 7.5 (per thousand live births), respectively. In 2007, the most frequent causes of death were cardiovascular diseases and tumors.

1.2.4. Institutional and Legal Framework Relevant to Climate Change

Montenegro became a member of the United Nations Framework Convention on Climate Change (UNFCCC) as a non-Annex 1 Party on 27 January 2007. The Kyoto Protocol was ratified in 2007. Considering that the EU accession is a national priority, approximation of national legislation to the parts of *acquis communautaire* on the environment and climate change represents a process whereby the national legal framework is strongly and increasingly shaped.

The Ministry for Spatial Planning and Environment(MSPE) has the key responsibilities in the area of climate change. The Ministry makes the policies and adopts relevant regulations, while the Environmental Protection Agency, as an executive admisitration body, plays a significant role in the implementation of climate change policies. The Designated National Authority for approval of CDM projects was established in 2008, within the Ministry of Spatial Planning and the Environment.

The Ministry of Economy also plays an important role in the area of climate change, by creating energy policies and establishing the objectives and measures to increase energy efficiency. This Ministry also has a department for energy efficiency and renewable energy sources.

1.3 Greenhouse Gas Inventory

For the purposes of the Initial National Communication, Montenegro selected the year 1990 as the baseline year for the inventory of greenhouse gases, and a detailed analysis of the emissions was prepared for this year.

The inventory of greenhouse gases for Montenegro was calculated in accordance with the revised Reference Manual of the Intergovernmental Panel on Climate Change of 1996 (1996 IPCC Reference Manual) and the IPCC Good Practice Guidance and Uncertainly Management Guidance of 2000 godine (IPCC Good Practice Guidance).

The inventory of greenhouse gases of Montenegro includes five sectors in accordance with the revised IPCC Reference Manual, as follows: energy, industrial processes, agriculture, waste and land use change and forestry (LUCF). This inventory did not address Solvent use due to the nonexistance of any valid data.
The emissions of main greenhouse gases were calculated for each inventory sector: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) from the sources and removal by absorption.

In accordance with the collected data, the emissions of synthetic gases were calculated: carbon tetrafluoride (CF_4) and carbon hexafluoride (C_2F_6) from the aluminium industry. The emissions of other perfluorocarbons (PFC), as well as fluorocarbon-hydrogen (HFC) and sulphur hexafluoride(SF_6), were not calculated due to absence of necessary data. Also, indirect gases (ozone precursors) were calculated according to Tier 1 method: carbon monoxide (CO); nitrogen oxides (NO_X); non-methane volatile organic compounds (NMVOC) and sulphur dioxide(SO_2).

In 1990, total greenhouse gas emissions amounted to 2,691.56 Gg CO_2, 27.02 Gg CH_4 and 1.19 Gg N_2O (Table 1.1). CO_2 is the main greenhouse with a share of 53.08 %. The volume of absorbed carbon dioxide in the so-called "sinks" is 485.00 Gg. The calculated emission of PFC gases by the aluminium industry amounts to 0.1936 Gg CF_4 and 0.02 Gg C_2F_6. The total volume of equivalent CO_2 is 4,585.28 Gg (i.e. 5,070.28 Gg if the constribution of absorption is excluded). 92 % of CO_2 emissions is contributed by the energy sector, corresponding to 2,491.92 Gg calculated based on the sector approach and 2,555.51 Gg calculated based on the reference approach; the remaining 8 % (199.64 Gg) comes from industrial emissions.

Table 1.1: A Brief Summary Overview of Direct Greenhouse Gases, 1990

A BRIEF SUMMARY OVERVIEW OF DIRECT GREENHOUSE GASES [illegible]Gg[illegible] Year [illegible]							
GHG SOURCES AND SINKS – CATEGORIES		CO_2 Emissions	CO_2 Absorption	CH_4	N_2O	CF_4	C_2F_6
Gg							
Total National Emissions and Absorption		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Energy	Reference Approach	[illegible]					
[illegible]	Sectoral Approach	[illegible]		[illegible]	[illegible]		
A Fuel Combustion		[illegible]		[illegible]	[illegible]		
B Fugitive Emissions from Fuels		[illegible]		[illegible]			
[illegible] Industrial Processes		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Application of dissolvers		[illegible]			[illegible]		
[illegible] Agriculture	[illegible]			[illegible]	[illegible]		
[illegible] Land Use Change and Forestry		[illegible]	[illegible]	[illegible]	[illegible]		
[illegible] Waste	[illegible]			[illegible]	[illegible]		
[illegible] Other [illegible]Specify[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
Memory Items							
International Bunkers				[illegible]	[illegible]		
[illegible] Aviation	[illegible]	[illegible]		[illegible]	[illegible]		
[illegible] Navigation	[illegible]	[illegible]		[illegible]	[illegible]		
CO_2 Biomass Emission		[illegible]					

Table 1.2.: Anthropogenic GHG Emissions in Montenegro, 1990. (Gg)

Greenhouse Gases	Total Emissions [illegible]Gg[illegible]	Emissions in CO_2 eq [illegible]Gg[illegible]	Share in Total Emissions [illegible]
CO_2	[illegible]	[illegible]	[illegible]
CH_4	[illegible]	[illegible]	[illegible]
N_2O	[illegible]	[illegible]	[illegible]
CF_4 [illegible] C_2F_6	[illegible]	[illegible]	[illegible]
TOTAL		[illegible]	[illegible]

Methane emissions in Montenegro are largely related to the agricultural sector (75% cooresponding to 20.19 Gg) and the waste sector (18% i.e. 4.97 Gg). The agriculural sector is responsible for 97% of the total nitrous oxide emissions. The emissions of synthetic gases calculated as CO_2 equivalent (CO_2eq) provide a total of 1,442.40 Gg CO_2eq. Although the emissions of synthetic gases are not large in absolute terms, still, due to their large heating potential, those are entered into the national inventory immediately after the carbon dioxide emissions (Table. 1.2).

The total equivalent emission of CO_2 (including the absorption) per capita (the 1991 population census) amounts to 7.7 t CO_2eq/person, placing Montenegro among the low-emission countries in comparison with the developed countries. Observing the ratio of CO_2 emission resulting from the combustion of fossil fuels, this ratio is more favorable amounting to 4.55 t CO_2eq/capita because of a significant share of synthetic gases in total emissions. For the purpose of comparison with other Annex 1 and Non-Annex 1 Parties, as well as the neighboring countries, the IEA statistics was used (International Energy Agency-2009 Edition), which takes into account only the emission of CO_2 resulting from fossil fuel combustion calculated according to the sectoral approach (Figure 1.1.). A low share of emissions per capita in Montenegro is explained by a low share of the thermal power sector in the total electric power generation.

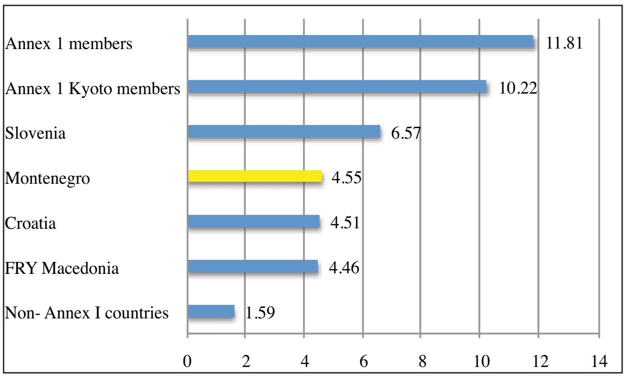

Figure 1.1: Comparative CO2 emissions per capita for Montenegro, countries in the region, Annex 1 and Non-Annex 1 Parties.

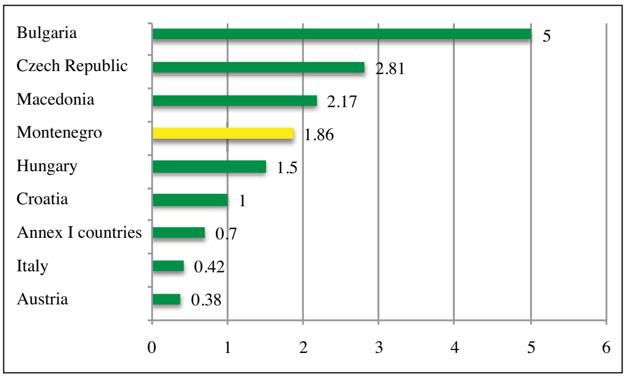

Figure 1.2: Comparative CO2 emissions per kg CO2/USD according to the exchange rate of 2000, for Montenegro, countries in the region, Annex 1 member countries (source: IEA data, 2009)

The emission per GDP is important from the aspect of contribution by the energy sector, and thus also by the realized emissions, to the generation of total revenues of the country. The calculated emission per GDP unit for 1990 amounted to 1.86 kg CO_2/USD, at the exchange rate of 2000. A lower GDP per capita in Montenegro in relation to the Annex 1 countries, as well as the fact that a considerable volume of electricity production is used to satisfy the demand of households and the service sector, results in a substantial increase in realized CO_2 emissions in Montenegro per GDP than is the case in developed countries of the European Union (Figure 1.2).

The 2003 greenhouse gas inventory was prepared in cooperation with the Italian Ministry for the Environment, Land and Sea, applying the IPCC methodology and the sectoral approach; it is transparent and consistent with the inventory from the baseline year 1990. In 2003, the total calculated emissions amounted to: 2,817.75 Gg carbon dioxide; 25.32 Gg methane; 0.92 Gg nitrous oxides; 0.231 Gg CF_4; and 0.02 Gg C_2F_6, whereas 853.26 Gg of carbon dioxide was absorbed by sinks.

Table 1.3 A Brief Summary Overview of Direct Greenhouse Gases, 2003

A BRIEF SUMMARY OVERVIEW OF DIRECT GREENHOUSE GASES (Gg) Year [illegible] god							
GHG SOURCES AND SINKS – CATEGORIES		CO_2 Emissions	CO_2 Absorption	CH_4	N_2O	CF_4	C_2F_6
Gg							
Total National Emissions and Absorption		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Energy	Reference Approach	[illegible]					
	Sectoral Approach	[illegible]		[illegible]	[illegible]		
A Fuel Combustion		[illegible]		[illegible]	[illegible]		
B Fugitive Emissions from Fuels		[illegible]		[illegible]			
Industrial Processes		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
Application of dissolvers		[illegible]			[illegible]		
Agriculture	[illegible]			[illegible]	[illegible]		
Land Use Change and Forestry		[illegible]	[illegible]	[illegible]	[illegible]		
Waste	[illegible]			[illegible]			
Other (Specify)		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Memory Item							
International Bunkers				[illegible]	[illegible]		
Aviation	[illegible]		[illegible]	[illegible]			
Navigation	[illegible]		[illegible]	[illegible]			
CO_2 Biomass Emission		[illegible]					

It was calculated that 92.8 % of carbon dioxide emissions were generated by the energy sector in 2003. The industry sector's contribution amounted to 7.2 % (203.63 Gg). More than 71% of methane emission, corresponding to 18.06 Gg, was contributed by the agricultural sector and 22% by the waste sector. The agricultural sector was the most significant source of nitrous oxide emission (0.89 Gg), with a share of 96.7 % in the total emission of this gas.

Table 1.4: Comparative Emissions of Direct Greenhouse Gases for 1990 and 2003

Greenhouse Gas Emissions	Baseline [illegible]	[illegible]	Change in Relation to [illegible]
	CO_2 equivalent (Gg)		
CO_2 emission (including CO_2 from LUCF	[illegible]	[illegible]	[illegible]
CO_2 emissions (including CO_2 from LUCF	[illegible]	[illegible]	[illegible]
CH_4	[illegible]	[illegible]	[illegible]
N_2O	[illegible]	[illegible]	[illegible]
PFC	[illegible]	[illegible]	[illegible]
Total (including CO_2 from LUCF)	[illegible]	[illegible]	[illegible]
Total (excluding CO_2 from LUCF	[illegible]	[illegible]	[illegible]

The ratio of carbon dioxide emissions by the energy sector and industry sector for 2003 and 1990 slightly changed, since the production volumes by TTP Pljevlja and the main industrial greenhouse gas emitters (ferrous metallurgy, and primarily non-ferrous metallurgy) did not differ significantly for the observed years. The emissions of synthetic gases went up in relation to 1990, due to an increase in aluminium production in 2003. The equivalent CO_2 emissions were reduced by 118.37 Gg (2.58 % reduction) between 1990 and 2003.

1.4 Policies, Measures and Estimates of GHG Emissions Reduction

The main objective of this chapter is to assess the potential for reduction of GHG gas emissions, in line with the adopted national economy development plans. The assessment was carried out through the identification of relevant measures, interventions, projects and practices that are likely to change in the key sectors during the period 2010-2025: energy; industrial processes; agriculture; land use change; forestry and waste. The measures were identified for each sector separately.

It was difficult to assess the GHG emissions due to a lack of sectoral development plans addressing the problems of climate change, relevant data, as well as other relevant national studies. This is particularly pronounced in the sectors of agriculture and forestry, which caused the inability to quantify the measures for reducing GHG emissions in those sectors.

This report is nevertheless important from the standpoint that the potential for reducing the GHG emissions was calculated for the first time in the country. It needs to be occasionally revised, taking into account relevant developments in the national economy.

After examining the inventory of gases for 1990, it is revealed that the sectors with the largest contribution to total GHG emissions in Montenegro are the energy sector, with more than 50% (dominated by CO_2 emissions), and industry, with approximately 32% (dominated by synthetic gases emissions - CF_4) of total emissions.

The projections of GHG emissions in Montenegro were prepared for the energy sector and the non-energy sector (industrial processes and waste). Estimation of reducing GHG emissions includes 2 scenarios: a baseline scenario and the one with measures to reduce GHG emissions.

The baseline scenario for GHG emissions is characterized by the absence of policy measures in support of the activities to reduce GHG emissions. By contrast, the scenario with measures to reduce GHG emissions assumes a gradual implementation of measures leading to reduction of GHG emissions.

Developing a scenario for the energy sector, the simulation software *Long-range Energy Alternatives Planning (LEAP) system* was used, which was, *inter alia*, designed to review the policies and measures in the energy sector for the purpose of preparation of national reports for the Non-Annex I Parties.

By means of LEAP, the scenarios that simultaneously analyze the production and consumption of energy are designed, with special reference to the calculation of GHG emissions according to the IPCC methodology.

Future demands for energy are designed individually for each of the sectors of final consumption (industry, households, transport, services, agriculture and construction industry).

Projections of GHG emissions in non-energy sectors (industrial processes and waste) were prepared using a revised IPCC methodology of 1996.

1.4.1 GHG Emissions Abatement Scenario

This scenario is oriented towards utilization of new renewable energy sources, which is primarily based on small hydro power plants and wind power plants, as opposed to the planned construction of the second block of TPP Pljevlja. In addition to different industrial structures, this scenario includes increasing the efficiency of the existing block of TPP Pljevlja. New production facilities include: small HPP, total capacity 80.2 MW, wind power plants, total capacity 96 MW, and HPP Komarnica, capacity 168 MW.

The following measures were examined in the energy consumption sector:

Combined heat and electricity generation (CHP);
Increasing industrial boiler-room efficiencies;
Substitute fuels for industrial boiler-rooms;
Substitute fuels for high-temperature heat generation;
Replacement of motor fuels;
Replacement of fuels for heating requirements;
Improvement of thermal insulation of residential buildings;
Increasing the share of heat pumps;
Small cogeneration;
Use of solar energy;
Increasing the share of TNG for cooking in households;
Energy efficient household appliances;
Replacement of classical light bulbs with LED light bulbs;
Boiler-room efficiency improvement;
Increasing the share of heat pumps;
Replacement of classical lamps in public lighting;
Motor poor energy efficiency improvement;
Introduction of alternative fuels as a substitute to the existing fossil fuels;
Planning and establishment of a more efficient transport system.

The following measures were examined in the industrial processes sector:

Improvement of technological processes by installing new equipment;
Improvement of technological processes by partial interventions on the existing equipment.

The following measures were examined in the agricultural sector:

Encouraging organic agriculture;
Reduction of methane emissions due to reduction of internal fermentation;
Improvement of animal waste management system practices;
Use of biomass from agriculture for energy purposes.

The following measures were examined in the sector of land use change and forestry:

Increasing carbon storage in plant mass;
Greater utilization of biomass of the wood intended for energy purposes.

The following measures were examined in the waste sector:

Construction of regional sanitary landfills with recycling centers;
Reduction of generated waste volumes by introducing primary selection and recycling;
Reduction of organic waste in municipal solid waste.

1.4.2 Overall Effect of Measures to Reduce GHG Emissions

Summarizing the effects of measures to reduce GHG emissions by sectors analyzed leads to an overall effect of the proposed measures on the level of GHG emissions in Montenegro until 2025. The results of those projections are shown in Figure 3.1. For comparison, the figure also indicates the level of GHG emissions in 1990.

According to the projections of GHG emissions in the baseline scenario, this leads to an increased level of GHG emissions by approximately 40% in 2025, in comparison with 1990. On the other hand, according to the scenario with measures to reduce GHG emissions, the projected level of GHG emissions in 2025 is lower by approximately 46% compared to the level for the same year in the baseline scenario, and lower by 25% than the level of GHG emissions in 1990.

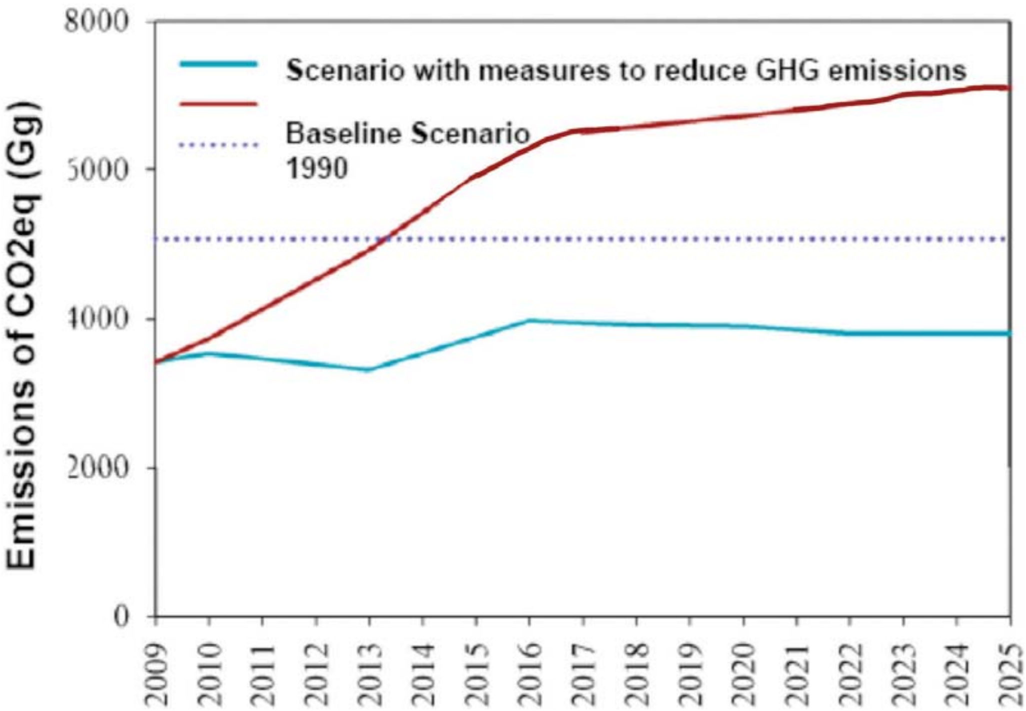

Figure 3.1: Total GHG Emissions in all Sectors in Montenegro until 2025

1.5 Vulnerability and Adaptation to Climate Change

1.5.1 Observed Climate Change 1949 - 2005

Changes in the value of climatic parameters on the level of Montenegro were monitored during the period 1949 – 2005, for air temperature and precipitation.

The results obtained shown an evident trend of air temperature rising in the second half of the XX century in most parts of the territory of Montenegro. Summers have become very hot, especially in the last 18 years. Deviations of mean temperature compared to climatological normal, expressed in the percentage range of 90-98% for the summer period in 1991-2005.

Annual precipitation oscillates around the normal and generally shows no tendency to increase or decrease. Exceptions are the north-eastern parts of Montenegro (Bijelo Polje) and the coast. In the northeast of the country, rainfall has increased since 1949, while at the coast there is a trend of slight reduction in rainfall.

1.5.2 Climate Change Scenario until 2100

The scenario of climate change for the area of Montenegro was prepared with the assistance of EBU-POM climate model. This is a regional linked climate model which represents the system of two regional models, one for the atmosphere and the other for the ocean.

The results of the regional climate model EBU-POM, from the experiments of future climate change for the territory of Montenegro, are focused on the results of scenario A1B for the period of 2001-2030 and 2071-2100, and the A2 scenario for the period of 2071-2100. The report focuses on changes in two fundamental surface meteorological parameters, temperature at 2 meters and accumulated rainfall. Changes in these parameters are shown in comparison to the average base period of 1961-1990.

The most significant temperature changes on the basis of the applied models were obtained for the A2 scenario, for the period 2071-2100, and for the northern part of the Republic during the summer period, amounting to 4.8°C (Table 1.5).

Table 1.5.: Projected Changes in Temperature Values according to the Climate Scenarios for the period 2001-2100, for the Territory of Montenegro

Climate Scenario	Season	Temperature ([illegible]C)	
A[illegible]B Scenario [illegible]		Southern Part of Montenegro	Northern Part of Montenegro
	DJF – December January February	[illegible]°C	[illegible]°C
	MAM – March April May	[illegible]°C	[illegible]°C
	JJA June July August	[illegible]°C	[illegible]°C
	SON – September October November	[illegible]°C	[illegible]°C
A[illegible]B Scenario [illegible]	**DJF** – December January February	[illegible]°C	[illegible]°C
	MAM – March April May	[illegible]°C	[illegible]°C
	JJA June July August	[illegible]°C	[illegible]°C
	SON – September October November	[illegible]°C	[illegible]°C
A[illegible] Scenario [illegible]	**DJF** – December January February	[illegible]°C	[illegible]°C
	MAM – March April May	[illegible]°C	[illegible]°C
	JJA June July August	[illegible]°C	[illegible]°C
	SON – September October November	[illegible]°C	[illegible]°C

In relation to the rainfall model, results show negative and positive changes in precipitation, depending on the part of Montenegro and the season. This can be seen for the season JJA, for the central area of Montenegro, and for the MAM season in the parts bordering on Bosnia and Herzegovina. These positive changes are very small, ranging up to 5%, compared to the value of the base period, 1961-1990. Negative changes, according to the A2 scenario, go even up to -50% in the southern part of Montenegro during the JJA season.

The effect of long-term climate change was analyzed for the most sensitive sectors, such as: water resources, coastal area, agriculture, biodiversity and public health. Forecasts are made on the basis of the results of climate scenarios A1B and A2 for Montenegro.

Water Resources

Analysis show that in the territory covering approximately 90% of the country there is a reduction – deficit of annual precipitation that ranges even up to 20% in certain areas. As water resources have a high degree of correlation with rainfall amount and regime, identified reduction in rainfall will also generate changes in water resources. Changes in water resources are reflected in a pronounced amplitude and oscillations, yield reduction, a sharp increase in flood waters and longer periods with reduced capacity.

In the climate period 2071-2100, according to the model of correlation between the volumes of rainfall and runoff, the trend of change in flow of the Morača River water resource through Podgorica will be reduced by 31% compared to the climatological normal for the period 1961-1990.

Considering the scenario for the changes in precipitation and temperature until 2100, a strong disturbance in the balance of water resources is expected. Given that there is a high degree of correlation between precipitation and the volume of flow and yield, in accordance with future climate scenarios, in which the precipitation is expected to decrease by different percentages ranging up to 50% in certain period (A2 scenario for the period 2071-2100), it can be expected that an overall water balance (water potential) will be reduced in certain areas even by as much as 50%. Climate change, especially in the precipitation regime, will determine the changes in water resources, as follows: in the first place a reduction of overall water balance, and then an increase of amplitudes of hydrological cycles. Accordingly, even in the years with low overall water balance and expressed fluctuation, there will be periods with severe deficit and those with a high surplus in rainfall. Flood waves will become more common due to the increased intensity of rainfall.
The most significant adaptation measures for water resources would include the establishment of a registry of water resources, individual water resource mapping, including all characteristics, and identifying areas of potential danger; water resources of fundamental importance, such as water sources, would have to be protected against any uncontrolled exploitation; establishment of high-level information exchange amongst institutions dealing with water resources as well as procurement of state of the art automatic masurment and control equipment.

Coastal Area

One of the consequences of global warming concerns increasing of the sea level. There are more reasons that lead to the sea level rising. In the first place, this is due to thermal expansion of water, caused by increasing sea temperatures. According to the estimates of the fourth IPCC report, the sea level is projected to rise by approximately 75% until the end of the century, as a result of thermal expansion, and only by 25% due to the melting of glaciers and the areas under the eternal ice.

The upper limit for the sea level increase in the basin of the Mediterranean Sea, including the Adriatic-Ionian basin, was +35 cm for the period 2071-2100 and the A2 scenario, of which +13 cm as a result of thermal expansion, +18 cm as a result of melting glaciers and permafrost, -2 cm as a result of changes in atmospheric pressure fields over the Mediterranean and +6 cm as a result of changes in circulation in the basin itself.

Rising of the Adriatic Sea level by approximately 35cm will provoke serious consequences. The water will continuously flood a large part of the coast that is now on the verge of flooding, and the tidal flood wave area will significantly increase, even in places that have never been targeted by the flood wave before. The naturally established equilibrium will be disturbed by the sea level rising. A large part of the beach area will be reduced, and some beaches will disappear, while the Bojana River will not be able to retain its natural flow to point where it joins the sea; the Bojana River delta will disappear; the torrential flows will not be discharged normally into the coastal waters, so that those will spread across the surrounding environment well before the imagined natural coast line, and this will lead to the flooding of areas which have not had such flood characteristics before.

The most important adaptation measures would include the development of a very high quality and operational service for monitoring the condition of the shore and the waves and warning about the existence of any danger a few days in advance, as well as the preparation of spatial planning documentation which should also include the effects of climate change on the coast, so as to prohibit the construction and urbanization in any zones that may be potentially exposed to dangerous tidal waves as a result of the new situation.

Agriculture

The analysis of agriculture as a vulnerable sector includes the effect of climate change on land, crop production and animal husbandry. Special attention is focused on the impact of the results of climate scenarios on crop production. The study included the calculation of reference evapotranspiration (ETo), as well as of water demand by plants.

Looking at the obtained values of summary reference evapotranspiration in the winter period for 3 different scenarios, it can be seen that the scenario A1B (2001-2030) shows an increased value of ETo as compared to the base climate scenario (1961-1990), by 3.6% to 8.7%. Lower values of ETo increasing correspond to the coastal sectors with the Mediterranean climate, while the higher ones correspond to the mountain and continental climate. An increase in the reference ETo for two scenarios relating to the period 2071-2100 amounts to 10.3-20.2% in the A1B scenario, and from 12-23.5% in the A2 scenario. The same increasing trend appears, as in the previous scenario, in case of the sectors with the Mediterranean, mountain and continental climate. Expressed in absolute values (mm of water column), this increase is the greatest in the A2 scenario (2071-2100) amounting to 12 mm.

The most important adaptation measures include irrigation and drainage systems in regulating the water content in the zone of root systems, reduced tillage, deep tillage, surface covering with crop residue, soil spreading, or the density of planting may be modified, all in order to preserve a certain volume of moisture in the root zone system

Forestry

The sensitivity of forest ecosystems to climate change impacts is commonly observed in the context of social capabilities and capacity of natural ecosystems to remain resistant or easily adaptable to the changed conditions in nature. The expected climate changes will result in the shifting of certain vegetation zones (forest types), both in terms of latitude and altitude. In some areas an increased drying of trees may be expects, as a result of stress and attacks of pests and plant diseases, as well as reducing weight gain, slower natural regeneration and greater damages caused by forest fires and atmospheric disasters.

On the basis of the results of climate scenario for the territory of Montenegro, expected changes in climate factors would have an adverse impact on the forest ecosystem, demonstrated by reducing moisture in the soil (particularly during the growing season when the plants need it the most), a prolonged duration of the growing season and hampered natural regeneration.

Expected climate change will influence the disappearance of sensitive forest types (species with narrow ecological valence), shift climate zones, and thereby shift the borders of certain forest types (vegetation zones) in relation to latitude and altitude.

The most important mitigation measures include implementing forest management systems that support and protect sustainable forest management, natural regeneration of forests, increasing forest area, care and protection of existing forests, conversion of coppice forests into high forests; reconstruction of degraded forests; sanitary felling in forests affected.

Biodiversity
It is very difficult to evaluate the impacts of climate change on biodiversity because the changes occur slowly and the effects of these changes are always in interaction with other influences that have already caused certain consequences and reactions.

In line with the expected climate change (increased temperature and reduced humidity), a reduction in and loss of species is expected, primarily those related to freshwater ecosystems, as well as species vulnerable to significant fluctuations in temperature and humidity environments (amphibians). It is estimated that this may reduce and fully endanger the populations of amphibians and reptiles in karst areas of old Montenegro and karst regions of Kuča-Žijovo, as well as in the coastal mountains of Rumija, Lovćen and Orjen. A temperature increase in the continental part of Montenegro would eventually lead to acceleration of eutrophication of mountain lakes, and then to their withdrawal and complete disappearance.

Data on the phenology of woody species already indirectly indicate the presence of the consequences of climate change on the productivity of some ecosystems in Montenegro. Available data show that the listing of some species (black locust, linden, oak, maple, ash, beech, poplar, alder, pine, and maritime pine) begins a few days earlier than usual. Listing of given species begins around 12 days earlier than on average.

In relation to the marine ecosystem, the foreseen climate change would lead to faster eutrophication of shallow and confined parts of the sea waters, as well as the introduction of new thermophilic (invasive) species from southern marine biogeographic zones. Also, one of the main problems may be migration of marine species through the Suez canal, mainly from the Red Sea, the Pacific and Indo-Pacific areas into the Mediterranean.

Significant measures to mitigate the consequences of climate change on biodiversity would cover the establishment of scientific infrastructure for the purpose of investigation of the impact of climate change on biodiversity, terrestrial ecosystems and the sea, training of experts; establishment of an intersectoral group which will deal with issues of water resources management and protection of biodiversity, etc.

Public Health
Climate change and weather conditions are related to human health in a complex manner. The changed climate has direct and indirect and predominantly negative effects on human health, causing changes and events in an organism which can cause injury, illness and disease with a fatal outcome.

In addition to direct impacts on health and disease, climate change leads to a rapid growth, development and propagation of disease vectors (mosquitoes, ticks) that transmit malaria, leishmaniasis, sandflies fever, dengue, viral encephalitis and meningoencephalitis.

Climate change directly affects the availability of water, crop yield, production and quality of food, + as a consequence causes a higher frequency of disease due to impaired water supply and unsafe food leading to diarrhea, diarrhea, dysentery, salmonellas, hepatitis and others. The effects of air pollution and soil lead to a number of diseases and premature death.

There are no reliable health statistics in Montenegro on the effects of climate change on population health, illness and dying there, because no attributes necessary for such a complex evaluation are contained in the mandatory health records.

1.6 Constraints, Gaps and Needs

Constraints and Gaps

The most important technical and methodological constraints and gaps identified during the preparation of the Initial Communication (which will influence the preparation of the following Communications and the implementation of measures) are:

- In preparing the inventory for 1990 and 2003 the lack of data was evident for several categories (sectors: "use of solvents"; "energy" - emissions from international aviation and maritime bunkers and from aircrafts; "industrial processes" - asphalt production and consumption of halogenated hydrocarbons and sulfur hexafluoride; "land use change and forestry "; " waste ").
- Due to the unavailability of input data needed to determine the indirect emissions of greenhouse gases, Tier 1 methods were taken for the calculation, which means that the obtained data should be interpreted with a high degree of uncertainty;
- Sectoral development plans and strategies generally do not consider the issue of climate change and therefore define no measures to reduce emissions.
- Lack of relevant data for the projections of GHG emissions is particularly pronounced in the sectors of agriculture and forestry, and to a lesser extent in the waste/wastewater sectors;
- Lack of technical and scientific research on vulnerability to climate change and adaptation is characteristic for all sectors which are considered in the Initial Communication;
- When it comes to institutional constraints, lack of experience, insufficient capacity, inadequate collaboration and exchange of information among institutions stand out, as well as a low level of knowledge and lack of funds for research programs; insufficient availability of financial resources in general represents a significant constraint.

Needs

Generally speaking, it is necessary to make further efforts towards the institutionalization of work on the National Communications and to develop capacity for monitoring and reporting on all elements of the Communication, to strengthen the awareness of climate change on all levels and mechanisms for the formulation of integrated responses to climate change. Specific needs that were identified include:

- Improving the availability of statistical data for all sectors and across all components of National Communications;
- Developing capacity for establishing a greenhouse gases inventory system;
- Development and application of national methods for improving the accuracy of GHG inventories;
- Securing support for implementation of identified measures to reduce GHG emissions, more precise definition of measures and determination of priorities within sectoral policies and strategies as well as in the process of preparing the following National Communications;
- Securing financial support to increase energy efficiency;
- Creating incentives and establishment of preconditions for the application of new technologies that enable the reduction of GHG emissions;
- Raising awareness about the problem of climate change, improving cooperation and information exchange;
- Identification of particularly vulnerable areas by sectors;
- Strengthening of scientific and research work in the field of vulnerability and adaptation;
- Ensuring sustainable management of natural resources and integration of climate change issues; Education and dissemination of information in order to develop awareness on the impacts of climate change on human health..

INTRODUCTION

2

2. INTRODUCTION

According to the latest, Fourth Report[1] of the Intergovernmental Panel on Climate Change (IPPC) of 2007, warming of the climate system is unequivocal. It is clearly indicated by the so far recorded increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.

The temperature increase is evident across the entire planet and is more significant at higher northern latitudes. Observations dating back since 1961 show that the average global ocean temperatures rose to a depth of at least 3,000 m, and that the oceans take up more than 80% of additional heat in the climate system. Global average level of the sea has risen at an average rate of 1.8 mm per year in the period 1961 - 2003 and much faster - on average by 3.1 mm per year - in the decade 1993 - 2003. In the period 1900 – 2005, the precipitation significantly increased in the eastern parts of North and South America, northern Europe and northern and central parts of Asia, while precipitation declined in the Sahel[2] region, the Mediterranean, southern Africa and parts of South Asia. The frequency and/or intensity of some extreme weather events have also changed in the last 50 years.

Causes of the observed changes are, *very likely*, increased concentrations of greenhouse gases (GHG) caused by human activities. This assessment from the Fourth IPCC Report (4AR) has a higher degree of certainty than the one given in the Third Report (TAR) from 2001, which said that "most of the observed warming over the past 50 years is *likely* to have been due to the increase in GHG concentrations". This means that the level of uncertainty about the nature of global warming is now lower than it used to be.

Global GHG emissions increased by about 70% in the period 1970 – 2004 alone. In 2005, atmospheric concentrations of some of the key GHG such as carbon dioxide and methane (CO_2, CH_4) were far above their natural ranges over the past 650,000 years. The global atmospheric concentration of CO_2, for example, increased from 280 ppm in pre-industrial period to 379 ppm in 2005.

If actions are not taken to reduce anthropogenic GHG emissions, the 4AR estimates that global average temperatures by the end of this century will increase by an additional 1.8 to 4.0 ° C (depending on the applied IPCC emissions scenarios), and for 6.4 ° C in the worst case scenario. Even an increase in temperature from the lower end of this range would lead to the total (past and future) growth of over 2°C compared to the pre-industrial period, which according to many scientists is the threshold above which irreversible and possibly catastrophic changes in the natural systems can be expected. For the decade 2090 - 2099, depending on the applied IPCC scenario, the sea level rise estimates are in the range of 18-59 cm, compared to the period 1980 - 1999.

Climate change is happening and is one of the greatest threats facing humanity, both in the field of environmental protection and in the economic and social arena. For southern Europe, for example, it is expected that climate change would worsen the conditions (high temperatures and drought) in this region already vulnerable to climate variability, as well as reduce the availability of water resources, hydropower potential, summer tourism and, in general, the productivity of crops.

1 Fourth Assessment Report or 4AR, 2007

2 Sahel is an ecoclimatic and biogeographical zone in the north of the African continent which encompasses transition between the Sahara Desert in the north and the Sudanian savannas in the south, extending across the entire continent: from the Atlantic to the Red Sea.

Societies can respond to climate change by reducing GHG emissions, in order to reduce the extent and magnitude of change, and by adaptation to the actual changes. In 1992, the need for a systematic and global response to climate change brought about the adoption of the United Nations Framework Convention on Climate Change (UNFCCC). The Convention entered into force in 1994, and has been ratified by 194 countries and the European Union. UNFCCC is a framework for international cooperation in the field of climate change aiming to stabilize concentrations of GHGs in the atmosphere, thus preventing dangerous anthropogenic influences on the climate system. So far, 15 annual conferences (COPs) of the member countries of the Convention have been held.

The Kyoto Protocol of 1997 (entered into force in 2005) represents a step in the direction of reversing the global trend of rising GHG emissions. The Protocol set legally binding quantified targets for developed, industrialized countries to reduce their GHG emissions on average by 5% by 2012 (in relation to 1990). Both the UNFCCC and the Kyoto Protocol are based on the principle of common but differentiated responsibilities of developed and developing countries (grouped in different Annexes of the Convention/ Protocol) for the previous increase in GHG concentrations in the atmosphere and global warming as well as for future action towards resolving the problem of climate change.

Final Document of the 15th Conference on Climate Change which was held in Copenhagen in December 2009 (the Copenhagen Agreement) is characterized, *inter alia*, by the following:

- For the first time a global agreement was reached on limiting the temperature increase to less than 2°C in relation to the pre-industrial period, thus confirming the position of the scientific community that the temperature rise should not exceed this limit;

- It is not legally binding, but represents the first step towards setting up legally binding and quantified targets for reducing emissions for the period 2013 - 2020 and in long term until 2050 (which is expected to be achieved at the next conference in Mexico).

The agreement stipulates that the countries will, until the end of January 2010, identify and communicate their national emission reduction targets until 2020, and also foresees significant financial resources to assist developing countries in combating global warming. Montenegro ratified the United Nations Framework Convention on Climate Change (UNFCCC) by succession in 2006, thus becoming a member of the Convention as a non-Annex 1 country on 27 January 2007. The Kyoto Protocol was ratified on 27 March 2007 (Law on Ratification was published in the Official Gazette of the Republic of Montenegro 17/07), so that Montenegro became its Non-Annex B member country on 2 September 2007. Having ratified the UNFCCC and the Kyoto Protocol, Montenegro joined the countries that share concerns and play an active role in international efforts to resolve the problem of climate change. The Council for Clean Development Mechanism (which performs the function of the Designated National Authority) was established on 5 February 2008. Montenegro also supported the Copenhagen Agreement and intends, on the basis of findings of the Initial National Communication on Climate Change to the UNFCCC, to define national measures to reduce emissions by 2020 and submit them to the Secretariat of the Convention.

Considering that Montenegro is a member of the Convention as a non-Annex 1 country, it is under no obligation to reduce GHG emissions. On the other hand, the country is required to periodically prepare GHG inventories as a part of its National Communications to the UNFCCC, as well as to report on the vulnerability of its natural resources and economy due to climate change. In addition to these, by becoming a member of the Convention, Montenegro assumed some obligations in respect of:

- adoption and implementation of programs of measures to mitigate the effects of climate change;
- developing practices and processes that control, reduce or prevent GHG emissions by sectors: energy, transport, industry, agriculture, forestry, waste management;
- transfer and application of technologies, research and systematic observation of climate (including meteorological and hydrological research), exchange of information and establishment of a database, which is related to the climate system;

- rational use of the GHG absorbers and reservoirs, including biomass, forests, oceans and other terrestrial and marine systems;
- inclusion of climate change assessments in the national strategies and policies of socio-economic development, in order to minimize negative effects on economic development, population health and the environment;
- cooperation in the field of education, staff training and public awareness strengthening.

For the developing countries, including Montenegro, the Kyoto Protocol did not foresee any new obligations in relation to those in the Convention (therefore there is no quantified target of reducing GHG emissions which the country is required to achieve by 2012).

The process of preparation of the Initial National Communication began in April 2008, and was financially supported by the Global Environment Facility (GEF), through a project of the Montenegrin Government and the UNDP / GEF – "Enabling Activity for the Preparation of Montenegro's Initial National Communication to the United Nations Framework Convention on Climate Change – UNFCCC". The main objective of the project was strengthening of technical and institutional capacity to address climate change issues and their integration into sectoral and national development priorities.

The first drafts of national GHG inventories for 1990 and 2003 were prepared in 2005, in the framework of the Memorandum of Cooperation signed by and between the ministries of environment of the Republic of Italy and Montenegro. For the purposes of this Communication, the first draft inventory for 1990, which was chosen as the base year, was evaluated and improved through review of all input data and by using more recent research results and documents that were not available for the preparation of the inventory version of 2005.

The Initial National Communication also presents the GHG inventories for 2003 and 2006 that were prepared as a part of the said cooperation with the Italian Ministry of Environment, Land and Sea. The GHG inventory for 2003 was prepared using the IPCC methodology with the Sectoral approach and is consistent with the inventory the base year 1990. The GHG inventory for 2006 was prepared for the purpose of reporting according to the LRTAP Convention, using the CORINAIR methodology. The emissions of greenhouse gases in 2006 are not comparable with those of 1990 and 2003, due to a partial consistency of methodologies, so for this reason the GHG emissions for 2006 are shown separately in Annex II to this Communication.

Around 20 local experts from various fields were engaged and have worked in multi-disciplinary teams to prepare an inventory of greenhouse gases, a program of measures for ensuring adequate adaptation to changed climatic conditions and a program of measures to mitigate climate change, An important role in this process was played by the Ministry for Spatial Planning and Environment (as the focal point for the Convention and Protocol), as well as by other relevant ministries (Ministry of Economy, Ministry of Agriculture, Water Management and Forestry, etc.) and institutions (Environmental Protection Agency, Hydrometeorological Institute, etc.). The Steering and Advisory Committees were established to monitor the preparation of the Initial National Communication, with representation from all relevant ministries, scientific and professional institutions, Academy of Science and Arts, non-governmental and business sectors and the UNDP. The document was planned to be completed and submitted to the Secretariat of the Convention until October 2010. Within the same project, the preparation of a study was initiated to assess the economic impacts of climate change on vulnerable sectors of the economy of Montenegro. This study is planned to be completed in parallel with the completion of the Initial National Communication.

The Communication that follows was prepared in accordance with the recommendations given in the "Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention" (17/CP.8), the appropriate GEF procedures and relevant Montenegrin legislation and documents. In the process of preparation of the Communication, technical and steering/ advisory teams encountered certain difficulties. Those were primarily related to lack of data (unavailability of certain data or data series, unreliability, etc.), but also to an insufficient level of knowledge and awareness about climate change and a relatively low level of institutional capacity.

Notwithstanding the aforementioned difficulties, the process of drafting the Initial National Communication and the document itself are in many ways significant for Montenegro. First of all, the process contributed to developing the capacity for systematic monitoring of GHG emissions and their reporting. In addition, the Communication identified for the first time a range of measures for climate change mitigation and adaptation, as well as general constraints, gaps and needs the country faces in its efforts to define the appropriate responses to climate change, stressing at the same time the necessity of integration of climate change in sectoral policies and programs. The assessment of economic impact of climate change on vulnerable sectors of the Montenegrin economy resulted in preliminary, rough estimates of economic effects of the expected physical impacts that were identified in the Initial National Communication in certain sectors due to climate change. The study also deals with the evaluation of methodologies, data required and the necessary development of analytical and institutional capacity to accurately assess impacts of climate change on economic parameters in the future. It is expected that this study would be useful for further climate change integration into sectoral policies and for the preparation of the Second National Communication.

The first national Communication is an important strategic document for the sustainable development of Montenegro. The principles and objectives adopted by the country through confirmation of the UNFCCC and the Kyoto protocol and by supporting the Copenhagen Agreement, as well as those originating from the process of stabilization and association to the EU, have been operationalized by this document. Starting from this important initial step in addressing the issue of climate change, Montenegro is planning to prepare the Second National Communication and will continue to play an active role in global and regional partnerships.

NATIONAL CIRCUMSTANCES

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NATIONAL CIRCUMSTANCES

3.1. Country Profile

Montenegro is a mountainous country in the Southeast Europe which regained its independence in the 2006. Geographic coordinates of extreme points of the state territory are 43º 32 '(Moćevići, Pljevlja) and 41º 52' (Ada, Ulcinj), north latitude, and 18º 26' (Sutorina, Herceg Novi) and 20 º 21' (Jablanica, Rozaje), east longitude. On land, it borders Croatia in the west (14 km), Bosnia and Herzegovina in the west/northwest (225 km), Serbia and Kosovo to the north and northeast (203 km), and Albania on the east/southeast (172 km). The length of the Adriatic Sea coast in the country amounts to 293 km.

The total surface of the state territory is 13,812 km2, while the surface of the territorial sea is around 2,540 km2. According to the census of 2003, Montenegro had 620,145 inhabitants, which gives the population density of 44.9 people per km^2. In administrative terms, the national territory is divided into 21 municipalities/ local self-governments units.

3.1.1. Geographic Characteristic

The terrain of Montenegro is made up of late Paleozoic, Mesozoic and Kenozoic rocks. As for the hydro-geological characteristics, it is dominated by highly permeable carbonate rocks. Due to the composition of the rocks, precipitation quickly penetrates into the ground feeding both confined and unconfined karst aquifers that discharge into the zones of erosion bases, coastal sea, Skadar Lake and along the rim of the Zeta-Bjelopavlići plain, the Nikšić field and alongside the waterbeds.

As a consequence of the long geological evolution of the terrain and changing endogenous and exogenous forces, the relief of Montenegro is highly diversified. The north is dominated by high mountains; the central part is made up of the karst area with major depression/lowland areas, while coastal plains varying in width from a few hundred meters to several kilometers extend in parallel with the coast. The coastal zone is separated from the mainland by the mountains of Orjen, Lovćen and Rumija, whose slopes sometimes, as in the case of Boka Kotorska Bay, steeply descend to the coast. The lowest part of the central mainland area consists of the Zeta River and lower flow of the Morača River valleys, making up the Zeta-Bjelopavlići plain with Skadar Lake - the largest lake in the Balkans. The mountain ranges in the north include 37 peaks with heights above 2,000 m, the highest of which are Bobotov Kuk (Durmitor) and Maja Rozit (Prokletije), with 2,522 m each. The mountain peaks of Montenegro are among those parts of the Balkan Peninsula, which were the most ice-eroded during the last glacial period. The deepest canyon in Europe, the Tara River Gorge with a depth of up to 1,300 m, is also located in the northern mountainous region.

The entire area of Montenegro, and especially its coastal and central part, is a seismically active area. An earthquake that measured 9 degrees on the Mercalli scale was for the last time registered in 1979, when the coastal area was particularly affected.

3.1.2. Climate

Besides latitude and altitude, the climate in Montenegro is determined by the presence of large bodies of water (Adriatic Sea, Lake Skadar), the sea entering deeply into the land (Boka Bay), moderately high mountainous area near the coast (Orjen, Lovćen, Rumija), Ulcinj field in the far southeast and the mountainous massif of Durmitor, Bjelasica and Prokletije.

Based on the data for the base climate period 1961 – 1990 and according to the classification by Köppen, two types of climate are present in Montenegro: moderately warm C and moderately cold D. The warm climate is present in the lower parts of the country, while the D-type climate can be found in the mountainous inland areas, mainly at altitudes above 1,000 m.

The southern part of Montenegro and the Zeta-Bjelopavlići plain have Mediterranean climate with long, hot and dry summers and relatively mild and rainy winters. Podgorica is the city with the highest mean monthly temperature in the summer, and with the highest average number of tropical days. The climate is significantly more severe in the karst fields whose lowest parts lie far below the surrounding mountain peaks and are located at a distance of 40-80 km from the Adriatic Sea, as well as in the fields that are quite close to the coast (about 20 km) but are separated from the sea by high mountains. The central and northern parts of Montenegro have some characteristics of mountain climate, but the influence of the Mediterranean Sea is also evident, which is reflected through the precipitation regime and higher mean temperatures in the coldest months. The far north of Montenegro has a continental climate, which is, besides the large daily and annual temperature variations, characterized by low annual precipitation evenly distributed over all months. In the mountainous areas in the north summers are relatively cool and humid, and winters are long and harsh, with frequent frosts and low temperatures, which rapidly decreases with height. The lowest mean annual temperature is recorded at Zabljak (Tara River basin).

An overview of average annual air temperatures (ranging from about 15.8^{0}C in the south to 4.6^{0}C in Žabljak) is shown in Figure 3.1. The mean annual cloudiness is increasing from south to north of Montenegro. The lowest values are recorded at the Montenegrin coast, Zeta-Bjelopavlići plain and in Nikšić area. Cloudiness on the coast ranges from 44% to 47%, in Podgorica it is 48% and in Nikšić 50%. The highest mean annual cloudiness is recorded in the mountain areas in the north, on average between 56% and 62%. Observed by months, the lowest cloudiness occurs in the south during the summer months and the highest one in the north during the period November – February.

Figure 3.1: Annual distribution of air temperature (^{0}C) for the averaging period of 1961-1990

The duration of the sunny periods on the coast varies from 2,400 to 2,600 hours per year, i.e. from 1,600 to 1,900 hours in the mountains. The Ulcinj region has the longest mean duration of sunshine with 2,557 hours per year. In all areas, the duration of sunshine in July and August is about 4-5 times longer than in the winter months

On average, annual number of days with precipitation is about 115-130 on the coast or up to 172 in the north. The rainiest months on average have 13-17, and the driest ones 4-10 rainy days. The number of days with somewhat more abundant daily rainfall (over 10 mm) ranges from 25 (Pljevlja) to 59 (Kolašin). However, the largest number of days with heavy precipitation is recorded in Cetinje – 74 days.

The snow cover is formed at the altitudes above 400 meters. A snow cover deeper than 30 cm can be expected at the altitudes above 600 m, and even deeper than 50 cm at those above 800 m. An average number of days with a snow cover deeper than 50 cm is 76 days in Žabljak, and 10 days in Kolašin.

Annual precipitation is very uneven ranging from about 800 mm in the extreme north to about 5,000 mm in the extreme southwest (Figure 3.2). On the slopes Orjen, in the village of Crkvice (940 m above sea level), precipitation may even reach 7,000 mm in record years, which makes it the raini-est place in Europe.

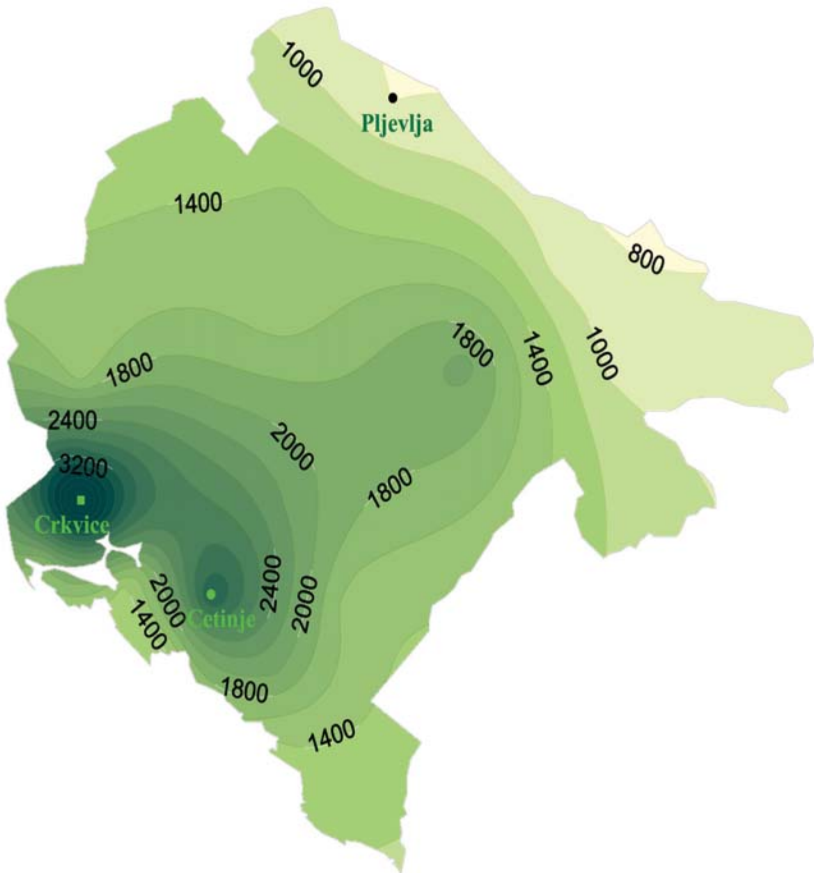

Figure 3.2: Annual distribution of rainfall (mm) for the averaging period 1961-1990

An overview of basic climatic parameters (number of sunshine hours in one day, precipitation, temperature, number of days with precipitation) for Podgorica, Bar and Žabljak is shown in Figure 3.3.

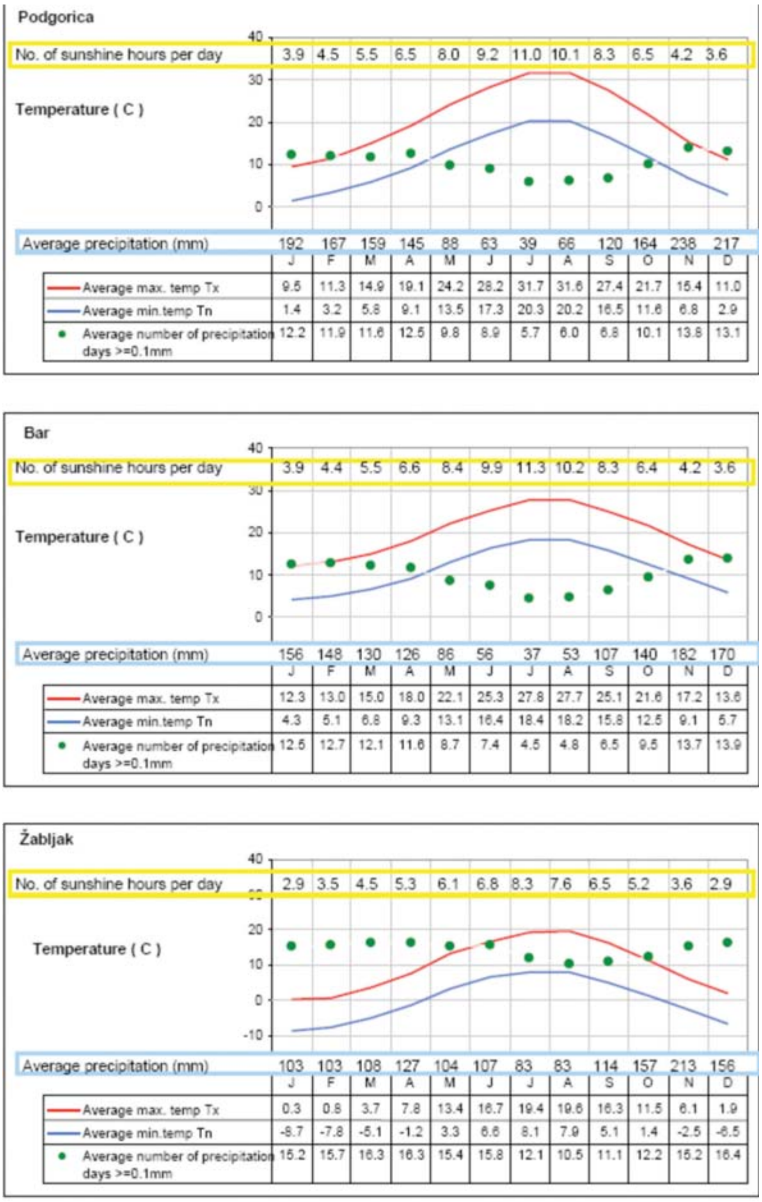

Figure 3.3: The number of sunshine hours in one day (framed in yellow), average rainfall (framed in blue), the average maximum and minimum air temperature and average number of days with precipitation ≥ 0.1 mm (represented by green dots). Averaging period 1961-1990

The year 2003. was the warmest year in Montenegro, when a tropical period of 100 consequent days (with maximum daily temperature greater than or equal to 30^{0}C) was recorded in Podgorica. The highest daily temperature of 44.8^{0}C was measured in August 2007 in Podgorica, while the lowest daily temperature of -32^{0}C was measured in Rozaje, in the eastern part of Montenegro, in January 1985.

The biggest floods were recorded in the upper flow of the Tara and the Lim rivers in 1963 and 1979, and then at the end of 1999 and in the first half of 2000. The last decade of the 20th century was warmer than what is indicated by the results of multi-year series of measurements (since 1949 until the present day)

3.1.3 Land Use and Spatial Planning

Agricultural land covers an area of about 5,145 km ^{2} and makes 37% of the total national territory, 6,225 km^2 or 45% is covered by forests, while the settlements, roads, water, rocky areas and other categories occupy 2,442 km^2 or 18% of the territory (data from the Spatial Plan, 2008). More details about the structure of forests and forest lands and the agricultural land are given in chapter 3.1.4.2 and 3.2.5.

In total, there are 40 urban and 1,216 countryside settlements in the country. The densest network of settlements is in the coastal area with an average of 15 settlements per 100 km^2, while the lowest density of 7.8 settlements per 100 km^2 is found in the north. The municipalities in the central region have about 8.8 settlements per 100 km^2, which is close to the average density of the network of settlements at the national level of 8.98 settlements per 100 km^2. Urban (detailed) plans are developed for an area of 66.74 km^2.

The existing and planned land uses are determined through a process of spatial planning. Spatial plans are made on the national (Spatial Plan of Montenegro, special purpose areas spatial plans such as those for the public maritime domain and the national parks, detailed spatial plans and national location studies) and on the local level (spatial - urban plans of local self-governments, detailed urban plans, urban designs and local location studies).

3.1.4 Natural Resources of Special Importance for Climate Change Considerations

3.1.4.1 Water Resources

In Montenegro, there are significant differences in the distribution and abundance of water resources - starting with arid karst areas to those that are rich in both surface and groundwater. Generally speaking, with an average annual runoff of 624 m^3/s (i.e. the volume of 19.67 billion m^3), the territory of Montenegro falls among the areas rich in water. An average specific runoff is about 43 liters/s/km^2. Of the total runoff, about 95% are inland waters, while the remaining 5% are transit waters.

The rivers drain into two basins: the Black Sea, with a total area of 7,260 km^2 (or 52.5% of the territory), and the Adriatic Sea with about 6,560 km^2 (or 47.5%). The major rivers of the Black Sea basin are the Lim (the longest river, 220 km long), the Tara (146 km), the Ćehotina (125 km) and the Piva (78 km), and of the Adriatic Sea basin the Morača (99 km), the Zeta (65 km) and the Bojana(40 km) rivers.

Natural lakes are also an important water resource, the most significant of which are Biogradsko (area of 0.23 km^2), Plav (1.99 km^2), Black (0.52 km^2), Šasko (3.6 km^2) and Skadar Lake. Surface area of the Skadar Lake, depending on the water level, varies from about 360 to over 500 km^2, while the volume of the lake ranges from 1.7 to 4.0 km^3. The total catchment area of Skadar Lake is some 5,500 km^2 (4,470 km^2 in Montenegro and 1,030 km^2 in Albania). Natural lakes are located at elevations ranging from 1.4 m (Šasko Lake) to 1,418 m (Black Lake), and three of them - Biogradsko, Black, and Skadar - are a part of the national parks. The largest artificial reservoir is Piva Lake with a total accumulation capacity of 880 x 10^{6}m^3. Other significant accumulations include the lakes of Slano, Krupac and Vrtac (225 x 10^{6}m^3) and the accumulation of Otilovići (18 x 10^{6}m^3).

Wetlands can generally be found in areas around the lakes and to a lesser extent in the coastal area. The most important wetland area is located in the vicinity of Lake Skadar, and is listed as an internationally important area (based on the Ramsar Convention).

The data on groundwater are incomplete since the previous surveying was rare and limited in scope.

Water Use

Not counting the water used for electricity generation[3], the largest water consumer is the population. In 2005, about 102 million m^3 of water was extracted for the purpose of water supply to the settlements (of which about 90% came from groundwater and spring water sources). This was followed by industry, with about 49 million m^3, while the sector of agriculture, with water use of less than 7 million m^3 per year, was not a significant consumer. An overview of extracted volumes (by source) for the industrial and agricultural purposes is shown in Table 3.1 below.

Table 3.1: The use of water for irrigation and industry 2003-2007 (in 000 m^3)

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Industry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Groundwater and Springs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Public Water Works	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Surface Waters	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Irrigation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Groundwater and Springs	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Surface Waters	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source: Statistical Yearbook 2008

A graphical representation of the abstracted volumes of water in 2005 for different categories of consumption - water supply, industry and irrigation, is shown in Figure 3.4, including the sources of abstraction.

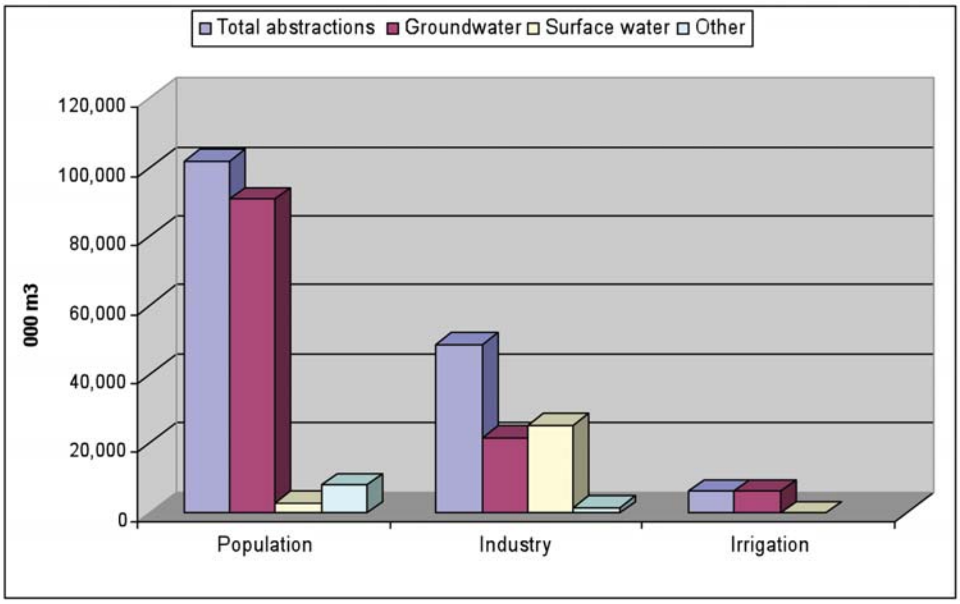

Figure 3.4: Abstracted volumes of vater in 2005, by sectors and sources

So far, two large hydropower plants have been built - HPP Perućica, with installed capacity of 307 MW and average annual production of about 900 GWh, and HPP Piva, with installed capacity of 342 MW and average annual production of about 750 GWh. The Energy Development Strategy until 2025 foresees construction of several new large hydropower plants, including a system of several successive reservoirs on the Morača River.

3 Volumes of water used by hydropower plants ranged from 2.5 to 4.6 billion m^3 over the past five years.

3.1.4.2 Forest[4]

Montenegrin forests and forest land are an extremely important ecosystem and economic resource with multiple role: they are important producers of biomass, sources of healthy and high-quality forest fruits, medicinal herbs and mushrooms, an important habitat for wild plant and animal species, the main factor for the maintenance and regulation of hydrological regime, provide protection from landslides and erosion, absorb significant volumes of carbon and represent the main air-purifying system. Due to the fact that they were mainly established by natural regeneration, as well as because of the characteristics of climate and terrain, forests in Montenegro are characterized by high biodiversity (3,136 taxa at the level of species and subspecies, 47 of which are endemic species).

Of the total surface, forests and forest land cover 743,609 ha or 54% of the state territory: the forest vegetation covers 620,000 ha or 45%, while the non-overgrown forest land makes up the remaining 123,000 ha (9%). The forest cover ration of 0.9 ha per capita ranks Montenegro in the group of most forested countries in Europe. Various belts of forest vegetation can be observed, including the evergreen Mediterranean vegetation, sub-Mediterranean thermophilous deciduous forests, mountainous oak forests, mountainous mesophilic beech forests, and coniferous forests.

Regarding ownership structure, 67% of the forests and forest land or 500,041 hectares is owned by the state, while the remaining 243,568 hectares is private property. Out of the state-owned area, commercial forests (intended for wood harvesting) cover about 348,000 ha or 81%, approximately 66,000 ha (16%) is covered by protective forests, while the forests in national parks cover 12,975 ha or 3% of the total area.

High and the most commercially valuable state-owned forests cover about 212,000 ha (71.2% of commercial forests) extending mainly in the northern and north-eastern part of the country. The remaining thirty percent of the state-owned commercial forests are coppice forests and thickets and underbrush (structure is shown in Figure 3.5). The structure of private forests is significantly less favorable since it is dominated by shrubs and maquis (47% of the total area) and coppice forest (37%), while the area covered by high forests is a little less than 40,000 ha (i.e. 16%).

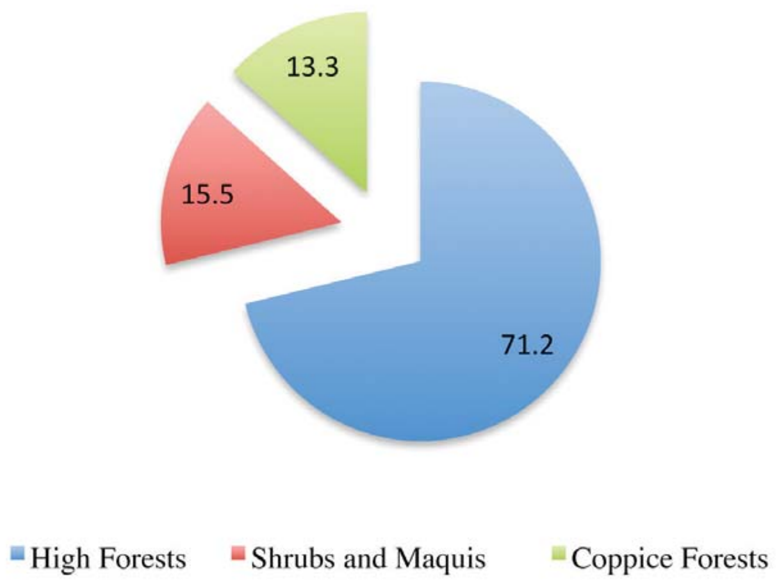

Figure 3.5: The structure of state-owned commercial forests

4 The National Forestry Policy is the source of data in this section, 2008

The total timber stock in Montenegrin forests is estimated at around 72 million m^3, of which 29.5 million m^3 or 41% are conifers and 42.5 million m^3 or 59% are broadleaves (an overview by different categories and types of forests is given in Table 3.2).

Table 3.2: Wood mass in Montenegrin forests

Forest Category	Conifers m^3	Broadleaves m^3	Total	[illegible]
Commercial Forests	[illegible]	[illegible]	[illegible]	[illegible]
Protective Forests	[illegible]	[illegible]	[illegible]	[illegible]
National Parks	[illegible]	[illegible]	[illegible]	[illegible]
State Forests	[illegible]	[illegible]	[illegible]	[illegible]
Private Forests	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]

Total increment in all forests is estimated at 1.5 million m^3 per year, of which about 0.7 million m^3 in coniferous and 0.8 million m^3 in deciduous forests. The planned annual allowable cut is about 815,000 m^3. Total harvesting exhibits a growing trend in recent years, from 514,708 m^3 in 2002 up to 631,273 m^3 in 2006.

Forest Condition

A reliable assessment of the current state of forests does not exist due to the fact that there is no complete and updated information on the total forest resources at the level of the entire country. For example, some of the inventories for the forest areas are older than 10 years, and for some forests no inventory has ever been done. Another problem is associated with the fact that there is no set up monitoring/control system that would allow an assessment of the past and current forest management practices. Despite incomplete information, it can be said that larger scale deforestation has been mainly avoided so far, although certain forest areas were degraded or impoverished by planned or illicit cutting. This includes forest areas on steep slopes, which contributes to erosion and flooding problems.

Other significant problems are forest fires and forest illnesses. In the last 15 years, more than 1,000 large forest fires were recorded in Montenegro, whereas an area of around 15,300 ha was burned and approximately 500,000 m^3 of timber damaged or destroyed.

3.1.4.3 Ores and Minerals

There are numerous ore and mineral deposits, spreading over relatively large areas. For example, the occurrence and deposits of white and red bauxite are registered in almost 1/3 of the territory of Montenegro. The peat area covers about 1,400 hectares. Coal reserves are located in Pljevlja and Berane basins, whereas the opencast mining of lignite in the vicinity of Pljevlja extends to several hundred hectares.

Total coal exploitation reserves in the Pljevlja Basin are estimated at 184.5 million tons. In Berane basin, the geological reserves of brown coal are estimated at about 158 million tons, but due to inadequate research, total assumed exploitation reserves are estimated at only 18.5 million tons.

3.1.5 Coastal Area

According to the existing legal and strategic framework, two areas were identified as the basis for planning and management in the coastal part of Montenegro, as follows:

- public maritime domain ("*morsko dobro*"), defined by the Law on Public Maritime Domain of 1992 as a special purpose area covering a narrow coastal strip[5] with the surface of 60 km^2, and inland waters and the territorial sea with the total surface of about 2,540 km^2;
- coastal area, defined by the draft National Strategy for Integrated Coastal Zone Management as an area the borders of which coincide with the outer border line of the territorial sea, and with the administrative boundaries of coastal municipalities on the mainland (with the exception of the territory of the National Park Skadar Lake in the Municipality of Bar).

There are six coastal municipalities that make up the coastal area: Herceg Novi, Kotor, Tivat, Budva, Bar and Ulcinj. The total area of these municipalities accounts for about 11% of the national territory and is often referred to as the "coastal" or "southern region" because of the similarity of socio-economic, geo-morphological and environmental conditions (although the administrative arrangements include no regional level, only the national and local i.e. municipal level). An overview of land areas by municipalities, with the respective public maritime domain (PMD) surfaces, both in absolute terms and as a percentage of municipal territories is given in Table 3.3. About one third of the total population of Montenegro lives in the coastal region.

Table 3.3: Surface of the public martime domain (PMD) and of the coastal municipalities (in km^2)

Municipality	PMD Surface	Municipal Surface	PMD Share in the Municipal Surface [illegible]
Herceg Novi	[illegible]	[illegible]	[illegible]
Kotor	[illegible]	[illegible]	[illegible]
Tivat	[illegible]	[illegible]	[illegible]
Budva	[illegible]	[illegible]	[illegible]
Bar	[illegible]	[illegible]	[illegible]
Ulcinj	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]

Sources: Special Purpose Area Spatial Plan for the Public Maritime Domain and the Statistical Yearbook 2008

The coastal area is the most developed and the most densely populated area of Montenegro, with beautiful nature and rich cultural heritage. This area is especially interesting for tourism development – the branch of economy which is viewed as a major driver of economic recovery and development. The contribution of tourism to GDP is estimated to be about 11% (and growing), with a dominant contribution of tourism in the coastal area; this sector makes up about 9% of total employment[6].

The coastal region is characterized by: a diverse geological composition of the terrain and complex geo-tectonic structures; coastal plains/fields and beaches; steep elevations of Orjen, Lovćen and Rumija mountains; short watercourses that drain into the sea and divide the region into smaller geo-morphological units, and Boka Kotorska Bay, including several smaller bays.

5 At least 6 meters on the land from the point reached by the highest waves during the strongest storms as well as adjacent land area that serves, by its nature or purpose, for the use of the sea.

6 Data from the study of the World Council of Travel and Tourism Council (WTTC) from the 2009.

The sea along the Montenegrin coast is a part of the valley of the southern Adriatic, where the Adriatic Sea reaches its maximum depth (up to 1,400 m). Salinity of the southern Adriatic Sea of 38.6% is slightly below average for the Mediterranean (39%). In summer, water temperatures reach 27°C. The currents are quite slow and move in parallel with the coast from north to west, and the waves are not high (an average amplitude is 35 cm).

According to the Special Purpose Area Spatial Plan for the Public Maritime Domain, total length of coastline on the mainland is 288.2 km (of which 105.5 km in Boka Kotorska Bay); the length of island coast is 25.6 km, while the riverbank of the Bojana River is 22.8 km long. The shores are dominantly rocky and the coastal sea is generally deep. The exception is the southernmost part in the area of Ulcinj and the mouth of the Bojana River, which is dominated by a coastal plain gently descending into the sea. Only 20% of the coastal sea, alongside low sandy beaches and accessible rocky shores, is relatively shallow having a sand and gravel bottom, suitable for swimming. Length of the beach varies from 20 m up to 10.2 km, the latter being the length of the Great Beach of Ulcinj (Velika Plaža).

Forests in the coastal zone are generally of low productivity and have a protective role. Coppice forests, thickets and shrubs make up 73% of the total forested territory on the coast. Agricultural land suitable for cultivation is mainly located in the municipalities of Ulcinj, Bar, Tivat and Kotor, and represents a limited resource.

Rivers and streams in the coastal area, with the exception of the Bojana River, are characterized by short watercourses and a relatively low average flow. Some of these rivers are drying up during the summer season, while during the rainy period almost all have a torrential character, which contributes to landslides and erosion. The most important rivers are the Željeznica (Municipality of Bar), Reževića River (Budva) and Sutorina (Herceg Novi). Šasko Lake occupies an area of about 360 ha (at low water levels) and is connected to the Bojana River by the canal of Sveti Đorđe.

The coastal region is an important center of biodiversity (in terms of diversity of habitats and species) with several rare and endemic species. Four areas were identified as important bird habitats according to the criteria of relevant EU regulations, those being the Delta of the Bojana River, the Mount Rumija, the area of Buljarica and Tivat's Salina. The areas of special conservation interest were identified as well, represented the basis for future establishment of Natura 2000 network.

The coastal region also has specific landscape values where the following types of landscape are recognized: 1) Boka Kotorska Bay, including the peninsula of Luštica, 2) Central and Southern Coast, including the Bay of Buljarica, 3) Tivat's Salina; 4) dunes in the area of Ulcinj and Ada Bojana Island, 5) valley of the River Bojana, Zogajsko mud, Ulcinj's Salina and Šasko Lake, and 6) mountain ranges of Orjen, Lovćen and Rumija.

3.1.6 Environment

3.1.6.1. Air

The results of previous programs for air quality monitoring show that significant sources of pollution include the main industrial and energy complexes (Podgorica Aluminium Plant, Pljevlja Thermal Power Plants, and Nikšić Steel Mills) that use old technology and as a rule apply no appropriate measures to mitigate pollution. Pollution from traffic is increasing, especially in urban centers, and factors that contribute to air pollution from traffic include the increase in the number of vehicles and traffic congestions, and fuel quality (for example, fuel with high sulfur content and leaded petrol are still being used).

Air quality monitoring and evaluation is carried out on the basis of stipulated limit values for a large number of parameters/pollutants and based on measurements at 16 fixed stations throughout Montenegro and one movable station.

In the latest report on air quality[7], based on the results of performed measurements and analysis, it was concluded that the air quality, assessed in terms of global indicators, was of satisfactory – very good quality, except for the content of dust particles. Certain indicators also point to the necessity of undertaking measures to prevent pollution in some locations. This primarily refers to reducing emissions of airborne particulate matter (dust and aerosols) and limiting content of heavy metals and polycyclic aromatic hydrocarbons (PAHs) in them. Long-term studies have shown that there is a trend of significant increase of these pollutants in the air.

3.1.6.2 Water

Around 65% of the population of Montenegro is connected to sewerage systems. Only a small portion of municipal wastewater[8] is treated before being discharged into natural recepients. In addition to municipal wastewater, untreated industrial wastewater and inadequate waste disposal also contribute significantly to pollution.

Water quality monitoring is based on the classification of water bodies in different quality categories with prescribed allowable concentrations of pollutants, and on-site testing. In total, the measurements are performed at 66 sampling sites on 13 rivers, 11 locations at 3 lakes and 19 sites for coastal waters. For groundwater, measurements have been carried out at 8 locations in the Zeta plain. In addition to regular testing of the coastal sea quality, a wider monitoring program was carried out for the first time in 2008, which included the quality of sediments, pollution load from tributaries and direct discharges into the sea, eutrophication and biomonitoring.

The quality of surface water is generally assessed as relatively good, with some deviations (described below) from the prescribed norms. The worst water quality was identified in watercourses of the rivers of Ćehotina, Vežišnica, Morača, Ibar and Lim[9]. Levels of pollutants higher than permitted (for a given class of water) in these rivers are normally recorded downstream of major settlements and industrial complexes. Occasional deviations from the prescribed class of water (for the permitted values for dissolved oxygen, phenols, various bacteria and other pollutants) have been also determined for a number of sites in coastal waters during the previous years. Water in the three monitored lakes - Skadar, Plav and Black - have mainly fulfilled the requirements for the prescribed classes. The largest deviation from the prescribed water quality class for Skadar Lake was recorded for phosphates, nitrites and oxygen saturation. Groundwaters of the Zeta Plain aquifer have been mainly assessed as excessively polluted (falling outside the prescribed standards) at all observed locations.

3.1.6.3 Soil

Multiple pressures on the soil are recorded in Montenegro. When it comes to agricultural land, the process of its conversion into construction land or land for infrastructure development is pronounced. Land degradation is present on a large scale due to the exploitation of sand and gravel, mining, disposal of tailings and construction waste, industrial operations, extraction of clay and similar activities. Other

7 Report on the State of the Environment for 2008 (report preepared by the Environmental Protection Agency - EPA)

8 The only currently operated wastewater treatment plants in Montenegro are in Podgorica, with a total capacity of 55,000 population equivalents, and a small plant in the town of Virpazar (population 400) on the shores of Lake Skadar.

9 Source: Information on the State of the Environment for 2008, EPA; a similar situation was also recorded in the previous years.

important factors of land degradation include erosion (water, wind) and *in-situ* damages (physical, chemical and biological).

Soil pollution is evident due to a number of human activities. Soil quality monitoring program is being implemented for more than 80 locations in 15 urban settlements. The locations where the samples are taken for monitoring are located near the sites for waste disposal, the busiest roads and transformer sub-stations. Samples are analyzed for the presence of 33 pollutants including heavy metals, PAHs and PCBs.

According to the EPA's Information on the State of the Environment for 2008, maximum allowable concentration for a series of dangerous and harmful substances were exceeded at various locations in all the settlements where the monitoring was carried out.

The main sources of soil[10] pollution were:

- inappropriate disposal of municipal waste (which led to an increased content of organic and inorganic pollutants at the sites in 10 municipalities), and
- inappropriate disposal of industrial waste (which has caused an increased concentration of pollutants at the measuring points in the municipality of Nikšić).

3.1.6.4 Nature and Biodiversity

Montenegro belongs to the group of European countries with the richest flora and fauna and highly diverse ecosystems. The country, for example, is considered as one of the most diverse floristic areas in the Balkan Peninsula, with about 3,250 plant species, whereas the vascular flora species-to-area ratio of 0.837 is the highest in Europe. From a total of 526 European bird species, 297 (or 57%) can be regularly found in Montenegro, while a number of other species (about 29) is occasionally present. The total share of protected areas in the national territory is 9.21% and it mainly refers to the five national parks.

Based on the criteria of Resolutions 4 and 6 of the Convention on the Protection of European Wildlife and Natural Habitats and Annexes I and II of the Habitats and Birds Directives, 156 types of habitats, 5 plant species, 5 species of mosses and 162 species of invertebrates and vertebrates of importance for conservation were identified on the territory of Montenegro. Furthermore, 32 Emerald sites have been identified and proposed for protection on the basis of criteria compatible with Natura 2000 (an overview of the proposed Emerald sites is shown in Figure 3.6).

A biodiversity monitoring program has been carried out since 2000; it is primarily focused on the most representative species and habitats of international and national importance. A special sub-program has been also carried out, relating to the biodiversity of Lake Skadar.

The results of monitoring programs in the past few years indicate that the pressures to which certain components of biodiversity are exposed have intesified. Forest vegetation is exposed to the greatest pressure due to continuous exploitation. Coastal ecosystems are also at risk due to the conversion of natural habitats into urban/built areas. Due to different types of pollution (which decreases their productivity), aquatic ecosystems are also subjected to considerable stress.

10 In addition to listed sources, traffic and to a lesser extent transformer stations also contribute to the soil pollution identified through the monitoring program.

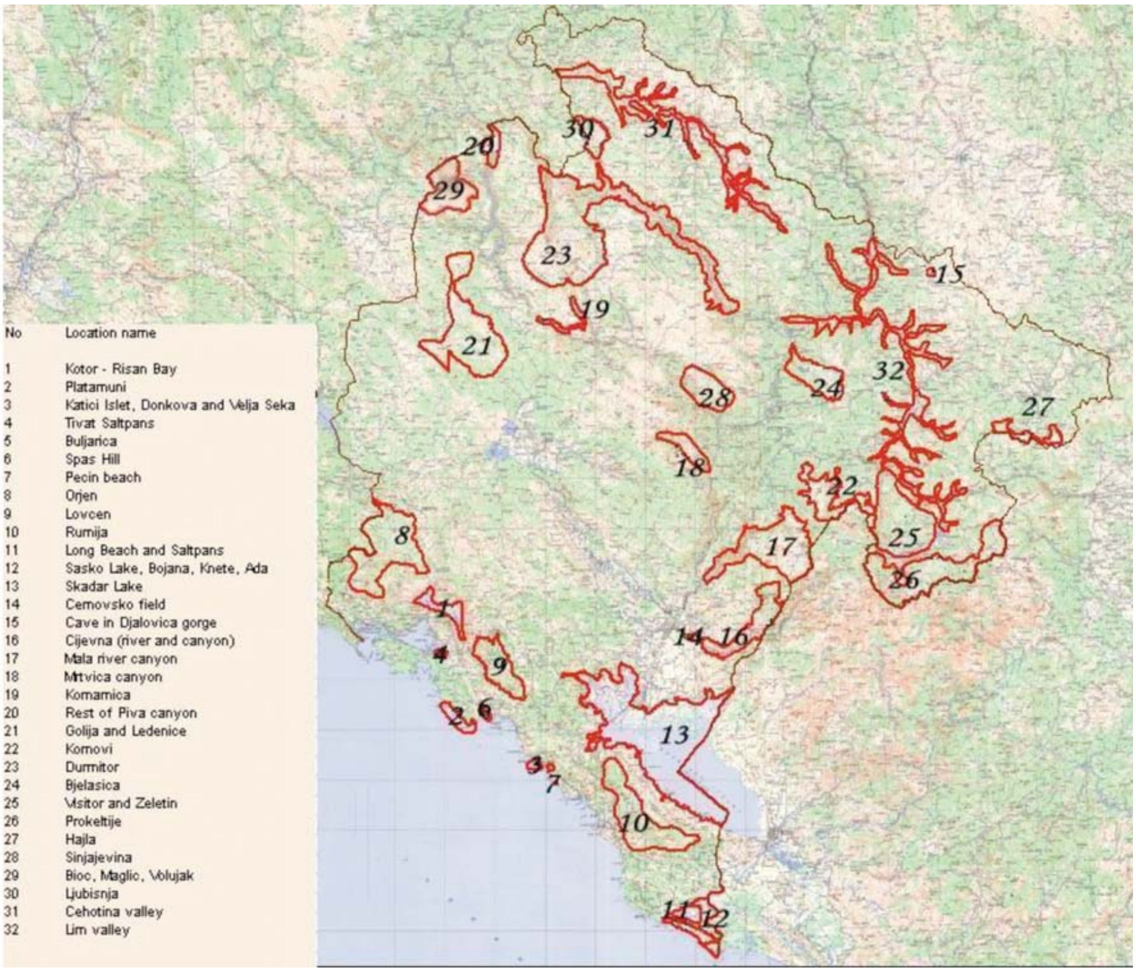

Figure 3.6.: Identified areas of special conservation interest *Source: Emerald Project*

3.1.6.5 Waste

The data on produced, collected, treated, and disposed total volumes, and specific waste streams are incomplete or not available at all[11], so the planning of waste management is still largely based on estimates, such as for example, estimates from the Strategic Solid Waste Management Master Plan and National Waste Management Plan. According to the Master Plan, the estimated amount of generated municipal waste is 0.8 kg per capita per day, i.e.193,148 tons in 2008. The assumed (also based on the Master Plan) rate of collection of total generated waste in urban and rural areas is 85% and 15%, respectively. The amount of waste collected is estimated at 50% of the generated quantities or around 100,000 tons per year (96,574 in 2008). In the presumed structure of municipal waste organic waste dominates with 28%, while the share of paper and cardboard, and plastic is 18% and 12 %, respectively. A significant share of ¼ falls in the category "Other". These data are presented graphically in Figure 3.7.

11 Reporting on the generated amounts is partial. Public companies for waste management provide incomplete information on waste to the Statistical Office, which processes and publishes this information. Measurements of disposed volumes are continuously carried out only for recently constructed sanitary landfills - temporary landfill Lovanja, which operated in the period 2004 - 2007, and Livade landfill in Podgorica.

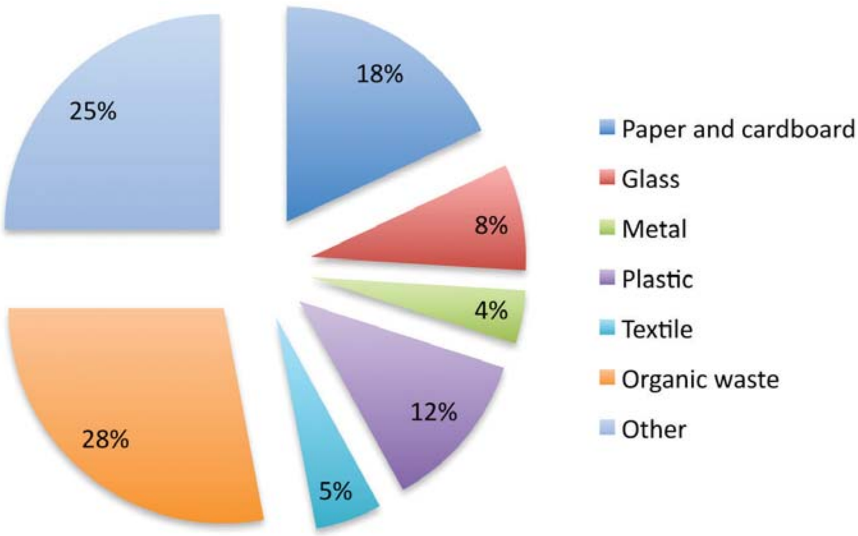

Figure 3.7: Assumed communal waste structure

The recycling of municipal waste is present on a small scale[12] and only for certain segments of the recycling process, mainly in the municipalities of Herceg Novi, Podgorica, Budva and Kotor

Inadequate disposal, mostly to the ordinary both legal and illegal dumps, is a significant source of air, soil, surface and groundwater pollution. Since there is no adequate separation of different types of waste prior to their disposal, the waste that has hazardous properties can be (and commonly is) mixed and disposed of with other types of waste, which increases health risks.

The first sanitary landfill in Montenegro was the temporary landfill Lovanja for the municipalities of Kotor, Budva and Tivat, which operated in the period 2004 - 2007. The total quantity of waste disposed at this landfill was about 110,000 tons, with an annual average (during the years of full landfill operation) of 32,000 tons.

The sanitary landfill Livade (currently the only one in Montenegro) in Podgorica, serving Podgorica, Cetinje and Danilovgrad municipalities has been in operation since 2007, and also used by several coastal municipalities since 2008. In 2007 and 2008, 49,000 and 91,000 tons of waste were disposed at the landfill, respectively, which suggests that the estimates from the Master Plan regarding the generated and collected quantities of waste for disposal were probably too low.

The availability of data on hazardous waste is also not satisfactory. The existing information mainly relate to the previously generated quantities which were either stored or disposed of in certain locations, while there is no continuous flow of data regarding the gerenation of hazardous waste. As assessed by the Master Plan, 18,792 tons of hazardous waste are produced annually.

3.2. Economy and Development Priorities

With a population of about 630,000 and the gross domestic product of 3.09 billion euros in 2008 (4,908 euros per capita), the Montenegrin economy belongs to the group of the small economic systems. Rates of GDP growth were 8.6% and 10.3% in 2006 and 2007, respectively. In the second half of 2008 the growth slowed down, and in 2009 the recession hit the national economy (fall in GDP is estimated at about 5-7%), which was to a significant degree caused by negative global economic trends.
The structure of GDP is dominated by services (including tourism), while industry and manufacturing sector focus on a limited number of products, primarily aluminium. Tourism was one of the main

12 The volume of separately collected waste for recycling in 2006 amounted to 3,380 tons.

drivers of recent economic growth, where the number of foreign tourists rose by more than 45% in 2005 and 2006, i.e. by nearly 55% in 2007. In 2008, the service sector's share in GDP was 77.2%, while the contribution of agriculture and industry (including mining) to the gross domestic product was 9.3% and 13.5%, respectively. Power generation, mining and metal processing account for about 70% of industrial production. Employment by sector is similar to the structure of GDP: in 2008, about 77% of total employment was in the service sector, around 15% in industry while the share of employed in agriculture, fishery and forestry was about 8%.

3.2.1 Energy

Total primary energy consumption in 2008. amounted to 47.26 PJ, or about 1,800 kg of oil equivalent per capita. In the period 1997 - 2008, primary energy consumption grew at an average rate of 3.1% per year. The total production and consumption for 1990 and the period 1997- 2008 are shown in Figure 3.8.

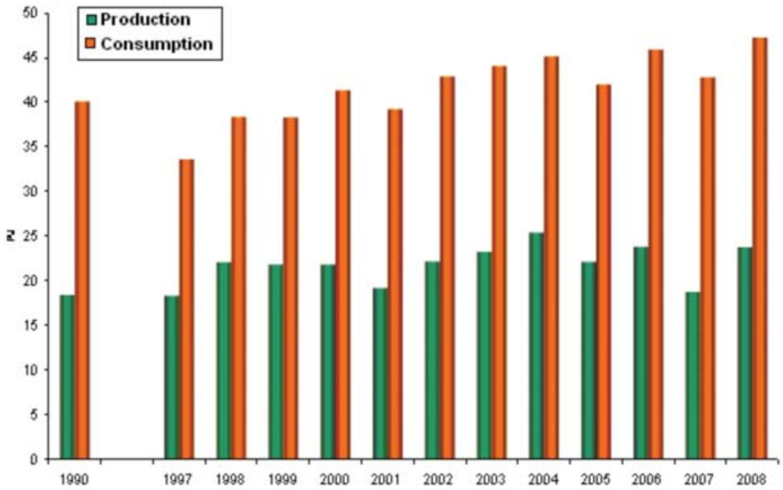

Figure 3.8: Total consumption and production of primary energy (1990, 1997 to 2008)
Source: Energy Balances

The degree of energy self-sufficiency in the last ten years, ranged from 44 to 58%, depending on the hydrological situation.

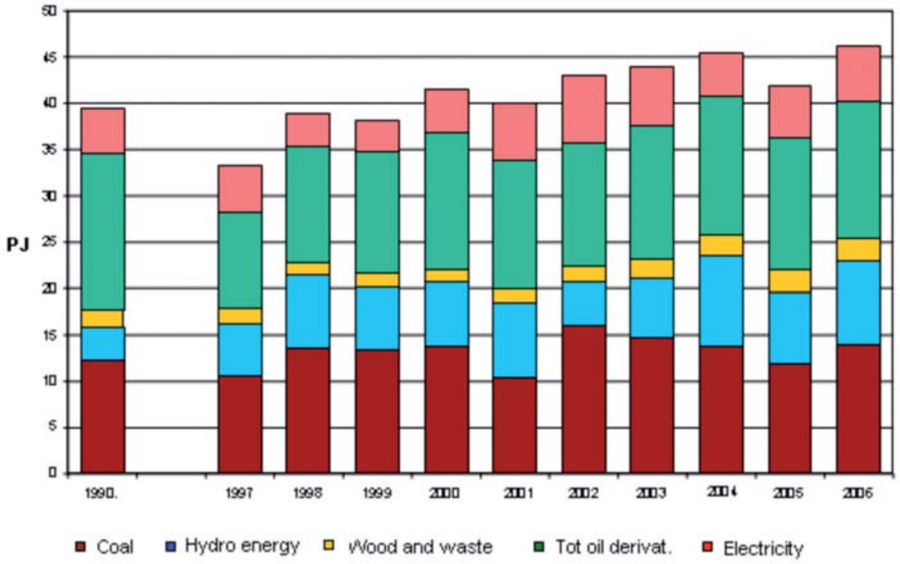

Figure 3.9: Total energy balance of Montenegro (1990, 1997-2006)
Source: Energy Development Strategy until 2025

The total energy balance include hydropower, oil derviatives, coal, wood and waste, and imported electricity. The structure of the energy balances for 1990 year and the period 1997 - 2006 is shown in Figure 3.9.

Fossil fuels have a dominant place in the consumption of energy accounting for as much as 70% of the total. The structure of consumption of fossil fuels is depicted in Figure 3.10, which shows that solid and liquid fuels are almost exclusively in use. All the needs for solid fossil fuels are met from own sources. Lignite is mostly used, while the use of brown coal was negligible until 2007. In the structure of liquid fossil fuels consumption, motor petrol, diesel and fuel oil dominate (80%). Entire needs for liquid and gaseous fossil fuels are covered from imports.

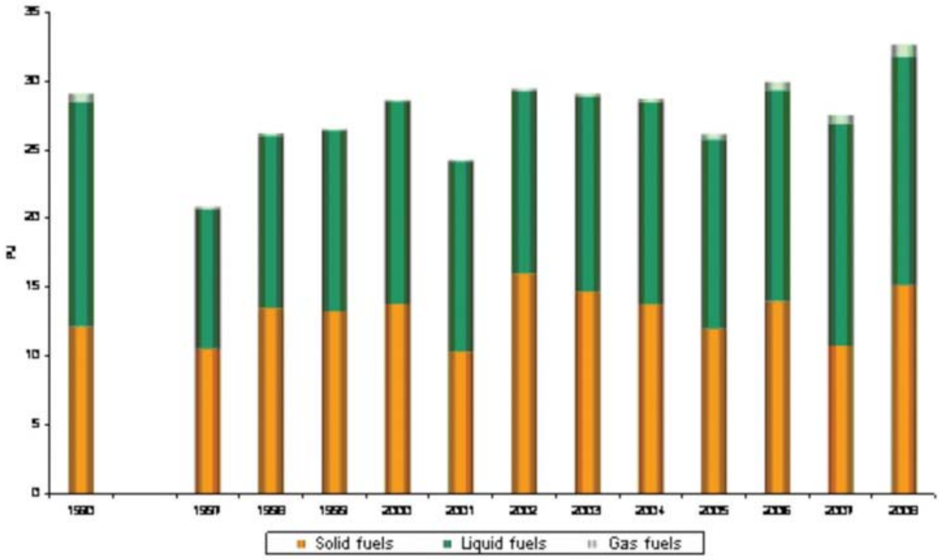

Figure 3.10: Fossil fuels consumption (1990, 1997 – 2008)

The domestic electricity generation takes place predominantly at the hydropower plants of Piva and Perućica (with a total installed capacity of 649 MW), which in years with favorable hydrological situation cover more than 50% of total needs. Lignite is used as fuel for the Plevlja thermal power plant (210 MW,) and in the years with bad hydrological situation the plant covers up to 30% of total electricity consumption.

Between 27% and 46% of primary energy produced in the country comes from renewable sources, of which 21-37% is hydropower (almost exclusively generated at large hydropower plants) and 6-10% is firewood. The share of renewables in total primary energy consumption was 26% in 2004. There is significant unused potential of renewable energy sources such as small hydropower plants, solar and wind power, biomass, etc.

The structure of total consumption by sectors is given in Table 3.4. The sector with the highest energy consumption is industry, followed by general consumption and transport. In 2004, energy conversion losses amounted to 24.5% of total consumption. The main reason for a significant share of conversion losses is outdated technology that is used in electricity production by the thermal power plant.

Table 3.4: Energy consumption in Montenegro by sectors in PJ

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Industry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Transport	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
General Consumption	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Households	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Services	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Agriculture	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Construction [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Propulsion Energy	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Non [illegible] Energy Consumption	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Conversion Losses	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Transport [illegible] Distribution Losses	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(Detailed sectoral data were only available for 1990 and the period 1997- 2004)

Final energy consumption rose from 29.33 PJ in 1990 to 30.58 PJ in 2004 (Table 3.5). Electricity (41-47%) has the most significant share in total consumption, with an annual increase of 2.9% in the observed period. Consumption of oil derivatives grew at a rate of 6.3% per year due to a significant increase in consumption of diesel fuel and motor petrol. Participation of fuel wood in the total consumption ranges from 4 to 7%, depending on the year and the average annual increase rate for this energy source is 4.2%. Participation of brown coal is negligible, while coal consumption has a decreasing trend at an average annual rate of 4.9%.

Table 3.5: Structure of final energy consumption (PJ)

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Electricity	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Coal	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Oil Derivatives	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Firewood	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Heat Energy	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Compared to the EU[13] countries, Montenegro consumes substantially less primary energy per capita than the twenty seven European countries, while the electricity consumption per capita is above the EU average. Consumption of primary energy in 2007 was 1.695 tons per capita, which is 2.2 times less than the EU-27 average (3.73 tons per capita). On the other hand, during the same year close to

13 Data on energy consumption in EU countries are taken from the publication of the International Energy Agency *Key World Energy Statistics 2009.*

8,000 kWh per capita was consumed in Montenegro, which is above the EU average of around 6,900 kWh per capita (Fig. 3.11). Indicators of energy intensity and energy efficiency are not continuously calculated, but the data and comparisons derived so far (e.g. the Energy Efficiency Strategy and the Strategy of Energy Development) indicate that there is a considerable room for introducing energy saving and energy efficiency measures.

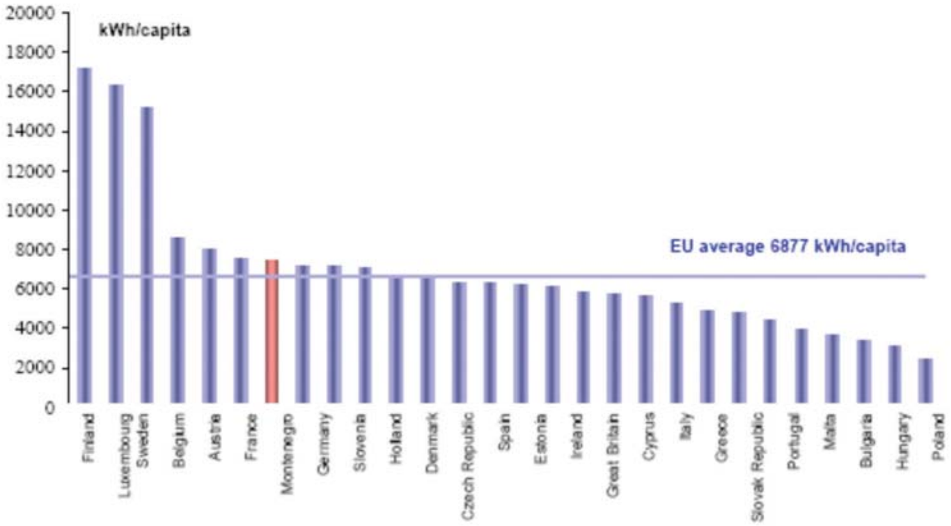

Figure 3.11: Total electricity consumption per capita in the EU and Montenegro 2007
Sources: International Energy Agency and energy balance of Montenegro

3.2.2. Industry and Mining

After a significant decline in industrial production during the last decade of the past century and a partial recovery in the first half of the 2000s, the share of manufacturing industry in GDP in recent years ranged from about 10% in 2005 to 7% in 2008. The contribution of mining in the same period was below 2%. In 2009 there was a further decline in industrial production (a decrease recorded in the first six months was 20% compared to same period 2008), primarily because of poor results in manufacturing industry and production of metals.

Outdated technologies that are characterized by a high level of emissions are predominantly found in the industrial facilities in Montenegro. The largest industrial facilities are in the fields of extractive metallurgy and metal processing - Podgorica Aluminum Plant and Nikšić Ironworks. Cement production is currently not present, although the possibility for renewal of this industry in Pljevlja is considered.

Recently, the structure of industrial production has slightly changed through a more significant presence of food and beverages industry, as well as an introduction of chemical production. Since 2003, the production of a narrow range of pharmaceutical products (approximately 17 tons per year) and lubricants (about 33 tons per year) has been recorded. The production of food and beverages mainly takes place in small and medium-sized enterprises. In the meat industry, production is at a level of approximately 1,300 tons per year; while annual production of soft drinks is about 10,760 tons, of flour 15,572 tons, of milk 72,700 tons, and of milk products more than 5,000 tons per year.

As for mining, coal and red bauxite production was dominant during the course of the previous six years (an overview is given in Table 3.6).

Table 3.6: Coal and metal ore production (in 000 t)

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Brown Coal	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Lignite	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Red Bauxite	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source: Statistical Yearbooks 2008 and 2009

3.2.3. Transport[14]

In the period 2005-2008, the share of transport (including storage and communications) in GDP was around 11-12%. A significant number of negative environmental impacts is linked to transport sector - ranging from emissions of gases and other polluting substances from the process of combustion of fossil fuels, noise emissions and generation of solid waste, to degradation of biodiversity, soil and landscape values due to the construction of transport infrastructure.

3.2.3.1 Road Transport

The road network in Montenegro consists of around 850 km of main roads, 950 km of regional roads and about 5,100 km of local roads. Total length of road network (including the aforementioned and uncategorized roads) by type of road surface is shown in Table 3.7.

Table 3.7: Total length of road network by type of road surface (2003 – 2008)

Road Surface Type	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Asphalt	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Crushed Stone	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dirt Roads	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The density of main roads is 13 km per 100 km^2, which ranks Montenegro among less developed countries. Measured by the length of roads in kilometers in relation to its population, Montenegro belongs to medium-developed countries. The country has no built highways. Over 66% of regional and main roads are older than 30 years. Plans for the development of road networks include, among other things, two highways - the Adriatic-Ionian highway and the Bar-Boljare one.

The number of registered vehicles is 186,730 passenger cars, 2,348 buses, 13,529 tractors, 1,767 trailers and about 2,000 special purpose vehicles (data for 2008.). The level of motorization (number of vehicles per thousand inhabitants) is about 300, which is much higher compared to other countries in transition, but less than in developed European countries.

Data on the transport of passengers and goods for the period 2003 - 2008 are given in Table 3.8.

14 The data on road, maritime and air transport in the following subsections were taken from statistical yearbooks for 2008 and 2009. The data on railway transport are from the statistical yearbooks and from the 2006 draft Strategy for Development of Transportation.

Table 3.8.: Road transport of passengers and goods

Transport of Passengers and Goods	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Number of transported passengers (in mill.)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Transported goods (in [illegible] t)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

3.2.3.2. Railway Transport

The length of railway lines in Montenegro is 250 km, with more than a quarter of those being bridges and tunnels[15]. The density of railway network per 1,000 km^2 is 18.1 km. In recent years, with assistance from international financial institutions, funds were provided for the reconstruction and modernization of existing infrastructure.

Total capacity of rail transport is estimated at about 8 million tons per year. In mid-2000s, about 1.2 million tons of cargo and about 1.1 million passengers were transported by this type of traffic, per annum (Table 3.9).

Table 3.9: Transport of passengers and cargo by railway transport

Passenger and Cargo Transport	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Number of transported passengers (in mill.)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cargo Transport (in [illegible] t)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source: Transport Development Strategy of Montenegro (draft), 2006

3.2.3.3 Air Transport

Air traffic takes place through two international airports - in Podgorica and Tivat.
Montenegro Airlines, the national airline, was founded in 1994. The Company had a fleet of 7 aircrafts in 2009.
In 2008, passenger traffic at the airports reached 1.1 million, which was an increase of about 75% compared to 2003.

3.2.3.4 Maritime Transport

In Montenegro, there are 4 ports open to international traffic - Bar, Kotor, Risan and Zelenika. The port of Budva is open to international traffic during the 4 months of the tourist season. The most important is the Port of Bar, which covers about 95% of all port activities. Over the previous three years this port received about 680 cargo ships and about 220 passenger ships. The port can accept ships up to 80,000 tones and handle 5 million tons of cargo annually.

In 2008, less than 90,000 passengers and about 600,000 t of goods were transported, whereas the transport of goods increased by about 10 times in comparison to 2003. Montenegrin naval fleet, which in the 1980s counted 42 overseas ships with capacity of approximately 1.3 million DWT, is currently composed of only two passenger ships with about 1,400 passenger seats and a cargo ship with the capacity of 1,225 DWT; the vessels operate within the Navigation of Bar company. In addition to this national maritime company, there is a small number of private ones. During the tourist season, a large number of small vessels operate in the territorial waters of Montenegro.

15 There are 122 major bridges of significant length (8,863 m in total), more than 330 small bridges and 121 tunnels with a total length of 58 km on the railways.

3.2.4 Tourism

Tourism is a significant economic branch which is considered to be one of the key development priorities and which has largely contributed to an overall economic growth achieved in mid-2000s.

The number of tourists has almost doubled in the period 2003 – 2007 – from about 599,000 to 1.133 million. In the same period, the total number of overnight stays increased by over 80% – from a little under 4 million overnights in 2003 to 7.3 million in 2007. In the last two years the number of tourists was at the level of about 1.2 million annually, while the number of overnight stays slightly declined from 7.8 millions in the 2008 to 7.6 million in 2009. The visits/ overnight stays registered in the coastal region prevail in the total tourism turnover. An overview of the total number of overnight stays by types of tourist locations is given in Table 3.10.

Table 3.10: Number of overnights by tourist locations (2004-2008)

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Capital City of Podgorica	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Coastal locations	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mountain locations	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Other	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source: Statistical Yearbook 2009

In 2007, the share of overnight stays generated in the mountainous areas in the total number of overnight stays was below 2%. The plans for tourism development recognize the fact that the tourism potential of the mountainous areas is under-utilized and that a further development of tourism in this area is of great importance, not only for the overall tourist offer of the country but also for the development of the northern region. The so far plans for tourism development in mountain areas are focused on the development of summer as well as on the development of winter and ski tourism.

3.2.5 Agriculture

Agriculture is an important economic sector. During the period 2005 – 2008, the share of primary agricultural production in GDP was at the level of about 9-10%. The structure of agricultural households is unfavorable from the standpoint of intensive and competitive production given the fact that small farms (less than 5 ha) dominate. On the other hand, there are significant competitive advantages such as for example opportunities for diversified production, low level of application of mineral fertilizers and pesticides, and the possibility of development of organic production. Montenegro has a significant trade deficit due to food imports (around 150 million euros per year).

According to the Statistical Yearbook data, in 2007, agricultural land covered a total of 516,465 ha (the structure shown in Figure 3.12):

- arable land and gardens (44,957 ha)
- perennial plants - orchards and olive groves (11,976 ha) and vineyards (4,225 ha)
- meadows (128,781 ha)
- pastures (323,876 ha), and
- other - wetlands (2,650 ha).

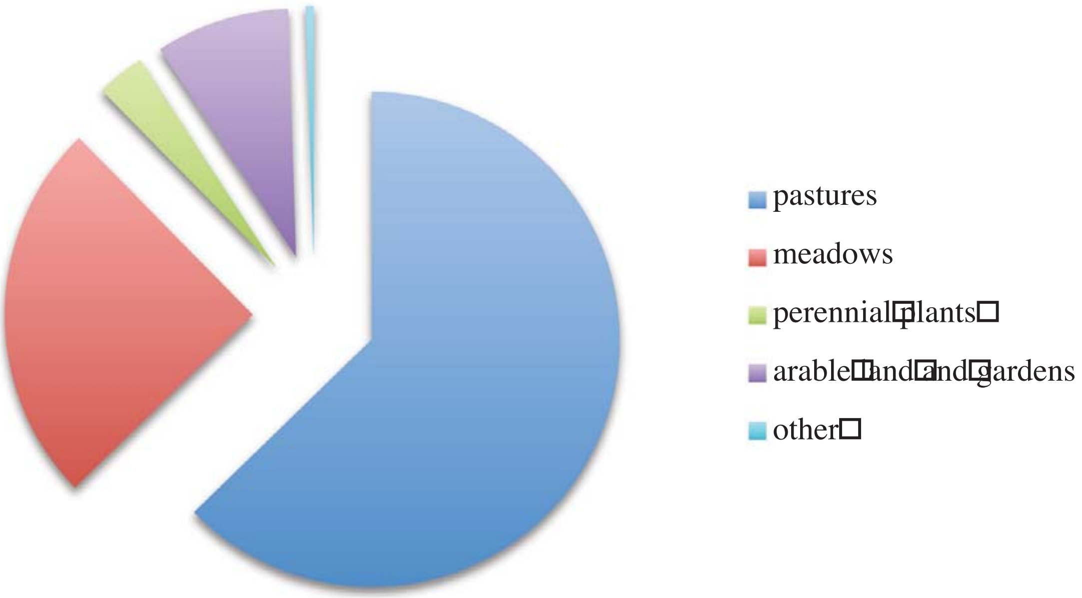

Figure 3.12: The structure of agricultural land in 2007 *Source: Statistical Yearbook 2008*

In the last ten years, there was a slight decline in total surface of agricultural land (a decrease of about 3,000 hectares - from 519,600 ha in 1997), while the structure remained approximately the same, with certain decreases in the arable land and gardens, and pastures categories, and with increased perennial plantations and meadows areas (Table 3.11.).

Table 3.11: Changes in agricultural land from 1996 to 2007 (000 ha)

Land Category	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Arable Land	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Perennial Plantations	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Meadows	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Permanent pastures	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wetlands	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Agricultural Land	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source: Statistical Yearbooks

Montenegro can be divided into 5 areas according to the specific characteristics and conditions for the development of agriculture (the data on surfaces and the percentage shares of the total agricultural land refer to situation in 2003):

- The coastal region with 50,815 ha (9.8% of the total) of fertile agricultural land which consists of deep alluvial – deluvial and brown anthropogenous soils; the region is suitable for fruit and vegetable production and for breeding of small ruminants, while on the other hand it is abundant with honey-bearing, aromatic and medicinal herbs and wild fruits (fig, pomegranate, etc.).

- The Zeta-Bjelopavlići region with 78,997 ha (15.3%) is the lowland region up to 200 m above sea level, suitable for various types of production (farming, fruits-vineyards, livestock).
- The karst region covers 74,320 ha or 14.3% of the total agricultural area and lies at elevations of up to 700-800 m. The arable land is scarce and is mainly located in the karst fields, karst funnel-shaped depressions and small valleys, whereas arid areas dominate. The most important agricultural sectors are livestock breeding (especially goats and sheep, and then the cattle) and beekeeping.
- The northern-mountainous region with 184,528 ha (35% of the total area) is characterized by numerous plateaus and highland; it is suitable for growing cereals, potatoes and brassicas, as well as for the development of livestock breeding due to large areas of meadows and pastures.
- The Polimsko-Ibar region covers 25% of the total area or 129,804 ha. Fertile land and abundance of springs and running water make this region important for all three branches of agriculture: farming with vegetable growing, fruit growing and animal husbandry.

In the period 1992-2003 a growth of total agricultural production was recorded, at an average annual rate of 2.8%. A greater increase is typical for crop production (annual growth rate of 4.7%), while for the livestock breeding significantly lower (0.8% per year) but more stable growth was achieved (Figure 3.13).

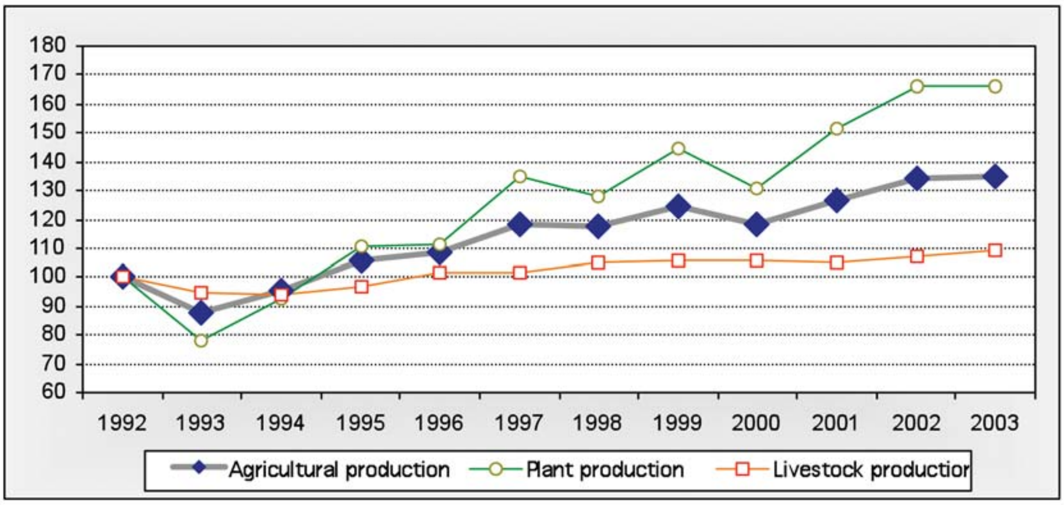

Figure 3.13: Indices of agricultural production for 1992-2003 *Source: Statistical Yearbooks*

The most important crops are vegetables and fruits, while commercial production of farm crops (cereals, maize, sugar beet, oilseeds)[16] is almost not represented. The main crops are potatoes (with a yield of around 107,000 t in 2007) and vegetable crops (about 108,000 in the same period). Most commonly grown fruit crops are plums (about 1.1 million bearing trees in 2007), apples (406,000), peaches (248,000) and pears (195,000), and in the south oranges and tangerines (282,000 trees), and figs (198,000). There are about 420,000 olive trees. In recent times the production of grapes and wines is increasing, with around 17 million bearing vines.

Livestock breeding is the most significant branch of agriculture, with a share of more than 60% in total new value. In the period 1992-2004, there was a relatively stable number of cattle and swine, whereas a decline in the number of sheep and horses was evident. In the 1990s, the number of poultry recorded a slight decline, and since 2000 there has been a positive trend. The data on the number and the production in goat breeding are still not published by the official statistics, while the Biotechnical Institute estimates the current population of goats at 50-55,000 heads.

16 In 2007, the production of cereals, for example, was about 2,800 t of maize, 2,000 t of wheat and about 1,000 t of barley. In the same period about 1,500 tons of forage, 2,000 t of sugar beet, 2,800 t of clover and about 11,500 t of alfalfa was produced.

Table 3.12: Livestock numbers in the period 1993-2004 (in 000 heads)

Livestock	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cattle	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Swine	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sheep	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Poultry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Horses	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source: Statistical Yearbook

3.3 Characteristics of Social Development

The economic growth which was recorded during the 2000s led to improvements in most socio-economic indicators. In 2008, average net wages was 416 euros (which is a significant increase compared to, for example, 195 euros in 2004), and the unemployment rate fell below 17%[17].

Although there are no continuous data on poverty, the available indicators for 2005 and 2006 showed a stagnation in poverty rates (relative to previous studies) at the level of about 11% and a slight decline in indicators of inequality (Gini coefficient, for example, fell from 0.259 in 2005 to 0.243 in 2006). UNDP research results published in the latest Human Development Report, however, showed that the indicators of inequality rose by 2008 (Gini coefficient was 0.35), while the poverty rate declined slightly to 10.8%. Poverty line was determined at the level of 165 euros per month; it was estimated that about 70,000 people lived below the poverty line, and that there were approximately 215,000 economically vulnerable people (living on a monthly income below 240 euro).

Human development index (from the local UNDP Human Development Report of 2009) was 0.828. According to the last globally published index (0.822) for 2007/2008, Montenegro was on the 64th place among 179 countries.

3.3.1. Population

The last censuses were held in Montenegro in 1991 and 2003, and the population numbers were 615,035 and 620,145, respectively. Between the two censuses the population grew at an average annual rate of 0.34% or by 4.8% in total. The rate of natural increase was nearly halved during the nineties - from 9.7 (per 1,000 inhabitants) in 1991 to 5.5 in 2001, and continued to fall until 2007, when it was only 3. At the same time, the share of population older than 60 years in the total population increased from 12.8% in 1991 to 16.7% in 2003. During the same period, the population aged 0-19 years declined from 33.5 to 28.5%. At the 2003 census, 43% of total population was in the category of active population (employed or seeking work), 17% were living on own revenues (such as pensions, property income, etc.), while the remaining 41% were dependent persons.

In 2003, population density was 44.9 people/km^2, though this indicator varies significantly by region. The northern region covering more than half the total territory has a lower density (26.6 inhabitants per km^2) than the national average, while the concentration of population is much higher in the central (56.8 inhabitants) and the coastal part of the country (91.8 people per km^2). Differences in population density resulted from the process of urbanization and internal migration of population.

17 The Central Bank was the source of data on salaries; the unemployment rate was taken from the Labour Force Survey.

Population migrations within Montenegro were quite intensive over the past 50 years, characterized by the decline in population in the north and increase in the central and southern parts. The share of the population of the northern region in the total population declined from 46.2% in 1961 to only 33% in 2003, while in the same period the central and southern region recorded a steady growth. Changes in regional population structure in the period 1961 - 2003 are shown in Figure 3.14.

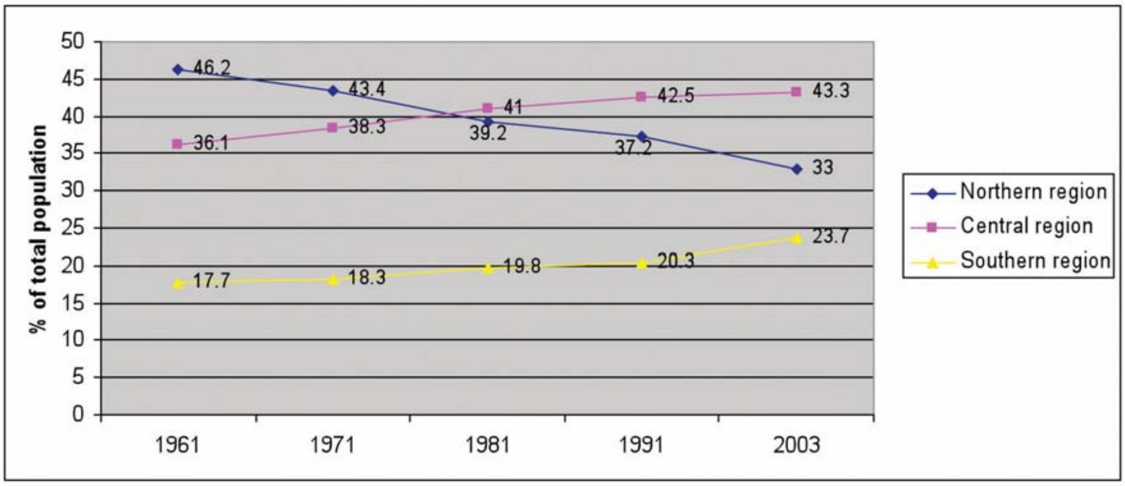

Figure 3.14: Regional structure of population 1961-2003 (in %) *Source: Spatial Plan of Montenegro*

Approximately 61% of the population lives in urban areas. As for the regional population distribution, the highest level of urbanization of more than 78% is recorded in the central region, on the coast it is around 62% and in the north 41.38% of population lives in urban centers.

An average number of inhabitants in the household decreased from 3.8 in 1991 to 3.25 members in 2003. In 2003, the number of members per household in urban areas was 3.24, while in other settlements it was 3.26.

3.3.2 Education

According to the 2003 census data, about 13% of the Montenegrin population had a degree from post secondary education (college and university degrees), of which 7.5% had university degrees. Most of the population (about 49%) had secondary education, while 37% had completed primary school (fully or several grades) or had no education (4% of the population was in the last category). The rate of illiteracy, according to data from the same census, was 2.35%. Primary schools enrollmnet rate is around 97%.

The educational system includes 454 elementary and 47 secondary schools. Higher education is acquired at the University of Montenegro (which has 20 units), two private universities and two private faculties. An appreciable growth in the number of enrolled students has been recently recorded - from about 13,000 enrolled in the school year 2005/2006 to about 18,000 in 2007/2008. Of the total number of enrolled students, 85% study at the state university (University of Montenegro).

Total number of scientific-research organizations is 32, out of which there are 25 faculties, four institutes and three research and development institutions. Available data indicate a slight increase of funds for research and development from public sources - from 0.18% of GDP in 2006 to 0.26% in 2007.

3.3.3. Healthcare

Life expectancy at birth is 71.2 years for men and 76.1 years for women. Rates of infant mortality (up to one year of age) were 7.4 (per thousand live births) in 2007 and 7.5 in 2008.

In 2007, the most common causes of mortality were cardiovascular diseases and tumors. Number of deaths is shown in Figure 3.15, in percentages by the groups of death causes.

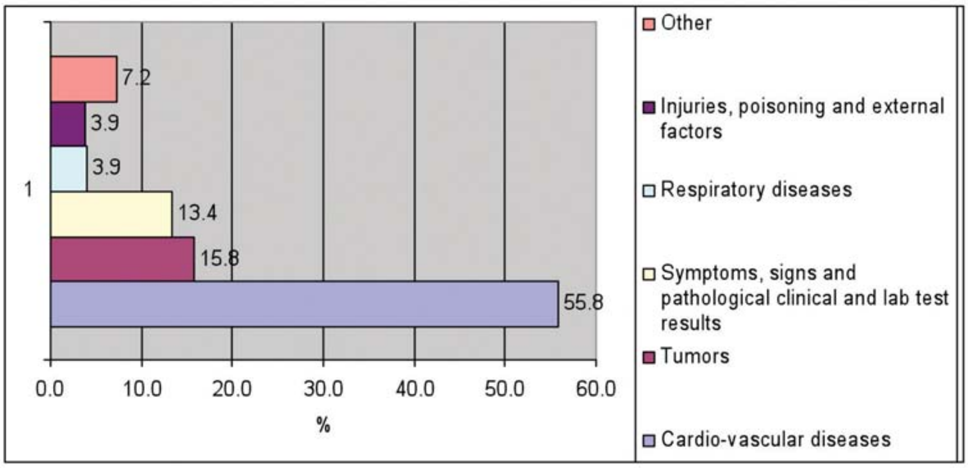

Figure 3.15: Causes of death in 2007 in % of the total number of deaths
Source: Statistical Yearbook of the Institute of Public Health 2007

In Montenegro hospital health care is provided to the population through seven general hospitals, five stationary units in health care centers, the three special hospitals (psychiatry, orthopedic trauma, and pulmonary diseases and tuberculosis), Institute for Physical Medicine, Rehabilitation and Rheumatology, and Clinical Centre of Montenegro. Outpatient care is done through health centers and specialized departments organized within them (such as for example the service of general medicine, services for the protection of pre-school children, etc.). The total number of doctors is 1,233, of which 889 specialists. The number of beds in hospitals and stationary units amounted to 3,948 in 2007.

3.4 Institutional and Legal Framework Relevant to Climate Change

3.4.1 Climate Monitoring and Research

The Hydrometeorological Institute of Montenegro provides data and information necessary for climate change risk assessment and development of adaptation strategies; the Institute also produces baseline data for the assessment of hydropower resources and energy potential of solar and wind power for the purpose of more intensive use of renewable energy sources. These activities are conducted by the Hydrometeorological Institute independently or in cooperation with relevant ministries, the Environmental Protection Agency (EPA), weather bureaus in the region and the appropriate educational and scientific institutions. Activities of the Institute include a program to improve the meteorological, hydrological and hydrographic information system, as well as climate research and possible impacts of climate change on various sectors of the economy, natural resources and human health. It also carries out institutional development and staff training activities in the field of climate change, as well as public awareness actions and knowledge raising about the causes and potential consequences of climate change. The Hydrometeorological Institute is the focal point to the IPCC and GCOS and participates in regional projects.

The Hydrometeorological Institute also carries out activities directed towards membership in the EUMETSAT, and makes efforts to intensify the application of satellite observations, improve analytical and forecasting systems and early warning systems for atmospheric and hydrological disasters and climate extremes, maintain databases on climate including information about the projections of regional and local climate change for the territory of Montenegro, as well as to intensify the application of ECMWF seasonal forecasts for the needs of different sectors of the economy.

In November 2008 a common platform for subregional cooperation was created in the field of climate change by interested countries of Southeast Europe with Montenegro's participation. The intention is to provide for development of capacities that are adaptable to the risks and impacts of climate change through the implementation of adaptation measures, and to help the countries of South Eastern Europe to implement Articles 5 and 6 of the UNFCCC, the Capacity Building Framework, and the Nairobi Programme of Work on impacts, vulnerability and adaptation.

3.4.2 Climate Change Policy

So far, Montenegro did not have a specific climate change policy, but this area was addressed through a certain (small) number of adopted strategies and plans. National Strategy for Sustainable Development (2007), for example, has set general goals and directions of action for the field of climate change, and this topic, as a global priority, has been paid special attention in the National Environmental Policy (adopted in 2008). The issue of climate change is poorly or not at all integrated into sectoral policies, strategies and plans such as for example the energy development and agricultural strategies, spatial plans, national policies for waste, etc. The exception is, to some extent, the national forestry policy that devotes considerable attention to climate-related matters. This document recognizes the role of forests for mitigation and adaptation, and formulates a separate policy statement on forest management and climate change.

Efforts to start with the implementation of international agreements on climate change have intensified in recent years, after gaining independence. Montenegro ratified the United Nations Framework Convention on Climate Change (UNFCCC) by succession in 2006 and became a member of the Convention as a non-Annex 1 country on 27 January 2007. The Kyoto Protocol was ratified in 2007 by the adoption of the Law on Ratification of the Kyoto Protocol (Official Gazette of the Republic of Montenegro 17/07), so that the country became its member on 2 September 2007.

Since the EU accession is a national priority, harmonization of Montenegrin legislation with the parts of *acquis communautaire* on the environment and climate change represents a process that is strongly and increasingly shaping the national legal framework. The basic provisions of the EU legislation on air quality and climate change were initially transposed into national legislation through the Law on Air Quality (Official Gazette of Montenegro 48/07). This law was passed as a framework law for managing the quality of ambient air in accordance with the then applicable EU regulations (Directive 96/62/EC, which amended Regulation (EC) 1882/2003). It regulates the air quality limit values, monitoring of air quality, protective measures, air quality assessments and improvements, and other issues. A new Law on Air Protection is currently in the phase of adoption whereby the mentioned Law on Air Quality will be put out of force in the process of harmonization with the new Directive 2008/50/EC.

By adopting the Law on Environment (Official Gazette of Montenegro 48/2008) the legal framework for climate change was amended in accordance with the obligations accepted by ratification of relevant international agreements. This law introduced an integrated approach to managing the environment and defined goals and principles for environmental protection. The law provides for preparation of the National plan for climate change mitigation, the National inventory of greenhouse gases by sources and sinks, the Action plan of measures and activities for the prevention of the causes and mitigation of adverse effects of climate change, as well as the National plan on combating desertification and mitigating the effects of droughts including an action plan.

Further harmonization with European legislation on climate change is taking place through the current and/or planned activities, such as transposition of Decision 280/2004/EC on the mechanisms for monitoring emissions of greenhouse gases in the Community and for implementation of the Kyoto Protocol, the Directive on Large Combustion Plants 2001/80/EC which was amended by Directive 2006/105/EC, and other relevant regulations. The ongoing establishment of a system for greenhouse gases inventory will, by means of fulfilling obligations to the UNFCCC, contribute to the forthcoming transposition of EU Directives 2003/87/EC and 2004/101/EC (ETS and the Linking Directive) on emissions trading.

Among the other sectoral and environmental laws, the following are also important for climate change issues:

- Energy Law (Official Gazette of the Republic of Montenegro 39/03);
- Law Ratifying of the Treaty on Energy Community between the European Community and the Republic of Montenegro (Official Gazette of the Republic of Montenegro 66/06);
- Law on Integrated Prevention and Pollution Control (Official Gazette of the Republic of Montenegro 80/05);
- Law on Strategic Evironmental Assessment (Official Gazette of the Republic of Montenegro 80/05);
- Law on Waste Management ((Official Gazette of the Republic of Montenegro 80/05)18;
- Law on Spatial Planning and Construction (Official Gazette of Montenegro 51/08);
- Law on Waters (Official Gazette of the Republic of Montenegro 27/07);
- Law on Forests (Official Gazette of Montenegro);
- Law on Nature Protection (Official Gazette of Montenegro 51/08); etc.

The Ministry for Spatial Planning and Environment(MSPE) has the key competences in the area of climate change. The Ministry adopts the policies and relevant regulations, while the newly established[19] Environmental Protection Agency, as an executiveadministration body, plays an important role in the implementation of climate change policy through, *inter alia*, permitting, inspection control, monitoring and reporting. The Designated National Authority for approving CDM projects was established in 2008 within the Ministry of Spatial Planning and the Environment.

The ministry responsible for energy and industry – this is now the Ministry of Economy - also plays an important role in the field of climate change by designing the energy policy and establishing goals and measures for improving energy efficiency. This Ministry has a department for energy efficiency and renewable energy sources.

The Ministry of Maritime Affairs, Transport and Telecommunications is responsible for the adoption and implementation of transport policy and transport development. MSPE is also responsible for waste management, protection of nature/biodiversity and spatial planning. Management of forests and waters is under the jurisdiction of the Ministry of Agriculture, Forestry and Water Management, i.e. Forests and Water Administrations. This Ministry is also responsible for agricultural development.

Other relevant stakeholders are the Ministry of Health (responsible for public health), Ministry of Tourism, local governments and institutions such as the Hydrometeorological Institute (competences described in section 3.4.1) and the Center for Eco-Toxicological Examinations that deal with climate, hydrology, emissions monitoring and similar activities.

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18 Fully enters into force in 2010.

19 Under the Environment Law (Official Gazette of Montenegro 48/2008).

INVENTORY OF GREENHOUSE GASES OF MONTENEGRO

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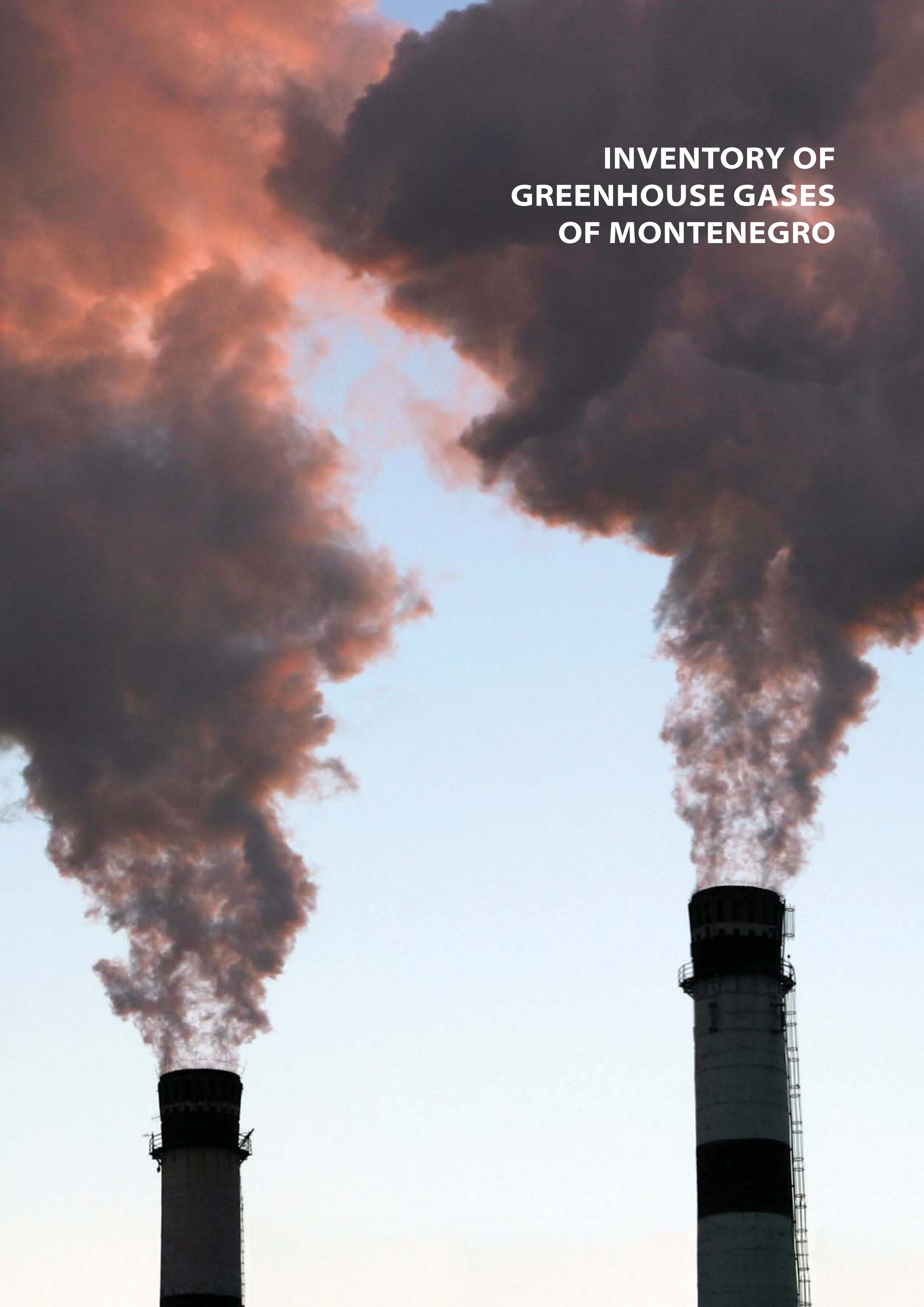
4

INVENTORY OF GREENHOUSE GASES OF MONTENEGRO



4.1. Introduction – Inventory Development Process

Montenegro, as a non-Annex 1 country of the United Nations Framework Convention on Climate Change (UNFCCC) is required, pursuant to Article 4, paragraph 1 (a) and Article 12, paragraph 1 (a), to provide to the Conference of Parties (COP), its national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHGs) not controlled under the Montreal Protocol. For the first national report, the Parties not included in Annex 1 carry out assessment of national GHG inventory for 1994, or as an alternative for 1990.

Montenegro designated the year 1990 as its baseline year, so that a detailed examination of the GHG emissions was carried out for this year. In order to determine the trend of GHG emissions, calculations of emissions for 2003 and 2006 were prepared.

In order to meet obligations under the UNFCCC and thus of GHG inventory, significant activities were initiated in November 2004 by the signing of the Memorandum of Understanding (MoU) on “Cooperation in the field of environmental protection” between the then Ministry for Environmental Protection and Spatial Planning of the Republic of Montenegro and the Ministry of Environment, Land and Sea of the Republic of Italy. The agreement includes the Annexes I and II relating to the provision of technical assistance to the Republic of Montenegro to sign and ratify the Kyoto Protocol and establish a system of green certificates for renewable energy. Annex I was signed with the involvement of the Ministry of Economy of the Republic of Montenegro.

In accordance with the MoU signed in 2005, the Italian Ministry for Environment, Land and Sea began with the realization of technical assistance in the preparation of an initial national communication through the preparation of the following parts of the National Communication:

- General Information
- Inventory of greenhouse gases
- Measures for climate change mitigation.

During implementation of the project “Ratification and signing of the Kyoto Protocol and establishment of a system of green certificates”, Montenegrin and Italian expert teams were appointed to worked on the three modules of this project: 1.Anlysis of legislation, 2. GHG inventory; 3. CDM (clean development mechanism) and a system of green certificates for renewable energy. As a result of joint work of the Italian - Montenegrin expert team, inventories of the emissions of greenhouse gases were prepared for 1990 and 2003 (inventory for 1994 and 1998 could not be calculated following the sectoral approach due to the large number of missing data). In order to meet some of the obligations under the Convention, the then Ministry of Tourism and Environmental Protection started preparing its initial national communication, through the GEF/UNDP project “Training activities for the preparation of the initial national communication of Montenegro, resulting from the obligations arising from the United Nations Framework Convention on Climate Change – UNFCCC”. The project document was signed in April 2008, and the Global Environment Facility (GEF) made the funds for the implementation of planned activities available to Montenegro. One of the activities included the preparation of a “National inventory of greenhouse gas emissions”.

In order to implement this activity, a team leader was appointed and a team of local experts established to complete the following tasks:

- Preparation of reports on the national GHG inventory in accordance with the IPCC methodology and UNFCCC reporting format, making the unofficial data on GHG emissions official and publicly announced;

- Improving the inventory for 1990, which was chosen as the baseline year, in terms of re-examination of all input data, using new research and documents that were not available for versions of the inventory in 2005;
- Identification of basic gaps and shortcomings in input data for the key sectors of the GHG inventory;
- Collection and filing of data necessary for the preparation of national GHG inventories, as well as the strengthening of technical and institutional capacity for systematic collection and periodic reporting on anthropogenic emissions of greenhouse gases by sources and removals by sinks.

Mission of the Italian Ministry of Environment, Land and Sea to Montenegro, i.e. its partner, the consulting company "Techno Consulting" from Rome, continues to provide technical and professional assistance through constant communication, organization of workshops and practical training on the preparation of GHG and LRTAP inventories. The preparation of an inventory of emissions at the national level is a particularly notable project, aiming to integration and fulfillment of obligations related to the Convention on long-range transboundary air pollution (LRTAP). In order to implement the provisions of LRTAP Convention, the data relating to 1990 were also collected. Available data were obtained from the Statistical Yearbook, issued by the Statistical Office of Montenegro, which relates to demographics, agriculture, livestock, food and beverage industry and energy.

The Initial National Communication presented the inventories for 2003 and 2006. The inventory for 2003 was made within the above-mentioned cooperation with the Italian Ministry for Environment, Land and Sea. The GHG inventory for 2003 was prepared using the IPCC methodology with the sectoral approach and is consistent with the inventory baseline year. The GHG inventory for 2006 was made for the purpose of reporting according to the LRTAP convention, using the *Corinar* methodology. The emissions of GHG gases in 2006 are not comparable with those of 1990 2003, due to a partial consistency of methodologies used, and as a result GHG emissions for 2006 are shown separately in Annex II.

4.2. Methodology Applied, Data Collection and Processing System

The inventory of greenhouse gases for Montenegro for the baseline 1990 and 2003 was calculated in accordance with the revised manual of the Intergovernmental Panel on Climate Change of (1996 IPCC manual) and the IPCC Guidelines and good practice guidance on managing uncertainty of 2000 (IPCC Good Practice Instructions)[20]. Revised IPCC Instructions provide a standard methodology that includes standard emission factors and in some instances standard information on the activities. Those can be used as a national methodology, if they better reflect the national situation, provided that those are harmonized with the IPCC methodology, transparent and well-supported by documentation. Using the IPCC manual is much easier by using the IPCC software developed for the calculation and estimation of emissions. The basic formula used for calculating emissions is:

Emission = $\sum$ (activity data x emission factor)

Emission factor is a representative value that links the amount of gas emitted into the atmosphere with the activity that led to the generation of this pollutant. These factors are generally expressed as weight of pollutant divided by the energy units (e.g. kilograms per nitrous oxide per TJ) or the mass of pollutant per mass of products (e.g., t CO_2/t metal). For the calculation of all direct and indirect gases in the national inventory pre-defined emission factors were used for all sectors, as given in the Tables of 1996 IPCC Manual.

20 Emission factor for arc blow furnace was taken from IPCC manual from year 2006..

The manual gives the method for calculation of all gases (Tier 1, 2, 3) which involve different levels of activity and technological detail. Tier 1 methods are generally very easy, requiring less data and expertise than much more complex Tier 2 and Tier 3 methods. In the national inventory only Tier 1 methods were used because the data available for all sectors allowed only the application of this method

The methodology includes the calculation of only those emissions that result from human (anthropogenic) activities. It does not include the gases that are the subject of the Montreal Protocol on Substances that Deplete the Ozone Layer. The IPCC good practice guidance and uncertainty management was used for the calculation of key categories of inventory and inventory uncertainties.

The inventory of greenhouse gases of Montenegro consists of five sectors in accordance with the 1996 IPCC Manual, namely: energy, industrial processes, agriculture, waste, and land use change and forestry (LUCF). Solvent use was not processed in the inventory due to lack of valid data.

The inventory contains, for each sector, a calculation of emissions of major greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) from sources and removals by sinks.

In accordance with the collected data, the following emissions of synthetic gases were calculated: carbon tetrafluoride (CF_4) and carbon hexafluoride (C_2F_6). Emissions of other perfluorocarbons (PFC) and hydrofluorocarbons (HFCs) and sulphur hexafluoride(SF_6) are not calculated due to lack of necessary data. Also, indirect gases (ozone precursors) were calculated according to the Tier 1 methods: carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC), and sulphur dioxide(SO_2).

A report on GHG emissions and removed quantities expressed in CO_2 equivalents was calculated using the global warming potential (GWP) provided by the IPCC in its Second Assessment Report ("1995 IPCC GWP Values") based on the effects of GHG on a 100-year time scale. GWP potential is a measure of the impact of a gas on the greenhouse effect compared to the effect of CO_2, when the emissions of greenhouse gases are expressed in CO_2eq unit (mass of equivalent CO_2). Global warming potentials of particular gasses are shown in Table 4.1 below.

Table 4.1: Global Warming Potential (GWP) of GHG gases

Gas	GWP
CO□	□
CH□	□□
N□O	□□□
CF□	□□□□
C□F□	□□□□
SF□	□□□□□

If, contrary to the emission, absorption of GHGs takes place, then this concerns sinking of greenhouse gases, and a negative sign is shown in front of the amount. The most important sinks are forests that absorb significant quantities of CO_2 through photosynthesis.

During the preparation of the inventory, the data from the Statistical Office of Montenegro (MONSTAT) were used, as well as other data sources, namely: basic data/ population average demographic growth rate, geographic and climatic characteristics, economic structure, the total acreage (basic features), the coverage of forest (basic features), data on agriculture, forestry and land conversion, the data in the field of energy/ manufacturing, exports, imports, international warehouses, market of solid and liquid fuels and gas, electricity consumption in economic sectors, the fuel consumption per sector, data on transport, consumption of motor fuels and lubricants, traffic intensity, structure and number of registered vehicles, production and consumption of iron and steel, aluminum production and consumption/waste information, waste volumes estimates, composition of municipal waste, wastewater, wastewater treatment. The main sources and types of data used for the inventory preparation are shown in Table 4.2 below.
Emissions of carbon dioxide emitted from energy sector were discussed using two approaches: top-down (IPCC Reference approach) and Bottom-Up (IPCC Sectoral approach). Reference approach is simpler and allows for expeditious consideration of the total CO_2 emissions due to fossil fuel consumption in the country as a whole, and it is an internationally acceptable, transparent method. Sectoral approach calculates CO_2 emissions using the step by step method, separating the emission due to consumption of different fossil fuels for individual energy subsectors. Reference approach was used for the calculation of CO_2 emissions for the energy sector for the period 1991 to 1998, based on the energy balance for this period. Emissions per sectoral approach could not be calculated due to a large number of missing data in the energy balances for this period.

Table 4.2: Main sources and types of data used for the inventory preparation

Data Source	Data Type
The 2003 population census (Statistical Office - Monstat)	Population data
Statistical Yearbook of Montenegro Nikšić Ironworks (documentation)	Production of steel and various steel products
Podgorica Aluminium Plant documentation	Aluminium production
Energy Balance of Montenegro	Consumption of lignite, bitumen, oil and other oil derivatives
Ministry of Economy Energy Sector Coal Mine "Ivangrad" – Berane documentation	Coal production
Statistical Yearbook of Montenegro Faculty of Economics Podgorica the level of development and quality of functioning of the transportation system in the economy of Montenegro of [illegible] Center for Entrepreneurship and Economic Development CEED	Consumption of fuel and oil in the road traffic (registered companies for cargo and passenger transport Average annual traffic for 2004 The final data were obtained by calculation Structure of vehicles by categories
Strategic Waste Management Master Plan	Waste generation data
Statistical Yearbook of Montenegro Strategy for Forest Management in the Republic of Montenegro	Forestry
Statistical Yearbook of Montenegro	Agriculture

4.3. GHG Emissions in the Baseline Year 1990

4.3.1. Direct Gas Emissions

Direct greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Carbon dioxide is the main greenhouse gas, because depending on the degree of combustion 99% of the carbon from fuel can possibly be converted into CO_2. The main emission sources of this gas are thermal power plants and combustion of fuel in the industry. CO_2 are also generated as a result of burning of biomass and other biofuels. However, according to the recommendations of the IPCC methodology, these emissions are not included in the total national emissions because it is a renewable energy source. In the inventory of 1990, the emissions from biomass (wood consumption) were calculated to amount to 409.59 Gg CO_2. CO_2 emissions by sector are shown in Figure 4.1 below.

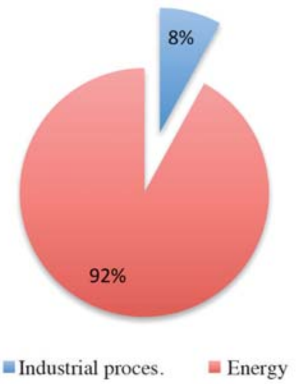


Figure 4.1 CO2 emission by economic sectors (2,691.56 Gg, 1990)

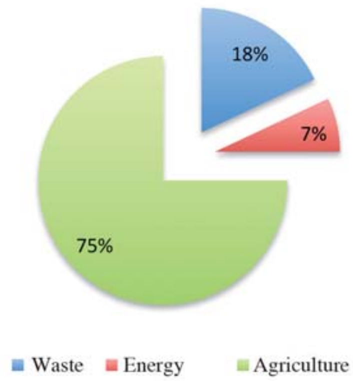


Figure 4.2: CH4 emission by economic sectors (27.02 Gg, 1990)

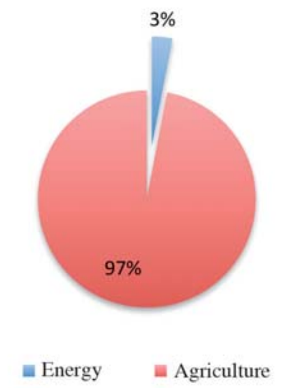


Figure 4.3: N2O emission by economic sectors 1.19 Gg, 1990

The main sources of methane (CH_4) are natural gas fields, livestock (methane emission due to internal fermentation of animals make 36% of total emissions of methane into the atmosphere) and organic waste (anaerobic decomposition of organic waste from methanogenic bacteria). Methane emissions in Montenegro are mainly associated with the agricultural sector (75%, which corresponds to 20:19 Gg) and waste sector (18% i.e. 4.97 Gg). CH_4 emissions by sectors are shown in Figure 4.2.

The contribution of nitrous oxide (N_2O) to the total greenhouse heating effect on the atmosphere amounts to about 6%. The main source of anthropogenic emissions of this gas is due to the use of manure and mineral fertilizers with high nitrogen content in agriculture, emissions due to animal production and indirectly caused by emissions due to agricultural activities. As for the emission of nitrous oxide, the agricultural sector is responsible for 97% of total emissions (Figure 4.3.). Emissions from the waste sector mainly come indirectly from human secretions, while those due to the combustion of fuel are neglectable. In Montenegro, agriculture sector is also the dominant source of nitrous oxide (1,156 Gg N2O)

4.3.2 Emissions of Synthetic Greenhouse Gases

Synthetic gases are gases that do not exist in nature. Emissions of synthetic greenhouse gases fluorocarbon-hydrogen (HFC), perfluorocarbons (PFC), and sulphur hexafluoride(SF_6) are significant due to their high global warming potential (GWP) and very long lasting in the atmosphere. The emissions of synthetic gases occur both during their production and use. The most important use of HFCs and PFCs is in refrigeration equipment and air conditioning, where they are used as substitute gases that damage the ozone layer, then the fire extinguishers and the prevention of explosions, etc. Sulphur hexafluorideis used as a means of insulation in different electrical equipment items, and it is assumed that a certain amount of this gas can be found in the electricity installations of the Electric Power Company of Montenegro. So far no research has been conducted relating to the imported quantities of synthetic gas, as in Montenegro there is no production of these gases.

During the melting process of aluminum, two PFC gas emissions are produced as a result of the electrolysis process: carbon tetrafluoride (CF_4) and carbon hexafluoride (C_2F_6). These gases are formed as a result of the phenomenon known as “anode effect” when the content of alumina in electrolytic cell is low, so that PFC emissions increase with the frequency, intensity and duration of anode effects. Emissions of CF_4 and C_2F_6 are calculated according to Tier 1b method, which requires more detailed technological information compared to Tier 1c method. Calculated emissions of CF_4 amount to 0.1936 Gg, while the emissions of C_2F_6 amount to 0.02 Gg, which converted to CO_2 equivalent (CO2eq) gives the total of synthetic gases amounting to 1,442.40 Gg CO2eq. Although emissions of synthetic gases are not large in absolute terms, still because of their large warming potential, those are ranked in the national inventory immediately after the emission of carbon dioxide (Table 4.3).

4.3.3. Total Anthropogenous Emissions

Total emissions of direct and synthetic greenhouse gases, including removal by sinks in Montenegro, for the1990 baseline year amounted to 4,585.28 Gg CO2eq.
The data presented data show that for the baseline year, CO_2 was the main greenhouse gas with a net emission of 2,691.56 Gg (no sink). Equivalent emissions of major greenhouse gases are given in Table 4.3 below.

Table 4.3.: Anthropogenous GHG emissions in Montenegro, 1990. (Gg)

Greenhouse Gases	Total Emissions (Gg)	Emissions in CO_2eq (Gg)	Share in Total Emissions (%)
CO_2	[illegible]	[illegible]	[illegible]
CH_4	[illegible]	[illegible]	[illegible]
N_2O	[illegible]	[illegible]	[illegible]
CF_4 & C_2F_6	[illegible]	[illegible]	[illegible]
Total		[illegible]	[illegible]

4.3.4. Indirect Gas Emissions

Indirect greenhouse gases: carbon monoxide (CO), nitrogen oxides (NOx) and non-methane volatile organic compounds (NMVOC) indirectly contribute to the greenhouse effect because they influence the processes of formation and decomposition of ozone (O_3) which is also one of the greenhouse gases. Sulphur dioxide(SO_2) affects the formation of atmospheric aerosols.

A more precise methodology for determining indirect emissions of greenhouse gases from various sectors and subsectors requires detailed information on fuel type, the type of applied technology and pollution control measures.

Emissions also depend on the production and capacity of the combustion technology, equipment maintenance, operating conditions, etc. Since these data were not available during the preparation of national GHG inventories, the Tier 1 methods were used for the calculation of emissions, so that the obtained results should be taken with significant uncertainty. It should be certainly noted that in 1990 the thermal and industrial facilities had no devices to reduce gaseous pollutants (in larger installations, there were only some devices for dedusting of flue gases). Indirect emissions of gases from the economic sector are shown in Figures 4.4. to 4.7 below.

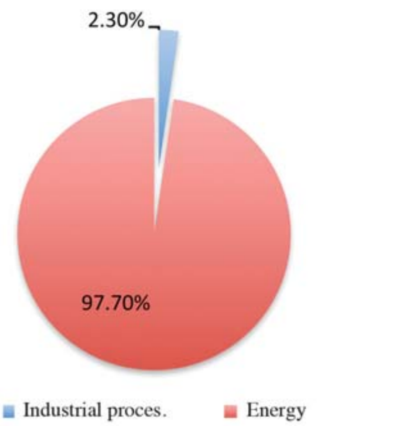


Figure 4.4: Nox emission from economic sectors (10.35 Gg, 1990)

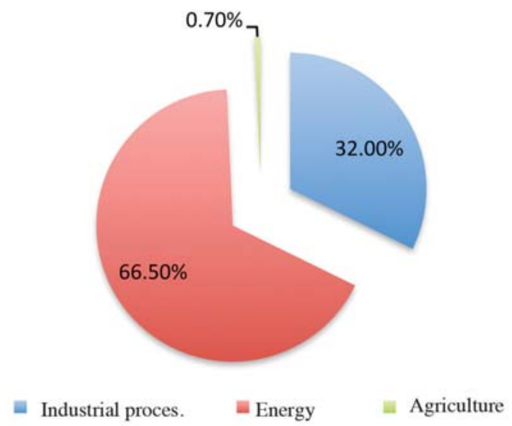


Figure 4.5: CO emission from economic sectors (42.99 Gg, 1990)

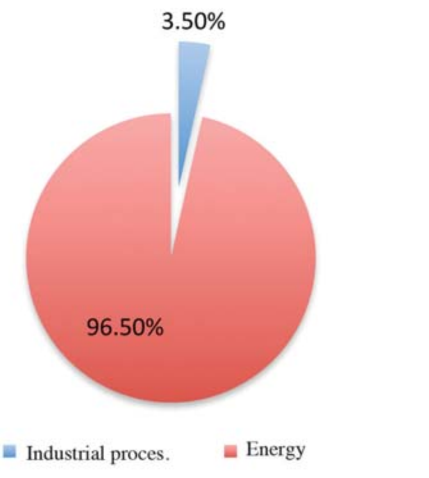


Figure 4.6: NMVOC emission from economic sectors (8.92 Gg, 1990)

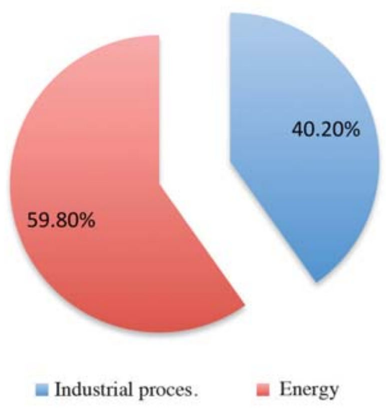


Figure 4.7: SO2 emission from economic sectors (42.75 Gg, 1990)

4.4 GHG Emissions from Economic Sectors

4.4.1. Energy

Energy includes all activities involving the consumption of fossil fuels (fuel combustion and non-energy use of fuels) and fugitive (fugitive) emissions from fuels. The energy sector is therefore a major source of anthropogenic emissions of greenhouse gases.

Is important to note that the data concerning the fuel consumption, broken down by activity, were available for the “Energy” sector, which is necessary to meet the sectoral approach of this sector, as envisioned in the IPCC methodology. Information on fuel consumption and imports are taken from the energy balance of Montenegro and the Ministry of Economy. The petroleum sector in Montenegro is limited to the distribution of petroleum products through the company Jugopetrol which was owned by the state in 1990. Some of the missing data for the transport sub-sector were obtained by calculation.

Emissions were calculated in accordance with the IPCC methodology following the simpler reference approach, taking into account the carbon content in fuel that is consumed throughout the country, as well as according to the sectoral approach, i.e. the distribution by fuel energy subsectors. Comparison of the values obtained with these approaches served as an internal control of accuracy of the calculations, which was less than 3% for the national inventory indicating an acceptable accuracy of the calculations.

The most important sub-sector in the energy sector is the transformation of energy, namely the production of electricity in TPP Pljevlja burning lignite from opencast mines in Pljevlja. Out of the total needs of Montenegro, which is 4.3 TWh of electricity per year, 0.8 TWh is produced in the TPP Pljevlja; hydropower plants produce 2.0 TWh, while the rest of 1.3 TWh per year is imported. As the TPP Pljevlja is the only thermal power plant in Montenegro, the share of this emitter in total emissions of CO_2 is high, so that in 1990 the TPP Pljevlja emitted 1,314.80 Gg CO_2 or 52.8% of total emissions from the energy sector, according to the IPCC calculations.

Fossil fuels are also intensively consumed by the sub-sector of industry and construction industry, where the Podgorica Aluminium Plant (KAP) is the largest consumer, which primarily consumes 110,000 tons of crude oil annually to support the production process. Total emissions from the sub-sector of industry and construction industry amounts to 608.90 Gg of CO_2, i.e. 24.4% of the total emissions from the energy sector.

The sub-sector of transport contributes to the anthropogenous emission primarily through fuel consumption in road transport (329.61 Gg CO_2), while the total contribution of this sub-sector to the total emissions from energy sector amounts to 379.45 Gg CO_2 or 15.2%.

Carbon dioxide emissions due to consumption of fuel from the remaining three sub-sectors (services, households and agriculture/fishing/forestry) are low, and their share in the total emissions by the energy sector is 7.6%. In Montenegro, the main sources of heating are electricity and biomass, while only some public institutions and state enterprises have central heating system (boiler rooms, capacity up to 1-5 MW) using lignite or liquid fossil fuels.

Total carbon dioxide emissions from energy sub-sectors due to the combustion of fossil fuels are shown in Figure 4.8. Fugitive emissions occur during the production, transmission, processing, storage and distribution of fossil fuels. In Montenegro, fugitive emission occurs due to coal production (open ore pits) and brown coal (pit exploitation) and are related primarily to methane emissions (1.66 Gg CH_4). The geological coal reserves in Montenegro are estimated to be above 400 million tons and Montenegro is an exporter of coal. About 80% of coal production comes from the opencast mine of Pljevlja (whose reserves are estimated at 70 million tons).

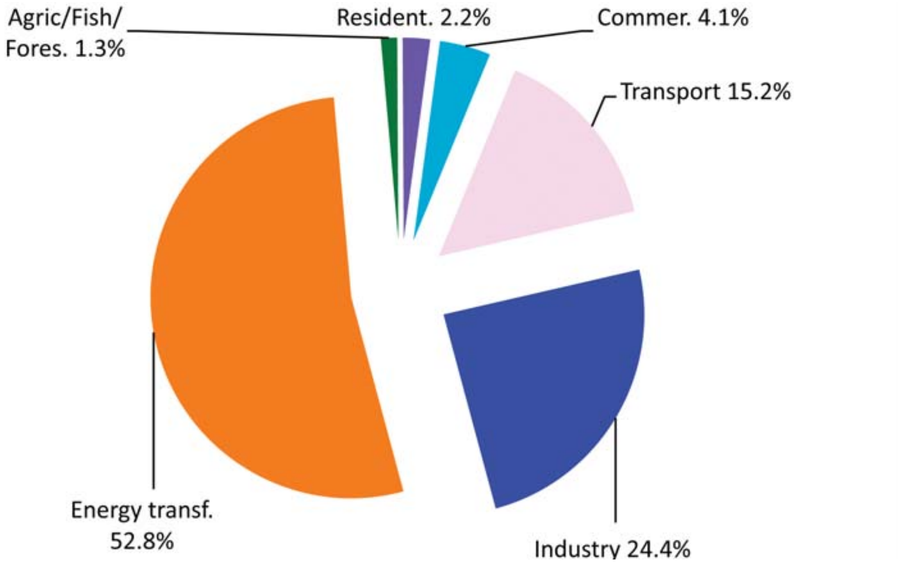


Figure 4.8: Shares of CO_2 emissions by energy sub-sectors due to fossil fuel combustion.

Total emissions of carbon dioxide per year were calculated by means of reference approach, using the data from energy balances of the state for the given years. The data from energy balances were not sufficiently detailed for the sectoral review of the inventory. However, the reference approach provides a sufficiently clear picture of the total CO_2 emissions for the observed period. Figure 4.9 shows CO_2 emissions for the period 1990-1998, calculated by reference approach.

As can be seen from the graph, CO_2, after 1991emissions recorded a significant decline as a direct consequence of a deep recession and a decline in all real economic parameters of the state. At the beginning of the 90s disintegration of the former Yugoslavia occurred, the state whose member was the Republic of Montenegro as well. Secession of the Yugoslav republics, Croatia and Bosnia and Herzegovina, was unfortunately followed by the war which was strongly felt in our country. The sanctions introduced in 1992 by the United Nations Security Council and countries of the European Union made the functioning of a heavily-industrialized Montenegrin economy totally impossible and led to a cessation of work or complete closing of a large number of production facilities. The fact that the TPP Pljevlja was out of service for the whole year 1995 illustrates well the situation that the Montenegrin society and economy found themselves in during the war and postwar developments in the region.

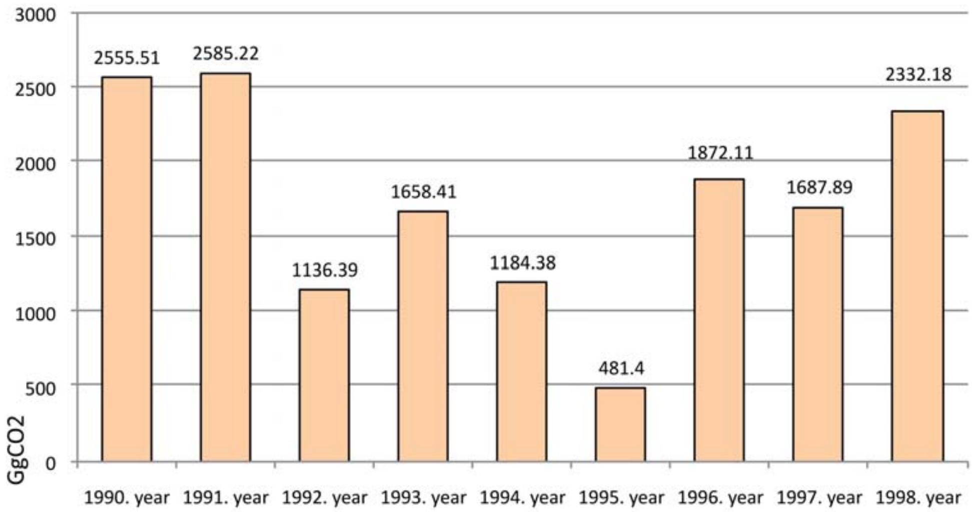


Figure 4.9: Comparative overview of CO_2 emissions for the period 1990-1998, by years (reference approach)

4.4.2. Industrial Processes

Until 1990, economic Development of Montenegro was characterized by intensive industrial production as the main development goal. The share of industry in gross domestic product (GDP) was about 30% until 1991. In addition to energy, mining and metal industry are the two main branches of industrial production in Montenegro. Aluminum is the main product that delivers half of the total revenue from the country's export. Other industrial facilities include wood, textile and food industries.

Emissions of greenhouse gases from industrial processes are calculated based on the IPCC methodology. Emissions were calculated on the basis of data on annual production, where the data from the largest factories were available in detailed, whereas for smaller industrial facilities no data on production, fuel and raw materials were available at all. For most of the missing data, values were found in the Statistical Yearbook of Yugoslavia, issued in Belgrade, under federal and national statistical institute, referring to the former Yugoslavia, i.e. .Serbia and Montenegro

The following industrial and chemical technological processes were considered in the inventory based on the collected input data: metal industry (ferrous and non-ferrous), production of lime, food and beverages.

The most significant CO_2 emitter (CO_2 emissions originating from fuel combustion are attributed to energy) is the aluminum industry in the amount of 156.60 Gg CO_2, while the main emitters of this gas are technological process of anode hard burning and aluminum melting in the electrolysis process. However, from the standpoint of equivalent emissions calculated emission of CF_4 and C_2F_6CF4 are much more significant equaling 1,442.40 Gg CO2eq, so that the aluminum industry is the largest single emitter of greenhouse gases if the emissions caused by fuel combustion are taken into account as well.

Emissions due to steel production are low (17.2 Gg CO2) since the steel is produced by melting steel scrap in electric arc furnaces (EAF). Emission factor for CO_2 emissions from the EAF process was taken from the IPCC's latest handbook from 2006 because the CO_2 emissions calculated using the emission factor from the 1996 IPCC manual were significantly overrated (emission factor from the 1996 IPCC manual is appropriate for the steel production in blast furnaces).
Cement factories are potentially significant emitters of carbon dioxide from this sector. The cement plant in Pljevlja, stopped operating before the baseline year due to outdated technology, so that all the cement in the country is now imported.

4.4.3 Agriculture

Agricultural land covers about 37% of the territory of Montenegro, and in 1990 the acreage was 517,136 ha (Statistical Office - Monstat, 1991). Most agricultural land is privately owned. Out of the largest agricultural facilities, the only one that is still publicly owned is the plantation of " Plantaže 13 Jul". Generally, farms are small, as well as the processing capacity. In 1990, as well as today, the most important agricultural products in Montenegro are grapevine and its products, vegetables and fruit. The areas where the small grains and corn are grown are small, while out of the industrial plants only tobacco is grown. There is no rice production in Montenegro. Livestock production is dominated by cattle and sheep farms and poultry. Fisheries, because of the outdated technology, have no significant role.

The most significant source of methane emissions is enteric fermentation in ruminants 20.18 Gg, where cows are the most significant emitters (Figure 4.10). N_2O emissions (1.15 Gg) from agriculture are mainly generated due to the use of mineral nitrogen fertilizers.

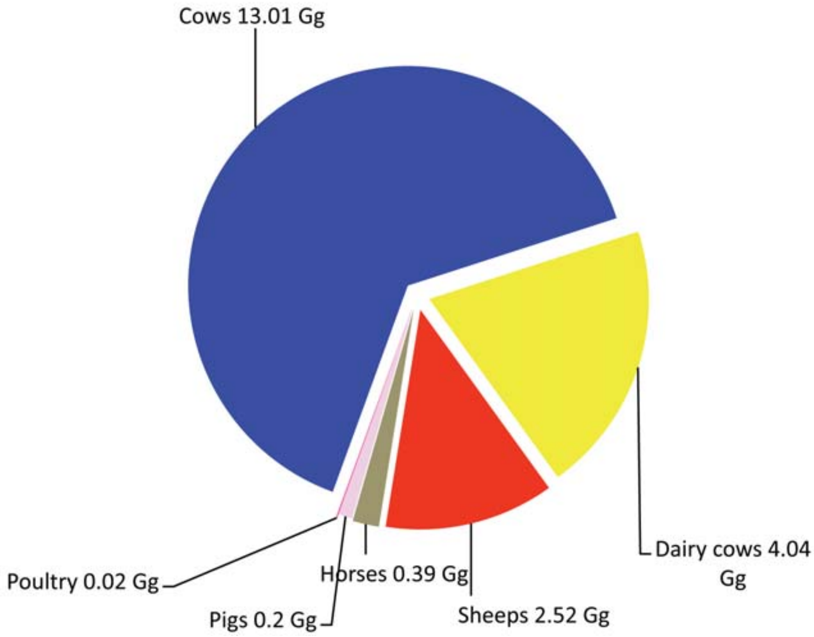


Figure 4.10.: CH_4 emissions due to enteric fermentation in animals bred in Montenegro

4.4.4 Land Use Change and Forestry

In 1990, forests and forest land in Montenegro covered 543,353 hectares (Statistical Office - Monstat, 1991), i.e. about 39,3% of its territory. But it should be noted that this without doubt very special forest resource of 0.88 hectares per capita is colorful. Namely, the stated figure includes forest land and forests of varying composition. About 226,000 hectares are covered by pure stands, while317,000 hectares are covered by mixed forest stands. Out of these 317 000, mixed stands of broadleaf cover 188 000 hectares, 35,000 ha are covered by mixed conifer forests, and some 94,000 hectares by mixed deciduous and coniferous forest (Figure 4.11). This relationship is important from the standpoint if removal of CO_2 emissions by sinks, because broadleaves have a greater ability to absorb CO_2 than the coniferous trees. Special purpose forests, such as national parks, cover an area of 12,957 hectares.

The inventory of greenhouse gases for a part of the change in land use and forestry was conducted according to the IPCC manual of 1996. Based on the data from the Statistical Office on biomass and proceeds of wood in the sub-model "Forest Changes," annual carbon bonding in evergreen (1990 kt) and deciduous (372.02 kt) forests was calculated at 462.02 kilotons of carbon.

Also, based on technical production of wood (375.92 kt dm), consumption of wood for heating (182.84 kt dm) and waste (100.74 kt dm), the total biomass of recovered wood was calculated in the amount of 659.5 kt of dry matter. Based on these data the annual amount of CO2 absorbed by sinks was calculated at - 485.00 Gg

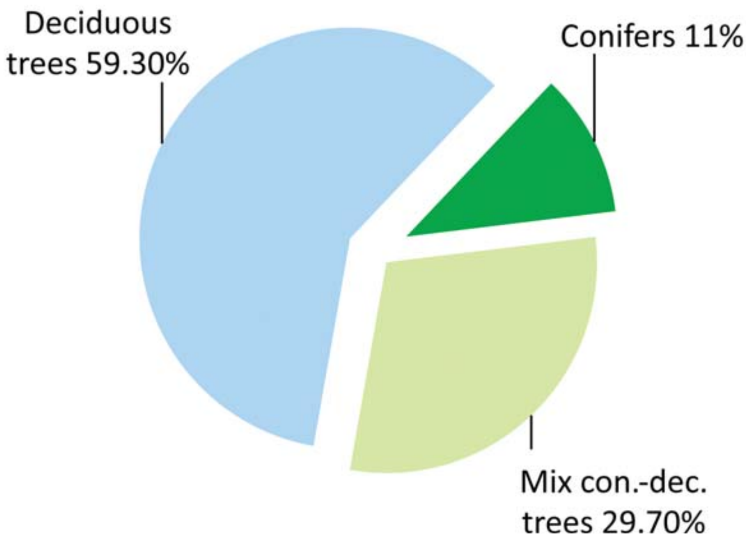


Figure 4.11: An overview of areas under different types of forest stand, in percentages.
Source: Statistical Office - Monstat 1991

4.4.4.1 Analysis of Removal by Sinks per Year for the Period 1990-1998

Based on the Statistical Office's data (MONSTAT), the volumes of CO_2 absorbed by sinks were calculated for the period 1990-1998 (Figure 4.12.)

Figure 4.12: Volume of CO_2 in Gg absorbed by sinks

The chart shows a trend of increasing volumes of absorbed CO_2 per year in 1998, to almost twice as much as in the baseline line year, which was caused by severe economic crisis, i.e. termination of operations or the reduction of capacity use down to a minimum in the entire wood processing industry during that period. Although this trend was not due to any sustainable management of forest wealth, the fact that CO_2 sinks have a direct impact on the final balance of national emissions represents an additional argument for the certainly desirable future development of wood processing industry to be founded on an economically cost-efficient and environmentally sustainable approach.

4.4.5 Waste Sector

Until 2005, solid municipal waste in Montenegro used to be taken to 20 waste disposal sites operated by communal enterprises, of which no waste disposal site could be called a landfill because those did not satisfy the basic elements defined under the applicable regulations for this type of facilities. The only organized sanitary landfill, Lovanja, operated from 2005 to 2008, while in 2006 the sanitary landfill of Livade started to operate, designated for the disposal of municipal waste from the area of the Capital City of Podgorica. It is therefore very difficult to assess the situation in terms of quantities of waste in Montenegro. The main reason for the lack of data on the qualitative and quantitative analysis of waste is the lack of reliable evidence about the amounts, composition and characteristics of waste.

Although there are no reliable data about the quantities of waste in Montenegro, the national Strategic Master Plan for Waste Management (2005) includes an estimate of the amount of waste generated from households in Montenegro for 2003, made on the basis of total population (Table 4.4).

Table 4.4 Quantities of produced waste

Region	Waste Producer			Projected
	Population	Tourists (number of overnight stays)	Displaced Persons	Projected Volumes (t/g)
Northern	[illegible]	[illegible]	[illegible]	[illegible]
Central	[illegible]	[illegible]	[illegible]	[illegible]
Coastal	[illegible]	[illegible]	[illegible]	[illegible]
Montenegro	[illegible]	[illegible]	[illegible]	[illegible]

The official data of Monstat about the quantity of waste generated by the urban population, 1kg/person/day, was used to estimate the emissions of methane, because it is considered that 85% of municipal solid waste in major cities is collected by the responsible services, as opposed to only 15% in rural areas. The share of biodegradable organic carbon was calculated based on data from Table 4.5

Total estimated emissions of methane from the waste sector amounted to 4.97 Gg CH_4. Methane emissions from plants for wastewater treatment were calculated to zero, because the wastewater of Podgorica is aerobically treated in a single wastewater treatment plant in Montenegro, while the other municipal and industrial wastewater is discharged, without prior treatment or by means of infiltration through the septic tanks, directly into water recipients.

Table 4.5 Assumed composition of municipal waste in Montenegro

Assumed composition of municipal waste in Montenegro								
	Paper Cardboard	Glass	Metal	Plastics	Textiles	Organic Matter	Other	Total
Central Region	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Coastal Region	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Northern Region	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Average Value	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

4.5. Analysis of Key Categories

Identification of key categories is described in Chapter 7, Good Practice Guidelines (IPCC - GPG 2000). When considering the national emissions, one of the priorities is to determine the key categories because the key categories are those that have the most significant impact on the inventory of greenhouse gases in a country. The key categories are those which summed together in a descending order by value make more than 95% of the total CO_2 equivalent emissions. In Table 4.6 the key categories are shown, calculated according to the Good Practice Guidelines according to Tier 1 methodology.

Table 4.6 shows that the sum of 14 key categories makes up 95.3% of total national emissions of GHG gases. Note: Categories due to the combustion of fossil fuels in stationary sources were not further traced, since the same emission factors were used for all the subcategories.

Table 4.6 The key categories of GHG inventories for 1990

IPCC Category	Gas	CO eq (Gg)	Share in Total Emission (%)
PFC emission aluminium production	CF□, C□F□	[illegible]	[illegible]
Emissions from stationary sources – lignite combustion	CO□	[illegible]	[illegible]
Emissions from stationary sources – crude oil combustion	CO□	[illegible]	[illegible]
Emissions due to internal fermentation	CH□	[illegible]	[illegible]
Emissions from mobile sources – combustion of gasoline	CO□	[illegible]	[illegible]
Emissions from aluminum production	CO□	[illegible]	[illegible]
Emissions from mobile sources – oil derivatives	CO□	[illegible]	[illegible]
Emissions from solid municipal waste disposal	CH□	[illegible]	[illegible]
Direct emissions from agricultural land	N□O	[illegible]	[illegible]
Indirect emissions from agricultural land	N□O	[illegible]	[illegible]
Emissions due to fertilizer management	N□O	[illegible]	[illegible]
Emissions due to fertilizer management	CH□	[illegible]	[illegible]
Emissions due to animal grazing at agricultural land	N□O	[illegible]	[illegible]
Emissions from stationary sources – crude oil combustion	CO□	[illegible]	[illegible]
	Σ	[illegible]	[illegible]

4.6 Main Emission Indicators

For the evaluation of intensity of national emissions of greenhouse gases it is useful to display mutual relations among the emissions per capita and per gross domestic product (GDP). These relations are important also from the standpoint of commitment that Montenegro will take over as a signatory to the Kyoto Protocol in the case of accession to the European Union and transition to Annex 1 countries.

The total CO_2 equivalent emissions (including the sinks) per capita (1991 census) is 7.7 t CO2eq/capita, which ranks Montenegro among the European countries with low emissions relative to developed countries. Observing the relation between CO_2 emissions caused by fossil fuel combustion, this ratio is more favorable, that is 4.55 t CO2eq/capita, because of a significant share of synthetic gases in total emissions. To compare emissions with other Annex 1, non-Annex 1 countries which have signed the Kyoto Protocol, as well as the countries from the region, the IEA statistics of 2009 (International Energy Agency - 2009 Edition) was used, which takes into account only the CO_2 emissions caused by fossil fuel combustion, calculated according to the sectoral approach (Figure 4.13.). The low ratio of emissions per capita in Montenegro is explained by a small share of the thermal power sector in total electricity production

Emissions per unit of GDP is significant from the standpoint of the energy sector, and thus also of produced emissions in the generation of total revenues of the country. Calculated emissions per unit of GDP for 1990 amounts to 1.86 kg per CO_2/USD using the exchange rate of 2000[21] (Figure 4.14.).

Lower GDP per capita in Montenegro in relation to Annex 1 countries and the fact that significant amounts of the electricity consumed are used to satisfy the demand of households and service sectors, resulted in a significantly higher generation of CO_2 emissions in Montenegro per GDP than it is the case in developed countries of the European Union.

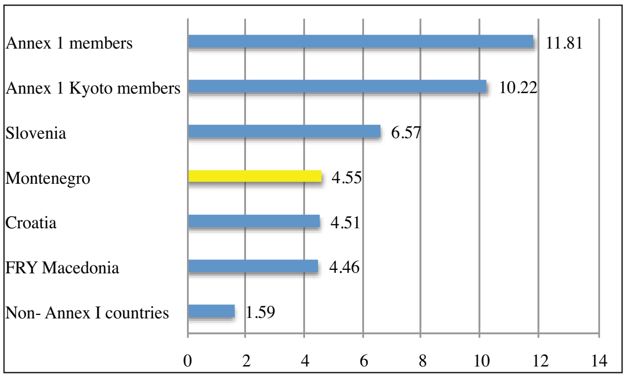


Figure 1.1: Comparative CO2 emissions per capita for Montenegro, countries in the region, Annex 1 and Non-Annex 1 Parties.

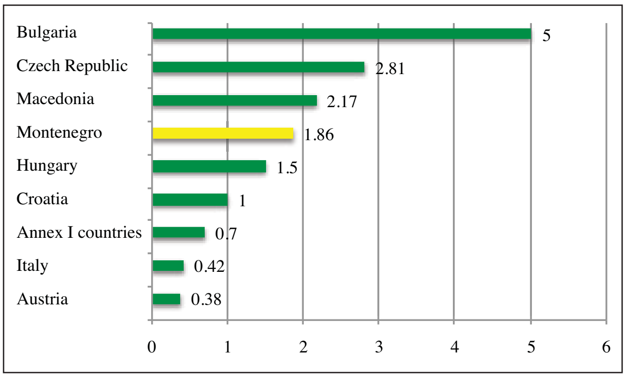


Figure 1.2: Comparative CO2 emissions per kg CO2/USD according to the exchange rate of 2000, for Montenegro, countries in the region, Annex 1 member countries (source: IEA data, 2009)

4.7 Basic Missing Data and Submodeles in the Inventory for 1990

Energy
Emissions from international aviation and marine fuel storages, emissions from aircrafts (Tier 2 method).

Industrial Processes
Asphalt production, consumption of halogen hydrocarbons and sulfur hexafluorides.

Land Use Change and Forestry
Change in land use and forestry: conversion of CO2 from forests and meadows from biomass; burning woods - no - CO_2 gases from burned biomass; abandoned land; change in the level of carbon in the soil for mineral soils; carbon for the agricultural land; carbon emissions from intensively treated soil with high levels of organic matter; carbon emissions due to lime adding to improve soil acidity; calculation of total CO_2-C emissions from agricultural activities of the affected land.

21 GDP of Montenegro for 1990 and 2003, using dollar exchange rate from 2000, was calculated for the purposes of this report by the Institute for Strategic Studies and Prognoses (ISSP), Podgorica

Waste
Emissions of nitrous oxide from human secretions (Data on consumption of protein per capita, the proportion of nitrogen in proteins).

4.8 GHG Inventory Uncertainty Assessment for 1990

Analysis of uncertainty measurement is one of the key activities in the annual inventory of emissions of greenhouse gases, and consists of identifying sources of uncertainty and its quantification. The purpose of estimation of measurement uncertainty is not to deny the validity of test results for greenhouse gas emissions, but to assist in improving the accuracy of estimation of emissions of these gases. Identification of sources of uncertainty is the first step in assessing the uncertainty of an investigation. Often there is no complete information available, or the measurement can not be repeated, so that many calculations of uncertainties include our best estimate.

Assessment of uncertainties of emission of greenhouse gases for 1990 was performed on the basis of analysis of all available data that are typical for Montenegro. In cases where there are no national data the results from other documented scientific literature were used. First, the sources were identified, and then an assessment of uncertainties was made for individual gases and sectors in the inventory of greenhouse gases. An assessment of measurement uncertainty was carried out for the key sources of gases.

4.8.1 The Process of Inventory of Uncertainty Measurement Identification and Quantification

Estimated uncertainty of emissions from individual sources (factories, motor vehicles, etc.) is a function of the characteristics of measuring instruments, sampling frequency, calibration (of measuring instruments) and direct measurement, or (more often) a combination of measurement uncertainties of emission factors for specific gases and related activity data.

Analysis of uncertainty for the inventory of emissions of greenhouse gases in Montenegro is based on the methodology of Tier 1, which is described in *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories Good Practice and Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, while the year 1990 was taken as the baseline year. The assessment of uncertainties for an individual gas represents a combination of information obtained on the basis of IPCC data and information from local sources.

Application of Tier 1 methodology for the analysis of uncertainties is based on the following equations:

$$u_{i,g} = \sqrt{u_{AD,i}^2 + u_{EF,i,g}^2}$$

$$U_{i,g} = \frac{u_{i,g} \cdot E_{i,g}}{\sum_{i,g} E_{i,g}}$$

$$U_{tot} = \sqrt{\sum_{i,g} U_{i,g}^2}$$

where:
i - an index that refers to emission sources; ***g*** - index relating GHG;
$u_{i,g}$ - combined measured uncertainty of the ***g***-gas from the ***i***-source;
$u_{AD,i}$ – measured uncertainty of data on activity from the ***i*** source;
$u_{EF,i,g}$ - measured uncertainty of the emission factor of the ***g*** gas of the ***i*** source;
$U_{i,g}$ - measured uncertainty estimated for the emission of the ***g***gas from the ***i*** source;
$E_{i,g}$ – emisssion of the ***g*** gas from the ***i*** source;
U_{tot} - measured uncertainty of the total GHG emissions.

4.8.2 Uncertainty Assessment for the Key Categories

Key categories of the national inventory contain 14 factors that cause the generation of more than 95% of the total emissions of greenhouse gases. Therefore it was decided to devote special attention to the assessment of uncertainties in key categories of inventory. An assessment of measurement uncertainties was carried out for the emissions of individual gases and key categories.

The main factors contributing to measurement uncertainty in determining the emission of PFC (CF_4 and C_2F_6) gas in the production of aluminum are the volumes of aluminum produced and uncertainty emission coefficients. Measurement uncertainty of the activities of aluminum, based on the obtained data, was estimated at 2.0%. Measurement uncertainty for the emission coefficient for CF_4 and C_2F_6 emission is 7.0% and 22.2%, respectively, so that the total estimated uncertainty of emission of PFC gases (CF_4 + C_2F_6) is 7.0%

The main factors that contribute to measurement uncertainty in determining the CO2 emissions in coal combustion from stationary sources include the quantity of combusted lignite and emission factor for CO_2. In Montenegro, lignite is produced in the coal mine in Pljevlja, so that on the basis of data obtained from this mine the uncertainty of coal produced can be evaluated, which represents the initial data in the calculation of emissions of carbon dioxide by its combustion. Thus, the estimated uncertainty is 1%. Measurement uncertainty emission coefficient is 7.0%. The total measurement uncertainty of CO_2 emission resulting from lignite combustion is 7.1%

CO_2 emissions from stationary sources – from the combustion of crude oil, have an estimated combined measurement uncertainty of 9.9%. The combined measurement uncertainty is obtained through the measurement uncertainties for the activity and emission coefficient which are taken from the documented scientific literature, amounting to 7.0%

The parameters that influence the measurement uncertainty due to emission of methane fermentation in domestic animals include a “correct” number of domestic animals, the emission factors for different types, etc. The combined measurement uncertainty for the emission of methane from the fermentation process in domestic animals is estimated at 34.7%.

Identified sources of measurement uncertainty for the emission of CO_2 during the combustion of petrol and oil derivatives are the quantities of imported fuel and associated emission factors. The combined uncertainty is 9.9% for CO_2 emissions from gasoline, as well as for its emissions from oil derivatives.

The combined uncertainty of CO_2 emissions from aluminum production amounted to 9.9%. Methane emissions due to disposal of solid waste also belong to the key source categories of gases that cause greenhouse effect. The estimated measurement uncertainty is 400%. Documented scientific literature was used for the calculation of measurement uncertainties emission coefficients. Measurement uncertainty of individual emission coefficients is large. Also, as already mentioned in Chapter 4.4.6 (Waste Sector), there is a large uncertainty of input active data on the amount of waste disposed for 1990, which led to large combined measurement uncertainty of methane emissions from waste.

The combined uncertainty of direct emissions of N2O from agricultural land, based on the individual measurements of uncertainties obtained from documented scientific literature, amounts to 51.3%. To estimate the combined uncertainty of indirect emissions of N_2O gas from agricultural lands, it is necessary to determine the measurement uncertainty of emission factors, the quantity of applied artificial fertilizers, number of heads of domestic animals and the volume of manure. The estimated combined uncertainty is 245%.

Measurement uncertainty of CH_4 emissions due to fertilizer management is 19.9%, while the uncertainty for N_2O is 99.4%

Emissions due to animal grazing on agricultural land have an estimated combined measurement uncertainty of 120%. The greatest contribution to measurement uncertainty was given by the uncertainty obtained from emission factors.

Emissions from stationary sources - combustion of crude oil are the last key category of emissions of greenhouse gases. Calculated combined uncertainty of CO_2 emissions from this category is 9.9%. Estimates of measurement uncertainty (without LUCF) for the key categories of greenhouse gases are shown in Table 4.7.

Table 4.7: Estimates of measurement uncertainty (not including LUCF) for the key categories of greenhouse gases

No.	IPCC Category	Gas	CO_2 eq. (Gg)	Measurement Uncertainty of Estimated Emission (%)
[illegible]	PFC emission - aluminium production	CF_4, C_2F_6	[illegible]	[illegible]
[illegible]	Emissions from stationary sources – lignite combustion	CO_2	[illegible]	[illegible]
[illegible]	Emissions from stationary sources – crude oil combustion	CO_2	[illegible]	[illegible]
[illegible]	Emissions due to internal fermentation	CH_4	[illegible]	[illegible]
[illegible]	Emissions from mobile sources - combustion of gasoline	CO_2	[illegible]	[illegible]
[illegible]	Emissions from aluminum production	CO_2	[illegible]	[illegible]
[illegible]	Emissions from mobile sources – oil derivatives	CO_2	[illegible]	[illegible]
[illegible]	Emissions from solid municipal waste disposal	CH_4	[illegible]	[illegible]
[illegible]	Direct emissions from agricultural land	N_2O	[illegible]	[illegible]
[illegible]	Indirect emissions from agricultural land	N_2O	[illegible]	[illegible]
[illegible]	Emissions due to fertilizer management	N_2O	[illegible]	[illegible]
[illegible]	Emissions due to fertilizer management	CH_4	[illegible]	[illegible]
[illegible]	Emissions due to animal grazing at agricultural land	N_2O	[illegible]	[illegible]
[illegible]	Emissions from stationary sources – crude oil combustion	CO_2	[illegible]	[illegible]
		Σ	[illegible]	[illegible]

The total measurement uncertainty of greenhouse gas emissions for the key categories, obtained by calculation according to Tier 1 methodology, was 11.1%.

The total estimated measurement uncertainty for the entire inventory of these gases is 14.8%.

4.8.3 Recommendations for Improving the Assessment of Measurement Uncertainty and Verification of Indicators

As noted above, the calculation of measurement uncertainties for the emissions of greenhouse gases was made according to the simplest Tier 1 methodology. Active input data obtained from various national sources (Table 4.2) were used for the calculation of combined measurement uncertainties, while the emission factors were taken from documented scientific literature.

To improve the estimation of measurement uncertainty for the emission of greenhouse gases, it is necessary to:

- Revise the data on the activities;
- Change the emission factors, i.e. calculate the national emission coefficients;
- Conduct trend analysis by years;
- Change the calculation methodology to multiple Tier, i.e. do the assessment of measurement uncertainty also using Tier 2, which is based on Monte Carlo simulation;
- Continue applying and working in accordance with QA / QC practices

Verification of calculation was carried out only in the case of CO_2 for the energy sector, by comparing the values obtained through the Reference and Sectoral approach. The values of the emitted CO_2 obtained thorough these approaches differ by less than 3%, indicating good acceptability of the calculation.

4.9 Inventory of Greenhouse Gases for 2003

The inventory of greenhouse gases for 2003 was prepared in cooperation with the Italian Ministry for Environment, Land and Sea, using the IPCC methodology with the Sectoral approach, which is consistent and transparent with the inventory of the baseline year.

U 2003, the total estimated emissions amounted to 2,817.75 Gg of carbon dioxide, 25.32 Gg of methane, 0.92Gg of nitrous oxide, 0.231 Gg of CF_4 and 0.02 Gg C_2F_6 while the sinks absorbed 853.26 Gg of carbon dioxide.

Table 4.9 Antrophogenous GHG emissions in Montenegro, 2003 (Gg)

Greenhouse Gases	Total Emissions (Gg)	Emissions in CO_2 eq (Gg)	Share in Total Emissions (%)
CO_2	[illegible]	[illegible]	[illegible]
CH_4	[illegible]	[illegible]	[illegible]
N_2O	[illegible]	[illegible]	[illegible]
CF_4, C_2F_6	[illegible]	[illegible]	[illegible]
Total		[illegible]	[illegible]

It was calculated that 92.8% of carbon dioxide emissions for 2003 accounted for the energy sector. The contribution of industrial sector was 7.3% (203.63 Gg). More than 71% of emissions of methane, equivalent to 18.06 Gg, were contributed by the agricultural sector and 22% by the waste sector. The agricultural sector is the major source of nitrous oxide emission (0.89 Gg) and contributes 96,7% to the total emission of this gas.

The total CO_2 equivalent emissions (including the sinks) per capita (2003 census) amount to 7.2 t CO_2eq/capita. The emissions calculated per unit of GDP for 2003 amount to 1.60 kg per CO_2/USD, based on the exchange rate of 2000.

4.9.1. Comparative Emissions of Direct Greenhouse Gases for 1990 and 2003

The emissions of carbon dioxide for energy and industry sectors for 2003 and 1990 did not change significantly, because the volume of production of TPP Pljevlja and the main industrial emitters of greenhouse gases (ferrous, and primarily and non-ferrous metallurgy) did not differ significantly for the observed year 1990. Emissions of synthetic gases increased in comparison with 1990 because of an increase in the production of aluminum in 2003. The emissions of equivalent CO_2 were reduced between 1990 and 2003 by 118.37 Gg, i.e. 2.58% (Table 4.10)

Table 4.10: Comparison of direct emissions of greenhouse gases for 1990 and 2003

Greenhouse Gas Emissions	Baseline [illegible]	[illegible]	Change in Relation to [illegible]
	CO_2 equivalent (Gg)		
CO_2 emission including CO_2 from LUCF	[illegible]	[illegible]	[illegible]
CO_2 emission not including CO_2 from LUCF	[illegible]	[illegible]	[illegible]
CH_4	[illegible]	[illegible]	[illegible]
N_2O	[illegible]	[illegible]	[illegible]
PFC	[illegible]	[illegible]	[illegible]
Total (including CO_2 from LUCF)	[illegible]	[illegible]	[illegible]
Total not including CO_2 from LUCF	[illegible]	[illegible]	[illegible]

4.10 Recommendations for Improving the Process of Inventory Implementation and Accuracy

4.10.1 Recommendations for the Strengthening of Technical and Institutional Capacity

The inventory of greenhouse gas serves as a strategic document for the performance of the obligations of Montenegro stemming from the UNFCCC Convention and Kyoto Protocol. However, it is no less important that the annual inventory of GHG and other gases are an essential element of the decision-making in national environmental policy. Transparent, accurate, consistent, comparable and complete inventories are used to extract information on emission trends in relation to the baseline year and assist in monitoring the application process both of the existing and future mitigation measures to reduce the emissions of greenhouse gases.

In order to create a national system for quality assessment of emissions of greenhouse gases, it is necessary to: properly plan the level of participation of institutions; clearly define and share the responsibilities among the participants in this system; establish a coordinating body for the implementation of the entire process; and provide, as soon as possible, for the transposition of European legal policies in the field of climate change.

By the beginning of 2009, the Environmental Protection Agency (EPA Montenegro) was established as the authority for the performance of professional and related administrative work in the field of environmental protection. In institutional terms, the establishment of the Agency represents a significant strengthening of capacities in the field of environmental protection, including climate change, and an essential prerequisite for the implementation of legal regulations. A technical operational body for the implementation of clean development mechanism was established within the Agency, and it is envisaged to be responsible for managing the inventory of GHG gases. Inventory team must be responsible for the selection of methodology, data collection (input data and emission factors provided by the statistical services and other organizations), developing and archiving of data and implementation of quality control and quality assurance (QA/QC)

Data base for the calculation of inventory for the year 1990 was mainly taken from MONSTAT – Statistical Office of Montenegro (Statistical Yearbook of 1990.). However, as noted in the National Capacity Self-Assessment (NCSA) for climate change, it is essential to improve the capacity of Monstat, both technical and of human resources, so that it can maintain a database of emissions through a department dealing with the environment. Monstat has no department in charge of the UNFCCC and the Kyoto Protocol. Only one employee is responsible for the environmental field, including inter alia the issues of climate change, which is certainly not enough. Projects participated by Monstat, such as "Development of Environment in the Balkans", which was implemented in cooperation with the Swedish International Development Agency (SIDA) are helpful, but not enough to enable this institution to implement all the necessary research and provide a complete, quality and transparent database. A positive example is the Agricultural Census, which is planned to be implemented in June 2010, which among other issues includes the question "Consumption of energy in the farms".

4.10.2 Recommendation for Improving Inventory Accuracy

The IPCC's guidelines highlight the need for using national methodologies, which increases the accuracy of data on activities and emission estimates. Priority should be given to the key categories that are analyzed in Chapter 4.5, in order to intensify the efforts so that those categories are given the priority in the preparation of next inventories, i.e. to prepare the best possible analysis for the most important key categories.

In the following paragraphs contain the proposals for some essential improvements to the inventory, by sector:

Energy

- Conduct studies/analysis for the application of domestic CO_2 emission factors for TPP Pljevlja (lignite combustion) and major energy facilities in the industry that use crude oil as fuel. Development of the National Register of Polluters, which was launched by the Ministry of Physical Planning and Environmental Protection in cooperation with the Agency for Environmental Protection and the LRTAP inventory for 2006, represents a good basis to obtain important technological details of the plant capacity, combustion technologies and pollution control measures applied. These data are also crucial for the calculation of indirect gases using more exact emission factors. However, the complexity of these studies must be noted because each application of national methodologies and emission factors should be thoroughly documented, which requires adequate financial and technical assistance with the additional involvement of local experts of different profiles.

- Pre-defined values from the IPCC manual on the degree of oxidation of carbon in the combustion process were identified as the source of the uncertainty of calculations. Practical emission measurements carried out at all major industrial plants by the Centre for Ecotoxicological Examinations of Montenegro, Podgorica, on behalf of environmental inspection already for a longer period of time, represent a good basis for the correction of these values.
- Energy Balance of Montenegro is the basic document that was used as a source of valid and active data for the energy sector. Determining the uncertainty (accuracy) of data from energy balances represents the basic prerequisite for improving the calculation of uncertainty for the power sector.
-

Industrial Processes

- Determination of accurate CO_2 emission factors in metal production (tones CO2/tonne of reducing agent: petroleum coke or toasted anode, graphite electrodes), together with accurate data on the mass of reducing agent, is an essential precondition for a more precise consideration of emissions from the metal industry
- Begin to collect input data, to consider the emissions of synthetic gases (HFCs, PFCs and SF_6), especially HFC because their application is growing rapidly, because these gases are used as the primary replacement for substances that deplete the ozone layer, which are placed outside of use in accordance with the Montreal Protocol. In line with this it is necessary to begin collecting active data have to consider at least the potential emissions of these substances and determine the baseline year[22].

Agriculture

- More efficient, monitored application of nitrogen and other fertilizers in the production of artificial fertilizers.

Land Use Change and Forestry

- Monitor and include into estimates the information on clearing of forest communities.
- Improve scientifically and professionally the relation between covered and bare areas (carbon depositing)

Application of Solvents

- This sector is mainly linked to emissions of NMVOC and to a very small extent to N_2O emissions, but some efforts certainly need to be placed into collecting input data for this sector, so that the inventory can be made more complete.

Waste

- Data on the volume and composition of generated municipal and industrial waste are constantly being improved in line with the importance that is attributed to the process of waste management in Montenegro, which will lead to improvements in end-use of data and more reliable methods for estimating emissions from this sector.

22 For Anex 1 members, the baseline year for synthetic gases is 1995 , according to Article 3 paragraps 7 and 8 of the Kyoto Protocol

GREENHOUSE GAS EMISSION REDUCTION POLICIES, MEASURES AND ASSESSMENTS

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GREENHOUSE GAS EMISSION REDUCTION POLICIES, MEASURES AND ASSESSMENTS

5.1 Regulatory Framework

5.1.1 Energy

Energy policy is within the competence of the Ministry of Economy of Montenegro. Energy policy and energy development are based on assumptions and requirements of EU in this field. A sustainable, secure and competitive energy supply is recognized as the basic goal.

The Energy Community Treaty was signed in 2005, and came into force in 2006 (Law on Ratification of the Energy Community between the European Community and Montenegro (Official Gazette of the Republic of Montenegro 66/06)). The Agreement on EC is the (first) legally binding document of Montenegro towards the EU.

Taking into account the basic aim of energy as a branch of the economy (provision of safe, safe, reliable and quality energy supply at realistic prices, taking into account the protection of tariff customers), as well as the previously listed liabilities relating to the EU accession, reorganization of the energy sector has been implemented and planned in the future through several steps and the adoption of strategic documents in this sector as follows:

- Energy Law (Official Gazette of the Republic of Montenegro 39/03);
- Energy Policy (2005);
- Energy Efficiency Strategy and Action Plan (2005);
- Energy Community Treaty (2006);
- Small Hydro-Power Plants Development Strategy (2006);
- Assessment of Energy Potential of Renerable Energy Sources (sun, wind, biomass) (2007);
- Energy Development Strategy until 2025 (2008);
- Energy Development Strategy and Action Plan 2008-2012 (2008);
- World Bank Study: Options for Public-Private Partnership in Montenegro in the Sector of Energy Generation (2010);
- UNEP DTIE BALREP Program: Feasibility study of application of the concept of financial support for the development of installations for solar water heating in Montenegro (2010)

The fundamental long-term planning documents in the field of energy include Energy Policy of Montenegro (hereinafter referred to as the “Energy Policy”) and the Energy Development Strategy until 2025 (hereinafter referred to as the “Strategy”). The Energy Policy and Strategy constitute a starting point for the Action Plan document, which aims to implement the Strategy. These documents are complementary, as they have the same goal: the concrete vision of energy development and assessment of ways in which this vision will be realized.

The strategy is based on the adopted energy policy, existing international obligations and guidelines of the EU energy policy. Among others, the main objectives of the strategy related to environmental protection are the following:

- Montenegro will strive to meet all the necessary steps for successful implementation of *Acquis Communautaire* in the areas of energy, environment, competition and renewable sources of energy according to the demands and dynamics of the Energy Community Treaty;
- Undertake resolute measures to maintain at least 20% share of renewable energy sources in total primary energy consumption in Montenegro;
- Improving efficiency and reducing the impact of coal mining and thermal power plants on the environment;

- Support the development and rapid inclusion of renewable energy sources, the use of solar energy for obtaining the thermal energy, replacement of industrial and of small boilers with cogenerations using liquefied petroleum gas (LPG) and liquid fuels; introduction of other systems of local power in the national energy system;
- Based on the ratification of the Kyoto Protocol in March 2007 , as a country outside the annex of developed countries at least until 2012, provide the opportunities and support to foreign investors for the implementation of projects known as Clean Development Mechanism (CDM);
- Improving energy efficiency in energy generation and consumption to the level of medium-developed EU countries.

Energy and environment are key sectors in the context of climate change in which the process of harmonization of the applicable domestic legislation with relevant EU framework is currently in progress.

The 2001/77/EU Directive on the promotion of electricity produced from renewable sources in the internal market in electricity and 2009/28/EU Directive on the promotion of energy from renewable sources were transposed into the new Energy Law (adopted on 22 April 2010 by the Parliament of Montenegro). This law provides for the measures and incentives for renewable energy sources and cogeneration. Favored manufacturers, except for hydropower installed capacity exceeding 10 MW, may be eligible to be granted an incentive price for generated electricity.

Implementation of the provisions of the new Energy Law relating to renewable energy sources is one of the main activities of the Department for Renewable Energy. This department was established within the Energy Sector of the Ministry of Economy and performs tasks related to: preparing draft texts and proposals of laws and regulations, as well as other regulations and proposals of policies in the field of renewable energy sources; promoting the use of new technologies related to energy; suggesting measures to increase use of renewable energy sources to prepare project proposals in the area of the Department to be funded from the budget of the Government of Montenegro and international aid and loans; technical evaluation of CDM projects; implementation of the procedures for awarding concessions for water stream research and technical-economical use of water energy potential for electricity generation in small hydroelectric power plants; adjustment of national legislation with the EU legislation relating to renewable energy sources.

From the existing legal framework and processes are the following documents essential to the renewable energy sources:

- Instructions on establishing the methodology of purchase price setting for the electricity from small hydropower plants (Official Gazette of Montenegro 46/07);
- Decision establishing the purchase price of electricity from small hydropower plants (Official Gazette of Montenegro 79/08);
- Rulebook on technical conditions for the connection of small power plants to the electric distribution network (Official Gazette of Montenegro 25/07);
- Rulebook on wind power plants (Official Gazette of Montenegro 67/09).

In the framework of "Cooperation in the field of environmental protection", the Ministry of Environment and Spatial Planning, Ministry of Economy of Montenegro and the Italian Ministry for the Environment and Territories agreed to assess the potential of renewable energy resources in Montenegro.

The first assessment of renewable energy potential in Montenegro, with special emphasis on the following three sources of renewable energy: wind power, solar energy and biomass, was carried out by the company CETMA, with the support of the Italian Ministry for Environment, Land and Sea (IMELS), Special unit - *Task Force* for Central and Eastern Europe.

In addition to the new Energy Law, the Law on Energy Efficiency was prepared for the first time in Montenegro (adopted on 22 April 2010 by the Parliament of Montenegro), regulating the relations in the field of energy efficiency in the sectors of final consumption, responsibility for the preparation and adoption of programmes and plans for improving energy efficiency at the national and local level, and at the level of energy companies and consumers, their enforcement, public authority and responsibility for identifying and implementing energy efficiency policies, as well as other energy efficiency measures and responsibilities for their implementation. The text of the Law is harmonized with European regulations relating to final energy consumption efficiency and energy services, energy efficiency in buildings, eco-design products that use energy and energy labeling devices for domestic use. The Act provided for the establishment of Energy Efficiency Agency, to prepare and monitor the achievement of the National Plan for Energy Efficiency and Energy Efficiency Fund, Special Unit of the Energy Efficiency Agency. The Energy Efficiency Fund is used to implement energy efficiency projects, projects related to the use of renewable energy sources and promoting energy efficiency.

The Energy Efficiency Sector of the Ministry of Economy performs the following tasks: development of strategies, programs and plans and projects in the field of energy and monitoring their implementation; preparation of draft laws and proposals of laws and other regulations in the field of energy efficiency; participation in preparation of laws, commenting and providing opinion on draft laws and proposals of laws and other regulations prepared by other agencies; preparation of secondary legislation for energy efficiency; implementation of measures and activities to increase energy efficiency at the national level and coordination and monitoring of measures implemented at the local level; nomination of projects and implementation of tender procedures and financial evaluation of projects to be funded from the Energy Efficiency Fund; participation in the preparation and implementation of procedures for energy-efficient procurement; management of national statistical and information system for energy efficiency, preparing analysis and reports, information and other materials in the field of energy efficiency; promotional and educational activities related to energy efficiency and use of renewable energy sources; cooperation with national and local government authorities and ensuring including of the requirements of energy efficiency and other sectoral policies, harmonization of national legislation with EU legislation in the field of energy efficiency; cooperation with international institutions and programs related to energy efficiency; performance of other tasks in the field of energy efficiency within the scope of its responsibility.

In 2008, the EU Council adopted *The EU Climate and Energy Package* for the period 2013-2020, which precisely defines the future EU climate policy and targets to reduce GHG emissions, widely known as the 20-20-20 package:

- 20% reduction in emissions of greenhouse gases;
- 20% improvement of energy efficiency, and
- 20% share of renewable energy in the EU energy balance.

In 2009, the EU Council adopted *The EU Climate-Energy Legislative Package* in order to achieve the goals of the climate-energy package. The package includes the following components:

1. Revision of the EU ETS (EU Emission Trading Scheme) - enters into force in 2013, in order to achieve greater emission reductions from energy-intensive sectors;
2. Decision on the "distribution of activities" (*"effort-sharing" decision*) that sets quantitative targets for the sectors not covered by EU ETS - enters into force in 2010;
3. Legislative framework for CCS installations (installations for "CO_2 capture and storage") - enters into in 2011, in order to provide for the application of this technology in the EU;

4. Directive on renewable energy sources, establishing new rules to promote the use of renewable energy - enters into force in 2011;
5. Regulation on CO_2 emissions from cars, with the aim to reduce road traffic contribution to global warming - comes into force in 2012th;
6. Directive on fuel quality and biofuels, aimed to improve air quality and reduce GHG emissions through environmental protection standards for fuels - comes into force in 2010.

Given that Montenegro is in the EU accession process expecting to obtain the status of a candidate country for the EU membership until the end of 2010, in order to start timely implementation of these measures in Montenegro, it is necessary to start transposing these EU directives into national legislation as soon as possible.

Current Project Activities in the Phase of Implementation

UNDP-GEF: Power sector policy reform to promote small hydro-power plant development in Montenegro

The project supports the Government of Montenegro in implementation of the objective to have new small production capacities of 15-20 MW in Montenegro until the end of the project in 2012, instead of 2015, as announced in the Strategy for development of small hydropower plants. This way between 402,360 and 536,480 tones of CO_2 emissions will be avoided during 20 years of operating life of the new facilities of small hydro-power generation capacity.

GTZ: Energy Efficiency Enhancement in Montenegro

The project aims to improve the preconditions for a wider use of selected technologies for energy conservation. The project plan includes three levels of intervention: the implementation of pilot measures, capacity building of institutions and intermediaries, and improving the legal and institutional prerequisites. The Project supported the Government of Montenegro in implementing the measures on the occasion of the "Year of Energy Efficiency 2008 – 2009".

International Bank for Reconstruction and Development: Energy efficiency improvements in public sector buildings in Montenegro

The project aims to improve energy efficiency in the educational and health facilities and increase the public knowledge about energy efficiency measures. The project finances implementation of energy conservation measures which relate primarily to: (i) improving the system for heating and hot water, (ii) improving the energy characteristics of the building facade and (iii) improving interior lighting.

5.1.2 Industrial Processes

The legislative and institutional framework of Montenegro includes no strategies or policies that are exclusively concerned with the industrial sector, but some of the issues related to the industry are addressed by other sectoral strategies or treated through the regulation of other segments of the environment, such as wastewater, waste, environmental monitoring environment, etc. It is likely that the National Strategy for Sustainable Development will play a role in the harmonization of individual sectoral strategies.

Some elements of policies and measures related to industry can be found only partly in the Spatial Plan of Montenegro, National Strategy for Sustainable Development and case studies, strategies and measures related to the energy sector. To some degree, the issues related to the industry address the strategy of energy efficiency through the energy sector.

Over the past five years a significant restructuring of the industrial sector has been planned for through the privatization process. Large companies and key pollutants are in such a state that radical changes need to be made and the problem of solving emissions of greenhouse gases approached. One of the documents that was supposed to answer the question of potential development and spatial distribution of industrial and mining facilities was the Spatial Plan of Montenegro. The plan, however, does not contain much information or guidance on the future development of the industry. Future plans pertaining to basic industries must include a recovery scheme to improve the control of air quality.

5.1.3 Agriculture

Agricultural policy is within the responsibility of the Ministry of Agriculture, Forestry and Water Management of Montenegro. The Law on Agriculture and Rural Development (Official Gazette of Republic of Montenegro 56/09) is the umbrella law in agriculture, governing: the development of agriculture and rural areas, objectives and measures of agricultural policy incentives in agriculture and the conditions for their implementation; customers incentives, additional activities in agriculture, the organization in agriculture, establishment of the Agency for payments in agriculture, as well as other issues of importance for the development of agriculture and rural areas.

By adopting the Law on Organic Agriculture (Official Gazette of the Republic of Montenegro 49/04), the commitment was confirmed to develop the agriculture of Montenegro in accordance with the principles of sustainability. The law allows the creation of brand "products from organic agriculture", which will significantly contribute to the protection of consumers and producers and support of the local products of high quality. The development of organic production provides an opportunity for consumers to consume quality domestic agricultural products that meet strict standards of food quality and preservation of the environment.

A strategic document that sets the broader framework for agricultural development in Montenegro is the Strategy of Food Production and Rural Development (2006).

In Montenegro, several project activities whose implementation will certainly contribute to the development of the agricultural sector are currently in progress:

1. Identification and registration of animals (phase II) - a project supported by the European Commission;
2. Support to the strengthening of administrative capacity; the project will be implemented through the cooperation between the Ministry of Agriculture, Forestry and Water Management and the U.S. Department of Agriculture (USDA);
3. Institutional Development and Strengthening of Agriculture of Montenegro (MIDAS) - a project partly funded by the GEF;
4. Development aid to farmers in mountainous regions of Montenegro; the project supported by the UN FAO (United Nations Food and Agriculture Organization);
5. Organic agriculture in Montenegro: Joint support to small producers in organic agriculture; the project supported by the UN FAO (United Nations Food and Agriculture Organization);
6. EU Information Centre for Montenegrin Agriculture; the project implemented in collaboration with the Ministry of Agriculture of the Slovak Republic and the Slovak Institute for scientific and technical information in agriculture.

5.1.4 Land Use Change and Forestry

The forest policy is within the competence of the Ministry of Agriculture, Forestry and Water Management of Montenegro. Sustainable and multipurpose forest management is achieved by the adoption and implementation of planning documents in accordance with the law. According to the Law on Forests (Official Gazette of the Republic of Montenegro 55/00), forests, as a resource of public interest, are renewed, maintained and used under the conditions and in a manner that provides permanent protection and magnification of their natural values and ecological functions, lasting and functional use, protection from harmful impacts and growing, which provides a permanent increase in yields. A new Law on Forests is currently under preparation. Strategic documents governing the forestry sector are the following:

- National forest policy (2008);
- Spatial plan of Montenegro (2008-202);
- The National Strategy for Sustainable Development of Montenegro (2007).

Only one statement in the National Forest Policy recognizes the issue of the role of forests in combating climate change.

5.1.5 Waste

The waste management policy falls under the competence of the Ministry of Spatial Planning and Environment. The Law on Waste Management (Official Gazette of the Republic of Montenegro 80/05 and Official Gazette of the Republic of Montenegro 73/08) regulates the types and classification of waste, planning of waste management, ensuring the conditions for dealing with waste management, rights, obligations and responsibilities of legal and natural persons in the management of waste, the conditions and procedure for the licensing, supervision and other issues of importance for waste management. In the field of waste management, the following strategic documents have been adopted in the previous period:

- National waste management policy (2004);
- National Strategic Master Plan for waste management (2005);
- Spatial plan of Montenegro and the document titled Sectoral studies of waste management (2005), prepared to meet the requirements of the Spatial Plan of Montenegro for the period until 2020 in this area (at 2008);
- Waste Management Plan of Montenegro for the period 2008 - 2012 (2008);
- National strategy for medical waste management (2008).

National waste management policy includes the vision, principles and goals, as well as the existing national regulations and standards. This policy document regulates an integrated and sustainable waste management in Montenegro, establishes the manner of waste management and defines the goals and strategies that will facilitate its implementation.

The Strategic Master Plan recommends the requirements for a rational and sustainable waste management at the state level. The aim of the Strategic Master Plan is to reduce the impact of waste on the environment, improve the efficiency of resource use, as well as repair the shortcomings of waste management in the past.

The sectoral study of waste management in Montenegro aimed to provide the preconditions for preparing a quality Spatial Plan of Montenegro. The study of waste management defined the development strategy and an efficient and rational management of municipal, industrial, medical, hazardous, inert waste, sludge from industrial processes and waste and sewage treatment.

The Waste Management Plan of Montenegro for the period 2008 - 2012 represents a basic document that defines medium-term objectives and provides the conditions for rational and sustainable waste management in Montenegro. The Waste Management Plan includes: an assessment of waste management; waste management objectives; long-term and short-term measures to manage waste in the planning period including implementation schedules; funding framework for the execution of the plan; manner of implementation and the entities responsible for implementation; and increasing public awareness on waste management.

The purpose of the National Strategy for the management of medical waste is to establish, based on general principles of EU waste management, a realistic framework for reducing the amount of medical waste and for its management in a health-safe and environmentally sound manner, compatible with the national economic situation and level of health care development.

Pilot project "Selective Collection of Waste "

The ministry responsible for environmental protection in cooperation with local governments, in mid-June 2008, initiated a pilot project titled the "Selective Collection of Waste". For this purpose, 600 containers of capacity 1.1 m3 and 10 containers of 5 m^3 were secured. The municipalities designated the areas where different containers would be set up, deciding that it would be the best to locate tem in the places where the best response by the citizens was expected. For the purpose of this project, brochures and videos were prepared aiming to educate the citizens.

5.1.6 Portfolio of Potential CDM (Clean Development Mechanism) Projects

By ratifying the Kyoto Protocol and its entry into force the conditions were created for Montenegro, in line with national interests and priorities, on a voluntary basis, to participate in the Clean Development Mechanism established under the Kyoto Protocol (hereinafter referred to as "CDM") and thereby provide an economically feasible way of inward foreign direct investments in the form of clean technologies.

In addition to ratifying the Kyoto Protocol, a condition for the participation in CDM projects is the establishment of institutional and legal framework for assessing and approving these projects and establishing a Designated National Authority (hereinafter referred to as "DNA"). In Montenegro, the DNA was established as the Council for Clean Development Mechanism. The DNA Secretariat is the ministry responsible for environmental protection, while within the Environment Protection Agency the Council for CDM established a Technical operational body for operative procedures including technical analysis and review of project documentation; approval of project proposals will be subject to prior consultation with interested ministries (Ministry of Economy, Ministry of Agriculture, Forestry and Water Management, Ministry of Transport, Maritime Affairs and Telecommunications and Ministry of Finance), depending on the subject of the project. The ministry responsible for environmental protection adopted Guidelines on the mode of operation, criteria and deadlines for the evaluation and approval of potential projects of clean development mechanism and the criteria and indicators for sustainable development. DNA Montenegro was officially registered with the Secretariat of the Convention and is on the website of the United Nations Framework Convention on Climate Change (UNFCCC).

Montenegro has the potential to generate a large number of carbon credits and thus reduce global warming over the coming years by directing investments in the energy sector, transport, industrial processes, waste, forestry and agriculture. These opportunities can be implemented through the projects that reduce emissions of GHG gases or increase their capturing.

A preliminary analysis of the potential for reducing CO_2 in Montenegro shows a total potential of about 2.5 million tons of CO_{2ekv} per year. An assessment of this potential by sectors is given in Table 5.1 below.

Table 5.1: Assessed potential for CO_2 abatement by sector

Sector	Sub Sector	Annual Potential by ktCO$_{2ekv}$
Energy conservation	Energy	[illegible]
	Industry	[illegible]
	Construction Industry	[illegible]
	Other	[illegible]
	TOTAL	[illegible]
Renewable energy sources	Hydro Energy	[illegible]
	Biomass	[illegible]
	Solar Energy	[illegible]
	Wind Energy	[illegible]
	Geothermal Energy	NA
	TOTAL	[illegible]
Waste		[illegible]
Land Use Change and Forestry		[illegible]
Total		≈ 2 500

Source: Assessment of project potentials in the areas of renewable energy sources, energy efficiency and forest management in the Clean Development Mechanism under the Kyoto Protocol in Republic of Montenegro, the Italian Ministry of Environmental Protection, Land and Sea; Department of Research and Development in the field of environmental protection, April 2007

Within the framework of cooperation with the Republic of Italy, in 2004 the ministry responsible for environmental protection of Montenegro signed a Memorandum of Understanding - Agreement on bilateral cooperation with the Ministry responsible for Environment of Italy, which focuses on environmental protection, improving the sustainable use of natural resources, preventing and reducing environmental pollution and promote sustainable development through joint programs, initiatives and projects . Annex I to this Memorandum, “Technical Support to Montenegro to sign and ratify the Kyoto Protocol and establish the green certificate system” was also signed with the ministry responsible for economic development of Montenegro.

Through bilateral cooperation with the Ministry of Environment, Land and Sea of the Republic of Italy and through the established Montenegro - Italian Trust Fund (EMIF) several important projects were implemented or in the process of implementation:

- Technical support in preparation of First National Communication under the UNFCCC, which includes basic information, the inventory of emissions of greenhouse gases and measures to mitigate climate change (assessment of measures undertaken to reduce GHG emissions);
- Assistance in defining the legal framework for establishing Designated National Authority for the clean development mechanism (DNA) in accordance with the Kyoto Protocol;
- Assistance in the preparation of a draft decision on establishing the Council for Clean Development Mechanism (DNA) and the Technical operating authority;
- Assisting in the preparation of instructions on the manner of operation, the criteria and deadlines for the evaluation and approval of potential projects of clean development

mechanism and criteria and indicators of sustainable development;
- Training of members of the Technical Operating Body on the manner of assessment and approval of potential projects of clean development mechanism
- Investigation of legal mechanisms related to the taxation of carbon credits - that is, certified emission reductions (CERs) that will result from implementing the clean development mechanism project in Montenegro;
- Preparation and development of national emissions inventories under the Convention on long-reaching, transboundary air pollution (LRTAP), which includes greenhouse gases;
- Training of staff of the Environmental Protection Agency to use a software for drafting and updating the national inventory of emissions;
- Development of legal framework in the field of air quality;
- Construction of an energy-efficient building for the Ministry.

Within the framework of cooperation, inter alia, assessments and analysis of potential CDM projects were made in the area of renewable energy, energy efficiency and reforestation. The first set of identified project ideas was presented in 2007 to the representatives of Italian companies and investors interested in CDM projects. After that, in early 2008, both in Montenegro and Italy a public invitation was published for the selection of the best bidders for the preparation of feasibility study and project proposal drafting (PDD - Project Design Document) for the identified project ideas aiming to select an Italian or Italian-Montenegrin company, with appropriate technical and professional qualifications, which would, through irreversible co-financing, prepare the feasibility studies and PDDs, with respect to the selected CDM projects, as a first step under CDM development process. The best bidders were selected in mid-2008. The selected projects included:

- Use of wood biomass for energy production in the Municipality of Berane;
- Connecting the landfills of Pljevlja and Nikšić – capturing and flaring of landfill gases;
- Use of methane from the landfill of Podgorica;
- Methane capturing at the farm of Spuž.

5.2 GHG Emission Reduction Measures

5.2.1. Energy

Basic characteristic of the energy sector in Montenegro is a high intensity of energy consumption. The reason is primarily the dominant share of industrial consumers in total consumption, using the worn out and insufficiently energy-efficient technologies compared to the contemporary standards. In addition to industrial consumption, inefficiency of energy consumption is significantly present in the household sector and services, especially in terms of meeting the heating requirements and electricity demand. Traffic is characterized by a constant increase in the number of vehicles and thus consumption of motor fuels. Other sectors have a less significant share in consumption, so that they do not pose a problem at the moment, but taking into account the growth of consumption, they could become a problem in the case of insufficient presence of active measures to promote energy efficiency.

Measures to reduce GHG emissions are based on scenarios of development of consumption and manufacturing capacity. Analysis of measures in the energy sector was carried out using specialized software LEAP.

Depending on the way to meet energy needs in some sectors, two scenarios were considered for the period 2010-2025, including: baseline scenario, characterized by a complete absence of measures to reduce GHG emissions, and the GHG emissions abatement scenario.

In order to create a scenario for GHG emissions, it is necessary to recognize the growth of energy demand. Projected growth in energy demand results from the corresponding assumptions of economic development and demographic growth. The basic indicators of economic development are the growth of gross domestic product (GDP) in the observed period and the development of its structure. Thus, for the development of the energy needs of Montenegro the following basic parameters were adopted:

- Average annual growth rate of the economy of 6%
- Average annual population growth rate of 0.16%.

These parameters are the primary determinants of the **medium scenario** for an increase in energy demand according to the Energy Development Strategy.

Based on the participation of individual sectors of consumption in GDP structure, scenarios were developed for an increase in energy demand by sectors. The scenarios for energy demand growth are the input data for LEAP, which performs the simulation of the energy sector and calculation of GHG emissions.

Currently the sector of electricity production of the electricity system of Montenegro consists of TPP Pljevlja, a thermal power plant that uses lignite as energy source, two hydroelectric power plants: HPP Piva and HPP Perućica and 6 smaller ones. The existing hydroelectric power plants will be operational until 2025.

Baseline Scenario (Table 5.2) for the development of electricity production is based on increasing the existing strength of the TPP Pljevlja block from 210 MW to 225 MW after 2010 and construction of new generating capacities for electricity generation: the second block of TPP Pljevlja, capacity 225 MW, after 2015 and HPP Moraca (Andrijevo, Milunović, Raslovići and ACTA), which would be gradually included into the system during the period 2013-2018, with a total capacity of 238.4 MW. Baseline Scenario for GHG emissions in the sector of consumption is determined by the increase in energy requirements defined as the medium scenario by the Energy Development Strategy of Montenegro until 2025. It involves the application of conventional technology in meeting energy needs without any active measures of the state, thus resulting in a reduced support to the introduction of new energy-efficient technology solutions and a slower breakthrough of application of renewable energy by the final consumers.

Table 5.2: Structure of production capacities according to the baseline scenario

Baseline Scenario	Power	Year
HPP Perućica	[illegible] MW	[illegible]
HPP Piva	[illegible] MW	[illegible]
Small HPPs	[illegible] MW	[illegible]
TPP Pljevlja	[illegible] MW	[illegible]
Reconstruction of TPP Pljevlja	[illegible] MW	[illegible]
Incrase of HPP Perućica capacity	[illegible] MW	[illegible]
HPP Andrijevo	[illegible] MW	[illegible]
HPP Raslovići	[illegible] MW	[illegible]
HPP Milunovići	[illegible] MW	[illegible]
HPP Zlatica	[illegible] MW	[illegible]
TPP Pljevlja [illegible]	[illegible] MW	[illegible]

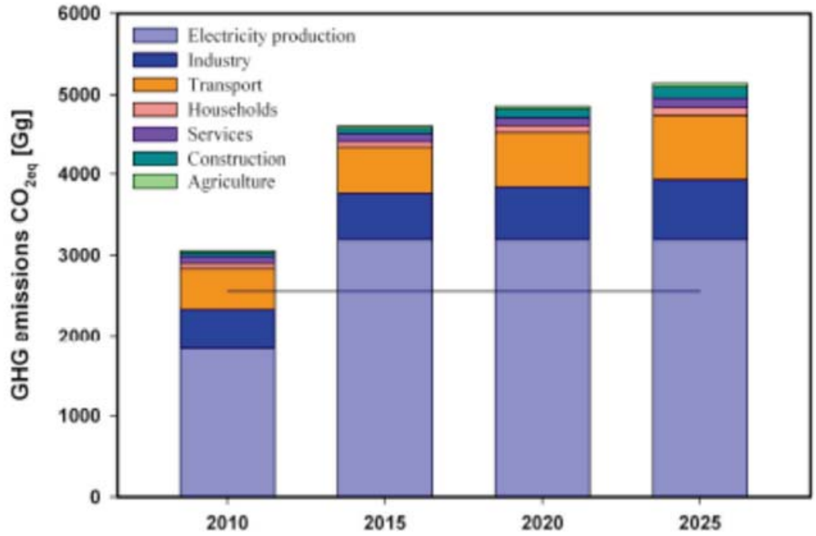


Figure 5.1: Baseline scenario for an increase in CO_2 emissions in the energy sector

5.2.1.1 Electric Power Generation

According to projections of GHG emissions rising in the baseline scenario, TPP Pljevlja retains a dominant share in total GHG emissions in the energy sector, and in total GHG emissions in Montenegro. This proportion further increases after the construction of the second block (Figure 5.1). Therefore, the scenario with measures to reduce GHG emissions (Table 5.3) in the sector of electricity generation offers an alternative to the construction of another thermo-block. This scenario is oriented to the exploitation of renewable sources of energy, primarily based on small hydro and wind power as opposed to the planned construction of another block of TPP Pljevlja. In addition to various industrial structures, this scenario includes increasing the efficiency of the existing block of TPP Pljevlja. New manufacturing facilities include: small hydro-power plants of total capacity amounting to 80.2 MW, which will become a part of the system in the period 2010-2012; wind power plants, total capacity 96 MW, which will be operational in 2011-2012, and HPP Komarnica, capacity 168 MW, staring to operate in 2017.

Table 5.3: The structure of production capacities according to the GHG emissions abatement scenario

GHG emissions abatement scenario	Power	Year
HPP Perućica	[illegible] MW	[illegible]
HPP Piva	[illegible] MW	[illegible]
Small HPPs	[illegible] MW	[illegible]
TPP Pljevlja	[illegible] MW	[illegible]
Reconstruction of TPP Pljevlja	[illegible] MW	[illegible]
New small HPPs	[illegible] MW	[illegible]
HPP Perućica power increase	[illegible] MW	[illegible]
HPP Andrijevo	[illegible] MW	[illegible]
HPP Raslovići	[illegible] MW	[illegible]
HPP Milunovići	[illegible] MW	[illegible]
HPP Zlatica	[illegible] MW	[illegible]
Wind power plants	[illegible] MW	[illegible]
HPP Komarnica	[illegible] MW	[illegible]

According to the strategic documents, the potential for solar energy use is primarily recognized in the consumption sector (households, services and agriculture) to meet the thermal needs. In this regard, the application of solar energy in electricity production has not been considered here.

Application of the technologies for carbon dioxide capturing and storing in geological formations (CCS technology) is still undergoing testing and is not taken into account in the scenario with measures to reduce GHG emissions until 2025. The main reason concerns technical problems with transport and storage of CO_2, but also the price of technology which is still high (150 U.S. $ per tCO2). The possibility of applying CCS-exist in TPP Pljevlja, and to a certain extent in the metal industry as well.

5.2.1.2 Energy Consumption

Industry

Industry is the sector with the highest energy consumption, with a share of approximately 32% in total final energy consumption. The industrial consumption is dominated by Podgorica Aluminum Plant and Niksic Ironworks. Those were built at a time when the selection of technologies was based on the criterion of minimum investment and is characterized by diminished energy efficiency. The structure of energy demand in the industry is made up of the:

- need for high-temperature heat;
- need for low temperature heat;
- other demand for electricity, and
- need for other energy sources.

High temperature heat is produced by direct combustion in industrial processes. The heat of low temperature is the heat in the form of vapor and hot water, and is provided by the production in industrial boilers, industrial cogeneration or from the remote heat system. To meet the thermal needs , liquid fuels (heating oil), as well as the coal and LPG are mostly used.

To reduce GHG emissions in the sector of energy, the following measures were considered in the industry:

- **Combined production of heat and electric power (CHP)** with respect to an expressed consumption of heat and electricity required by industrial processes (ferrous and non-ferrous metallurgy), the analysis shows the potential of cogeneration, i.e. the combined production of heat and electricity.
- **Increasing the efficiency of industrial boilers**
  Application of modern solutions to increase efficiency of fuel combustion (coal and liquid fuels) and the utilization of heat produced.
- **Fuel replacement in industrial boilers**
  Gradual replacement of coal by introducing LPG in industrial boiler rooms.
- **Replacement of fuel for producing high-temperature heat**
  Gradual replacement of coal by introducing LPG in industrial plants for producing high-temperature heat.

Energy conservation in industrial electric motor facilities provides minimal annual savings in emissions, and is not considered as a measure to reduce GHG emissions. The reason for this is primarily small annual electricity consumption in industrial electric motor facilities.

Construction Industry

The construction sector has a small share in total final energy consumption (around 1%), and thus little potential for savings in CO_2 emissions at the level of the energy sector. The structure of energy demand in the construction industry consists of:

- the need for motor fuels;
- thermal needs;
- other demand for electricity.

The structure of energy demand is dominated by the need for motor fuels, which indicates the greatest potential for savings, followed by heat and demand for electricity.

In order reduce GHG emissions in the energy sector, the following measures were considered in the construction industry:

- **Replacement of motor fuels**
  Reduced use of diesel, by replacing it with biodiesel and gasoline.
- **Replacement of fuel for heating purposes**
  Reducing the use of coal for thermal needs by substituting it with LPG and liquid fuels.

Households

After the industry sector, households are the sector with the highest consumption in final energy consumption. Their share in final energy consumption is 21%, and in the final consumption of electricity 29%. The structure of energy demand in this sector consists of:

- space heating;
- water heating;
- cooking;
- space cooling; and
- other demand for electricity

Analysis of energy use indicates high intensity of power consumption for all of these needs, which is the basic potential for savings through energy efficiency measures. Measures to reduce GHG emissions in the sector of energy consumption in households is primarily based on the use of the potential for improving energy efficiency, resulting in inefficient use of electricity and heat to satisfy the needs of the household. The following measures were considered:

- **Improving the thermal insulation of residential buildings**
  By improving the thermal insulation of residential buildings energy needs for space heating and cooling are reduced. Given the average age and poor insulation of residential buildings in Montenegro, there is great potential for application of these measures.
- **Increase the share of heat pumps**
  Taking into account that the electricity has a large share in meeting the needs of space heating, heat pumps are imposed as a real option with respect to their high efficiency of electricity consumption in the production of heat.
- **Small cogenerations**
  Small cogeneration plants generate electricity and heat with high efficiency. In addition to increased efficiency of heating and water heating, small cogeneration reduces consumption and losses of electricity in the power system.
- **The use of solar energy**
  As an alternative to electricity used for hot water and to some extent for space heating, using solar energy is gaining in importance. Taking into account the increase in prices of electricity, using solar energy has a greater economic acceptability.
- **Increase the share of LPG for cooking purposes**
  As an alternative to electricity used for cooking, use of LPG is gaining in importance.
- **Energy-efficient devices in household devices in the households**
  Household appliances made by modern standards of energy efficiency use up to 35% less

electricity than the conventional ones.

- **Replacing conventional lamps by more energy-efficient LED lights**
  There is a great difference in electricity consumption by classic incandescent light bulbs compared to LED lamps for the same light intensity.

Services
Services sector accounts for approximately 10% of final energy consumption. The structure of energy demand in this sector includes the following::

- thermal needs;
- cooling needs;
- other demand for electricity.

Approximately half of the thermal energy needs are those that are satisfied by the dominant use of electricity and coal. So, as with the household sector, service sector is also characterized by high intensity of power consumption. Taking this into account, measures based on the use of the potential for increasing energy efficiency were selected:

- **Fuel substitution**
  Replacement of coal and liquid fuel by LPG as a cleaner alternative in boiler central heating systems in the service sector.
- **Increase of boiler room efficiency**
  Application of new technology solutions in the process of fuel combustion and a higher level of utilization of heat produced by worn-out boilers.
- **Increase in the share of heat pumps**
  Greater use of heat pumps for heating purposes.
- **Use of solar energy**
  In the case of commercial installations, the use of solar energy for water heating has a higher cost, so that its application in the service sector has a greater effect of energy conservation than in the case of households.
- **Replacing conventional lamps in public lighting**
  Most of the public lighting infrastructure is older than 20 years. Application of energy efficient LED lamps in street lighting has a significant potential for saving energy and thereby reducing GHG emissions. Additional contribution is obtained by applying advanced software solutions for management and automation of public lighting.

Agriculture
The agricultural sector has the lowest share in final consumption (less than 1%), and has a negligible effect on CO_2 emissions due to energy use of fuels. In the structure of energy needs in this sector the following is recognized:

- thermal needs;
- the need for fuel; and
- other demand for electricity.

The need for automotive fuel is expressed in the structure of energy demand (approximately 85%), which is satisfied by diesel, while the thermal needs are satisfied by liquid fuels (oil, crude oil).

In order to reduce GHG emissions in the energy sector, the following measures are considered in agriculture:

- **Substitution of motor fuels**
  Gradual replacement of diesel by introducing biodiesel.
- **Replacement fuel for heating purposes**
  Gradual replacement of liquid fuels by introducing LPG, biomass and solar energy in the structure of energy sources to meet the thermal needs.

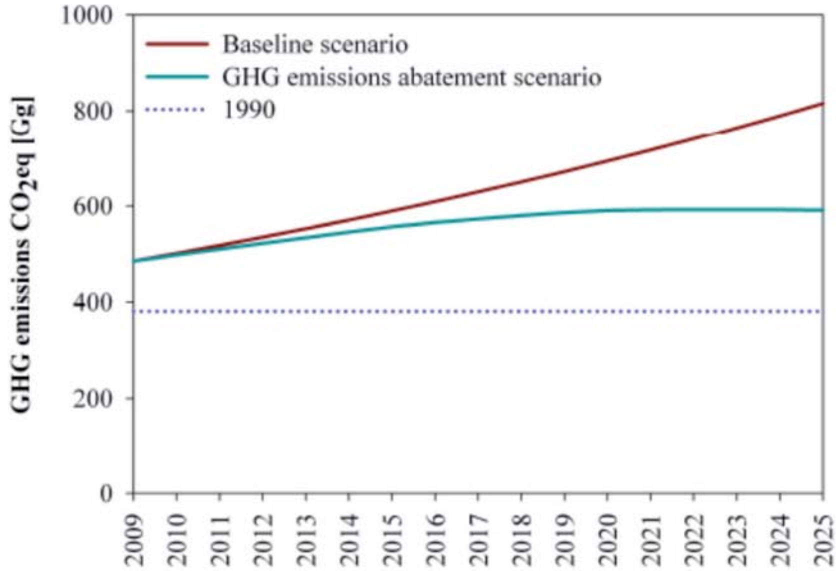
Transports

The sector of transport accounts for approximately 10% in the final energy consumption. Road traffic accounts for almost 90% of energy consumption in the transport sector, with a predominant share of passenger cars. This trend is expected in the future as well, due to an increasing number of cars, increased travel mileage per car and lower number of passengers per car. Therefore the basic potential of EE measures in the rational consumption of energy is in the field of road traffic. An additional reason for the transport sector to be included in EE programs is the fact that all fuel is imported and because the emissions of harmful gases increase the pollution of the environment in urban areas. Development of sustainable transportation has been the focus of measures which are introduced in the transport sector.

In order to reduce emissions of greenhouse gases on roads in Montenegro, it is necessary to implement a package of measures that includes:

- **Increase energy efficiency of motor pools**
  Increasing energy efficiency of motor pools affects the reduction of average specific consumption (lit/100 km), and thereby reduce GHG emissions. This measure involves procurement of energy efficient vehicles, informing the consumers about the specific consumption of vehicles and CO_2 emissions of passenger vehicles, the prescribed fees proportionate to fuel consumption paid at the moment of purchase of vehicles, stricter mandatory periodic vehicle exhaust emission control, more efficient vehicle maintenance application of technical measures to reduce fuel consumption by vehicles. This measure includes regulation of fuel quality control system and introduction of EU standards in this field.
- **Introduction of alternative fuels as a replacement of existing fossil fuels**
  This measure refers to the transfer of new automotive technologies and the introduction of environmentally acceptable alternative fuels as a replacement of the existing liquid fuels. The introduction of alternative fuels (biodiesel, hydrogen, compressed natural gas (CNG), etc.) as a replacement of existing fossil fuels, as well as hybrid and electric vehicles, particularly for those entities that have a great need for mobility - taxis, driving schools, service delivery, vehicle of national and local government bodies, etc.
- **Planning and establishing a more efficient transportation system**
  Planning and establishment of an efficient transit system includes improving transportation planning in cities, planning a continuous spatial development of urban settlements, harmonization of regional economic and demographic development of the country, building roundabouts in the larger cities and especially in the cities on the coast, construction of new and expansion of the existing roads, electrification, etc. By electrifying the remaining railway infrastructure and renewal of rolling stock of rail transport, make this kind of transportation more attractive for a more intensive transport of passengers and goods

Total potential of analyzed measures in the transport sector, is shown in Figure 5.2 below.



Fugure 5.2: Total GHG emissions in the transport sector until 2025

The result obtained by simulation of the proposed measures under LEAP is that a total reduction of GHG emissions in 2025 will amount to approximately 27%, compared to the baseline scenario. Despite the significant impact of the measures to reduce GHG emissions in the transport sector, total emissions in 2025 were approximately 55% higher those in 1990.

5.2.1.3 Effects of Measures for the Reduction of GHG Emissions in the Energy Sector

Taking into account the parameters defining the baseline scenario and the one with measures to reduce GHG emissions, using the LEAP program, the cumulative effect of measures in the energy sector is obtained, which is presented in Figure 5.3. below. Total reduction of GHG emissions in 2025 compared to the baseline scenario is estimated to be approximately 50% of total GHG emissions in 2025, according to the scenario with measures at the level of GHG emissions in 1990.

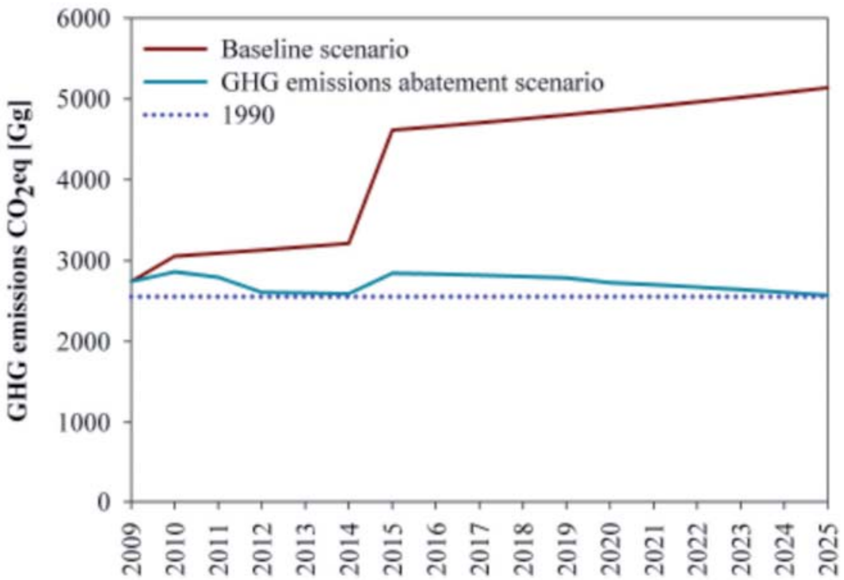


Figure 5.3: Total GHG emissions in the energy sector until 2025

In addition to collective representation, the contribution of individual measures in the overall reduction of GHG emissions is shown in Figure 5.4. below. As can be seen in the Figure, the greatest potential (62%) to reduce GHG emissions in the energy sector is in measures in the sector of electricity production, i.e. a commitment to generate the capacity from renewable sources instead of building another block of TPP Pljevlja.

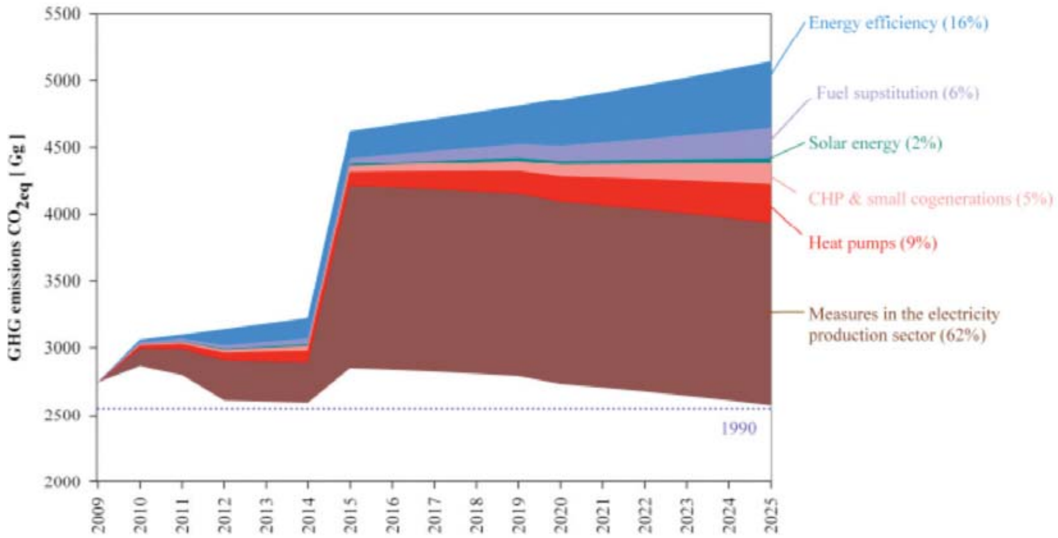


Figure 5.4: Contribution of indivudual measures to an overall reduction of GHG emissions in the energy sector until 2025

Energy efficiency measures stand out among other measures, since their contribution to the overall reduction of GHG emissions is around 16%. The contribution of individual energy efficiency measures is shown in Figure 5.5 below..

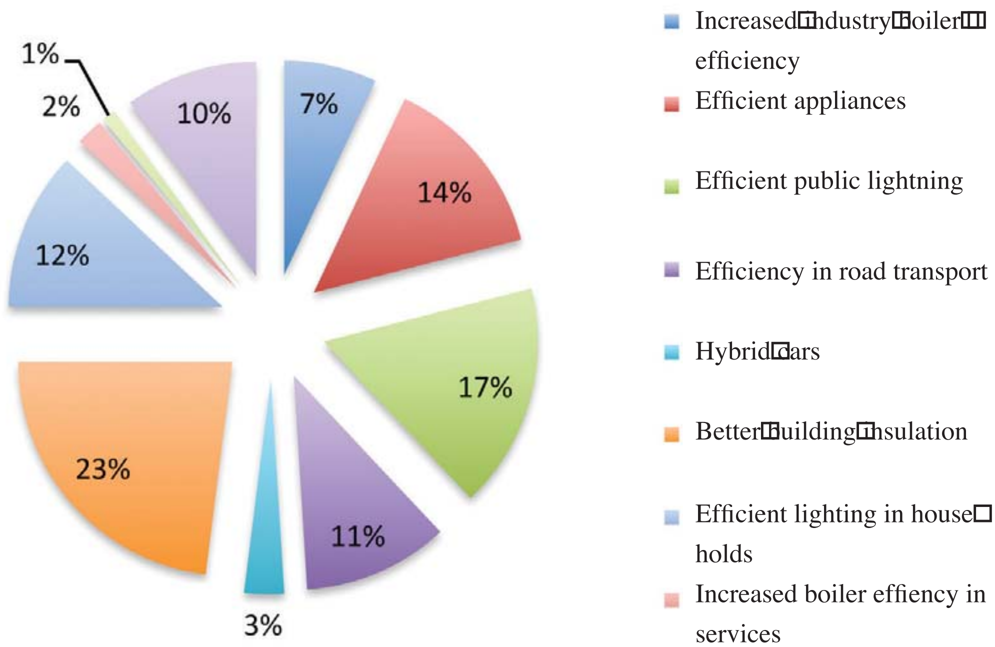


Figure 5.5: Structure of energy efficency measures

Significant reduction in GHG emissions leads to an increased share of heat pumps as an energy-efficient manner of meeting thermal needs. Thus reduces otherwise a significant share of electricity in meeting the thermal needs of the household sector and services. The share of substitution of fuels which are characterized by pronounced GHG emissions by cleaner alternatives amounts to 6% and is characterized by several measures shown in Figure 5.6. It is observed that the substitution of coal and liquid fuels with LPG has the greatest contribution to reducing GHG emissions, primarily in industry (67%), followed by the introduction of biodiesel in the transport and a higher share of LPG in households.

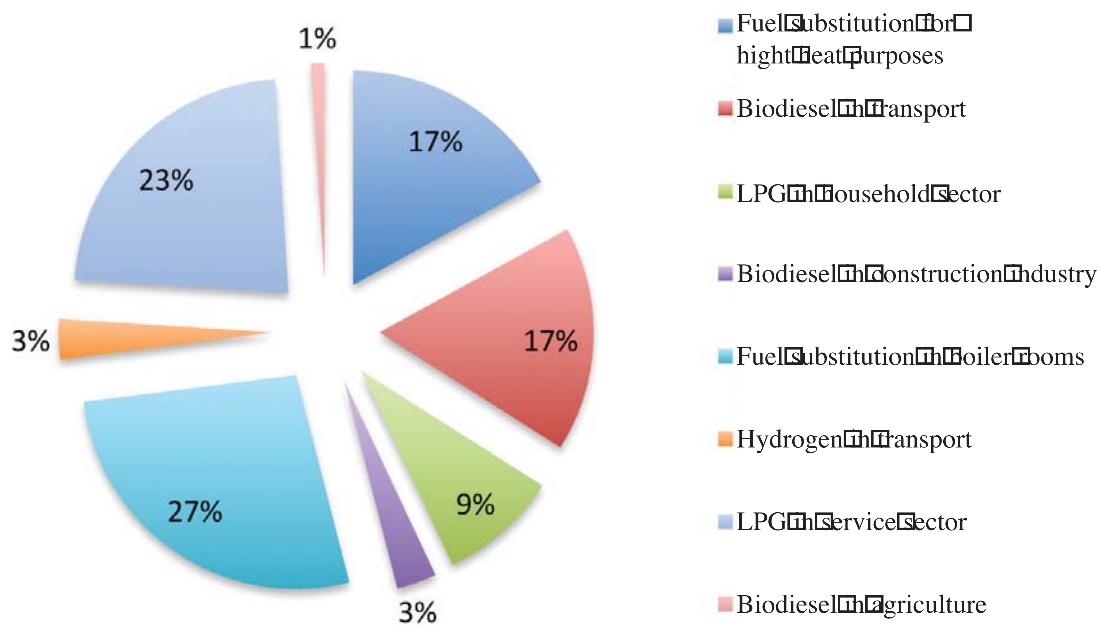


Figure 5.6: Structure of fuel substitution measures

The effect of measures to reduce GHG emissions by sector is shown in Figure 5.7. As previously mentioned, the biggest share is held by the measures to reduce GHG emissions in the sector of electricity generation, followed by domestic sectors, services, industry, transport, construction industry and agriculture.

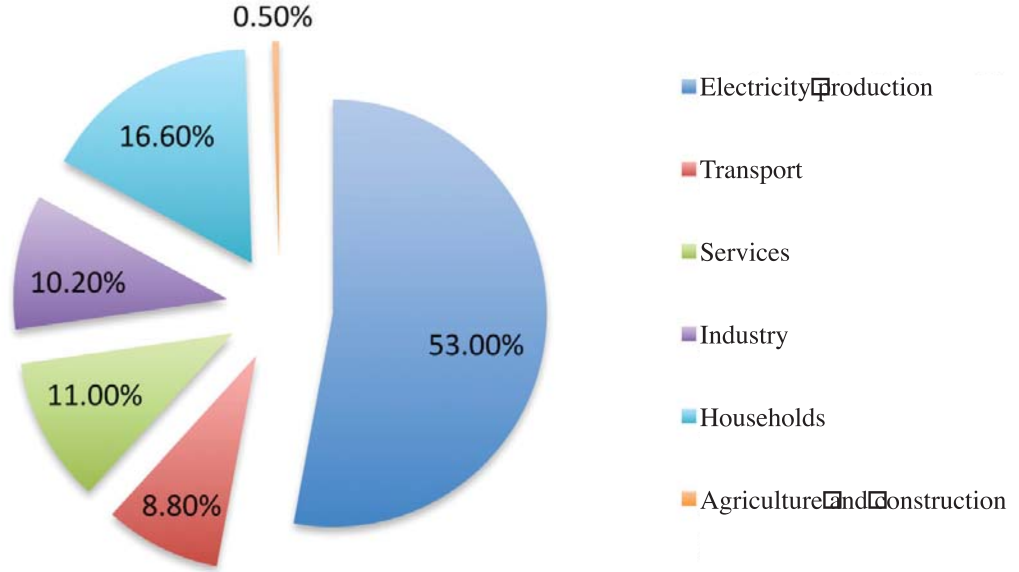


Figure 5.7.: Effect of GHG reduction measures by sectors of energy generation /consumption

5.2.2 Industrial Processes

The sector of industrial processes in Montenegro includes technological processes of production in the field of metal processing industries, manufacture of food and beverage and pharmaceutical industries. By reviewing active industrial polluters it can be seen that the dominant capacities are those of extractive metallurgy and metal processing capacity of two giant companies: Podgorica Aluminum Plant (KAP) and Niksic Ironworks, i.e. their sectors for aluminum electrolysis (KAP) and steelworks (ironworks), whose contribution is dominant when speaking of the emission of greenhouse gases. The contribution of food and beverages, and pharmaceutical industry to the total GHG picture in the sector of industrial processes is almost negligible, so it is not taken into account in assessing the reduction of emissions of greenhouse gases.

The presence of large pyrometallurgical aggregates in aluminum and steel industries that use liquid fuel, primarily crude oil, degraded and unprotected equipment, use of poor quality crude oil with high sulfur content cause an increase in GHG emissions. On the basis of register of waste gases, it can be noticed that those are released into the atmosphere without any prior treatment. It is dominated by the sulphur dioxidegenerated by combustion of crude oil or fuel oil in these plants. This is followed by carbon dioxide and carbon monoxide from the combustion process. The electrolysis facility in KAP has been recognized as a dominant source of CF_4.

In the process of steel production the most dangerous facility from the aspect of GHG emissions and in general degradation of the environment is a steel works, i.e. its arc furnace. Furnace gases are dominated by electric-furnace dust, volatile organic compounds (VOC), CO, CO_2 and nitrogen oxides (NOx). The processing facilities in the Ironworks are also the sources of GHG emissions.

During the previous period of time some interventions have been carried out at the main technological production lines of some of the facilities, primarily in aluminum industry, as a part of their capital maintenance (significant capital interventions on the calcinations furnace, power plant, melting furnaces and electrolyzer automation) which, due to their character, could have had an impact on the reduction of GHG emissions. In 2009 some significant technical and technological development investments were initiated, which will improve the technological processes in the Aluminum Plant and Ironworks, and at the same time reduce GHG emissions.

Problems that arose during the elaboration of GHG emissions projections in the sector of industrial processes are based on the fact that the total industrial production in the country dropped significantly since the nineties of the last century. In addition to this, there is a typical lack of valid test data and statistical data for all sub-sectors, particularly in the period before 2000, as well as the lack of strategic documents, i.e. uncertainty of development, termination or reactivation of some of the industrial facilities.

In the absence of appropriate sectoral policies, it was necessary to identify appropriate measures to reduce GHG emissions in the sector of industrial processes, define their sustainability and clearly identify those that were in the domain of real operations in industrial processes and could be quantified. The measures were defined in two key industrial giants: Aluminum Plant and the Ironworks, due to the fact that GHG emissions in other industries were negligible, as seen from the aspect of size of industrial plants and nature of the technological process. The existing project documentation stemming from specific contractual obligations served as the basis for defining measures to reduce GHG emissions, and these measures are as follows:

- Improvement of technological processes by installing new equipment;

- Improvement of technological processes by partial interventions on the existing equipment.

Set of these measures is mainly the responsibility of management structure of companies. In the context of introducing the concept of cleaner production, the Ministry of Spatial Planning and Environment, Chamber of Commerce of Montenegro and the newly formed Center for Cleaner Production would find an adequate place in the system of accountability. Possible financial allocations for the set of these measures can be predicted on the basis of existing documentation range about 15 million €.

As previously stated, the existing documents or contractual obligations do not indicate the possibility of any significant expansion of extractive or metal processing complexes in the future. A similar situation is with other industrial plants

Projections of GHG emissions in the industrial processes sector for the period 2010 to 2025 were made using the revised IPCC methodology from 1996, neglecting potential differences due to unplanned closure of certain parts or whole plants. The following two scenarios were considered:

The baseline scenario is based on increasing production in the metal industry plants, not applying any technical and technological measures.

The GHG emissions abatement scenario is based on the proposed technical and technological measures, in fact, already initiated actions and interventions in the technological processes.

The effect of reducing GHG emissions is calculated from the time when it is realistic to expect large-scale technological intervention in aluminum and steel industry (the beginning of 2010). Some of the major investments that could be initiated in this period, or even completed include: installation of new cyclone calcination furnace, switch to the use of better quality fuel, i.e. crude oil with sulfur content up to 1%, electrolyzer reconstruction and automation, as well as reducing the duration and frequency of occurrence of anode effects and installation system for dry cleaning of gases in the KAP aluminum plant, as well as installation of a new arc furnace with a system for the steel mill dedusting at the Ironworks.

Starting from the previously proposed technological interventions, the analysis can begin with the effects of reducing fuel consumption through installation of new calcination furnaces in KAP. This technological measure ensures the reduction of fuel consumption by 30% compared to that in an old rotary calcination furnace. This is expected to reduce GHG emissions, primarily CO_2 and CO by about 70%. Significant impact on reducing GHG emissions in the KAP, primarily of CF_4 and also CO_2 at the electrolysis facility, resulted from the installation of spot electrolyzer, reducing the number of anode effects (up to 50% compared to the reference condition), and duration of individual anode effects. Additional reducing of GHG emissions is achieved after the reconstruction of electrolyzers and their automation. A realistic timeframe for this type of intervention is 2010-2013.

Additionally, the GHG emissions abatement scenario also takes into account the real contribution in terms of reducing GHG emissions, arising from temporary suspension of some of the plants in KAP and the Ironworks. Thus, starting from 2009 the calculation also anticipated the contribution to reducing GHG emissions due to shutdown of 50% out of the 528 existing elektrolyzers, i.e. temporary stoppage of operation of the ironworks. It is anticipated that such a state of the KAP could also remain effective for a large part of 2010. In the event of absence of the application of these measures in the electrolysis, the effect of reducing GHG emissions would be insignificant compared to the situation from 2009. A slight effect of reducing GHG emissions, in this case, could be achieved only by effective operation of elecrolyzers (reducing the number and duration of anode effects).

Figure 5.8 shows the baseline scenario and the one with measures to reduce GHG emissions in the sector of industrial processes. The Figure shows that as a result of the contribution of all the measures in the 2025 total GHG emission reduction in this sector was about 38% compared to the baseline scenario. Also, reduced levels of GHG emissions over the last year of the observed period would be about 34% lower than the level in 1990.

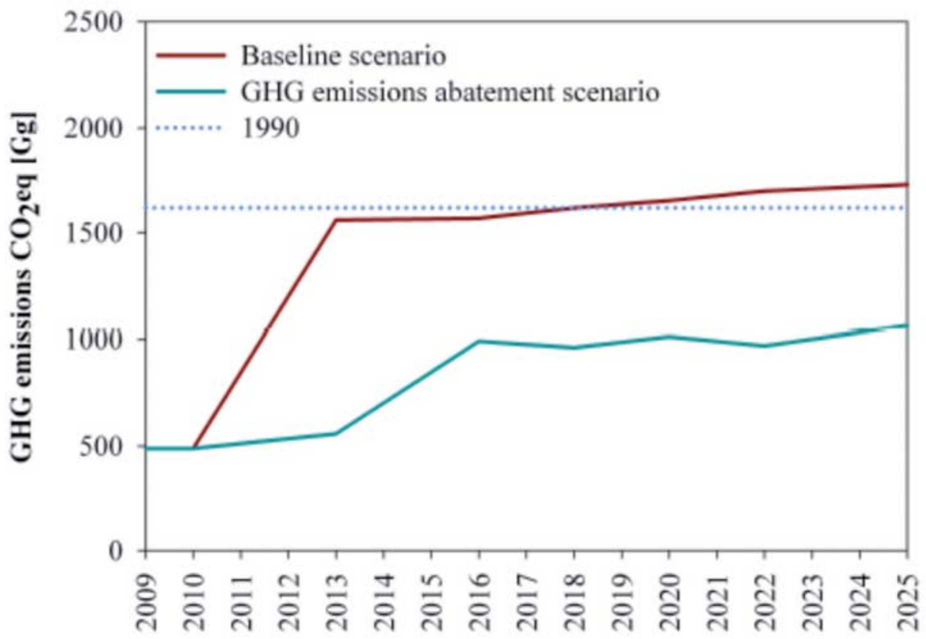


Figure 5.8: Total GHG emissions in the sector of industrial processes until 2025

5.2.3 Agriculture

The current state of development of agriculture is characterized by the fact that policy documents had not recognized the importance of specific activities to introduce and implement measures to reduce emissions of greenhouse gases in this sector. Therefore, the proposed set of measures that could be applied in Montenegrin agriculture includes:

Encouraging of organic agriculture
Development of sustainable agriculture, and especially the affirmation and development of organic agriculture, is particularly important from the aspect of the constitutional definition of Montenegro as an ecological state. Development of organic agriculture in Montenegro deserves special attention considering that to about 300,000 ha of natural pastures and more than 100,000 ha of arable land, i.e. nearly 80% of total agricultural land (520,000 ha), no chemicals are practically applied. In general, Montenegro spends about 12 times less mineral fertilizers and chemicals than the average in EU countries, which significantly affects the reduction of emissions of nitrous oxide. As organic farming usually involves less energy consumption and reduced emissions of carbon dioxide and nitrous oxide, it is necessary to continue promoting and stimulating type of farming at the national level.
From the aspect of application of nitrogen fertilizers, measures for their effective agro-technical application should be applied. In this sense, significant effects are provided by the “low input” crop production practices. The essence of the above practice is reflected in the reduction of doses and target

application of active substances for crop fertilization. For the application of this practice to achieve full economic and environmental effects, it is necessary to analyze the composition of the soil before any application of artificial fertilizers, and then adjust their quantity to the culture that is grown, and then adjust the time of application to climate conditions.

The Rulebook on methods of organic crop production (Official Gazette of the Republic of Montenegro 38/05) and collecting wild fruits and herbs provides for the possibility of adding mineral fertilizers only in their natural form, in order to increase the solubility of self-grounding and mixing with water. The Rulebook on organic livestock production methods (Official Gazette of the Republic of Montenegro 38/05, 45/05) provides a limited number of animals per unit area in order to avoid over-grazing and erosion and allow for the proper use of fertilizers (manure) and avoid the negative environmental impact in terms of soil pollution, surface and groundwater. Number of animals per hectare of agricultural land must match the production of 170 kg of nitrogen per hectare per year.

Reducing methane emissions due to reduction of internal fermentation
The simplest way to reduce methane emissions from animal production (fermentation during digestion and fermentation of manure) is to reduce the total number of domestic animals, especially ruminants. However, this solution is unacceptable for Montenegro, starting from the fact that the strategy of development of food production and rural areas in the future anticipated an increase in the production of animal products, as well as the number of domestic animals. Therefore, the solution should be sought in a better way of keeping and feeding cattle.

Nutrient supplements that enhance the growth and activity of bacteria will increase the digestibility of rumen bacteria and reduce methane emissions per unit of product. Microbial growth in the rumen is limited primarily by ammonia concentration, available energy, phosphorus, sulfur and other minerals. In order to increase microbial growth in the rumen, the digestibility of food, supply of protein ruminants, urea and molasses can be added to the feed. This increases production and reduces emissions of methane.

If the pastures are fertilized with larger quantities of nitrogen fertilizers, those will produce large quantities of methane. At the same time, as food is drier, it will be harder to digest and will cause greater amounts of methane. In contrast, feed with a higher share of leguminous plants reduces emissions from cattle. Thus, the introduction of feed containing easily soluble carbohydrates, such as from corn and sorghum or joint corn and soybean crops can increase digestibility of organic matter.

In developed countries there is the practice of mandatory installation of equipment for the removal of methane from the stables, which should in our case be introduced as an obligation for all stationary facilities beyond a certain capacity.

More efficient reproduction of domestic animals can also reduce the emissions of methane, because this significantly reduces the number of animals needed to produce offspring. For this purpose the so-called method of artificial insemination of animals is used, so that by its consistent application racial composition changes and improvement of genetic potential of cattle is achieved in the most efficient way. In addition to the above-mentioned methods the method of synchronization of estrus is used as well, while the method of embryo transfer is not used yet.

AWMS (Animal Waste Management System) practices
Improving waste management system, for the waste of animal origin, or abbreviated AWMS practice, is applied also aiming to reduce emissions of greenhouse gases associated with manure treatment.

In order to realize this measure one of significant proposals relates to the drying of cattle garbage. Specifically, the dry weight of cattle manure produces seven times less methane than the wet one. In addition, the importance of collecting and treatment of manure in anaerobic digester is also recognized. Covering of the existing lagoons on farms and biogas capture enables its application for the production of heat energy to meet the requirements of the manufacturing process.

Use of biomass from agriculture for energy purposes
Biogas can be used in the thermal plants for crop production (drying, dehydrators, fans, refrigerators, etc.), as well as in animal production (cooling and heating on farms). It would therefore be important, through measures of agricultural policy, to encourage manufacturers to use biogas to a more significant extent by offering favorable loans and tax incentives for the use of biogas technology. Also mechanization in agriculture and animal husbandry represent an important area for using biodiesel, so that some incentive measures in this context would imply multiple benefits.

The total contribution of the above-stated measures to reduce emissions of greenhouse gases in the agricultural sector could not be calculated for the period 2010-2025 due to lack of key data for the calculation according to the revised IPCC methodology.

5.2.4 Land Use Change and Forestry

The current state of forestry development is characterized by the fact that the existing strategic documents do not recognize the importance of specific activities which prescribe the measures to increase the removal of emissions of greenhouse gases by sinks. Therefore, a set of measures that could be applied in the Montenegrin forestry was proposed:

Increasing the stock of carbon in plant weight
Increasing the stock of carbon in plant weight is applied by increasing forest area and the favorable structure of forests, as well as by increasing biomass in existing forests. Reforestation is the most effective measure to increase sinks of emissions of greenhouse gases. Annually in Montenegro an area of about 620 ha is planted with forest trees, out of which afforestation of bare land takes place on more than 200 ha. Additionally, the Action Plan of the National Strategy of Sustainable Development envisages afforestation of approximately 100 ha per year.

The rehabilitation of forests should primarily include natural regeneration, and where necessary, high-quality native plant material should be used for planting. It is necessary to take care and protect the genes of commercially endangered species of forest trees. By increasing the growing stock in forests their resilience will be enhanced, and at the same time the accumulation of CO_2.

This should be: - To; - Increase the participation of highly productive forests in relation to low-production forest types; - repair or to reconstruct the devastated forest

- At that, the following should be achieved:
- Preserve and enhance the woodland habitat and biodiversity;
- Increase the share of highly-productive forests in relation to low-production forest types;
- Remediation i.e. rehabilitation of the devastated forests.

Young forests on good habitats should be brought to the structural shape of high forests, while the coppice forests should be gradually transformed into a higher form of stand or develop coppice management system for the greater biomass production. For more intensive management, primarily for growing and protection of forests from fire, one should invest into the construction of forest roads.

In recent decades, due to population migration to the cities, a portion of pastures and agricultural areas are overgrown as a result of natural processes in the forest. In addition, afforestation and natural healing resulted in the formation of karst forests in the coastal areas. This is mainly a maquis scrubs, low and coppice forests that have very important protective role in karst. The main limiting factors for the development of these forests have been uncontrolled urbanization and forest fires. Regarding forest management at the coast, priority should be given to the demarcation of forest areas from areas intended for urban development through the harmonization of forest management plans and regional spatial plans and protection of forest lands from usurpation.

There are no data for any activities relating to the establishment of larger or smaller areas of park-forests, with dominant dendroflora, in the settlements. Also, no register of trees in urban areas has ever been made.

The activities already carried out by the NGO sector, foreign donors and other organizations that engaged in afforestation and greening activities should be mentioned here. Thus, in 2009, during the campaign "This Country is Our Home – Montenegro my Part of the Planet" approximately 650,000 plants were planted (a new tree per citizen).

Through the assistance of the Project "Forestry Development in Montenegro", FODEMO, jointly funded by the Government of the Grand Duchy of Luxembourg and the Government of Montenegro, two nurseries with a total capacity of about 2 million seedlings were revitalized.

Greater utilization of wood biomass intended for energy purposes
In assessing the potential for using the entire biomass of trees including the waste (sawdust, large and small branches, debris, etc.) there are great uncertainties in determining the theoretical and computational potential, technically and economically usable potential and economically justifiable use. The use of entire biomass has significant socio-economic and environmental consequences, which should be taken into account in the assessment of the potential.

In determining the current use of firewood and use of woods for commercial purposes, there is a disagreement between the official data and calculations that can be made based on the field data. Specifically, information on the number of companies that use wood as fuel and harvesting for commercial purposes, as well as their consumption, indicate a much greater use of wood as fuel than it is reported as officially registered.

In Montenegro, only some isolated attempts of exploiting the existing quantity of wood waste have been made, mainly by using dry sawdust and waste from wood industries. In order to use the entire biomass, it should be previously prepared for energy utilization, including biomass collection, transport, and its further processing and use. The production of fuel briquettes and pellets is still only in its infancy and of low capacity, so that it is not possible to estimated the volumes of this type of fuel for the future period.

The potential could also be expressed by the following calculation. If the maximum level of harvest that amounted to 632.000m3 in the previous period is used, the percentage of usable waste in forestry (not including timber industry), which was on average 25% of gross cut timber, this results in up to 158,000 m3 of raw materials that can be channeled into the industry of briquettes, wood pellets or tablets. Firewood cutting would be reduced by using this fuel. The related effects should be mentioned, such as:

- - cleaning of forest waste;
- - reducing the possibility of insect infestation;
- - reducing the possibility of infection from phytopathological causes;
- - improving fire safety;
- - environmental benefits in forests and factories.

The total contribution of the above-stated measures to increase sinks of emissions of greenhouse gases in the sector of land use change and forestry could not be calculated for the period 2010-2025 due to lack of key data for the calculation according to the revised IPCC methodology from 1996.

5.2.5 Waste

The waste in Montenegro is mostly disposed untreated at unorganized dumpsites, which poses a threat to the health of the population and the environment. The sites of waste dumps have not been selected in accordance with the principles of environmental protection, no adequate technical protection measures are applied (collected waste is deposited directly on the ground, without any protective measures). Waste dumps contain a mix of different types of waste and theirs rehabilitation should be strictly tended to. Recycling of municipal waste, with minor exceptions, is not performed, i.e. there are no adequate facilities for waste recycling. Specifically, the facilities for some of the segments of the recycling process exist only in Herceg Novi, Podgorica, Kotor and Budva. The quantities of selectively collected secondary raw materials in 2006 in Montenegro amounted to 3,380 tones /year.

The amount of waste produced significantly differs from the volumes of collected, treated and disposed waste, so that is very difficult to assess the current situation regarding the waste in Montenegro. According to the data used for estimating purposes, the volume of generated municipal waste ranges from 0.25 to 1.5 kg/capita/day, with an average value of about 0.8 kg/capita/day. An estimated annual production of waste in Montenegro for 2004 amounted to 182,456 t, while it was 197 000 t for 2008.

According to data obtained from all municipalities in Montenegro, it was determined that the collection of waste is secured mainly in the urban centers (cities, i.e. urban areas) of the local government units, while the waste that is generated in rural areas, i.e. villages and smaller settlements is not collected, so that it is disposed at dumpsites. Assuming that the collection rates in urban and rural areas amount to 85% and 15% respectively, total waste produced, an estimated quantity of waste collected in Montenegro is 50% of the volumes produced, i.e. 96,574 tones/year.

Rural and local dumpsites are difficult to count, but one should bear in mind that there is a significant quantity of waste in such places as well. Rural dumpsites, where those exist, include waste with different characteristics. Such waste mainly consists of glass, plastics and bulky waste that cannot burn, as well as organic waste from agriculture (organic waste is mostly incinerated, despite the existing conditions for compost generation through the natural process of aerobic digestion).

Currently in Montenegro there is the only one operating sanitary landfill of Livade in Podgorica. A system of wells (biothorns) has been installed at this landfill for the purpose of removal of landfill gases from sanitary cells, so that the collection, transport and flaring of landfill gases started in February 2008. The collected landfill gas is flared at the so-called "torch" (a tower for gas flaring), continuously measuring the volumes of gas that is flared. The volume of landfill gases that was flared in 2009 amounted to 630,720 m^3.

The construction of six new regional sanitary landfills has been envisaged by the strategic documents. Currently, significant activities are carried out to provide the funding for the construction of planned landfills. The required funds were estimated at approximately € 72.5 million.

Until 2014, regarding the field of waste management in Montenegro, it is planned to invest approximately € 120 million into the construction of regional sanitary landfills for all 21 municipalities, including rehabilitation of existing dumps, procurement of equipment and resources for improving technical equipment of public communal companies, addressing the issue of hazardous waste disposal, etc.

A set of measures to reduce GHG emissions has been considered in the waste sector in Montenegro, based on strategic documents in this area, although these were not marked as the measures to reduce GHG emissions in those documents. These measures are as follows:

- Construction of regional sanutary landfills with recycling centers;
- Reducing the volumes of waste produced as a result of introduction of the primary selection and recycling;
- Reducing the volumes of organic waste in solid municipal waste.

Projections of GHG emissions in the waste sector were made for the period 2010-2025, using the revised IPCC methodology of 1996. The following two scenarios were considered:

Baseline scenario, based on increasing the amount of waste produced in Montenegro in accordance with demographic developments and the absence of measures to reduce GHG emissions.

The scenario with measures to reduce GHG emissions is based on the construction of six regional sanitary landfills with recycling centers. GHG emissions from the waste sector are additionally reduced by installing the systems of biothorns for the capturing, draining and flaring of landfill gases. The production of waste is reduced by introducing primary selection and recycling, so that the percentage of recycled waste in total municipal waste amounts to approximately 25% in 2014, i.e. 50% in 2020, in accordance with EU directives. The reduction in the amount of disposed biologically degradable component parts of municipal waste in sanitary landfills is anticipated to increase from about 63% (2010) to approximately 47% (2015), and 22% (2025).

The baseline scenario and the scenario with measures to reduce GHG emissions in the waste sector are shown in Figure 5.9 below.

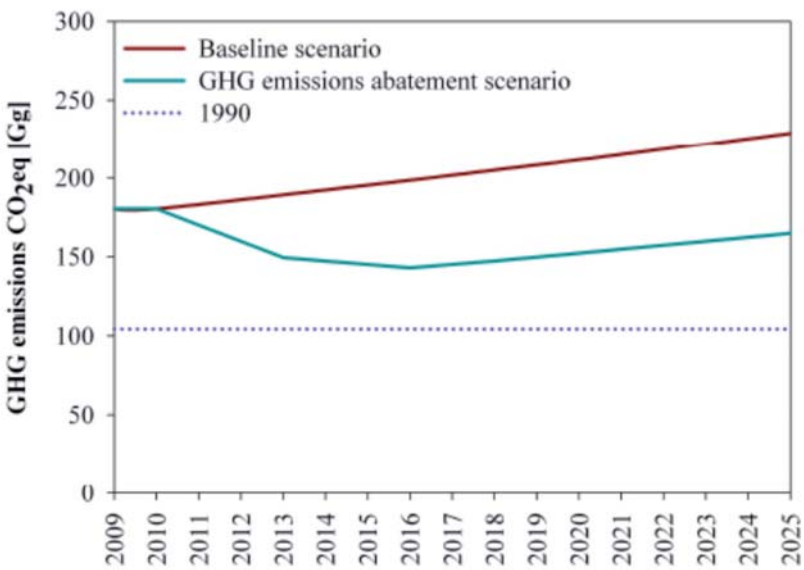


Figure 5.9: Total GHG emissions in the waste sector until 2025

The Figure shows that as a result of the contribution of all the measures in 2025, total reduction of GHG emissions in this sector was about 28% compared to the baseline scenario. Also, an overall level of GHG emissions in the last year of the observed period, according to the scenario with measures to reduce GHG emissions, would be 58% higher than the one in1990.

5.2.6 Overall Effect of Greenhouse Gas Abatement Measures

Summarizing the effects of measures to reduce GHG emissions by sectors analyzed, leads to an overall effect of the proposed measures on the level of GHG emissions in Montenegro until 2025. The results of those projections are shown in Figure 5.10. The Figure, for the purpose of comparison, indicates the level of GHG emissions in 1990.

According to the projections of GHG emissions in the baseline scenario, the level of GHG emissions will increase by approximately 40% in 2025, in comparison with 1990. On the other hand, according to the scenario with measures to reduce GHG emissions, in 2025 projected levels of GHG emissions will be by lower by approximately 46%, compared to the level for the same year in the baseline scenario, and 25% lower than the level of GHG emissions in 1990.

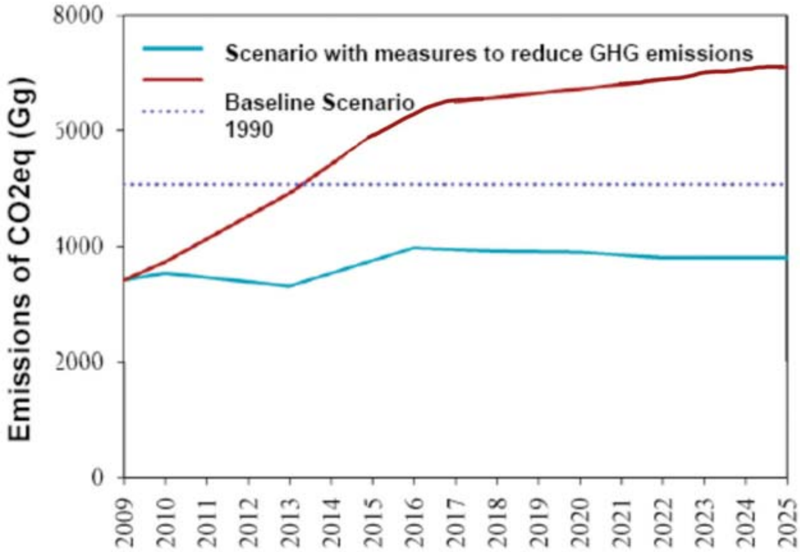


Figure 5.10: Total GHG emissions in all sectors in Montenegro until 2025

VULNERABLITY AND ADAPTATION TO CLIMATE CHANGE

6

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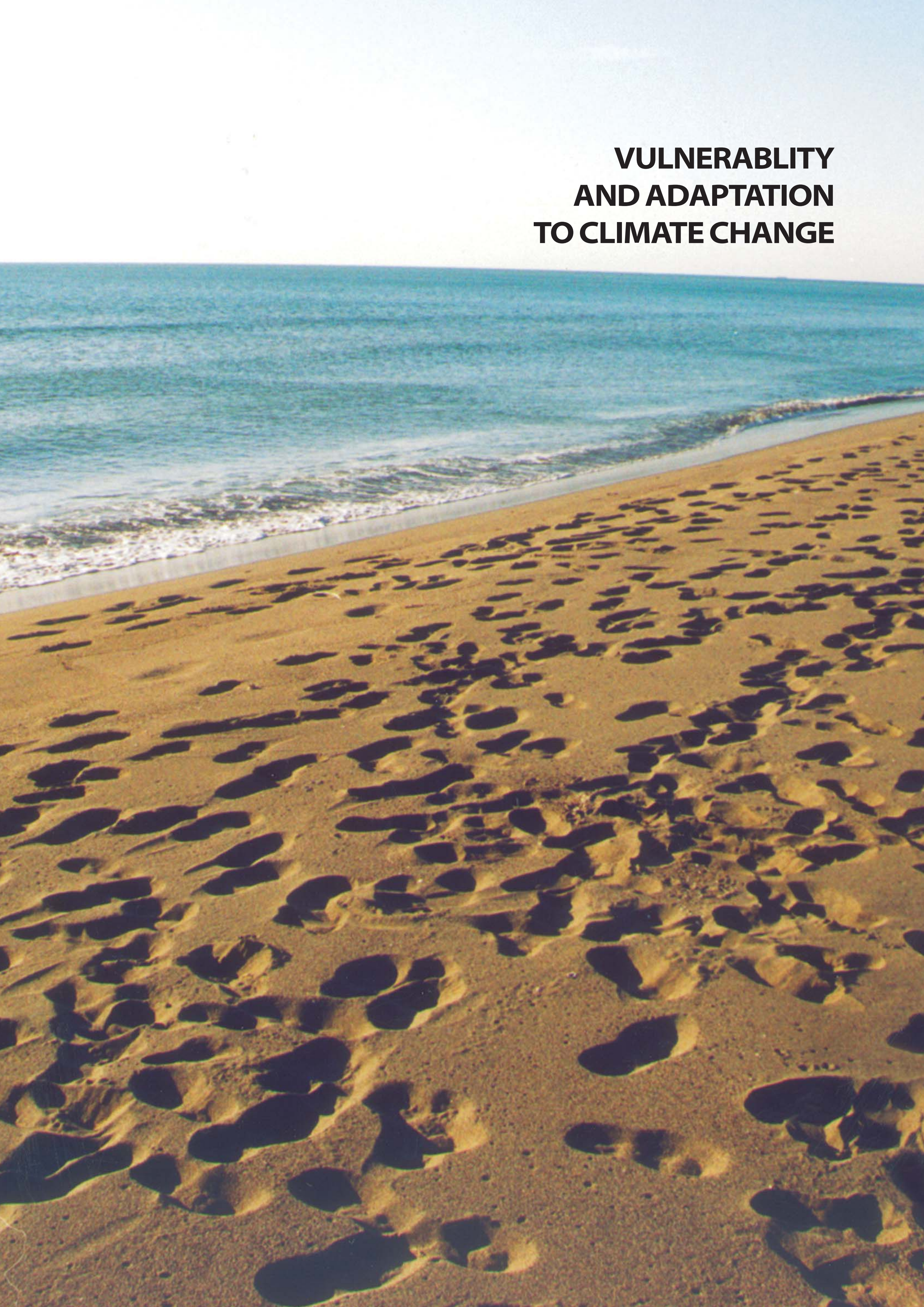
VULNERABLITY AND ADAPTATION TO CLIMATE CHANGE



6.1. Observed Climate Change in Montenegro since the Beginning of Instrumental Measurement in 1949/1950 until 2005

6.1.1. Air Temperature

The trend of increasing air temperature in the second half of the twentieth century has been evident in most of the territory of Montenegro. Summers have become very hot, especially in the last 18 years. Deviations of mean temperatures compared to the climatological normal are expressed in percentages in the range of 90-98% for the period from summer 1991 to 2005, meaning that the average temperatures are in the range from 2% to 10% of the greatest values in relation to the climatological normal, and that some of them significantly differ since they exceed the significance threshold of $p < 0.05$ (analysis of variance ANOVA and mean values test).

Average annual maximum air temperature positively deviate from the climatological normal from late 80-ies, and the minimum one since the late 90's, being within normal limits (Figures 6.1 and 6.2). The regression line (line) is positive and growing, while the correlation coefficient ranges from 0.1 to 0.5

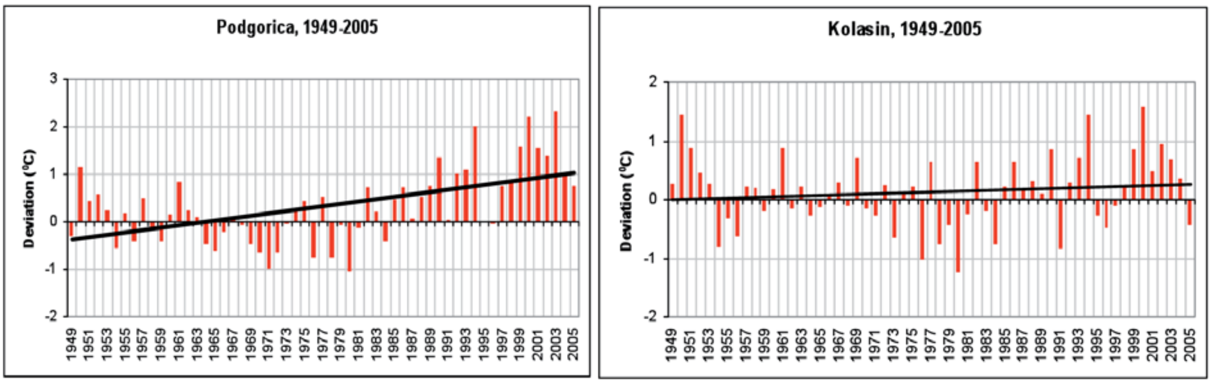


Figure 6.1: Deviation of mean annual maximum temperatures from climatic normal 1961-1990 (example: Podgorica and Kolašin) and trend 1949-2005 (blue line)

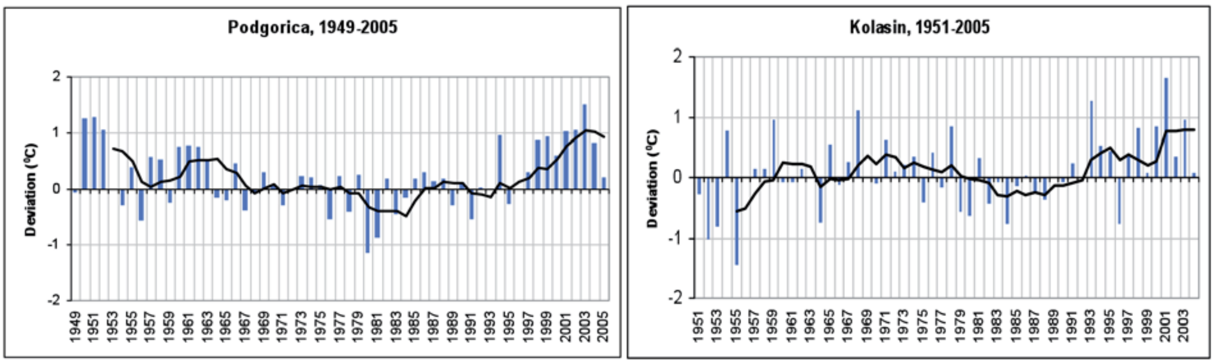


Figure 6.2: Deviation of mean annual minimum temperatures from climatic normal 1961-1990 (example: Podgorica and Kolašin) and five-year sliding mean values (black line)

Analysis of seasonal anomalies of temperature fluctuations shows that since the 90-ies there has been a slight trend of positive deviation in the winter, which could be a consequence of a less frequent presence of the cloud cover in relation to the period 1961-1990.

6.1.2. Precipitation

In the period 1991-2005, there was a statistically significant increase in mean precipitation in September compared to the climatological normal (Podgorica, Kolašin, Figure 6.3). Exceptions are the mountainous areas above 1,000 m, where there is a weak trend of precipitation (Žabljak, Figure 6.3).

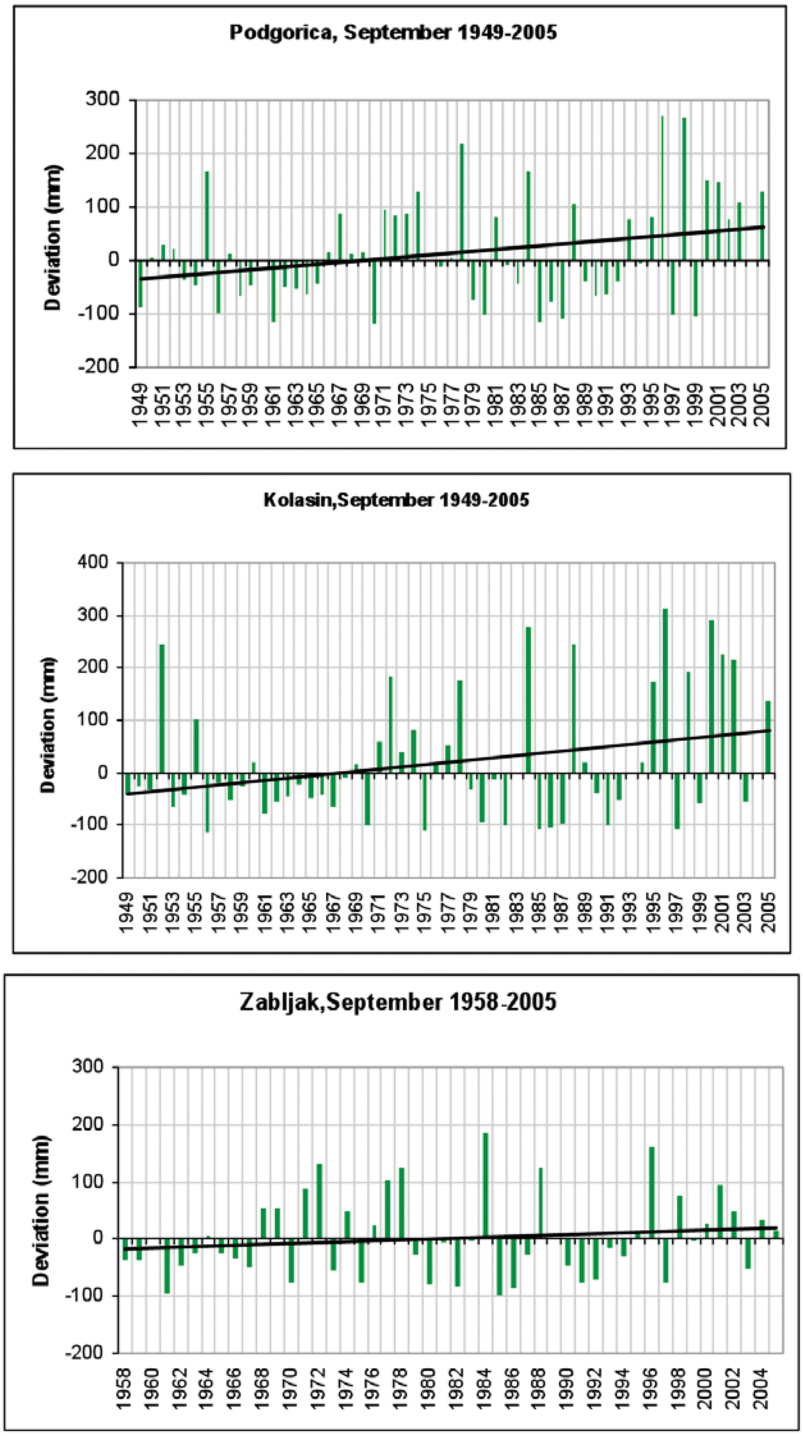


Figure 6.3: Deviation of monthly precipitation volumes from climatic normal in September.
The black line shows five-year mean values for Podgoricu and a trend line for Kolašin and Žabljak

The spring, summer and winter, especially since the 80s, have been mostly dominated by a negative trend of precipitation, but within normal limits (Figure.6.4). Autumn is characterized by a positive upward trend and, also within the normal threshold.

Annual precipitation volumes oscillate around the normal and generally show no tendency to increase or decrease. Exceptions are the north-eastern parts of Montenegro (Bijelo Polje) and the coast. In the northeast of the state, precipitation has been increasing since 1949 (the correlation is good), while at the coast there is a trend of slight reduction in rainfall (correlation is small, i.e. 0.3).

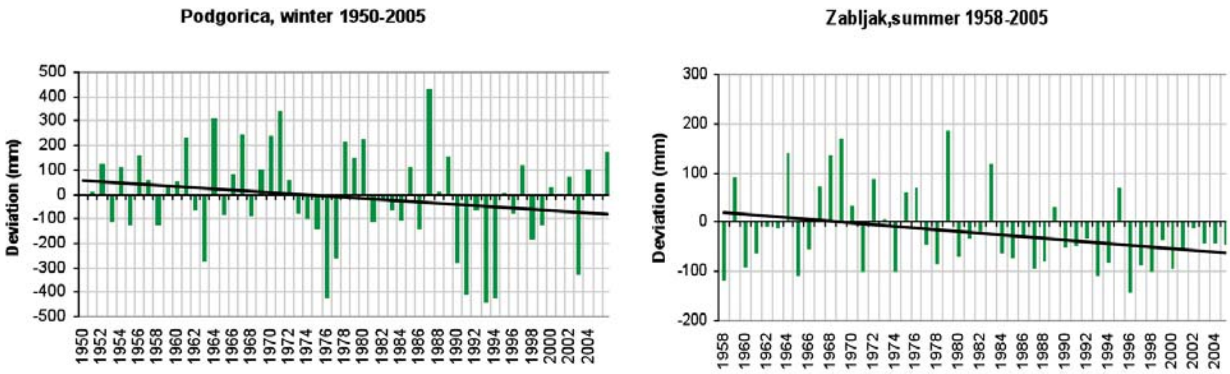


Figure 6.4.: Deviation of total precipitation (in Podgorica in winter and Žabljak in summer) compared to 1961-1990

6.1.3 Extreme Weather Conditions

The most extreme weather phenomena in Montenegro are: heavy rain leading to floods, winter storms, extreme cold and heat, drought, dense fog, phenomena related to the storm cloud (city, lightning, rain, rainfall, storm wind, pressure drop) and icing (on the ground and in the air).

According to the available data, i.e. in a series of measurements since 1949, and at some stations and since 1958 until the present day, it is evident that since 1998 extreme heat has started appearing more often, and especially during August. In the northeastern regions of Montenegro (confluence of the Tara and the Lim), maximum annual precipitation in mm/day has been on the rise since the 80's. However, there is no systematic increase and it has been strictly localized.

6.2 Climate Change Scenario until 2100

The scenario of climate change for the area of Montenegro made with the assistance of the EBU-POM (Eta Belgrade University – The Princeton Ocean Model) climate models. It is a linked regional climate model, which is a system of two regional models, one for the atmosphere and one of the oceans (Đurđević and Rajković, 2008, 2008b, Gualdo et al. 2008). The reason for including the oceanic component of the system is due to the fact that during long-lasting time scales such as climate measurements, air-sea interaction plays a crucial role in defining the status of both components individually. The mutual interaction becomes particularly important in the immediate vicinity of large bodies of water, and this is precisely the case in the region of interest, the Euro-Mediterranean area, which Montenegro belongs to.

The Special Report on Emissions Scenarios (SRES, Nakicenovic and Swart, 2000) is part of the third IPCC report (Third Assessment Report, TAR). This report defines possible future greenhouse gas emissions as a result of future technological, social and economic development based on human activities. These so-called SRES scenarios were used for the last, the fourth IPCC report. Within these, four families of scenarios were defined, A1, B1, A2 and B2, each of them including an adequate description of the scenario, the so-called "storyline".

The results of the regional climate model EBU-POM from the experiments of future climate change are focused on the results of scenario A1B and A2. In relation to the concentration of greenhouse gases, A1B was characterized as a "medium" and A2 as "high" scenario. Values of CO_2 concentration at the end of the twenty-first century for the A1B scenario are around 690 ppm, and for A2 scenario about 850 ppm, which represents approximately 2 times, i.e. 2.2 times higher value compared to the current observed value of 385 ppm.

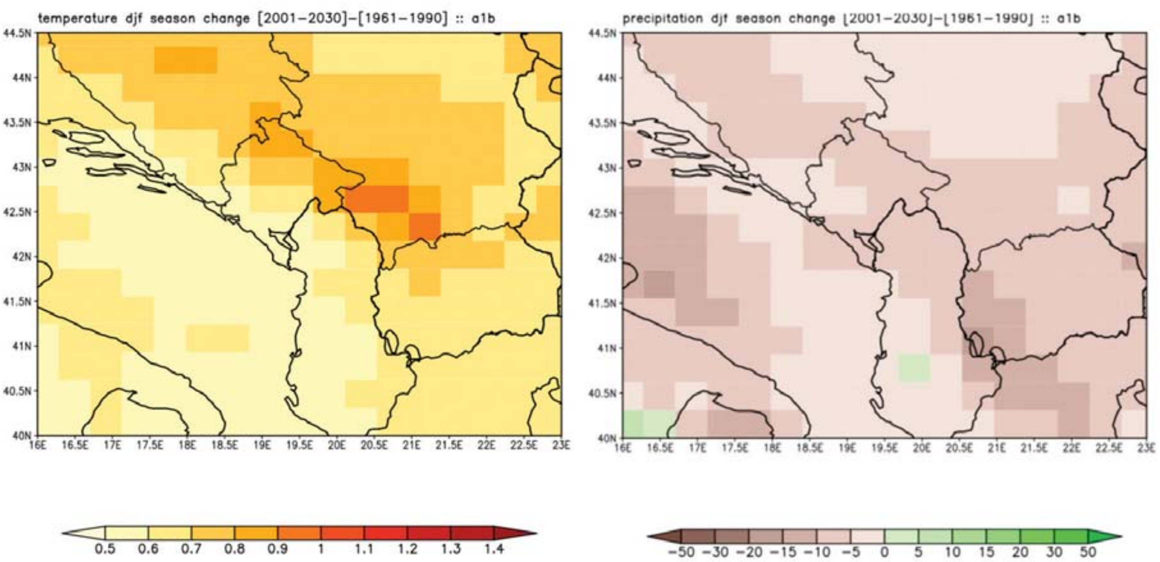
The A1B scenario assumes a well-balanced mix of technology and utilization of basic resources, and technological improvements that allow avoiding the use of only one source of energy. The implications of such possible development of society in the future will be reflected on the emissions of greenhouse gases, ranging from very intense carbon emissions to possible decarbonization of emissions, at least as much as is the variability of other conditioning factors relevant to this SRES scenario.

The A2 scenario assumes a heterogeneous society. In the background of this society are the requirements for reliance on local resources and preserving the identity of local communities. Due to a very slow increase of material goods and proper allocation by regions, a more significant increase of the population would be expected. Economic development is primarily regionally oriented and technological exchanges would be much slower and more locally oriented compared to the other scenarios (Nakicenovic and Swart, 2000).

The results from the model for the territory of Montenegro were analyzed for the periods 2001-2030 and 2071-2100. The report focuses on two fundamental changes: surface meteorological parameters, temperature at 2 meters and accumulated rainfall. Changes in these parameters are shown in comparison to the average baseline period 1961-1990.

6.2.1 A1B Scenario, 2001-2030

Model results for the SRES A1B scenario for the change in temperature at 2 meters above the ground and accumulated precipitation are shown in Figures 6.5. and 6.6. Each Figure has four panels, the panels on the left show the temperature changes, and those on the right changes in precipitation. For four seasons were identified, DJF - December, January, February, MAM - March, April, May, JJA-June, July, August, and SON - September, October, November. Median anomalies were calculated for the period 2001-2030.



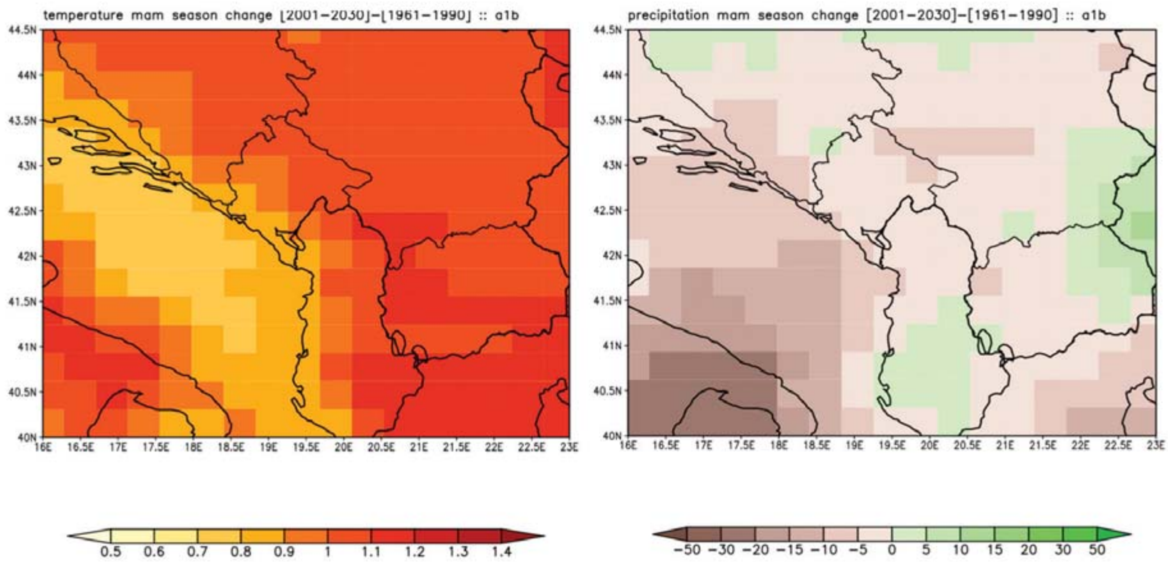


Figure 6.5: Changes for DJF (upper panelas) and MAM (lower panels) season, temperatures at 2 m (°C) (panels to the left) and accumulated precipitation (%) (panels to the right) in the territory of Montenegro for the A1B scenario during the period 2001-2030.

According to the results of the model seasonal changes in mean temperature during the observed period, 2001-2030, are moving in the range of 0.60^{0} C to 1.3°C, depending on the season and the area of Montenegro. Except for the SON season, it is evident that the temperature changes are significantly greater in the northern, mountainous part of Montenegro, compared with smaller changes in the area near the Adriatic Sea. The biggest change is during the season JJA, with values of 1.3°C in the north and 1° C in coastal areas. For the season DJF changes in the coastal part are about 0.5°C, while in the northern part the temperature increases by 0.9°C. For the season MAM, changes are somewhat larger than in DJF with a value of 0.8°C in the south to 1.1°C in the north. The SON season was characterized by almost the absence of differences in temperature change, going from south to north, with more or less steady change in the entire territory of about 0.7°C.

Model results show negative and positive changes in precipitation, depending on the part of Montenegro and the season. Positive changes in precipitation, and their increase can be seen for the season JJA, for the central area of Montenegro, and for the MAM season in parts of that border with Bosnia and Herzegovina. These positive changes are very small, ranging up to 5%, compared to the value of the baseline period, 1961-1990. In other areas of Montenegro during the two seasons, DJF and MAM, model results show a decrease in precipitation from -10% to 0%. The MAM season is characterized by deficient rainfall and the highest values of -20%, almost over the whole territory of Montenegro.

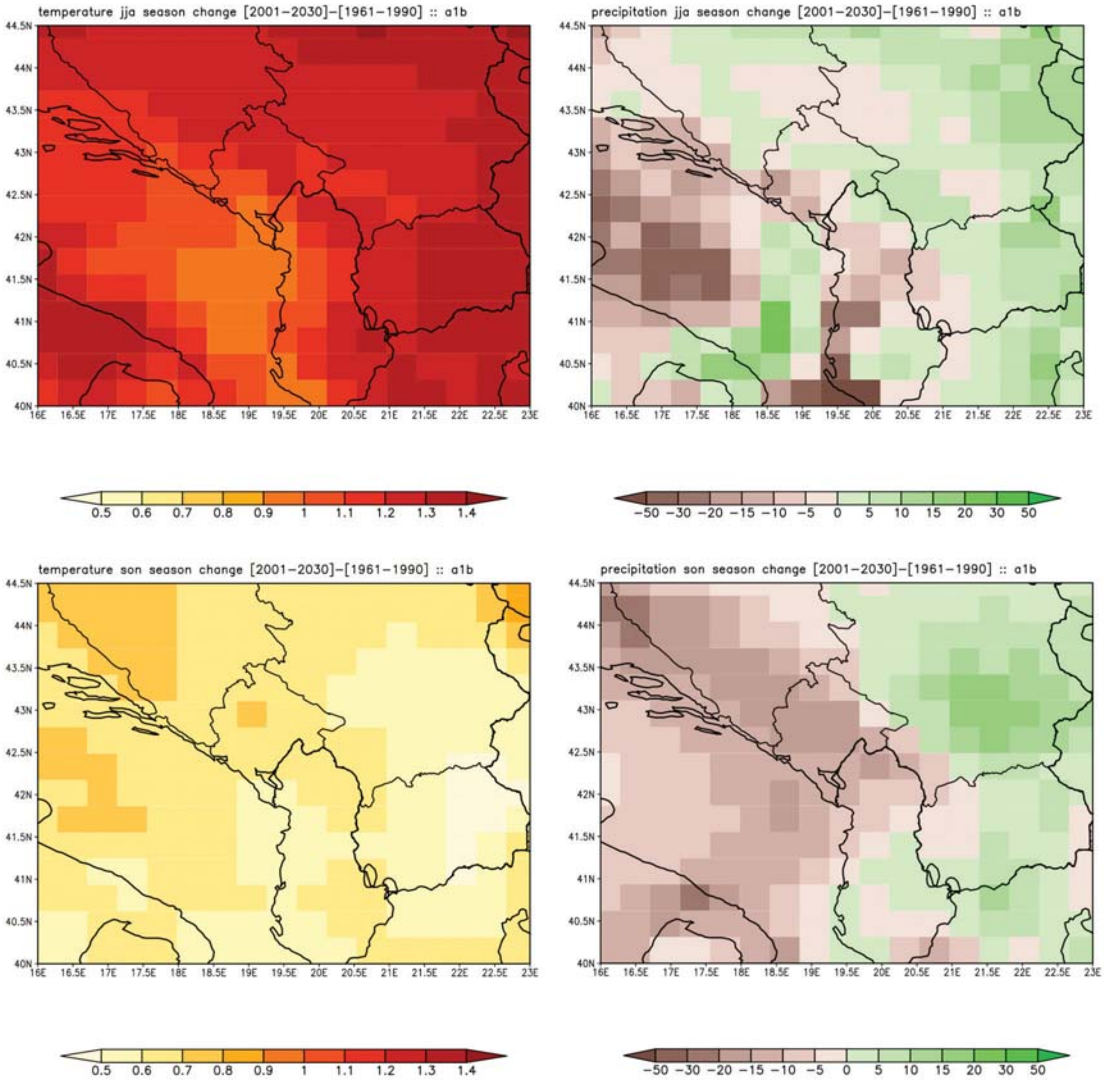


Figure 6.6: Changes for JJA (upper panels) and SON (lower panels) season, temperature at 2 m (°C) (panels to the left) and accumulated precipitation (%) (panels to the right) in the territory of Montenegro for the A1B scenario during the period 2001-2030.

6.2.2 A1B scenario 2071-2100

Results for scenario A1B for the period 2071-2100 are shown in Figures 6.7 and 6.8 The arrangement of panels according to the seasons and the parameters are the same as in the previous section for the period 2001-2030.

Based on these results, for the past 30 years of the twenty-first century, it can be seen that the spatial structure of changes of relevant parameters has been similar to the previously observed period of 2001-2030, but with a greater magnitude of change. Again, the area along the Adriatic Sea has minor temperature changes compared to those in the northern mountainous region. This time temperature changes 2 meters above the ground range between 1.6°C and 3.4°C. The biggest changes are again recorded in the season JJA. Along the coastal area the temperature increased by approximately 2.4°C, and in the northern mountainous region of the country these values are 3.4 °C. During the winter season (DJF), there is a noticeable gradient from the south towards the north of the country, with a temperature increase of 1.6°C the coastal area, and 2.6°C in the north. For the MAM season, these changes vary from 1.6°C to 2.6°C, though the area with a change of 2.6° is much wider than in the previous period. Finally, for the SON season changes in the coastal region are about 1.6°C, and 2.4°C in the northern area along the border with Serbia.

During this period there is no season or area in Montenegro which is characterized by a positive anomaly of precipitation. For the DJF season in the central parts of Montenegro there is a negative anomaly of precipitation of -30%, while the northern and coastal parts also record a negative change, though with values of up to -30%. The MAM season was characterized by a far more uniform deficit and values of about -10% in the whole territory. A significant deficit during the season JJA is evident in coastal areas, while in the central and northern parts negative anomalies are in the range of -20 to -15%. For the season SON, model results also show a significant decrease in precipitation from -30 to -50%.

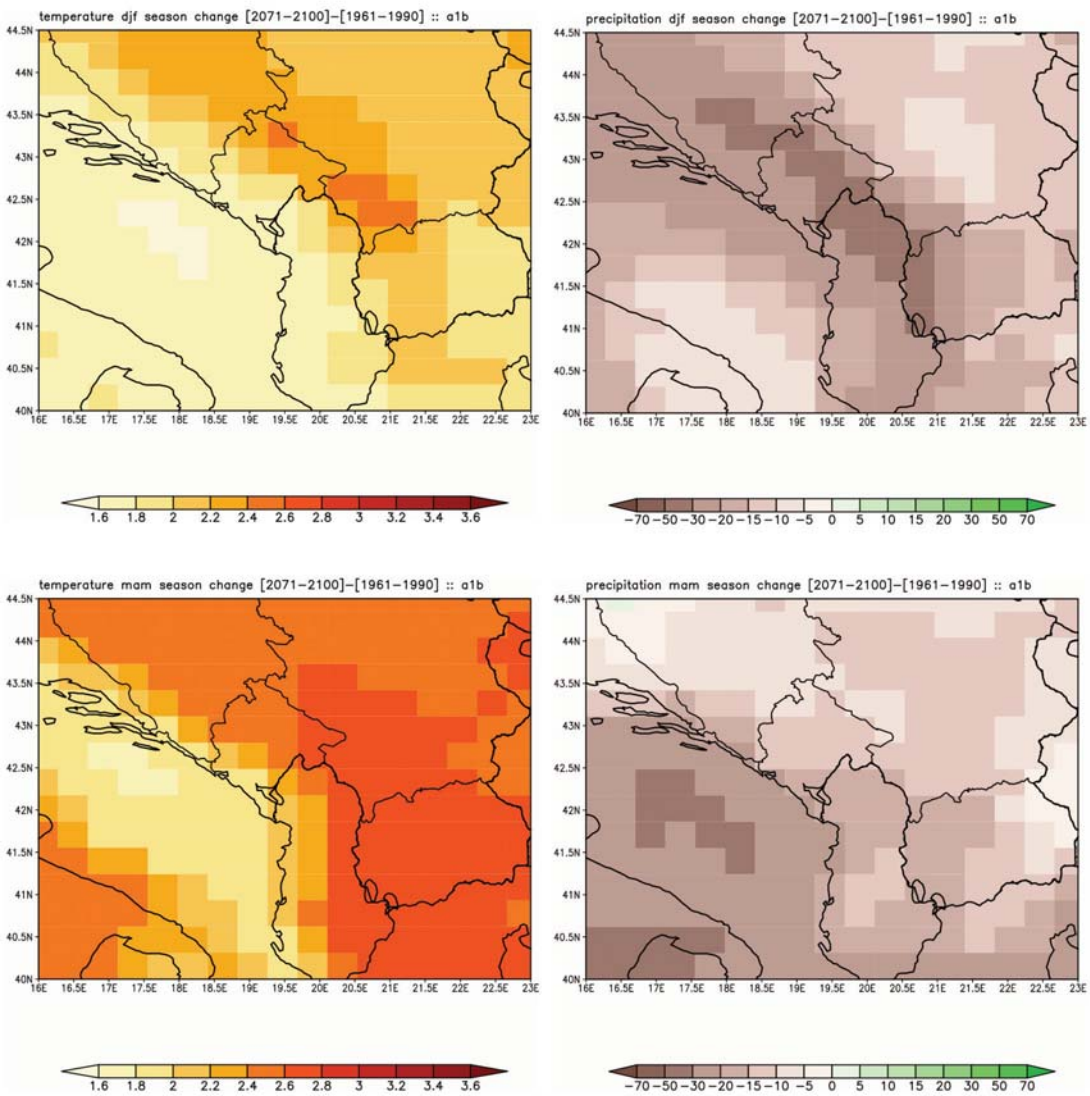


Figure 6.7: Changes for DJF (upper panels) and MAM (lower panels) season, temperatures at 2 m (°C) (panels to the left) and accumulated precipitation (%) (panels to the right) in the territory of Montenegro for A1B scenario during the period 2071-2100

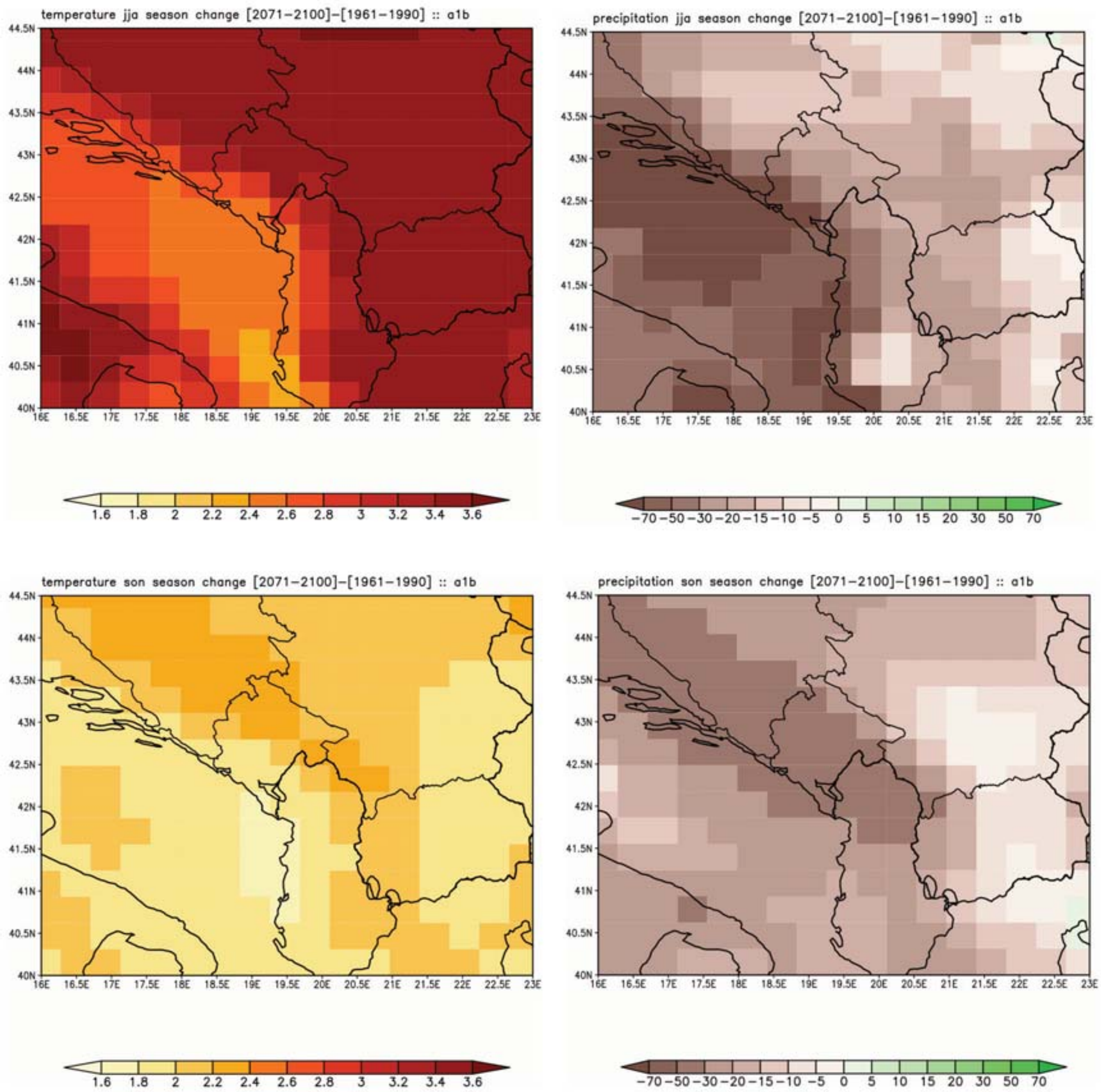


Figure 6.8: Changes for JJA (upper panels) and SON (lower panels) season, temperatures at 2 m (°C) (panels to the left) and accumulated precipitation (%) (panels to the right) in the territory of Montenegro for the A1B scenario during the period 2071-2100.

6.2.3 A2 Scenario 2071-2100

The A2 scenario results for the period 2071-2100 show an increase of temperature in the territory of Montenegro within the limits of 2.6°C to 4.8°C. The greatest increase is during the JJA season in the mountainous region in the north, with values over 4.8° C. For this season, an increase in temperature of 3.4°C is foreseen. For the DJF season, temperature increase along the Adriatic coast is about 2.6°C, while this value in the northern parts is about 3.4°C. These values are somewhat higher during the MAM season, from 2.8°C to 3.6°C. Spatial distribution of changes is far more uniform during the SON season, in relation to other seasons, in the range of 2.6°C to 3°C. C to 3 C. For this scenario, the south-north gradient in the amplitude of temperature change is again present (Figures 6.9 and 6.10).

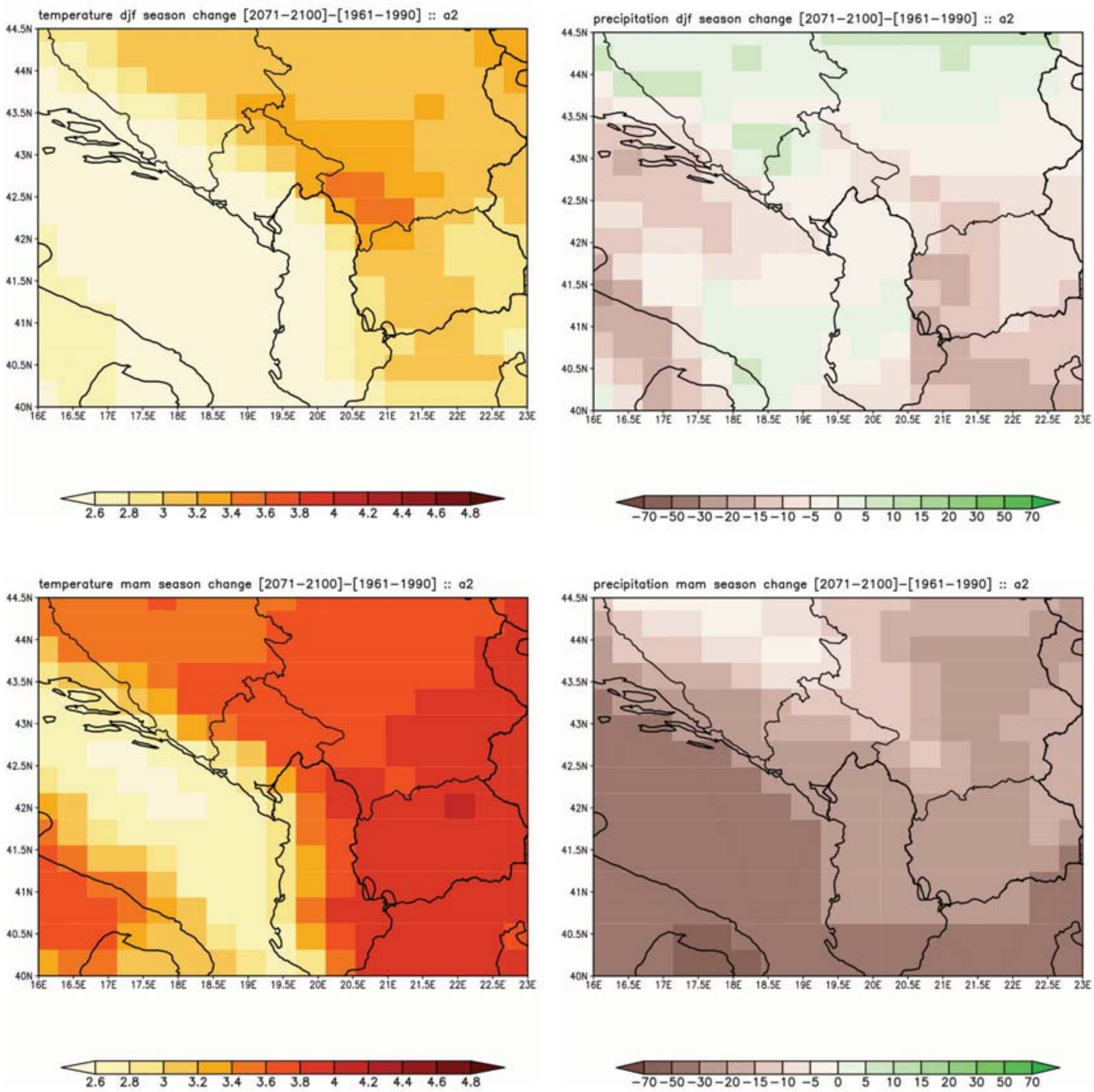


Figure 6.9: Changes for DJF (upper panels) and MAM (lower panels) seasone, temperature at 2 m (°C) (panels to the left) and accumulated precipitation (%) (panels to the right) in the territory of Montenegro for the A2 scenario during the period 2071-2100.

During all seasons, except for DJF, a negative anomaly of accumulated rainfall over the entire territory of Montenegro is predicted for the A2 scenario. A positive anomaly in the range 5-10% will be recorded only in the north-western parts during the season DJF, while during the same season changes in other parts of the country will vary from -5% to -10%. The biggest changes according to this scenario are along the coast and during the JJA season, with a value of -50%. During this season an anomaly of -10% will occur in the northern parts. During the seasons of MAM and SON, the spatial distribution of anomalies is more uniform with a mean value of -20%.

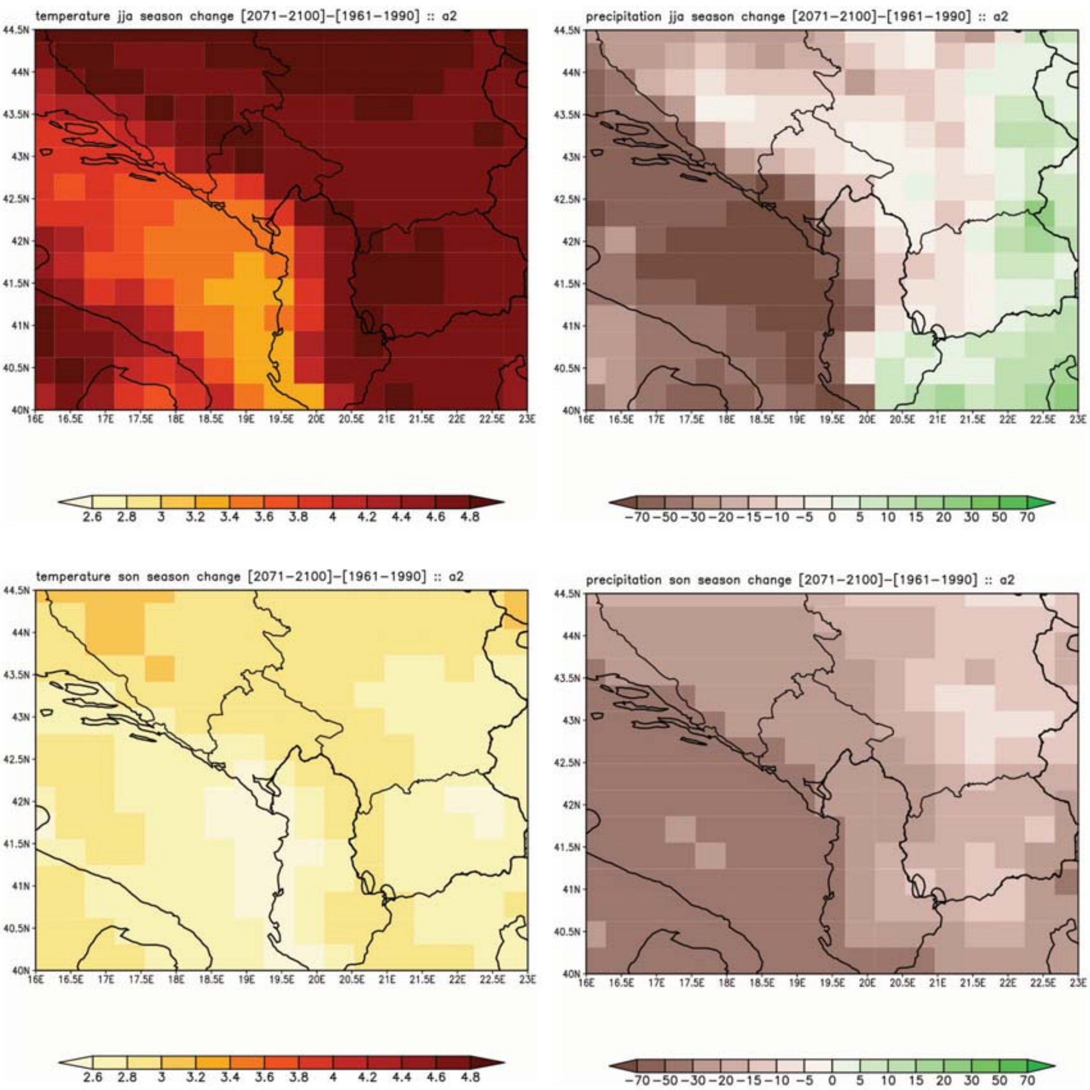


Figure 6.10: Changes for JJA (upper panels) and SON (lower panels) sesone, temperatures at 2 m (°C) (panels to the left) and accumulated precipitation (%) (panels to the right) in the territory of Montenegro for the A2 scenario during the period 2071-2100

6.3 Vulnerability by Sectors and Adaptation Measures

The effect of a long-term climate change was considered for the sensitive sectors such as: water resources, coastal areas, agriculture, forestry, biodiversity and public health. Predictions are made on the basis of climate scenarios A1B and A2 for Montenegro

6.3.1 Water Resources

6.3.1.1 Effects of Climate Change on Water Resources

Since the water resources of Montenegro are mostly formed and located in the territory of the state, except for Skadar Lake which is shared with Albania and Bileca Lake that is shared with Bosnia and Herzegovina (Republic of Srpska), the yield and balance of water resources is directly related to climate factors in the territory of Montenegro. Precipitation, snowfall, temperature and evaporation of the climatic parameters are of fundamental importance for the balance of water resources, and this is exactly where some strong climate anomalies were identified. At about 90% of the country there is a deficit-reduction of annual precipitation that ranges up to 20% in certain areas[23]. As water resources have a high degree of correlation with rainfall volumes and regime, the decrease in precipitation will generate changes in water resources. Changes in water resources are reflected in the amplitude and pronounced fluctuations, reducing capacity, a sudden increase in flood waters, and longer periods with reduced capacity in both natural flows, as well as accumulation water resources for commercial purposes (Figure 6.11).

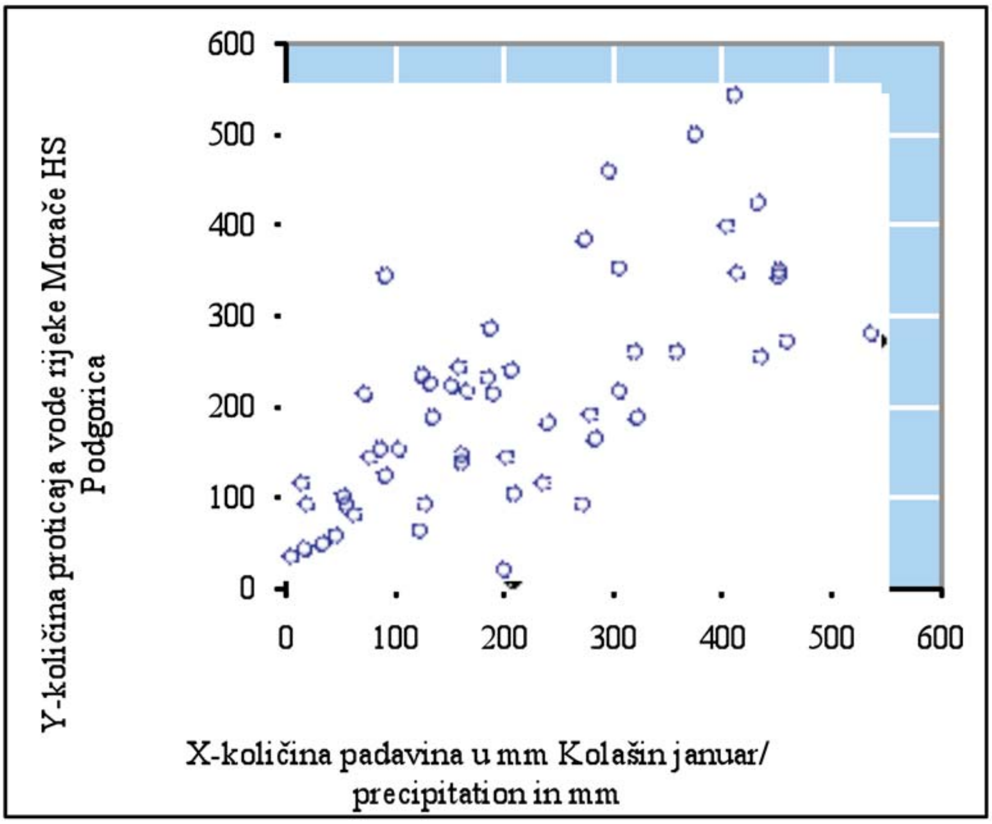


Figure 6.11: Correlation between multi-annual monthly volumes of precipitation in Kolašin and the Morača river flow volume at the HS[24] Podgorica for the month of January

23 Hydrometeorological Office of Montenegro

24 HS-hydrological station measuring hydrological parameters

Changes in the regime of water resources arising as a consequence of climate change are evident.

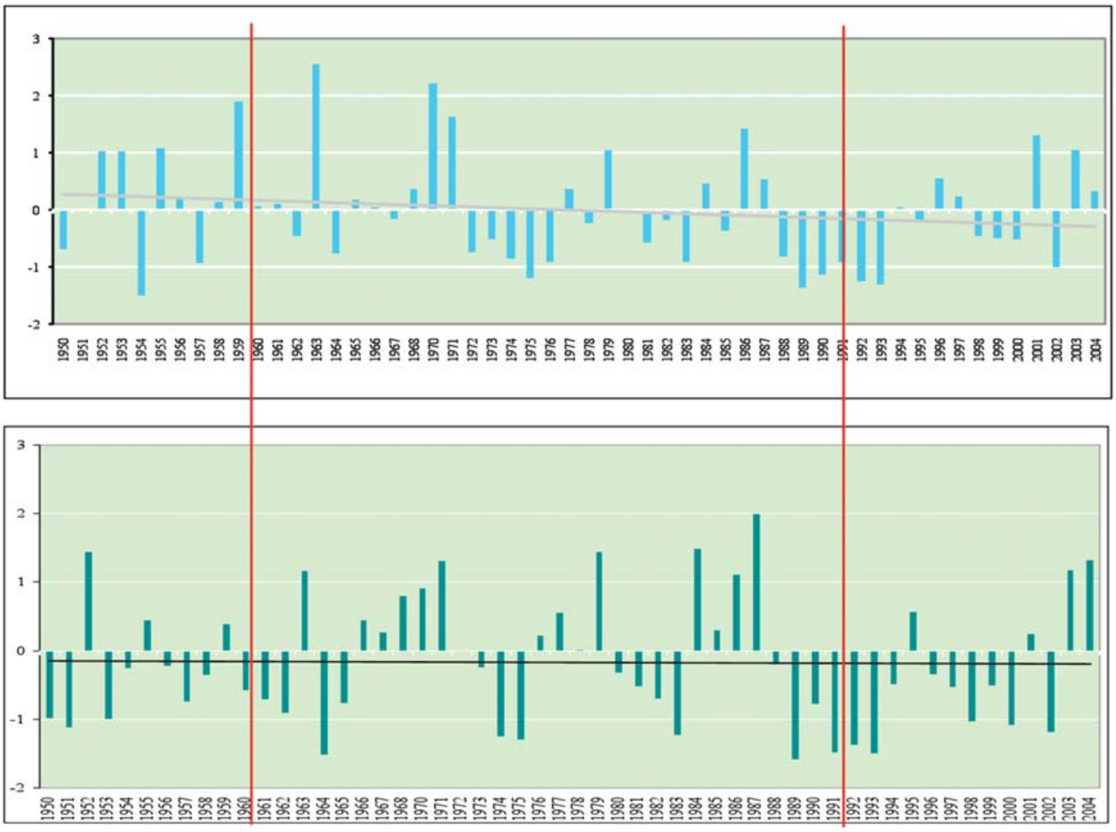


Figure 6.12: Upper: normalized monthly precipitation volumes for January in Kolašin.

Lower: normalized monthly flow volumes of the Morača River for January at HS Podgorica

During the climate period 2071-2100, according to the model of correlation between rainfall and the amount of flow, the trend of change in discharge of the Morača water resource through Podgorica will be reduced by 31% compared to the climatic normal for the period 1961-1990 (Figure 6.13).

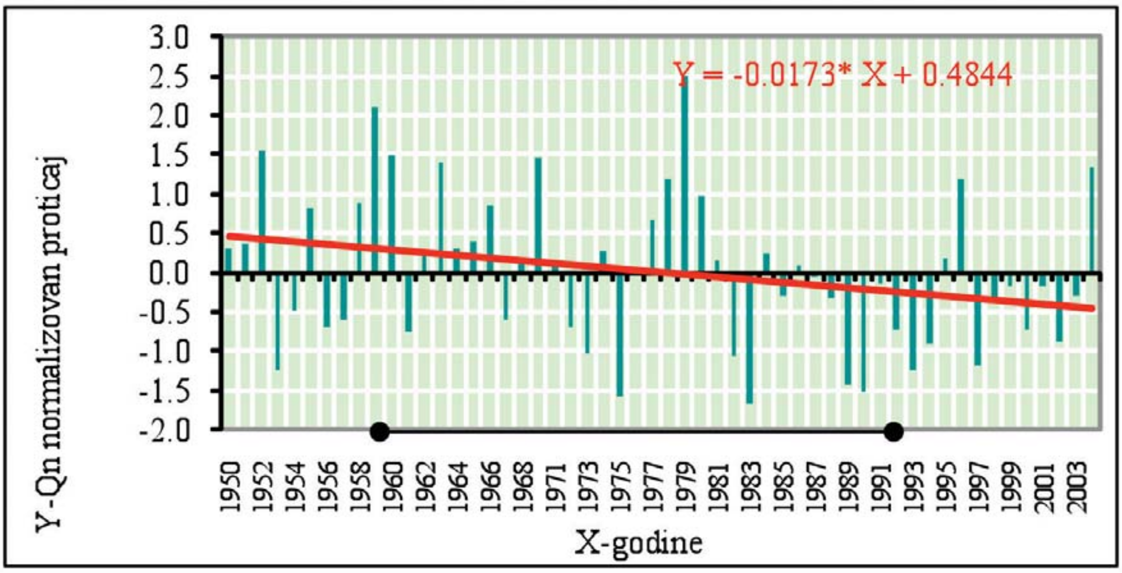


Figure 6.13: Normalized aveage annual flow volumes of the Morača River in Podgorica, with a trend change line

Table 6.1: Annual flow reduction for the Morača River in Podgorici using the model of trends of normalized annual flows by Gaus

Trend model equation	$Q_{yi} = \bar{Q}_{61/90} + Qn * O_{61/90}$
Forecast Period	Reduction in [illegible]
Until [illegible]	[illegible]
Until [illegible]	[illegible]

Considering the scenario for the changes in precipitation and temperature, a strong disturbance in the balance of water resources is expected to occur until 2100. Given that there is a high degree of correlation among the rainfall, flow volumes and yield, in and accordance with the expected climate scenarios envisaging different percentages of reduction in rainfall, ranging even up to 50% in some periods (scenario A2 for the period 2071-2100), it can be expected that an overall water balance (water potential) in certain areas would be reduced by as much as 50%. The changes in water resources will be determined by climate change, especially in the regime of precipitation, as follows: first, a reduction of overall water balance and secondly an increase in the amplitude of the hydrological cycles. Accordingly, in years with low overall water balance and with pronounced oscillations there will also be periods of severe deficits and those with an intensive surplus in rainfall. In this new situation, there will be pronounced dry and rainy periods. Flood waves will become more frequent due to an increased intensity of rainfall (not of the volumes, since for example the volumes shall remain within average monthly limits but the number of rainy days will be lower than it is normally the case) and a change in the type of precipitation. Specifically, during the cold months of the year, when precipitation is the largest in the upper reaches of major river courses (which are mostly mountainous), rainfall usually occurs in the form of snow. Over the past twenty years, due to warming and higher temperatures[25], there is an absence of snow and rainfall, so that it happens that with the same volume of precipitation there is a lot more water in the lower courses of rivers, and an increased risk of flooding, only because a part of this water previously used to be deposited in the form of snow with a delayed discharge over a longer period of time, which is no longer the case. In accordance with the scenario A1B and somewhat more pessimistic scenario A2, envisaging an increase in temperature, it cab be expected that the lack of snow, and thus the flood waves as well, will be more frequent and stronger.

A change according to this scenario will have a strong impact on the economic-social component. The yield of water sources will be reduced, and some springs will dry up or experience intermittent flow. The sources of water supply to cities will not have the capacity to meet the water demand. The capacity of accumulations used for industrial and commercial purposes will be reduced, as well as energy generation, whereby the imports of electricity will be increased, thus directly increasing the costs, which will result in a powerful economic and social impact.

The effect of climate change on water resources is reflected through:

- reduced volumes of rainfall, thus reducing an overall water balance;
- changes in rainfall regime with a pronounced dry and rainy periods, and consequently pronounced fluctuations of hydrological systems;
- reduced volumes of snowfall and consequently reduced water potential for surface and underground hydrological systems;

25 About +4 C was identified, the data of the Hydrometeorological Office were obtained through the Project "AEN-atmospheric natural disasters". The most recent example is the flooding in the basin of Skadar from 4-13 January 2010. Temperatures in the upper highland areas where it should have been snowing have been record-high for the past 60 years, maybe even longer, because the data were available only for those years.

- shortening of the period of duration of the snow cover, which will be a shock to the hydrological groundwater supplies;
- more intensive melting of snow, consequently causing hazardous hydrological flooding events;
- an increase in evaporation and evapotranspiration, which will have a very destructive effect on water resources, especially for smaller hydrological systems in relatively warm areas.

Generally speaking, climate change will certainly affect the condition of water resources, so that those will be generally reduced, consequently resulting in the reduction of reliability of their exploitation. Changes in water resources will certainly have a negative impact both on the plant and animal communities that exist in a variety of water resources, erosive processes will be increased as has been evident over the recent 20 years[26]. Due to prolonged drought periods, surface vegetation creating natural soil cohesion which is very important in sloped areas will become dry in large areas, and then after a long dry period, rainy periods will follow with abundant and long-lasting rainfall that will cause landslides and severe erosion processes.

6.3.1.2 Adaptation Measures

So far, in our country no professional-scientific research has been carried out on possible factors potentially leading to self-adaptation. Although the entire territory of Montenegro, hence every aspect of water resources was directly or indirectly affected by strong climatic anomalies in the last twenty years, no mechanisms determining self-adaptation have been identified. At this point there are no national strategies or adaptation measures and estimates of the expected mechanisms of self-adaptation.

Climate change increases water demand by means of its activity. The problem of water resources is very complex and not at all simple especially as those are affected by climate change from one and excessive demands for economic and commercial exploitation from the other side. The concept of adaptation measures must have administrative, professional and operational character:

- It is necessary to prepare the cadastre of water resources, map each water resource with all its characteristics and identify areas of potential danger;
- Water resources of fundamental importance, such as water sources, have to be protected from uncontrolled exploitation and a strategy-plan developed to protect them against the effects of climate change;
- Each water resource needs to be addressed individually, and therefore, an individual strategy-plan for the management and exploitation, as well as a protection plan, needs to be adopted for each one of them;
- Establish a high level of information exchange among different institutions dealing with water resources for the purpose of timely identification of any changes in water resources and undertaking adequate protection measures;
- provide a modern automated measuring and control system for the controlled management of water resources. Provide numerical models and their use in daily operational practice, for the purpose of daily monitoring of the status of water resources and obtaining by numerical simulation a prognostic status of water resources for several days in advance for the purpose of protection and to warn the people to protect their property from flood waves.

Considering that this is a process, adaptation measures will be changed and updated daily. It is very important to adopt a strategy and plan based on the facts as a starting point that will be changed later on and adapted to the new situation. The strategy, in addition to directly addressing the water resources,

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should also include the natural systems that indirectly affect water resources, such as forest areas and the exploitation of forest resources, as well as the exploitation of sand and gravel from riverbeds. For now, there is no formal strategy or government policy[27] which treats this problem integrally and provides recommendations for adaptation. Yet, there are some projects that are localized to specific river basins, for example, the project titled "Integrated Management of River Basins of the Tara and Lim" (International Development Bank, funds from the Global Environment-GEF, provided a grant to the Government of Montenegro in the amount of $ 350,000)

6.3.2 Coastal Area

6.3.2.1 Scenario of Climate Change Effects on the Coastal Area

6.3.2.1.1 Changes in Sea Level and Sea Surface Temperature

The scenarios used for assessing the impacts of climate change on coastal areas are the A1B and A2 scenarios obtained from climate models, including maritime numerical models to estimate sea level rise.

One of the consequences of global warming is the increasing sea level. There are several reasons that lead to an increased sea level. Firstly, it is the thermal expansion of water caused by temperature increase. According to the estimates from the most recent IPCC report (IPCC Fourth Assessment Report: Climate Change 2007: Working Group I), a projected increase in sea level by the end of the century of about 75% will result from thermal expansion, and only 25% from the melting glaciers in the area under the eternal ice (Arctic, Antarctic, Greenland).

However, despite a large interest and need for information on the situation relating to the sea level and the coast, especially for long-term planning, all estimates of future changes in the sea level have a very low level of reliability especially when it comes to small local basins such as the Mediterranean and the Adriatic Sea. One of the reasons for this low level of confidence is that the global models have relatively little degradation to be able to explain such small basins correctly, and on the other hand regional models such as the EBU-POM were not able to properly add in the share of melting glaciers and eternal ice that are global, not regional problems, in the sea level rise. On the other hand, an obstacle that results from the EBU-POM model calculation of thermal expansion is that this is a model with the so-called "free" area, whereas all proposed and developed methodologies so far can be used only for calculating the thermal expansion with the so-called "fixed" surface area.

27 This resource is managed by the Government

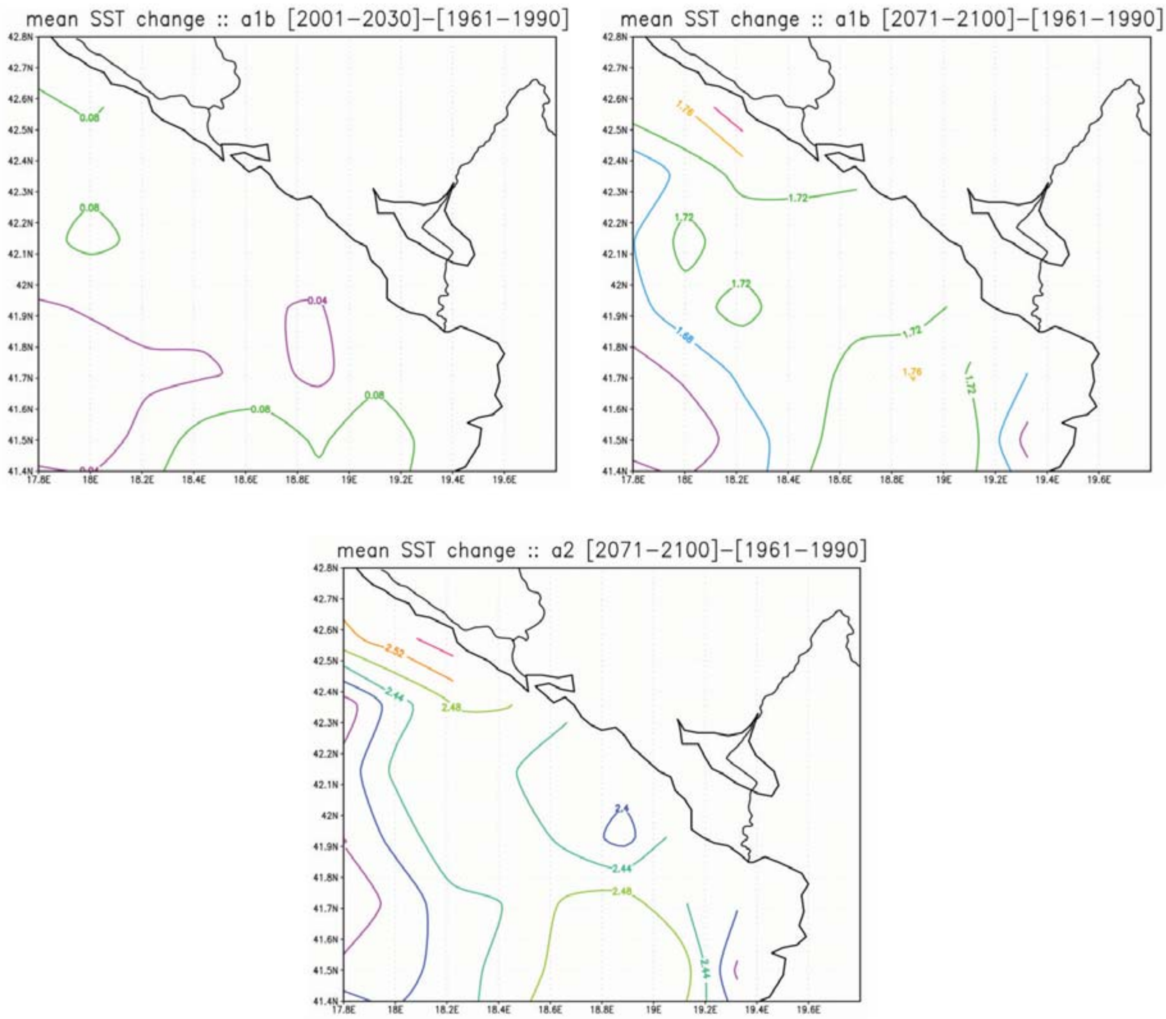

Figure 6.14: Changes in mean annual sea temperature in °C for the coastal area of Montenegro (a) for the period 2001-2030 and scenario A1B, (b) for the period 2071-2100 and scenario A1B, (c) for the period 2071-2100 and scenario A2

For scenario A1B mean annual temperature changes of the Adriatic Sea for the period 2001-2030 range within the limits of 0.04°C to 0.08°C, while for the period 2071-2100 this change is about 1.7 °C. For the "pessimistic" scenario A2 and the period 2071-2100, the change in sea surface temperature is about 2.4°C (Figure 6.14).

For the period 2071-2100 and the A2 scenario, the upper limit of increase in sea level in the basin of the Mediterranean Sea, including the Adriatic-Ionian basin, is +35 cm, out of which +13 cm as a result of thermal expansion, +18 cm of melting glaciers and permafrost, -2 cm of changes in atmospheric pressure fields over the Mediterranean and +6 cm of changes in circulation in the very basin.

Climate changes and their impact on the coast can be seen through two fundamental scenarios. The first scenario concerns the increase in sea level with a few scenarios, depending on the height increase in sea level. Another scenario, in addition to increasing sea level, concerns an increased frequency of tidal waves and an increase in their amplitude, which is in direct correlation with the cyclic depressions and strong south and south-western current flow field.

In the first scenario A1B, rising of the level of the Adriatic Sea for about 35cm will provoke serious consequences, much of the coast that is now on the verge of flooding seawater will be constantly flooded, and the flood area of tidal floods waves will significantly increase, even in places that have never been subject to the impact of flood waves before. Rising of the sea level will disturb the naturally established equilibrium. A huge part of the beach will be reduced, and some beaches will disappear, the Bojana river will lose its existing natural flow to the point where it empties into the sea, the delta of the Bojana river will disappear, torrential flows will not have a normal flow to the receiving coastal waters, so that such water will be spread out into the surrounding environment well before the imagined natural coastline, which will have the effect of flooding the areas that have never had this kind of flood characteristics before. This scenario involves replacement of the current situation by the new one. This new situation is the result of numerical simulations with a rather unreliable probability of occurrence during the period up to 2071 or by 2100.

The other scenario A2, in addition to the sea level rising of 35 cm and a higher amplitude and frequency of tidal flood waves, will be of much greater importance. With this scenario, the coastal area will be exposed to much greater and more dangerous effects than with an average increase in the sea level. With this scenario, simply some zone adjacent to the coast will have limited usefulness because those will be targeted by these waves several times a year. This means that in these zones no structures can exist, no biological community can be formed, and the natural environment will suffer significant modifications as well. This scenario does not assume a replacement of the current situation by a new one, but includes in the current situation some pronounced anomalies of the sea and tidal wave, i.e. increases the degree of stressfulness. This is expressed even today, to very small extent. But over time, as a consequence of climate warming and an increased energy available in the system of air, water and land, this is expected to be the significantly emphasized.

6.3.2.2 Effects of Climate Change on the Coastal Area and Adaptation Measures

Climate change will have a very strong influence on the coastal area which can be reflected through the following changes:

- disruption of natural balance;
- reducing beach area and even disappearance of some beaches;
- the flow of the river systems that empty into the sea will be distracted so much that the space around the rivers will be flooded and destroyed, and practically lost, especially where the coast is low, as Velika Plaža (The Great Beach);
- the river Bojana flow will be stopped much before its current end, which means that this whole part of the area, which is now practically even with the surface of the river Bojana will be flooded;
- tidal waves of cyclonic depression will destroy the structures whose foundations are practically in water, which are currently pounded by even the smallest waves on daily basis. The safety of infrastructure, ports, water breaks, marinas, shipyards, etc. will be endangered, and in particular their normal functioning.
- the walls built at the end of the beaches or immediately by the coast will be destroyed and these areas, so that the water will reach the highest points and distances that have never been reached before , and strong erosive processes will be generated in those zones;
- the sea water - waves will put a strong pressure on the water sources adjacent to the coast, which are used for water supply, so that a large number of sources will be out of use because those will have salt water;
- due to the change of microclimate and the effect of salt water deep into the land, this may also result in possible consequences for local agricultural production;
- due to the change of microclimate in the area of the coast, the conditions facilitating the development of plant pests will be generated, which will have a substantial affect on the process

of agricultural production, especially on olive trees and the emergence of flies which cause immense damage to olive trees on the shore;
- possible degradation of plant and animal life in the sea, significant damage to coral reefs, some migration as a result of increasing temperature and temperature amplitudes;
- due to a sudden large volume of rainfall in the mountainous hinterland, an enormous influx of fresh water into the waters of the Boka Kotorska Bay is expected to occur, and all that water, as surface runoff or through underground channels will reach the sea and take up the surface layer of water. Due to the presence of fresh water in the winter months when temperatures are below zero, there will be a regular occurrence of frost-icing of the sea, which will have some unforeseeable consequences for this resource.

These impacts will generate strong social and economic consequences. In the first place, the economic and tourism potential of the coast will be reduced, while an investment risk will be increased. Economic activities, such as maritime transport, fisheries, agriculture etc. will constantly be under "stress." Due to climate change-anomaly in some years these coastal resources will be fully compromised. There are almost no distinctive mechanisms of self-defense and self-adaptation.

As for the adaptation measures, those would primarily include:
- developing high quality and very operational services for monitoring the condition of the shore and waves, as the biggest potential danger, and early warning of the existence of danger, several days in advance;
- amendments to the applicable legislation in the field of spatial planning in order to include the problem of climate change in coastal during the preparation of spatial planning documentation, so as to prohibit the construction and urbanization of the areas that will be exposed to potentially dangerous tidal waves as a result of the new situation;
- the existing infrastructure facilities should be resized to stand the load of new extreme climatic parameters and waves. This means that the existing buildings should be further strengthened and a maximally adapted to new climatic parameters and the new state of the sea level;
- provide for maximum possible protection of water sources from the penetration of sea water. If possible, specific reservoirs should be moved to higher elevations, where only a few meters more would be enough to keep the situation completely under control;
- some buildings should be demolished and the inhabitants relocated, thus allowing for an unimpeded propagation of strong tidal waves, with no consequences for the environment and the people;
- some parts of the coast, will be completely flooded several times a year, and no life or existence will be possible to be established there. According to the present situation regarding the level of population and urbanization, it is expected that between 10% and 20% of the urbanized coast will be relocated, as a measure of adaptation.

The strategies and plans of today are unfortunately based only on the level, scope, quantity and method of economic exploitation of this resource, and of course all of these documents are in accordance with the existing legislation. The strategy is mainly engaged in the construction of large tourist facilities, i.e. space-planning documentation, not taking into account the effects of climate change.

6.3.3 Agriculture

6.3.3.1 Effects of Climate Change on Soil and Adaptation Measures

Soil quality is determined by different soil processes, which can be physical, chemical, or biological, which are of different intensity, and react with each other making the soil a complex part of the terrestrial ecosystems. Soil reaction to climate change is determined by the changes that occur in the intensity of soil processes that lead to changes in soil characteristics with far-reaching consequences. Soil processes directly depend on the influence of temperature, precipitation, and changes in atmospheric CO_2, so that they affect the water regime and plant growth, and indirectly depend on the influence of forced climatic changes in the way of land use and agro-technical measures. Changes in the soil will also affect the composition of the vegetation structure and contribute to changes in the climate system. A set of responses to climate change is presented in Table 6.2, also showing which climate parameter causes the change, time-course for specific changes, and also if the process is reversible or not.

Table 6.2: Soil reaction to climate change (taken from Rounsevel et al., 1999)

	Change Time	Soil Process	Climate Impact	Reversible Process	Other Impacts
Soil Moisture Content	daily	infiltration, drainage, surface runoff, percolation	P, T, ET, CO_2	Yes	COM, soil structure
Operating ability	daily, weekly	infiltration, drainage, surface runoff, aggregation, processing	P, T, ET, CO_2	Yes	Moisture content, COM, structure
Soil temperature	daily	Thermal conductibility	P, T, ET, CO_2	Yes	Moisture content, COM
Soil Structure	monthly, annual	Freezing, melting, shrinking, expansion, aggregation	P, T, ET, CO_2	Yes	Area sizes of elementary soil particles, Moisture content, COM
Degradation	daily, annual	salinization, alcalization, erosion, acidity	P, T, ET, CO_2	Yes, Yes, No	Area sizes of elementary soil particles, Moisture content, COM
Organic Matter Content	annual, centenial	aspiration, biomass recovery, decomposition	P, T, ET, CO_2	Yes	Moisture content, structure
Nitrogen Content	monthly, annual	mineralization, nitrification, denitrification, volatilization deep percolation	P, T, ET, CO_2	Yes	Moisture content, COM
Ecological Composition	annual		P, T	Yes	Moisture content, COM
Nutrient Status (macro and micro)	daily	mineralization, dissolution	P, T, ET, CO_2	Yes	Moisture content, COM
Area Sizes of Elementary Soil particles	decade, centenial	Clay translocation, decomposition	P, T, CO_2	No	Moisture content
Mineralogy (e.g. clay, Fe and Al)	centenial, multi centenial	pedogenesis, decomposition	P, T, CO_2	No	Moisture content

* P-Precipitation, T-Temperature, ET-Evapotranspiration, COM – Content of organic matter in the soil (humus)

Future changes in climate and atmospheric composition will be represented by evolutions of heat and rain regime, changes in vegetation and land use, factors that have an impact on the soil and its dynamism. Short-term response of the soil to climate change is widely discussed and presented in scientific literature. The most important role of the soil in terrestrial ecosystems is that it is the environment and a resource for plant production, that it has an impact on climate change and a significant participation in the hydrological cycle. The effects of climate change on the soil, as well as the adjustment measures, are shown in Table 6.3 below.

Table 6.3: Climate change impact on soil and adaptation masures

Climate Change Impact	Adaptation Measure
reduction of organic matter in soil due to increased temperature and aridity that affect its faster decomposition	application of organic fertilizers system of recommendations for the application of mineral fertilizers on the basis of analysis of plant body parts growing of leguminous plants and their plowing reduced cultivation
accelerated soil erosion primarily through increased soil erodibility (change in land use), increased rainfall intensity and longer dry periods	afforestation implementation of new irrigation techniques increasing awareness of farmers

The spatial scale of adaptation to climate change is taking place at several levels:

- At the very plots, for example using different machines and run time farming operation, growing other crops, using irrigation;
- At the level of households, through socio-economic changes affecting farm size and method of orientation in the production determined by profitability;
- At the regional or national level, through policy measures or soil protection regulation.

6.3.3.2 Effects of Climate Change on Plant Production

Favorable climatic conditions are the main condition for successful agricultural production. The lack of one abiotic factor cannot be replaced by using another factor. The effect of an abiotic factor can be improved to a certain level through agricultural measures. In the current climate conditions it can fully limit plant growth and development or lead to a significant reduction in yield. The expected climate change will affect agricultural production even more significantly, having its positive and negative impacts. The adverse impacts will lead to the reduction and limitation of production, while the positive ones can be achieved only by adopting measures to adapt to climate change.
An analysis of the impact of climate change on agriculture of Montenegro was done by comparing the baseline climate scenario representing the baseline period of 1961-1990 with the two future climate scenarios A1B and A2 for the projected climate conditions during the period 2001-2030 and 2071-2100. The comparison was based on the calculation of reference evapotranspiration (ETo) and the assessed needs of plants for water. The entire territory of Montenegro is divided into 22 sectors. Reference evapotranspiration and water demand by plants were estimated within each sector.

Looking at the obtained values of summary evapotranspiration in the winter for 3 different scenarios, it can be noticed that the scenario A1B (2001-2030) records an increased value of ETo in relation to the baseline scenario for only 3.6 to 8.7%. Lower values of increase correspond to the coastal sectors with the Mediterranean climate, while the higher ones relate to the mountain and continental climate. An increase of reference ETo for two scenarios relating to the period 2071-2100 amounts of 10.3-20.2% in the A1B scenario, and from 12-23.5% in the A2 scenario. The same rising trend also occurs in the previous scenario in the case of sectors with the Mediterranean, mountain and continental climate. Expressed in absolute values (mm of water column) this increase was the greatest in the A2 scenario (2071-2100) amounting to 12 mm (Figure 6.15 a).

In the spring period, summary evapotranspiration increases relative to the baseline scenario for 2-7.6% in the A1B (2001-2030), 8.7-15% in the A1B (2071-2100) and by 11.1% to 19.4% in the A2 (2071-2100) scenario. Expressed in absolute values, a maximum increase amounts to up to 15.2 mm in the A1B (2001-2030), from 9.0 mm to 30.8 mm in the A1B (2071-2100) and from 11.7 mm to 45.1 mm in the A2 scenario (2071-2100) (Figure 6.15. b).

In the summer period, when Eto values are the highest, there is an increase of 1.3-5.6% in the A1B (2001-2030), from 8.3-14.3% in the A1B (2071-2100) and from 10.9 to 17.2% in A2 (2071 to 2100) scenario. This increase in absolute values ranges from 13.8 mm to 23.3 mm for the A1B (2001-2030), from 13.4 mm to 60.5 mm for the A1B (2071-2100) and from 18.1 mm to 78.1 mm in the A2 (2071-2100) scenario. If this value of 78.1 mm is divided by the number of days in the three summer months, this results in a daily increase in ETo of 0.85 mm, which is quite a high value (Figure 6.15. C).

In the autumn an increase in ETo with respect to the baseline scenario is 11.2-15.6% for the A2 (2071-2100), 9.9-13.3% for the A1B (2071-2100) and 2.7-5.3% for the A1B (2001-2030) scenario. For this period of an increase in ETo for the A2 scenario (2071-2100) goes to 24.9 mm, for the A1B (2071-2100) even up to 22.0 mm, an to 8.2 mm in the A1B scenario (2001-2030) (Figure 6.15 d).

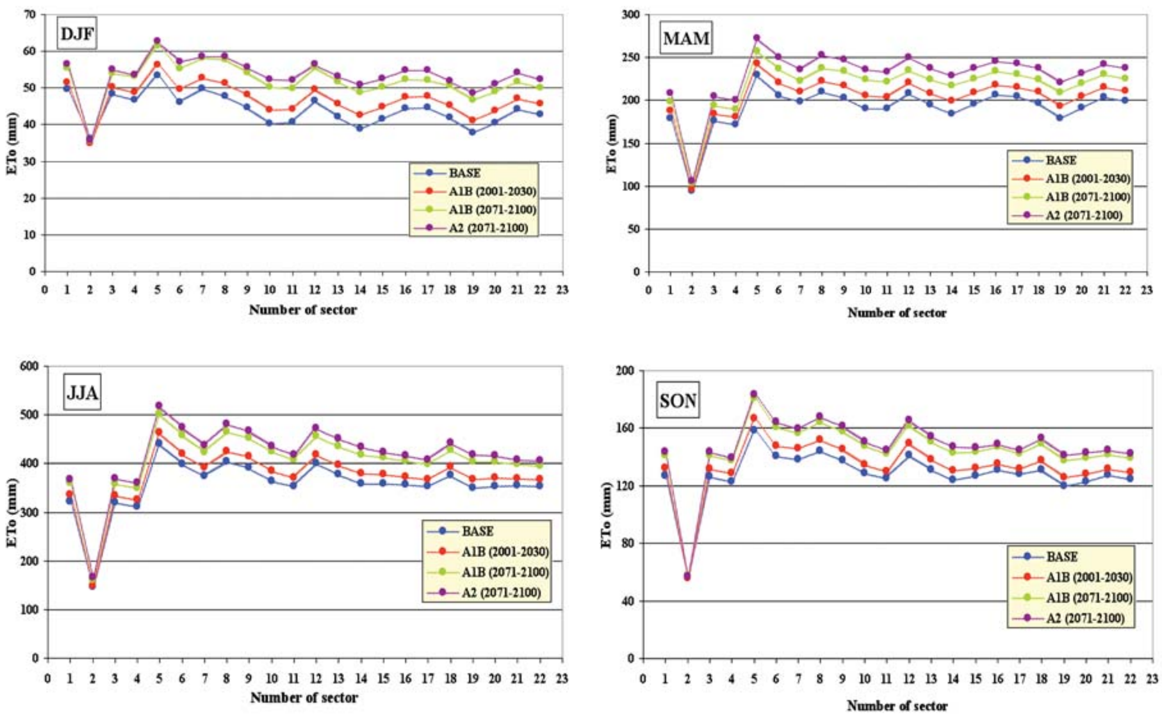

Figure 6.15: Summary reference evapotranspiration of winter season DJF (a), spring season MAM (b), summer season JJA (c) and autumn season SON (d) for the baseline (BASE) and three future climate scenarios (A1B (2001-2030), A1B (2071-2100) and A2 (2071-2100))

Looking at the water demand by plants in the winter period (Figure 6.16 a) shows that in all areas of some excess water occurs, i.e. that the values of ETo are smaller than the value of effective rainfall. Due to the extremely large amount of rainfall in the coastal belt, the volumes of excess water in that region are considerably larger. It is interesting that future climatic conditions affect the reduction in such a surplus, and thereby reduce surface runoff. Measured volumes of excess water range from -40.4 mm in the mountainous area to -394.3 mm in the coastal zone, in the A1B scenario (2001-2030). In the scenarios for the period 2071-2100, these range from -28.6 to -284.4 mm for the A1B, and from -30.2 to -388.1 mm in the A2scenario..

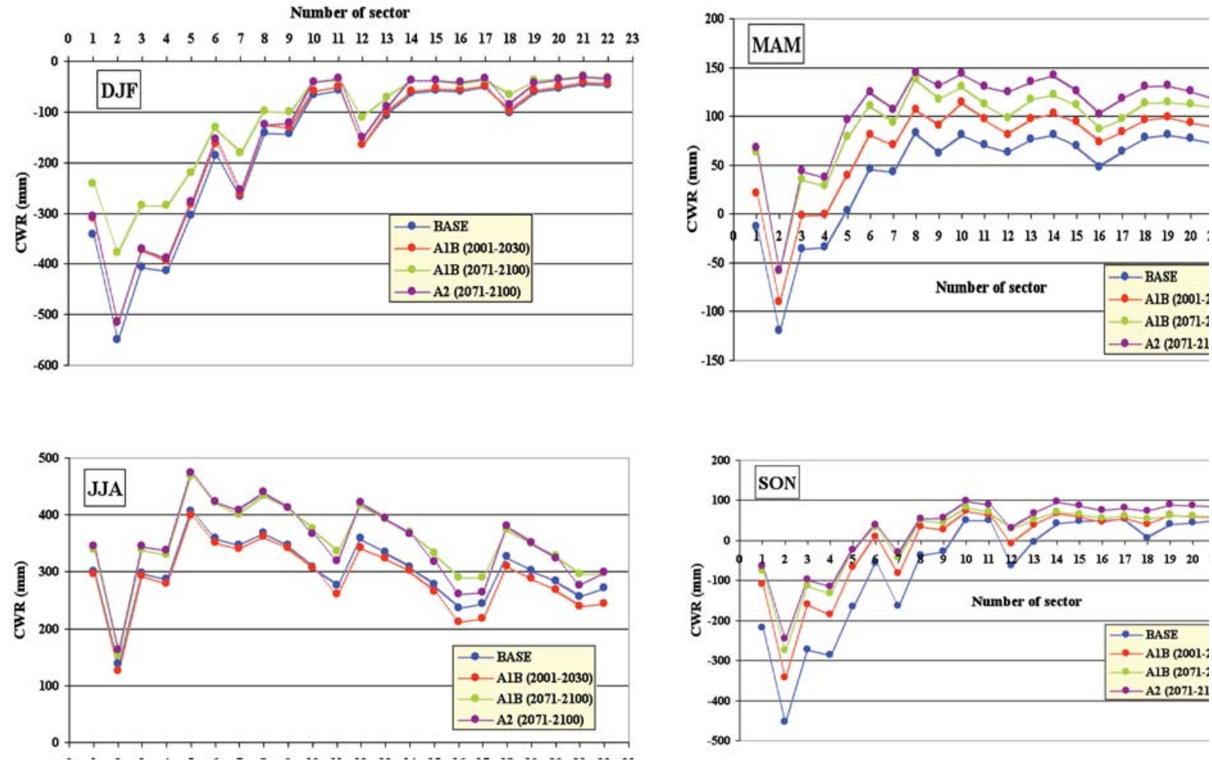

Figure 6.16: Water demand by plants in winter DJF (a), spring MAM (b), simmer JJA (c) and autumn season SON (d) for the baseline (BASE) and three future climate scenatios (A1B (2001-2030), A1B (2071-2100) and A2 (2071-2100))

In spring, there is a significant reduction in rainfall compared to the winter period and the baseline scenario, as well as an increased evaporisation, resulting in the phenomena of minor water shortages in the coastal zone, and more significant shortages in the mountain area, ranging from -1.7 mm (small surplus) to 39 mm in the coastal belt, up to 114.1 mm in the hilly and mountainous regions, for the scenario A1B (2001-2030). For the scenarios during the period 2071-2100, the shortages range from 29.2 m to the 130.7 mm for the A1B, and from 37.6 mm to 145.3 mm for the A2 scenario. In relation to the baseline scenario, this surplus amounts even up to 92.8 mm for the A2 scenario (2071-2100), so that this is actually an increase of 1 mm per day in water demand, which is a significant increase (Figure 6:16 b).

In summer period, water demand by plants is the highest, expressed in absolute values, although this increase was not the largest in percentages in relation to the baseline scenario. In the A1B scenario (2001-2030) this demand ranges from 212.3 mm to 399.2 mm. For the scenario A1B (2071-2100), water demand ranges from 290.3 mm to 468.2 mm, and for the A2 scenario (2071-2100) from 261.2 mm to 474.1 mm. Expressed in absolute values, this increase amounts to 68.3 mm in the A2 scenario (2071-2100) and up to 67.7 mm in the A1B scenario (2071-2100), in relation to the baseline scenario. So, the expected increase in daily water demand in the period 2071-2100 was 0.75 mm and 0.74 mm (Figure 6:16. c).

In the autumn months, there is excess water in the coastal belt which goes even up to 184.4 mm in the A1B (2001-2030), 132.3 mm in the A1B (2071-2100) and 114.2 mm in the A2 (2071-2100) scenario. In the mountainous areas water shortage in the fall is up to 73.6 mm for the A1B scenario (2001-2030), up to 83.8 mm for the A1B scenario (2071-2100) and up to 98.4 mm in the A2 scenario (2071-2100). Observed in absolute values, the largest increase in water demand of 48.3 mm occurs in the A2 scenario (2071-2100), which is 0:53 mm per day (Figure 6:16 d).

6.3.3.2.1. Adaptation to Climate Change

The analysis and quantification of the process of evapotranspiration for future climate conditions of 2001-2030 and 2071-2100, for two scenarios, A1B and A2 (2071-2100), may propose specific measures to mitigate the effects of climate change on agriculture in Montenegro, in terms of water demand (Figure 6.17). In order for this to be accurately done, a detailed study of each sector will be required, especially under the current circumstances, and then under the conditions of future production.

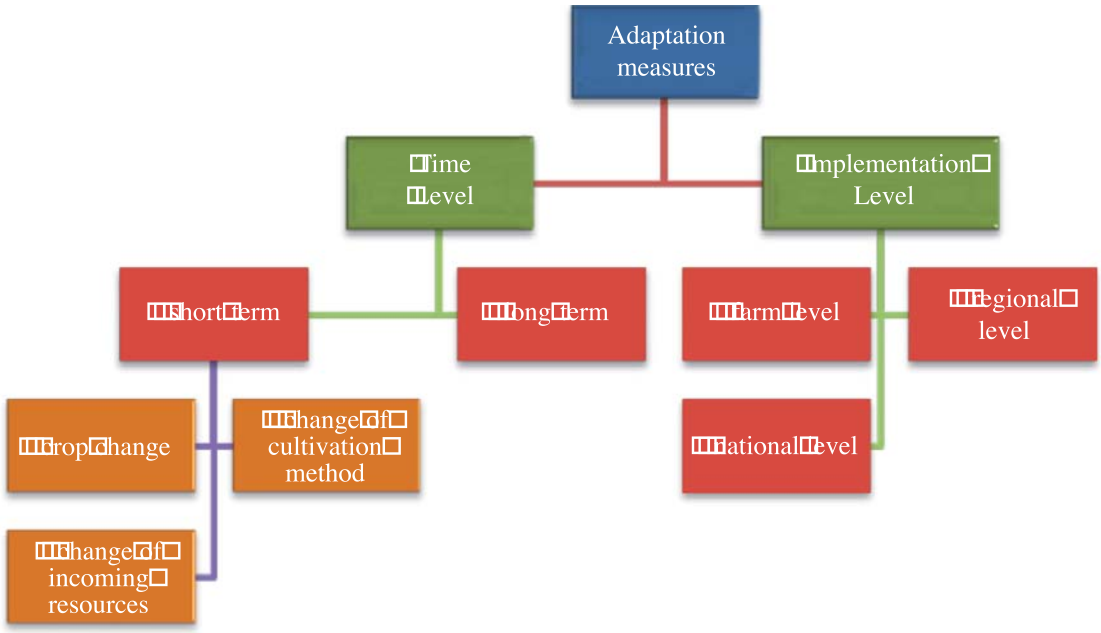

Figure 6.17: Breakdown of measures to adapt crop production to climate change impacts

Irrigation and drainage are the measures regulating the content of water in the root system zone. The concept of water demand can be reflected through two measures. The first one relates to satisfying an increased need for irrigation. The second measure relates to the reduction of irrigation, in which case some savings are achieved, but this makes the yield "shorter", i.e. a certain reduction in yield occurs as well. Besides irrigation, there are other measures of adjustment such as reduced tillage, deep tillage, crop residue covering the surface, soil spreading, or modification of planting density, all aiming to preserve some moisture in the root system zone.

At the same time as the air temperature changes, the soil temperature changes as well, so that it will be possible to plant the crops earlier in the spring, including earlier emergence, accelerated growth and maturation, in order to avoid major droughts during the summer months. A detailed study of changes in the planting season due to climate change and its role in the final yield can be done using various models.

One of the characteristics of increased temperature is a shorter growing period, having an effect on yield reduction. One of the adaptation measures would be to use the varieties and hybrids of different maturity periods in order to avoid the worst parts of the year. The manner of using pesticides and fertilizers will change under the conditions of climate change, although these changes in agriculture have been spontaneously occurring for years. Higher temperatures are expected to accelerate the activities of pests and insects, requiring earlier application of substances against pests and insects. The application of fertilizers will also change because the need for nitrogen will be more pronounced in the future, and also in addition to changes in the volume of fertilizers that are related to economic factors, the time of application of fertilizers will also change, which the producers have to be aware of.

National policy regarding the impact of climate change on agriculture could be developed by being ready to use a series of adaptation measures at the national level, which would be part of the regional development strategy. So the following measures should be taken:

- Climate change should have an active participation in the strategies for future development, which is quite problematic, because these strategies are not adopted for such long periods;
- It is necessary to assess the sensitivity of particular regions to climate change, and to isolate the most sensitive areas and recommend some measures of adaptation to climate change;
- The aim should be to make the agricultural system more flexible, so as to minimize any adverse impacts and disasters on a broad level;
- The response should be focused on individual research and producer training, as well as communication relating to the corresponding adaptation measures. In particular, it is necessary to point out that the government should use the results of scientific-research work more effectively, both domestic and foreign, and to create its policy attitude towards climate change within the framework of sustainable regional development and development of rural areas.

6.3.3.3 Effects of Climate Change on Animal Husbandry and Adaptation Measures

Animal husbandry makes the largest contribution to the agriculture of Montenegro. Cattle breeding allows the use of low productive areas that prevail in the structure of the total agricultural area of Montenegro. Currently, the leading livestock sectors are cattle and sheep breeding.

The number of cattle and pigs in the last decade has remained relatively stable, while there was a reduction in the number of sheep and horses (Table 6.4). In the past five years, since 2000, the poultry has been constantly growing. The official statistics have no data on the number of goats, but on the basis of certain assumptions, it is approximately 50-55000.

Table 6.4: Number of heads in the period 1992-2004 (1000 animals)

Sort	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cattle total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
out of that cows and young cows	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Swines	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sheep	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Poultry	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Horses	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source: Statistical Yearbook of Montenegro

Adaptation of animals to climate change refers to the physiological reactions whereby they adapt to new conditions. There are three strategies that can be adopted to reduce the impact of heat stress on animals: change in living conditions, genetic development of new breeds and improved nutrition. Measures to adapt to climate change largely depend on government policies in the agricultural sector.

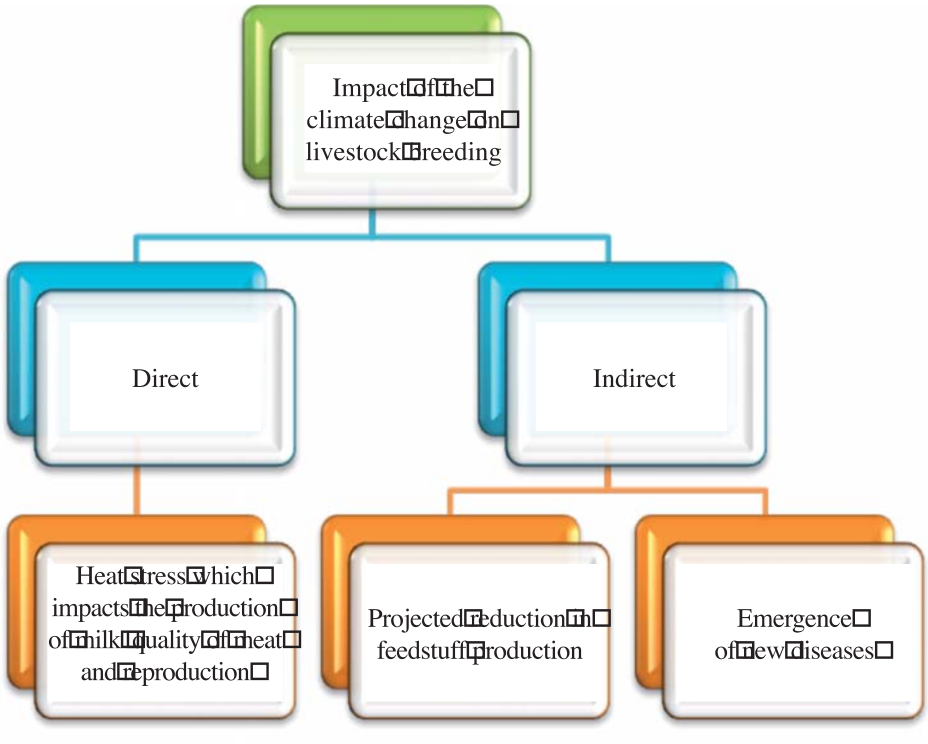

Figure 6.17: Climate Change Impact on Animal Husbandry

In order for the livestock production to be better adapted to climate change, it should be examined which regions are favorable for certain breeding races and types of livestock, and it is necessary to introduce the use of breeds that are resistant to heat stress and tropical disease, continue working to repair the existing structure of breeds, and then create the necessary conditions for cultivation under the new climatic conditions and apply new technologies that include nutrition management. It is also necessary to educate the producers in the application of new technical adjustments, as well as develop new precision norms and regulations in the production of healthy food, which will improve public awareness about the negative impacts of climate change, and it is also necessary to provide financial support to research programs

6.3.4 Forestry

6.3.4.1 Sensitivity of Forest Ecosystems to Climate Change

6.3.4.1.1 Effect of Climate Change on Changes in Forest Ecosystems (Migrations)

The sensitivity of forest ecosystems to climate change impacts is commonly observed in the context of social capabilities and capacity of natural ecosystems to remain resistant or easily adaptable to the changed conditions in nature. Since climate change can definitely cause the stress in nature with consequent socio-economic effects, it is necessary to pay special attention to the phenomena that make the forest ecosystems vulnerable.

The expected climate changes will result in a shift of certain vegetation zones (forest types), both in terms of latitude and the altitude. In some areas an increased drying of trees can be expect as a result of stress and attacks of pests and plant diseases, reducing weight gain, more difficult natural regeneration and an increasing damage caused by forest fires and atmospheric disasters.

It should be especially noted that there is no continuous monitoring of important elements essential for the growth and development of forest vegetation (vitality of forest ecosystems), due to which there is no basis for any analysis or comparison, which diminishes the possibility of planning future changes in forest ecosystems.

On the basis of climate scenarios for the territory of Montenegro, adverse impacts of the expected changes in climate factors on the forest ecosystem would be manifested as follows:

- reduced volumes of moisture in the soil (especially in the vegetation period when the plants are needed the most);
- extended duration of the growing season;
- impeded natural regeneration;
- increased number and intensity of climate extremes, etc.

Expected climate change will influence the disappearance of sensitive forest types (species with narrow ecological valence), shift climate zones, and thereby shift the borders of certain forest types (vegetation zone) in relation to latitude and altitude.

Stronger droughts and increased summer temperature were recorded in the period 1981-1990, especially from 2000-2009, both in the south and in the northern region of Montenegro, which had a negative impact on the existing condition of forest funds.

In the central and southern parts of Montenegro changes in climate parameters were particularly manifested, such as: increased aridity, increased number of days with temperatures above 25°C, reduced mean annual precipitation, changes in mean air temperature, reduced moisture in soil, increased transpiration, etc.

In light of assumptions made, it can be expected that future climate change could affect the expansion of sub-Mediterranean deciduous forests, both towards the interior and towards higher altitudes. Above the forest and scrub hornbeam underbrush the coastal forests and thickets of black hornbeam and downy oak (*Ostryo-Quercetum pubescentis*) will spread, while the thermophilic oak forests (*Quercus pubescens, Quercus cerris, Quercus virgiliana*) with black ash (*Fraxinus ornus*) would spread towards the inland areas.

In the southern and western areas of Montenegro (Orjen, Bijela Gora) fir stands are particularly threatened. It could disappear from much of its current range in this area. Varying degrees of damage affected by over 60% of fir stands on these sites (Vujanović, 1994), which is a worrying phenomenon, since the fir stands here are on the southern border of their area in the country. It is believed that this resulted from changes in climatic conditions, particularly changes in climatic conditions of soil in thinned fir stands.

In the areas of high rocks an extinction or reduction of local beech forests is likely to occur. These forests cover smaller or larger areas on the coastal slopes of the Dinaric Alps (Orjen Lovćen, Rumija) above the forest of oak and hornbeam and make the border between the forest communities of the Mediterranean and Eurosiberian-North American region. This noise is different in character, composition, structure and environmental conditions than those in the continental part. Beech forests on the slopes of Rumija are particularly vulnerable. Biologically less valuable species (shrubs hornbeam, oak, ash, etc.) prevent their natural regeneration.

The climate zone of coniferous forests is above the belt of beech and fir. The forests of fir and spruce, pure or mixed, occur in very cold subalpine climate, while the communities of endemic-relict whitebark pine and Macedonian pine in warmer enclaves, which are influenced by the Mediterranean climate. These trees are common in the northern area of Montenegro. Predictions are that an increase in temperature and decrease in moisture have the strongest adverse impact on fig and beech, and somewhat less on spruce fir. The reason for this is an express mesophilic character of these species. Additionally, these species are particularly vulnerable to frost. In case of an increase in mean annual

temperature for 2 or 3 degrees, the lower limit of climate belts of beech and fir will move from 600 to 750 m or 800 m above sea level.
Spruce fir is particularly sensitive to soil warming, since it has shallow roots.

Pure spruce forests, devastated stands (interrupted circuit), forests on poor habitats exposed to southern and eastern exposures are particularly vulnerable. Examples of this are some localities in the forests of Rožaje, Plav and Bijelo Polje. The areas where an average annual rainfall is less than 800mm will be especially threatened.

6.3.4.1.2 Effect of Climate Change on the Occurrence of Forest Fire

Forest fires represent a latent danger for the loss of forests and forest lands. More frequent occurrence of forest fires, which, especially in the inshore and coastal region of Montenegro, often take on large scale and jeopardize the forests as well as other natural ecosystems, settlements and human life, legitimately cause the concern of the society. Forest fires can be caused by natural factors and it is part of the dynamics of these ecosystems. However, due to the negative impact of humans, especially during long dry periods, there is an increased frequency of occurrence of fire, which inflicted immeasurable damage to forest resources and therefore enhances the negative effects of climate change on our planet.

Accordingly, in Montenegro the most endangered forests are in the coastal and central region of Montenegro, where the bioclimatic conditions and high air temperature in summer period and vegetation characteristics are conducive to the emergence and development of fire. Particularly critical period for the occurrence of fire in our conditions includes the months of July and August, when the intensity of rainfall is very low and the air temperature is extremely high, as well as the months of February and March - during dry and warmer winter conditions. Depending on these parameters, the area of Montenegro can be divided into:

- the area of high fire risk - the southern and middle regions (the municipalities of Ulcinj, Bar, Budva, Tivat, Kotor, Herceg Novi, Cetinje, Danilovgrad, Nikšić and Podgorica);
- the area of increased fire risk - the southwestern and western part – covered by conifers (the municipalities of Pljevlja, Žabljak, Mojkovac, Rožaje, Plav and Plužine);
- The area of moderate fire danger - oak, elm and other broadleaf stands (the northern municipalities: Šavnik, Bijelo Polje, Berane, Kolašin and Andrijevica).

In addition to damages expressed in the loss of timber, ecological, social and economic functions of forests are complete damaged or destroyed. These losses are associated with soil erosion resulting in the creation of deserted landscapes where no vegetation can be renewed.

In the last 15 years in Montenegro, there were 1007 major forest fires, where an area of 15,300 acres was burned, and about 500,000 m^3 of timber damaged or destroyed. Especially critical were the years of 2000 and 2003, when there was an extremely high number of forest fires in the region of Southeastern Europe which destroyed large forest areas (more than 300 fires were registered in Montenegro only in 2003, when nearly 2500 ha of forest areas were burned).

6.3.4.1.3 Effect of Climate Change on the Health of Local Forest Ecosystems

Climate change and air pollutants are the initial predisposing factors that operate over a longer period of time and that lead to physiological weakening of the plants. The forests of reduced vitality are highly subject to the attacks by parasites, weaknesses and secondary insect pests. The infectious potential and aggressiveness of the pathogens is often enormously increased by warmer climate, so that these become the dominant factor in the spread of disease. Secondary pests can also multiply quickly, resulting in their gradation, so that they become primary and attack healthy trees. Adverse factors operate simultaneously, or occur in succession.

Drying of forests has a global character with a trend of further increase of intensity; it is somewhat selective with respect to individual tree species, their structural form, stand age and site quality, which leads to progressive degradation of forest ecosystems, and reduces the production potential of forests.

In Montenegro, general health and drying of forests has been monitored according to the adjusted ECE methodology from 1988 until 2003, with minor interruptions. The most intense investigations were carried out from 1988-1992, after which this data was collected partially and at a smaller number of bioindicative points. In assessing the parameters that determine the viability of samples of trees on bioindicative counts, the greatest importance is attributed to the symptoms of defoliation, decolourization and necrosis. Current data (up to 2003) show that 30% to 35% of forests in Montenegro are in various stages of degradation. It is therefore necessary to understand better the basic characteristics of forest ecosystems and the basic threatening factors, as well as to find solutions to overcome the existing problems. It is a general conclusion that conifer forests are getting much more damaged compared to the broadleaf stands. The particularly vulnerable forests include spruce and beech *(Picetum excelsae subalpinum, Fagetum subalpinum)* in the subalpine belt, beech and fir forests *(Abieti-Fagetum)* belonging to the Dinaric vegetation zone, and sub-Mediterranean forests of oak and hornbeam (*Querco-Carpinetum orientalis*). Of particular concern are high percentages of dry spruce fir forests in the area of Kolašin and of fir forests in the southwestern region of the country, which is particularly affected by drought on shallow soils. The deciduous species are dominated by chestnut, oak, oak, etc.

Projected weather characteristics (temperature and precipitation) will initiate numerous negative impacts on forest ecosystems and positive impacts on the distribution and physiological state of insects (such as defoliators, bark beetles) and phytopathogenic fungi (e.g. powdery mildew, causers of diseases of fungal assimilation organs and polypore mushrooms). An indirect effect of temperature increase is reflected in the fact that the insects are poikilothermic organisms so that as the temperature is increasing the conditions for their development become closer to an optimum. Pests will also extend to the north. Mild winters will provide additionally favorable conditions for their survival through the winter.

6.3.4.2 Mitigation Measures Relating to the Effects of Climate Change on Forests

In order to prevent or minimize adverse effects of climate change that are inevitable due to changes in the value of climatic factors, it is necessary to implement the following measures on the forest ecosystem:

- apply forest management systems that support and protect sustainable forest management that includes rational use, improvement and protection of forests with respect to the principle of multifunctionality and maintenance of ecological balance;
- natural regeneration of forests should be a priority wherever possible due to natural conditions;
- an increase in forest area - the degree of forest cover of Montenegro of 45% is satisfactory. This level can be increased since there are considerable areas of publicly owned bare land suitable for afforestation. The priority in reforestation is given to large complexes of bare soil, as well as land areas in the vicinity of cities (urban forestry);
- improving the quality of managed forests . The aim is to improve the condition of forests through forestry development measures for the purpose of optimal use of habitat potential;

- The following measures are envisaged to improve the condition of forests:
  - care for and protection of existing forests;
  - conversion of coppice forests into high forests;
  - rehabilitation of degraded forests;
  - substituting of failed natural regeneration in high forest;
  - sanitary felling in forests affected;
- monitoring and risk assessment are key to adaptation. In order to optimally manage forest ecosystems monitoring of all segments of the environment must be ensured. Thanks to these activities relevant information would be obtained about the vitality and productivity of our forest ecosystems, which would allow assessment of the risks (threats to the dominant forest stands). Also, the obtained data would be significant for other disciplines such as population growth, forest management, vegetation research, biodiversity;
- an integral part of future forest management plans should include some concrete measures for the protection, preservation and enhancement of biodiversity in forest ecosystems;
- in the felling and transportation of wood products, technology and the means resulting in minimal damage to the forest should be used;
- increase the area of forests that are managed primarily to preserve the protective function- when creating a new basis of forest management, the following parts of the protective forests must be isolated:
  - parts of the forest complexes in areas prone to soil erosion;
  - trees on terrain slopes above 30°;
  - forests in water source areas and next to flooding water courses;
  - relict forest communities of mountain pine, maple, Macedonian pine and whitebark pine, etc;
- improvement of the condition of forests on karst - progressive succession of vegetation is clearly visible and happens naturally. The process needs to be accelerated by measures of care, where the environmental conditions are favorable for the development climate communities.
- The area of the Mediterranean and sub-Mediterranean represents a significant potential for the development and utilization of generally beneficial forest functions expressed in ecological and social functions of forests, so that the future development of forests in this area should be aimed in that direction;
- Integrated protection of forest ecosystems from the adverse effects of all biotic and abiotic factors. including man. Preventive measures to protect forests and methods of biological fighting must have a primary character.

6.3.5 Biodiversity

6.3.5.1 Effect of Climate Change on Biodiversity and Natural Ecosystems

6.3.5.1.1 Effect on Terrestrial Species

It is very difficult to evaluate the impacts of climate change on biodiversity because the changes occur slowly and the effects of these changes are always in interaction with other influences that have already caused certain consequences and reactions.

In line with the expected climate change (increased temperature and reduced humidity), a reduction and loss of species is expected, primarily related to freshwater ecosystems, as well as the species vulnerable to significant fluctuations in temperature and humidity in the environment. Firstly, it is likely that the amphibians that live in surface waters in the karst area can suffer some major changes in living conditions and habitats in the future, due to a reduced flow or complete absence of water. The reduction in fresh water volumes and moisture will cause changes in the entire country, but differences will be the most obvious and drastic in the karst area. Dry periods may be followed by periods with strong and extreme rainfall, which will cause destruction and reduction of populations of land and freshwater species in higher mountainous regions. It is estimated that the populations of amphibians and reptiles may be reduced and fully threatened in the karst areas of Old Montenegro and the karst region of Kuči-Žijovo, as well as in the coastal mountains of Rumija, Lovćen and Orjen[28]. As the temperature in the continental part of Montenegro increases (1.2°C during the first 30 years of the twenty-first century according to the A1B scenario, and up 4.8°C to during the last 30 years of the twenty-first century according to the A2 scenario) would eventually lead to the acceleration of eutrophication of mountain lakes and then their withdrawal or complete disappearance. Within the National biodiversity monitoring programme[29] during herpetological field surveys in the month of August 2001, the condition of recommended indicator species was monitored, primarily tailed amphibians *(Caudata)*, i.e. the species of the genus *Triturus (T. alpestris, T. carnifex and T. vulgaris)* on the so-called representative area model, mostly in karst areas. The study of amphibians in this area has shown a continued declining trend in population sizes, both in native waters and those of anthropogenic origin, which is accompanied by reduction of the number of permanent aquatic habitats that are suitable for reproduction and amphibian life. There was no research of bioflora before the establishment of biodiversity monitoring program, so that some general information about the vulnerability of this group of plants was provides. Specifically, anthropogenic impacts, primarily pollution, have led to the disappearance of aquatic mosses, which are indicators of clean water (such as *Fontinalis Antipyretica, Cratoneuron Commutatum, Bryum Ventricosum, Didymodon Tophaceus*, etc.), which is a sign that the water courses often permanently changed. These changes lead to the destruction of tufted moss flora, which is registered in Montenegro at a small number of sites, i.e. only in the canyon of the Tara River (Bailovića limestone) and the Lim. However, the current research has not established any link between the decline of population and climate change during the period of monitoring. Also, there are no available data about any negative trends of populations of species and climate change.

Data on the phenology of woody species (Hydrometeorological Office[30]) already indirectly indicate the presence of the consequences of climate change on the productivity of some ecosystems in Montenegro. The available data for 2007/2008 show that the listing of some species (black locust, linden, oak, maple, ash, beech, poplar, alder, pine, maritime pine) begins a few days earlier than usual. The listing of given species begins around 12 days earlier than on average.

6.3.5.1.2 Effect on Marine Species

An increasing eutrophication in the basin of the Bay of Boka Kotorska and the presence of algae *Caulerpa Racemosa* in the waters of the Adriatic Sea is a known fact but there is no clear evidence of connectivity between the global warming and the set out data. In accordance with a predicted increase in temperature, an introduction of new thermophilic (invasive) species from southern marine biogeographic zones is expected. Also, one of the main problems may be migration of marine species through the Suez Canal, mainly from the Red Sea and Indo Pacific regions into the Mediterranean. It is the so-called. Lessepsian migration path. It is also expected that a significant number of invasive species will be imported in ballast water. In addition to structural changes in the composition of the phytoplankton community, there will be a new competitive relationship between the stenovalent and eurivalent organisms. As the most sensitive and vulnerable areas for the introduction of new thermophilic invasive species on the Montenegrin coast are the territory of Boka Kotorska Bay, the channel of Port Milena and the mouth of the river Bojana.

28 Buskovic, V. 2008. Vulnerability and impacts of Climate Change on Marine and Coastal Biodiversity in Montenegro

29 Biodiversity monitoring program 2000- 2008, Ministary of Spatial Planning and Environment (http://www.mturizma.vlada.cg.yu/vijesti.php?akcija=rubrika&rubrika=258)

30 http://www.meteo.cg.yu/misc.php?text=62&sektor=1

6.3.5.1.3 Effect on Habitats, Biocenoses and Ecosystems

The available statistical data, biodiversity monitoring program and previous research have still not provided any adequate information about the consequences of climate change on natural habitats, plant and animal communities and ecosystems. The current data on the destruction and fragmentation of habitats and ecosystems are directly related to local anthropogenic activities (construction of road and tourism infrastructure, urbanization). In this context, the impact of climate change is considered as an additional factor that can cause irreversible changes to biodiversity.

Sea level rising of 35cm until 2100 (scenario A2) could lead to the following changes in the coastal zone[31]: a) due to the surface soil erosion, damage will be expressed initially in the lower parts of the sandy beaches, lagoons and coastal terrain, as follows: Tivat Salina, wetland area of the Bay of Buljarica, and the area Velika Plaža-Knete-Ada Bojana; b) due to salinization of soil and groundwater in the area of the foregoing coastline areas, the following will be affected: shallow water-bearing strata, and (potentially) potable groundwater (in Štoj), as well as the areas planned for the development of tourist facilities; c) conversion of brackish and fresh water in a constantly salty water, as follows: at the mouth of the Bojana river, in the area of Knete and Port Milena in Ulcinj, in the marshy areas of the Bay of Buljarica, rivers and canals in the hinterland of Jaz, and then in the Morinj Bay, estuary of the Sutorina river and Tivat Salina. Regarding halophytic vegetation in the sand dunes at Velika Plaža, its lowest part would be flooded and the whole vegetation belt would be endangered, which would eventually lead to its withdrawal and disappearance.

The existing freshwater and brackish biocenoses would be threatened/replaced in time by expanding plant and animal communities from the sea. This would allow an expansion of marine ecosystems into the earlier mentioned new areas, which would be targeted first by an increasing sea level, due to their position and elevation.

Speaking of continental species, according Hopkins' Bioclimatic Law, vegetation of higher mountain areas will gradually be replaced, wholly or in part, by the communities of temperate areas. Temperature will be the main limiting factor in higher continental areas, while at the lower elevations of the continent it will be precipitation and total humidity. Slow migration capabilities, lack of migratory routes and the lack of alternative sites will be the cause of fragmentation or disappearance of some (communities) stands. To some extent, spreading of Mediterranean ecotypes into the zone sub-mountainous floral elements can be expected.

The problem of introduction of invasive species in natural ecosystems, which is already significantly present, will become more pronounced with climate change. The dynamics of penetration of allochthonous species may be increased, while more aggressive types of natural habitats can displace some native species. Although these processes are evident, no forecast can be made with any certainty regarding which mechanisms of penetration of these species will be present. In addition, sensitivity (vulnerability) of some long-lasting woody species is likely to increase in parallel with the dismissal of their living (ecological) optimum, i.e. moving away from the center of their areas.

Based on the analysis and assessment of impacts of climate change on biodiversity in Montenegro, the following impacts of climate change can be expected:

- shifting of vegetation zones (belts) in the horizontal and vertical direction;
- shifting and changes in geographic distribution of some plant and animal species;
- disappearance of certain species;
- changes in qualitative and quantitative composition of biocenoses;
- fragmentation of habitats;
- changes in the functioning of ecosystems

31 Buskovic, V. 2008. *Vulnerability and impacts of Climate Change on Marine and Coastal Biodiversity in Montenegro*

6.3.5.2 Climate Change (Effects) Adaptation and Mitigation Measures

General mitigation and adaptation to climate change should be directed towards the inclusion of impact assessment of climate change on species, communities and ecosystems in general measures to protect biodiversity. The level of knowledge and understanding impacts of global climate change on terrestrial and marine ecosystems and biodiversity of Montenegro is very scarce, also bearing in mind that this issue was not addressed by previous research (in a few cases it was the subject matter), so that it can be said that there is a lack of experts and lack of adequate education in this field. There is a clear shortage and lack[32] of detailed data on biodiversity - the majority of taxonomic groups is still poorly investigated. There is no publicly available database of any taxonomic groups, and there are no "Red Books" of rare and endangered species (Atlas of the flora and fauna, vegetation maps, biodiversity maps, habitat maps, etc.). The existing biodiversity monitoring program does not provide enough information about the condition, threatening factors and threats to biodiversity, for which reason a part of this material should be developed for the purpose of impact assessment and planning (options) of adjustments.

The activities that need to be carried out in order to assess the impact of climate change, as well as options for adaptation and mitigation are the following:

- Establishing an infrastructure for scientific research of impacts of climate change on biodiversity, terrestrial ecosystems and the sea;
- Training of experts on the issues of climate change and implementation of modern technologies;
- Collection of necessary data to assess the impacts of climate change on terrestrial ecosystems, the sea and biodiversity;
- Preparation of an assessment of the effects of climate change on terrestrial ecosystems, sea and biodiversity;
- Appointment of an intersectoral group which will deal with the issues of water resources management and protection of biodiversity;
- Preparation of a National Action Plan on Climate Change, whereby, *inter alia*, measures for adaptation and mitigation of the effects of climate change on biological diversity should be recognized and established;
- Strengthening of awareness about the importance and impact of climate change on biodiversity;
- Elaboration biocorridors and migratory routes of various species under the conditions of climate change;
- Establish a gene bank of endemic, threatened and endangered species;
- Assessment of options for the protection of biodiversity (species) under *ex situ* conditions;
- An increase of surface area under protection in accordance with the approved official documents (The Spatial Plan of Montenegro until 2020; The National Strategy for Sustainable Development).

6.3.6 Public Health

6.3.6.1 *Effect of Climate Change on Human Health*

Climate change and weather conditions are in complex relation to human health. Climate change has both direct and indirect and predominantly negative effects on human health, causing changes and events in an organism which can cause injury, illness and disease with a fatal outcome.

32 National Biodiversity Strategy and Action Plan for the period 2009-2014. Proposal.

In addition to direct impacts on health and disease, climate change lead to a growth, rapid development and reproduction of disease carrier vectors (mosquitoes, ticks) that transmit malaria, leishmaniasis, sandflies fever, dengue, encephalitis and viral encephalitis.

Climate change directly affects the availability of water, crop yield, production and quality of food, a greater frequency of disease due to impaired water supply and unsafe food leading to diarrhea, diarrhea, dysentery, salmonellas, hepatitis and others.

Due to the effects of air and soil pollution, a number of diseases and premature death are caused. In the first half of the twentieth century numerous human activities that adversely affected climate change were observed and quantitatively determined. There is a significant effect of demographic explosion that causes overpopulation and increasing urbanization, so that it is believed that the world has reached a critical moment in terms of comfortable human existence.

Normal body temperature of human beings is maintained within narrow limits despite the temperature extremes in human environment and the time spent in physical activity. Extreme weather changes lead to a number of pathological conditions in human population regardless of whether those are caused by high or low temperatures.

Certain groups of people such as children, the elderly, pregnant women, chronic patients and vulnerable groups of people, whose immune system is not sufficiently developed or is impaired, are particularly vulnerable to the effects of climate change.

There is no reliable health statistics in Montenegro on the effects of climate change on population health, illness and dying there, because no necessary information for such a complex evaluation is contained in the mandatory health records.

During muggy and hot summer days, the inhabitants of Montenegro may experience heat cramps, exhaustion caused by heat, less frequent thermal injuries and the rarest but most dangerous to life heatstroke that occurs when the thermoregulatory mechanisms are unable to emit sufficient amounts of heat. Heat strokes are an urgent medical condition and require urgent therapeutic measures with varying success. Those are suffered in particular by the elderly, people with long term chronic diseases, those suffering from mental illness and those who take antipsychotic medication, as well as the people who live in poorly ventilated dwellings. Since it takes a long tome to get acclimatized to high climatic extremes, from 7-14 days, the majority of persons at risk fails to acclimatize and can get more or less severely sick.

In winter, hypothermia can occur due to accidental or long exposure to cold resulting in body frosting accompanied by high lethality, especially in the case of elderly people, alcoholics, vulnerable persons, vagrants and homeless people.

According to the data of the protection services for preschool children, from 1999 to 2007, children most often visited doctors because of respiratory illnesses and infectious diseases (Figure 6.18.), while in the service of general medicine, most adults suffered from cardiovascular diseases and respiratory diseases (Figure 6.19)

It was observed that the risk of myocardial infarction and apoplexy of the central nervous system was more frequent during the low air pressure, and in hot humid summer months with high temperatures and their large fluctuations. Asthma is a common disease during winter and spring, and in summer it is allergic rhinitis caused by pollen, as well as various illnesses due to the abundance of allergens of plant origin. Neurovegetative diseases also become more frequent during hot longer-lasting summer days. In colder months, the most common causes of death are diseases of cardiovascular system, respiratory diseases, as well as more frequent traffic accidents and suicides.

The percentage of mortality in relation to the five most common groups of diseases in Montenegro from 1999 to 2007 is shown in Figure 6.20 below.

The morbidity from intestinal infectious diseases is declining due to improved supply of safe drinking water, as well as improved disposition of waste materials. There is an increase in alimentary toxicoinfections for failure in the process of manufacturing and storage of food, as well as infections with different species of Salmonella (Figure 6.21).

After the declared eradication of malaria in Yugoslavia in 1973, single cases of malaria have been registered, imported by sailors who had been infected in the tropics, while those who suffer from leishmaniasis are more rare, two persons per year, (Figure 6.22). There were no other parasitic diseases specific to tropical areas in Montenegro.

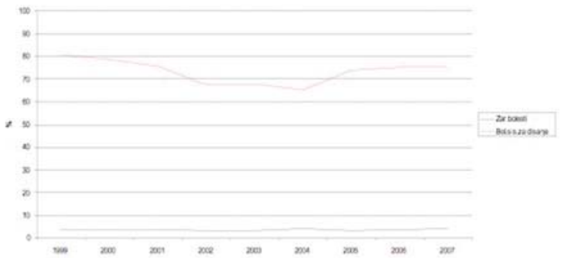

Figure 6.18: Child mortality rate, under the age of seven, at pediatric services in Montenegro from 1999 to 2007

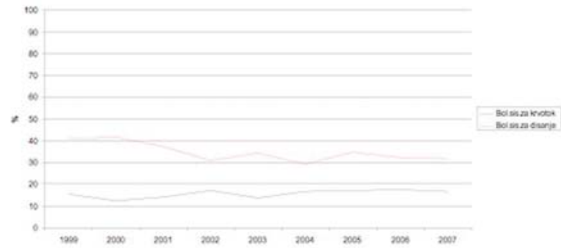

Figure 6.19: Adult mortality rate at general medicine services in Montenegro from 1999 to 2007

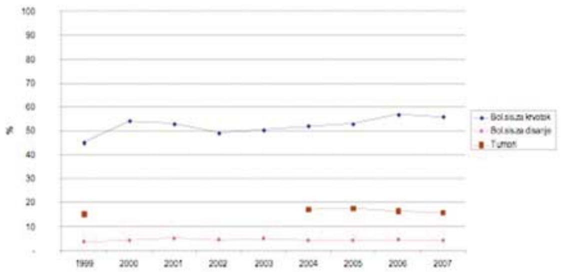

Figure 6.20: Mortality rate (percentage) in relation to the five most frequent groups of diseases in Montenegro from 1999 to 2007

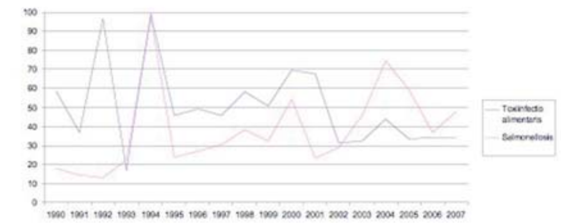

Figure 6.21: Mortality rate per 100 000 inhabitants caused by alimentary toxic infections and salmonella from 1990 to 2007

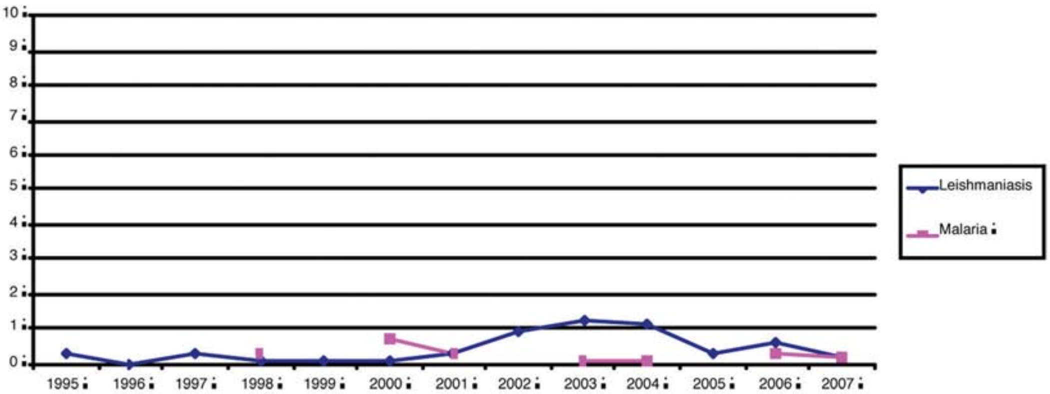

Figure 6.22: Mortality rate per 100 000 inhabitants caused by malaria and leishmaniasis from 1995 to 2007

According to the scenario of climatologist for the future, Montenegro can expect a further increase in temperature, especially in the summer months of JJA, which will negatively affect the health condition of high-risk groups, while on the other side a temperature increase during the winter will lead to lower morbidity and mortality, particularly for chronic patients. An increase in average monthly temperature, especially for the JJA season from 2000-2035, will cause a higher frequency of diseases that are transmitted by food and water, such as salmonellosis, toxicoinfections and diarrhea. The announced reduction in rainfall can lead to a reduction in available water for drinking and food sources, in particular for the scenario from 2070 to 2100.

Increasing temperatures in MAM will prolongue spring vegetation, and thus also the allergy-caused respiratory diseases: seasonal allergic rhinitis and allergic asthma caused by pollen from trees, grasses and weeds, especially in case of children. Due to the predicted future warming, a further trend of growth of certain infectious diseases outside of their natural foci can be expected, as is the case with malaria. Warmer fall and winter months of DJF may facilitate the survival of rodents that transmit hantavirus and leptospirosis, as well as carrier vectors (tick-borne encephalitis, Lyme disease, Toscana virus).

6.3.6.2 Adaptation Measures

What needs to be done as a priority, through education and continuous information, is to encourage a change in behavior, build awareness of population about the impact of climate on health, and how to reduce the impact of future climate change.
Necessary primary measures of adaptation for the purpose of prevention, preparedness and action to prevent, mitigate and adapt to climate change include:

- permanent surveillance and control of health safety of drinking water;
- maintaining and improving water and sewer infrastructure, with special emphasis on the coastal part;
- air monitoring;
- quality control and improvement of the food chain; production and implementation of national action plans for food;
- strengthening of surveillance and control of communicable diseases;
- strengthening of the already existing public health measures of disease control and health protection, especially for high-risk groups;
- development and implementation of legal regulations concerning the environment and health;
- strengthening of regional and international cooperation to manage the risks carried by climate change;
- reform and strengthening of the public health sector for the coming climate change, its early organization and professional training in extreme situations, and especially well organized emergency medical services;
- preparation of national action plans, strategies for the prevention of effects of climate change on human health, their mitigation, adaptation to new conditions, especially for extreme heat;
- establishing a national system for early warning of impending disasters;
  inter-sectoral collaboration, research, pilot projects and studies on the influence of meteorological parameters on health, which will help finding the correlation between climate change and health.

CONSTRAINTS, GAPS AND NEEDS

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7

CONSTRAINTS, GAPS AND NEEDS

In the process of preparation of the Initial National Communication on Climate Change, a certain number of constraints, gaps and needs was identified, relating both to the preparation of technical components of this and future communications, and to implementation of recommended measures to reduce GHG emissions and adapt to climate change.

Generally speaking, the main constraints in the preparation of the Initial Communication concerned the lack of data and insufficient capacity for the calculation and estimation of emissions/of greenhouse gases, and the lack of information and knowledge about vulnerability and adaptation to climate change. For the purpose of a more detailed discussion by each Communication component, constraints and gaps were grouped into the following two categories:

- Constraints and gaps of technical and methodical nature; and
- Institutional constraints and lack of capacity, including financial resources.

The identified needs relate to further efforts towards the institutionalization of the work on national communications and development of capacity for monitoring and reporting on all the Communication components, raising the awareness of climate change on all levels and strengthening mechanisms for the formulation of integrated responses to climate change.

7.1 Technical and Methodological Constraints and Gaps

7.1.1 Inventory of Greenhouse Gases

Among the technical and methodological constraints in the work on the GHG inventories for 1990 and 2003[33], those relating to the lack of data for specific inventory categories were the most pronounced ones. The sector "use of solvents," could not be processed because of insufficient data. In energy sector, data on emissions from international aviation and maritime bunkers, as well as on emissions from aircraft (Tier 2 method) were not available. For the sector "industrial processes", data on asphalt production and data on the consumption of halogenated hydrocarbons and sulphur hexafluoridewere missing. Incompleteness of the data was also pronounced for the "land use change and forestry" and "waste" sectors.

Methodology for determining indirect emissions of greenhouse gases through activities (sectoral and sub-sectoral) requires detailed information on the type of fuel, applied technologies and pollution control measures. Since these data are unavailable, Tier 1 methods were taken for the calculation, which means that the obtained data should be interpreted with a high level of uncertainty.

7.1.2 Assessment of GHG Emissions Reduction

Regarding the component of the Initial Communication dealing with the estimates on GHG emissions reduction, the following constraints and gaps were determined:

- Sectoral development plans and strategies generally do not consider the issue of climate change and therefore do not define measures to reduce emissions; the number of studies and research on these issues is low, and for certain sectors, no such research or analysis exists.
- Lack of relevant data for GHG emissions projections. This is especially pronounced in the sectors of agriculture and forestry, which in effect meant that it was not possible to quantify effects of GHG emissions reduction measures in these sectors. However, emissions from these two sectors are relatively low and changes in the projections assumptions would not have a significant impact on the final result.

33 More detailed discussion of constraints for preparation of GHG inventory is included in the respective chapter, while the key findings of the team who worked on the GHG inventory are presented here.

- Lack of data needed for the projections of GHG emissions was also very pronounced for waste and wastewater.
- It was not possible to calculate the costs per ton of CO_2 reduction due to lack of financial indicators.

7.1.3 Vulnerability and Adaptation Measures

The following gaps and constraints were identified in the assessment of vulnerability and definition of adaptation measures:

Lack of technical and scientific research on vulnerability to climate change and adaptation is typical for all sectors that were considered in the Initial Communication.

- There is no expert and technical documentation (written records, photos, data, etc.) on vulnerability to serve as the basis for defining measures of adaptation; there is no database on vulnerability by specific sectors.
- There is no national strategy to mitigate the effects of climate change on water resources and coastal area.
- There is no numerical-mathematical model for predicting the impacts of climate parameters and their changes on the coastal area (for vulnerability assessment "expert judgment" was used to a significant extent).
- Estimates of the expected changes in mean annual temperature of the Adriatic Sea have a low level of confidence (the global models have relatively low use when it comes to downscaling, and regional models such as the EBU-POM cannot properly factor in the effects of melting glaciers and polar ice).
- National policy on the impacts of climate change on agriculture is not defined.
- There is no continuous monitoring of important components that affect the growth and development of forest vegetation (the vitality of forest ecosystems), which makes it difficult to assess vulnerability and plan adaptation measures.
- The available statistical data, biodiversity monitoring program and previous research do not provide adequate information on the impacts of climate change on natural habitats, plant and animal communities and ecosystems; the "expert judgment" method was used for vulnerability assessment.
- Another constraint encountered in the field of biodiversity is the lack and unavailability of detailed data on biodiversity: there is no publicly available database on some taxonomic groups, there is no "Red Book" of rare and endangered species, etc.
- There is no reliable health statistics about the impacts of climate change on population health, morbidity and mortality, because the mandatory health records do not contain the necessary characteristics for such a complex evaluation.

7.2 Institutional Constraints and Insufficient Capacities (Human, Technical, Financial)

When it comes to institutional constraints and the missing capacities for **GHG inventory**[34], it is necessary to emphasize that there has been no institutionalized approach to the collection of data on emissions and periodic reporting so far. Thus, the capacities are on a rather low level, while the roles of and cooperation among the institutions are not fully defined.

The following constraints and gaps can be singled out:

- Technical and human resources that are available at Monstat are not sufficient for the collection and processing of data in the manner and to the level of detail required for GHG inventories; this applies especially to the Monstat's section dealing with environmental statistics.

34 For more detailed elaboration, see the *Inventary of Greenhouse Gases* chapter.

- Environmental Protection Agency has a key role in preparing future GHG inventories; on the other side, this is a young institution whose capacity development is at the very beginning.
- Lack of capacity is also evident in other institutions that play an important role in the preparation of GHG inventory - whether at the level of collecting and providing data, or at the level of coordination and policy-making (the ministries and administrative bodies competent for the development of information systems in transport, industry, agriculture, waste, spatial planning and forestry; professional institutions).
- Lack of financial resources also appears as a limiting factor for establishing an efficient system for GHG emissions monitoring and periodic reporting.

When it comes to **estimating GHG emissions reduction**, the main gap is that the institutions competent for the creation of sectoral policies and their implementation do not have sufficient experience and adequate capacity to integrate climate change issues and develop measures to reduce GHG emissions. This refers to the Ministry of Economy (competent for energy and industry), Ministry of Agriculture, Forestry and Water Management (responsibilities for development of agriculture and forest management), Ministry of Transport, Maritime Affairs and Telecommunications, and also to the Ministry of Spatial Planning and Environment which, in addition to having the key role in the area of climate change, is responsible for waste and spatial planning.

Furthermore, it was determined that there were significant constraints regarding the availability of knowledge, technology and financial resources for carrying out measures to reduce GHG emissions. There is obviously a large number of initiatives for the implementation of measures in the field of energy efficiency. Establishment of a fund for energy efficiency has been planned for a long time and should contribute to overcoming financial constraints in this area. The biggest industrial facilities have experienced financial difficulties over the last few years, which to a large extent casts doubts on the prospects of reducing emissions; consistent application of the Law on Integrated Pollution Prevention and Control, and possibly better control of privatization arrangements from the technological aspect, are of great importance here.

Institutional and capacity constraints related to **vulnerability assessment and adaptation measures** are the following:

- Exchange of information among different institutions is not satisfactory; there are no expert/advisory bodies for vulnerability and adaptation.
- Cooperation between the research sector and policy makers is not satisfactory - administration bodies should effectively use the information on the impacts of climate change on agriculture.
- Level of knowledge and understanding on the impacts of global climate change on terrestrial and marine ecosystems and biodiversity of Montenegro is very limited - experts, information and knowledge in this field are lacking.
- Capacities to assess impacts of climate change on human health are insufficient.
- There is a pronounced lack of funds for research programs on vulnerability and adaptation, as well as for support to the work of expert and/or advisory bodies in this field.

7.3 Needs

7.3.1 Inventory of Greenhouse Gases

Concerning the preparation of GHG inventory (considering also the fact that the establishment of a system for inventory of greenhouse gases is an important obligation in the context of EU accession), the following needs were identified[35]:

- In accordance with defined roles and responsibilities, efforts need to be made to develop capacities, especially of Monstat and the Environmental Protection Agency.
- Collect, through cooperation with relevant projects, information on the industrial plants capacities, combustion technologies and pollution control measures applied to allow calculation of indirect emissions of gases using more exact emission factors.
- Develop and implement methods to improve the national inventory accuracy, especially for the "energy" and "industrial processes" sectors through:
    - establishing national CO_2 emission factors for TPP Pljevlja and major power plants in the industrial sector that use fuel oil for propulsion;
    - determination of national CO_2 emission factor for metal production (tone of CO_2/ tonne of reduction agent);
- Begin with the collection of input data for determining emissions of synthetic gases (HFCs, PFCs and SF_6);
- Begin with the collection of input data for determining emissions from the "use of solvents" sector;
- For the sectors "agriculture", "land use change and forestry" and "waste", work should be undertaken to improve availability of data that currently do not exist.

7.3.2 Assessment of GHG Emissions Reduction

In order to improve the measures to reduce GHG emissions and estimation of their effects for the next Communication,, it is necessary to work on collecting the data that are currently not available, strengthening capacity for implementation of methods and models to estimate the effects of measures, formulating and prioritizing programs and measures, and cost estimates for the measures to reduce GHG emissions.

For the very implementation of measures to reduce GHG emissions, it is essential to:

- complete the legal basis for the implementation of measures to reduce GHG emissions in all sectors;
- develop adequate statistical system (energy database) for all the energy consumption sectors to ensure availability of basic energy indicators;
- increase the efficiency of conversion of lignite into electricity at TPP Pljevlja;
- provide financial support for improving energy efficiency in general;
- create incentives for development of those types of transport that are more favorable in terms of emissions of greenhouse gases;
- assess resource availability for biofuel production in Montenegro;
- improve energy efficiency in transport;
- introduce new technologies (BAT - Best Available Technology approach) in the industrial sector (particularly the KAP and Ironworks) and/ or the apply measures to reduce GHG emissions, and improved fuel quality control (use fuel oil containing up to 1% of sulfur);
- increase recycling and reduce the volumes of disposed biodegradable waste, with landfill gas collection;
- implement relevant regulations and intensify educational and promotional activities aimed at improving practices in waste management (both for waste generators, including citizens, and for legal entities performing the tasks of waste management);
- define more precisely measures in agriculture; possible directions are to increase use of biogas

35 More information on the needs for the preparation of annual GHG inventories is provided in the respective chapter.

for energy purposes, reduce methane emissions, improve animal waste management, and promotion of organic agriculture;

- define more precisely measures in forestry; possible directions are greater use of biomass as a fuel, improvement of the conditions and composition of forests and increasing forest area in order to strengthen their resistance to climate change and CO_2 absorption capacity;
- involve private sector and introduce models of public-private partnerships;
- have CDM promoted by the Designated National Authority and prepare CDM projects;
- raise public awareness about global climate change problem (information campaigns) and promote the new low-carbon and low GHG emissions technologies;
- formulate incentive measures (such as for example tax exemptions - reduction of the VAT rate) to import cars and technologies with low GHG emissions (which are usually expensive and therefore less available or unavailable);
- implement programs of capacity development to manage new technologies (through training of national experts and firms in sectors with significant GHG emissions) and mobilize international funds to assist with technology transfer;
- conduct an analysis of necessary preconditions for the introduction of cleaner production;
- stimulate cooperation between science, research and education on the one hand, with private sector on the other;

ensure the enforcement of producer's liability on the basis of the legal framework (Law on Integrated Prevention and Pollution Control, Environment Law).

7.3.3 Vulnerability and Adaptation Measures

In order to improve assessment of vulnerability and adaptation, as well as proposed measures for the next Communication, it would be useful to:

- establish an expert/ advisory body for climate change and/or a separate body for vulnerability and adaptation;
- establish particularly vulnerable areas by sectors, where more significant effects of climate change can be expected, and pay special attention to such areas in the formulation and implementation of sectoral policies;
- strengthen the support to scientific research and improve cooperation/exchange of information among all stakeholders, and
- establish databases by sectors and ensure their regular updating.

For the implementation of adaptation measures, the following needs were identified:

- Prepare the cadastre of water resources, protect the most important water resources, and improve water information system (including modeling, simulation, early warning).
- Provide for adjustment of spatial planning documentation to the effects of climate change in coastal area; preparation of a coastal zone management strategy, taking into account the impacts of climate change.
- Determine the sensitivity of particular agricultural regions to climate change, identify the most vulnerable ones; strengthen research and training of agricultural producers; disseminate information about the appropriate adaptation measures.
- Adjusted fertilizer application (control of mineral, promoting organic), reduced tillage, raising farmers' awareness, reforestation, adapted techniques of irrigation, changing cultures and ways of cultivation; analysing suitability of regions for specific breeds and species of livestock, breeding livestock species that are resistant to heat stress and disease.
- Application of sustainable forest management, natural regeneration of forest resources,

enhancement of forest stocks in general and of forests in the karst areas, increase in the area under protective forests; monitoring and risk assessment, are of crucial importance for adaptation.

- Collection of necessary data for the assessment of impacts of climate change on biodiversity, training of experts, awareness raising.
- Education, information dissemination to encourage changes in behavior and build awareness on the impacts of climate change on health and thus reduce the effects in the future; strengthening of information systems and systems for managing health risks from climate change, elaboration of preventive measures.

ABBREVIATIONS

8

Annex 1 members of UNFCCC – Industrialized countries and countries with economies in transition that have an obligation to reduce GHG emissions in accordance with Article 3 of the Kyoto Protocol
AWMS –Animal Waste Management System)
EPA – Environmental Protection Agency
BAT – Best Available Technology)
GDP – Gross Domestic Product
C_2F_6 – Carbon hexafluoride
CCS – Carbon Capture and Storage
CDM – Clean Development Mechanism
CER – Certified Emission Reduction
CF_4 – Tetrafluomethane
CH_4 – Methane
CHP – Combined Heat & Power
CNG – Compressed Natural Gas
CO – Carbon monoxide
CO_2 – Carbon dioxide
CO_2eq – equivalent carbon dioxide
COP – Conference of the Parties to UNFCCC
DMCSEE –Drought Management Centre for Southeastern Europe
DNA – Designated National Authority
DWT –deadweight tonnage
EBU-POM – Regional Climate Model
EC – European Commission
ECMWF –European Centre for Medium-Range Weather Forecasts
EE – Energy Efficiency
EAF – Electric arc furnace
ETo- evapotranspirations
ETS –Emissions Trading Scheme
EU – European Union
EU ETS – EU Emission Trading Scheme
EUMETNET – a network grouping 26 European National Meteorological Services
EUMETSTAT – European organization for meteorological satellites
EZ – European Community
FODEMO –Forestry Development in Montenegro Project
GCOS – Global Climate Observing System)
GEF – Globalni Fond za životnu sredinu (Global Environmental Facility
Gg – Gigagram
GHG – Greenhouse Gas
GTZ – Society for Technical Cooperation (Gesellschaft für technische Zusammenarbeit)
GWh – Gigawatt hours
GWP –Global Warming Potential
HPP – Hydro-power plant
HFC – Hydrofluorocarbons
HOM – Hydrometeorological Office of Montenegro
IAE – International Energy Agency
IPCC –Intergovernmental Panel on Climate Change
KAP – Podgorica Aluminium Plant
kt – Kiloton

KWh – Kilowatt hour
LEAP – Specialized software for greengas emissions planning (Long-range Energy Alternatives Planning)
LED – Light-emitting diode
LRTAP –Convention on Long-Range Transboundary Air Pollution
LUCF – Land Use Change and Forestry
MCS – Mercalli scale
CZM – Coastal Zone Management
MONSTAT – Statistical Office of Montenegro
MoU – Memorandum of Understanding
MSPE – Ministry for Spatial Planning and Environment
MW – Megawatt
N_2O – Nitrous oxide
NCSA – National Capacity Self-Assessment
Non-Annex 1 Parties to UNFCCC – developing countries not obliged to reduce their national emissions of greenhouse gases
NMVOC –Non-Methane Volatile Organic Compounds
NO_x – Nitrogen oxides
NSDS- National Sustainable Development Strategy
NGO – Non-governmental organizations
RES – Renewable energy sources
PAH – Polycyclic aromatic hydrocarbons
PCB – Polychlorinated biphenyls
PDD – Project Design Document
VAT – value added tax
PFCs – Perfluorocarbons
PJ – Peta joule
PP – Physical Plan
PP ME until 2020 – Physical (Spatial) Plan of Montenegro until 2020
Ppm –parts per million
QA/QC –Quality assurance/Quality control
RME – Republic of Montenegro
Revised IPCC Guidelines of 1996 –the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
SF_6 – Sulphur hexafluoride
SFRY – Socialist Federative Republic of Yugoslavia
SIDA – Swedish International Development Agency
SO_2 – Sulfur dioxide
SRES – The Special Report on Emissions Scenarios
TAR – IPCC Third Assessment Report
TPP – Thermal power plant
LPG– Liquefied Petroleum Gas
toe – tons of oil equivalent
KWh – kilowatt hour
UN ECE –United Nation Economic Commission for Europe
UN FAO –Food and Agriculture Organization of the United Nations
UNDP –United Nations Development Porgramme
UNFCCC –United Nations Framework Convention on Climate Change

VOC – Volatile Organic Compounds
HT – High Temperature
WTTC –World Travel and Tourism Council

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ANNEXES

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ANNEX I

Tabular Overview of the Inventory of Greenhouse Gases for 1990 and 2003

Table I : A brief summary overview of direct greenhouse gases, 1990

A BRIEF SUMMARY OVERVIEW OF DIRECT GREENHOUSE GASES (Gg)							
GHG SOURCES AND SINKS – CATEGORIES		CO_2	CO_2	CH_4	N_2O	CF_4	C_2F_6
		Emissions	Absorption				
		Gg					
Total National Emissions and Absorption		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Energy	Reference Approach	[illegible]					
	Sectoral Approach	[illegible]		[illegible]	[illegible]		
A Fuel Combustion		[illegible]		[illegible]	[illegible]		
B Fugitive Emissions from Fuels		[illegible]		[illegible]			
Industrial Processes		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
Application of dissolvers		[illegible]			[illegible]		
Agriculture				[illegible]	[illegible]		
Land Use Change and Forestry		[illegible]	[illegible]	[illegible]	[illegible]		
Waste				[illegible]	[illegible]		
Other (Specify)		[illegible]	[illegible]	[illegible]	[illegible]		
Memory Items							
International Bunkers				[illegible]	[illegible]		
Aviation		[illegible]		[illegible]	[illegible]		
Navigation		[illegible]		[illegible]	[illegible]		
CO_2 Biomass Emission		[illegible]					

Table II: A brief summary overview of indirect greenhouse gases, 1990

A BRIEF SUMMARY OVERVIEW OF INDIRECT GREENHOUSE GASES (Gg) [illegible]					
GHG SOURCES AND SINKS – CATEGORIES		NOx	CO	NMVOC	SO
		Emissions			
		Gg			
Total National Emissions and Absorption		[illegible]	[illegible]	[illegible]	[illegible]
Energy	Reference Approach				
	Sectoral Approach	[illegible]	[illegible]	[illegible]	[illegible]
A Fuel Combustion		[illegible]	[illegible]	[illegible]	
B Fugitive Emissions from Fuels		[illegible]	[illegible]	[illegible]	[illegible]
Industrial Processes		[illegible]	[illegible]	[illegible]	[illegible]
Application of dissolvers				[illegible]	
Agriculture		[illegible]	[illegible]		
Land Use Change and Forestry					
Waste		[illegible]			
Other (Specify)					
Memory Item					
International Bunkers					
Aviation					
Navigation					
CO Biomass Emission					

Table III: A brief summary overview of direct greenhouse gases, 2003

A BRIEF SUMMARY OVERVIEW OF DIRECT GREENHOUSE GASES [illegible] Gg [illegible]							
GHG SOURCES AND SINKS [illegible] CATEGORIES		CO_2	CO_2	CH_4	N_2O	CF_4	C_2F_6
		Emissions	Absorption				
		Gg					
Total National Emissions and Absorption		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1 Energy	Reference Approach	[illegible]					
	Sectoral Approach	[illegible]		[illegible]	[illegible]		
A Fuel Combustion		[illegible]		[illegible]	[illegible]		
B Fugitive Emissions from Fuels		[illegible]		[illegible]			
2 Industrial Processes		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
3 Application of dissolvers		[illegible]			[illegible]		
4 Agriculture		[illegible]		[illegible]	[illegible]		
5 Land Use Change and Forestry		[illegible]	[illegible]	[illegible]	[illegible]		
6 Waste		[illegible]		[illegible]			
7 Other (Specify)		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Memory Items							
International Bunkers				[illegible]	[illegible]		
Aviation			[illegible]	[illegible]			
Navigation			[illegible]	[illegible]			
CO_2 Biomass Emission		[illegible]					

Table IV: A brief summary overview of indirect greenhouse gases, 2003

A BRIEF SUMMARY OVERVIEW OF INDIRECT GREENHOUSE GASES (Gg [illegible]					
GHG SOURCES AND SINKS [illegible] CATEGORIES		NOx	CO	NMVOC	SO[illegible]
		Emissions			
[illegible]	[illegible]	Gg			
Total National Emissions and Absorption		[illegible]	[illegible]	[illegible]	[illegible]
Energy	Reference Approach				
[illegible]	Sectoral Approach	[illegible]	[illegible]	[illegible]	[illegible]
A Fuel Combustion		[illegible]	[illegible]	[illegible]	[illegible]
B Fugitive Emissions from Fuels		[illegible]	[illegible]	[illegible]	[illegible]
Industrial Processes		[illegible]	[illegible]	[illegible]	[illegible]
Application of dissolvers					
Agriculture		[illegible]	[illegible]		
Land Use Change and Forestry					
Waste					
Other (Specify[illegible]					
Memory Item[illegible]					
International Bunkers					
Aviation					
Navigation					

ANNEX II

Direct and Indirect Greenhouse Gas Emissions for 2006, calculated according to the CORINAIR Methodology

LRTAP inventory was implemented by the consulting firm Techno Consulting within the cooperation between the Ministry for Spatial Planning and Environmentof Montenegro and the Ministry of Environment, Land and Sea of the Republic of Italy.

The inventory of emissions into the air for Montenegro was developed in electronic form, using APEX.COM software, developed by Techno Consulting. APEX.COM is designed to manage database subcategories and emission factors, produce reports on the incoming data and reviewed emissions and link all of this with a geographic information system.

Organization of data from the LRTAP inventory by economic sectors, for the purpose of reporting according to UNFCCC convention is shown in Table V below.

Table V.: GHG by economic sectors – year **2006**

Montenegro [illegible]	Emissions [illegible] Gg [illegible]						
Economic Sectors	CO_2	CH_4	N_2O	NOx	CO	VOC	SOx
[illegible] Energy	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Industry processes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Application of dissolvers	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Agriculture	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Other Sources and Sinks [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Waste	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Other							
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Total calculated GHG emissions in Montenegro in 2006 amounted to 4,446.09 Gg of carbon dioxide, 51.34 Gg of methane and 0.40 Gg of nitrous oxide, while 836.03 Gg of carbon dioxide was absorbed by sinks. Total CO_2 eq emissions amounted to 4,850.42 Gg.

In 2006, energy sector emitted 94% of carbon dioxide; 33% of methane emissions come from agriculture and 59% from the waste sector. The emissions of nitrous oxide were generated by the energy sector and agriculture.

Synthetic gases were not calculated for the requirements of LRTAP inventory because the reporting of emissions of these gases is not required by this Convention.

The results of the 2006 inventory are not directly comparable with the results from the inventories for 1990 and 2003 due to the use of different methodologies. In the following period of time, it is planned to undertake the comparison of data from all inventories, i.e. a complete consistency of the IPCC and Corinair methodology.

EXECUTIVE SUMMARY II

The Initial National Communication on Climate Change of Montenegro to the United Nations Framework Convention on Climate Change (UNFCCC) is a document of special importance, both for the fulfillment of the assumed obligations following the ratification of the Convention and the Kyoto Protocol, and because of the contained information which will serve as the basis for future activities relating to climate change in Montenegro. The Initial National Communication consists of the following five sections:

- National circumstances;
- Inventory of greenhouse gases of Montenegro;
- Greenhouse gas emission reduction policies, measures and assessments;
- Vulnerability and adaptation to climate change;
- Constraints, gaps and requirements.

This document is the result of a two-year process of consultations and research coordinated by the Ministry for Spatial Planning and Environmentand the UNDP Mission to Montenegro, and participated by a large number of institutions of the system, as well as eminent both international and national technical experts. Some of the results and conclusions from this document are reviewed below, whereas the results of each segment are summarized in the form of an abstract at the beginning of this communication, in the first chapter.

The results for *total equivalent greenhouse gas emissions* (CO_2eq), i.e. the emissions resulting from the use of global warming potential of individual gases (GWP), by economic sectors, not including LUCF, for the years of 1990 and 2003 are shown in Table 10.1 below.

Table 10.1: GHG Emissions and Percentage Shares by Economic Sectors (not including LUCF)

Sector	Baseline Year [illegible]		[illegible]	
	Emissions in CO_2eq [illegible] Gg	Share in Total Emissions [illegible]	Emissions in CO_2eq [illegible] Gg	Share in Total Emissions [illegible]
Energy	[illegible]	[illegible]	[illegible]	[illegible]
Industrial Processes	[illegible]	[illegible]	[illegible]	[illegible]
Agriculture	[illegible]	[illegible]	[illegible]	[illegible]
Waste	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]

The foregoing table shows that the energy sector has the highest share in total emissions, so that an overview of GHG CO_2eq emissions is shown by energy sub-sectors in Table 10.2 below.

Table 10.2 GHG Emissions with Percentage Shares in Total Emissions by Energy Sub-Sectors

Energy Sub Sector	Baseline Year [illegible]		[illegible]	
	Emissions in CO_2eq [illegible] Gg	Share in Total Emissions [illegible]	Emissions in CO_2eq [illegible] Gg	Share in Total Emissions [illegible]
Energy Conversion	[illegible]	[illegible]	[illegible]	[illegible]
Industrial Production and Construction Industry	[illegible]	[illegible]	[illegible]	[illegible]
Transport	[illegible]	[illegible]	[illegible]	[illegible]
Services	[illegible]	[illegible]	[illegible]	[illegible]
Households	[illegible]	[illegible]	[illegible]	[illegible]
Agriculture /fishing industry forestry	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]

The energy sector is the most important sector from the aspect of its share in the total GHG emissions generated in Montenegro, i.e. of the energy conversion sub-sector (Pljevlja Thermal Power Plant). However, if the emissions are analyzed individually, i.e. from the standpoint of contribution by particular industries, then the largest share in total emissions (emissions caused by fuel combustion, in addition to those resulting from the technological processes) is generated by the aluminum industry (Podgorica Aluminium Plant).

As it can be noticed, no individual emissions by gases are specified in these tables, though such data can be found in the chapter on inventory of greenhouse gases.

The projections of GHG emissions in Montenegro were prepared both for the energy and non-energy sector (industrial processes and waste). An assessment of GHG emissions reduction includes 2 scenarios: a baseline scenario and the one including measures for GHG emissions reduction.

The baseline scenario for GHG emissions is characterized by the absence of political measures in support of the activities towards a reduction of GHG emissions. By contract, the scenario which includes the measures for GHG emissions reduction assumes gradual introduction of measures leading to the reduction of GHG emissions. This scenario is oriented towards utilization of new renewable energy sources, which is primarily based on small hydro power plants and wind power plants, as opposed to the planned construction of the second block of TPP Pljevlja.

The following measures were examined in the energy consumption sector:

Combined heat and electricity generation (CHP);
Increasing industrial boiler-room efficiencies;
Substitute fuels for industrial boiler-rooms;
Substitute fuels for high-temperature heat generation;
Replacement of motor fuels;
Replacement of fuels for heating requirements;
Improvement of thermal insulation of residential buildings;
Increasing the share of heat pumps;
Small cogeneration;
Use of solar energy;
Increasing the share of TNG for cooking in households;
Energy efficient household appliances;
Replacement of classical light bulbs with LED light bulbs;
Boiler-room efficiency improvement;
Increasing the share of heat pumps;
Replacement of classical lamps in public lighting;
Motor poor energy efficiency improvement;
Introduction of alternative fuels as a substitute to the existing fossil fuels;
Planning and establishment of a more efficient transport system.

The following measures were examined in the industrial processes sector:

Improvement of technological processes by installing new equipment;
Improvement of technological processes by partial interventions on the existing equipment.

The following measures were examined in the agricultural sector:

Encouraging organic agriculture;

Reduction of methane emissions due to reduction of internal fermentation;
Improvement of animal waste management system practices;
Use of biomass from agriculture for energy purposes.

The following measures were examined in the sector of land use change and forestry:
Increasing carbon storage in plant mass;
Greater utilization of biomass of the wood intended for energy purposes.

The following measures were examined in the waste sector:
Construction of regional sanitary landfills with recycling centers;
Reduction of generated waste volumes by introducing primary selection and recycling;
Reduction of organic waste in municipal solid waste.

According to the projections of GHG emissions in the baseline scenario, in comparison to 1990, the level of GHG emissions will increase by approximately 40% in 2025. On the other hand, according to the scenario with GHG emissions reduction measures, in 2025 the projected level of GHG emissions will be lower by approximately 46% than the one for the same year according to the baseline scenario, and lower by 25% than the level of GHG emissions in 1990.

Analyzing the vulnerability and adaptation to the effects of climate change, this communication addressed the effect of long-term climate change on the most sensitive sectors such as: water resources; coastal area; agriculture; forestry; biodiversity and public health. The forecasts were prepared based on the results of climate scenarios A1B and A2 for Montenegro. Some adaptation measures were proposed for the foregoing vulnerable sectors; *inter alia*, the most significant measures for water resources would include the establishment of a registry of water resources, individual water resource mapping, including all characteristics, and identifying areas of potential danger; water resources of fundamental importance, such as water sources, have to be protected against any uncontrolled exploitation. The most important adaptation measures for the coastal area would understand the development of a quality and highly operational service monitoring the condition of the coast and waves, warning of the existence of danger several days in advance, and preparing relevant spatial planning documentation which should include the effects of climate change on the coast, so that no construction or urbanization activities will be permitted in the zones which are potentially exposed to dangerous tidal waves, as a result of the new situation. Other measures in all mentioned sectors are set out in the chapter on vulnerability and adaptation to climate change.

Finally, the communication also establishes the most significant technical and methodological constraints and gaps recognized during the preparation of the Initial Communication, the requirements that undoubtedly prove the necessity for institutionalization of the preparation of national communications and for the development of monitoring and reporting capacity in all elements of the Communication, in addition to the strengthening of climate change awareness on all levels and mechanisms for the formulation of an integrated response to climate change. These issues are addressed in more detail under the chapter on constraints, gaps and requirements.