Second National Communication of the Republic of Serbia under the United Nations Framework Convention on Climate Change

SECOND NATIONAL COMMUNICATION OF THE REPUBLIC OF SERBIA

under the United Nations Framework Convention on Climate Change

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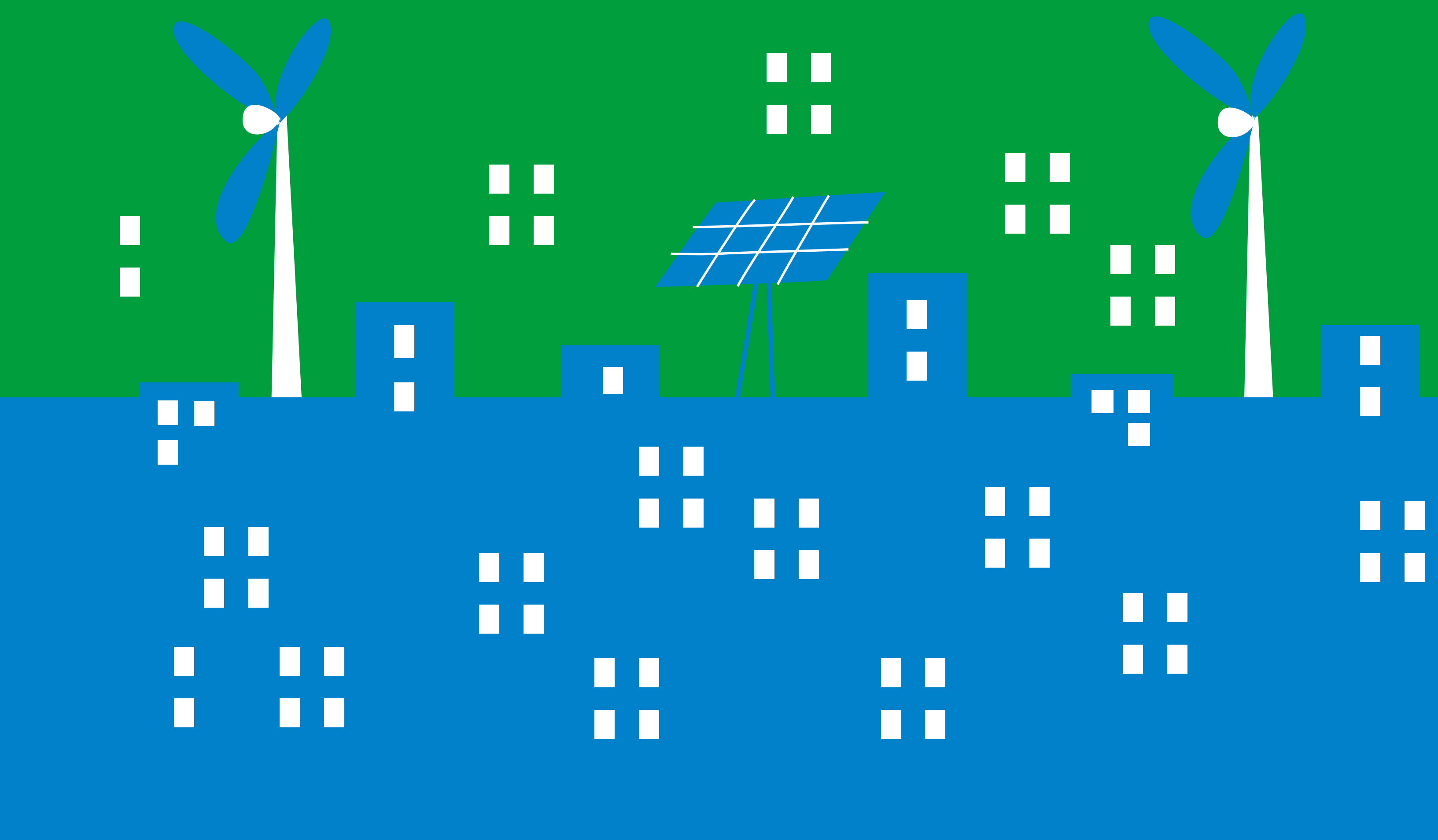
1. SUMMARY



1.1. NATIONAL CIRCUMSTANCES

Geographic profile

The Republic of Serbia is located in the central part of the Balkan Peninsula, covering a total surface area of 88,361 km2. Serbia has three major geographical areas: the Pannonian Plain; hilly areas with lower mountains; and low-lands and mountainous area. The highest mountain peak is Đeravica in the Prokletije Range (2656 m) and the longest river is the Danube (588 km).

Climate profile

For the most part Serbia has a moderate continental climate. July is the warmest month, and January is the coldest. June is the month with most rainfall. The months with the least rain are February and October. Snow typically occurs from November to March, with the highest snowfall recorded in January. Northwesterly and westerly winds are the rule in the warm season, while easterly and southeasterly winds (the Košava) prevail during the cold season.

Socio-political system

The Republic of Serbia is an independent democratic state (since 2006) with a multi-party parliamentary system. In March 2012, Serbia was granted EU candidate status. The system divides the institutions of government into three branches: legislative, executive and judicial.

Population

The largest cities in Serbia are the capital city of Belgrade (1,659,440 inhabitants), Novi Sad (341,625), Niš (260,237) and Kragujevac (179,417). The majority of the population is Serbian (83.3%), and the three largest ethnic minorities are Hungarians, Roma people and Bosniaks.

Main characteristics in relevant sectors

Economic and sectoral reforms in Serbia began in 2001. The energy sector accounts for 10% of the GDP. Primary energy is generated by exploitation and use of local sources of coal, crude oil, natural gas and renewable energy sources (hydro, geothermal energy and biomass). Electricity is produced from the combustion of low quality domestic lignite in existing power plants and the use of hydropower potential in the existing flow and pumped-storage hydroelectric power stations.

The industrial sector accounts for 22.4% of the GDP. Industrial production is still primarily based only on uncompetitive traditional technologies, of previous generations and older (dating from the 70's and the 80's of the last century). In recent years, the so-called "high – technology" sub-sectors, such as car industry, the production of electrical and, electronic devices, as well as ICT have increased their presence in the industrial production phase.

Road transport has traditionally been the most dominant form of transportation. Rail passenger transport has been in continuous decline since 2004. In 2013 there were 50% less passengers compared to 2000. The new law on railways was enacted, which should contribute to high railway system efficiency. Inland navigation is another important form of transport (the second most common form of transport of goods). However, the utilization of the existing facilities in the river traffic is very low. In recent years, state policy has been directed towards the development of intermodal transportation.

Agriculture is one of the key components in the Serbian economy, accounting for 9.5% of GDP (2013). With 10% of the labor force working in food processing industry, agricultural services and food manufacturing companies, agricultural sector employs more people than any other industry.

In 2000-2013, the intended use of 1.15% of total land area was changed. The most significant changes occurred in urban areas, where pastures and mixed agricultural land was converted into construction sites.

According to the National Forest Inventory, forests cover 2,252,400 ha, or 29.1% of the total area. State-owned forests cover 53% of the land and 47% are privately owned. According to the data provided by the Statistical Office of the Republic of Serbia in 2014, forests cover 2,168,746 ha (44% are state-owned forests, and 56% are privately owned).

The share of waste management sector in GDP is 1.2%, with a growth rate of 0.3% in 2012. Over the last twenty years, average waste composition has continuously changed, and the amount of waste collected has increased. The collected waste is disposed of at disposal sites that do not meet sanitary landfill standards.

Surface water and groundwater are both important sources for community water supply needs. Estimates have shown that about 20% of supplied water is irreversibly lost. The key sources of water pollution are: untreated industrial and municipal wastewater, agricultural drainage water, leaching water from landfills, and pollution related to river navigation and operation of power plants.

State of implementation of the UNFCCC

The Ministry of Environmental Protection (MoEP) is responsible for climate change on a national level and for reporting under the UN Framework Convention on Climate Change (UNFCCC).

Having in mind multi-disciplinary nature of the climate change issues, and with the view to more effective reporting under the UNFCCC, the Government of the Republic of Serbia established the National Climate Change Committee (The National Committee). The National Committee consists of representatives of governmental institutions, local government, scientific and expert community, and civil society organizations.

In 2010, the Initial National Communication (INC) for the Republic of Serbia was adopted by the Government and submitted to the UNFCCC. In 2016, the Republic of Serbia submitted the First Biennial Update Report (FBUR) under the UNFCCC.

The Second National Communication of the Republic of Serbia under the UNFCCC was produced through a Project financed by the Global Environmental Facility (GEF). The MoEP/Climate Change Division implemented the project, with the technical support of the United Nations Development Programme (UNDP).

1.2. National greenhouse gases inventory

For the purpose of drafting the present report the Serbian Agency for Environmental Protection (The Agency) developed the 2000-2014 national greenhouse gases (GHG) inventory.

The GHG Inventory of the Republic of Serbia was performed by using the Intergovernmental Panel on Climate Change (IPCC) Inventory Software[1], according to the Tier 1 approach of the 2006 IPCC Guidelines and default emission factors for all source categories and removals.

Based on the GHG inventory, in 2014 estimated total emissions in the Republic of Serbia without removals were 67,148.23 Gg CO_2eq. Since 2000, total GHG emissions without removals have increased by 7.8%. In 2014, the total GHG emissions with sinks were 49,299.24 Gg CO_2eq, which is a 2.4% increase compared to 2000. Emissions from the energy sector have the largest share (80.0%) in total emissions in 2014, which is a slight increase of 0.8 % compared to 2000. The second largest GHG emitting sector is the Agriculture, Forestry and Land Use (AFOLU).

The main greenhouse gases 2014 was carbon dioxide (CO_2), expressed as CO_2 (CO_2eq), accounting for 79.7% of total GHG emissions. The next one is methane (CH_4) expressed as CO2 equivalent with a share of 13.1% and nitrous oxide (N_2O) with a share of 6.9% in total GHG emissions. Hydrofluorocarbons (HFCs) collectively accounted for 0.3% of the total GHG emissions in 2014[2]. In 2000, the share of CO_2 emissions in the total emissions remained the same, 79.7%. However, the share of CH_4 in the total emissions decreased by 2.3%, and that of N_2O increased by 2.0%.

Removals by sinks in forestry in the course of 2014 amounted to -17,848.99 GgCO_2eq, which is increase of 26.0% comparing to the removals by sinks in 2000. By all means, GHG inventory for 2014 will have to be improved in the following report.

Due to lack of data for 2014 caused by disastrous floods, the data collection system has not been complete. Thus, the GHG inventory will have to be updated in the near future.

1.3. Projected GHG emissions by 2030

Projections of total and sectoral GHG emissions are made for three scenarios: baseline scenario, scenario "with measures" and scenario "with additional measures". Projections were made until 2030, in five-year intervals (2015, 2020, 2025), where the year 2010 was chosen as a starting point for projections. The LEAP (Long range Energy Alternatives Planning System) model was used for developing all projections.

Trends of total GHG emissions in the period 2010-2030 developed from the three scenarios are presented in Figure 1.1:

1 http://www.ipcc-nggip.iges.or.jp/software/index.html

2 Data on import and consumption as well as the available quantities of HFC, PFC and SF6 are available from 2004 and were used to estimate emissions of these gases since then.

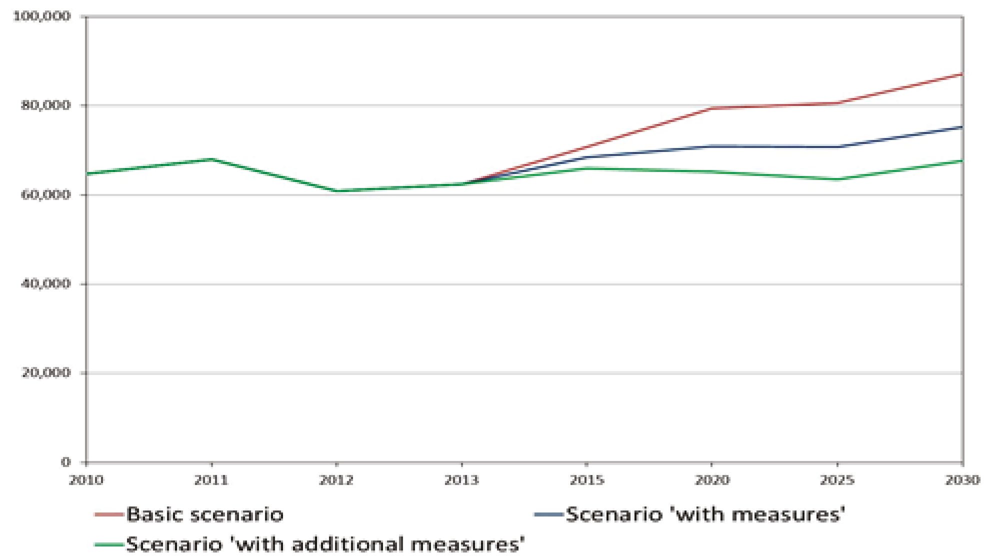


Figure 1.1: **2010-2030 Trend of GHG emissions, for three scenarios, $GgCO_2$ eq**

In 2030, if applying the scenario "with measures" GHG emission will decrease by 14.37% compared to the basic scenario, and by 23.50% under the scenario "with additional measures".

In 2012, the Republic of Serbia identified NAMAs and submitted to the NAMA Registry[3] projects that were taken into consideration during the development of scenarios "with measures" and "with additional measures".

1.4. Long-term GHG emission reduction by 2050

Estimated reduction in total GHG emissions by 2050, like in the case of projections made by 2030, relied on three scenarios: a basic scenario, a scenario "with measures" and a scenario "with additional measures". The year 2010 was chosen as a starting point for projections, and LEAP model was used.

First estimates have shown a reduction in GHG emissions by 35% if applying the scenario "with measures" compared to the basic scenario, and by 49% under the scenario "with additional measures". In other words, in 2050 GHG emissions will reduce by 42% if applying the scenario "with additional measures" compared to the GHG emissions in 1990, and by 22% compared to GHG emissions in 2013.

1.5. Vulnerability assessment, climate change impacts and adaptation measures

Observed climate changes

During the period 1960-2012, significant increase of daily mean temperature, as well as in daily maximum and daily minimum temperatures was observed in Serbia with an average trend of 0.3°C increase per decade and on annual level. Eight out of ten hottest years ever recorded were observed after 2000.

[3] http://www4.unfccc.int/sites/nama/SitePages/Country.aspx?CountryId=154

Positive trends have been observed in most of the precipitation stations, including changes in the rainfall distribution during the year. This includes intensity distribution where certain parts of the year favored heavy precipitation events while other parts favored no precipitation.

Analysis of multiple extreme indices has shown that the Republic of Serbia experienced an increased number of episodes with heavy precipitation, even though the total rainfall per year was relatively small. However, the most remarkable changes were observed in the temperature rise trends, coupled with extreme high temperatures and extended warm periods.

Expected climate change - climate change scenarios

Climate scenarios predict a plausible temperature rise in the near future. Under A1B scenario for 2011-2040 and 2041-2070 it is likely that the temperature will rise by 0.5-0.9 °C and 1.8-2.0 °C respectively. According to A2 scenario the expected temperature rise is 0.3-0.7 °C in 2011-2040 and 1.6-2.0 °C in 2041-2070. By the end of the century (2071-2100) the predicted change in temperature obtained by A2 scenario is 3.6-4.0 °C, and according to A1B scenario it will be 3.2-3.6 °C. It is expected that warming will be most pronounced in the summer and fall season, with the temperature rise over 4.0 °C by the end of the century.

For the period 2011-2040 both scenarios predict precipitation changes that are positive compared to the base period, and that will be decreasing toward negative values by the end of the century. Under A1B scenario, projected precipitation changes for the end of the century range from +5% to -20%, and from +20% to -20% according to A2 scenario. The negative trend is most expected during the summer season.

By the end of the century, the number of frost days will have reduced to the level when it can be considered a rare event. The number of summer days will have increased by 20 – 30 days (A2 scenario). The number of days with tropical nights, will have increased by over 20 days by the end of the century. During the second half of the century the length of the growing season will have extended by over a month. Longer periods of drought are to be expected, lasting for over one month, according to the both scenarios.

Vulnerability and adaptation measures

Vulnerability assessments were made for the following sectors: hydrology and water resources, forestry, agriculture and health care, and it was confirmed that these sectors are affected by the changed climate conditions.

Specific adaptation measures for each of these sectors were developed, with the aim to timely adapt to climate change, taking into account climate scenarios. However, analyses show the need for further and more detailed research in all sectors and awareness raising on needs and possibilities of adaptation at the sectoral level.

1.6. Implementation of the United Nations Framework Convention on Climate Change

The Republic of Serbia has been part of the United Framework Convention on Climate Change – UNFCCC (Convention) since 2001 and the Kyoto Protocol (Protocol) since 2008. The Ministry of Environmental Protection (MoEP) is responsible for climate change issues. The Republic of Serbia supported Copenhagen Accords and in 2012 identified 12 Nationally Appropriate Mitigation Actions (NAMA) actions, seeking support for their implementation.

In June 2015, the Government of the Republic of Serbia submitted "Intended nationally determined contributions" (INDCs) - a document that contains as well a section related to losses incurred by natural disasters and indicates the need for adaptation to impacts of climate change. In order to achieve the goals defined in INDCs and fulfill commitments under Paris Agreement, a number of activities were initiated in cooperation with relevant ministries.

In 2008 the South East European Virtual Climate Change Centre-SEEVCCC within the Republic Hydro Meteorological Service of Serbia was established.

In 2014 the Government of the Republic of Serbia established the National Climate Change Committee.

An initiative was made and activities are in progress for establishment of a monitoring, reporting and verification system. It is expected that the MRV system will become operational in 2019.

In the previous period, significant efforts have been made to improve the legal framework and policies that directly or indirectly affect the implementation of activities related to climate change. Various institutions participated in bilateral, regional and international projects. Significant attention was dedicated to education, capacity building and raising awareness, especially of representatives of local governments.

The Ministry made a web site www.klimatskepromene.rs and produced expert publications about influence of climate change on agriculture and health.

Number of civil society organizations and their knowledge about climate change has significantly increased in recent years.

However, the current level of integration of climate change into sectoral and overall development strategies, level of knowledge, institutional and individual capacities, available technology and financial resources at the national level and involvement of local governments are still not sufficient for an effective and rapid response to climate change problem. Therefore, strengthening cooperation at the bilateral, regional and international levels, continued cooperation with the GEF, and establishing cooperation with the private sector are essential for the effective implementation of the Convention and providing a response to climate change problem at the national level.

1.7. Financial, technological and capacity building needs

Analysis of financial, technological and capacity building needs in the process of developing this Report had re-confirmed the necessity of building capacities of the relevant ministries and increasing the number of employees at the Agency for Environmental Protection and in the Climate Change Division.

Estimates show that establishing a complete inventory system will require funds in the amount of 50-60,000 EUR per annum, until the inventory system becomes fully operational. The time required for the establishment of such a system will be shorter if the Agency is consistently provided with the necessary capacities.

With the view to effective adaptation to climate change it is essential to draft a National Plan for Adaptation.

Table 1.1. below contains an assessment of funds required for the implementation of activities that will lead to total and GHG emission reduction by 2030 (projected in scenarios), developed based on the existing strategic documents from different sectors.

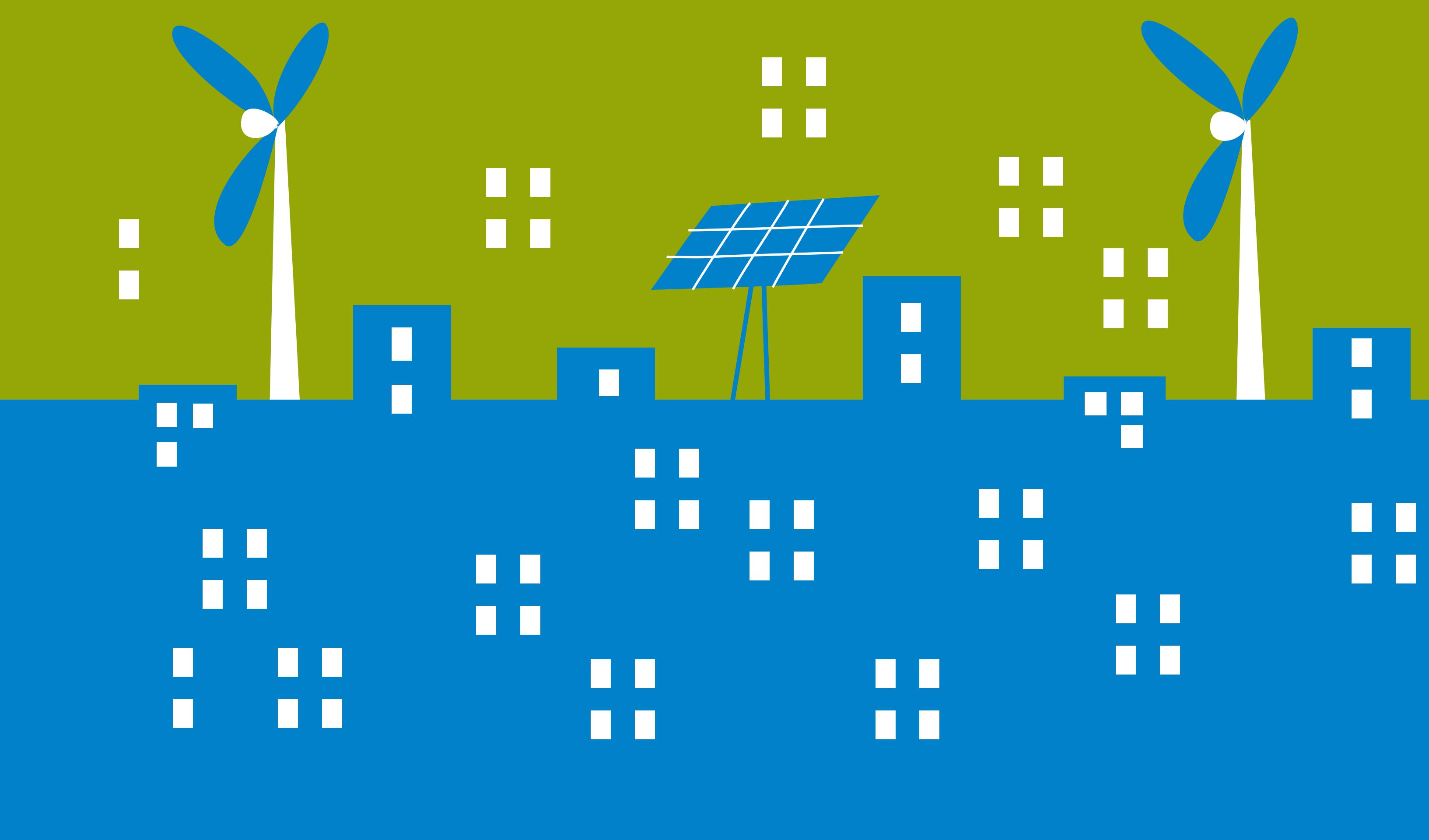
Table 1.1: Funds required for reduction of GHG emissions

Energy	
Measures	**Total required funds (€)**
TENT B3 (750 MW)	1,600,000,000
TPP Kolubara B (2 x375 MW)	1,500,000,000
TPP Kostolac B3 (350 MW)	450,000,000
TPP Novi Kovin (2 x 350 MW)	1,330,000,000
TPP Stavalj (300 MW)	650,000,000 750,000,000
TPP HP Novi Sad (340 MW)	400,000.000
HPP Velika Morava (147,7 MW)	360,000,000
HPP Ibar (117 MW)	300,000,000
HPP Srednja Drina (321MW)	819,000,000
PS HPP Bistrica (4 x 170MW)	560,000,000
PS HPP Djerdap 3 (I phase) (2 x 300 MW)	400,000,000
Mini HPP (387 MW)	500,000,000
Restructuring, modernization and construction of heat sources	90,000,000
Revitalization and construction of distribution network	105,000,000
Revitalization and construction of heating substations	45,000,000
Completion of gasification in the Republic of Serbia and rehabilitation of the existing gas pipeline system	500,000,000
Waste sector	
Measures	**Total required funds (€)**
Construction of sanitary landfills	94,470,000
Construction of centralized composting plants	18,100,000
Provision of compost bins for rural households	41,540,000

Costs of additional caretaking of 164 registered landfills	48,280,000
Costs of closing 4,481 wild landfills	94,830,000
Forestry	
Measures	**Total required funds (€)**
Afforestation	82,076,510
Regeneration of even-aged high forests	58,457,292
Reconstruction of devastated forests	5,094,291
Indirect conversion of coppice forests	23,522,299
Direct conversion of coppice forests	117,952,426
Rehabilitation of stands damaged by abiotic and biotic factors	4,665,102
Rehabilitation of fire-damaged stands	62,604,091
Forest certification	900,000
Development of strategic documents for forestry sector	794,880
National forest inventory	730,000
Research (developing capacities and implementation of projects)	94,025,000

In view of a large amount of investment needed, as well as the current level of economic and technological development of the Republic of Serbia, goals to reach GHG emission reduction by 2030 can only be fulfilled with technological and financial support from the international community.

2. NATIONAL CIRCUMSTANCES



2.1. GEOGRAPHIC PROFILE

The Republic of Serbia covers an area of 88,361 km2; the major part of the country is located in Southeastern Europe; in the central part of the Balkan Peninsula, while a smaller, northern part of the country belongs to Central Europe and covers an area of 88,361 km2.

Serbia consists of three geographical areas: the Pannonian plain, hilly ground with low mountains and plains and mountainous areas.

Areas higher than 1,000 m cover less than 10% of the territory of Serbia. A few mountain peaks rise above 2,000 m (15) and the highest one of them is Đeravica in the Prokletije Range (2,656 m).

The primary rivers belong to the basins of the Black, Adriatic and Aegean Sea. Three rivers are navigable across the whole length of Serbia: the Danube, the Sava and the Tisa. The Danube is the longest river, and its course through Serbia is 588 km long. Most of the rivers have a rainy snow regime of water levels and flow rates. The maximum water level is recorded in the spring, and the minimum in August and September.

The total length of the artificial channels is 939.2 km. The largest canal system is located in the lowlands of the country and is known as the Danube-Tisa-Danube Canal, after the names of the Rivers that it connects.

Serbia does not have large natural lakes, but it does have nine artificial lakes, created by damming river beds to create waterpower for electricity production. The largest of these is the Đerdap Lake on the Danube.

2.2. CLIMATE PROFILE

The climate of Serbia is moderate-continental, with more or less pronounced local characteristics and a gradual transition between seasons. Continental climate prevails in the mountainous regions of above 1,000 m altitude. The southwestern part of the country borders Mediterranean, subtropical and continental climate.

According to the Köppen climate classification, most of Serbia has a moderately warm rainy climate with warm summers, whilst mountainous have a snowy climate.

July is the warmest month and autumn is warmer then spring. January is the coldest month, with average monthly temperature of -6°C in mountainous area, up to 0oC in flat areas of the country.

Serbia has a continental precipitation regime, with heavier rainfall in the warmer half of the year, except for the southeastern areas, which have the most rainfall in autumn. June is the rainiest month, with an average of 13% of the total annual rainfall. The least rainy months are February and October. Annual rainfall for the entire country is 896 mm.

It generally snows from November to March, and sometimes in April and October, except in the mountains above 1,000m. January has the most days with snow cover, on average 30-40% of the total number of days with snow cover.

Northwesterly and westerly winds are typical of the warm season, while easterly and southeasterly winds (the Košava) blow during the coldest period of the year. In the mountainous area in southwest Serbia, southwesterly winds prevail.

Annual sums of sunshine duration range from 1,800 to 2,100 hours, with only Požega having around 1,550 hours per year.

2.3. SOCIAL AND-POLITICAL SYSTEM

The Republic of Serbia is an independent democratic state (since 2006) with a multiparty parliamentary system. In March 2012, Serbia was granted European Union (EU) candidate status.

The basic principles underlying the political and governmental system were established by the Constitution (2006).

The system divides the institutions of government into three branches: legislative, executive and judicial. The responsibilities of the different government bodies are divided between the central government, provincial and municipal authorities.

Under the Constitution of the Republic of Serbia, the autonomous provinces have a form of territorial autonomy and have the same degree of independence, that is, autonomous rights and duties that correspond to their particular characteristics and interests. The Republic of Serbia includes the Autonomous Province of Vojvodina and the Autonomous Province of Kosovo and Metohija with forms of territorial autonomy. The Autonomous Province of Vojvodina is located in the northern part of the Republic of Serbia, and constitutes almost one quarter of the Serbian territory or 21,506 km2. In the south, the Autonomous Province of Kosovo and Metohija is under the interim civil administration of the United Nations, based on United Nations Security Council Resolution 1244, adopted on June 10, 1999. The Autonomous Province of Kosovo and Metohija covers an area of 10,849 km2.

The territory of the Republic of Serbia includes 30 administrative districts, 24 cities, 28 city municipalities and 194 municipalities. The Republic of Serbia has 6,158 settlements, 193 of which are urban settlements.

The city of Belgrade, as the capital, has a special status as regulated by the Law on Capital Cities and the Statute of the City of Belgrade.

2.4. POPULATION

From 2000 to 2014, two censuses were conducted, in 2002 and 2011. According to the results of the 2011 Census, as the main source of statistical data, the population is estimated at 7,186,862 inhabitants. The results of the 2002 and 2011 Census should be taken with caution because they were not conducted across the entire territory (Data for the Autonomous Province of Kosovo and Metohija which is under the interim civil administration United Nations were not included). Comparing to the previous census the population decreased (Table 2.1).

Table 2.1: Numbers of population, households and housing units

	Year		
	1991	2002	2011
Number of population	7,822,795	7,498,001	7,186,862
Number of households	2,418,156	2,521,190	2,487,886
Housing units	2,556,092	2,743,996	3,012,923

The largest cities are: Belgrade (the capital city, 1,659,440 inhabitants), Novi Sad (341,625), Niš (260,237) and Kragujevac (179,417).

The average life expectancy of male and female population in Serbia has grown over the last ten years – from 69.9 years to 72.5 years for men, and from 75.1 to 77.7 years for women. The average age of population increased from 40.3 years (2003) to 42.4 (2013).

The majority of the population is Serbian (83.3%), and the three largest ethnic minorities are Hungarians, Roma people and Bosniaks. All citizens have equal rights and responsibilities and enjoy full national equality. 84.6% of the total population is Eastern Orthodox followed by Roman Catholic (5%), and Islam (3%)

2.5. MAIN CHARACTERISTICS IN RELEVANT SECTORS

2.5.1. Economy

Economic and political reforms in Serbia began in early 2001. Data on gross domestic product (GDP) of the Statistical Office of Serbia are shown in Table 2.2. Having transferred to the new ESA 2010 (the European system of accounts) methodology, the Statistical Office of the Republic of Serbia carried out a revision of the previously published data on GDP for the period since 1997.

Table 2.2: Serbian gross domestic product in the period 2001-2015

	GDP, total, in mil €	GDP per capita in €	GDP real growth in %
2001	13,113	1,748	4.8
2002	16,811	2,241	4.2
2003	18,010	2,401	2.5
2004	19,723	2,629	8.4
2005	21,104	2,814	6.2
2006	25,262	3,354	5.7
2007	30,581	4,058	7.0

2008	28,467	4,445	3.8
2009	30,654	4,187	-3.1
2010	29,766	4,082	0.6
2011	33,423	4,620	1.4
2012	31,683	4,4010	-1.0
2013	34,262	4,783	2.6
2014	33,318	4,672	-1.8
2015	33,491	4,720	0.8

Due to the heavy floods that have significantly damaged the mining and energy sector, agriculture, infrastructure and households, as well as reduced external demand, a rise in GDP was not recorded in 2014.

Unemployment rate was constantly decreasing, from 19.2% in 2014 to 18.2% in 2015. The unemployment rate among women (19.3%) was higher than among men (17.4%).

2.5.2. Energy

The energy sector accounted for 10% of the GDP. This sector consists of oil and natural gas industry, coal mines, an electric power system, and a decentralized municipal district for heating and industrial energy. Majority of the Serbian energy infrastructure is owned by the Public Utility Enterprise „Elektroprivreda Srbije" (EPS).

Repairing of an old and outdated infrastructure started in 2000 with the assistance of international funds, but it still needs significant investments. The entire Serbian transmission system is operated by the Public Enterprise "Elektromreža Srbije" (EMS), as a transmission system operator.

Primary energy is generated by exploitation and use of local sources of coal, crude oil, natural gas and renewable energy sources (hydro, geothermal energy and biomass). Electricity is produced from the combustion of low quality domestic lignite in existing power plants and the use of hydropower potential in the existing flow and pumped-storage hydroelectric power stations.

Total installed production capacity is 8,359 MW. Data on total energy production and renewable energy production in 2012 are shown in Tables 2.3 and 2.4. The first wind farm in Serbia was opened in November 2015.

Table 2.3: Primary energy production (2012)

Primary energy production (2012)		
	TJ	%
Total production	**423,174**	**100**
Coal	304,725	72
Hydro-electricity	35,690	8

Crude oil and natural gas liquid	51,256	12
Wood fuels*	11,480	3
Natural gas	19,762	5
Geothermal energy	261	0

Table 2.4: Renewable energy production (2012)

Renewable energy production (2012)		
	TJ	%
Total	**45,174**	**100**
Hydro-electricity	33,433	74
Wood fuels*	11,480	25
Geothermal energy	261	1

Electricity consumption in Serbia in 2009 was 28,854 GWh, and in 2012 it amounted to 33,589 GWh. High consumption is greatly affected by the use of electricity for household heating and the low energy efficiency of buildings (mainly built in the 1970s and 1980s).

2.5.3. Industry

Industrial goods sector is still characterized by low competitiveness and high oscillations. Industrial production is still uncompetitive, and primarily relies on imported traditional technologies dating from the 70's and the 80's of the last century. Insufficient financial resources and lack of investment, mainly in 1990s, have obstructed much needed industrial reconstruction and modernization, including introduction of clean technologies.

The "high technology" sectors such as manufacture of motor vehicles, manufacture of electrical and electronic equipment and information technologies have had an increasing share in total production.

According to data from 2013, the industrial goods sector accounts for 22.4% of the GDP. The share of manufacturing production in GDP is 18%. Industrial goods production in the Republic of Serbia increased in 2013 compared to 2012 by 5.5%. In 2013 industrial goods production was most influenced by production of motor vehicles and trailers, manufacture of chemicals and chemical products and electrical equipment. Serbian automotive industry was modernized and restored due to investment of FIAT Company.

2.5.4. Transportation

The transport infrastructure of the Republic of Serbia in 2013 included 44,604 km of roads, 3,819 km of railways, 1,680 km of inland waterways, four airports used for commercial purposes, two of which service international flights and three are partly developed intermodal terminals.

Road transport has traditionally been the most developed mode of transportation.

Rail passenger transport has been in continuous decline since 2004. In 2013 there were 50% less passengers compared to 2000. The main reasons include a low level of investment, poor state of infrastructure facilities and vehicles, low quality of services, increasing debt and inadequate organization of the system.

In May 2013, a new Law on Railways was adopted, which should contribute to greater efficiency of the railway system and its integration in the market of transport services.

Until 2005, the share of intermodal transport in the Republic of Serbia was approximately 0.5% in overall transport. In recent years, the national policy has been increasingly oriented towards the development of intermodal transport.

Inland navigation is another important form of transport (the second most common form of transport of goods). However, river traffic is very rarely used.

The number of passenger cars in Serbia has been constantly growing. In 2013 the number of vehicles was 28.05% higher compared to 2000. Out of the 1,770,206 passenger cars, 12% are under the age of 5; 34% are older than 15; and 10% older than 25 years.

2.5.5. Agriculture

Agriculture is one of the key components in the Serbian economy, accounting for 9.5% of GDP (2013). With 10% of the labor force working in food processing industry, agricultural services and food manufacturing companies, agricultural sector employs more people than any other industry.

Agricultural land covers approximately 5,100,000 ha, of which 3,861,477 ha are arable land. In 2013, the share of arable land was 64.6% of the total agriculture land, followed by orchards (4.7%), vineyards (1%), permanent grassland (12.8%), and pasture (16.2%). Agricultural production is spread across the whole country, and it is a dominant type of production in Vojvodina.

According to the Census of Agriculture in 2012 there were 631,522 farms, 628,955 of which were family farms and 2,567 were commercial farming enterprises and agricultural cooperatives. The total number of farm owners and workers was 1,442,628. The census recorded 108,230 households engaged in agriculture production for their own use but as not qualifying as a farm. The size of an average family farm is 4.5 hectares. Approximately 90% of arable land is privately owned and 10% belongs to the government. The Census (2012) also provided data on livestock, as shown in the Table 2.5.

Table 2.5: Number of livestock

LIVESTOCK	
Number of cattle	908,102
Number of pigs	3,407,318
Number of sheep	1,736,440
Number of goats	231,837
Number of poultry	26,711,220
Number of beehives	665,022

The number of the organic farms has increased (in 2005 there were 36 organic farms and by 2011, 218 certified organic farms were producing organic products).

2.5.6. Land-use change and forestry

In 2000-2013 period, 1.15% of total land area was subjected to a change in land use. The most significant changes occurred in urban areas, where pastures and agricultural land were converted into construction sites.

According to the National Forest Inventory (2009), forests covered 2,254,400 ha or 29.1% of the total territory. State-owned forests covered 53% of total forest area and 47% were privately owned. According to the data provided in the Statistical Yearbook of Serbia 2014, in 2011 forests covered 1,962,335 ha, out of which 47.3% were state-owned forests and 52.7% were privately owned.

In the last fifteen years, only 5,000 ha were forested, which is only 0.2% of the whole territory.

The present condition of state-owned forests is characterized by scarce forestry stocks, negative growth-age relationship, insufficient forest percentage and forest density, unfavorable forest structure and tree species according to silvicultural principles, and an unsatisfactory state of forest health.

State-owned forests (in total 97.6%) are managed by public enterprises.

2.5.7. Waste management sector

The waste management sector has a share of 1.2% in the national GDP, with a recorded growth rate of 0.3% in 2012. Table 2.6 below contains municipal waste data collected in the period 2006-2012.

Table 2.6: Indicators of municipal waste

Indicator	2006	2007	2008	2009	2010	2011	2012
Total quantities of generated waste (mill. t)	1,73	2,07	2,55	2,63	2,65	2,71	2,62
Quantities of waste collected and disposed of by municipal public utilities enterprises (mill. t)	1,04	1,24	1,52	1,58	1,59	2,09	1,83
Average coverage of waste collection (%)	~60	~60	~60	~60	~72	~77.3	~70
Average daily quantities of municipal waste per capita (kg)	0,62	0,77	0,95	0,98	0,99	1,01	0,99
Average annual quantities per capita (t)	0,23	0,28	0,35	0,36	0,36	0,37	0,36

Over the last twenty years, municipal waste composition has been changing, and the amount of waste collected increased. The equipment of public utility companies is inadequate, outdated and poorly maintained.

Collected waste is disposed of at disposal sites that are unsanitary dumps.

2.5.8. Water management

According to multi-annual average, the total amount of available water is 5,648.34 m3/s or 178-125.4 million m3/year. Around 8% of the available surface water originates in the national territory.

Both surface water and groundwater are used for water supply. Estimates have shown that about 20% of supplied water is irreversibly lost.

Flood protection is the most important aspect of defense against the harmful effects of water. However, after years of reduced investment in the maintenance of facilities and due to lack of maintenance of river beds, levels of security and protection from the destructive effects of water have decreased, as well. Thus, the stability of embankments associated with waterways under a torrential hydrological regime has been threatened, which became evident during the disastrous spring floods in 2014.

The key sources of water pollution are untreated industrial and municipal wastewater, agricultural drainage water, leaching waters from landfills, and pollution associated with river navigation and operation of power plants. Wastewater treatment plants are only available in 21 municipalities. Large cities that do not have access to a wastewater treatment plant, dispose their wastewater directly into rivers.

2.6. STATE OF IMPLEMENTATION OF THE UNFCCC

In line with the requirements under the UNFCCC, the Republic of Serbia has committed to submitting national communications and biennial update reports. Biennial reporting requires continuous collection and processing of data and information relevant to climate change which should comply with the appropriate institutional and legal framework.

In conformity with the law, the Ministry of Environmental Protection (MoEP) is the national focal point for climate change. The Climate Change Division (Division) was set up within the Ministry in 2008, with the aim of establishing the necessary institutional capacities to fulfill the commitments and obligations required by the UNFCCC, including those relating to the drafting of this report. The Division hires six full-time employees.

According to the Law on Air Protection, the Serbian Environmental Protection Agency (SEPA) is responsible for preparation and improving the inventory, including the GHG inventory. Three employees are currently performing these tasks at SEPA. SEPA obtains its GHG inventory data from for the following organizations: the Statistical Office of the Republic of Serbia; Ministry of Mining and Energy; Ministry of Interior and the Traffic Police.

In order to strengthen cooperation and exchange of information with regard to climate change issues and policy, and with the view to reporting and awareness raising on this issue at the national level, the Government of the Republic of Serbia established the Climate Change Committee (National Committee) in November 2014. The Committee will, among other things, monitor the fulfillment of international commitments of the Republic of Serbia in the field of climate change and review reports with regard to fulfillment of UNFCCC commitments.

Members of the Committee are representatives of all relevant ministries and other governmental institutions and institutions of the Autonomous Province of Vojvodina, as well as representatives of universities and scientific institutions, local government and civil society. The work of the National Committee has significantly contributed to increasing the transparency of the process of drafting reports under the UNFCCC.

In the past, budget resources from the Republic of Serbia were not allocated to combatting climate change, and to fulfilling the commitments under the UNFCCC. Although the number of employees in the Division (since 2008) increased, both its capacity and that of the SEPA are still insufficient to meet the requirements under the UNFCCC.

Due to the reasons previously mentioned, allocation of funds from the Global Environment Facility (GEF) is crucial for drafting of reports to the UNFCCC, in terms of fulfilling the commitments, capacity building and engaging the national scientific and technical institutions in the development of these reports.

With regard to establishing a complete and functional reporting system under the UNFCCC, it is worth mentioning that transposition of the EU Monitoring Mechanism regulations is under way, in cooperation with the European Commission. Activities were initiated aimed at establishing an institutional and legislative framework that will ensure consistent monitoring of the implementation of the UNFCCC at the national level and reporting on a regular basis. In this way, a considerable portion of the requirements related to monitoring, reporting and verification (MRV) of climate change data and information change will be fulfilled.

Another important initiative relevant for the establishment of MRV is the establishment of the monitoring, reporting and verification system required for successful implementation of the European Union Emission Trading System (EUETS) (as a requirement in the EU accession process). This System will secure collection of data on GHG emissions at the level of industrial and power plants. Establishing a complete MRV system is expected in 2019.

The Government of the Republic of Serbia adopted and submitted the Initial National Communication (INC) under the UNFCCC, in 2010.

The First Biennial Update Report (FBUR) for the Republic of Serbia was submitted to the UNFCCC in 2016.

The Second National Communication under the UNFCCC (SNC) was produced with the financial support of the Global Environmental Facility (GEF), the total budget of the project being US$500,000. The Ministry of Environmental Protection implemented this project, as well as INC and FBUR, with the technical support of the United Nations Development Programme (UNDP).

In order to include adequate and relevant information in the national report, a working group (on a project basis) was formed. The working group consisted of representatives from relevant institutions, officially appointed by institutions following a decision of the minister responsible for climate change. Sections of the report related to the greenhouse gas inventory are prepared with direct cooperation with the Environmental Protection Agency, which is legally responsible for the preparation of inventory. Sections relating to the climate and climate scenarios are drafted in direct cooperation with the Republic Hydrometeorological Institute. The final version of the SNC document was drafted by employees in the Division, as well as by volunteers contracted by the UNDP. The draft version of the national report was presented and improved based on suggestions from the members of the National Committee. After the corrections were made, the national report was approved by the Committee before official ministry consultants and finally approved by the Government. Teams of experts, representatives of scientific institutions (faculties, institutes, research centers), were also engaged for this specific project of drafting the document.

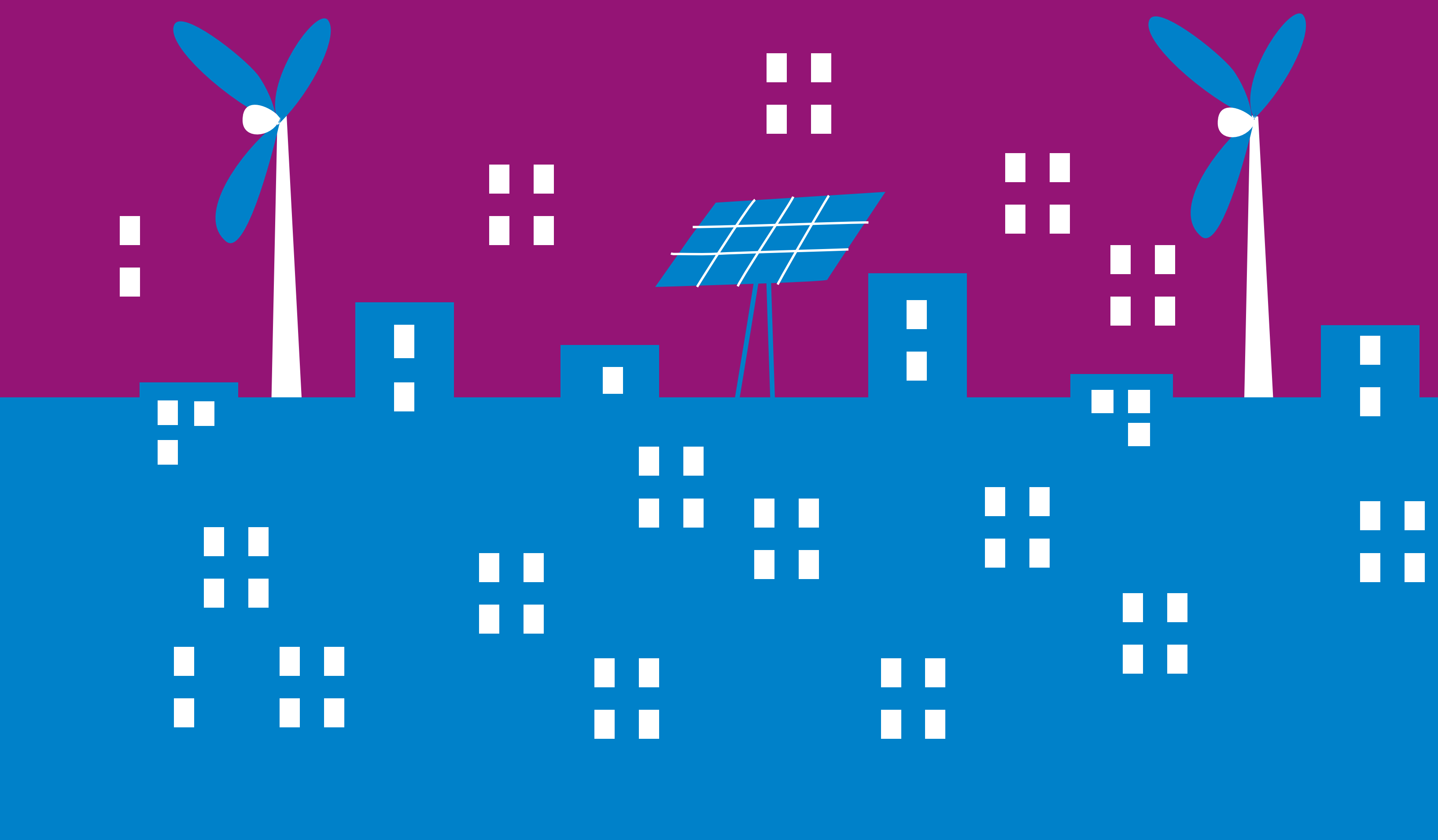
In order to increase the transparency, starting from the development of FBUR, a draft version was presented to the general public in specially organized public events and at the final phase (before being adopted by the Government) the document was available electronically through the Ministry website, for comments and suggestions.

In order to establish a permanent institutional structure for the development of national reports, the governmental decision of establishing the National Committee provided an opportunity for setting up working groups for individual issues. The working groups have a role in collecting relevant information.

In the process of drafting the next national communication and reports under the UNFCCC, a permanent working group within the Council will be established. The aim is to keep the team that took part in the drafting of the SNC.

Despite numerous activities and efforts to establish a systematic, permanent and functional system required for efficient UNFCCC reporting, some extra time, capacity building and financial resources, as well as bilateral and multilateral cooperation and assistance will be necessary.

3. NATIONAL GREENHOUSE GAS INVENTORY



3.1. General information

According to the Law on Air Protection, the Serbian Environment Protection Agency (SEPA) is a national entity responsible for preparation and improvement of national GHG inventory. SEPA's responsibilities include activity data quality control (QC), archiving data and calculation of emissions and GHG removals. SEPA prepares national GHG inventories in accordance with the UNFCCC reporting requirements for non-Annex I Parties.

Activity data used for the GHG emission calculations originate from different sources such as: the Statistical Office of the Republic of Serbia; Ministry of Mining and Energy; The Ministry of Interior, Traffic Police, industrial plants; and the Food and Agriculture Organization (FAO). Activity data required for calculation of GHG emissions from waste disposal is collected by SEPA through its own activities.

Sources of activity data used for developing GHG inventory for SNC are presented in Table 3.1.

Table 3.1: Sources of activity data for GHG inventory

IPCC sector	Activity data	Source
Energy	National energy balance	Ministry of Mining and Energy
	Registered motor vehicles	Ministry of Interior (database)
	Fuel characteristic data	Ministry of Mining and Energy, NIS (oil company)
	Processed natural gas (scrubbed), CO_2 content before scrubbing and CO_2 emission	NIS (oil company)
Industrial processes and product use	Production and raw material/ feedstock consumption for different industrial processes; use of products; population	Statistical Office of the Republic of Serbia (Statistical yearbook and bulletin for industry) Serbian Agency for Environmental Protection (SEPA)

AFOLU	Number of different category of livestock	Statistical Office of the Republic of Serbia (Statistical yearbook and bulletin for industry)
	Consumption of mineral fertilizers	Statistical Office of the Republic of Serbia (Statistical yearbook and bulletin for industry)
	Land areas; annual increment, harvest	*Corine Land Cover database*
Waste	Amounts of municipal solid waste disposed to disposal sites	Serbian Environmental Protection Agency
	Waste composition	University of Novi Sad Serbian Environmental Protection Agency
	Wastewater handling	Statistical Office of the Republic of Serbia (Statistical yearbook

The 2010 Regulation on Methodology for National GHG Inventory Data Collection provides guidance for activity data collection and general responsibilities of relevant government agencies and organizations, public institutions, local governments, associations, businesses and other entities for submission of activity data to SEPA by 31 March of the current year for the previous calendar year. Although a fully functional system in accordance with this Regulation has not yet been established, SEPA developed GHG inventories for the period 1990-2014. Being short-staffed, SEPA has not yet fully established the required system for assessing the quality of data and calculation.

Although the Republic of Serbia adopted a regulation on mandatory reporting on the activities, there is a need for further development and improvement of the institutional, legislative and procedural framework that includes raising awareness in order to provide support for the planning, preparation and management of GHG inventory.

3.2. Methodology

In preparing the national 1990-2014 GHG inventory, SEPA used the IPCC Inventory Software[4], employing the Tier 1 methods from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, and default emission factors for all source and removal categories. GHG inventories for the period after 2010 do not include data relevant to the Autonomous Province of Kosovo and Metohija, since relevant institutions do not have official data from this territory. Due to a lack of data in certain activities, GHG inventories are based on estimations (interpolation and extrapolation). Inventories do not include GHG emissions from international air and river transport due to a lack of the data collection system in place for such activities. Activity data used for GHG inventories for the period 1990 - 2014 are archived and available at SEPA.

The GHG emissions are expressed in CO_2 equivalent in accordance with the IPCC's 4th Assessment Report (Global warming potential values are 1 for CO_2, 25 for CH_4 and 298 for N_2O).

The GHG inventories for years 1990, 2000, 2005 and the period 2010 – 2014 can be found under the ensuing sub-headings. The quality of activity data for the period 2010 - 2014 has significantly improved. Emissions

[4] http://www.ipcc-nggip.iges.or.jp/software/index.html

that were not estimated due to lack of data are labeled as "NE". NO" corresponds to emissions that are not relevant or where they do not occur at the national level and NA corresponds to emissions that are not relevant or where no specific emissions of gases from various processes occur (not applicable). Also, the National Climate Change Strategy and Action Plan (in preparation) will use 2010 as the reference year. For the entire period since 1990, GHG emissions are graphically represented in categories broken down by sectors according to the level of emission contribution.

3.3. GHG Inventory and trends by sector

3.3.1. Energy sector

The energy sector is traditionally the main contributing sector in the GHG inventory of the Republic of Serbia. According to 2014 estimates, emissions from energy sector amounted to 53,732.71 Gg CO_2eq, or 80.0% of total GHG emissions. However, these values should be interpreted with caution due to lack of necessary data, and final GHG inventory will be made in the next report.

Since 2000, emissions have increased by 9.0%, mainly as a result of significantly higher consumption of diesel and gasoline in road transport and moderate fuel consumption in energy industry.

Table 3.2: Total emissions and GHG emissions broken down by sub-sectors within Energy sector (Gg CO_2eq)

Energy (Gg CO_2 eq)	1990.	2000.	2005.	2010.	2011.	2012.	2013.	2014.
1.A - Fuel Combustion Activities	**61.272,15**	**46.399,09**	**51.972,60**	**47.780,42**	**51.100,06**	**46.032,98**	**46.938,07**	**50.925,24**
1.A.1 - Energy Industries	40.746,42	35.619,66	35.358,43	34.122,91	37.190,07	32.989,09	34.338,47	36.617,07
1.A.2 - Manufacturing Industries and Construction	5.715,04	5.001,38	6.929,42	4.027,38	4.375,11	4.395,50	3.824,22	4.874,56
1.A.3 - Transport	4.952,13	2.376,36	6.698,73	6.677,40	6.033,37	5.334,05	5.829,74	6.331,87
1.A.4 - Other Sectors	9.738,34	2.720,53	2,.442,87	2.297,65	2.696,60	3.314,34	2.945,65	3.101,74
1.A.5 - Non-Specified	120,22	681,16	543,16	655,09	804,90	0,00	0,00	0,00
1.B - Fugitive emissions from fuels	**4.458,23**	**2.901,80**	**3.451,48**	**3.224,44**	**2.819,67**	**2.638,50**	**2.722,99**	**2.807,47**

1.B.1 - Solid Fuels	970,42	1.022,05	955,79	1.004,51	1.099,05	1.020,23	1.070,75	1.121,26
1.B.2 - Oil and Natural Gas	3.487,81	1.879,75	2.495,69	2.219,93	1.720,62	1.618,26	1.652,24	1.686,21
1.B.3 - Other emissions from Energy Production	NO	NO	NO	NO	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Total	**65.730,38**	**49.300,89**	**55.424,08**	**51.004,86**	**53.919,72**	**48.671,48**	**49.661,06**	**53.732,71**

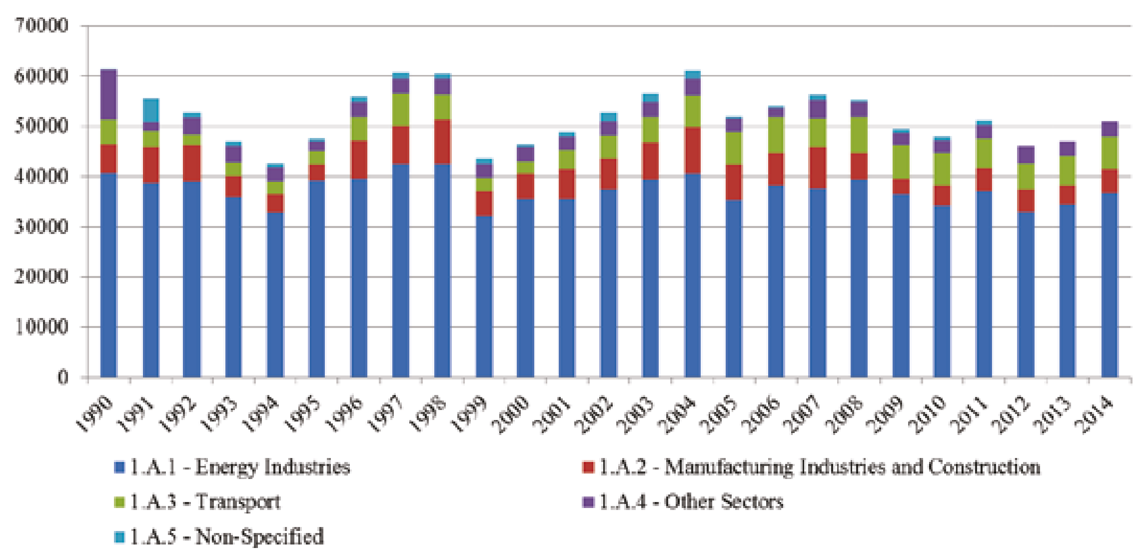


Figure 3.1: **GHG emissions by source categories in 1.A Fuel combustion activities in the energy sector (Gg CO_2eq))**

Out of total estimated GHG emissions from energy sector in the year 2014, 94.8% originated from fuel combustion activities (source category 1.A.), in which 71.9% belong to energy industries, 9.6% to manufacturing industries and construction, 12.4% to transport and 6.1% to other sectors. Out of fugitive emissions from fuels (source category 1.B.), with the share of 5.2% in total emissions from energy sector, 60.1% belong to oil and natural gas extraction, transport and distribution, and 39.9% to solid fuels (domestic coal extraction).

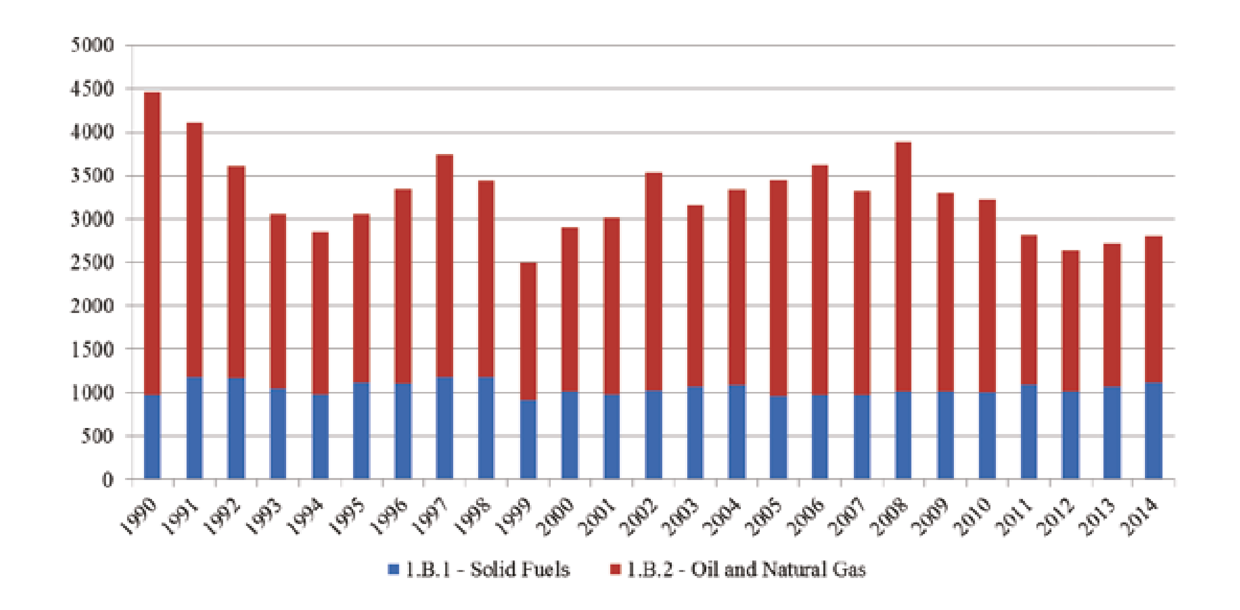


Figure 3.2: GHG emissions broken down by source categories in 1.B Fugitive emissions from fuels in the energy sector, (Gg CO_2eq)

Trends of GHG emissions from fuel combustion activities in the period 2000-2014 show an increase of emissions from all source categories, except from manufacturing industries and construction (2.5% decrease). The highest increase of GHG emission in the observed period was in transport sector (almost three-fold). Decrease of GHG emissions was caused by specific national circumstances characteristic of the period until 2000 (international community sanctions). In the most recent period, 2010-2014, there were no significant changes in level of emissions as well as in the shares of different source categories in energy sector.

3.3.2. Industrial processes

In 2014, emissions from the industrial processes sector amounted to 3402.20 Gg CO_2eq, or 5.1% of total GHG emissions. Since 2000, emissions from this sector have increased by 10.9% in total, but with significant differences in the share of individual sub-sectors: mineral industry (decreased by 37.6%), chemical industry (increased by 2.7 times), metal industry (decreased by 18.6%).

Table 3.3: Total and GHG emissions broken down by source categories within the Industrial processes sector (Gg CO_2eq)

IPPU (Gg CO_2 eq)	1990.	2000.	2005.	2010.	2011.	2012.	2013.	2014.
2.A - Mineral Industry	**1.937,33**	**1.583,19**	**1.595,68**	**1.317,49**	**1.316,05**	**1.131,19**	**1.061,23**	**987,83**
2.A.1 - Cement production	1.340,26	1.045,8	1.187,86	1.050,52	1.031,96	877,66	772,02	666,37
2.A.2 - Lime production	410,47	378,96	286,47	184,39	210,76	183,69	214,92	246,16

2.A.3 - Glass production	27,07	11,27	4,78	4,22	3,31	2,42	3,35	4,27
2.A.4 - Other process uses of carbonates	159,53	147,17	116,57	78,36	70,01	67,41	70,94	71,02
2.A.5 - Other	NE	NE	NE	NE	NE	NE	NE	NE
2.B - Chemical industry	**1.242,17**	**491,36**	**898,62**	**722,85**	**852,91**	**745,26**	**1.034,52**	**1.323,8**
2.B.1 - Ammonia production	215,13	128,93	112,35	69,75	143,69	162,57	229,84	297,1
2.B.2 - Nitric acid production	633,61	203,83	458,62	337,93	458,62	504,22	541,76	579,31
2.B.8 - Petrochemical and carbon black production	393,43	158,6	327,65	315,17	250,59	78,47	262,92	447,37
2.C - Metal industry	1.497,59	931,93	1.920,2	1995,2	2131,71	576,24	662,46	758,76
2.C.1 - Iron and steel production	1.423,5	914,54	1.916,59	1985,61	2126,48	572,56	660,95	749,35
2.C.4 - Magnesium production	29,69	0	2,68	4,79	0	0	0	9,23
2.C.5 - Lead production	3,12	3,63	0,93	4,81	5,23	3,68	1,51	0,18
2.C.6 - Zinc production	41,28	13,76	0	0	0	0	0	0
2.C.7 - Other (please specify)	NE	NE	NE	NE	NE	NE	NE	NE
2.D - Non-Energy products from fuels and solvent use	194,04	9,24	29,57	39,5	44,8	44,21	61,9	79,58
2.D.1 - Lubricant use	194,04	9,24	29,57	37,14	41,85	41,26	58,95	76,63
2.D.2 - Paraffin wax Use	0	0	0	2,36	2,95	2,95	2,95	2,95
2.E - Electronics industry	NE	NE	NE	NE	NE	NE	NE	NE

2.F - Use of Product containing ozone depleting substances	0	1,12	10,49	68,72	80,11	107,1	143,33	188,07
2.F.1 - Refrigeration and air conditioning	0	1,12	10,49	68,72	80,11	107,1	143,33	188,07
2.G - Other product manufacture and use	0	51,6	51,43	57,9	57,23	58,35	67,97	64,17
2.G.3 - N_2O from product uses	0	51,6	51,43	57,9	57,23	58,35	67,97	64,17
2.H - Other	NE	NE	NE	NE	NE	NE	NE	NE
Total	**4.871,13**	**3.068,45**	**4.506**	**4.201,66**	**4.482,8**	**2.662,35**	**3.031,42**	**3.402,2**

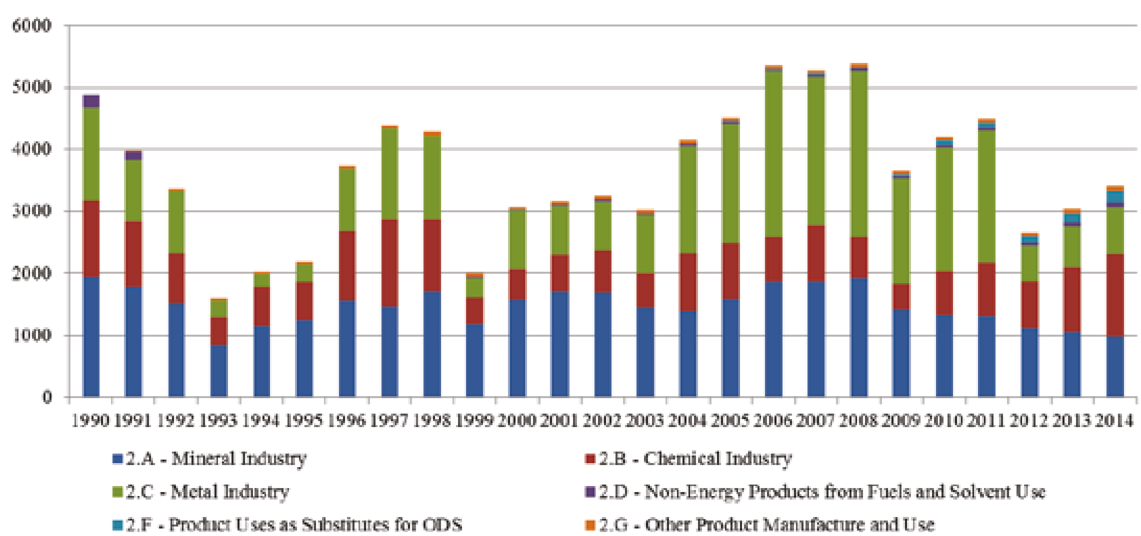


Figure 3.3: **GHG emissions broken down by categories in the Industrial processes and product use sector (Gg CO_2eq)**

As regards the industrial processes and product use sector in the year 2014, 38.9% of the total GHG emissions were from chemical industry, where the share of nitric acid, carbon black and ammonia production was 17.0%, 13.1% and 8.7% respectively. Mineral industry followed with 29.0%, where cement production was the highest individual contributor with 19.6% to total emissions from this sector. Iron and steel production in metal industry contributed with 22.0% to total emissions from this sector. The remaining emission sources include: use of products that contain Ozone Depleting Substances (5.5%), lubricant and paraffin wax use (2.3%) and N_2O from product uses (1.9%).

Following 2008, the national economy was considerably affected by global economic crisis, so that GDP growth rate, which had a positive trend in the pre-crisis period, started to decline. The economic sectors that were most severely stricken by the crisis are the ones that had the highest growth rates in the previous period, particularly mineral and steel industry and construction. Consequently, the key underlying factor for a significant decrease of GHG emissions from industrial processes in the period 2010-2014 was low demand for Portland cement and iron and steel which consequently led to under-utilization of production capacities in these industries. In 2010 industrial sector slowly started recovering from impacts of global economic crisis, particularly chemical industry (GHG emission increased by 83.1% from this source category in the period 2010-2014), but this is still not the case for metal industry and construction.

3.3.3. Agriculture, Forestry and Other Land Use sector (AFOLU)

In the year 2014, estimated total net removals[5] from Agriculture, forestry and other land use sector (AFOLU) amounted to -11,111.69 Gg CO_2eq. Since 2000, total net removal has increased by 46.8%. Table 3.4 and figure 3.4 present trends of GHG emissions from source and removal categories within AFOLU sector.

Table 3.4: Total emissions and GHG emissions broken down by categories in the AFOLU sector (Gg CO_2eq.)

AFOLU (Gg CO_2eq)	1990.	2000.	2005.	2010.	2011.	2012.	2013.	2014.
3.A - Livestock	**5.109,26**	**4.193,87**	**3.705,89**	**3.222,84**	**3.177,8**	**3.165,19**	**3.142,5**	**3.087,71**
3.A.1 - Enteric fermentation	3.554,08	2.874,84	2.511,18	2.118,8	2.106,03	2.095,23	2.058,97	2.019,13
3.A.2 - Manure management	1.555,19	1.319,03	1.194,71	1104,04	1.071,78	1.069,96	1.083,53	1.068,58
3.B - Land	-16.560,97	-13.866,41	-10.869,96	-16198,52	-16.368,77	-14.430,9	-15.373,89	-17.507,2
3.B.1 - Forest land	-16.855,17	-14.160,39	-11.244,36	-16558,11	-16.730,18	-14.791,84	-15.735,64	-17.848,1
3.B.2 - Cropland	110,04	110,01	235,84	221,03	222,86	222,38	223,19	223,99
3.B.3 - Grassland	102,27	102,19	5,25	5,25	5,25	5,25	5,25	5,25
3.B.4 - Wetlands	30,44	30,44	21,64	21,64	21,64	21,64	21,64	0
3.B.5 - Settlements	43,07	42,97	110,57	110,57	110,57	110,57	110,57	110,57
3.B.6 - Other land	8,36	8,36	1,1	1,1	1,1	1,1	1,1	1,1

[5] Net removals are calculated as difference between removals from sinks and emissions per categories in AFOLU sector.

3.C - Aggregate sources and non-CO_2 emission sources on land	**3.674,77**	**2.106,07**	**3.287,24**	**2883,79**	**2.920,21**	**2.851,95**	**3.116,71**	**3.308,67**
3.C.1 - Emissions from biomass burning	3,59	3,24	0,14	1,35	5,46	20	1,51	2,1
3.C.2 - Liming	NE	NE	NE	NE	NE	NE	NE	NE
3.C.3 - Urea application	32,18	35,05	132,83	97,48	94,46	91,45	88,44	85,43
3.C.4 - Direct N_2O emissions from managed soils	2.452,82	1.268,14	2.165,38	1.882,83	1.917,73	1.833,92	2.062,83	2.268,83
3.C.5 - Indirect N_2O emissions from managed soils	785,31	447,35	659,67	570,56	585,21	583,7	631,86	623,17
3.C.6 - Indirect N_2O emissions from manure management	400,86	352,29	329,23	331,58	317,35	322,88	332,08	329,14
3.C.7 - Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO
3.C.8 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
3.D - Other	**-0,19**	**-0,39**	**-1,26**	**-0,75**	**-2,99**	**-2,09**	**-1,42**	**-0,91**
3.D.1 - Harvested wood products	-0,19	-0,39	-1,26	-0,75	-2,99	-2,09	-1,42	-0,91
3.D.2 - Other (please specify)	NO	NO	NO	NO	NO	NO	NO	NO
Total	**-7.777,13**	**-7.566,86**	**-3.878,08**	**-10.092,64**	**-10.273,74**	**-8.415,84**	**-9.116,1**	**-11.111,7**

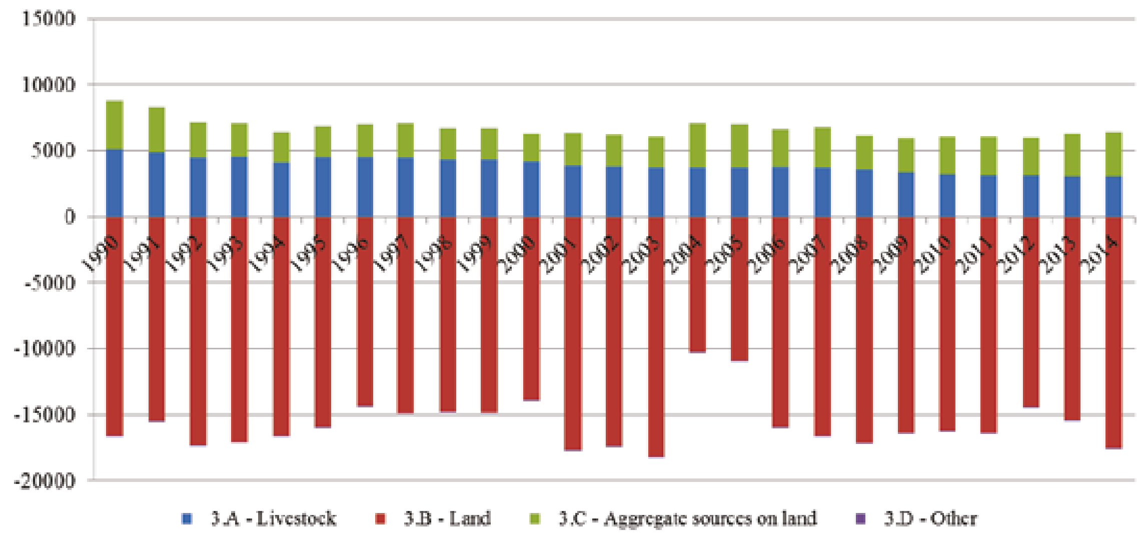


Figure 3.4: GHG emissions broken down by categories in the AFOLU sector (Gg CO_2eq).

In 2014, sources within the AFOLU sector emitted 6737.29 Gg CO_2eq, 3087.71 Gg CO_2eq (45.8%) of which were a result of both direct and indirect emissions of CH_4 and N_2O generated by livestock activities and manure management. GHG emissions from aggregate sources and non-CO_2 land emission sources, including emissions from biomass burning, urea application, managed soil and manure management, amounted to 3308.67 Gg CO_2eq (49.1%). The remaining emissions in 2014, which make up approximately 5% of total emissions, originate from land use change, such as the intended use of croplands, grasslands, wetlands, settlements and other land.

On the other hand, the share of emissions under Land and "Other" category, or more precisely forest land and the use of harvested wood products (HWP) to remove GHG emissions, was 17848.08 Gg CO_2eq and -0.91 Gg CO_2eq, respectively.

Although total net removals from AFOLU sector have increased by 46.8% since 2000, in the same period GHG emissions from livestock have decreased by 26.4% mainly as a result of large decrease in total number of dairy cows (46.6% decrease in the period 2000-2014). Emissions from aggregate sources and non-CO_2 emissions sources increased by 57.1% in the period 2000-2014 due to more frequent use of UREA (2.4 times more frequently) and nitrogen-based synthetic fertilizers (increased by 3.2 times) on managed land.

3.3.4. Waste management sector

In 2014, estimated emissions from the waste sector amounted to 3276.03 Gg CO_2eq, or 4.9% of total GHG emissions. Estimated emissions in 2014 decreased by 1.3% compared to emissions in 2000 from this sector.

Table 3.5: **Total and GHG emissions broken down by source categories within the waste management sector**

Waste (Gg CO_2eq)	1990	2000	2005	2010	2011	2012	2013	2014
4.A - Solid waste disposal	2362.58	2176.18	2049.85	1993.05	1990.37	1991.15	1986.32	1989.24
4.B - Biological treatment of solid waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.C - Incineration and open burning of waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.D - Wastewater treatment and discharge	1477.19	1142.40	1098.23	1147.85	1174.68	1255.82	1221.13	1286.78
4.E - Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**3839.77**	**3318.58**	**3148.09**	**3140.90**	**3165.05**	**3246.97**	**3207.45**	**3276.03**

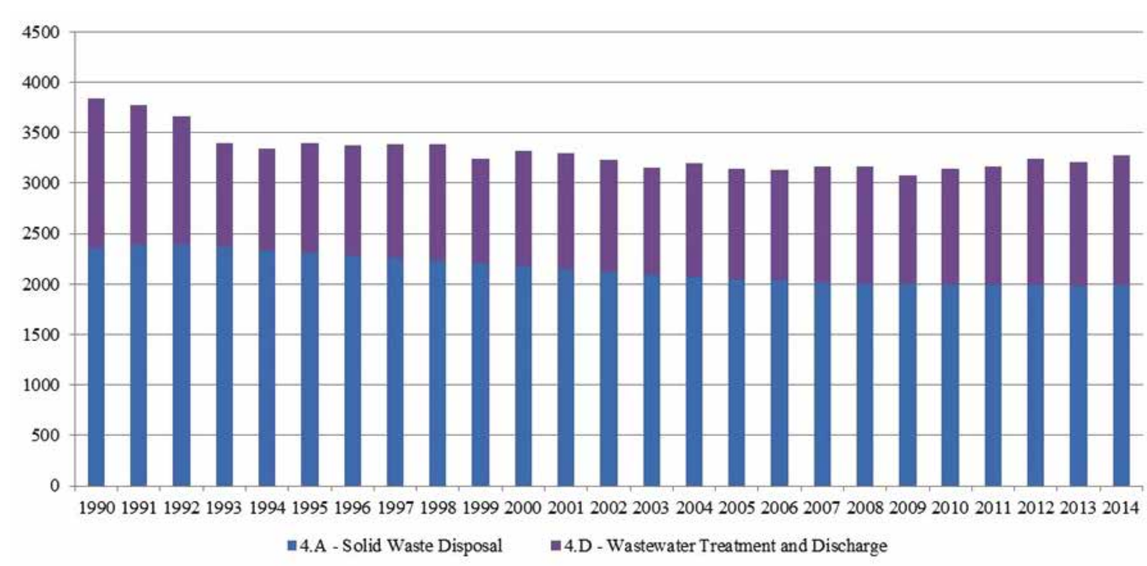


Figure 3.5: **GHG emissions broken down by categories in the waste management sector (Gg CO_2eq)**

In the sector of waste management 60.7% of total emissions in the year 2014 originated from solid waste disposal on land, and 39.3% from wastewater treatment. Despite improvements in waste and wastewater management practices in the recent period, the total number of waste management facilities and amounts of treated solid waste and wastewater is still negligible and the share of GHG emissions from these categories has remained almost constant over the observed period.

3.4. GHG emissions and removals and gas trends

3.4.1. Carbon dioxide (CO_2)

The most important greenhouse gas in the Republic of Serbia is CO_2 In the year 2014, CO_2 emissions amounted to 53208.70 Gg. In the period 2000-2014, the share of CO_2 emissions in total GHG emissions excluding removals ranged from 78.9% to 83.8%. Overall, CO_2 emissions have increased by 7.8% since 2000. Most of CO_2 emissions originate from energy sector; in the year 2014 energy sector accounted for 95.0% in total CO_2 emissions.

Table 3.6: **CO_2 emissions and removals, broken down by categories (Gg)**

CO_2 (Gg)	1990.	2000.	2005.	2010.	2011.	2012.	2013.	2014.
1 - Energy	**62.889,85**	**46.513,39**	**52.891,35**	**48.453,59**	**51.109,54**	**45.653,14**	**46.578,69**	**50.552,64**
1.A - Fuel combustion activities	60.786,74	45.721,84	51.227,4	47.285,75	50.596,46	45.341,78	46.269,31	50.245,25
1.B - Fugitive emissions from fuels	2.103,1	791,55	1.663,95	1.167,83	513,08	311,36	309,37	307,39
1.C - Carbon dioxide transport and storage	NO	NO	NO	NO	NO	NO	NO	NO
2 - Industrial processes and product Use	**4.237,52**	**2.811,9**	**3.985,45**	**3.737,11**	**3.886,84**	**1.992,68**	**2.278,34**	**2.570,64**
2.A - Mineral industry	1.937,33	1.583,19	1.595,68	1.317,49	1.316,05	1.131,19	1.061,23	987,83
2.B - Chemical industry	608,56	287,53	440	384,91	394,29	241,05	492,76	744,47
2.C - Metal industry	1.497,59	931,93	1.920,2	1.995,2	2.131,71	576,24	662,46	758,76
2.D - Non-energy products from fuels and solvent use	194,04	9,24	29,57	39,5	44,8	44,21	61,9	79,58
2.E - Electronics industry	NE	NE	NE	NE	NE	NE	NE	NE
2.F - Use of products containing ozone depleting substances	NA	NA	NA	NA	NA	NA	NA	NA

2.G - Other product manufacture and use	NE	NE	NE	NE	NE	NE	NE	NE
2.H - Other	NE	NE	NE	NE	NE	NE	NE	NE
3 - Agriculture, forestry, and other land use	**-16.528,98**	**-13.831,75**	**-10.738,39**	**-16.101,8**	**-16.277,29**	**-14.341,54**	**-15.286,87**	**-17.422,7**
3.A - Livestock	NA	NA	NA	NA	NA	NA	NA	NA
3.B - Land - removals	-16.855,17	-14.160,39	-11.244,36	-16.558,11	-16.730,18	-14.791,84	-15.735,64	-17.507,2
3.B - Land - emissions	294,19	293,97	374,4	359,6	361,42	360,94	361,75	85,43
3.C - Aggregate sources and non-CO_2 emissions sources on land	32,18	35,05	132,83	97,48	94,46	91,45	88,44	-0,91
3.D - Other	-0,19	-0,39	-1,26	-0,75	-2,99	-2,09	-1,42	0
4 - Waste	**NA**	**NA**	**NA**	**NA**	**NA**	**0**	**0**	**0**
4.A - Solid waste disposal	NA	NA	NA	NA	NA	NA	NA	NA
4.B - Biological treatment of solid waste	NA	NA	NA	NA	NA	NA	NA	NA
4.C - Incineration and open burning of waste	NA	NA	NA	NA	NA	NA	NA	NA
4.D - Wastewater treatment and discharge	NA	NA	NA	NA	NA	NA	NA	NA
4.E - Other (please specify)	NA	NA	NA	NA	NA	NA	NA	NA
Total CO_2 emissions excluding Removals	**67.453,74**	**49.654,32**	**57.384,02**	**52.647,76**	**55.452,26**	**48.098,22**	**49.307,21**	**53.208,7**
Total CO_2 emissions including removals	**50.598,38**	**35.493,54**	**46.138,41**	**36.088,9**	**38.719,09**	**33.304,29**	**33.570,16**	**35.700,63**

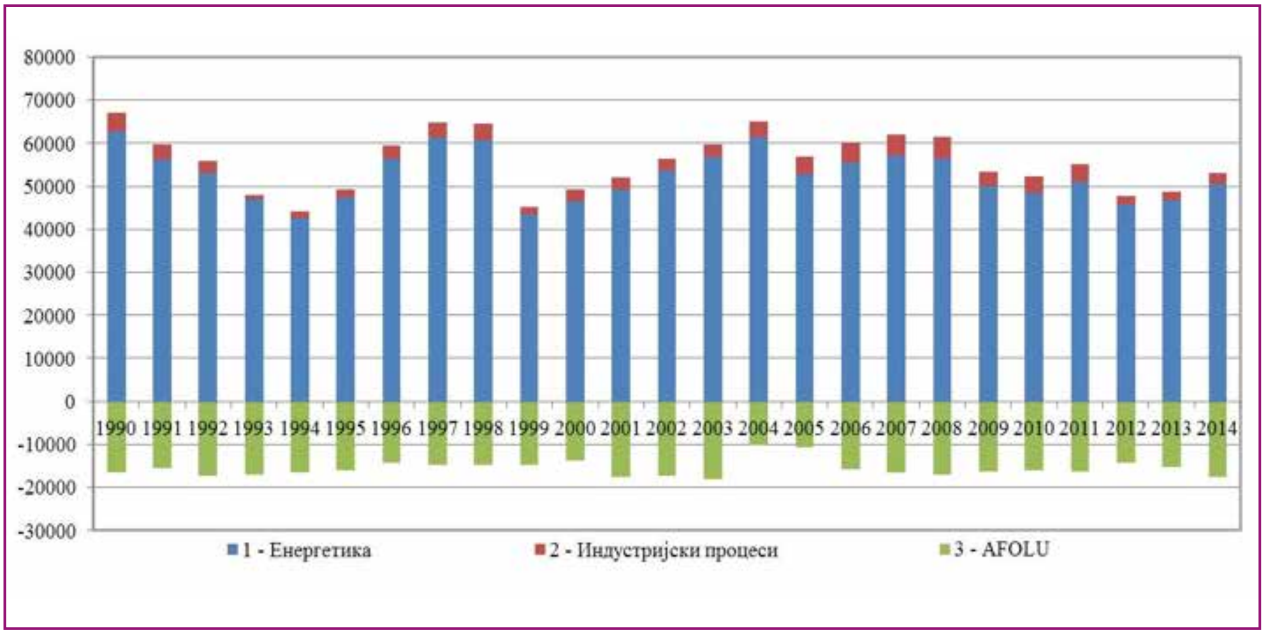


Figure 3.6: CO_2, emissions and removals, broken down by sector, in 1990-2014 (Gg CO_2)

3.4.2. Methane (CH_4)

In 2014, methane (CH_4) emissions equaled 351.39 Gg. The share of CH_4 emissions in the total GHG emissions ranged from 11.3% to 15.3% in 2000-2014. Overall, CH_4 emissions decreased by 8.0% in 2014 in comparison to 2000. There are three source categories that were the most significant contributors to CH_4 emissions in the year 2014: 3.A Livestock (31.5%), 1.B Fugitive emissions from fuels (28.4%) and 4.A Solid waste disposal (22.6%).

Table 3.7: CH_4 emissions broken down by categories (Gg)

CH_4 (Gg)	1990.	2000.	2005.	2010.	2011.	2012.	2013.	2014.
1 - Energy	**102,47**	**101,44**	**88,85**	**91,61**	**101,70**	**109,75**	**111,75**	**114,86**
1.A - Fuel combustion activities	8,65	17,17	17,65	9,56	9,52	16,72	15,25	14,91
1.B - Fugitive emissions from fuels	93,82	84,27	71,19	82,05	92,17	93,03	96,49	99,95
1.C - Carbon dioxide transport and storage	NO	NO	NO	NO	NO	NO	NO	NO

2 - Industrial processes and product use	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
2.A - Mineral industry	NA	NA	NA	NA	NA	NA	NA	NA
2.B - Chemical industry	NA	NA	NA	NA	NA	NA	NA	NA
2.C - Metal industry	NA	NA	NA	NA	NA	NA	NA	NA
2.D - Non-energy products from Fuels and Solvent Use	NA	NA	NA	NA	NA	NA	NA	NA
2.E - Electronics industry	NA	NA	NA	NA	NA	NA	NA	NA
2.F - Use of products containing ozone depleting substances	NA	NA	NA	NA	NA	NA	NA	NA
2.G - Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO
2.H - Other	NE	NE	NE	NE	NE	NE	NE	NE
3 - Agriculture, forestry, and other land use	**187,98**	**153,50**	**134,90**	**115,98**	**114,79**	**114,53**	**112,66**	**110,60**
3.A - Livestock	187,86	153,38	134,89	115,93	114,60	113,84	112,61	110,52
3.B - Land	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate sources and non-CO_2 emissions sources on land	0,12	0,11	0.00	0,05	0,19	0,69	0,05	0,08
3.D - Other	NA	NA	NA	NA	NA	NA	NA	NA

4 - Waste	**147,99**	**127,20**	**120,60**	**120,42**	**121,41**	**124,73**	**123,19**	**125,92**
4.A - Solid waste disposal	94,50	87,05	81,99	79,72	79,61	79,65	79,45	79,57
4.B - Biological treatment of solid waste	NE	NE	NE	NE	NE	NE	NE	NE
4.C - Incineration and open burning of waste	NE	NE	NE	NE	NE	NE	NE	NE
4.D - Wastewater treatment and discharge	53,48	40,15	38,60	40,69	41,79	45,08	43,73	46,35
4.E - Other (please specify)	NE	NE	NE	NE	NE	NE	NE	NE
Total CH_4 emissions	**438,44**	**382,13**	**344,34**	**328,00**	**337,90**	**349,01**	**347,59**	**351,39**

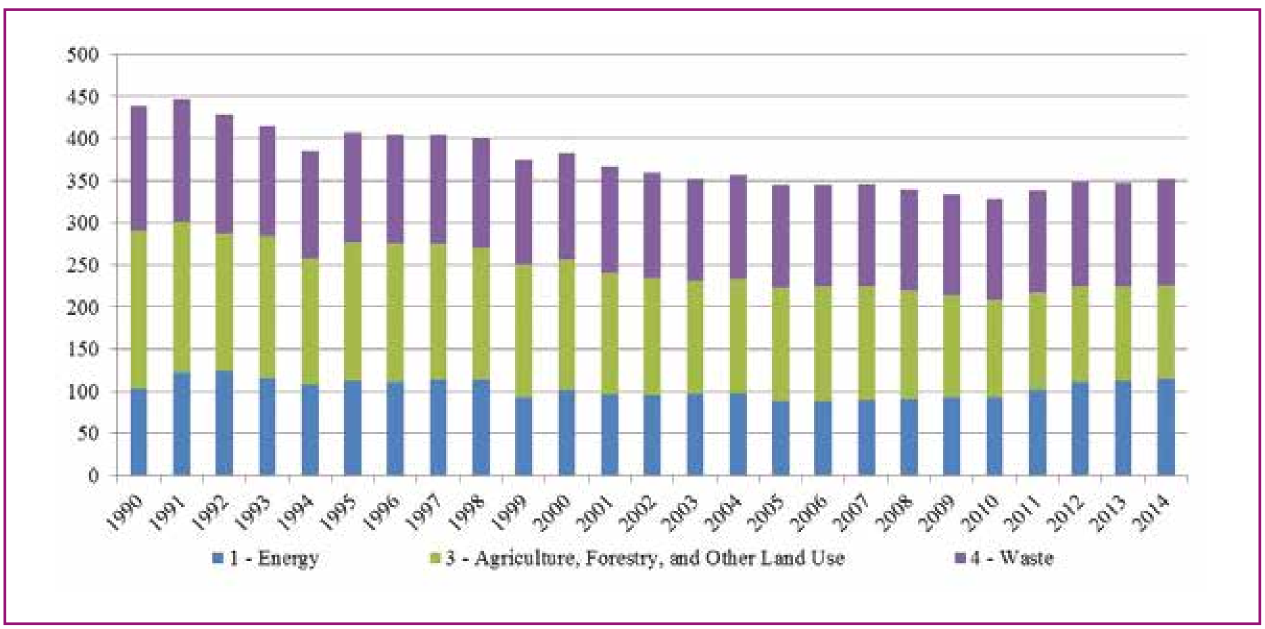


Figure 3.7: **CH_4, emissions broken down by sector from 1990-2014 (Gg).**

3.4.3. Nitrous oxide (N_2O)

In 2014, N_2O emission amounted to 15.52 Gg. In general, N_2O emissions increased by 50.5% in 2014 in comparison to 2000. In 2000-2014 period, the share of N_2O emissions in the total greenhouse gas emissions excluding removals ranged from 4.7% to 7.0%. The most important N_2O emissions in 2014 are listed under categories Aggregate sources and Non-CO_2 emissions sources on land, in other words, these are direct and indirect N_2O emissions from managed soils (due to application of nitrogen based fertilizers in agriculture).

Table 3.8: N_2O emissions, by categories (Gg).

N_2O (Gg)	1990.	2000.	2005.	2010.	2011.	2012.	2013.	2014.
1 - Energy	**0,94**	**0,84**	**1,05**	**0,88**	**0,90**	**0,92**	**0,97**	**1,04**
1.A - Fuel combustion activities	0,90	0,83	1,02	0,86	0,89	0,92	0,96	1,03
1.B - Fugitive emissions from fuels	0,03	0,01	0,03	0,02	0,01	0.00	0.00	0.00
1.C - Carbon dioxide transport and storage	NO	NO	NO	NO	NO	NO	NO	NO
2 - Industrial processes and product Use	**2,13**	**0,86**	**1,71**	**1,33**	**1,73**	**1,89**	**2,05**	**2,16**
2.A - Mineral industry	NA	NA	NA	NA	NA	NA	NA	NA
2.B - Chemical industry	2,13	0,68	1,54	1,13	1,54	1,69	1,82	1,94
2.C - Metal industry	0.00	0.00	0.00	0.00	0,00	0.00	0.00	0.00
2.D - Non-energy products from fuels and solvent use	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
2.E - Electronics industry	NA	NA	NA	NA	NA	NA	NA	NA
2.F - Use of products containing ozone depleting substances	NA	NA	NA	NA	NA	NA	NA	NA
2.G - Other product manufacture and use	NA	0,17	0,17	0,19	0,19	0,20	0,23	0,22
2.H - Other	NE	NE	NE	NE	NE	NE	NE	NE

3 - Agriculture, forestry, and other land use	**13,60**	**8,15**	**11,70**	**10,44**	**10,52**	**10,28**	**11,26**	**11,90**
3.A - Livestock	1,39	1,21	1,12	1,09	1,05	1,07	1,10	1,09
3.B - Land	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate sources and non-CO_2 emissions sources on land	12,21	6,94	10,58	9,35	9,47	9,21	10,16	10,81
3.D - Other	NA	NA	NA	NA	NA	NA	NA	NA
4 - Waste	**0,47**	**0,47**	**0,45**	**0,44**	**0,44**	**0,43**	**0,43**	**0,43**
4.A - Solid waste disposal	NA	NA	NA	NA	NA	NA	NA	NA
4.B - Biological treatment of solid waste	NE	NE	NE	NE	NE	NE	NE	NE
4.C - Incineration and open burning of waste	NE	NE	NE	NE	NE	NE	NE	NE
4.D - Wastewater treatment and discharge	0,47	0,47	0,45	0,44	0,44	0,43	0,43	0,43
4.E - Other (please specify)	NE	NE	NE	NE	NE	NE	NE	NE
Total N_2O Emissions	**17,13**	**10,31**	**14,91**	**13,08**	**13,58**	**13,52**	**14,70**	**15,52**

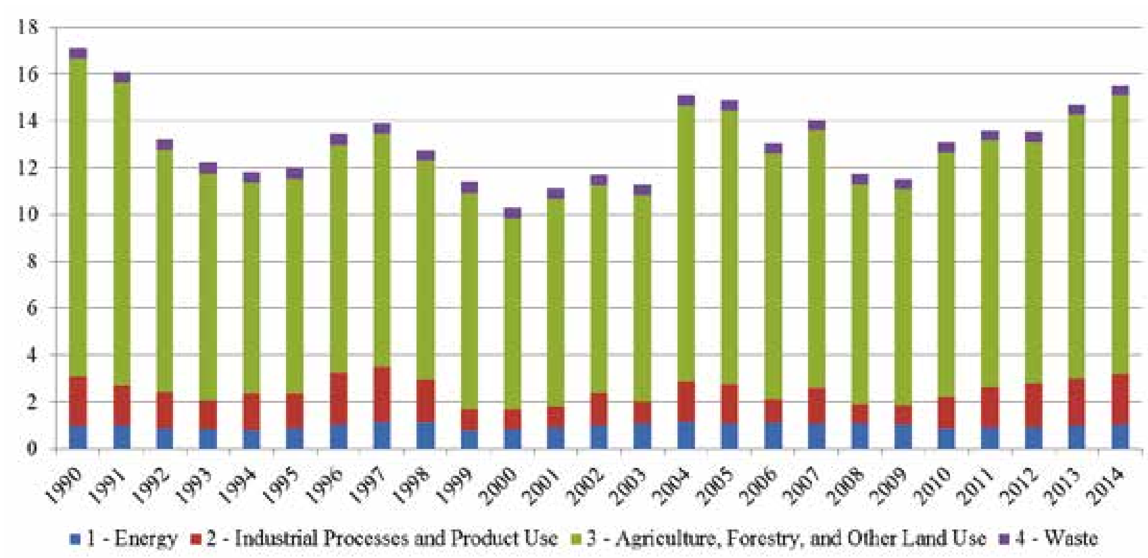


Figure 3.8: **N_2O emissions, broken down by sector for 1990-2014 (Gg).**

3.4.4. Hydrofluorocarbons (HFCs)

The consumption of HFCs has significantly increased since 2000 mainly as a result of substitution of ozone depleting substances in air conditioning systems. This was the key factor for a potential increase in emissions of HFCs, although it makes up under 1% of total national GHG emissions. Table 3.9 shows a trend of HFCs emissions from source category 2.F Use of products containing ozone depleting substances.

Table 3.9: **HFCs emissions, broken down by source categories (Gg CO_2eq).**

HFCs (Gg CO_2eq)	1990.	2000.	2005.	2010.	2011.	2012.	2013.	2014.
2 - Industrial processes and product use	**0.00**	**1,12**	**10,49**	**68,72**	**80,11**	**107,10**	**143,33**	**188,07**
2.A - Mineral industry	NA	NA	NA	NA	NA	NA	NA	NA
2.B - Chemical industry	NA	NA	NA	NA	NA	NA	NA	NA
2.C - Metal industry	NA	NA	NA	NA	NA	NA	NA	NA
2.D - Non-energy products from fuels and solvent use	NA	NA	NA	NA	NA	NA	NA	NA
2.E - Electronics industry	NE	NE	NE	NE	NE	NE	NE	NE

2.F - Use of products containing ozone depleting substances	NE	1,12	10,49	68,72	80,11	107,10	143,33	188,07
2.G - Other Product Manufacture and Use	NA	NA	NA	NA	NA	NA	NA	NA
2.H - Other	NA	NA	NA	NA	NA	NA	NA	NA
Total HFCs Emissions	**0.00**	**1,12**	**10,49**	**68,72**	**80,11**	**107,10**	**143,33**	**188,07**

3.5. Total emissions and trends of total GHG emissions

3.5.1. By sectors

In 2014, total GHG emissions excluding removals in the Republic of Serbia amounted to 67148.23 Gg CO_2 eq. Since 2000, total GHG emissions excluding removals have increased by 7.8%. Total GHG emissions including removals, in 2014 were 49,299.24 Gg CO_2eq, which is an increase of 2.4% compared to 2000. Table 3.10 and Figure 3.9 show trends of GHG emissions and removals broken down by sectors in the period 1990-2014.

Table 3.10: GHG emissions by sources and removals by sinks, broken down by sectors (Gg CO_2eq).

Source and sink category	1990.	2000.	2005.	2010.	2011.	2012.	2013.	2014.
Emissions								
Energy	65.730,38	49.300,89	55.424,08	51.004,86	53.919,72	48.671,48	49.661,06	53.732,71
Industrial processes and product use	4.871,13	3.068,45	4.506,00	4.201,66	4.482,80	2.662,35	3.031,42	3.402,20
Agriculture, forestry, and other land use	9.078,22	6.593,92	7.367,53	6.466,23	6.459,43	6.378,09	6.620,96	6.737,29
Waste	3.839,77	3.318,58	3.148,09	3.140,90	3.165,05	3.246,97	3.207,45	3.276,03
Removals								
Agriculture, forestry, and other land use	-16.855,36	-14.160.78	-11.245,61	-16.558,87	-16.733,17	-16.733,17	-15.737,06	-17.848,99
Total GHG Emissions excluding removals	**83.519,50**	**62.281.84**	**70.445,69**	**64.813,65**	**68.027,00**	**60.958,89**	**62.520,88**	**67.148,23**
Total GHG emissions including removals	**66.664,14**	**48.121.06**	**59.200,08**	**48.254,78**	**51.293,83**	**44.225,72**	**46.783,83**	**49.299,24**

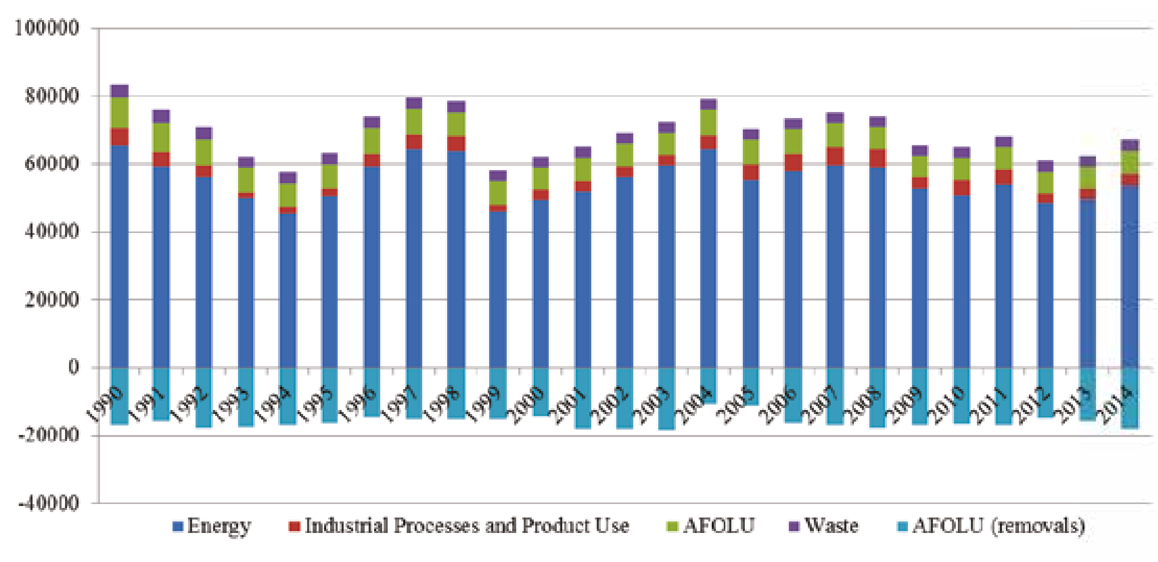


Figure 3.9: GHG emissions by sources and removals by sinks, broken down by sectors, in 1990-2014 (Gg CO_2eq).

The largest share in 2014, or 80.0% of the total GHG emissions, originates from energy sector, while in 2000 the share of this sector in total emissions was 79.2%. The share of AFOLU sector (excluding removals), which in the year 2000 emitted 10.6% of the total GHG emissions as a result of intense agricultural production (biochemical processes in stockbreeding and farming) was 10% of the total GHG emissions in 2014. The share of GHG emissions derived from industrial processes and product use, as well as generated by production and consumption of mineral raw material such as cement, lime, limestone and sodium carbonate, production of chemicals (primarily ammonia production), iron and other metals, and other products was 5.1% in the total GHG emissions in 2014 and 4.9% of the total GHG emissions in 2000. GHG emissions from waste management sector accounted for 5.3% of total emissions in the year 2000, and 4.9% in 2014. Therefore, from 2010 to 2013, GHG emissions changed at different rates in different sectors, but the share in total emissions remained the same.

3.5.2. By gases

In the year 2014, the main greenhouse gas (GHG) was carbon dioxide (CO_2), accounting for 79.7% of total GHG emissions expressed in CO_2 equivalent (CO_2 eq), followed by methane (CH_4) (13.1%) and nitrous oxide (N_2O) (6.9%). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6) collectively accounted for 0.3% of total GHG emissions in the country[6]. In comparison with emissions in 2000, the share of CO_2 in total GHG emissions was the same, i.e. 79.7%, while the share of CH_4 decreased by 2.3% and N_2O increased by 2.0%.

Removals by sinks in forestry in 2014 amounted to -17848.99 Gg CO_2 which is by 26.0% more than in the year 2000. Table 3.11. and Figure 3.10. show greenhouse gas emissions and removals broken down by gases.

[6] Data on import and consumption as well as on available quantities of HFC, PFC and SF6 were made public in 2004 and were used to estimate emissions of these gases since then.

Table 3.11: Greenhouse gas emissions, broken down by gases (Gg CO_2eq).

Greenhouse gas	1990.	2000.	2005.	2010.	2011.	2012.	2013.	2014.
Emissions								
CO_2	67.453,74	49.654,32	57.384,02	52.647,76	55.452,26	48.098,22	49.307,21	53.549,62
CH_4	10.960,93	9.553,27	8.608,51	8.200,09	8.447,43	8.725,14	8.689,75	8.784,69
N_2O	5.104,83	3.073,12	4.442,67	3.897,07	4.047,20	4.028,43	4.380,58	4.625,86
HFCs	0,00	1,12	10,49	68,72	80,11	107,10	143,33	188,07
Removals								
CO_2	-16.855,36	-14.160,78	-11.245,61	-16.558,87	-16.733,17	-16.733,17	-15.737,06	-17.848,99
Total GHG emissions excluding removals	**83.519,50**	**62.281,84**	**70.445,69**	**64.813,65**	**68.027,00**	**60.958,89**	**62.520,88**	**67.148,23**
Total GHG emissions including removals	**66.664,14**	**48.121,06**	**59.200,08**	**48.254,78**	**51.293,83**	**44.225,72**	**46.783,83**	**49.299,24**

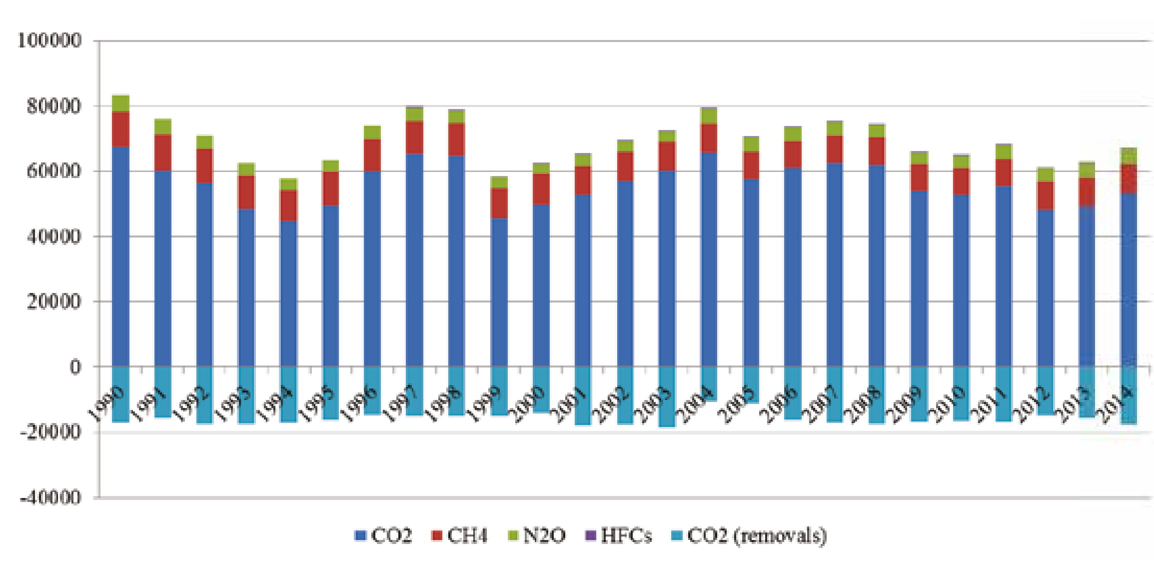


Figure 3.10: GHG source emissions and removals by sinks, broken down by gas types, from 1990 to2014 (Gg CO_2eq).

The trend of total GHG emissions from 2000 to 2014 shows periodical fluctuations influenced mainly by economic factors, both internal and external, starting with a positive trend in the period 2000-2004, and a negative trend after 2008 as a result of global financial and economic crisis that adversely affected the previous period of recovery of national economy and GDP.

The most recent period, 2010-2014, was characterized by a decrease in demand for some commodities such as Portland cement, iron and steel which consequently led to lower utilization of production capacities in these industries. During 2010 economy has started to slowly recover from global economic crisis but without a significant effect on GHG emissions profile, except in the latest inventory year of 2014.

At the same time, the Republic of Serbia has started to develop and implement legislative framework and awareness raising activities on the need of using cleaner and energy- efficient technologies, and renewable energy sources, which eventually lead to further economic growth and reduction of GHG emissions.

3.6. Key categories

Key categories from national GHG inventory, both sources and sinks, were identified using Tier 1 approach (2014) and trend assessment (1990-2014). Key categories are presented in Table 3.12. in the sense of IPCC categories and gases, where L means that assessment was made and T that trend assessment was done.

Table 3.12: Key categories, level and trend assessment

IPCC Category Code	IPCC Category	GHG	Level Assessment (L)	Trend Assessment (T)
Energy				
1.A.1	Energy industries – Solid Fuels	CO_2	L	T
1.A.3.b	Road transportation	CO_2	L	T
1.A.2	Manufacturing Industries and Construction – Gaseous Fuels	CO_2	L	T
1.A.1	Energy Industries – Gaseous Fuels	CO_2	L	T
1.A.2	Manufacturing Industries and Construction – Liquid Fuels	CO_2	L	T
1.A.4	Other Sectors – Solid Fuels	CO_2	L	T

1.B.1	Solid Fuels	CH_4	L	T
1.B.2.a	(Crude) Oil	CH_4	L	T
1.A.4	Other Sectors – Liquid Fuels	CO_2	L	T
1.A.4	Other Sectors - Gaseous Fuels	CO_2	L	T
1.A.1	Energy Industries – Liquid Fuels	CO_2	L	T
1.A.2	Manufacturing Industries and Construction - Solid Fuels	CO_2	L	T
1.A.3.c	Railways	CO_2		T
1.B.2.a	(Crude) Oil	CO_2		T
1.A.4	Other Sectors - Biomass	CH_4		T
Industrial processes and product use				
2.A.1	Cement production	CO_2	L	T
2.C.1	Iron and Steel Production	CO_2	L	T
2.B.2	Nitric Acid Production	N_2O	L	
2.B.8	Petrochemical and Carbon Black Production	CO_2		T
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs		T
AFOLU				
3.B.1.a	Forest Land Remaining Forest Land	CO_2	L	T
3.C.4	Direct N_2O emissions from managed soils	N_2O	L	T

3.A.1	Enteric Fermentation	CH_4	L	T
3.C.5	Indirect N_2O Emissions from managed soils	N_2O	L	
3.A.2	Manure Management	CH_4	L	
3.B.2.b	Land Converted to Cropland	CO_2		T
Waste				
4.A	Solid Waste Disposal	CH_4	L	T
4.D	Wastewater Treatment and Discharge	CH_4	L	

3.7. Uncertainty analysis

The uncertainty related to the annual GHG emissions, as well as to the trends during time, has been assessed in accordance to the 2006 IPCC Good Practice Guide and Uncertainty Management in National Greenhouse Gas Inventories and Good Practice Guidance for Land Use, Land-Use Change and Forestry, by using the Tier 1 approach. The total uncertainty assessed is combination of the individual uncertainties of emission factors and activities.

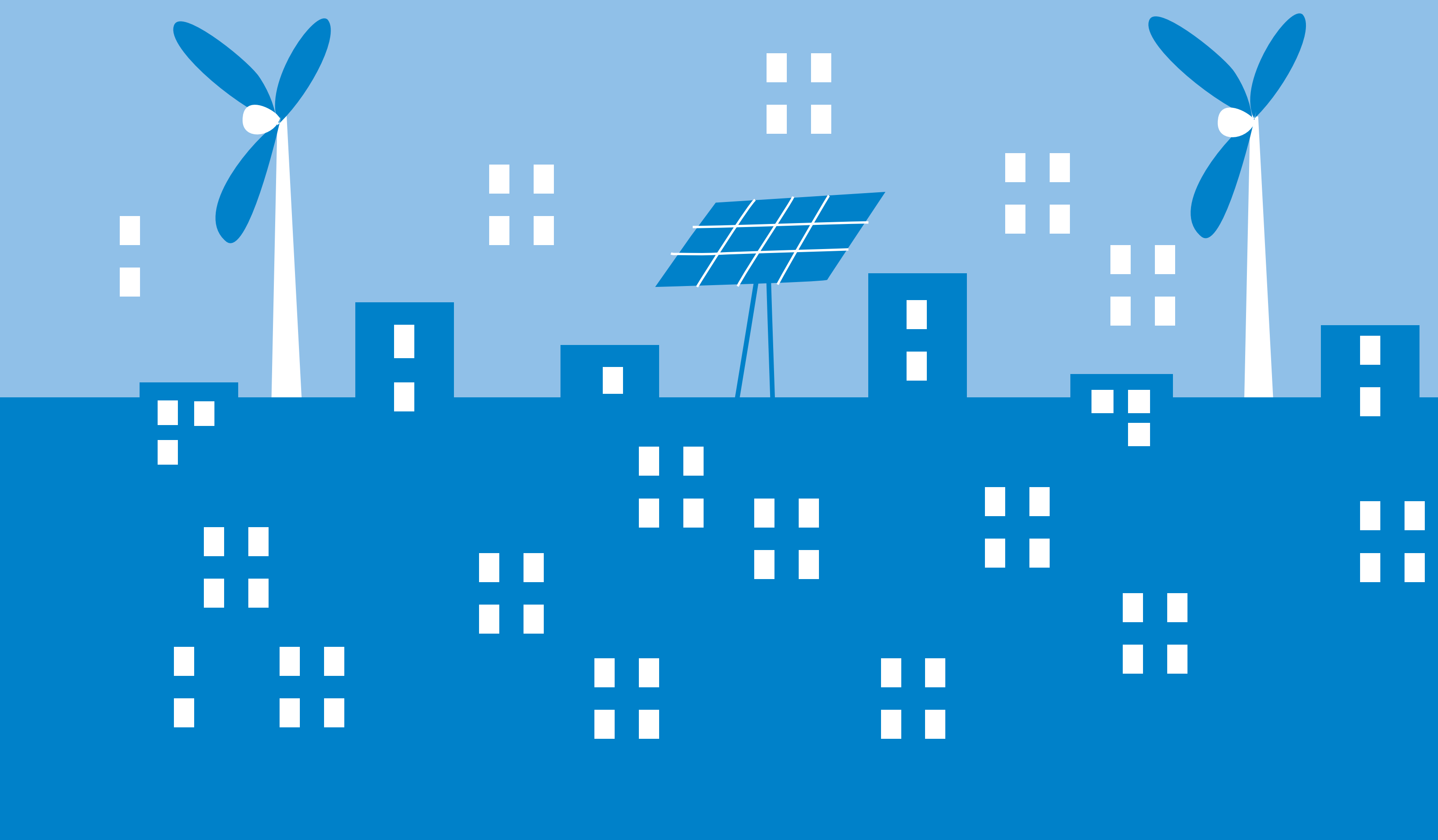
Assessed uncertainty of 2013 emission inventory is 60.4%, while the trends uncertainty is 11.1%. The key sectors having the highest uncertainty are: 3.B.1.a. Forest land (85.2%), 1.B.2.a.ii Flaring (15.1%), 1.A.1.a.i Power generation – solid fuels (10.6%), and 3.C.4 Direct N_2O from the soil management.

The uncertainty of the emission factors used is 5%.

Calculation of energy consumption of available/combusted fossil fuel in energy sector and carbon dioxide emission, according to the Reference and the Sector approach, showed a difference of 4% for solid fuel, 11% for liquid fuel and 20% for gas fuels.

One of the main objectives is to strengthen the capacity of SEPA and institutions that collect activity data. This would improve the quality of data and reduce these uncertainties.

4.PROJECTED GHG EMISSIONS FOR THE PERIOD UNTIL 2020



4.1. Methodology

Projections of total GHG emissions and emissions from individual sectors have been made for three scenarios: basic scenario, scenario "with measures" and scenario "with additional measures". Projections were made until 2030, including 2015, 2020 and 2025. 2010 was chosen as the starting point for projections. LEAP (Long range Energy Alternatives Planning System) model was used for developing all projections.

The basic scenario implies implementation of policies and measures that were in force in 2010, until 2030. The scenario "with measures" entails improving the implementation of the existing policies and measures to be in accordance with the commitments under the EU accession process. The scenario "with additional measures" implies a further reduction in final energy consumption.

In order to achieve consistency and compliance of projections for 2020 and 2030, in preparation of the three scenarios (for total emissions and emissions per sector) the same assumptions were taken into account as those used for drafting of the FBUR of the Republic of Serbia to the UNFCCC. These assumptions, as well as measures related to GHG emission reduction, are described in Annex 1.

Some of the reporting priorities to the UNFCCC include: projection improvements, the definition of specific activities for reduction of GHG emissions, reducing emissions estimates by gases and the monitoring of the GHG emission reduction potential.

4.2. Scenarios of the total GHG emissions

4.2.1. Basic scenario

Based on assumptions presented in the Annex 1, the projected level of total GHG emissions in 2030 is 87.099,71 Gg CO2eq, according to the basic scenario. which is the same for 2015, 2020 and 2025, out of which energy sector has the highest share (79.25%), and the waste sector has the lowest (3.04%). Projections of total and GHG emissions broken down by sector in the basic scenario are shown in Table 4.1.

Table 4.1: Projections of total GHG emissions and GHG emissions broken down by sector in the basic scenario, Gg CO2eq

Basic scenario	1990.	2015.	2020.	2025.	2030.
Energy	65.730,38	56.554,04	64.628,68	63.760,12	69.029,59
Industrial Procedures	4.871,13	4.868,97	5.373,90	6.203,43	7.213,29
Agricultural	9.078,22	6.672,16	6.753,00	8.033,23	8.209,49

Waste	3.839,77	2.688,06	2.686,79	2.665,20	2.647,35
Total emissions	**83.519,50**	**70.783,23**	**79.442,37**	**80.661,99**	**87.099,71**

4.2.2. Scenario "with measures"

Based on assumptions presented in Annex1, projected total GHG emissions in 2030 based on scenario "with measures" are 75,293.72 Gg CO2eq, the highest share being held by energy sector (78.50%), and the smallest share by waste management sector (2.97%) (Table 4.2.).

Table 4.2: Projections of total and GHG emissions by sectors in the "scenario with measures", Gg CO_2eq

Scenario with measures	1990.	2015.	2020.	2025.	2030.
Energy	65.730,38	55.136,49	57.259,53	55.313,29	59.111,10
Industrial processes	4.871,13	3.859,11	4.255,84	4.941,11	5.734,57
Agriculture	9.078,22	6.672,16	6.753,00	8.033,23	8.209,49
Waste sector	3.839,77	2.742,66	2.698,16	2.461,42	2.238,56
Total emissions	**83.519,50**	**68.410,42**	**70.966,54**	**70.749,05**	**75.293,72**

Scenario "with measures" results in GHG emission reduction of 11,805.99 GgCO2eq until 2030, compared to the basic scenario. Based on this scenario, the highest emission reduction comes from energy sector (9,918.49 GgCO_2eq).

4.2.3. Scenario "with additional measures"

Based on assumptions presented in Annex1, total GHG emissions in 2030 projected by the scenario „with additional measures" are 67,613.66 Gg CO2eq, out of which 78.10% belongs to from Energy sector, and the smallest share of 2.17% to Waste sector (Table 4.3).

Table 4.3: Projections of total and GHG emissions broken down by sectors as per the scenario "with additional measures", Gg CO_2eq

Scenario with additional measures	1990.	2015.	2020.	2025.	2030.
Energy	65.730,38	53.307,56	52.411,46	49.188,04	52.810,77
Industrial processes	4.871,13	3.642,71	3.714,85	4.364,04	5.121,44
Agriculture	9.078,22	6.672,16	6.753,00	8.033,23	8.209,49
Waste sector	3.839,77	2.392,72	2.284,77	1.888,21	1.471,66
Total emissions	**83.519,50**	**66.015,15**	**65.164,09**	**63.475,53**	**67.613,66**

The scenario "with additional measures" can lead to GHG emission reduction of 19,486.05 GgCO2eq by 2030, compared to the basic scenario. The highest contribution according to this scenario comes from Energy sector, with 16,218.82Gg CO_2eq emission reduction.

4.2.4. Levels and trends of total GHG emissions

Levels of total GHG emissions in 2030, including 2015, 2020 and 2025, determined on the basis of three scenarios (baseline scenario, the scenario «with measures» and scenario «with additional measures»), are summarized in Table 4.4.

Table 4.4: Levels of total GHG emissions in 2030, including 2015, 2020 and 2025, for three scenarios, Gg CO_2eq

Total emissions (Gg CO_2eq)	2015.	2020.	2025.	2030.
Basic scenario	70.783,23	79.442,37	80.661,99	87.099,71
Scenario "with measures"	68.410,42	70.966,54	70.749,05	75.293,72
Scenario „with additional measures"	66.015,15	65.164,09	63.475,53	67.613,66

Figure 4.1. shows GHG emission trends in the period 2010-2030, based on three scenarios.

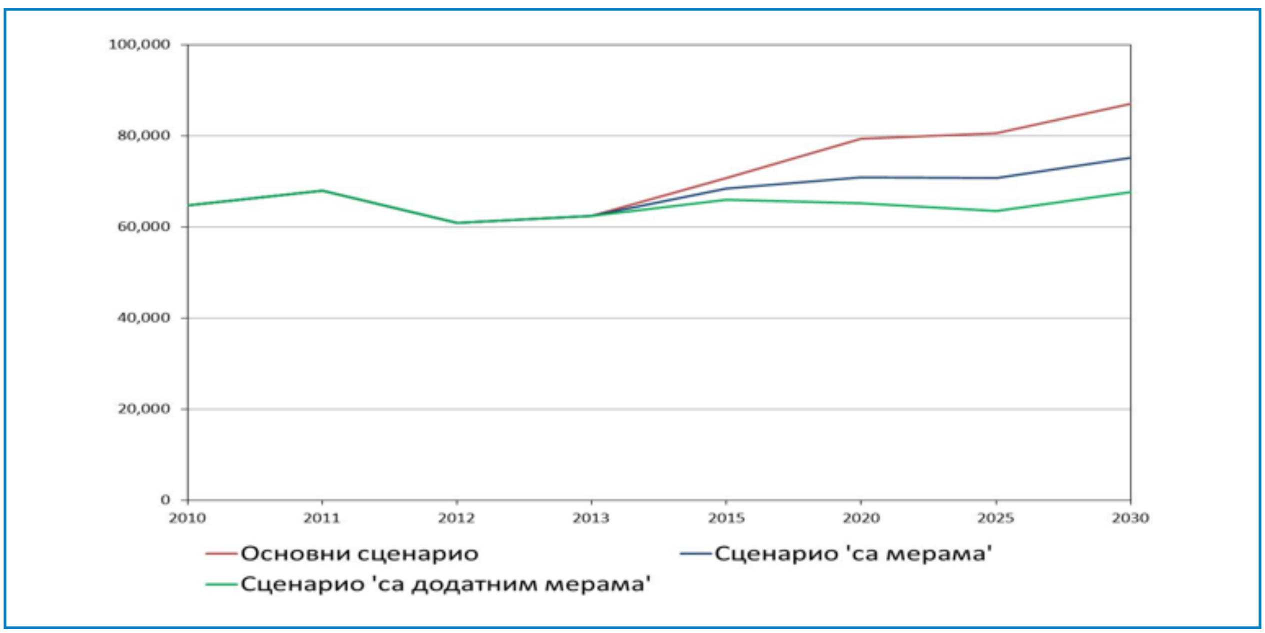


Figure 4.1: GHG emission trend in the period 2010-2030 for three scenarios, Gg CO2eq

Compared to the baseline scenario, total GHG emissions reduction by the year 2030 obtained from the scenario with measures and scenario with additional measures is 14.37% and 23.5% respectively.

4.3. GHG emissions scenario by sectors

4.3.1. Energy sector

HEmissions from Energy sector by 2030, based on the three scenarios, with averages in 2015, 2020 and 2025 are summarized in Table 4.5.

Table 4.5: Levels of total GHG emissions for Energy sector, for three scenarios, Gg CO2eq

Scenario	1990.	2015.	2020.	2025.	2030.
Basic scenario	65.730,38	56.554,04	64.628,68	63.760,12	69.029,59
Scenario "with measures"	65.730,38	55.136,49	57.259,53	55.313,29	59.111,10
Scenario "with additional measures"	65.730,38	53.307,56	52.411,46	49.188,04	52.810,77

According to the scenario "with measures" the level of emissions in 2030 is 59,111.10 Gg CO2eq, i.e. by 9,918.49 Gg CO2eq lower compared to the emissions in the basic scenario. In the scenario "with additional measures" emissions are 52,810.77 Gg CO2eq, i.e. by 16,218.82 Gg CO2eq lower compared to the basic scenario.

In 2030 the implementation of the scenario „with measures" will have led to 14.3% emission reduction in Energy sector, and the scenario "with additional measures" will yield 23.5% reduction compared to the basic scenario. In addition, it should be noted that a large part of energy sector emission sources will be included in the European Trading System (ETS) (following accession to the EU), which will lead to further reduction of projected emissions.

Scenario outcomes for Energy sector are presented in Annex 1 (section 2), and expected values for source categories are shown below.

Basic scenario

Table 4.6 shows GHG emissions within Energy sector (broken down by source categories), as projected by the basic scenario for 2030 under source categories.

Table 4.6: Level of GHG emissions under source categories within the energy sector, as per basic scenario, Gg CO2eq

	2015.	2020.	2025.	2030.
1 – Energy	**56.554**	**64.629**	**63.760**	**69.030**
1.A – Fuel Combustion Activities	53.728	61.399	60.574	65.580
1.A.1 – Energy industries	37.679	42.519	39.259	42.722
1.A.2 – Manufacturing industry and Construction	4.738	5.367	6.253	7.281
1.A.3 – Transport	7.660	9.550	10.878	11.152
1.A.4 – Other sectors	3.651	3.962	4.185	4.424
1.A.5 – Other	0	0	0	0
1.B - Fugitive Emissions from Fuels	2.826	3.230	3.186	3.450
1.B.1 - Solid fuels	989	1.130	1.115	1.207
1.B.2 - Oil and natural gas	1.837	2.099	2.071	2.242

Scenario "with measures"

Table 4.7 shows GHG emissions within Energy sector (broken down by source categories), as projected by the scenario "with measures" for 2030.

Table 4.7: **Level of GHG emissions under source categories within energy sector, as per scenario with measures, GgCO2eq**

	2015.	2020.	2025.	2030.
1 – Energy	**55.136**	**57.260**	**55.313**	**59.111**
1A – Fuel Combustion Activities	52.381	54.398	52.549	56.157
1A1 – Energy industries	36.536	36.797	32.889	35.362
A2 – Manufacturing industry and Construction	4.657	5.270	6.126	7.121
1A3 – Transport	7.592	8.858	10.168	10.425
1A4 – Other sectors	3.596	3.473	3.366	3.249
1A5 – Other	0	0	0	0
1Б — Fugitive Emissions from Fuels	2.755	2.861	2.764	2.954
1Б1 – Solid Fuels	964	1.001	967	1.034
1Б2 – Oil and Natural Gas	1.791	1.860	1.979	1.920

The level of GHG emission reduction based on use of renewable energy sources (RES), as per the scenario "with measures", are shown in Table 4.8.

Table 4.8: **GHG emissions reduction as a result of the use of RES, scenario "with measures", Gg CO2eq**

Year	2015.	2020.	2025	2030
Electricity and heat production	1.143	5.722	6.370	7.360
Industry	81	97	127	160
Transport	68	692	710	727
Other sectors	55	490	819	1.175
Fugitive emissions	71	368	422	496
Total	**1.418**	**7.369**	**8.447**	**9.918**

Scenario "with additional measures"

able 4.9 shows GHG emissions from Energy sector (broken down by source category), as per the scenario "with additional measures".

Table 4.9: Projections of GHG emissions broken down by source category in Energy sector, scenario "with additional measures", GgCO2eq

	2015.	2020.	2025.	2030.
1 – Energy	**53.308**	**52.411**	**49.188**	**52.811**
1A – Fuel Combustion Activities	50.644	49.792	46.730	50.172
1A1 – Energy industries	35.651	34.003	32.561	34.986
1A2 – Manufacturing industry and construction	4.035	3.782	5.274	6.563
1A3 – Transport	7.489	8.948	5.731	5.566
1A4 – Other sectors	3.468	3.060	3.064	3.056
1A5 – Other	0	0	0	0
1Б — Fugitive Emissions from Fuels	2.664	2.619	2.458	2.639
1Б1 – Solid fuels	932	917	860	924
1Б2 – Oil and natural gas	1.732	1.702	1.598	1.715

GHG emission reduction levels based on the use of renewable energy sources in the scenario "with additional measures" are shown in Table 4.10.

Table 4.10: The levels of GHG emissions as a result use of RES, broken down by source category in Energy sector scenario "with additional measures", Gg CO2eq

Year	**2015.**	**2020.**	**2025.**	**2030.**
Electricity and heat production	1.899	8.195	9.991	11.074
Industry	81	97	127	160
Transport	68	692	710	727
Other sectors	55	490	819	1.175
Fugitive emissions	111	498	613	691
Total	**2.214**	**9.972**	**12.259**	**13.827**

The potential for reducing GHG emissions by increasing energy efficiency (broken down by source categories), as per the scenario „with additional measures“ is presented in Table 4.11.

Table 4.11: Potential for reducing GHG emissions by increasing energy efficiency per source category, scenario "with additional measures", Gg CO_2eq

Year	2015.	2020.	2025.	2030.
Electricity and heat production	128	322	328	375
Industry	621	1.489	752	558
Transport	103	459	815	1.145
Other sectors	128	413	302	194
Fugitive emissions	52	112	116	120
Total	**1.032**	**2.245**	**2.313**	**2.392**

4.3.2. Industrial processes

GHG emissions in Industrial processes, according to the three scenarios, are shown in Table 4.12.

Table 4.12: Projections of GHG emissions in the Industry processes sector, three scenarios, Gg CO_2eq

Scenarios	1990.	2015.	2020.	2025.	2030.
Basic scenario	4.871,13	4.868,97	5.373,90	6.203,43	7.213,29
Scenario "with measures"	4.871,13	3.859,11	4.255,84	4.941,11	5.734,57
Scenario "with additional measures"	4.871,13	3.642,71	3.714,85	4.364,04	5.121,44

Based on the scenario "with measures" GHG emissions in 2030 will be 5,734.29 Gg CO_2eq, which is a reduction of 1.478,72 Gg CO_2eq compared to the basic scenario. The scenario "with additional measures" projects a 5.121,44 Gg CO_2eq, emission reduction, i.e. a reduction lower by 2,091.85 Gg CO_2eq compared to the level of emissions defined in the basic scenario.

Therefore, in 2030 the implementation of the scenario "with measures" would lead to 20.5% emission reduction in Industry processes, and the scenario "with additional measures" will lead to 29% emissions reduction compared to the basic scenario.

It is important to emphasize that over 100 emission sources in industry sector will be included in the EU Emissions Trading System (ETS) upon the accession of the Republic of Serbia to the EU, which should lead to further emission reductions compared to the projected values.

4.3.3. Agriculture

One scenario has been developed for agriculture sector and source categories, as shown in Table 4.13.

Table 4.13: Projections of GHG emissions in Agriculture sector, three scenarios, Gg CO_2eq

Basic scenario	1990.	2015.	2020.	2025.	2030.
3.A. Livestock	5.109,26	3.069,36	3.109,47	4.110,29	4.235,15
3.B. Land	294,19	360,93	360,93	360,93	360,93
3.C. Aggregate sources and non-CO2 emissions sources on land	3.674,77	3.241,88	3.282,61	3.562,02	3.613,41
Total	**9.078,22**	**6.672,16**	**6.753,00**	**8.033,23**	**8.209,49**

Projected emissions in 2030 amount to 8,209.49 Gg CO_2eq, mainly due to emissions from Livestock sector, which are expected to be 4.235,15 Gg CO_2eq.

4.3.4. Waste management sector

Projections of GHG emissions from Waste sector, including solid waste disposal on land and wastewater treatment, are presented in Table 4.14, as per the three scenarios.

Table 4.14: Projections of GHG emissions from waste management sector, Gg CO_2eq

Scenarios	1990.	2015.	2020.	2025.	2030.
'Basic scenario'	3.839,77	2.688,06	2.686,79	2.665,20	2.647,35
'With measures'	3.839,77	2.742,66	2.698,16	2.461,42	2.238,56
'With additional measures'	3.839,77	2.392,72	2.284,77	1.888,21	1.471,97

According to the scenario "with measures", in 2030 GHG emissions will be 2,238.56 Gg CO_2eq, with is a reduction of 408.79 Gg CO_2eq compared to the level of emissions given in basic scenario. The projected GHG emissions, according to the scenario "with additional measures" are 1,471.97 Gg CO_2eq, which is a reduction of 1175.38 Gg CO_2eq (or 44.4%) compared to the basic scenario.

4.4. NAMAs

In 2012 the Republic of Serbia submitted to the NAMAs registry a number of projects[7] which were taken into account in developing scenarios "with measures" and "with additional measures". Those projects would require financial assistance from donors. The relevant NAMAs measures are shown in Table 4.15. They contributed to total emission reduction by 4,242,835t CO_2eq on the annual level

Table 4.15: NAMAs projects

Name	National Implementing Entity	Status	Estimated emission reduction	Total estimated budget (Euro)
NS-31 – Expansion of the existing heating network in Valjevo	City of Valjevo	Seeking support for implementation	252,270 t CO_2 eq (30 years) Methodology applied for estimation: general calculation method as used in IPCC Guidelines Estimated annual emission reduction: 8,409 t CO_2 eq/yr	6.000.000,00
NS-32 – Introduction of the metering system and billing on the basis of consumption in long-distance heating systems in Serbia	Public Utility Company" Beogradske elektrane" and Business Association "Toplane Srbije"	Seeking support for implementation	6,582,340 t CO_2 eq (20 years) Methodology applied for estimation: The Initial National Communication methodology, based on IPCC Guidelines Estimated annual emission reduction: 329,117 t CO_2 eq/yr	212.000.000,00

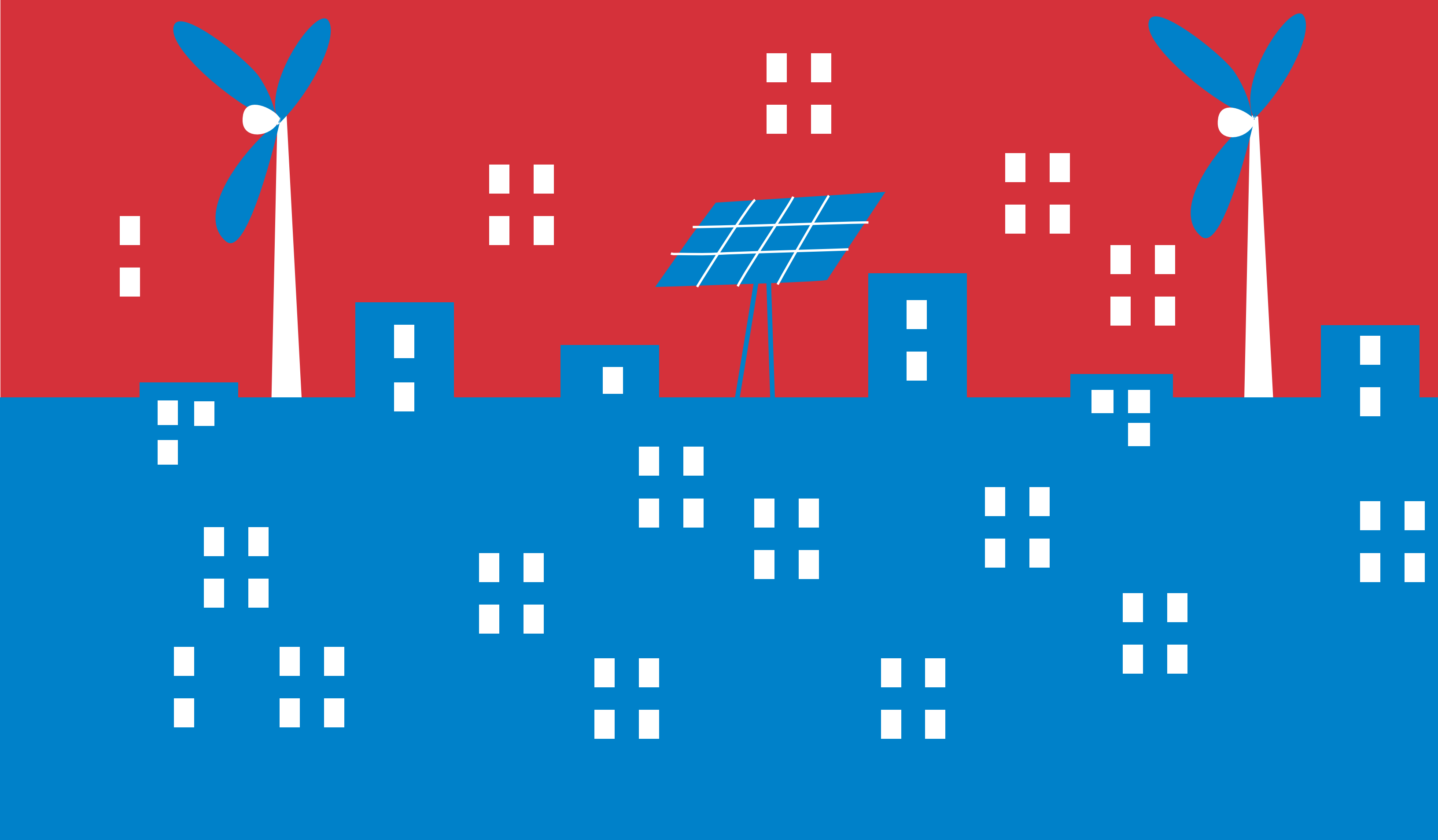
[7] Source: http://www4.unfccc.int/sites/nama/SitePages/Country.aspx?CountryId=154

Name	National Implementing Entity	Status	Estimated emission reduction	Total estimated budget (Euro)
NS-33 – Use of Solar energy for domestic hot water production in the Heating plant „Cerak" in Belgrade	Public Utility Company" Beogradske elektrane" and Business Association «Toplane Srbije «	Seeking support for implementation	12,220 t CO_2 eq (20 years) Methodology applied for estimation: general calculation method used in IPCC Guidelines Estimated annual emission reduction: 611 t CO_2eq/yr	1.050.000,00
NS-34 – Thermal Power Project with Capacity and Efficiency Increase II – TTP Nikola Tesla – Unit A3	Public Enterprise" Elektroprivreda Srbije"	Seeking support for implementation	1.40 Mt CO_2 eq; estimation is calculated based on 15 years of shelf-life of installation after the reconstruction. Estimated annual emission reduction: 93,333 t CO_2 eq/yr	47.000.000,00
NS-35 – Introduction of 1000 MW small biomass boilers in Serbia	Ministry of Energy, Development and Environmental Protection	Seeking support for implementation	Total reductions amount to 10.36 Mt CO_2 eq in 25 years Estimated annual emission reduction: 414,400 t CO_2 eq/yr	250.000.000,00

Name	National Implementing Entity	Status	Estimated emission reduction	Total estimated budget (Euro)
NS-36 – Rehabilitation of arterial roads in Serbia	Public Enterprise “Roads of Serbia”	Seeking support for implementation	Total reduction: 5,234 t CO_2 eq (20 years) Methodology applied for estimation: road transport calculation software tool (COPERT 4) Estimated annual emission reduction: 266,2 t CO_2 eq/yr	139.328.000,00
NS-37 – Revitalization of the existing small hydropower plants and construction of new small hydropower plants (SHPPs)	Public Enterprise “Elektroprivreda Srbije”	Seeking support for implementation	4.10 Mt CO_2 eq; calculated based on 40 years of shelf life of the installation Estimated annual emission reduction: 102,500 t CO_2 eq/yr	55.000.000,00
NS-39 – Thermal power project for capacity and efficiency increase of II – TPP Nikola Tesla – Unit B2	Public Enterprise “Elektroprivreda Srbije”	Seeking support for implementation	5.30 Mt CO_2 eq; calculated based on 15 years of shelf life of the installation after the reconstruction. Estimated annual emission reduction: 353,333 t CO_2 eq/yr	111.000.000,00
NS-40 – Construction of a super-critical lignite-fired power plant TPP Kostolac B	Public Enterprise “Elektroprivreda Srbije”	Seeking support for implementation	56.0 Mt CO_2 eq; calculated based on 40 years of shelf life of the installation Estimated annual emission reduction: 1,400,000 t CO_2 eq/yr	954.000.000,00

Name	National Implementing Entity	Status	Estimated emission reduction	Total estimated budget (Euro)
NS-41 – Energy efficiency improvements in public buildings: 23 schools and 26 hospitals – Serbian Energy Efficiency Project (SEEP)	Ministry of Energy, Development and Environmental Protection	Seeking support for implementation	Total reduction: 208.150 Mt CO_2 eq in 25 years Estimated annual emission reduction: 8,326 t CO_2 eq/god	12.500.000,00
NS-46 – Improvement of architectural coating (exterior doors, windows and thermal insulation) in Serbia	Ministry of Construction and Urban Planning	Seeking support for implementation	Total CO_2 reduction for 30- year period is 15,119,070 t CO_2 eq. The calculations were made with the estimates of the total floor surface to be covered in the existing buildings and total annual energy consumption before and after the implementation. Estimated annual emission reduction: 503,969 t CO_2 eq/yr	578.784.000,00
NS-50 – Replacement and construction of a new natural gas-fired cogeneration power plant CHP Novi Sad	Public Enterprise Electric Power Industry of Serbia	Seeking support for implementation	36.00 Mt CO2 eq; calculated based on 35 years of shelf life of the installation Estimated annual emission reduction: 1,028,571 t CO_2 eq/yr	127.500.000,00

5. LONGTERM FRAME FOR GHG EMISSION REDUCTION BY 2050



5.1. Scenarios and trend

Projections of reducing total GHG emissions by 2050 and by 2030 were made based on three scenarios: basic scenario, scenario "with measures" and scenario "with additional measures". The reference year for scenarios was 2000 and LEAP model was used. Projections of GHG emission reduction are based on theory, and not on a national policy. The reason for this is lack of long-term sectoral policies, particularly in energy sector, and absence of a national consensus on the issue.

The above projections were made for the first time at the national level and will certainly need to be improved in the process of drafting future national reports to the UNFCCC, parallel with building national capacities for this purpose.

The basic scenario is an extrapolation of emission trend for the period 2020-2030.

Previous projections for different sectors for the period by 2030 were taken into consideration in developing scenario "with measures", too. The trend of energy consumption is expected to be directly proportional to an increase in GDP, and the largest consumption will be in the transport sector. For projections after 2030, industry energy reduction rate was used; 1% annually for the period 2030-2040 and 1.5% annually for the period 2040-2050; for other sectors the reduction rate is 0.5% and 1.0% respectively.

The scenario "with additional measures" projects a rise in energy consumption despite higher energy efficiency by 2030, and then a continuous fall by 2050. The scenario "with additional measures" projects a fall in energy consumption by 31% compared to the basic scenario, i.e. 20% lower than in the scenario "with measures".

Both scenarios, "with measures" and "with additional measures", project that the Republic of Serbia will be able to independently meet its electricity needs by 2050. Additional projections are as follows:

- 37% higher share of renewable energy sources, by 93% compared to 2030, for all the three scenarios;
- Highly efficient cogeneration installations (CHP) using biomass and natural gas by 57% more in 2050 compared to 2030 in the scenario "with additional measures".

Additionally, the scenario "with measures" projects that:

- Large thermal power plants with capacity exceeding 300 MW will be revitalized (TENT blocks A3-A6, TENT B1-B2, Kostolac B1-B2 with total installed capacity of 3.160 MW and average annual production capacity of 19.000 GWh). The use of Best Available Technologies (BAT) in these thermal power plants could lead to energy savings of up to 30 %.
- Some thermal power capacities below 300 MW will gradually cease operation.
- Capacities and production from renewable energy sources will increase by 564 MW based on the projected trend from 2020-2030, which will mean additionally 1159 MW generated by wind, sun and

biomass in 2050). Thus, an emission reduction of 3-4 million tCO_2 could be achieved, depending on the source structure.

The scenario "with additional measures" includes the following projections:

- 20% lower energy consumption compared to the basic scenario,
- Increased capacity and production from renewable energy sources by over 50% compared to the capacities projected in the scenario "with measures".

Based on these projections, by 2050 GHG emissions will reduce by 40% compared to the scenario "with measures" and 63% compared to the basic scenario.

The scenario "with additional measures" also projects the implementation of carbon capture and storage technology (CCS). CCS technology in new coal power plants (700 MW) can lead to an additional reduction of 4000 $GgCO_2$.

In the transport sector, higher living standards should increase the number of vehicles and provide greater mobility. Reduction measures include introduction of vehicles with high energy efficiency (more efficient engine, design and fuel), intermodal freight and passenger transport, promotion of intelligent and integrated traffic system in cities (sustainable transport mobility), eco-driving and the use of biofuels.

Thus, according to the scenario "with additional measures", emissions in transportation sector will be by 10% lower compared to the scenario "with measures", and by 16% compared to the basic scenario.

As regards energy sector, significant GHG emission reduction is expected as a result of implementation of measures for renovation of public, residential and commercial buildings, as well as private houses. Namely, these measures include: increased energy efficiency through improvement of thermal insulation of buildings; installation of a new system or replacement of the existing heating systems with energy-efficient systems for hot water supply; installation of individual heat metering, use of energy-efficient household appliances and office equipment; smart and efficient lighting; smart heating and cooling systems, as well as the use of renewable energy sources and integrated smart systems; installation of solar thermal systems for supply and maintenance of water temperature; , and finally, construction of low-energy buildings (of minimum A energy level). The largest savings are envisaged in the area of housing, where the scenario "with measures" projects 1% building retrofit rate, or else 35% by 2050. The scenario "with additional measures" projects the retrofit rate of 2%, which would lead to renovation of 70% of the total building stock.

Projections for industrial sector, in general, rely on the process of modernization which will increase energy efficiency, renewable energy and production of fuel from waste. The calculation was made on the basis of EU experience, where 0.75% increase in energy efficiency of per year, or 15% for the period 2030-2050 was projected for each scenario. This will lead to 70% reduction of GHG emissions according to the scenario "with additional measures" compared to the baseline scenario, and by 25% reduction compared to the scenario "with measures".

The use of CCS technology in refineries, steel mills and cement industry could further reduce GHG emissions. However, this possibility needs further analysis.

In view of overall projected emission reduction and an increase in agricultural activities, the projections of GHG emissions from this sector have an increasing share in the total GHG emissions. Expected changes in the agriculture sector by 2050 include: change of livestock farming, manure anaerobic digestion and production of biogas, extension of crop rotation with a larger share of legumes, more frequent crop rotation by using intercropping, improvement of methods of use of mineral fertilizers and organic fertilizers, agricultural forestry, change of diet regiment of livestock and of livestock food quality. However, the scenario "with measures" will not lead to any emission reduction in the period of 2030-2050. On the other hand, 5% GHG emission reduction was calculated in the scenario "with additional measures", compared to the scenario "with measures", and a 13% reduction compared to the baseline scenario.

Given that the measures implemented by 2030 as per the scenarios "with measures" and "with additional measures" will lead to fulfillment of all requirements for the treatment of biodegradable waste, as well as to introduction of the latest technical solutions, it is expected that the level of GHG emissions from the waste sector would remain the same by 2050 (increase of the amount of waste and reduction of the population). Thus, according to the scenario „with additional measures", the level of GHG emissions from the waste sector was calculated as approximately 35% lower than in the scenario "with measures", or 43% compared to the baseline scenario.

If circular economy would take place in this sector, further emission reduction of 5% can be expected as per the scenario "with additional measures" compared to the scenario „with measures".

Implementation of above mentioned measures should lead to total GHG emission reduction of 35% according to the scenario "with additional measures" and to 49% reduction compared to the basic scenario. According to the scenario "with additional measures", emissions in 2050 will be 42% lower than 1990 emission levels and 22% lower than 2013 emissions.

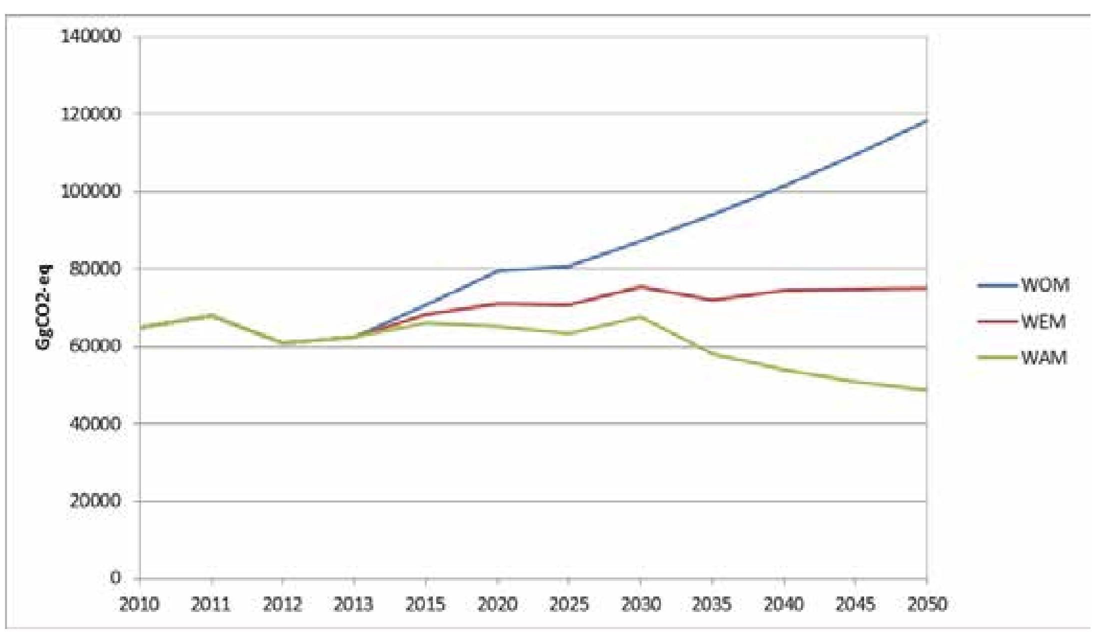
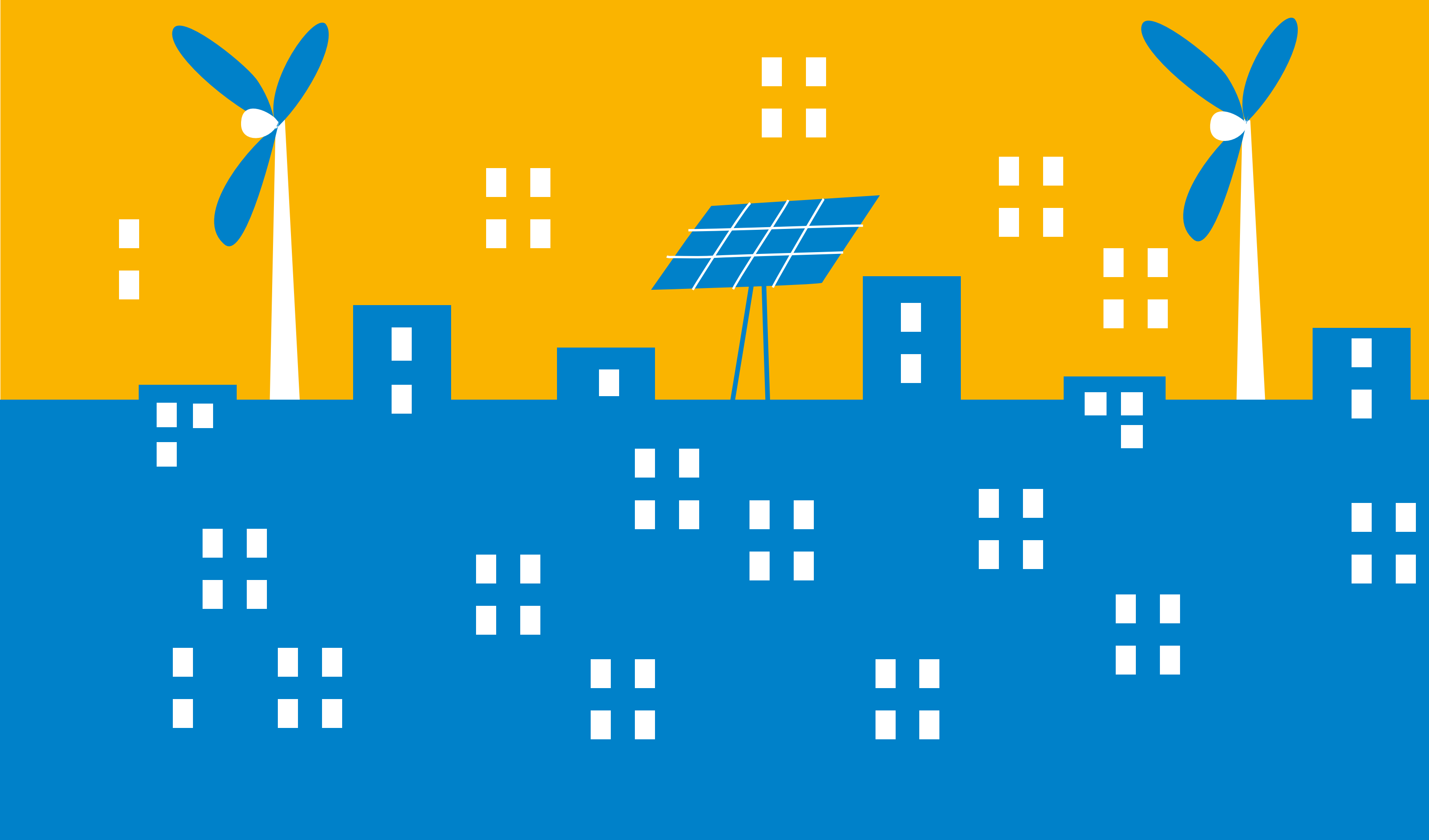


Figure 5.1: Emission projections of greenhouse gases in the Republic of Serbia by 2050

6. CLIMATE CHANGE IMPACTS, VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES



6.1. Observed and expected climate changes

6.1.1. Methodology

An analysis of key climate variable trends and derived climate indexes has been made in order to assess observed climate change. Data from meteorological stations operated by the Republic Hydrometeorological Service of Serbia were used.

An assessment of future climate conditions has been done for the following periods: 2011-2040, 2041-2070 and 2071-2100, compared to the base period 1961-1990 (EBU-POM regional climate model was used). Two possible scenarios of future climate conditions were shown (IPCC/SRES scenarios, mid-line A1B and extreme A2). Changes in air temperature and precipitation have been analyzed at both seasonal and annual level, and selected indices of extremes have been studied. Moreover, comparison of results of different climate models was also made (ENSEMBLES project and EBU-POM model).

Various models and approaches were used to analyze vulnerability of various sectors, and to identify potential adaptation measures. Details on the methodological approaches are presented in Annex 2. The impact of climate change on biodiversity is presented in the Biodiversity Strategy of the Republic of Serbia for the period 2011 - 2018, funded by GEF.

6.1.2. Observed climate changes

During the period 1960-2012, significant increase of daily mean, daily maximum and daily minimum temperature was observed in Serbia with an average trend of 0.3°C/decade on annual level. The highest trend was obtained for the daily maximum temperature 0.35°C/decade, then for mean daily temperature 0.3°C/decade, and lowest for minimum temperature 0.25°C/decade. Higher trends for daily mean and daily maximum temperature are specific for altitudes higher than 1000m, in cooperation to lower altitudes.

The whole territory of Serbia experienced a significant increase in temperatures from the middle of the previous century, especially during the summer and spring seasons. In the summer season, positive trends were most pronounced while trends during the autumn season were less pronounced. Positive trends were generally observed on an annual basis.

In Figure 6.1 annual mean temperature anomalies from 1961-2012, with respect to the period 1961-1990, for the whole globe, Serbia and Belgrade are presented. Considering the rate of temperature increase, it is clear that Serbia faced faster increase of temperature in comparison to increase of global averages After 1990 only four years show negative anomalies and eight out of ten hottest years were observed after 2000. The hottest year was 2000, with positive anomaly of 1.86°C, followed by the years of 2008, 2007, 1994 and 2012.

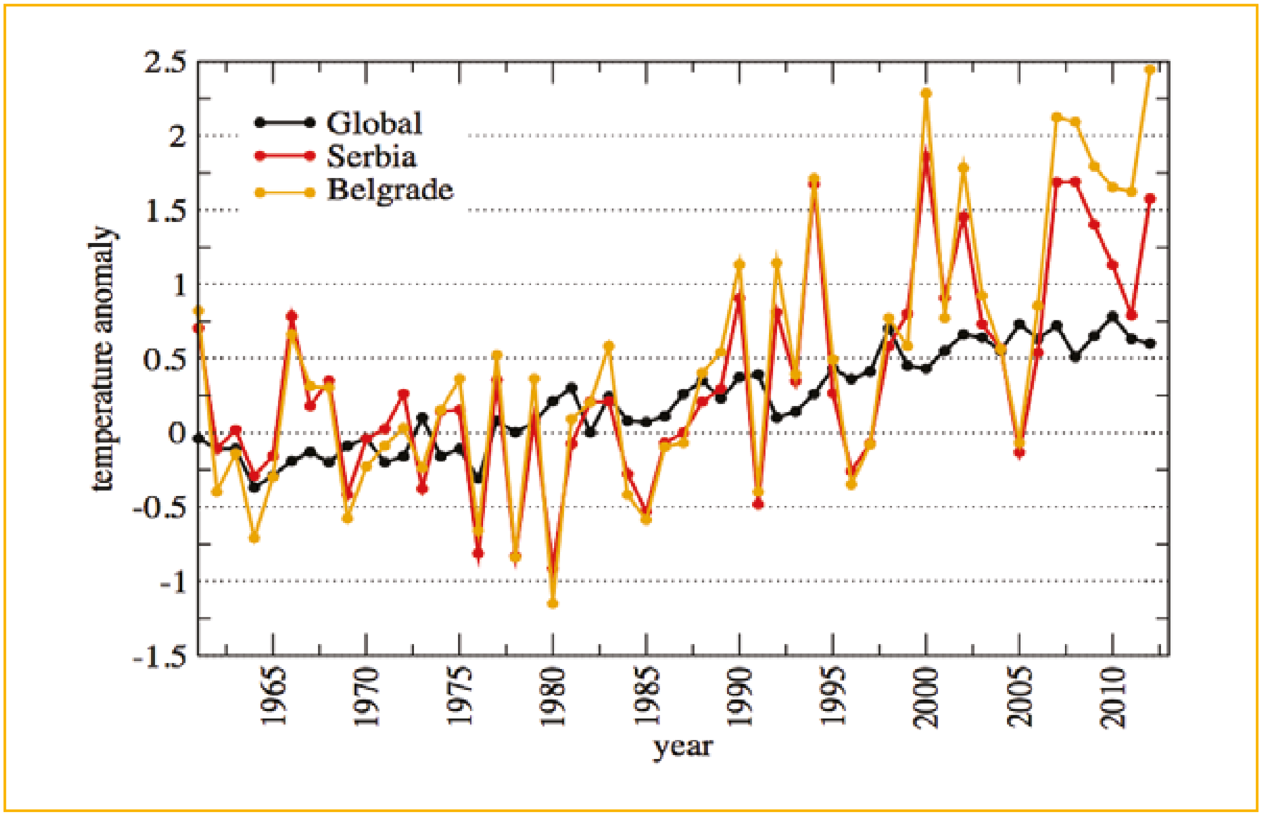


Figure 6.1: Annual mean temperature anomalies in °C with respect to the period 1961-1990 compared to 1961-1990, for the whole globe, Serbia and Belgrade

On an annual basis, the major part of the Serbian territory had a positive precipitation trend. The average trend for stations with positive values is 12.47mm/decade and the average trend for stations with negative trend values is -6.8mm/decade. The observed trends also indicate changes in the precipitation distribution per year, as well as possible changes of intensity distribution in terms of more days with heavy precipitation and also of days with no precipitation. In general, the winter and spring seasons showed negative trends, while the fall season showed positive trends in precipitation.

The number of frost days (list of selected indexes and their definition are attached in Annex 2) showed negative trends with average values of -2.4/decade, and the number of ice days was a -1.1 days/decade. The number of days with tropical nights showed a positive trend (on average 1 day in a decade and the summer day index shows a significant positive trend, of 4.7 days/year on average.

A significant positive trend was observed in monthly maximum value of daily minimum temperature and in the warm night index in the whole territory, while the cold night index had a significant negative trend. Average positive value for monthly maximum values of daily minimum temperature is 0.5°C/decade, for cold nights it is -2.8days/decade and for warm nights it is 7.5days/decade.

The monthly maximum value of daily highs and the warm day-time index showed a positive trend, and the cold day-time index showed a remarkable negative trend. Average positive value for monthly maximum values of daily highs is 0.7°C/decade, for cold day-times it is -2.5days/decade and for warm day-times it is 8.4days/decade.

Growing season length had a positive trend and the average value is 4.5days/decade. Extension of the growing season is more likely to happen as there is a shift to an earlier season start in spring.

Due to an increase in extremely high temperatures, trends have shown a significant increase in the duration of the warm spell (an average of 4.4 days per decade, and over 6 days at high altitudes). Cold spell duration index, consecutive dry and wet days do not show significant trends.

A very heavy precipitation day index shows a positive trend for all selected stations in Serbia, except Požega. Even though many stations have positive trend, only three of them have a significant positive trend: Leskovac, Sjenica and Sombor. The average value of this index for all stations with a positive trend is 0.3 days/decade, with the upper limit of positive trends of about 0.5 days/decade.

Index that reflects changes in the amount of accumulated precipitation during the days with very heavy precipitation (episodes when daily accumulation was over 95th percentile of daily-accumulated precipitation) also shows a positive trend, with the exception of Vranje. A significant positive trend was shown for stations in Loznica, Sjenica and Vršac. An average value with a positive trend is very close to 10mm/year. Extreme precipitation indices had also a positive trend, with average values of 6.5 mm/decade.

To sum up, the precipitation trend analysis shows an increased number of episodes with heavy precipitation, although changes in the total quantity of precipitation were negligible. However, the most profound changes are observed in the warming trend, demonstrated by extremely high temperatures and an increase of warm spell durations.

6.1.3. Climate change scenarios

According to climate change scenarios, future positive trends of temperature change across Serbia are to be expected. Under A1B scenario for the period 2011-2040 an increase in temperature of 0.5-0.9 °C is expected, and an increase 1.8-2.0 °C from 2041-2070. According to A2 scenario the expected temperature rise is 0.3-0.7 °C and 1.6-2.0 °C for the periods 2011-2040 and 2041-2070. By the end of the century (2071-2100) the expected change of temperature as per A2 scenario is 3.6-4.0 °C, and 3.2-3.6 °C according to A1B scenario. Warming is most pronounced during the summer and fall season, going over 4.0 °C by the end of the century.

Precipitation trend under both scenarios compared to the base period is positive during the period 2011-2040, and decreases toward negative values across Serbia by the end of the century. Under A1B scenario, annual precipitation change ranges from +5% to -20% by the end of the century. Under A2 the change ranges from +20% to -20%. The summer season shows the most pronounced deficit.

Temperature indexes show changes toward warmer climate conditions. By the end of the century, number of frost days will have reduced to the level when it can be considered a rare event. Numbers of summer days and tropical nights are most pronounced over lower altitude regions (Vojvodina, parts of central Serbia). Number of summer days will have increased from 20 – 30 days (A2 scenario) in the middle of this century. Number of tropical nights shows an increase by over 20 days until the end of the century. Growing season length also shows a sharp rise, extending by over a month in the second half of the century. Consecutive dry day indices show longer duration of dry periods. By the end of the century dry periods will last for over one month, according to both scenarios.

Figures showing temperature, participation and index changes are included in Annex 3.

6.1.4. Comparative analysis of climate change scenarios

A comparative analysis was conducted on the results of the EBU-POM model and those of other climate models in order to evaluate the accuracy of climate projections presented in previous chapters. Figure 6.2. shows anomalies in annual mean temperature and annual accumulated precipitation from EBU-POM model (EBUPOM-ECHAM5) data sets and those from other models (16 ENSEMBLES models commonly used to analyze the impacts of climate change across the European Union). Figure 6.2 also shows the results of the EBU-POM model (EBUPOM-SXG) from the Initial National Communication.

Results of the model show that temperature anomalies range from 0.5-1.5 °C for the first 30 years to 1.9-5.3 °C by the end of the century. During the first half of the century EBU-POM model results are in the lower half of the range, and in the rest of the century the values are approaching the median of the ensemble. During the last thirty years anomalies of the EBU-POM model are about 3.8 °C and are closer to the median of the results of other models. Precipitation anomalies are ±7 % at the beginning of the 21st century. Models that show negative anomalies are equal to the models that show positive anomalies, however, the number of models that have negative anomalies increase over time. During the second half of the century, all results show a decrease in accumulated annual precipitation over the territory of Serbia, reaching -10 % reduction on average by the end of the century. EBU-POM/ECHAM5 compared with ensemble members gave values that are within the spread of ensembles values for all 30 years periods. EBU-POM/ECHAM5 produced accumulated precipitation values approximately equal to other models for the end of the century. As in the case of temperature anomalies at the end of the century, EBU-POM/ECHAM5 values were approximately in the middle of range of possible changes.

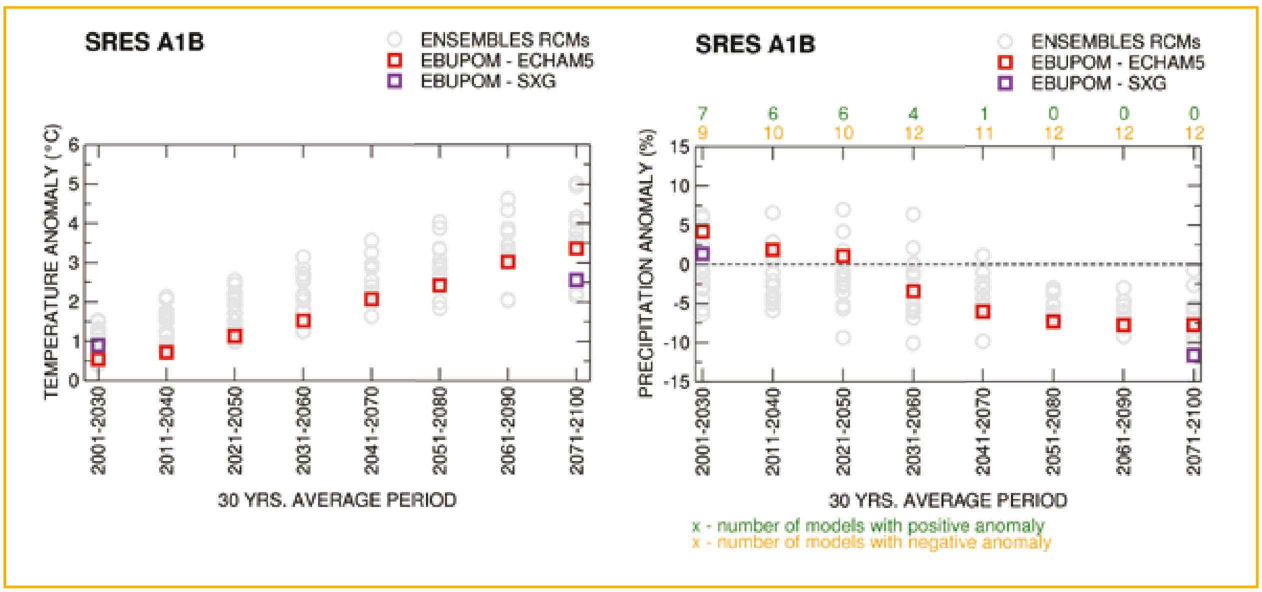


Figure 6.2: Anomalies of the mean annual temperature (left) and accumulated annual precipitation (right) across the territory of Serbia for 30-year periods during 21st century with respect to the period 1961-1990; A1B scenario

Periods 2011-2040 and 2071-2100 were chosen for analysis of seasonal changes. Mean seasonal temperature anomalies and precipitation anomalies for the selected period are shown in Figure 6.3. EBU-POM model results are within the range for both variables, for all periods and seasons except the winter season where temperature anomalies in the period 2011-2040 are outside the ensemble range. The spring rainfall anomalies for the same period are also slightly outside the ensemble range.

Comparative analysis of the results shows that the EBU-POM models, used in this report, produce similar results as other climate models (with the exception of two cases, when the difference is insignificant) and can therefore be considered reliable.

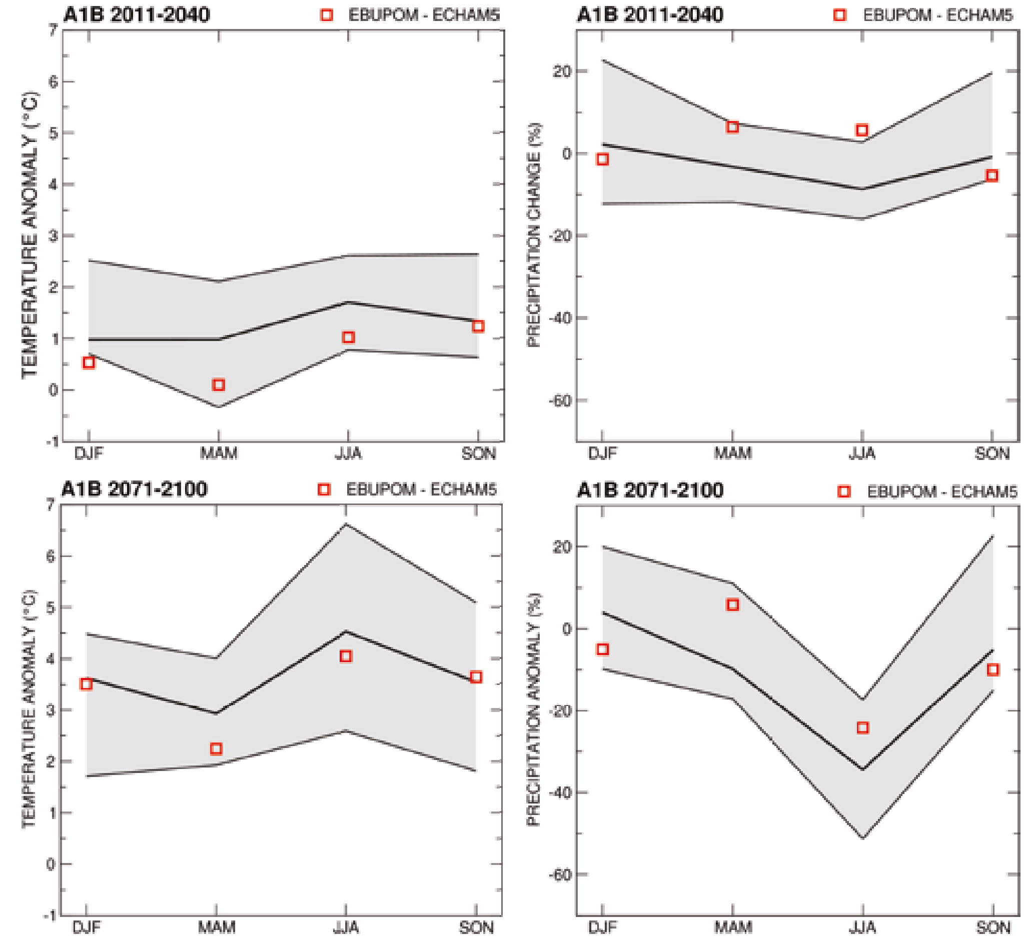


Figure 6.3: Average ensemble (black line) and maximum and minimum (grey area) ensemble values of mean seasonal temperature anomalies (left), and mean seasonal accumulated precipitation anomalies (right) for the period 2011-2040 (upper panel) and 2071-2100 (lower panel) compared to 1961-1990; A1B scenario.

6.2. Vulnerability and adaptation measures

6.2.1. Hydrology and Water Resources

In order to assess the impact of climate change on water resources, the changes of river flow trends have been examined (data at 18 selected river monitoring stations in central Serbia). A negative trend was already observed, particularly from the period 1950-1960. The results indicate that the long-term average yearly hydrological trend is approximately -30%/100 years, but its spatial distribution varies. The observed long-term trends of annual averages for the Danube and Sava rivers in Serbia are also negative, amounting to approximately -10%/100 years. Absolute annual daily maxima exhibited distinct downward trends for nearly all rivers, except the Danube and the Tisa rivers that had a slight upward trend, while the daily minima showed a changeable trend. With regard to other analyzed criteria for extreme flows, large rivers generally recorded a downward trend against all criteria, while small rivers showed varying results.

Scenario results indicate that future discharge will decrease, especially for the period 2071-2100. In terms of magnitude, it appears that the Kolubara catchment, located in central Serbia, and the Toplica catchment in southern Serbia will sustain the greatest possible change, with some projections for the period 2071-2100 close to 40% decrease in comparison to the period 1961-1990. On the other hand, the Drina and the Lim catchments, located in western Serbia, will undergo moderate change in terms of magnitude. For closer time frames, changes in water discharge are within few percent, rarely greater than 10%.

The decreasing trend of average groundwater availability is generally expected to be lower than for surface water, especially for deep aquifers. It should be noted that there is a lack of long-term data sets for a detailed analysis on the climate change impacts and the availability of groundwater resources.

Analysis based on climate scenarios (scenario A1B the addressed future periods 2021-2050 and 2071-2100) applied on test areas (four locations) showed that a considerable decrease in the capacity of groundwater resources is to be expected (Table 6.1).

Table 6.1: Future annual discharge changes (%) at selected locations according to A1B scenario, 1961-1990

Test area	2021-2050	2071-2100
Alluvial groundwater source "Jelak" for water supply of V. Gradište (Pek River)	-13%	-30%
Alluvial groundwater source "Mlaka" for water supply of Kučevo (Pek River)	-13%	-45%
Karst groundwater source "Beljanica"	-13%	-32%
Karst groundwater source "Stara Planina"	-6%	-20%

The data indicates the likelihood for considerable pressure on Serbia's water supply in the future. Besides the big cities, the most vulnerable areas are expected to be in the southeastern, eastern, central and northern part of the country

In addition to the common approach, based on climate scenarios and observed data, average annual temperature, precipitation and river discharge were co-related and the results for the 18 analyzed catchments are shown in relative values in Figure 6.4.

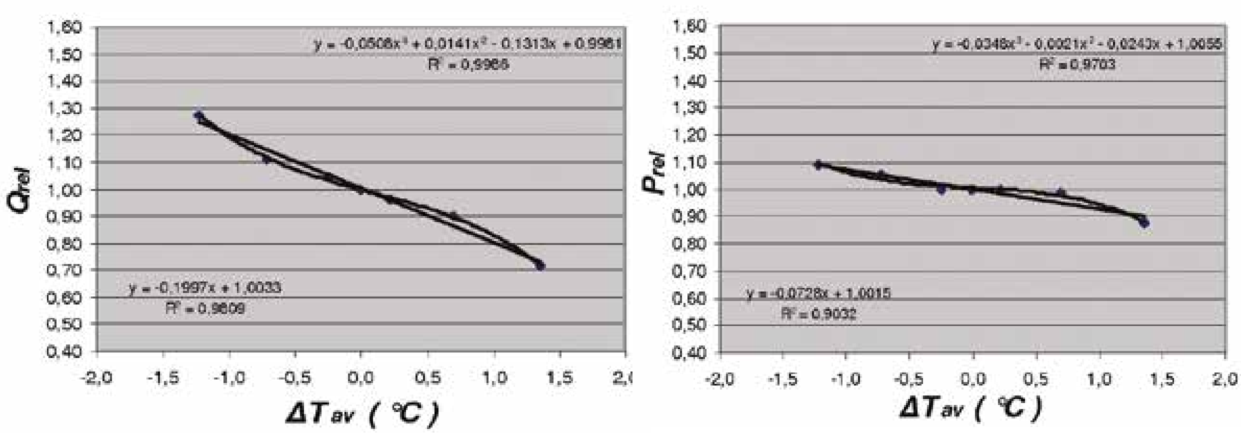


Figure 6.4: Relative average annual river discharge and precipitation in function of deviation from average annual temperature

A deviation from average annual temperature by +1°C has an inversely proportional effect on average annual precipitation levels (about 7%), and on the average annual river discharge (about 20%). This means that in the near future, years with an average annual temperature 2°C higher than the average in the last 60 years, can be expected to result in 40-50% less water in Serbia's rivers, on average.

Water temperature increase, particularly during low flow periods, can have adverse effects on water quality. These effects are already evident in the Velika Morava, Južna Morava and Zapadna Morava river basins where a negative trend was observed. It is expected that these effects are likely to continue in the future, given the expected increase in temperature by the end of this century.

There are 99 areas in Serbia that are under a significant flood risk. The largest potentially flooded areas lay along the Danube, Tisa, Sava, Drina, Velika Morava, Južna Morava, and Zapadna Morava rivers. Floods occurred in these areas between 1965 and 2011, resulting in large-scale damage (total of 73 events). The disastrous flood in May 2014 hit 42 significant flood prone areas in Western and Central Serbia (Figure 6.5). Approximately 1.6 million inhabitants were affected, while damage and losses were estimated at 1.5 billion Euro in 24 municipalities. Extraordinarily prolonged and heavy rainfall caused this event. The recurrence interval of these 2-3 day rainfall is 100-200 years. Due to expected climate changes in future, it is moderately to highly likely that more erosion, torrents, and floods on small rivers are going to happen. There is a moderate probability of increased floods on medium-size rivers and a low probability this to happen in large rivers in the near future. Further analysis needs to be done in this field.

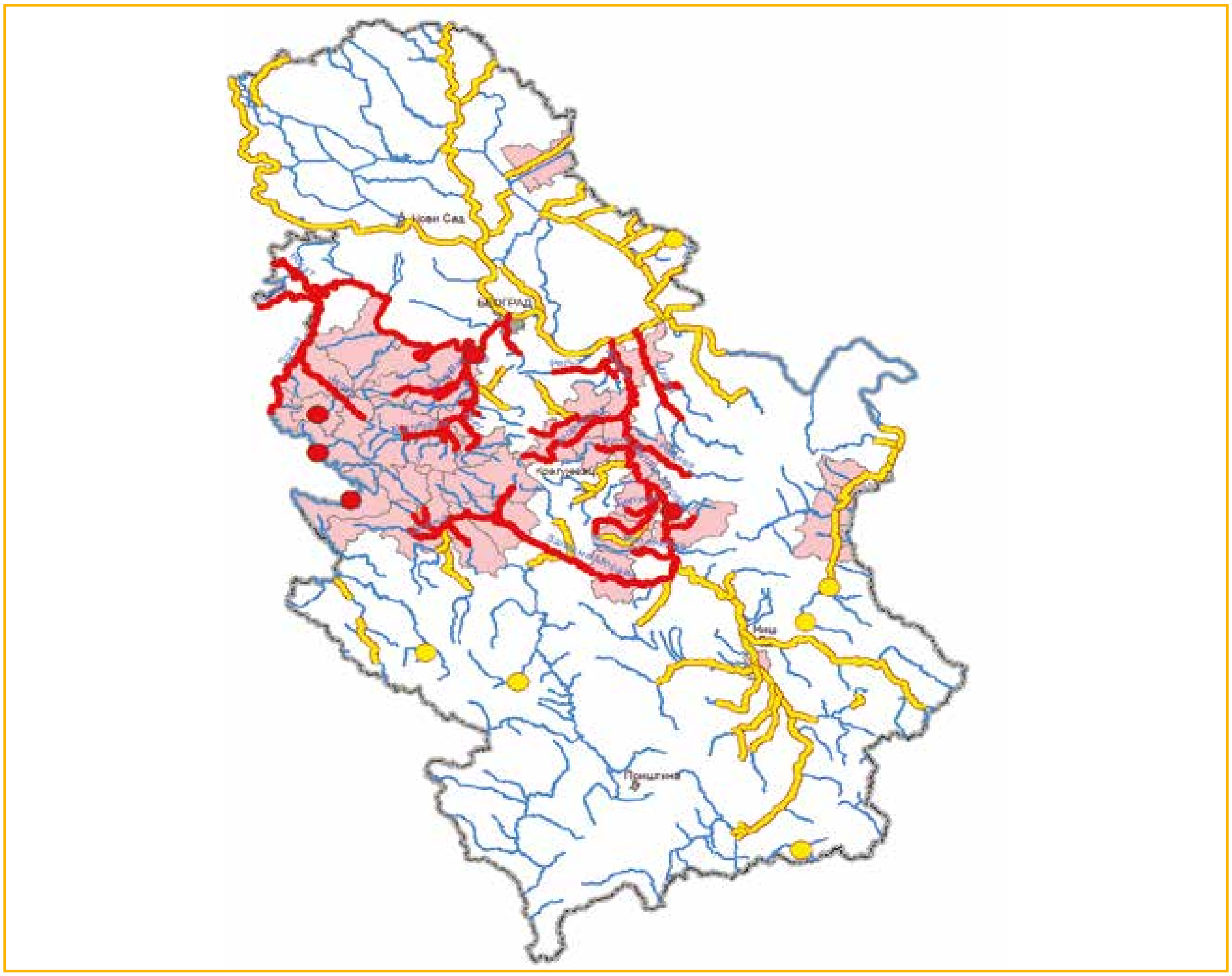


Figure 6.5: Areas of potentially significant flood risk in Serbia (yellow) and flood-prone areas affected by May 2014 flood (red)

In addition, potentially negative effects and impacts of climate change on water sector in Serbia will be reflected in shortage of water, more periods of intense drought and areas affected by droughts, and finally an increased duration of low-flow conditions in rivers. It is worth mentioning that low-flow conditions may be critical for water quality in the catchments of the Morava and the Tisa rivers, as well as in smaller rivers of eastern Serbia, such as the Nišava, Timok, and Mlava.

Due to observed and expected effects of climate change in the water sector, specific adaptation measures have been proposed in Table 6.2. According to approximate length of time needed for implementation of each measure, they have been divided into short-term (ST), medium-term (MT), long-term (LT), and continuous long-term (CLT). The adaptation measure classes (no regrets - NR, low regrets - LR, and techno-economic analyses required - TEAR) have been assigned to each measure.

When planning adaptation measures for changed climate conditions in water sector, it is important to note that the Law on Water does not include the impact of climate change and the need for adaptation to changing climate conditions.

Table 6.2: Proposed adaptation measures in hydrology and water resources sector

Strategic segments		Adaptation measures

Risk reduction	Water use	• Increased efficiency of water supply systems (NR, MT) including:
		  • Optimum decrease of losses
		  • Economic pricing of drinking water
		  • Optimal organization of waterworks.
		• Application of best available irrigation techniques and cooperation with upstream countries (bilateral commissions, ICPDR, ISRBC), with respect to water quantity (LR, CLT)
		• Reduction in specific water use by industry and irrigation, especially for new industrial and irrigation systems (NR, MT)
		• Transferring water from water-abundant regions to water-deficient areas (TEAR, LT)

	Water quality	• Wastewater treatment plants for all settlements with over 2000 inhabitants and industrial centers (NR/LR, CLT), many of them based on priorities (NR, ST) • Best available techniques applied for diffuse sources of pollution originating mainly from agriculture (LR, CLT) • Increase in wastewater tariffs (LR, MT) • Construction of green areas along the river flows (CLT)
	Protection against the adverse effects of water	• Development of flood protection plans for international rivers and large river basins (Danube, Sava, Tisa, etc.) (LR, ST) • Preservation of the existing natural flood zones and construction of green areas along the river flows (LR, CLT) • Formation of protective forest vegetation and grass communities along important "torrential streams" (NR, CKT) • Regular maintenance and retrofit of flood protection infrastructure and drainage systems (LR, CLT) • Increase in water storage capacity within river basins by constructing flood cells and retentions in flood-prone areas (TEAR, LT) • Restriction of building and infrastructure development in flood-prone areas (NR, MT) • Improved flood protection, especially near urban areas, large industrial centers, the biggest thermal power plants, etc. (LR, CLT) • Integrated approach and harmonized activities of institutions and organizations in charge at local, regional and national levels (LR, ST/MT)
	Multi-purpose	• Increase in water storage capacity (TEAR, CLT) • Transferring water from water-abundant regions to water-deficient areas (TEAR, LT)
Policy and legal framework		• Water Management Strategy (NR, LT); (adoption ST) • River Basin Management Plans (NR, MT) • Other planning documents according to the Law on Water, e.g., Water Pollution Protection Plan, Flood Protection Plans, etc. (NR, MT)

Monitoring and research	• Improvement of monitoring and other non-structural measures to combat droughts (LR, CLT) • Hydrological monitoring network improvement (NR, CLT) • Improvement of the early warning systems for extreme climate and hydrological events (NR, CLT) • Establishment of database on extreme meteorological and hydrological events and disasters (NR, ST) • Research improvement in the field of numerical modeling of hydrological processes (LR, CLT) • Advancement of research of climate change impacts on water resources (NR, CLT) • Advancement of multidisciplinary research of climate change impacts (LR, CLT) • Monitoring of the specific ecosystem and species which may be useful biological indicators of the state of the river basin and assessing the influence of climate change (CLT)
Capacity building and public awareness	• Improvement of coordination/harmonized activities of institutions and organizations in charge at local, regional and national levels (NR, CLT) • Capacity building of government institutions (NR, CLT) • Building of local community capacities (LR, CLT) • Capacity building of research and educational institutions (LR, CLT) • Improved inter-sectoral cooperation and ongoing international cooperation (NR, CLT) • Public awareness raising and better information dissemination on climate change impacts and possible adaptation measures (LR, CLT) • Capacity building and active participation of civil society organizations (LR, CLT)

6.2.2. Forestry

In the period 2003-2012, the reported damage from fires was 36,095 ha, or 1.6% of the forest area. Damage from fires usually occurs in the following four months: March, April, July and August (80% of all cases). During the fire outbreaks in 2012, 14,360 ha of privately owned forests were destroyed.

Estimations showed that total damage caused by forest fires in national forests in the period 2000-2009 exceeded 34 billion RSD. During this period, largest area affected by fires was recorded in 2007, a year with very dry conditions. On the other hand, after the extremely dry year of 2003, in the next three consecutive years insect attacks and diseases were reported. The year 2013 recorded several major fires after a long period of drought. The predicted temperature rise in, and increased periods of drought will lead to faster expansion of forest fires.

Occurrence of oak forest decline and mortalities were recorded in many occasions in the Sava River basin from 2004-2008. Research shows that after 1970, occurrence of oak forest decline in Srem region was recorded. Preliminary research results suggest that severe oak dieback is closely related to change of climate in the past 35 years, the most dominant factor being a decrease of groundwater level in this region. Predicted temperature rise and precipitation deficits may exacerbate the problem in the future.

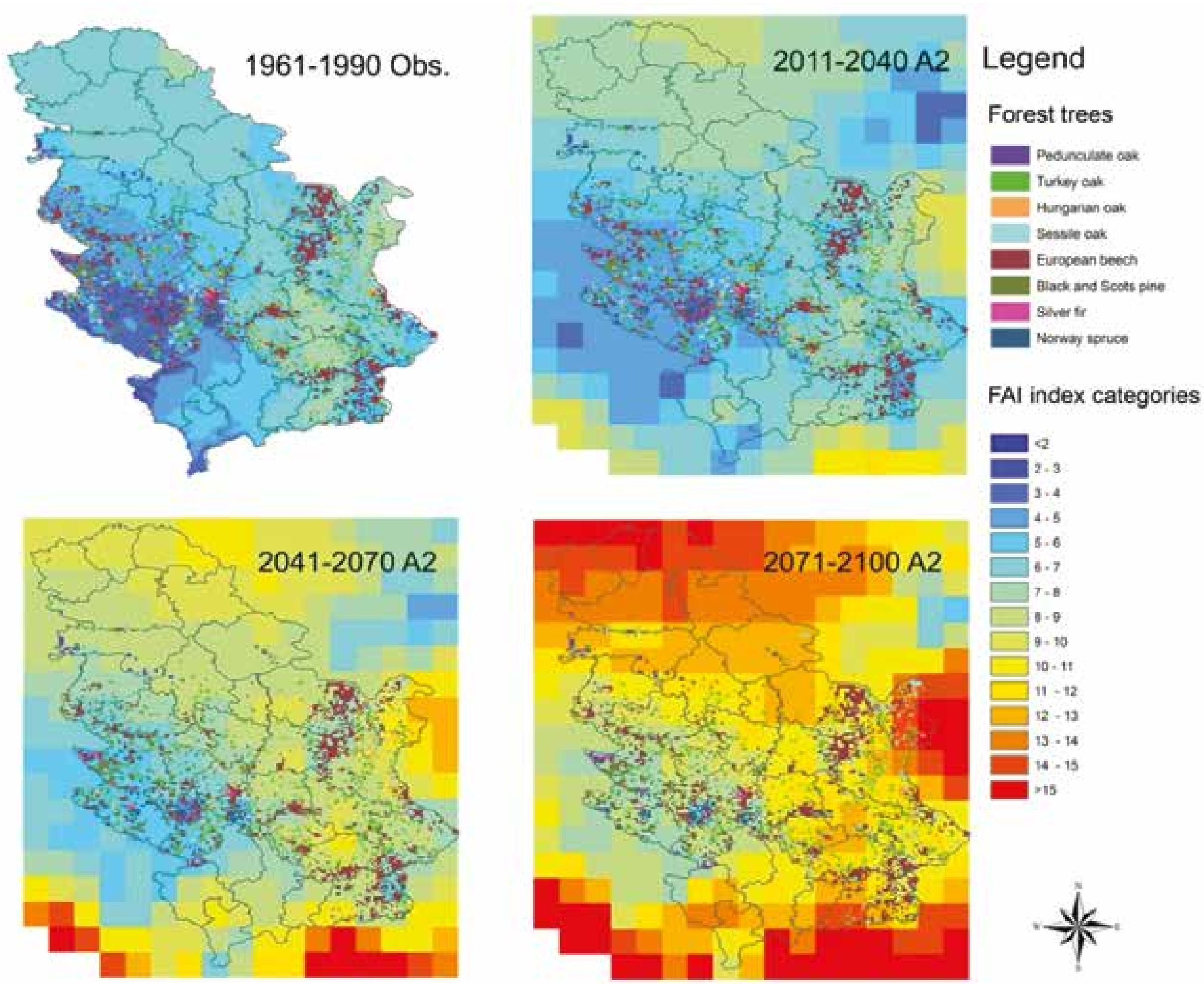


Figure 6.6: **Maps of Forest Aridity Index (FAI), 1961-1990 – observed climate, periods 2011-2040, 2041-2070 and 2071-2100**

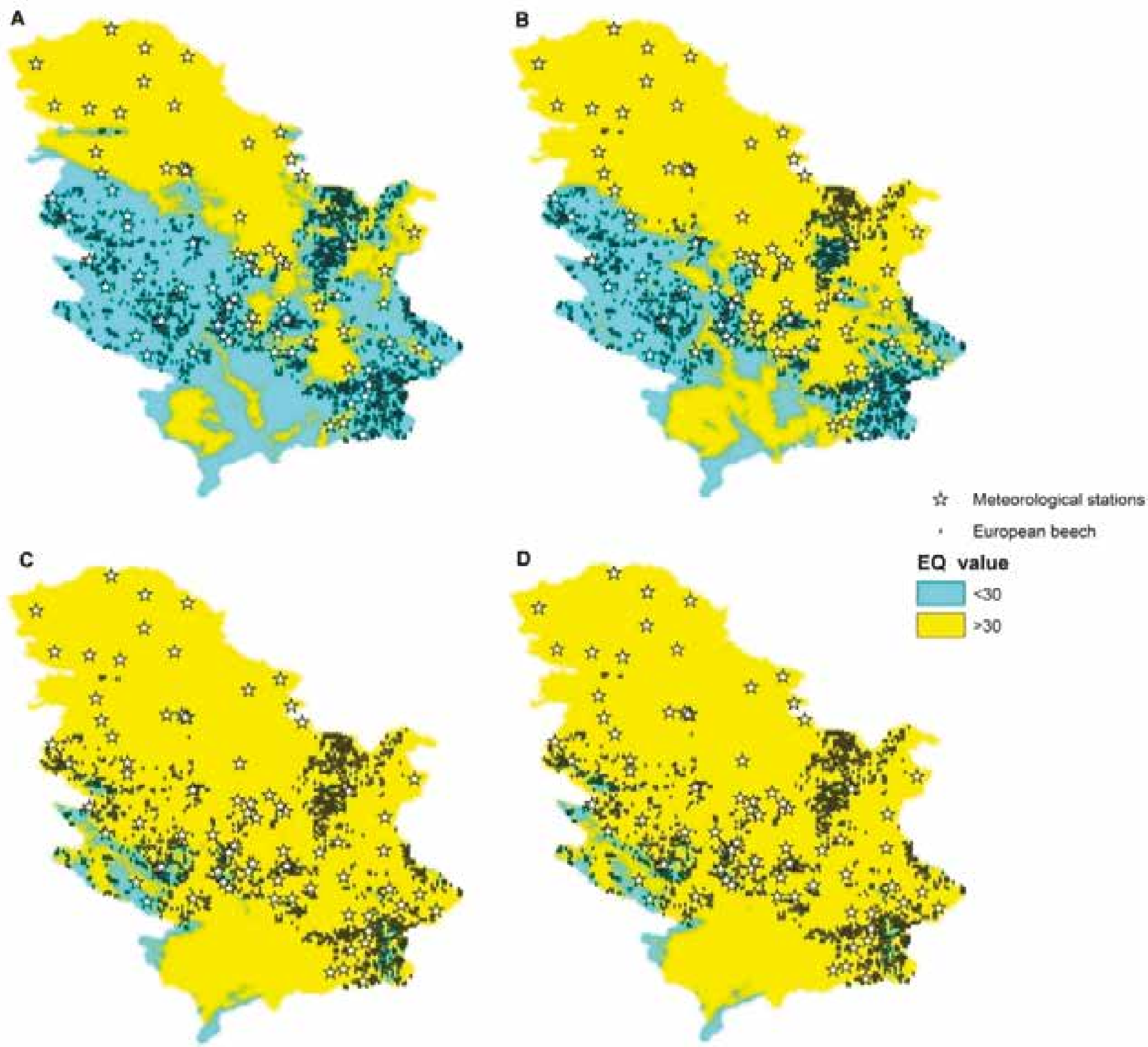


Figure 6.7: Maps of Ellenberg's climate quotient (EQ).

In order to predict future distribution of present day forests in Serbia, the forest aridity index was used. The considered species are: European beech – Fagus sylvatica L., Turkey oak – Quercus cerris L., Sessile oak – Quercus petraea (Mattuschka) Liebl., Hungarian oak – Quercus frainetto Ten., Pedunculate oak – Quercus robur L., Norway spruce – Picea abies (L.) H.Karst., Silver fir – Abies alba Mill., Black and Scots pine – Pinus nigra Arn, and P. sylvestris L. Distribution maps were generated for the period 1961-1990 (using observed data), as well as for the future periods of 2011-2040, 2041-2070 and 2071-2100 (using A2 scenario).

The usual forest aridity index values below 10, which were present across Serbia in reference period 1961-1990, will be drastically changed. By the end of the century those values will rise to above 15 in some parts of country. Thus, the least favorable conditions for forests in the 20th century will be the best conditions in the period 2071-2100. Forest aridity index values and distributions are shown in Figure 6.6.

Pedunculate oak will be the tree species most exposed to negative impacts of climate change due to its dependence on groundwater that are in general decline in recent decades. Sessile oak, Turkey oak, Silver fir, Norway spruce and European beech will experience distribution changes by the end of the 21st century. Black and Scots pine and Hungarian oak, species which are already present in the arid areas, will be the least affected by potential future climate change.

A special focus was placed on European Beech since it is the most important and abundant tree species in Serbia. Impacts of the past and future climate on beech in Serbia, were analyzed using Ellenberg's coefficient (EQ) and A1B and A2 scenarios. The results in Figure 6.7 show beech-suitable climate with EQ values less than 30 (blue area). Black dots represent beech stands and stars represent meteorological stations. The map A represents the distribution of beech in 1961-1990 climate period, Map B shows the period 2001-2030 (A1B scenario), Map C reflects the period 2071-2100 (A1B scenario) and Map D 2071-2100 period (A2 scenario). It is evident that the beech distribution will change in the 21st century. By the end of the 21st century, approximately 90% of the current beech forests will be outside their 20th century bioclimatic niche, and approximately 50% of beech forests will be within a bioclimatic niche where mass beech mortality is expected.

The strongest negative factors in forest ecosystems in the period 2003-2012 were pest and disease attacks. Among them gypsy moth (Lymantria dispar) outbreaks were the most prominent. During 2013, gypsy moth was present in 175,000 ha; in 2014 its numbers doubled (more than 340,000 ha). Currently there are no studies that indicate a clear correlation between climate change and the increased gypsy moth population. Additional monitoring is needed to address this correlation.

Due to climate change, which will reduce the forests vitality in general, and lack of preventive measures in forestry over the past years, it is expected that the gypsy moth attacks will contribute to significant economic losses in the sector and reduce the number of various ecosystem services.

When formulating adaptation measures for changing climatic conditions in the forestry sector, it is important to take account the tree species, as well as the fact that afforestation will be increasingly difficult. For example, instead of using English oak for afforestation, Turkey Oak can be used instead. In Vojvodina region, 80% of afforested area in 2012 was lost due to a severe drought. Proposed specific adaptation measures to climate change are given in Table 6.3. Based on approximate length of time needed for implementation, measures are divided into short term (ST), medium term (MT) and long term (LT). Insufficient funding and lack of stakeholder awareness can be possible barriers for implementation of these measures.

Table 6.3: Proposed climate adaptation measures for forestry sector

Strategic area	Adaptation measure

Risk reduction	• Reduction of biotic and abiotic disturbances through building adaptive capacity of forests
	   • Building fire protection forest roads in fire-prone regions (MT)
	   • Early treatment of pests (ST)
	   • Management of thinning of conifer plantations (MT)
	   • Promotion of mixed forests (LT)
	   • Promotion of uneven-aged forests (LT)
	• Choice of adequate tree species, provenances, population and genotypes, which show higher tolerance to altered climate conditions or are specially adapted to potential climate conditions in the future (LT)
	• Introducing the practice of adaptive management of forests and forest resources in order to adapt to climate change
	• Change of forest management practices and promotion of "close-to-nature" forest management concept (LT)
	• More intense rehabilitation of degraded lands by afforestation, after mining and industrial activities
	• Prevention of erosion and land slide of forests

	Specific measures - Lowland species (Pedunculate oak, Turkey oak, etc.) as the most endangered species
	• Improve water resource management; increase groundwater level in dry periods, if possible (MT) • Adapt thinning and felling operations to altered environmental conditions (MT) • Promote a "close to nature" regeneration (reduce the size of regeneration plots) (MT) • Promote mixing of oak forests (optimal mixing with ash and hornbeam) (LT)
	Specific measures - Mountainous forests (European beech, Silver fir, Norway spruce, etc.) as potentially highly endangered based on future climate projections
	• Promotion of selective felling management and "close to nature" approach (LT) • Promotion of mixed forests (LT)
Policy	• Framework for better implementation of the process of afforestation among various stakeholder groups. (MT) • Increasing the forest area (in particular protective and urban forests/parks) • Building capacity of public enterprises and the forestry sector through the regulation of appropriate legal, organizational and financial framework. (MT) • Transfer of knowledge from the existing European models (e.g.: Germany, Austria and Switzerland) (MT) • Greater involvement of private forest owners in the process of forest management (educating them and helping with organization of their activities)

Monitoring and Research	• Additional research and monitoring in the field of climate change impacts on forests, vulnerability and adaptation (LT) • Continued inventory of private forests (LT)
Capacity building and public awareness	• Capacity building of public enterprises and the forestry sector through the provision of appropriate legal, organizational and financial framework (MT) • Awareness raising on the importance of forests for adapting of the society as a whole to climate change (LT) • Awareness raising on multiple forest ecosystem services and their multi-functionality (LT) • Training on the impacts of climate change on forests and adaptability of forests to changing climate conditions

6.3.2. Agriculture

Climate change impact assessment on agriculture sector was primarily focused on how changes in temperature and precipitation affect the dynamics of plant growth changes in crop yield.

The results show higher vulnerability of agricultural production due to increased growth rate of plants. In particular, expected time shifts for flowering and ripening of the winter wheat, maize and soybeans crops have been carefully calculated. In the case of maize and soybean, changes of flowering times in the period 2001-2030 will be only a few days. Regarding the time of maturity, maize is expected to mature 7-13 days earlier, while for soybean and wheat there is no significant change. However, in the period 2071-2100 both maize and soybean are expected to flower more than two weeks earlier. Full maize maturation can occur up to two months earlier, which can significantly affect the quality and quantity of yield. Full soybean maturation can occur about two weeks earlier. This would alter flowering and ripening dates in order to maintain the usual length of the growing season.

In general, dynamic changes in vegetation can significantly affect crop yield and field work organization. At the same time, early planting can be a significant factor to crop adaptation due to expected climate change.

For the period 2001-2030, relative changes in winter wheat yield across Serbia varied from approximately -16% in northwest and north regions, to 21% in southeastern regions. The period 2071-2100 will experience a different vulnerability, with the highest relative crop change in central regions (6%) and with reduced yield in southern Serbia (-10%).

Expected maize yield changes obtained for the period 2001-2030 varied depending on the region with maximum possible decrease of -6%. For the period 2071-2100, changes range from -52 to -22 % for the whole territory of Serbia. These results are consistent with the results obtained from an analysis which excludes irrigation. Analysis shows that with the use of irrigation in the middle of the 21st century, maize yield loss could be reduced up to 31%.

For the period 2001-2030, changes in soybean yield varied from 31% (northern region) to 41% (southern region), and from -14% to 20% for the period 2071-2100, with expected increase in northern and south-eastern regions of Serbia.

In the period 2001-2030 sugar beet production may face serious difficulties. The trends of increased temperature and a shortage in rainfall will influence beet growth, and thus reduce sugar production per hectare. Additional irrigation would be necessary under these conditions for securing yield stability. Traditional planting, starting in March, if affected by typical rainfall deficit, may seriously jeopardize or hinder germination process. Increasing temperature (daily highs over 25^{0}C) and a number of summer days during spring can have an unfavorable influence on germination process and development of just sprouted seedlings. Due to the fact that beet root sugar synthesis is most active during warm days and cooler nights, an increasing trend in the number of tropical nights, with minimum temperatures up to 20^{0}C, may lead to the reduction of sugar content in the root in September.

Projections of future climate change show that Serbian viticulture will not be significantly affected over the next couple of decades, but considerable changes are expected at the end of the 21st century. Warmer and prolonged growing season in the second half of 21st century, accumulated heat, and a longer frost-free period with generally reduced frost frequency will likely affect the yield and ripening potential of grapes and introduce changes in varietal suitability and wine styles. Projected changes may call for additional vineyard irrigation, but may also open up the possibility that areas at a higher altitude, previously too cool for cultivation of grapevines, become areas with optimum climate for viticulture. Naturally, such localities require additional vulnerability assessment due to increased risk of soil erosion on steep slopes of vineyards, if protection measures against soil erosion are not applied.

Overall, expected climate change will increase the length of the vegetation period and shift the growing season to earlier dates (up to 20-30 days on average by 2100) affecting crop management and required time for field works. Spatial shifts in the field of agricultural climatology will strongly affect crop growing conditions and crop selection in the future. Warming will affect crop phenology, leading to a faster crop development rate. Dry periods will have the greatest impact on the yield, causing reduction of spring crops that are not irrigated, if the crop cultivars are not adapted to higher temperature demand (changing ripening groups). More intense and frequent occurrences of heat waves will increase production risk and reduce crop and livestock production. Heat stress negatively affects the health and production of livestock, and it compromises proper sanitation conditions (milk and meat).

Based on the scenario until 2100, significant vulnerability due to summer droughts are expected for rain fed crops in regions of Novi Sad, Kragujevac, Krusevac, Cuprija, Zajecar and especially in Vranje and Nis.

Soil erosion is an already present problem in the current climate in Serbia. It is estimated that erosion affects approximately up to 80 % of agricultural soil in Serbia. The central region and hilly mountainous regions are affected by water erosion, while Vojvodina is affected by wind erosion (about 85% of agricultural soil). Based on climate scenarios, erosion by water can be expected in mountainous regions (e.g. Zlatibor). In the long term, the effects of extreme weather conditions can reduce land fertility and significantly impair its function. Special attention should be paid to erosion caused by extreme rainfall combined with bare soil on steep mountainous areas. It is necessary to monitor the trend of soil erosion and assess additional risks that may be caused by climate change.

In addition, assessment of climate change impacts on pest and disease outbreaks in some of the most important agricultural crops was also made. The analysis shows that there will be a particular challenge to protect plants in the coming decades from fungal diseases and pest occurrence, and related virus diseases.

All crops (winter and summer crops) will be affected in all regions by changing pest and disease pressure due to warming and changes in precipitation, with increasing the overall vulnerability especially related to pests (thermopile insects). These risks are crop specific and are strongly influenced by relevant crop acreage in a region, crop management and crop rotation (i.e. maize in Vojvodina and Mačva regions; sugar beet in Vojvodina region and district area of Kruševac; orchards in Vojvodina region but also in all other parts of Serbia except in mountain regions. A detailed analysis is necessary in the upcoming reports.

In order to timely adjust to climate change in the agricultural sector, potential adaptation measures are shown in Table 6.4. Proposed adaptation measures are divided by the time needed for implementation into short-term (ST), medium-term (MT) and long-term (LT). All proposed adaptation measures should not incur any additional costs, and their implementation should increase production stability.

Certain barriers that can limit the implementation of these measures in the next period could be: unreliable income and high costs of modern technologies, a large number of small farms and the inadequate efficiency of manufacturing, the need for subsidies for irrigation, and other relevant measures.

Table 6.4: **Proposed climate adaptation measures in agricultural sector**

Strategic area	Adaptation measure
Risk reduction	• Change times of field operations (ST) • Ensure optimal soil cultivation time and sowing time, especially for Bačka and northern Banat (ST) • Achieve optimal plant density per area unit, especially for Bačka, northern Banat and Srem (ST) • Introduce minimum tillage or reduced soil cultivation (ST) • Introduce and breed drought and heat resistant cultivars (MT) • Breed earlier ripening cultivars in drought prone areas without irrigation in the summer, particularly in surroundings of Vranje, Niš, Zaječar, Ćuprija, Kragujevac and Novi Sad (MT) • Breed more productive cultivars (like C-4 plant types) (MT) • Increase percentage of winter crops (MT) • Use a variety of feed crops in crop rotation system, including alfalfa (MT) • Ensure more crops per year by using crop rotation and thus benefit from the increasing length of vegetation period (MT) • Ensure rational and effective use of fertilizers (ST) • Increase organic content in soils, especially northern parts of Vojvodina, Subotičko-horgoški (ST) • Ensure alternative use of residues by partial ploughing, particularly in the region of Bačka and northern Banat (ST) • Plough into ground plant residues combined with nitrogen application to provide better and faster decomposition of crop residues, especially for southern Vojvodina (ST) • Improve effective water management (MT) • Improve irrigation and water use efficiency and in order to produce specific crops by optimizing irrigation techniques and methods (MT) • Use more hail nets (MT) • Switch to integrated fruit production, particularly for regions of Fruška gora and Bela Crkva (MT) • Introduce alternative, early and table cultivars, particularly for western Serbia (MT) • Apply more effectively techniques for protection of grapevine against early autumn and later spring frosts (MT) • Introduce snow arresting tree belts, especially in areas influenced by Košava wind (MT) • Use of protective snow hedge especially in areas influenced by Košava wind (MT) • Slope terracing (MT) • Improve practice for water erosion protection, by building practice of water accumulation into soil (improving soil structure and infiltration capacity to reduce erosion caused by extremely heavy rainfall) (MT) • Improve afforestation in order to protect the soil from erosion (MT)

Policy	• Provide legislative framework for implementation of adaptation and mitigation measures in agriculture (LT) • Strengthen institutional policies enabling successful information chain between stakeholders and experts through providing the necessary capacities for agricultural research and advisory services; establish monitoring and alert systems for agriculture (MT) • Provide subsidies for adaptation and/or mitigation measures (MT) • Implement adapted legislative measures for specific environmental problems i.e. protection of quality of water resources through fertilizing or land use restrictions (MT) • Support training and education of farmers (ST)
Monitoring and Research	• Monitoring: adaptation capacity building, cost effectiveness of applied adaptation measures, changes of insurance policy, raising farmers' awareness, education of people involved in implementation of adaptation measures, time and place of appearance of harmful organisms, awareness raising of producers, education of all stakeholders involved in implementation of adaptation measures, work of agricultural advisory services • Research: Development of varieties more resistant to stress and drought, development of procedures for minimization of evapotranspiration, reducing soil saturation and improving efficiency of irrigation, more efficient use of modeling results (i.e. using numerical weather prediction of different scales and advanced agricultural tools with the aim to predict adverse effects and mitigate their effects)
Capacity building and public awareness	• Training and education of farmers related to production technologies and farm management options • Support and advice for direct marketing options for farmers • Advisory services available for all farmers/farming systems • Provision of education opportunities for young generation of farmers • Merging of small farms in medium and large ones; building cooperatives where applicable • Maintaining balance between crop and livestock production in order to avoid an increase of GHG emissions on both local and on global scale

Adaptation measures for individual crops are shown in Table 6.5.

Table 6.5: Adaptation measures for individual crops

Crop	Measure
Small Grains	• Crop cultivation in an area influenced by climate change implies developing new genotypes with adaptability to abiotic and biotic factors or adaptation of existing genotypes to future requirements. • A detailed risk assessment based on meteorological and biological observations in a wider region is required to prevent disease outbreaks and epidemic in a given area.
Maize	• Changing sowing dates (earlier planting time), selection of tolerant hybrids and irrigation in order to reduce overall stress. In the future, it will be necessary to spend more water for irrigation in large areas than before • Replacement of current varieties to those that ripen later and are resistant to high temperatures. • Changing pest and disease pressures can be reduced by sound crop rotations. • Pest and disease monitoring and forecasting can strengthen effective crop protection measures and reduce risk of crop failure.
Sugar Beet	• Irrigation • Earlier sowing • Delayed harvesting of sugar beet, which prolongs production and exposure to outdoor conditions for at least another month • Selection of tolerant hybrid plants and identifying the region with favorable conditions for cultivation.
Grapes and Fruits	Adaptation measures that take into account the expected changing climatic conditions for raising new orchards and vineyards are listed below: • Timed fertilization • Irrigation • Setting up anti-hail nets • Weed control • Constant pruning • Removing fallen leaves

More detailed information on the effects of climate change and adaptation measures for this sector are presented in the following publication: «Warming crops - how to respond», which was produced in the process of drafting the Second National Report of the Republic of Serbia to the UNFCCC.

6.3.4. Health

Over the last couple of decades Serbia has been facing new direct and indirect risks to human health related to observed climate change. Among them are heat waves, leading to an increased number of fatalities. Between 16 and 24 July, 2007 there were 167 deaths caused by heat waves. Out of the total number of deaths, there were 151 people aged 75 years and older (90%) , and thus mortality rate among elderly increased by 76% in comparison to the baseline mortality. Cardiovascular and malignant neoplasms mortality accounted for the highest number of excess deaths, 77 and 49, respectively, but the highest increase in general mortality rate was from diabetes mellitus (286%), chronic kidney disease (200%), respiratory system diseases (73%), and nervous system diseases (67%). Excess female mortality rate was over two times higher than the male one (54% versus 23%). It was found that as mean daily temperature goes beyond 90th, 95th and 99th percentiles, the average number of deaths increases by 15.3%, 22.4% and 32.0%.

The Institute of Public Health of Serbia (IPHS) together with the Republic Hydrometeorological Service of Serbia (RHMSS), introduced an early warning system in situations where extreme climatic conditions pose a risk to health of the population. From May 1st to September 30th, RHMSS will issue an alert for periods with extreme temperatures. The alert will then be forwarded to the IPHS. IPHS through a network of local institutions of public health, will then alert medical institutions, as well as provide instructions on how to respond to patients.

During floods that hit Serbia in May 2014, 51 casualties were recorded. Out of this number 23 person drowned as a result of floods and landslides. An indirect threat of floods was a potential occurrence of contamination of surface water, groundwater and surrounding soils with hazardous materials and sewage. Heavy metals were released from mine workings to the Korenita stream in Loznica Municipality when a dam broke. Also, water supply for Mali Zvornik Municipality was affected by heavy metals due to groundwater level rising from old mine sites. Another indirect health impact of this flood episode was that 15 municipalities reported that some of their health care facilities had been damaged and several of them were temporarily closed.

Indirectly, climate change brings new challenges in controlling infectious diseases. Climate change will definitely lead to a change of distribution and to an increase of incidence of vector-borne diseases (malaria, dengue, West Nile virus, etc.), as well as to spread of waterborne diseases, such as cholera and diarrhea. In 2012 the Institute of Public Health of Serbia established a seasonal permanent monitoring of West Nile virus in human population. During the summer season of 2012, the number of registered (potentially infected and confirmed) cases was 71, including nine deaths that may be linked to the West Nile virus. In 2013, 302 people were infected by West Nile virus by the end of October, and 35 died, which is approximately four times higher than in 2012. This large increase suggests that West Nile virus may pose a growing threat to human health in Serbia in the future. Beside West Nile fever, Lyme disease as well as malaria occurrence is increasing (Figure 6.8). In 2012, these two vector-borne and climate-related diseases experienced a mild decline, but six years before an increasing trend was observed. For the first time in past several years, in 2012, inflammation of the brain caused by a virus transmitted by ticks was reported (four cases).

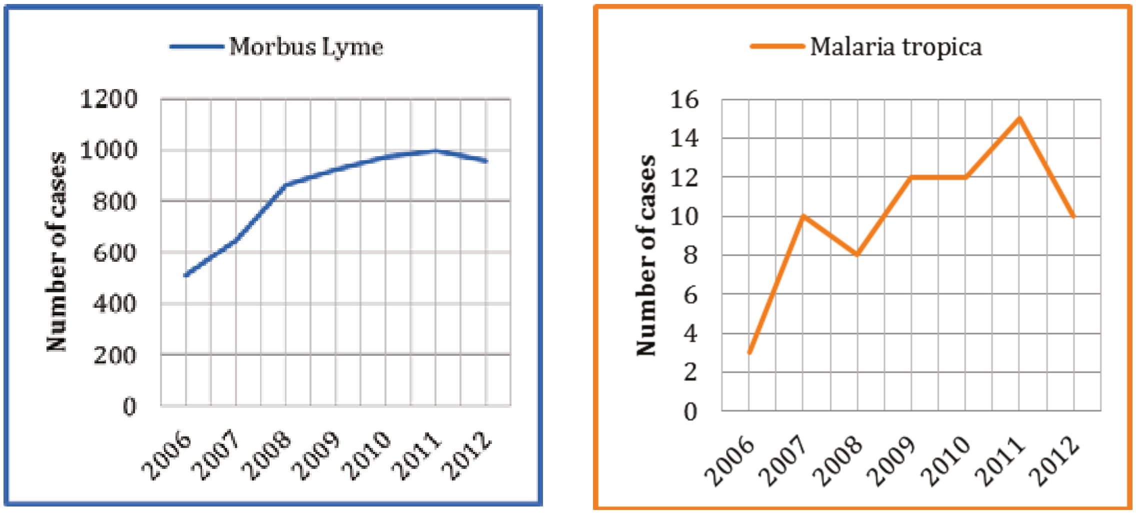


Figure 6.8: Number of cases affected by Lyme disease (left) and of Malaria tropical (right) in Serbia in the period 2006-2012

A summary of potential impacts of the effects of climate change on human health in Serbia are given in Table 6.6.

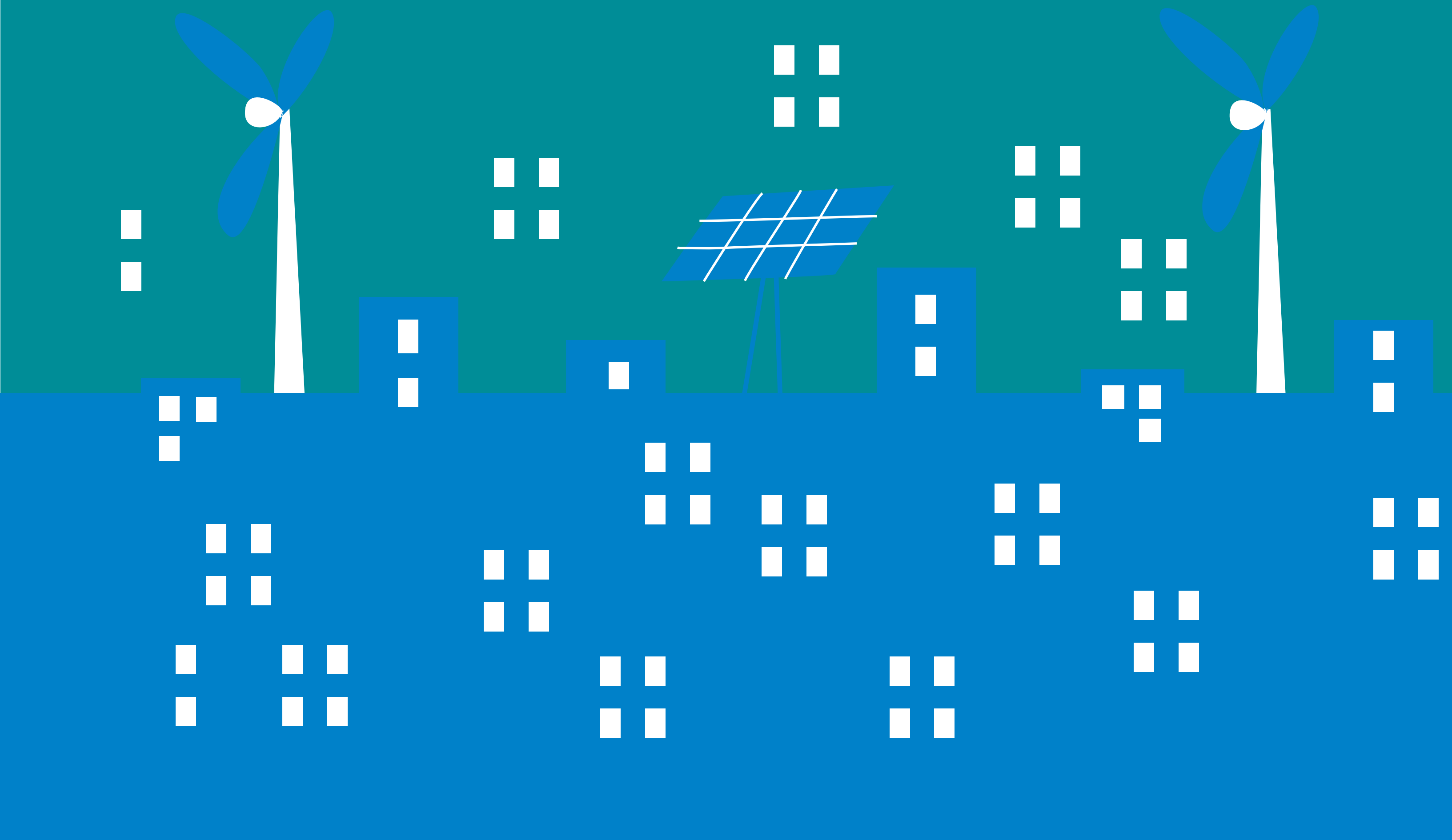
Табела 6.6: Потенцијални утицаји промена климе на здравље

Weather events	Health effects	Populations most affected
Heat Waves	• Premature death • Heat-related illnesses such as: heat stroke, heat exhaustion, and kidney stones • Heat stress • Excess deaths	Elderly, children, diabetics, poor, urban residents, people with respiratory diseases, those active outdoors (workers, athletes, etc.).
Poor air quality	• Increased asthma occurrence • Increased chronic obstructive pulmonary disease (COPD) and other respiratory diseases	Children, those active outdoors (workers, athletes, etc.), elderly, people with respiratory diseases, the poor.

Extreme rainfall and floods	• Injuries • Death from drowning • Increased number of water-borne diseases from pathogens and water contamination from sewage overflows • Increased food-borne disease	Residents in flood prone areas, elderly, children, the poor, residents in the areas under the risk of water torrents
Wildfires	• Death from burns and smoke inhalation • Injuries • Eye and respiratory illness due to fire-related air pollution	People with respiratory diseases, people in areas prone to wildfires
Droughts	• Disruptions in food supply • Changing patterns of crops, pests, and weed species • Water shortages • Malnutrition • Food- and water-borne disease • Emergence of new vector-borne and zoonotic disease	The poor, elderly, children
Increased average temperature	• Increased number of food-borne diseases, such as Salmonella poisoning • Increased number of vector-borne diseases such as West Nile virus, encephalitis, Lyme disease, etc. • Increased strain on regional drinking water supplies • Increased vulnerability to wildfires and associated air pollution	Children, those active outdoors (workers, athletes, etc.)
Increased temperature and rising CO_2 levels	• Increased allergies caused by pollen • Increased number of cases of rash and allergic reactions from plants and trees	People with respiratory disease, people with acute allergies, children, those active outdoors (workers, athletes, etc.)

Even though some progress was achieved (monitoring vectors of infectious diseases and development of early warning systems), a detailed analysis of the impact of climate change on human health and the development of climate change adaptation measures is essential in the future.

7. IMPLEMENTATION OF THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE



7.1. General information

The Republic of Serbia has been part of the United Nations Framework Convention on Climate Change (UNFCCC) since 2001 and the Kyoto Protocol (Protocol) since 2008. The Ministry of Environmental Protection (MoEP) is the national climate change focal point.

In 2010, the Republic of Serbia associated with the Copenhagen Accord and in 2012 developed a list of 12 Nationally Appropriate Mitigation Actions (NAMAs) for which is seeking support for implementation.

In 2010, following Governmental approval, the Republic of Serbia submitted the First National Communication under the UNFCCC (INC). The First Biennial Update Report of the Republic of Serbia (FBUR) was submitted in 2016.

In June 2015, the Government of the Republic of Serbia submitted the "Intended National Determined Contributions" (INDCs) foreseeing 9.8% GHG emission reduction by 2030 compared to base-year (1990) emissions. INDCs of the Republic of Serbia contains a part related to loss and damage associated with extreme events and indicates the need for adaptation to impacts of climate change. President of the Republic of Serbia has signed the Paris Agreement at the Paris Climate Agreement Signing Ceremony. The Republic of Serbia ratified the Paris Climate Agreement on 29 May 2017.

In order to achieve the goals defined in INDCs and fulfill the commitments under Paris Agreement, many activities were initiated in cooperation with the relevant ministries.

7.2. Institutional framework

The Climate Change Division (CCD) of the Ministry was formed in 2008 with the aim of establishing the necessary institutional capacities to fulfill the commitments that are required by the UNFCC and the EU. On a national level, the Climate Change Division is responsible for initiating, coordinating and participating in activities that are in line with the UNFCCC guidelines. The Division has six full-time employees.

In 2007, the South East European Virtual Climate Change Centre-SEEVCCC within the Republic Hydrometeorological Service of Serbia was established, as an effort to strengthen regional cooperation and identify joint actions in the area of adaptation. SEEVCCC is active in the field of scientific research, regional and international cooperation, publishing seasonal forecasts for South-Eastern Europe and producing climate projections (using the atmosphere-ocean regional climate models).

In 2008, the Serbian government established the National Designated Authority for implementation of the Clean Development Mechanism Serbia (DNA), operated by Climate Change Division as its Secretariat.

Members of the DNA, as an inter-ministerial body, are nominated representatives from ministries in charged for energy, transport, construction, agriculture, waste management, forestry and water management.

Other government institutions relevant to the implementation of activities in the field of climate change are: Forests Directorate and Water Directorate (within the Ministry of Agriculture, Forestry and Water Management); Ministry of Mining and Energy; Ministry of Construction, Transport and Infrastructure; Ministry of Interior; Ministry of Health; and Ministry of Education, Science and Technological Development. The Ministry of Finance plays a key role in terms of providing funds for climate change actions.

With the view to strengthening cooperation and exchange of information between the relevant Governmental institutions, scientific and other professionals, and local communities with regard to climate change issues and policy, as well as to promoting this issue at the national level, the Government of the Republic of Serbia established the Climate Change Committee in November, 2014. The Committee shall: monitor development and implementation of national policies on climate change, sectoral policies and other planning documents in terms of consistency with national climate change policies and propose measures for improving and coordinating policies, measures and actions in this field; monitor the fulfillment of international commitments of the Republic of Serbia in the field of climate change; review reports with regard to fulfillment of UNFCCC commitments, propose measures to mitigate climate change, greenhouse gas emission reductions, and adaptation measures; discuss amendments to laws and regulations relevant to climate change issues and submit its opinion to the Government; propose actions to combat climate change especially in the process of negotiations with the EU; monitor implementation and propose measures to improve the National Strategy on Climate Change with the Action Plan; promote the process of combating climate change and mainstreaming climate change concerns into sectoral policies; initiate changes in policies, legislation and measures with regard to climate exchange in accordance with European regulations and United Nations' standards, as well as draft decisions relevant for the implementation of projects and other activities in the field of climate change. Members of the Committee are representatives of all relevant ministries and other governmental institutions, as well as representatives of universities and scientific institutions, including ministries responsible for Agriculture, Environmental Protection, Finance, Economy, Mining, Energy, Construction, Transport, Infrastructure, Interior, Education, Science and Technological Development, Health, Foreign Affairs, European Integrations, Cooperation with Civil Society; Agency for Environmental Protection; Republic Hydrometeorological Service of Serbia; Statistical Office of the Republic of Serbia; Institute for Nature Conservation of Serbia; Provincial Secretariat for Urban Planning, Construction and Environmental Protection; Provincial Secretariat for Energy and Mineral Resources; Secretariat for Environmental Protection of the City of Belgrade; University of Belgrade; University of Novi Sad; University of Nis; Standing Conference of towns, municipalities, and civil society associations. The Climate Change Division has the role of a Secretariat, and the Minister responsible for climate change is Chairman of the Committee. A permanent working group for national reporting within the National Committee will be established during the process of drafting the next national report to the UNFCCC.

7.3. Legislative framework and policies

Significant efforts have been made recently to improve the legislative framework and policies that directly or indirectly affect the implementation of activities related to climate changes. In accordance with the strategic goals of the country, the process of harmonization of national with the European Union legislation was initiated, which contributes significantly to fulfillment of obligations under the Convention.

In 2004, the Government adopted a first set of legislation with regard to environmental protection. Based on the Law on Environmental Protection, the Environmental Protection Agency was established.

The National Sustainable Development Strategy of the Republic of Serbia (2008) and its Action Plan for 2009 – 2017 highlight the necessity of inter-agency action that would lead to GHG emission reduction, as well as the need for developing an adaptation plan for industry.

The National Programme for Environmental Protection 2010-2019 (2010) has defined activities required to reduce climate change impacts.

The "National Strategy for Incorporation of the Republic of Serbia into Clean Development Mechanism (CDM) under the Kyoto Protocol for Waste Management, Agriculture and Forestry sector" (2010) has identified ways and possibilities for implementing mechanisms offered by the Kyoto Protocol for these sectors. The Strategy was developed with the financial support from the Government of the Kingdom of Norway. The first CDM project of the Republic of Serbia was registered by the UNFCCC in November 2011. Seven CDM projects were registered in June 2013. Out of the seven CDM projects registered so far, four are wind energy projects.

In 2012, the Republic of Serbia developed 12 Nationally Appropriate Mitigation Actions (NAMA) plans, seeking support for implementation. NAMAs plans mainly refer to energy supply sector (65%), construction (29%) and transport (6%). The development of these NAMAs and preparation of the necessary documentation was accomplished through the project «Building capacities to prepare nationally appropriate mitigation actions» in cooperation with the Japan International Cooperation Agency (JICA). Part of the project was development of the "NAMA Development Guideline of the Republic of Serbia".

The Forestry Development Strategy (2006), Waste Management Strategy (2010), Biodiversity Strategy of the Republic of Serbia for 2011-2018 (2011), National Strategy for Disaster Risk Reduction and Protection and Rescue in Emergency Situations (2011), National Strategy of Sustainable Usage of Natural Goods and Resources (2012), Energy Development Strategy 2025 (2015), First National Energy Efficiency Action Plan (2010), National Renewable Energy Action Plan of the Republic of Serbia (2013), National Rural Development Strategy (2015), and other relevant documents have recognized the problem of climate change and have proposed activities that contribute to solving this problem.

In 2016, in cooperation and financial support by EU, the process of drafting the National Climate Change Strategy started. The main aim of the Strategy is to define, every five years, a long-term framework to combat climate change and specific activities to fulfill this goal for the period 2020-2050, , as well as predictions for emission reduction until 2070. The National Climate Change Strategy with Action Plan will also ensure fulfillment of the Paris Agreement (revision of INDCs, long-term strategy etc.).

In 2015, the city of Belgrade adopted the "Climate Change Adaptation Plan and Vulnerability Assessment", as the first local action plan related to climate change.

However, the current level of integration of climate change into sectoral and overall development strategy, the level of knowledge, institutional and individual capacities, available technology and financial resources at the national level, together with involvement of local governments, are not sufficient despite numerous activities and efforts for an effective and rapid response to climate change issues. For these reasons, strengthening cooperation at the bilateral, regional and international levels, continued cooperation with the GEF, and establishing cooperation with the private sector are essential for the effective implementation of the Convention and the response to climate change at the national level.

7.4. Research and systematic observation

Serbian climate research has a long history. Milutin Milanković, a distinguished Serbian scientist (1879–1958) and lecturer at Belgrade University, in his famous "Astronomical theory of climate change on the Earth" (1941), explained the effect of key factors of natural long–term climate changes. Milanković's theory provided a scientific basis for the study of the effects of anthropogenic factors on the Earth's climate system.

Serbian universities have an over century–old tradition in the field of meteorology. Researchers at Belgrade University have developed a new version of the regional climate EBU–POM model, which was employed in the development of regional climate change scenarios and utilized in the production of the relevant chapters of the National Communications.

Generally speaking, most of the research in the area of climate change was done thanks to the participation of scientific, state and other institutions, as well as individuals in scientific and technical programmes of the World Meteorological Organization, research and development programmes of the European Union, as well as in bilateral and multilateral cooperation programmes. Moreover, the Republic Hydrometeorological Service (RHMSS) and the South East European Virtual Climate Change Center (SEEVCCC) are participating in bilateral and multilateral projects important for climate research and improvement of systematic climate observation.

As a member of the World Meteorological Organization, the Republic of Serbia supported the establishment of the GCOS and actively participates in the implementation of the GCOS Action Plan for Central and Eastern Europe (adopted in 2005). The National Hydrometeorological Service of Serbia, as a national Hydrometeorological institution, is tasked with meeting Serbia's commitments towards the GCOS.

Within the national observational network, the synoptic, climatological and agrometeorological situations are continuously observed at 28 of the 32 surface synoptic stations. The four remaining stations work intermittently. The national network of meteorological stations is comprised of an upper air observation station, 75 climatological stations and 481 precipitation stations. The observation system was automated in the past two years.

The Republic Hydrometeorological Service of Serbia currently uses CLIDATA as a central climate data management system (CDMS). CLIDATA is the National climatological database (http://www.clidata.cz/en/ introduction/) and contains three types of observations: hourly data from synoptic stations, daily climatological observations from synoptic and climatological stations and daily observations of precipitation from precipitation stations. Currently, observations are imported in database from 159 different stations. The data cover period from 1965 to 1981 depending on date when a station started with operational observation. At 30 stations in which observations started before 1965, the observed data are digitalized but not imported in database. There are about 150 stations in a non-digital form at that have been recording observations since 1945. The oldest recorded data is from 1887. In general, about 85% of all climatological daily data observed within the national network in recent decades are imported into the database. A small number of hourly observations from synoptic stations are recorded into the database. The station with longest record is Belgrade, and imported data covers period from 1975 to 2003, including 2005 and 2012. For

8 synoptic station data were digitalized in the period 1967-1970, and for 10 additional stations observations were digitalized for period 1975-1983.

Data from five precipitation stations was imported in the period 1989-1992 and at one station data was recorded from 1992-2007. In this case, there is more data in digital form than imported data. About 600 stations were digitalized starting from 1992 up today and there are about 900 stations in non-digital form starting from 1941. The earliest recorded data is from 1888. Data from precipitation stations consists of daily observations of amount and type of precipitation, snow height and daily snow accumulation. Besides these three basic types of imported data in national database, CLIDATA also contain data from about 20 automatic rainfall stations imported since 2008, and data from automatic weather stations installed on synoptic stations locations since 2007 together with converted GTS-SYNOP coded messages from the same stations.

7.5. Education, training and public awareness

In the last decade, educational programmes which, in direct or indirect way, deal with climate change issues became a part of primary, secondary and high education curriculum. The Educational Strategy until 2020 (2012) recognized the importance of environmental protection, climate change, trends in developing new technologies and engineering solutions necessary for sustainable development.

The number of academic programmes at undergraduate or post-graduate level that include climate change in their curriculum as well as the number of high schools which offer an opportunity to educate for the occupation – Environmental Protection Technician have risen significantly. The basic knowledge and initiatives which have an influence on development of environmental awareness at an early age, start from grades 1-8, through different educational curricula. Schools organize a one-week long "Classes in Nature" for 1st – 4th grade children. Over the last 5 years, some primary and secondary schools have been participating in global campaign to promote the International Day of Climate change.

The Ministry of Education, Science and Technological Development has provided every primary school with the so-called Green package that includes educational content, including information about climate change, prepared by the Regional Environmental Center for Central and Eastern Europe (REC).

An initiative of the civil sector related to certification of schools to get a status of an Eco–school started in 2013. This international initiative on Education for Sustainable Development has an aim to provide information of different aspects of environmental education, teaching each child practical skills and involving them in different activities.

Although positive steps related to climate change education have been made, further improvement is necessary in order to have skilled specialists who can directly apply their knowledge.

The Ministry Environmental Protection has identified a need to build capacity of different stakeholders, as one of the important aspects of climate change. The Ministry organized a number of workshops, seminars and conferences for different stakeholders (employees in state administration, local government, media, investors, civil sector, and experts).

During 2014 and 2015, the Ministry, in cooperation with UNDP and civil society organizations, implemented seven regional workshops, aimed at capacity building and awareness raising on climate change, especially regarding requirements under UNFCCC and the content of the Second National Communication and the First Biennial Updated Report of the Republic of Serbia under the UNFCCC.

Moreover, in October 2015 and 2016 two conferences were organized with the aim to promote Conferences of the Parties to the United Nations Framework Convention on Climate Change, which took place in Paris, France and Marrakesh, Morocco.

In addition, other organizations were organizing events with the aim to raise awareness, such as: Directorate for Water ("Days of the Danube" and "Days of the Sava"), Ministry of Construction, Transport and Infrastructure, Ministry of the Interior (Department for Emergency Management), European Integration Office, Chamber of Commerce, authorities of AP Vojvodina and civil organizations. International institutions, agencies and organizations such as EU and its member states (France, Italy, Spain, and Germany), UNDP, UNEP, OECD, World Bank, JICA, and Regional Environmental Center for Central and Eastern Europe (REC) are important partners for organizing and implementing seminars and workshops. Funds provided by GEF are essential for implementation of these activities.

Local authorities and civil society organizations are more active in global and regional initiatives. For example, 59 cities, 37 schools and 40 civil society organizations participated in the campaign "Earth Hour" in 2013).

The South East European Forum on Climate Change Adaptation, financed by EU, has been established and 17 civil society organizations from Serbia as participants. Forum organized a regional conference (June 2012, in Montenegro, Sutomore), gathering more than 80 CSOs from the region. As a part of the Forum the study "Assessment of Vulnerability to Climate Change" was developed.

The scientific community is actively participating in projects related to analysis of climate change as well as promoting activities about climate change resilience through distribution of publications, leaflets and other material.

A large number of employees in government institutions had an opportunity to attend training, directly or indirectly relevant to the activities in the area of climate change, organized by the Government of Japan, through the Japan International Cooperation Agency (JICA),

The Ministry, in cooperation with UNDP and GEF, made a website www.klimatskepromene.rs, with the aim to raise awareness. Another significant source of relevant information about climatology and vulnerability is the website of the Republic Hydrometeorological Service of Serbia (http://www.hidmet.gov.rs/).

Also, the Ministry developed special publications about the effects of climate change on agriculture and health sectors, in order to promote and raise public awareness about the issue and possibilities for mitigation in these sectors.

However, the level of overall understanding of links between climate change and development of sectors is still insufficient. Therefore, during the process of developing SNC a survey was made (over 60 institutions, total number of responses - 30) based on which an analysis of needs for future training was made.

7.6. Bilateral, regional and international cooperation

So far the Republic of Serbia has invested enormous efforts in continuously strengthening cooperation with the UNFCCC member states and bodies. Due to its status of EU membership candidate country, Serbia's cooperation with the European Commission and the institutions of the EU member states has significantly improved. Cooperation is very important for the Republic of Serbia for transfer of experience in the implementation of EU legislation. Therefore, a number of activities are carried out through projects and various forms of bilateral and regional cooperation as well as cooperation at the international level.

After devastating floods in 2014, the number of regional projects aimed at disaster risk reduction has considerably increased compared to other regions. Serbia is a member of many international initiatives, particularly those supported by the GEF.

Projects are being implemented in cooperation with various international and regional organizations and implementing agencies, such as the United Nations Development Program, United Nations Environment Program, World Bank, World Meteorological Organization, United Nations International Strategy for Disaster Reduction (UNISDR), Organization for Security and Co-operation in Europe (OSCE) etc.

The regional ECRAN project (Environment and Climate Regional Accession Network), financed by the EU, is aimed at strengthening cooperation and improving capacity building in the candidate countries and potential candidate countries for EU membership.

Although a large number of projects in the area of climate change are funded by the EU, contributions of the Global Environment Fund and the Green Climate Fund are particularly important for activities at the national level, as well as for improving regional cooperation in the area of adaptation.

7.7. Monitoring, reporting and verification (MRV)

Recognizing the importance of the monitoring, reporting and verification system both for monitoring of the state of climate and improved planning and implementation of policies relevant for climate change, the Republic of Serbia has established some important elements of this system. Establishment of the system for continuous monitoring, reporting and verification (MRV) of data and information related to combating climate change and reporting under UNFCCC, has started during the process of national reporting under UNFCCC.

The establishment of MRV system with regard to GHG inventory started in 2009, when the Law on Air Protection designated the Serbian Environmental Protection Agency as the one responsible for developing the national GHG inventory.

General procedures and methodologies for collection and archiving of activity data for preparation of national GHG inventory are stipulated by the relevant by-laws, namely the Regulation on the Methodology of Data Collection for the National Greenhouse gas Inventory (2010). The state and local governmental bodies, public institutions, legal and other entities that are directly or indirectly related to environmental protection and that collect and/or possess activity data needed for preparation of GHG inventory are required to submit entry data. Activity data are submitted to SEPA by the mentioned entities on hard-copy and electronic forms stipulated by the ministry responsible for environmental protection. The deadline for submission of activity data is 31 March of the current year for the previous calendar year. The Agency is responsible for implementing quality control procedures and for ensuring transparency, accuracy, completeness and consistency of activity data, emission factors and other calculation parameters, as well as calculation of GHG emissions and removals in accordance with the Quality Assurance/Quality control (QA/QC) Plan.

Key short-term challenges in further development of GHG inventory are first of all related to institutional and human resources, improvement of data flow management, including IT infrastructure, since the existing capacities are underestimated when compared to monitoring and reporting requirements.

A comprehensive MRV system implies MRV of GHG emission reduction measures. These measures in the Republic of Serbia are formulated as goals set by the legislative and strategic documents (for instance renewable energy sources) and as specific activities designed at the project-level (NAMA projects). In both cases, it is necessary to identify and define qualitative and quantitative indicators and procedures and commitments of monitoring and reporting.

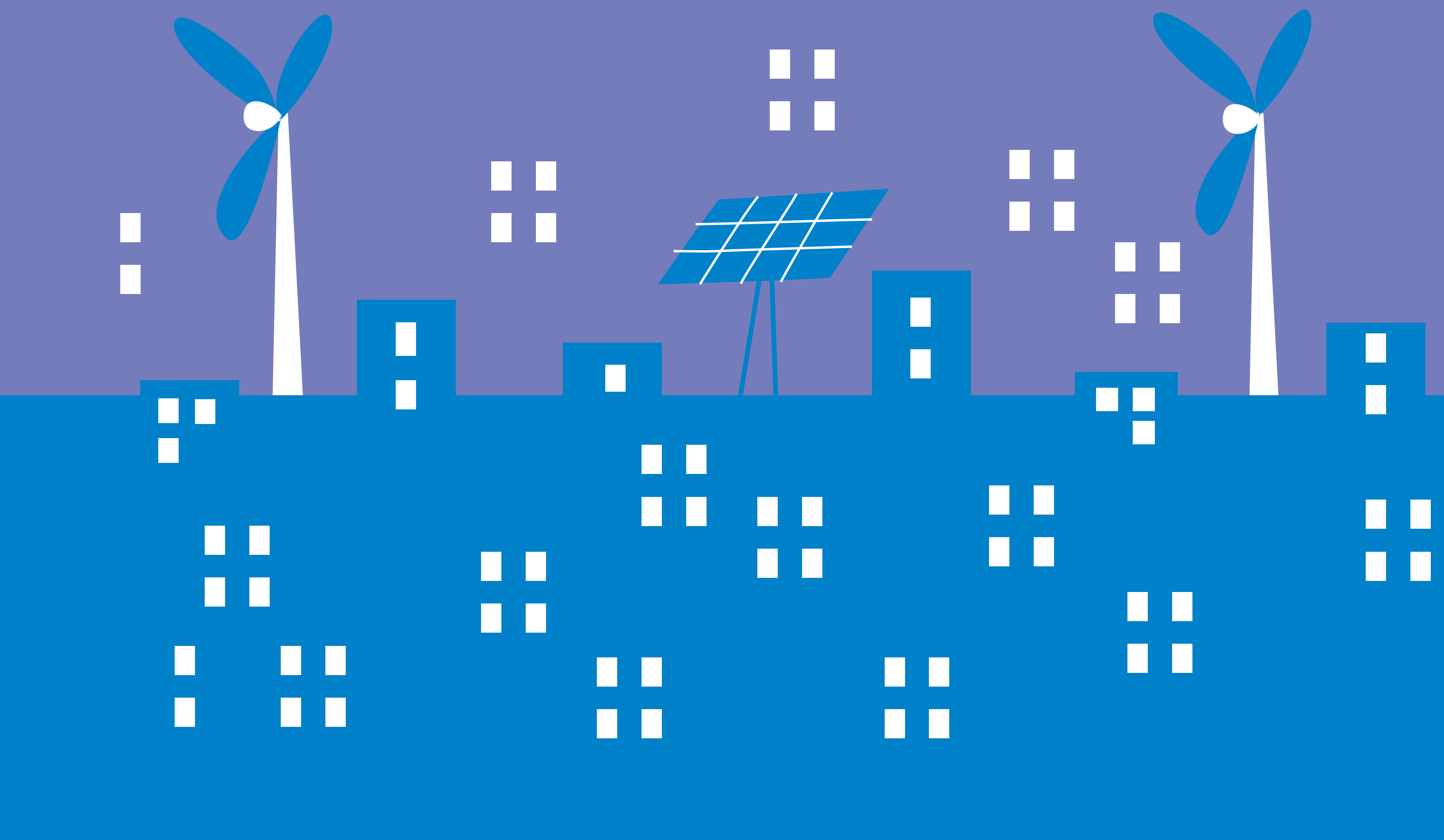
The establishment of a complete MRV system was initiated with the establishment of the EU Emission Trading System (as a requirement in the process of EU accession).

The establishment of a comprehensive MRV was initiated by establishing a framework for implementing the EU Emission Trading System (as a requirement in the EU accession process). In the framework of the Project "Creation of the Monitoring, Reporting and Verification system for the Successful Implementation of the EU Emissions Trading System (EU ETS)", financed by EU and implemented in the period 2013-2015, a legislative and institutional framework for MRV system for EU ETS was established. The law stipulating the requirement to collect, report and verify the data on GHG emissions from industrial and power plants should come into force in 2017.

This process continued through the project "Establishment of a Mechanism for Implementation of MMR" (financed by EU and implemented in the period 2015-2017). The EU Greenhouse Gas Monitoring Mechanism Regulation, the so-called MMR, introduces requirements to ensure timely and efficient monitoring of fulfilling objectives set by sectoral and general policies, with regard to reducing GHG emissions and adaptation measures, as well as reporting to the UNFCCC. The completion of these activities is planned for 2018. The expected start of operation is 2019.

Previous activities aimed at establishing MRV systems have shown the need to continue the process and improve data quality, monitoring and reporting, both on emissions and GHG projections and on policies and measures leading to GHG emission reduction. More effective involvement and capacity building of the relevant policy-making institutions is inevitable.

8. FINANCIAL, TECHNOLOGICAL AND CAPACITY BUILDING NEEDS



8.1. Institutional needs

The Republic of Serbia has established an important component of the institutional and legal framework for combating climate change. At the same time, there is still a need for its improvement, as well as for capacity building and knowledge of responsible and competent institutions, both at national and local level, but also at the level of the general public.

A sound basis of planning and policies in combating climate change is accurate, consistent and transparent data on GHG emissions (GHG Inventory). The credibility of the GHG inventory largely depends on the quantity and quality of relevant data. Therefore, it is necessary to clearly and precisely define the responsibility for data collection and procedures for data submission, improve data quality, as well as the QA/QC procedures and the assessment of uncertainty, reporting and archiving.

In this context, it is necessary, inter alia, to build the capacity of the Agency for Environmental Protection for preparing the GHG inventory itself, as well as inventory reports for the purposes of national reporting and biannual updates. Capacity building means increasing the number of employees and their training, which requires details and tailored planning. Estimates show that it is necessary to provide between 50-60,000 Euro per year, in order to complete the establishment of a functional inventory system.

In addition, it is necessary to identify opportunities and legally define the modality and responsibility for drafting sections of national reports required under UNFCCC, primarily those relating to projections and mitigation measures. In this context, it is necessary to build the capacity of the Climate Change Division. Estimations suggest the need for employment of at least four engineers.

In addition, it is necessary to build capacity at the local level, but also of the scientific community, educational institutions and the media.

Multi-disciplinary nature of climate change and the current level of knowledge and awareness about the problem certainly indicate the need for systematic and continuous work on awareness raising on this issue.

Awareness raising and active participation of local governments and other stakeholders has been identified as a key need for effective implementation of measures for reduction of emissions and vulnerability of sectors to climate change. Assistance from the international community and the European Union.

8.2. Developing GHG inventory

- Developing accurate and reliable GHG inventories in a transparent manner is one of the key prerequisites for effective planning and monitoring of policies and measures to reduce GHG emissions. Although some segments required for developing the inventory have been established, it is necessary to identify priorities of its further development and improvement, as follows:

- Enhancement of institutional and legal arrangements including awareness raising of data owners to support GHG inventory planning, preparation and management
- Building institutional capacities and development of supporting tools to prepare GHG inventory on a regular biennial basis
- Development of a reliable and timely activity data collection system to estimate GHG emissions and removals
- Development and improvement of country-specific emission factors and other parameters, including supporting methodologies

8.3. Adaptation to climate change

Importance for implementing climate change adaptation activities is also expressed in Serbia's INDCs, comprising of a section that refers to the losses incurred by natural disasters and indicates the need for adaptation.

The process of UNFCCC reporting showed a lack of systematic and continuous monitoring, data collection and the existence of database important for assessing vulnerability of sectors. Government institutions responsible for the creation of sectoral policies generally do not recognize the importance of incorporating climate change into their activities and measures. Therefore, the priority is to establish a law and procedures that define responsibilities and obligations. Building capacity of relevant policy-making institutions and local governments to identify priorities and implement measures is necessary to increase the resilience of the sector and system.

An advanced integrated analysis of the impact of climate change on sectors, as well as analysis of financial and societal needs should be developed. Development of the National Adaptation Plan could start a process of creation of a platform for capacity building of stakeholders on climate change issues and adaptation options. Therefore, financial support from the Green Climate Fund is essential.

8.4. GHG emission reduction

The process of UNFCCC reporting showed the need to establish an institutional and legislative framework that will ensure the development of GHG emission projections and identify opportunities for GHG emission reduction on a continuous basis. Capacity building of institutions that will be involved in this process will definitely be necessary, as well as cooperation with countries that already have an advanced system in place.

Tables 8.1, 8.2 and 8.3 show estimations of the total funds needed to achieve the reduction planned by 2020, 2025 and 2030, according to the scenario "with measures" and "with additional measures", required for fulfillment of measures and activities that will lead to GHG emission reduction through increased use of renewable energy and higher energy efficiency to the level recommended by strategic documents. These measures and activities were taken into account in the chapter on GHG projections. The following tables present the funds required from the international community to complete the implementation of these measures, as well as the level of investment needed to achieve GHG emissions reduction, in accordance with the provisions of the Convention and the status of the Republic of Serbia under the Convention (developing country).

Table 8.1: **Assessment of funds required for GHG emission reduction by 2020**

	Cost item	Unit	Scenario (2020)	
			WEM	WAM
1.	Total investment	Mil. EUR	9.183,025	9.521,359
1.1.	Renewable energy - electric energy	Mil. EUR	874,417	1.212,750
1.2.	Renewable energy – heating	Mil. EUR	361,609	361,609
1.3.	Energy efficiency	Mil. EUR	7.947,000	7.947,000
2.	NPV Total investment	Mil. EUR	8.176,239	8.477,479
3.	Emissions reduction	Gg CO_2eq	24.942,550	43.144,620
4.	Average investment cost of abatement	EUR/t CO_2eq	327,803	196,490
5.	Energy import savings	Mil. EUR	-3.008,025	-5.203,160
6.	NPV Energy import savings	Mil. EUR	-2.628,143	-4.557,201
7.	Total cost of emission reduction	Mil. EUR	6.175,000	4.318,199
8.	NPV Total cost of emission reduction	Mil. EUR	5.548,096	3.920,279
9.	Average cost of emission reduction	EUR/t CO_2eq	222,43	90,86
10.	Avoided health care costs (not included)	Mil. EUR	2.196,375	3.799,202
11.	NPV avoided health costs (not incl.)	Mil. EUR	1.918,996	3.327,540
12.	Total emission reduction costs as % of GDP	%	3,35%	2,37%
13.	Energy import as % of GDP	%	1,59%	2,75%
14.	Avoided health care costs as % of GDP	%	1,16%	2,01%

Table 8.2: **Assessment of required funds for GHG emission reduction until 2025**

	Cost item	Unit	Scenario (2025)	
			WEM	WAM
1.	Total investment	Mil. EUR	20.936,050	21.612,717
1.1.	Renewable energy - electric energy	Mil. EUR	1.748,833	2.425,500
1.2.	Renewable energy – heating	Mil. EUR	723,217	723,217
1.3.	Energy efficiency	Mil. EUR	18.464,000	18.464,000
2.	NPV Total investment	Mil. EUR	16.777,275	17.326,113
3.	Emissions reductions	Gg CO_2eq	71.021,340	111.295,300
4.	Average investment cost of emission reduction	EUR/t CO_2eq	236,229	155,68
5.	Energy import savings	Mil. EUR	-8.565,041	-13.422,003
6.	NPV Energy import savings	Mil. EUR	-7.483,665	-11.722,931
7.	Total cost of emission reduction	Mil. EUR	12.371,009	8.190,714
8.	NPV Total cost of emission reduction	Mil. EUR	10.963,942	7.273,515
9.	Average cost of emission reduction	EUR/t CO_2eq	154,38	65,35
10.	Avoided health care costs (not included)	Mil. EUR	6.253,952	9.800,371
11.	NPV avoided health care costs (not incl.)	Mil. EUR	5.464,362	8.559,756
12.	Total emission reduction costs as % of GDP	%	3,10%	2,06%
13.	Energy import as % of GDP	%	2,12%	3,31%
14.	Avoided health care costs as % of GDP	%	1,54%	2,42%

Table 8.3: **Assessment of funds required for GHG emission reduction until 2030**

	Cost item	Unit	Scenario (2030)	
			WEM	WAM
1.	Total investment	Mil. EUR	33.793,050	34.469,717
1.1.	Renewable energy - electric energy	Mil. EUR	1.748,833	2.425,500
1.2.	Renewable energy – heating	Mil. EUR	723,217	723,217
1.3.	Energy efficiency	Mil. EUR	31.321,000	31.321,000
2.	NPV total investment	Mil. EUR	24.510,740	25.059,577
3.	Emissions reduction	Gg CO_2eq	121.670,470	189.095,920
4.	Average investment cost of emission reduction	EUR/t CO_2eq	201,45	132,52
5.	Energy import savings	Mil. EUR	-14.673,231	-22.804,611
6.	NPV Energy import savings	Mil. EUR	-10.350,627	-16.189,838
7.	Total cost of emission reduction	Mil. EUR	19.119,819	11.665,106
8.	NPV Total cost of emission reduction	Mil. EUR	14.160,112	8.869,739
9.	Average cost of emission reduction	EUR/t CO_2eq	116,38	46,91
10.	Avoided health care costs (not included)	Mil. EUR	10.713,982	16.651,289
11.	NPV Avoided health care costs (not incl.)	Mil. EUR	7.557,737	11.821,367
12.	Total emission reduction costs as % of GDP	%	2,99%	1,87%
13.	Energy import as % of GDP	%	2,19%	3,42%
14.	Avoided health care costs as % of GDP	%	1,60%	2,50%

Table 8.4 shows the funds required to implement activities in energy, waste management and forestry sectors, presented in this report, in order to achieve levels of emissions by 2030, projected by different scenarios. For these activities funds will be provided mainly by the international community, in accordance with the provisions of the Convention and the status of the Republic of Serbia under the Convention

(developing country), and from the budget of the Republic of Serbia planned within the limits allocated to the ministry in charge of environmental protection and ministry in charge of energy, as defined by the Ministry of Finance.

Table 8.4: **Required financial needs for implementing GHG emission reduction activities until 2030**

Energy	
Measures	**Required funds (€)**
TEnT Б3 (750 MW)	1.600.000.000
TPP Kolubara B (2 x375 MW)	1.500.000.000
TPP Kostolac B3 (350 MW)	450.000.000
TPP Novi Kovin (2 x 350 MW)	1.330.000.000
TPP Stavalj (300 MW)	650.000.000 750.000.000
TPP HP Novi Sad (340 MW)	400.000.000
HPP Velika Morava (147,7 MW)	360.000.000
HPP Ibar (117 MW)	300.000.000
HPP Srednja Drina (321MW)	819.000.000
PS HPP Bistrica (4 x 170MW)	560.000.000
PS HPP Djerdap 3 (I phase) (2 x 300 MW)	400.000.000
Mini HPP (387 MW)	500.000.000
Revitalization, modernization and construction of heat sources	90.000.000
Revitalization and construction of distribution network	105.000.000
Revitalization and construction of heat substation	45.000.000
Finalization of gasification process in the Republic of Serbia and rehabilitation of the existing gas pipeline system	500.000.000
Waste sector	
Measures	**Required funds (€)**
Construction of sanitary landfills	94.470.000
Construction of centralized composting plants	18.100.000
Buying compost bins for rural households	41.540.000

Cost of additional cleaning of 164 registered dumpsites	48.280.000
Costs of closing 4,481 dumpsites	94.830.000
Forestry	
Measures	**Required funds(€)**
Afforestation	82.076.510
Regeneration of high forests	58.457.292
Reconstruction of devastated forests	5.094.291
Indirect conversion of coppice forests	23.522.299
Direct conversion of coppice forests	117.952.426
Rehabilitation of stands damaged by abiotic and biotic factors	4.665.102
Rehabilitation of fire-damaged stands	62.604.091
Forest certification	900.000
Development of strategic documents for forestry sector	794.880
National forest inventory	730.000
Research (developing capacities and implementation of projects)	94.025.000

This type of measures, activities and assessments of necessary total investments and financial assets, as well as the level of economic and technological development of the Republic of Serbia clearly indicates the need for technological and financial support of the international community to achieve GHG emissions reduction goals.

9. Annexes

ANNEX 1

BASELINE FOR DEVELOPING SCENARIOS AND PROJECTED MESURES

1. PROJECTIONS OF GHG EMISSIONS

Projections of GHG emissions on sectoral and total level are made for three scenarios: basic scenario, scenario "with measures" and scenario "with additional measures".

For agriculture sector only one scenario was developed, as the existing policies and measures do not have an influence on changes in GHG emissions, based on strategic development aims until 2024, which are: production growth and producers' income stability; increased competitiveness and adjustments to the requirements of both local and international markets; improvement of agricultural technology; improvement of the quality of life in rural areas and poverty reduction; efficient public policy management and improvement of institutional framework for agricultural and rural areas development.

The key policy documents that shape the future development of industrial sector in the Republic of Serbia and that outline policies and measures directly or indirectly contributing to GHG emission reduction in industrial processes and product use, are: Strategy and Policy of Industrial Development of the Republic of Serbia from 2011 to 2020 and the Draft of Energy Development Strategy of the Republic of Serbia by 2025 with projections till 2030. All these documents announce significant recovery in industrial production, which was used as a baseline in all scenarios for Industrial Processes sector, with the corrections that occurred as a result of negative economic trends in 2011 and 2012.

Additional projections per scenario are:

1.1. Basic scenario

The basic scenario was developed on the following projections for major sectors:

- **Energy sector:** share of renewable energy sources and energy efficiency will stay at 2010 level;
- **Industrial processes:** main industrial sectors (production of cement, iron and steel) stay dependent on high energy, i.e. will have high energy consumption per unit of product;
- **Agriculture:** stabilization by 2015 and gradual recovery of livestock number;
- **Waste management sector:** composition of municipal waste and dominant waste treatment will not change, which means continued disposal of poorly separated municipal waste at landfills.

1.2. 1.2. Scenario "with measures"

The following projections are included in this scenario:

- **Energy sector:** more frequent use of renewable energy resources in production, in accordance with national economy-wide mandatory targets which, on the level of whole economy, are:
  - 27% share of renewable energy in gross final consumption;
  - 10% share of renewable energy in gross final energy consumption in transport sector.
- **Industrial processes:** modernization of industrial process technology, increased energy and material efficiency and non-selective catalytic reduction.

The projected values for these two sectors are highly uncertain, taking into account that development of these sectors is mostly depends on the state of the global market, as well as on the implementation of EU ETS system.

- **Agriculture:** stabilization by 2015, and then gradual recovery of livestock numbers.
- **Waste sector:** improvement of waste management practices, including a decrease of biodegradable components of waste disposed on landfills and increased recycling.

1.3. Scenario "with additional measures"

The scenario "with additional measures" was developed based on the following projections:

- **Energy sector**: increased energy efficiency (in production and consumption), according to nationally binding targets, and increased energy efficiency and changes in production process technology, i.e. implementation of measures aimed at reducing final energy consumption in housing, commercial sector and services, industrial sector and transportation. economy-wide indicators for reducing final energy consumption for the period 2010-2018 are:
  - Achieve 9% cumulative savings, i.e. 752 ktoe. This target is divided into the following sub-sectors:
    - Manufacturing industries and construction: 272.0 ktoe
    - Transport: 196.7 ktoe
    - Commercial/institutional: 220.0 ktoe
    - Housing: 83.1 ktoe
- **Industrial processes:** additionally increased energy efficiency and changes in production process technology, i.e. improvement of the combustion process, the use of waste heat from production processes, replacement of existing electric motors, process control of energy use and introduction of measures and procedures of energy management.
- **Agriculture:** stabilization by 2015, and then gradual recovery of livestock numbers

- **Waste sector:** higher percentage of municipal waste, treated by biological treatment options, mainly by using anaerobic digestion and to a less degree by composting. Plants for thermal treatment of waste and heat recovery are planned only for big cities (Belgrade, Novi Sad, Niš).

2. PROJECTIONS AND MEASURES IN SCENARIOS BY SECTORS

2.1. Energy sector

The basic scenario for Energy sector projects that the share of renewable energy sources and energy intensity will remain the same as in the base year (20.1% in 2010), and that all newly planned production capacities (2 900MW) will be based on the utilization of fossil fuels.

Main assumptions used for developing the scenario with measures" and "scenario with additional measures" are:[8]

- annual GDP growth in the production sector is estimated to be 3% by 2020 and 3.5% by 2030;
- population by 2030 is estimated to be in the range from 6.72 to 6.85 million;
- the rise of final energy consumption is in direct relation with GDP growth;
- electricity consumption rise is 5.6% in 2020, 17% in 2030, and 17% by 2030;
- in transport sector, average EU vehicle per capita rate will be reached after Serbia's accession to the EU.

The accession to the EU will lead to a significant increase in the flow of goods and capital, i.e. a significant increase in the number of kilometers per passenger is expected, and vehicle-specific emissions will increase due to less restrictions on the import of used vehicles.

The scenario "with measures" projects that the Republic of Serbia will reach its national goal of 27% share of renewable energy sources in gross final consumption and 10% share of biofuels in transport in 2020. This scenario also projects increase of energy use in transport due to the rise of GDP and economic activities, which will be 0.5% per annum.

The scenario "with additional measures" projects a 27% share of energy from renewable energy sources in gross final consumption and a 10% share of renewable energy in gross final energy consumption in the transport sector by 2020, as well as implementation of energy efficiency measures that will lead to 9% of reduction in the final consumption compared to the previous scenario. This scenario includes implementation of measures aimed at reducing final energy consumption in construction, commercial sector and services, industry and transportation (the First Serbian Energy Efficiency Action Plan for 2010 - 2012 (2010) and Draft Energy Development Strategy by 2025 with projections until 2030). Consequently, a relative reduction in energy consumption (reduction per unit of GDP) in manufacture and services will be accomplished. All activities and documents promote energy efficiency as "new energy resources".

Table 2.1.A1 shows the expected new capacities of renewable energy sources which will enable the achievement of national goals in energy, according to each of the two scenarios for GHG emissions reduction until 2030.

[8] Draft Serbian Energy Development Strategy until 2025 with projections to 2030

Table 2.1.A1: **Capacity and energy produced from renewable energy sources**

RES source	Scenario		Scenario "with measures"		Scenario "with additional measures"	
	Year		2020	2030	2020	2030
RES for electricity						
Hydro	Installed capacity	MW	438	650	540	650
	Energy produced	GWh	1.831	2.717	2.257	2.717
		ktoe	157	234	194	234
Wind	Installed capacity	MW	500	600	650	1.700
	Energy produced	GWh	1.250	1.500	1.625	4.250
		ktoe	107	129	140	365
Sun	Installed capacity	MW	10	215	75	300
	Energy produced	GWh	14	301	105	420
		ktoe	1	26	9	36
Biomass	Installed capacity	MW	143	286	238	286
	Energy produced	GWh	1.001	2.002	1.666	2.002
		ktoe	86	172	143	172
Geothermal energy	Installed capacity	MW	1	5	1	5
	Energy produced	GWh	7	35	7	35
		ktoe	0.6~1	3	0.6~1	3
RES for transport						
Biofuels	Energy produced	ktoe	246	246	246	246
RES for heat						
Biomass	Energy consumed	ktoe	84	247	84	247
Geothermal energy	Energy consumed	ktoe	10	50	10	50
Solar thermal energy	Energy consumed	ktoe	55	70	55	70

The projected additional capacities of renewable energy sources installed in the scenario "with additional measures" could prove feasible if construction costs decrease. Expected reduction of final energy consumption according to the National Energy Efficiency Action Plan (targets shown in Table 2.2.A1) will contribute to the projected level of emissions in energy sector in 2030.

Table 2.2.A1: Classification of indicative targets per sectors of final energy consumption

Classification of indicative targets per sectors of final energy consumption					
Sector	Final energy consumptionin 2008	Targets until 2012	Share of target until 2012	Targets until 2018	Share of target until 2018
	Mtoe	Mtoe	%	Mtoe	%
Residential buildings + public and commercial services	3,219	0,0235	19	0,3031	40
Industry	2,832	0,0566	45	0,2526	34
Transport	2,310	0,0453	36	0,1967	26
TOTAL	**8,360**	**0,1254**	**100**	**0,7524**	**100**

2.2. 2.2.Industrial processes

Основни сценарио у сектору индустријских процеса претпоставља високу потрошњу енергенатThe basic scenario in Industrial processes projects high consumption of energy per unit of production in branches of industry that are the main source of GHG emissions (production of cement, iron and steel).

The scenario „with measures" assumes that an increase in overall industrial production and consequently GHG emissions from this sector will follow an increase of final energy consumption in manufacturing industries, with implementation of measures of modernization of industrial process technologies, increase of energy and material efficiency and implementing non-selective catalytic reduction. For the scenario "with additional measures", an expert assumption is increasing energy efficiency and implementation of technological changes in production process. These measures are relate to: the improvement of the combustion process by replacing existing burners with efficient ones, higher use of waste material as energy-generating product and modified structure of used energy-generating products, introduction of technical oxygen in the combustion process, modernized construction of industrial furnaces and boilers, the use of waste heat from production processes, replacement of the existing electric motors, and improvement of monitoring and management process.

Activities in the scenario "with measures" and scenario "with additional measures" include implementation of measures in different industries, in accordance with the best available techniques, broken down on the basis of the required funding.

The levels of GHG emissions in Industrial processes sector based on the "scenario with measures" imply implementation of technical solutions in different industries, in line with the best available techniques, as follows:

Table 2.3.A1: Specific activities in Industrial processes based on scenario "with measures"

Industry	Cement industry	Lime industry	Ceramics i ndustry	Glass industry	Iron and steel industry	Chemical industry
Activity	• Optimal functioning of the automated process control; • reduction of "bypass" flows	Optimal functioning: • Ensure continuity of operation of the furnace (switching on/ switching off furnaces); • Maintain parameters to control the furnace according to the projected values; • Automated process control	Reconstruction of furnaces and dryers: • Automatic control of the dryer; • Automatic control of humidity and temperature; • Improved sealing of kills; • Improved thermal insulation of furnaces	Optimal monitoring of operating parameters: • Improve maintenance of smelter; • Apply techniques for combustion control	Improvement and optimal use of the system to achieve a stable production: • Automated process management • Introduction of gravimetric dosing systems; • Introduce preheating of air and materials; • Use waste heat	Automatic control of processes
	Using waste as a fuel	Using waste as a fuel (biomass, waste oils, solutions)	Using waste heat from furnace: • Reduce the length of the transport of waste, • Insulate channels for waste gas	Using the «Cullet», i.e. glass that is a product of recycling processes (debris, crushed glass)	Reduce the use of basic raw materials, i.e. replace by scrap metal	Optimal use of the steam cycle of production
	The replacement of natural raw materials (clay and limestone) with waste and materials that are by-products of other industrial processes (certain types of slag, ash, pyrite charred residues, etc.).		Replacement of oil fuel and solid fuels with lower emissions fuels	Using waste heat from boilers		Using surplus of thermal energy "on-site" or "off-site"
	Reducing the clinker content in cement by adding fillers and/or appropriate supplements (blast furnace slag, limestone, fly ash and pozzolana)					
	Training furnace operators with the aim to manage the process with less energy and raw materials consumption					

Activities taken into account in the development of the scenario "with additional measures", beside the ones included in the scenario "with measures", also include the following:

Table 2.4.A1: Mitigation measures based on scenario "with additional measures"

Industries	Cement production	Lime production	Ceramic industry	Glass production	Iron and Steel production	Chemical industry
Activity	Install new dosing system	Install new dosing system	Use of alternative fuels by using waste materials with a high content of organic material, of organic origin such as: waste oil, solvents, biomass, bone and meat meal, etc.	Optimal operation of the furnace and design and selection of melting technique	Re-use of waste gas: • Use of gas from the sinter cooler; • Use of gas and other parts of the sinter chain	Installation of «preheating» combustion air
	Installation or modernization of homogenization tanks				Minimize the amount of gas released from the furnace during charging: • "bell-less top" • primary and secondary equalizing; • Return system of gas or ventilation; • Using furnaces gas to exert pressure on the top of the bunker	Modernization or installation of highly efficient heat exchange
	Optimization by installing "pre-blending beds"				Using the isolated gas of furnaces as fuel	
	Install new cooling clinkers					

2.3. Agriculturea

At the moment, there are no implemented and/or adopted as well as planned measures in agriculture sector which specifically target GHG reduction and therefore only one scenario, 'basic scenario' was developed, using regressive analysis of trends and expert assessment.

From historical data on livestock numbers in the period 2008-2013 it could be concluded that for some categories of livestock there is a linear downward (dairy cows) or upward (other cattle) trend. For other categories (swine, sheep) there are marked fluctuations in the trend, which could be a result of changes in market demand and/or incentives offered by the Government. Taking into account the new incentive policy of the Government, expert assessment projects a trend in livestock reduction by 2015, followed by stabilization and gradual increase in 2020 and after. In addition, it is important to note that the mean value for 2008-2013 was taken as a baseline for projections in the future for categories with considerable fluctuations in the number.

With regard to GHG categories related to aggregate sources and non-CO_2 emissions sources on land (3.C) it is clear from GHG emission inventory that the following source categories represent key emission sources:

- CO_2 emissions from UREA application on cropland
- Direct N_2O emissions from managed soils
- Indirect N_2O emissions from managed soils
- Indirect N_2O emissions from manure management.

Projections of emissions from these source categories depend on amount of urea and nitrogen (N) applied on land, where nitrogen could originate from different sources including: synthetic fertilizers, animal manure, urine and dung deposits, and crop residues. It was projected that the amount of urea applied on land will remain constant following the trend for 2008-2013. The amount of animal manure, urine and dung deposited and crop residues will also remain constant since their historical trends are more or less stable. Amounts of nitrogen synthetic fertilizers applied on land are expected to moderately increase, especially after 2020. The reason is intensive agricultural development and following best practice from the EU member states.

Cropland, grassland, wetlands, settlements and other land, except forest land, are estimated as net sources of CO_2 emission in GHG emissions inventory and these emissions did not change in the period 2010-2013. The main assumption is that the level of emissions will remain the same in the whole projected period.

2.4. Waste management sector

All three scenarios for waste management sector are based on data indicating an average increase of generated waste of approximately 0.5% per year, but in the future it will change significantly in line with economic development and the rising standard of living. However, population growth, particularly after 2020, will affect the amount of generated waste.

In order to define the basic scenario, it is projected that the characteristics of the waste by 2030 will remain unchanged. In addition, the projection that the current practice for waste management and treatment will not change in the future was taken also into account.

The main assumption in waste water management is that number of waste water treatment plants will increase by 20% by 2020, and 30% by 2030.

Based on the scenario "with measures", the level of GHG emissions in waste management sector projected for 2030 is a result of the construction of 26 regional centers for separation of recyclable waste, as well as a number of recycling sites, as well as the construction of a facility for mechanical-biological treatment of municipal waste, with the aim of doubling the level of recycling by 2020. By the year 2020, the amount of generated waste will have increased by 27.4%, i.e. approximately 1.7% per year until 2030. Expressed in kilograms per capita per year, this means that, by 2030, the quantity of generated solid municipal waste will have increased to 434.1 kg per capita annually. The share of biodegradable categories (garden and food waste) will have decreased to 40%, with 11.2% of paper and cardboard 15.5% plastic, 6.6% glass and 2.4% metal, while all other categories of waste together have a projected share of 24.3% of the total amount of waste.

The results of projected changes in treatment of municipal waste in Serbia indicate that in comparison to other treatment options, municipal solid waste landfills will be still the most dominant in the future, but that generally the percentage distribution of this way of waste treatment will have decreased. Compared to the current 92% of disposed solid waste, according to projections, the projected value by the end of 2030 will be 53.3%. Recycling of municipal waste will have increased, with the expectation that in 2030, municipal waste recycling level will be four times (16.2%) higher compared to 2013. Thermal methods of treatment of municipal waste, despite the projected growth in the future, will not have a significant share in comparison to other options, in other words 6.5% of all waste treatment options. In contrast, biological methods for the treatment of municipal waste based on the results of modeling show the greatest growth trend in relation to other forms of treatment. With the current projected share of 2.0%, this value will have increased to 24% in 2030.

The scenario "with additional measures" projects a larger percentage of municipal waste treated by biological methods, with the assumption that anaerobic digestion will have precedence over regular composting options. Compared to the previous scenario, almost 30% of municipal waste will be treated by anaerobic digestion.

In addition, based on the assumption that in the largest cities in Serbia, such as Belgrade, Novi Sad and Niš, significant quantities of municipal waste will be treated within incineration facilities, the scenario projects a much higher share of thermal treatment methods compared to the scenario "with measures". As per the scenario "with additional measures", it is projected that 18.6% of municipal waste will be treated in this way by 2030. 25.2% of waste will be disposed by recycling.

An increased share of municipal waste that could be treated by the above-mentioned modern waste treatment options, will lead to reducing the share of municipal waste disposed at landfills. Compared to the scenario "with measures", which projected 53.3% of municipal waste disposed in 2030, according to the scenario "with additional measures" this share would be only 26.2%. Also, it is projected that all the dumped quantities of waste will end up in sanitary landfills, with the optimistic assumption that almost the entire amount of methane (CH_4) will be utilized.

ANNEX 2

METHODOLOGY

1. Methodology used for analysis of observed climate changes

The trends over the period 1960-2012 and significance of trends have been calculated for key climate variables: daily mean temperature (Tg), daily maximum temperature (Tx), daily minimum temperature (Tn) and daily precipitation (RR) for 25 meteorological stations of the national network. When p-value of the trend significance test is less than 0.05, which correspond to confidence level of 95%, the trend will be marked as significant. The selected time period was the maximum period of almost uninterrupted observation of selected variables. The name, position and altitude of selected stations are shown in Table 1.1.A2.

Табела 1.1A2: **Листа одабраних метеоролошких станица, станица са локацијом и висином.**

Station name	Latitude (degrees)	Longitude (degrees)	Elevation (m)	Station name	Latitude (degrees)	Longitude (degrees)	Elevation (m)
Beograd	44.80	20.47	132	**Novi Sad**	45.20	19.51	84
Ćuprija	43.56	21.22	123	**Sjenica**	43.16	20.01	1038
Dimitrovgrad	43.01	22.45	450	**Sombor**	45.47	19.05	88
Kragujevac	44.02	20.56	185	**S. Palanka**	44.22	20.57	122
Kikinda	45.51	20.28	81	**Sr. Mitrovica**	44.58	19.38	81
Kuršumlija	43.08	21.16	382	**Valjevo**	44.32	19.92	176
Kraljevo	43.43	20.42	215	**V. Gradište**	44.45	21.31	82
Leskovac	42.59	21.57	230	**Vranje**	42.29	21.54	432
Loznica	44.33	19.14	121	**Vršac**	45.09	21.19	84
Negotin	44.14	22.33	42	**Zaječar**	43.53	22.17	144
Niš	43.20	21.54	201	**Zlatibor**	43.44	19.43	1028
Palić	46.06	19.46	102	**Zrenjanin**	45.24	20.21	80
Požega	43.51	20.02	311				

The same sets of observed key climate variables were used to derive selected climate indices relevant for assessment of changes in extreme climate and weather condition (Table 1.1.A2.). The selected indices are a subset of indices recommended in WMO Guidelines on Analysis of Extremes in a Changing Climate in Support of Informed Decisions for Adaptation (WMO, 2009). R-based software (RClimDex) was chosen for index calculation (WMO, 2009).

Table 1.2.A2: List of selected indices with their definition. Tg - daily mean temperature, Tx – daily maximum temperature, Tn – daily minimum temperature and RR – daily accumulated precipitation

Short name	Long name	Definition	Units
Temperature indices			
FD	Frost days	Count of days where Tn < 0°C	days
ID	Ice days	Count of days where Tx < 0°C	days
TR	Tropical nights	Count of days where Tn > 20°C	days
SU	Summer days	Count of days where Tx > 25°C	days
Tnx		Monthly maximum value of daily minimum temperature	°C
Tn10p	Cold nights	Count of days where Tn < 10th percentile	days
Tn90p	Warm nights	Count of days where Tn > 90th percentile	days
Txx		Monthly maximum value of daily maximum temperature	°C
Tx10p	Cold day-times	Count of days where Tx < 10th percentile	days
Tx90p	Warm day-times	Count of days where Tx > 90th percentile	days
GSL	Growing season length	Annual count of days between the first span of minimum six days when Tg > 5°C and the first span in the second half of the year of minimum six days when Tg < 5°C	days
WSDI	Warm spell duration index	Count of days in a span of at least six days where Tx > 90th percentile	days
CSDI	Cold spell duration index	Count of days in a span of at least six days where Tn < 10th percentile.	days
Precipitation indices			
CDD	Consecutive dry days	Maximum length of dry spell (RR < 1 mm)	дани
CWD	Consecutive wet days	Maximum length of wet spell (RR ≥ 1 mm)	дани
R20mm	Very heavy precipitation days	Count of days where RR ≥ 20 mm	дани
R95p		Precipitation due to very wet days (RR > 95th percentile)	mm
R99p		Precipitation due to extremely wet days (RR > 99th percentile)	mm

2. Methodology used for climate change scenarios

EBU-POM, fully coupled atmospheric-ocean regional climate model (Regional climate model – RCM) was used for regionalization of climate scenarios. Its atmospheric component is EBU, a version of NCEP's Eta model and the ocean component is Princeton Ocean Model (POM). EBU-POM participates in MedCORDEX initiative (http://www.medcordex.eu/). The results of the global climate model ECHAM5 (Roeckner et al. 2003) were used as a boundary condition. Horizontal resolution of the GCM output was T63 (~140x210km) with 48 vertical levels. ECHAM5 model results are available at CERA database (http://cera-www.dkrz.de/). The EBU-POM climate simulation domain is the Euro-Mediterranean region, with the center of the atmospheric part positioned on the coordinates 41.5°N, 15°E. The model boundaries are 19.9° versus east and west, and 13.0° versus north and south from the center of the model. The horizontal resolution of the atmospheric model is 0.25. EBU-POM simulations are done for the period 1950-2000 with an observed concentration of GHG. Two simulations are performed for the future climate, both in the period 2001-2100, one under the A1B and other under the A2 IPCC/SRES scenario. For assessment of uncertainty for climate change scenarios, integrations of different RCMs from ENSEMBLES database was used (http://ensemblesrt3.dmi.dk/). In total, 16 simulations were selected with different combinations of Global Climate Models (GCM) and Regional climate models (RCM) that are listed in Table 2.1.A2.

Table 2.1.A2: GCM/RCM climate models from ENSEMBLES data base

Institution	RCM	GCM	Period
C4I	RCA3	HadCM3Q16	1951-2098
CNRM	Aladin	ARPEGE_RM5.1	1950-2100
DMI	HIRHAM5	ARPEGE	1951-2100
ETHZ	CLM	HadCM3Q0	1951-2098
ICTP	RegCM	ECHAM5-r3	1951-2100
KNMI	RACMO2	ECHAM5-r3	1950-2100
METNO	HIRHAM	BCM	1951-2050
MPI	REMO	ECHAM5-r3	1951-2100
OURANOS	CRCM	CGCM3	1951-2050
SMHI	RCA	BCM	1961-2100
SMHI	RCA	ECHAM5-r3	1951-2100
SMHI	RCA	HadCM3Q3	1951-2098
UCLM	PROMES	HadCM3Q0	1951-2050
VMGO	RRCM	HadCM3Q0	1951-2050
METO-HC	HadRM3Q0	HadCM3Q0	1951-2098
METO-HC	HadRM3Q3	HadCM3Q3	1951-2098

Hydrology and water resources

For climate change impacts in Hydrology and water resources results from different projects were used. For the purpose of hydrological modeling in these projects the following models were used: EBU-POM results as an input, WNC linear regression model, HBV model and HEC-HMS (Hydrologic Engineering Center – Hydrologic Modeling System) model.

Forestry

For climate change impacts in Forestry sector two climate indices were used: forest aridity index and Ellenberg index. The forest aridity index (FAI) is designed for yield assessment and calculations about potential forest tree distribution. It is calculated according to the formula FAI=100*(TVII-TVIII)/(PV-VII+PVII-VIII),. where TVII, TVIII is average temperature of the critical months (July and August), PV-VII is precipitation sum in the main growth cycle (May to July), and the PVII-VIII is precipitation sum in the critical months (from July to August). The Ellenberg's climate quotient (Ellenberg, 1988), which explains in a straightforward way the connection between this tree species distribution and climate, is defined as EQ = (TJuly / Pannual) * 1000 where TJuly is July mean temperature, and Pannual annual precipitation sum. Future values of both indices are calculated by using results from EBU-POM model.

Agriculture

For climate change impacts on Agriculture the DSSAT cropping system model (DSSAT-CSM) is used. EBU-POM results were used as input data for DSSAT model. Furthermore, results from statistical downscaling of ECAHM global climate model were used for the scenario A1B. For some additional assessments results from statistical downscaling of ECAHM global climate model was used for scenario A1B. The DSSAT model was run for 10 locations, uniformly distributed across Serbia. The locations are given in Table 2.2.A2. The selected stations represent agricultural production regions.

Table 2.2.A2: **Geographical position and dominant soil type for selected locations**

Station	Longitude	Лонгитуда (степени)	Висина (m)	Тип тла
Sombor	19.1	45.7	88.0	Chernozem
Novi Sad	19.8	45.2	80.0	Chernozem
Pozarevac	20.0	43.8	310.0	Cambisol
Kraljevo	20.7	43.7	215.0	Cambisol
Krusevac	21.3	43.5	166.0	Fluvisol
Cuprija	21.3	43.9	123.0	Fluvisol
Nis	21.9	43.3	201.0	Fluvisol
Zajecar	22.2	44.8	144.0	Cambisol
Dimitrovgrad	22.7	43.0	450.0	Fluvisol
Vranje	21.9	42.4	432.0	Fluvisol

3. Projects important for research and observation of climate change

The Republic Hydrometeorological Service (NHMSS) is actively participating in the following projects:

- SINTA project as a form of scientific cooperation and exchange of expertise between the Italian Scientific Institution INGV (National Institute of Geophysics and Volcanology), NHMSS and the Belgrade University;
- Development of Climate of the Carpathian Region-CARPATCLIM, Digital climate maps for Carpathian region (Funded by the European Commission Joint Research Center – JRC);
- The project "Distributed Research Infrastructure for Hydro-Meteorology – DRIHM" which involves comparative numerical simulations of selected weather conditions with extreme rainfall and flooding, hydrological models for infiltration and runoff, hydraulic models and impact models (an international project funded by the EU via its FP7 Programme);
- "Further improvement and development of flood forecasting services in Serbia" which introduced hydrological forecasts and warnings of floods to all small and medium-sized basins in Serbia, where there is a significant risk of flooding;
- Ongoing permanent drought monitoring.

The South East European Virtual Climate Change Center (SEEVCCC) is active in scientific research (number of published papers, presentations and participation at international and national conferences), regional and international cooperation (Mediterranean Climate Outlook Forum - MedCOF 1, Distributed Research Infrastructure for Hydro-Meteorology (DRIHM), Structured network for integration of climate knowledge into policy and territorial planning - ORIENTGATE, Joint Disaster Management Risk Assessment and Preparedness in the Danube Macro-region-SEERISK, South – East European Climate Outlook Forum - SEECOF). SEEVCCC issues seasonal forecasts for the region of South East Europe as well as climate projection using a regional atmosphere–ocean coupled model (RCM-SEEVCCC).

The Ministry of Education, Science and Technological Development of the Republic of Serbia is has been funding a number of studies related to climate change, such as: "The Study of Climate Change and its Impact on the Environment: Monitoring Impacts, Adaptation and Mitigation" (2011-2014), "Spatial, Environmental, Energy and Social Aspects of Urban Development and Climate Change – Interaction" (2011-2014), and other projects related to climate change and how they affect architecture and urban planning, as well as projects related to biological remediation aimed at preserving the environment and preventing climate change.

In 2012, UNISDR (The United Nations Office for Disaster Risk Reduction) and WMO started joint implementation of the Project: Building Resilience to Disasters in the Western Balkans and Turkey (2012 – 2014), supported by the European Commission under the Instrument for Pre–Accession Assistance (IPA 2012). The NHMSS was a direct beneficiary. The overall scope of the project was to reduce vulnerability of the Western Balkans countries and Turkey to disasters caused by natural hazards in line with the Hyogo Framework for Action and to increase their resilience to climate change (http://www.preventionweb.net/ipadrr/intro.php). The main focus was to: build capacities for disaster resilience, share knowledge on how to reduce risks, community-based activities, hazard analysis and mapping, hazardous phenomena forecasting, climate risk management and climate change adaptation, multi-hazard early warning system.

Serbia and Montenegro participated in the project "Cross–border Flood Protection and Rescue", funded by EU (2013-2014).

ANNEX 3

CHANGES OF TEMPERATURE, PRECIPITATION AND INDEXES

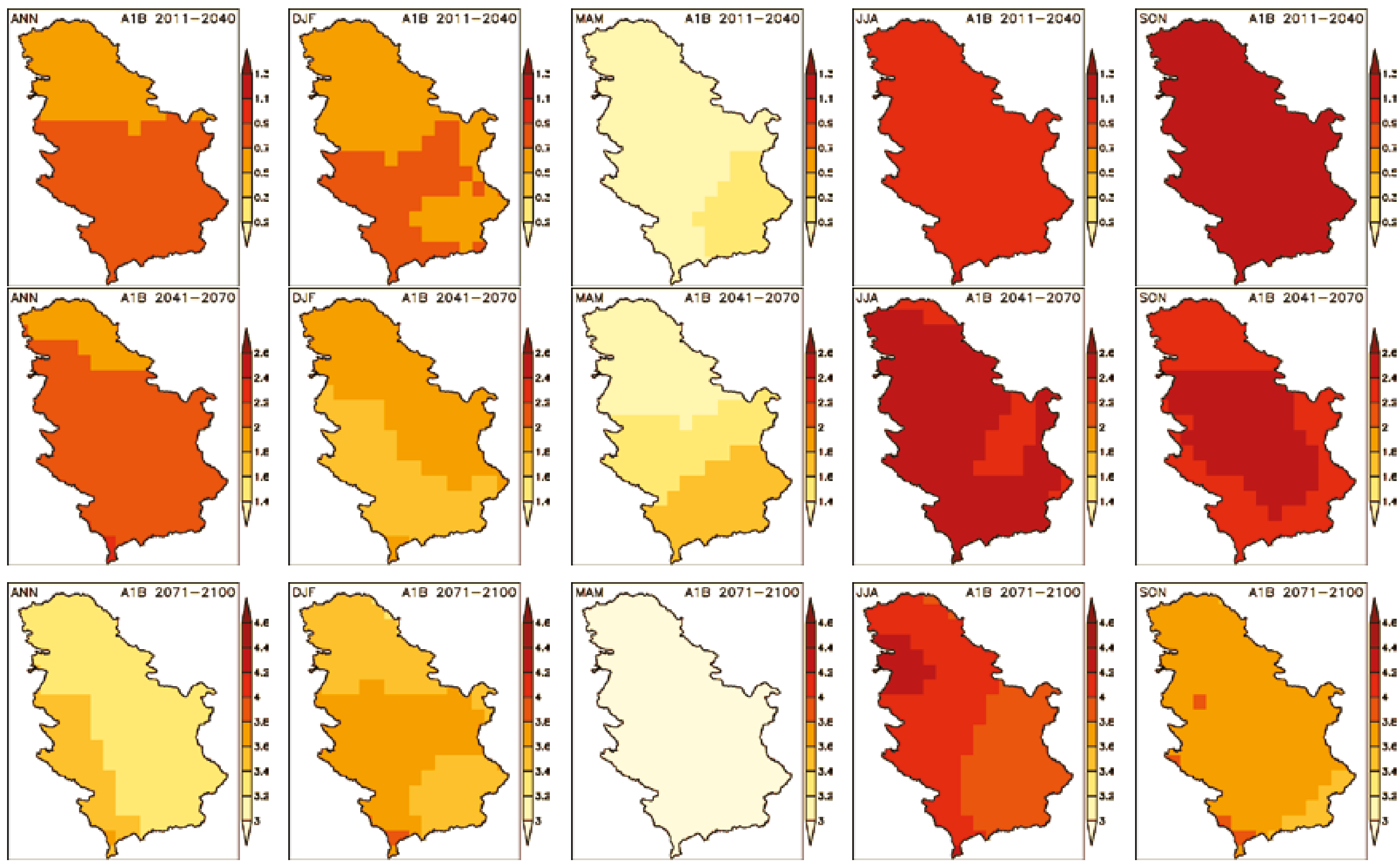


Figure 1.A3: **Temperature change for the periods 2011-2040, 2041-2070 and 2071-2100 compared to 1961-1990; A1B scenario, on annual level (ANN) and for four seasons.**

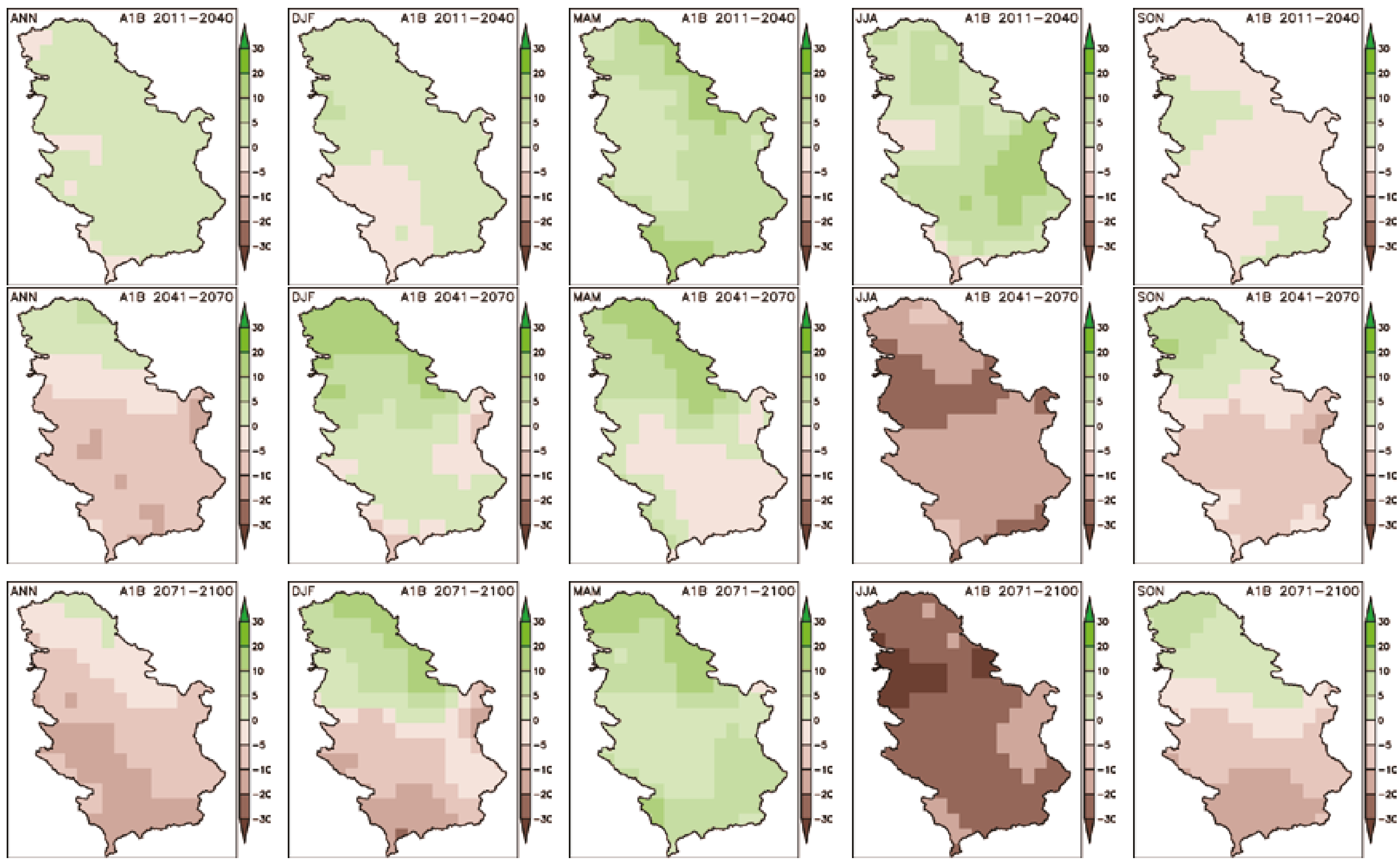


Figure 2.A3: **Precipitation change for the periods 2011-2040, 2041-2070 and 2071-2100 compared to 1961-1990; A1B scenario, on annual level (ANN) and for four seasons.**

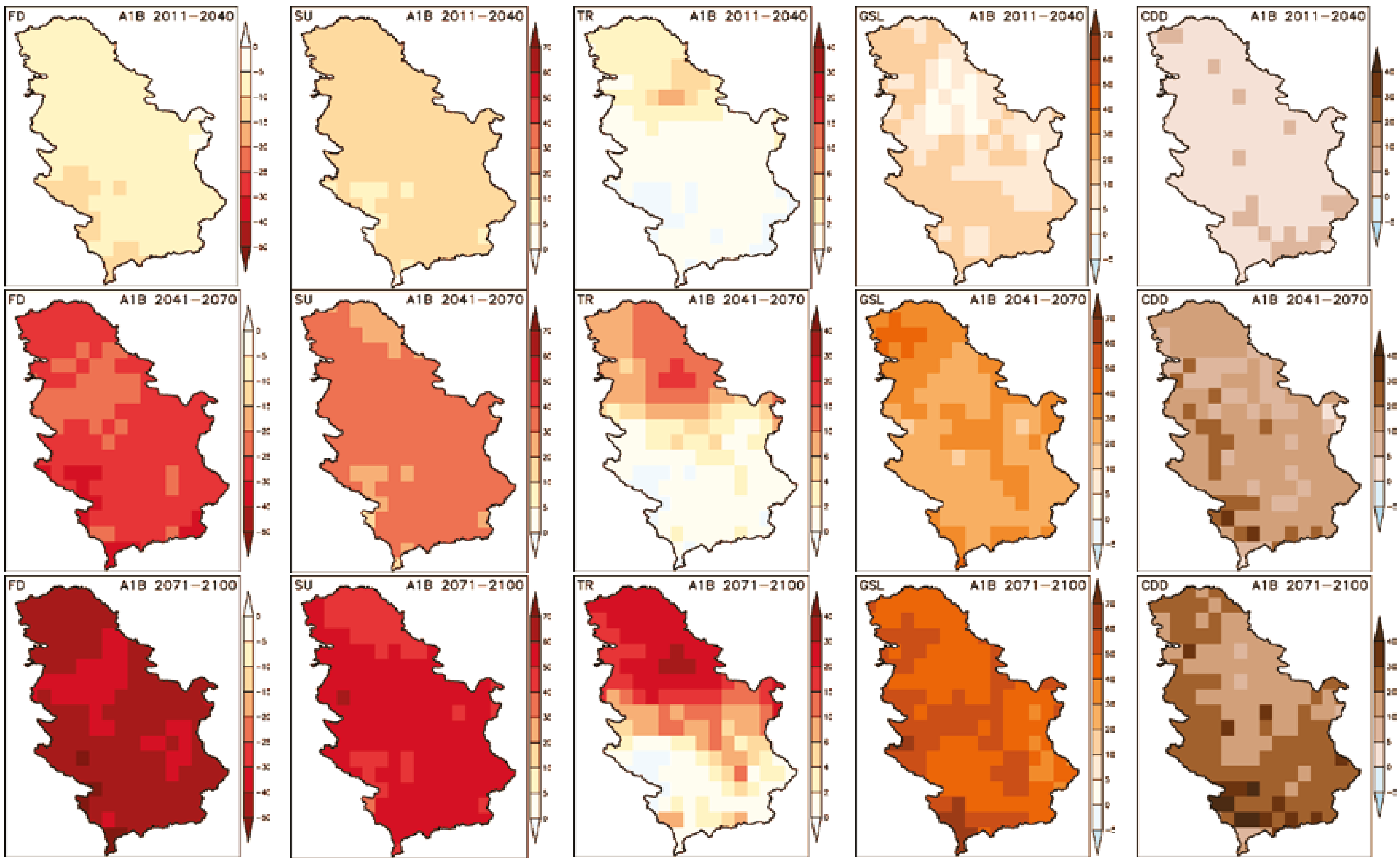


Figure 3A3: Changes in climate extremes indices for the periods 2011-2040, 2041-2070 and 2071-2100 compared to 1961-1990; A1B scenario, on annual level (ANN) and for four seasons.

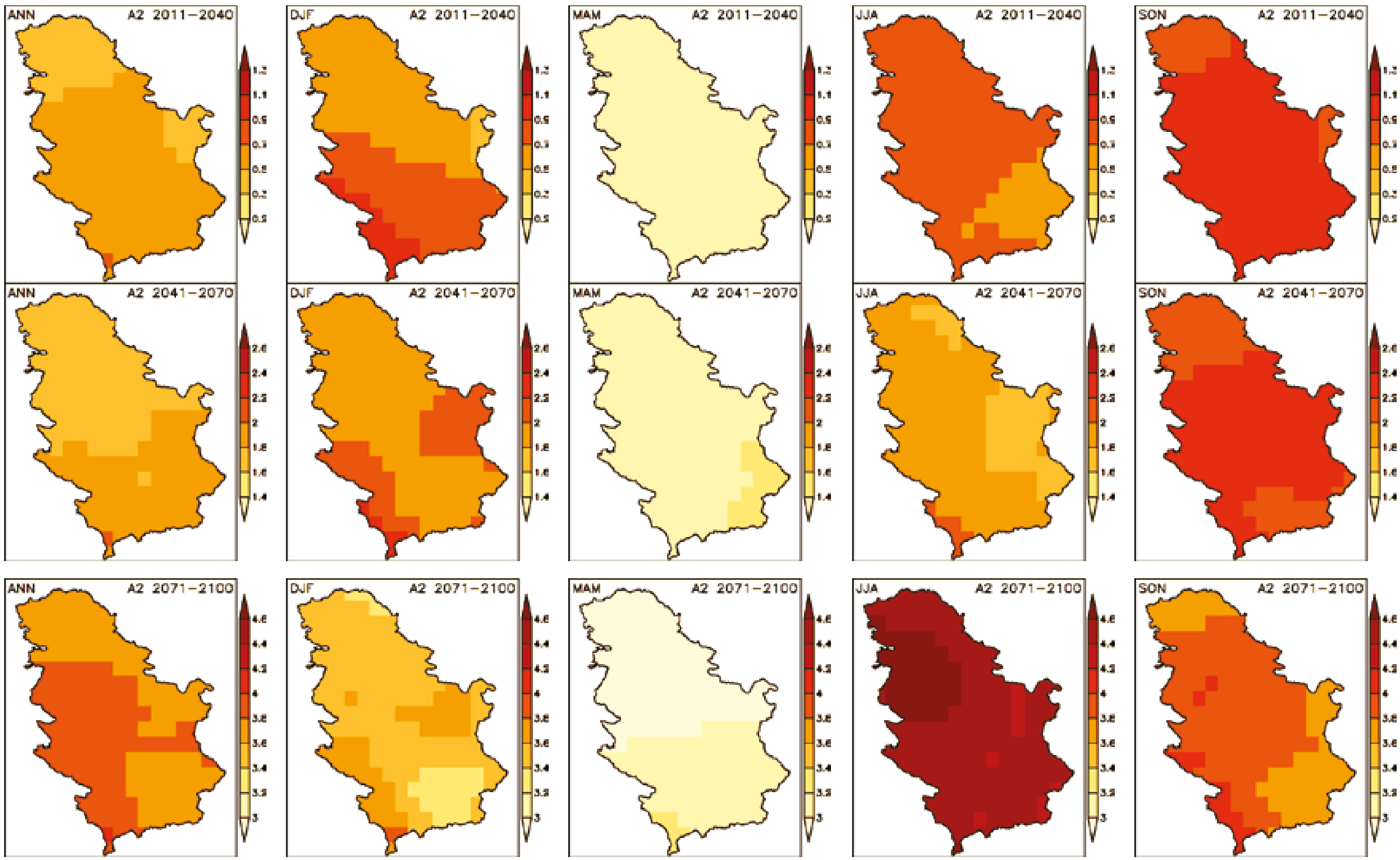


Figure 4.A2: **Temperature change for the periods 2011-2040, 2041-2070 and 2071-2100 compared to 1961-1990; A2 scenario, on annual level (ANN) and for four seasons.**

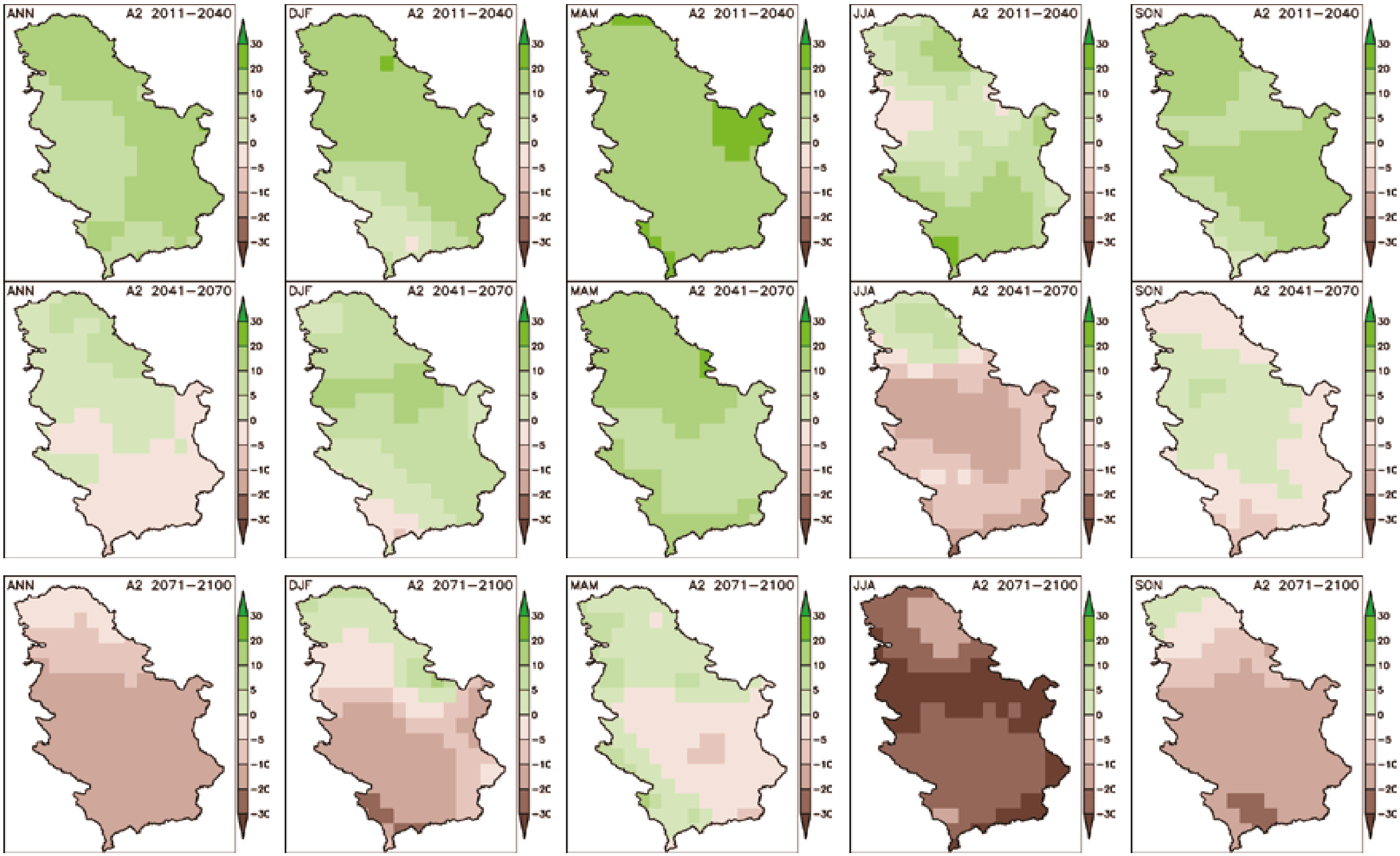


Figure 5.A3: Precipitation change for the periods 2011-2040, 2041-2070 and 2071-2100 compared to 1961-1990; A2 scenario, on annual level (ANN) and for four seasons.

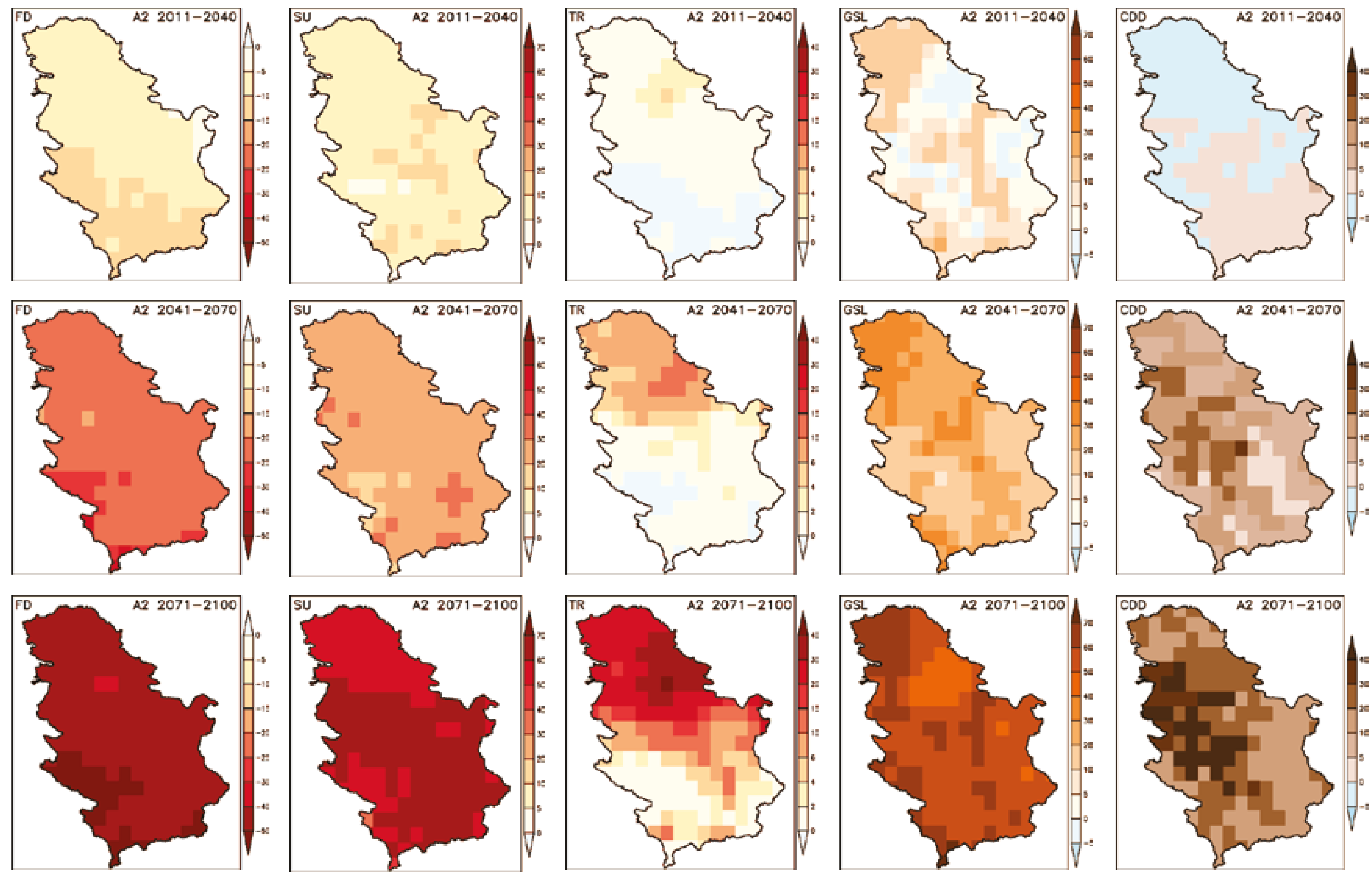


Figure 6.A3: Changes in climate extremes indices for the periods 2011-2040, 2041-2070 and 2071-2100 compared to 1961-1990; A2 scenario, on annual level (ANN) and for four season

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11. LIST OF ABBREVIATIONS

AFOLU	Agriculture, Forestry and Other Land Use
CCS	Carbon capture and storage
CDM	Clean Development Mechanism
EU	European Union
FBUR	First Biannual Updated Report
GDP	Gross domestic product
GEF	Global Environmental Fund
GHG	Greenhouse gases
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
INC	Initial National Communication
INDC	Intended Nationally Determined Contribution
JICA	Japan International Cooperation Agency
MMR	Monitoring Mechanism Regulation
MRV	Monitoring, Reporting and Verification
NAMAs	National appropriate mitigation actions
OECD	Organisation for Economic Co-operation and Development
QA/QC	Quality assurance/quality control
RHMSS	Republic Hydrometeorological Service
SNC	Second National Communication
UN	United Nations
UNDP	United Nations Development Programme

UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFCCC	Оквирна конвенција Уједињених нација о промени климе

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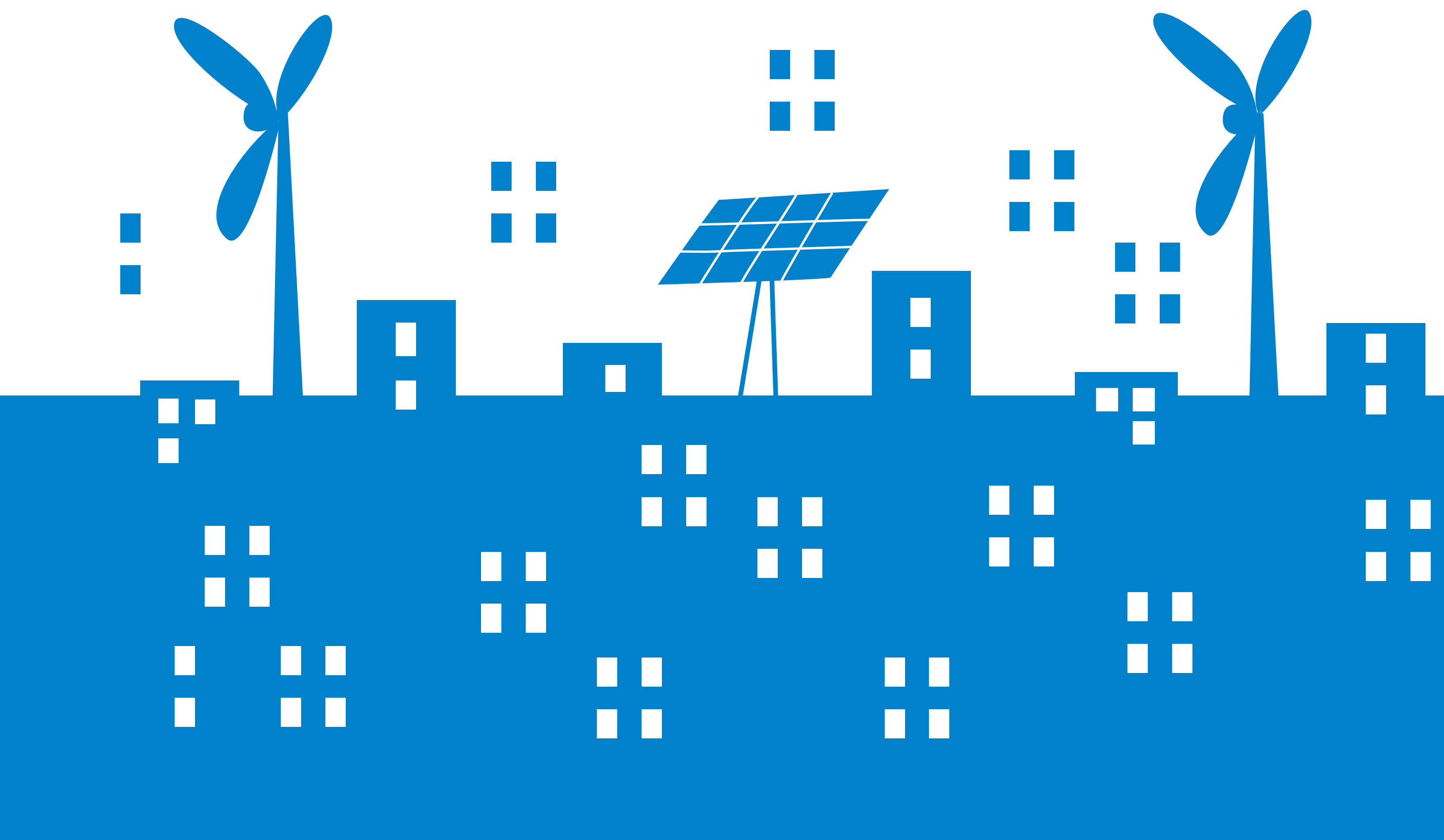

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