INITIAL NATIONAL COMMUNICATION OF THE REPUBLIC OF SERBIA

INITIAL NATIONAL COMMUNICATION OF THE REPUBLIC OF SERBIA UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

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LIST OF ACRONYMS

AECID	Agencia Española de Cooperación Internacional para el Desarrollo
AP	Autonomous Province
CDM	Clean Development Mechanism
DNA	Designated National Authority
EC	Population equivalent
EU	European Union
GDP	Gross Domestic Product
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GEF	Global Environmental Facility
GHG	Greenhouse Gases
GWP	Global Worming Potential
HSDTD	Hydro system Danube-Tisza-Danube
ICP Forests	International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests
IMELS	Italian Ministry for Environment, Land and Sea
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
KP	Kyoto Protocol
LUCF	Land-Use Change and Forestry
LULUCF	Land -Use and Land-Use Change and Forestry
MESP	Ministry of Environment and Spatial Planning
NAMA	National Appropriate Mitigation Action
NAPA	National Appropriate Adaptation action
NE	Non Estimated
NHMSS	National Hydrometeorological Service of Serbia
NO	Non Occurring
OEBS	Organization for Security and Co-operation in Europe
PC EPS	Public enterprise „Electric power industry of Serbia”

RA VI	Regional Association VI
RCC	Regional Climate Center
REC	Regional Environment Center for Central and Eastern Europe
SFRJ	Socialist Federal Republic of Yugoslavia
SEE/CCFAP	South-East European Climate Change Framework Action Plan for Adaptation)
SEEVCCC	South East European Virtual Climate Change Center
TE	Power plant
TE-TO	Power plant – heating plant
UN	United Nations
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

INTRODUCTION

The United Nations Framework Convention on Climate Change (hereinafter: the Convention – UNFCCC) was adopted and signed at the Earth Summit in Rio de Janeiro, Brazil, in June 1992. The Convention entered into force in March 1994.

The Kyoto Protocol (hereinafter: the Protocol) to the Convention, was adopted at the third session of the Conference of the Parties, held in December 1997 in Kyoto, Japan.

The Republic of Serbia has been a member of the Convention since 10 Jun, 2010, and Kyoto Protocol since 17 January 2008, as a developing country (non–Annex I country). Taking into account the status under the Convention, the Republic of Serbia does not have quantitative greenhouse gases (hereinafter: GHG) emission reduction commitments, in the first commitment period. Simultaneously, the Republic of Serbia has all the commitments with regards to establishing and implementing measures and activities that contribute to achieving the objectives of the Convention

The Ministry of Environment and Spatial Planning is the national coordinator for the implementation of the Convention and Protocol. The Ministry of Environment and Spatial Planning, in cooperation with other ministries and special Governmental organizations, began a series of activities to fulfil the obligations undertaken with the ratification of the Convention and Protocol. The process of developing the Initial National Communication of the Republic of Serbia under the Convention is one of these activities.

The Initial National Communication of the Republic of Serbia is the very first national report regarding climate change issues. This report is prepared following the "Guidelines for preparation of national communications by Parties not included in Annex I to the Convention" (17/CP.8), as well as procedures of the Global Environment Fund, national legislation, documents and strategies.

In the development of the National Communication, not only were involved the relevant ministries, institutions that deal with observation and monitoring of climate change and scientific institutions involved, but also relevant businesses and economic entities, non–governmental sector and other stakeholders.

The preparation of the Initial Communication of the Republic of Serbia under the Convention would not have been possible without the support of the Global Environment Fund, which provided funds for the implementation of the project: "Enabling activities for the preparation of the Initial National Communication of the Republic of Serbia to the United Nations Framework Convention on Climate Change – UNFCCC". The project was implemented with the assistance of the UNDP, as implementing agency and Ministry of Environment and Spatial Planning as executing agency.

1. EXECUTIVE SUMMARY

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1.1. INTRODUCTION

Republic of Serbia is a member of the UN Framework Convention on Climate Change (in furthur text: Convention) since 10th of June 2001. The Kyoto Protocole (in furthur text: Protocole) has come into force on 17th of January 2008.

The Republic of Serbia, as a non–Anex I state member of the Convention, in line with its capabilities and principles of sustainable development, endeavours to contribute to the

fulfilment of the primary goals of the Convention.

The preparation of the Initial National Communication to the Convention represents one of the activities of the Government aiming to contribute to the climatic change mitigation on global level, as well as to the adaptation to the changed climatic conditions on the national level.

The Initial National Communication of the Republic of Serbia is an important national strategic document which represents a basis for future actions, investigations and policies in the area of climate change, national capacity building and attainment of knowledge, sustainable development of the country, as well as the preparation of the future national reports.

1.2. NATIONAL CHARACTERISTICS

Geografic profile

The Republic of Serbia is Serbia is situated in the central part of the Balkan Peninsula and covers an area of 88,361 km^{2}. Northern Serbia is mainly flat, while central parts are highlands. Going to the south, the hills gradually turn into mountains

The mountains of Serbia can be divided into: the Rhodope Mountains, the Carpathian–Balkan Mountains and the Dinaric Alps. Up to 30 mountain peaks are over 2000 m above sea level, the highest being Djeravica in the Prokletija Range (2656 m).

The State Rivers belong to the Basins of the Black, Adriatic and Aegean Seas. Three rivers are navigable along the whole length through Serbia: the Danube, the Sava and the Tisa. The longest river in the country is the Danube.

Climate

Most of Serbia has a temperate continental climate. A continental climate prevails in the mountainous, whilst the climate in the Serbian southwest borders on the Mediterranean subtropical and continental.

According to measurements made during 1961–1990, the mean annual air temperatures are between 3 °C at altitudes above 1,500 metres and 12 °C in the lowlands. The coldest month is January, the warmest is July.

The lowest amounts of annual precipitation, under 600 mm, is characteristic for Vojvodina and parts of Kosovo. Precipitation in the Sava region as well as in the Great Morava and South Morava valley regions ranges between 600 and 700 mm, in the mountainous areas between 800 and 1000 mm a year, and above 1,000 mm a year on some mountain peaks in Southwest Serbia.

Socio–political system

The Republic of Serbia is an independent (regained its independence in 2006), democratic state with a multiparty parliamentary system. The governmental system is based on the division of power into legislative, executive and judiciary.

Integral parts of the Republic of Serbia are the Autonomous Province of Vojvodina and the Autonomous Province of Kosovo and Metohija as forms of territorial autonomy. The Autonomous Province of Vojvodina is situated in the northern part. The Autonomous Province of Kosovo and Metohija, on the basis of the United Nations Security Council Resolution 1244 which was adopted on June 10, 1999., is under the interim civil administration of the United Nations.

The territory of the Republic of Serbia is divided into: municipalities (194), cities (24) and Belgrade as a unit of local self – government. The territory is also divided into 29 administrative districts and the territory of the city of Belgrade, as a district of its own. The Republic of Serbia has 6169 settlements, of which 207 are urban settlements.

Population

The total population, according to the 1991 census, was 7,595,636 inhabitants, and according to the 2002 census 7,498,001. Those data are only estimation taking into account that census was not realised on the whole territory. Estimates show that during the period 1991–2002, there was a significant increase in population growth due to intense violent migrations during the 1990s.

According to the 2002 census, the largest cities in Serbia are Belgrade (1,576,124 inhabitants), Novi Sad (299,294), Nis (250,518) and Kragujevac (175,802).

The ethnic population of the Republic of Serbia is very diverse as a result of the country's turbulent past. Serbs are the majority, while 37 nationalities live jointly with them in Serbia.

Economy

Economic development of the Republic in Serbia in the period from the mid nineties of the last century to the year 2000 was characterized by a slow–down in industrial production and reduced investments, high unemployment rate, problems related to internal and external dept, high external trade deficit and low competitiveness on the international market. The specified industrial slow–down of the country and other circumstances that occurred in the considered period resulted in a decreased gross domestic product (GDP) per capita.

A process of economic recovery and a modest social development has commenced in 2001. Macroeconomic stability was restored and sustainable, stable economic development was continued, large system restructuring and privatization of state–owned enterprises was initiated and legal adaptation of all economic sectors and social areas to the new circumstances commenced.

Energy industry

In contrast to other industrial sectors in the country, the energy sector has not experienced a drastic decline in production when compared to production levels achieved during the 1990s. Reduced industrial production, lack of imported fuels and an unrealistically low electricity price (imposed as a social peace–keeping factor), have led to a changes in the structure of electricity consumption. General domestic, public and commercial electricity consumption has increased significantly at the expense of industrial electricity consumption.

Electricity production in the Republic of Serbia during the 1990s was, as it is today, based on the combustion of low–rank domestic coals in thermal power plants and utilization of available hydro potential in run–off–river and pumped storage hydro power plants. The said production is organized through the facilities of the Public Utility Enterprise „Elektroprivreda Srbije" (EPS).

The overall electricity consumption per capita was relatively low during the considered period. However, the specific consumption per unit GDP increased significantly in the said period. The relatively low efficiency of the energy transformation processes still represents one of the key problems facing the energy sector in Serbia.

Industry

In the period 1990 – 2000, a particularly bad situation was observed in the industrial sector, where 60 % decrease in production level was recorded. During several years in the considered period, industrial facilities were operating at only 10% capacities. Production in some industrial facilities ceased completely. The most significant decrease in production was observed in the highly import–dependent and traditionally export–oriented industrial branches, mainly caused by interrupted supplies and market placement opportunities.

Industrial sector is still characterized by low competitiveness, relying on traditional imported technologies, mainly dating from the 1970s and 1980s. Insufficient financial resources and lack of investments have prevented much needed industrial reconstruction and modernization, including the introduction of clean technologies.

Transport

Poor economic situation of the country, damaged and destroyed transportation infrastructure (the road network and bridges) and discontinuation of international traffic that occurred during the 1990s, has resulted in a reduced physical volume of transportation (in all branches of the transport sector), causing a slow–down in transport sector development towards the provision of more efficient and competitive transport sector services.

During the period considered, as well as today, one of the key problems with respect to energy efficiency, environmental protection and transportation safety represent the old age of vehicle fleet, import of low–quality fuels and similar.

Investments in rail and river transport made since 1990 were insignificant, causing this mode of transportation today to be in particularly unenviable situation. This is especially reflected in the poor condition of rail infrastructure and transport vehicles, low service quality, increased debt, high operation costs and business losses, improper system organization and similar. The higher utilization rate of railway and waterway transport at the expense of road freight transport is deemed one of the country's priorities in the period to come.

During the 1990s, the advantages of air transport were not utilized, which was reflected in reduced GHG emissions and was therefore associated with positive environmental effects.

Agriculture

During the 1990s, in agriculture, which is traditionally considered to be one of the key sectors contributing to the economic development of the Republic of Serbia, agricultural production volumes was reduced and production structure altered. Although revenues from agricultural activities were significantly reduced (due to decreased demand and supply), an increase in the relative contribution of agriculture sector to the GDP was recorded. Reduction in agricultural production recorded in the period 1990–2000 had resulted in reduced the strain on natural resources, primarily due to the decreased use of chemicals in agricultural production. However, a modest increase in agricultural production has been recorded during the last couple of years.

The agriculture sector in the Republic of Serbia has a large potential to enable GHG emission reduction, primarily through improved agricultural practices and utilization of agricultural residues for energy generation.

Land–use change and forestry

In the period 1990 – 2000, 1.15 % of the total land area of the Republic of Serbia was subjected to a land use change. Agricultural land areas were reduced by 8.473,00 ha, while forest areas were increased by 36.419,00 ha.

Today, 65 % of the territory (88,361 km^2 in total) is considered to be agricultural land, forestland occupies 29.7 % of the territory (26,276 km^2), while other land types comprise the remaining 5.3%.

Current condition of the state–owned forestland is characterized by insufficient production capacities, unfavourable stand structure with respect to stand age, unsatisfactory stand density, unfavourable forest composition, including a large number of locations occupied by damaged forest stands and large percentages of weed infested areas, as well as unsatisfactory tree health. The ongoing process of transition to a market oriented economy has imposed higher demands on forestland use change, caused by additional land needed for construction of industrial, infrastructure and recreational facilities.

Waste management

A total of 2.5 million tons of municipal and commercial waste, as well as some fractions of other waste (mainly biodegradable) are generated annually in the Republic of Serbia. Over the last twenty years, the average waste composition has been continuously changing in accordance with changes in the social and social–economic situation in the country. The improved quality of life achieved during the last couple of years has resulted in an increased quantity and "quality" of generated waste.

Approximately 60% of generated municipal waste is collected via organized waste collection systems, which are developed only in urban areas. The share of municipal waste collected via waste collection systems has exhibited no significant fluctuations since 1990. Disposal of the collected waste at disposal sites that were not constructed in accordance with relevant standards, therefore considered as dumps, represents the only manner of organized waste handling. The gas generated by decomposition of the disposed waste, representing the main source of methane emissions, is not properly handled and routed in an organized manner.

In spite of the fact that effective national legislation and strategic directions for proper waste management have been developed and defined over the last couple of years, the provision of well developed and properly equipped waste collection systems remains to be one of the main challenges facing the sector considered.

Inland waters

Majority of waterways that run through the country represent international transit waterways such as the river Danube, Sava, Tisa and other. Southern, south–western and western regions of the country are characterized by more abundant water resources when compared to northern, central and eastern regions of the country.

Ground waters are predominantly used for meeting the drinking water needs of the population. About 1/3 of available groundwater resources is currently utilized in water supply network. Population uses about 45% of the overall water consumption, industry and public consumption make for about 25%, while the remaining 30% represent water treatment related consumption and water distribution losses. Direct water supply losses are estimated to be equal to 20% of the overall water intake. Quality of the surface water is deemed unsatisfactory.

The most important sources of water pollution represent untreated industrial and municipal wastewaters, agricultural land drainage and disposal site filtrates, as well as pollution resulting from river navigation and operation of thermal power plants. Approximately 10% of total wastewaters discharged into recipients on the territory of the Republic of Serbia are generated in households.

Health

Very little was invested in the health care system, including public health, until 2000. This led to hospitals being in disrepair, obsolete equipment and health care staff having difficulties in obtaining professional development. All this had negative effects both on health and on the ability of the health care service and the society as a whole to protect and improve the health of citizens.

Since 2000, the area of integral planning of health care protection has seen some evident progress. A new health care policy was defined, putting an emphasis on health improvement, reducing health inequality and the importance of preventive and primary health care as its priorities. Introducing public health concept and "health in all (other) policy" principle, with a goal to lower negative impacts on human health, is a great challenge for all relevant sectors.

Education

Compulsory and free–of–charge primary education is provided for everyone under equal. Since the school year 2006/07, pre–school education for children age six is also compulsory.

The education system in the school year 1998/99 (no data for Kosovo and Metohija) consisted of 3623 primary schools and 471 secondary schools.

In Serbia, there are 7 state–founded universities covering 86 faculties, and additional 2 state faculties not belonging to any university. In addition, there are 7 private universities with 44 faculties, and 5 private faculties not belonging to any university. The number of non–university educational institutions is 49, of which 42 are state–founded and 7 are private.

Compulsory education and secondary education are free and funded from the state budget of the Republic of Serbia.

The literacy rate is 96.4 % of the population (men 98.9 %, women 94.1 %).

In 2002, the percentage of the population with higher education was about 6.5 % of the total population, which is 1 % more than in year 1991

1.3. INVENTORY OF EMISSIONS OF GREENHOUSE GASES

The GHG inventory for the Republic of Serbia was prepared according to the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, and employing the Tier 1 Method for both the year 1990, as the base year, and the year 1998. The internationally recommended values for net calorific values and emission factors were used, except for low calorific lignite. Serbian open pit mined lignite, due to its characteristics, has a significantly lower net calorific value and a higher emission factor value than the internationally recommended values.

The GHG emissions and removals for the year 1990

The total GHG emissions in the referent year 1990, not taking into account the amounts removed by forests, was 80,803 GgCO_2eq.

The largest share, 77.69 % of the total emissions, *i.e.* 62,776 GgCO_2eq, came from the energy sector. The agriculture sector, due to the relatively intense agricultural production (biochemical processes in stockbreeding and farming), emitted 11,827 GgCO_2eq or 14.64 % of the total GHG emissions. The emission of GHG due to chemical reactions from industrial processes was estimated in the order of 4,270.8 GgCO_2eq, *i.e.* 5.28 % of the total GHG emissions. The emissions from municipal dumps and from sludge waste were 1,929.5 Gg CO_2eq or 2.39 % of the total GHG emissions. Taking into account that the assessed amount of the removed CO_2 by the forests in 1990 was in the order of 6,665 $GgCO_2eq$, the net GHG emissions in 1990 were 74,138 $GgCO_2eq$.

The GHG emissions per sectors are shown on Figure 1.1.

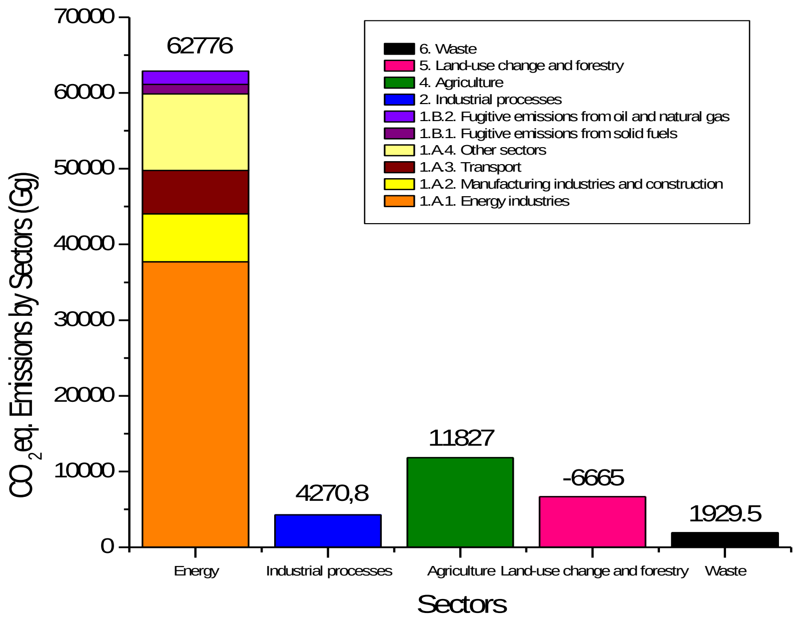


Figure 1.1. Greenhouse Gas Emissions (GHG) by sector, Republic of Serbia in 1990.

The total carbon dioxide emission in 1990 was 62,970 Gg (not including the 99 Gg of CO_2 emitted as a result of conversion processes by forest fires). The emissions originated as a result of fossil fuel combustion in the energy sector were 59,259 Gg, *i.e.* 94.1 % of the total CO_2 emissions, and due to chemical reactions in industrial processes 3,711 Gg, *i.e.* 5.89 % of the total CO_2 emissions.

The total methane emissions was 432.46 Gg CH_4, of which 194.13 Gg, or 44,89% of the total emissions, was released due to biochemical processes in agriculture. The energy sector emitted 36.44% (157.58 Gg), the sector of waste 18.55 % (80.22 Gg), and chemical processes in industry 0.12% (0.53 Gg) of the total emissions of CH_4.

The total emission of nitrous oxide was estimated to be 28.23 Gg N_2O. The largest part occurred from biochemical processes in agriculture 88.55 % (25 Gg N_2O), then from chemical processes in industry 6.27 % (1.77 Gg), from biochemical processes during the decay of waste 2.8 % (0.79 Gg) and from processes of fossil fuel combustion in the energy sector 2.37 % (0.67 Gg).

According to the available data, there was no production of synthetic gases (halogenic hydrocarbons: HFC and PFC, or sulphur hexafluoride SF_6) in the Republic of Serbia in 1990. In the available official documents, there is no record of import and consumption, *i.e.*, the available amounts of synthetic gases, and thus the related emissions could not be estimated. Certain data is available starting from 2004.

The emission of nitrogen oxides (leaving out nitrous oxide) was 208 Gg. The energy sector was the largest emitter of nitrogen oxides with 197 Gg or 95 % of the total amount. The remaining amounts were generated in agriculture by field burning of biomass leftovers 3.4 % (7Gg) and chemical processes in industry 1.5 % (3 Gg).

The total emission of carbon–monoxide was 644 Gg, of which the sector of energy emitted 489 Gg or 75.9 % of the total amount, sector of agriculture 152 Gg or 23.6 %, chemical processes in industry 2 Gg or 0.31% and forest fires 1 Gg or 0.2 %.

The total NMVOCs emission was 271 Gg, of which 157 Gg or 57.9 % emanated due to the physical/chemical processes in industry and 114 Gg or 42.1 % from the sector of energy.

The total emission of the sulphur oxides was 490 Gg. The greatest share, 95.1 % (466 Gg), was a result of use of fossil fuels in the energy sector. The chemical processes of sulphuric acid production and, to a lesser extent from other industrial processes, altogether contributed 4.8% (24 Gg).

The GHG emissions and removals for the year 1998

The total emissions of GHG in 1998, disregarding the net removed amounts of CO_2 in forests, amounted to 66,346 Gg CO_2eq.

The greatest share in the total emissions, amounting to 76.19 % (50,549 Gg CO_2eq), was contributed by the energy sector. The agriculture sector contributed to total emissions with 14.32 %, *i.e.*, 9,500 Gg CO_2eq, industrial processes with 5.46 % (3.620 Gg CO_2eq), and communal landfills and sludge waste with 4.04 % (2.678 Gg CO_2eq). Emissions per sectors are shown on Figure 1.2.

Since the estimated amount of the removed CO_2 in 1998 in the forest complex of the Republic of Serbia was 8661 Gg CO_2eq, the net emissions of GHG for the year 1998 amounted to 57,685 Gg CO_2eq.

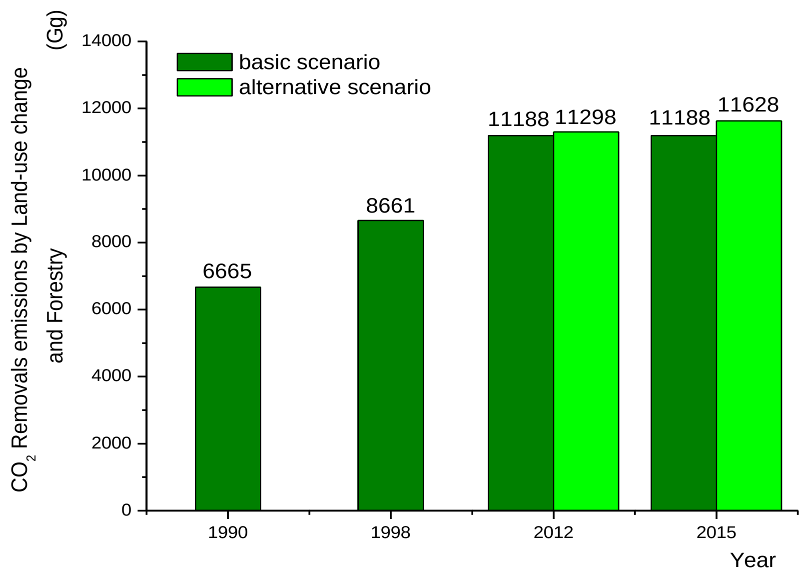


Figure 1.2. Greenhouse Gas Emissions (GHG) by sector, Republic of Serbia in 1998.

The total emission of carbon dioxide was 50,605 Gg CO_2, of which 47,430 Gg CO_2 or 93.73 % emanated from the energy sector while the remaining part, 6.27 % or 3,176 Gg CO_2, resulted from industrial processes.

Of the total emission of methane (424.52 Gg), 39.48 % or 167.61 Gg CH_4 was emitted from the agriculture sector, 33.11 % or 140.57 Gg from the energy sector, 27.25 % or 115.71 Gg by landfill gases and 0.15 % or 0.63 Gg from chemical processes in industry.

The emissions of nitrous oxide (22.02 Gg) originated mostly from the agriculture sector 87.6 % or 19.29 Gg, while the remaining 13.4 % or 2.73 Gg emanated from industrial chemical processes, decomposition of the organic matter in waste waters and the energy sector.

In the available official documents there is no record of import or consumption of synthetic gases, *i.e.* of the available amounts, and thus the related emissions could not be estimated.

The total emission of nitrogen oxides (disregarding nitrous oxide) was 165 Gg, carbon monoxide 465 Gg, NMVOC 115 Gg and sulphur oxides 389 Gg. The energy sector, due to combustion of fossil fuels, primarily participated in the emissions of all indirect GHG: 94.55 % of the nitrogen oxides, 70.32 % of the carbon monoxide, 64.35 % of the non–methane organic volatile matter and 98.2 % of the sulphur oxides.

Emission trends and the uncertainty of the calculations

The total GHG emissions in 1998, in the case without consideration of the amounts removed by the forest complex (LUCF), had a significant trend of decrease (–21,8%) in relation to 1990.

Taking into account the amounts removed by the forest complex, the trend of decrease of GHG emissions in 1998 in regard to 1990 is even more evident: –28.5%.

The estimated uncertainty of the total GHG emissions for the year 1990, determined according to the internationally recommended methodology (Tier 1 Method), is 10.5 %.

1.4. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

Observed climate changes

There was an increase in mean annual temperatures in almost all parts of Serbia, except southeast part of the country, up to 0,04°C/year. The rises in temperatures were higher in the northern than in the southern parts of Serbia, and the increase was the highest in the spring.

Most of the territory, except the east and south parts, was characterized by a minor annual precipitation trend. A decrease in precipitation was observed in winter and spring in northern and eastern Serbia.

Climate Change Scenarios

Assessment of climate change in the future obtained by regional climate model integrations show that further annual mean temperature increase can be expected. According to A1B scenario, increase in temperature, over the territory of Republic of Serbia, for the period 2001–2030 is from 0.8 to 1.1°C, whilst in case of A2 scenario this increase for the period 2071–2100 is from 3.4 to 3.8°C. In case of A1B scenario, change in precipitation in the first thirty years of this century would have minor increase from +5% over most of the area, comparing to reference period 1961–1990. According to A2 scenario, during last thirty years of this century over the territory of Serbia deficit in annual precipitation would exist with maximum of –15%.

Inadequate climate conditions caused by further increase in temperature, decrease in precipitation and other changes in climate system in the future would certainly have many negative consequences.

Hydrology and water resources

A preliminary assessment of climate change effects on the water resources indicate that a decrease of water flow on the national level, is to be expected in the forthcoming period (up to 2100). The results of numerical models indicate that the average annual discharge in Serbia will drop by 12.5% until 2020 and by 19% until 2100. Since these assessments are preliminary, need for further research on the impacts of climate change on the water resources is necessary, as is the adoption of a detailed programme of adaptation measures.

Forestry

Current warming and large–scale disturbances have caused considerable changes in the forest land in Republic of Serbia. Droughts, insect invasions and forest fires caused by climate changes become more probable and threaten to transform entire forest ecosystems, changing the distribution and composition of forests.

Agriculture

Increasingly frequent and intensive droughts in the past two decades have caused great damage to Serbian agriculture. According to the evaluation of drought impacts on the crop yield the average drop in yield was 40.9% in comparison to the average annual yield in the years without drought. In AP Vojvodina climate change in the past decade has caused a higher or lower intensity of the following diseases in crops and vegetables: powdery mildew in wheat, Fusarium class, leaf spot in sugar beet, downy mildew in sunflower and potato and tomato blight.

Bearing in mind the projected increase in air temperature and decrease in precipitation, it was concluded that agricultural production will be very vulnerable. Assessments obtained from crop production models show that in second half of this century drop in yield for some crops can be expected to be up to 10%.

Biological diversity and natural land ecosystems

Systematic collection of data and analyses concerning climate change impacts on biodiversity has not yet been realised. Still, the observed climate change impacts on biodiversity and natural ecosystems in Serbia indicate that climate change may lead to the following: phenological changes; changes in the morphology, physiology and behaviour of species; loss of existing habitats and emergence of the new ones; changes in the number and distribution of species; increase in the number of vermin and diseases; genetic changes, followed by extinction of species unable to adjust to climate change and changes in the natural fish population.

Health

Exiting approximate data indicate a increase in the last few years of the number of heat strokes and mortalities during periods with extremely high daily air temperatures in the last few years. Available data indicate the possible spread of vectors and exotic diseases that can be transmitted from tropical regions to Serbia. Since the beginning of the millennium, more introductions have been registered, the latest one being the African virus (Chikungunya) transmitted by the Asian tiger mosquito (*Aedes albopictus*). This invasive species was registered in Serbia in 2009.

Adaptation – problems and needs

Some of basic problems and priority needs for efficient definition and implementation activities and adaptation measures to climate change were indicated during the production: Inadequate systematized data collection and lack of a data base; inadequate vulnerability assessment of the sectors and systems and lack of financial and technical–technological capacities.

Amount of available data and information about vulnerability and adaptation indicate priority need for National Adaptation Plan.

1.5. ASSESSMENT OF CLIMATIC CHANGE MITIGATION

The assessment of the climatic change mitigation opportunities is based on: the detailed analysis of GHG emissions in 1990 and 1998, preliminary analysis of GHG emissions (total and specific per sector and per gas) in 2007, expected changes in emissions till 2012 and 2015 and the analysis of the legal and strategic documents.

Energy sector

After the decrease of consumption during the 90–ies of the last century, the level of consumption of fossil fuels in the energy sector has constantly increased in the past ten years. The projections according to the baseline scenario show an increase in consumption in 2012 of

8.23 % and in 2015 of 15.69 % in relation to the reference year 1990. According to the alternative scenario this increase would be 6.52 % in 2012 and 8.91 % in 2015.

Industrial processes

The GHG emissions from this sector in 1990 had a relatively small share in total GHG emissions. The level of GHG emissions has practically remained the same for more than twenty years and after 2003 had a tendency of constant moderate increase. The GHG emissions from this sector mainly result from prime processing/refining, energy intensive, industries.

In the period up to 2015, there are minimal possibilities for reducing the expected growth rate of GHG emissions from this sector.

Agriculture

In the period after 2002 there is a clear trend of revival of stockbreeding and farming production, which is expected to continue in the next period.

Under the baseline scenario, the GHG emissions from biochemical processes in agriculture will in 2012 reach the emissions in the base year 1990 and surpass them in 2015 by +8.8 %. According to the alternative scenario, the GHG emissions will be at the level of 99.3 % in 2012 and 107.7 % in 2015, compared to the emissions in the base year 1990.

Forestry

The net annual amount of carbon dioxide bound in the timber mass of the forest complex has been rising in the last 20 years. This trend is also expected in the coming period, hence, the amount of removed CO_2 will increase by about 68 % by the end of the analyzed period compared to the reference amount of CO_2 removed in the base year 1990.

According to the alternative scenario, with the provision of providing financial resources for further afforestation of 9000 ha/year, the amount of removed CO_2 will increase by 69.5 % in 2012 and 74.5 % in 2015, compared to the reference amount of CO_2 removed in the base year 1990.

Waste management

The GHG emissions from the waste management sector have increased steadily in the period since 1990 until today. Under the baseline scenario the estimated emissions in 2012 could be two times larger and in 2015 even 215.2 % larger compared to the emissions in the base year 1990.

Alternatively, the construction of the planned regional landfills with the employment of the landfill gas, a significantly higher degree of recycling and the introduction of co–combustion of waste in coal power plants by 2015 would limit the GHG emissions in this sector to the level of 179.3 %, compared to the reference emissions in the base year 1990.

Summary of emission trends

Under the baseline scenario, the total GHG emissions would reach a level of 112.23 % in 2012, and 120.41 % in 2015 of the 1990 value of GHG emissions.

According to the alternative scenario, this upward trend in emissions would be mitigated, *i.e.*, the GHG emissions in 2012 would reach the level of 110.56 %, and in 2015, the level of 111.66 % of the total GHG emissions in the base year 1990.

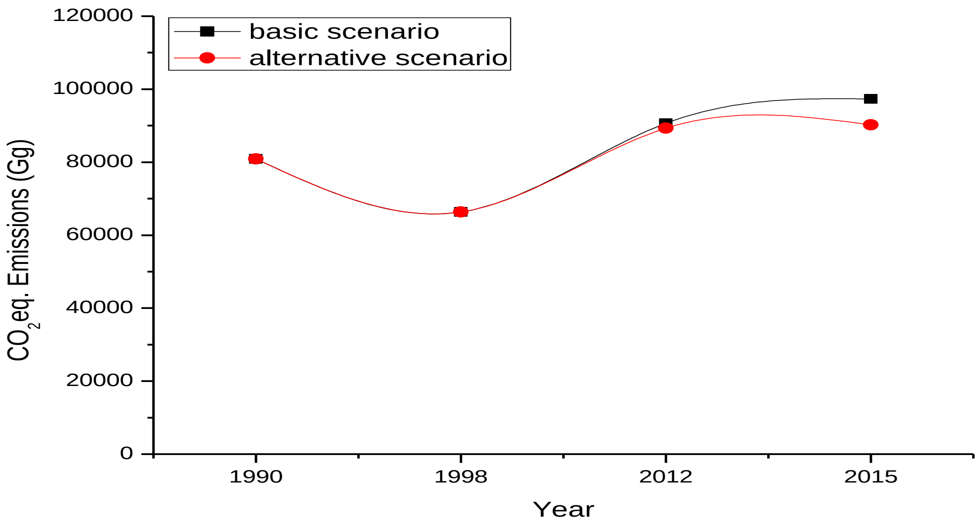


Figure 1.3. GHG emissions projection until 2015 according to the baseline and alternative scenario

By comparing the total levels of GHG emissions according to the baseline and alternative scenarios, it may be seen that the expected increse in GHG emissions by the year 2015 may be decreased by the amount of around 7,000 Gg.

The aim of the Government of the Republic of Serbia is to slow down the expected upward trend in GHG emissions in a relatively short period of time, until the year 2015, by implementation of additional measures, under the provision of securing the transfer of modern technologies and significant investment resources through bilateral and multilateral cooperation.

1.6. RESEARCH AND SYSTEMATIC MONITORING

Efficient dealing with climate change impacts and adaptation requires involving all relevant sectors to research, measurements and analyses.

Serbian experiences in climate monitoring and research date back to the mid–19th century. In his famous astronomical theory of climate change on Earth (1941), Milutin Milanković, a distinguished Serbian scientist (1879–1958) and lecturer at Belgrade University, understood the effect of key factors of natural long–term climate changes.

Due to the complex economic and social situation, advanced research on the national level considerably slowed down in the 1990s. Since 2000, the situation has significantly improved. Research in the area of climate change and its impacts is a priority for the forthcoming period (2011–2014).

Generally speaking, most of the research realised in the area of climate change was enabled thanks to the participation of scientific, state and other institutions, as well as individuals in scientific and technical programmes of the World Meteorological Organisation, research and development programmes of the European Union, as well as in bilateral and multilateral cooperation programmes. Continuous bilateral and multilateral cooperation is the key in all respects, as it enables the transfer of knowledge and practice.

Monitoring system

As a member of the World Meteorological Organisation, 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 (NHMSS), as a national hydrometeorological institution, is tasked with meeting Serbia's obligations towards the GCOS.

Serbia applies systematic observations in the fields of meteorology and hydrology. However, maintenance and meeting new requirements in the context of climate change remains a challenge. At the same time, due to the limited funding and inadequate equipment, systems of integral monitoring of climate parameters and environmental parameters in forestry, agriculture, public heath, biodiversity and ecosystems are still underdeveloped or even non–existent. Almost identical problems are present in scientific research.

Strengthening cooperation between sectors and integration of climate change problem into sectoral priorities is one of the most important aspects for efficient and complete implementation of systematic research and monitoring.

1.7. EDUCATION, TRAINING AND PUBLIC AWARENESS BUILDING

The process of producing strategic documents with regards to climate change, and especially this document, but also intensification of the campaign, training and workshops has led to the popularization of climate change.

The results of these activities are still relatively modest.

Therefore, it is necessary to work systematically and in detail to identify opportunities for an efficient and continuous system of organizing training and workshops, development of educational material, dissemination of information, and educational reform that would introduce this issue into the formal education system.

The main goal of the state is, above all, to build and strengthen the existing capacities of national experts, but alsodecision makers, representatives of academia, industry, the private sector, non–governmental organizations and the media.

The key problems in the realization of these activities may be limited financial and human resources.

1.8. PROBLEMS AND NEEDS

During the process of drafting the Initial National Communication it was noticed that climate change problem became an object of broader interest only in the past few years. Thus, it is still necessary to work on integration of climate change into national development strategies. It is essential to bear in mind that, still, there is a lack of capacity, unsatisfactory accuracy and absence of some data for the inventory, insufficient studies of climate change impacts and possibility of adaptation and mitigation. Drafting the Second National Communication could be a significant contribution in solving these problems and therefore it is fundamental to continue the cooperation with the GEF.

2.

NATIONAL CIRCUMSTANCES

2. NATIONAL CIRCUMSTANCES

2.1. GEOGRAPHIC PROFILE

The Republic of Serbia is continental country, mainly located in south–eastern Europe (about 80 % of the territory). The smaller, northern part of the country belongs to Central Europe. Serbia is situated in the central part of the Balkan Peninsula, between 41° 53' and 46° 11' latitude North and 18° 49 'and 23° 00' longitude East.

The general length of the state border is 2,397 km. In the east, Serbia borders Bulgaria (371 km), in the northeast Romania (544 km), in the north Hungary (166 km), in the west Croatia (315 km) and Bosnia and Herzegovina (391 km), in the southwest Montenegro (236 km) and in the south Albania (122 km) and Macedonia (252 km).

The Republic of Serbia covers an area of 88,361 km^2.

Northern Serbia, or more preciously the Pannonian Plain, is mainly flat. Flatlands exist also in Mačva, the Sava Valley, the Morava Valley and the Stig, and Negotin Marshes in eastern Serbia. South of the Sava and Danube Rivers is the central part of Serbia and the Highlands Sumadija. Going to the south, the hills gradually turn into mountains. The valleys of the Great, Southern and Western Morava, the Ibar and the Nisava Rivers intersect the mountainous parts of the country and are main traffic routes.

55 per cent of Serbia is arable land, mainly located in Vojvodina, the main agricultural region of the country.

The mountains of Serbia can be divided into: the Rhodope Mountains, the Carpathian–Balkan Mountains and the Dinaric Alps. Up to 30 mountain peaks are over 2,000 m above sea level, the highest being Djeravica in the Prokletija Range (2,656 m).

The State Rivers belong to the Basins of the Black, Adriatic and Aegean Seas. Three rivers are navigable along the whole length through Serbia: the Danube, the Sava and the Tisa. The Great Morava and the Tamis are partly navigable. The longest river in the country is the Danube, which flows for 588 km, of its 2,783 km course, through Serbia, and it comprises over 90 % of the river basins. The Danube is a waterway connecting the western and Central European countries with the countries of eastern Europe.

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

The largest artificial reservoir is located on the Danube and is called the Lake; it covers an area of 163 km^2 on the Serbian side (the Romanian part: is 253 km^2).

Serbia has 5 National Parks: Đerdap, the Kopaonik, Tara and SAR Mountains, and Fruska gora.

2.2. CLIMATE

Most of Serbia has a temperate continental climate, with more or less pronounced local characteristics. A continental climate prevails in the mountainous areas of over 1,000 metres. The climate in the Serbian southwest borders on the Mediterranean subtropical and continental.

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

According to measurements made during 1961–1990, the mean annual air temperatures are between 10 and 12 °C in the lowlands and Metohija, below 10 °C at altitudes higher than 600 metres, around 6 °C at altitudes above 1,000 metres, and around 3 °C at altitudes above 1,500 metres (Figure 2.1, left panel).

The coldest month is January, the warmest is July.

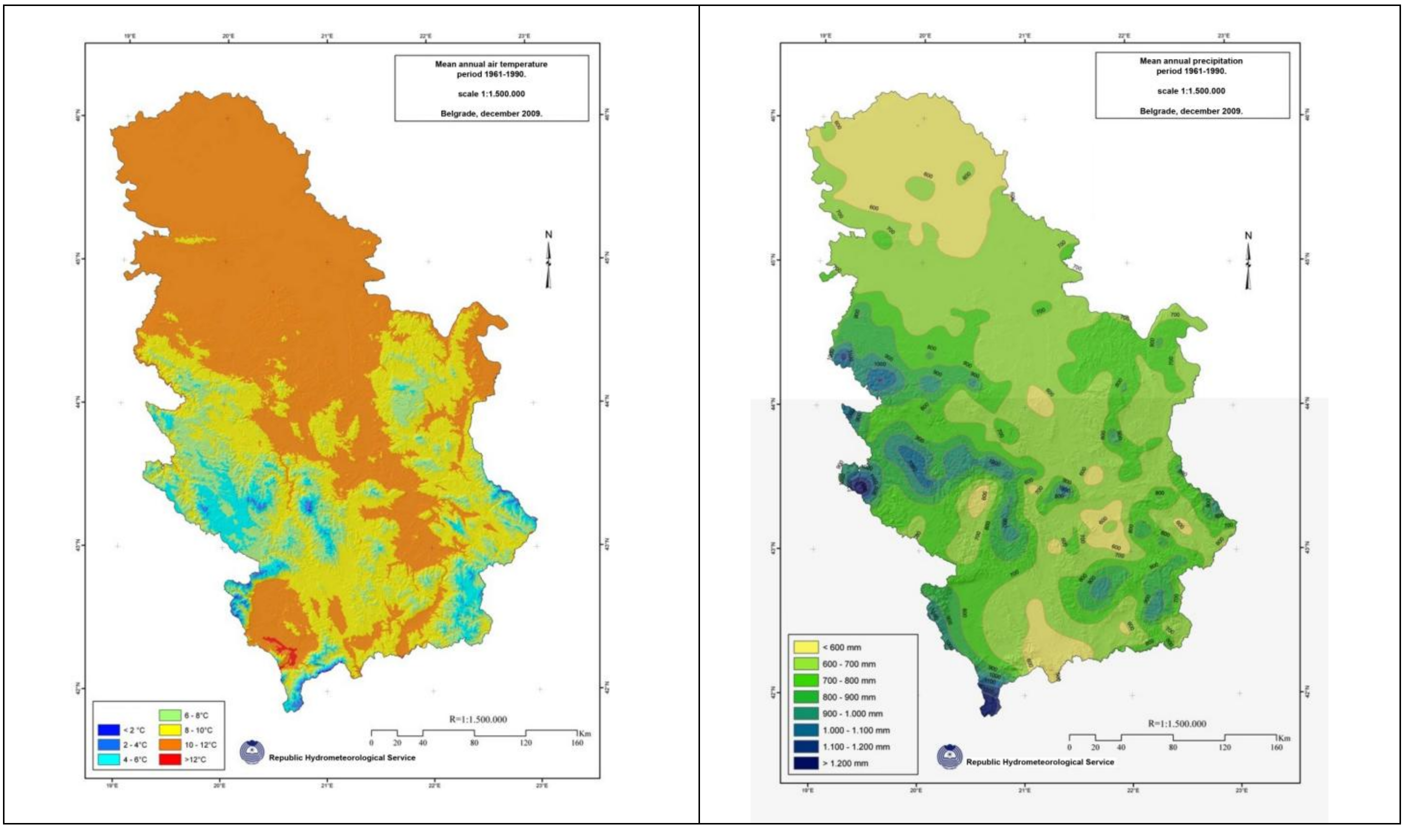


Figure 2.1 Mean annual air temperature (°C) and accumulated precipitation (mm) for the period 1961–1990.

The sum of the annual precipitation increases with altitude. The lowest precipitation, under 600 mm, is characteristic for northern Serbia and parts of Kosovo. The amounts of precipitation in the Sava region as well as in the Great Morava and South Morava valley regions ranges between 600 and 700 mm, in the mountainous areas between 800 and 1000 mm a year, and above 1,000 mm a year on some mountain peaks in Southwest Serbia (Figure 2.1, right panel).

The number of days with an average annual precipitation higher than 0.1 mm and higher than 10 mm is 120–150, while 20 days have more than 10 mm.

The major part of the Pannonian Plain and central Serbia receives most rain in late spring, most often in May and June. The secondary precipitation maximum is in February, whilst October is the driest month in this area. Due to the influence of the Mediterranean climate in the far southwest of Serbia, this region receives maximum rainfall in late autumn and the minimum in the summer months.

North–westerly and westerly winds dominate the warmer period of the year, whilst easterly and south–easterly winds (Košava) blow during the cold period of the year. In the mountainous areas in southwest Serbia, south–westerly winds prevail.

The annual sums of sunshine duration range from 1,800 to 2,100 hours, with only Pozega having around 1,550 hours a year.

2.3 SOCIO–POLITICAL SYSTEM

Serbia is an independent democratic state with a multiparty parliamentary system. The Republic of Serbia regained its independence in 2006.

The basic principles underlying the political and governmental system of the Republic of Serbia are established in the Constitution from 2006.

The governmental system is based on the division of power into legislative, executive and judiciary. The Government has executive power, and consists of a president, vice presidents and ministers. The National Assembly, as the unicameral parliament consisting of 250 deputies elected in general elections for a four–year term, has constitutional and legislative power. The National Assembly, based on the recommendation of the President of the Republic, votes the Prime Minister and ministers into the Government. The President of the Republic is elected directly by the citizens for a five–year period.

The responsibilities of the different government bodies are divided between central government and 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. These are: decision making and by–laws governing specific issues relevant to the citizens of the province in areas such as culture, education, official language and script of national minorities, health and social care, industry, protection and improvement of the environment, agriculture, water, forestry, hunting, fishing, tourism *etc*.

Integral parts of the Republic of Serbia are the Autonomous Province of Vojvodina and the Autonomous Province of Kosovo and Metohija as forms of territorial autonomy. In accordance with the Constitution and law, the provinces have revenues, a budget and balance sheet and provide funds to local governments to perform delegated tasks.

The Autonomous Province of Vojvodina is situated in the northern part of the Republic of Serbia and constitutes almost one quarter of the Serbian territory or 21, 506 km^2. Novi Sad is the administrative, economic and cultural seat of the province.

The Autonomous Province of Kosovo and Metohija, on the basis of the United Nations Security Council Resolution 1244 which was adopted on June 10, 1999, is under the interim civil administration of the United Nations. The Autonomous Province of Kosovo and Metohija covers an area of 10,849 km^2.

The territory of the Republic of Serbia is divided into: municipalities (194), cities (24) and Belgrade as a unit of local self – government. The territory is also divided into 29 administrative districts and the territory of the city of Belgrade, as a district of its own. The Administrative Districts are a form of devolution, governed by a prefect responsible to the Government for implementation of regulations within the district. A district consists of several units of local self–government municipalities, which, unlike the district represent a form of decentralization of power and as such have their revenues and local authorities (Figure 2. 2). The Republic of Serbia has 6169 settlements, of which 207 are urban settlements.

Figure 2.2. Map of the Republic of Serbia – territorial division

In accordance with the Law on Local Self–Government sectoral laws, such as the Law on Environmental Protection and other laws in this area, identify the jurisdiction of municipalities in the environmental field. Accordingly under the jurisdiction of the municipality are to nurture the environment, decide strategies for the use and protection of natural resources and environmental protection action plans and recovery plans in accordance with strategic documents and its interests and specifics, perform treatment and removal of rainwater and wastewater, sanitation in cities and towns, maintenance of landfills and establish a special fee for the protection and improvement of the environment. Based on the laws on environmental protection, local governments are entrusted with the following tasks: environmental impact assessment, strategic impact assessment, issuing integrated permits, waste management (internal and non–hazardous), air protection, noise protection, *etc*. Moreover, local self–government units are entrusted with inspection supervision tasks.

Under the Constitution, the City of Belgrade is a special unit of local self–government. The position of Belgrade, the capital of the Republic of Serbia, shall be regulated by law and statute of the capital city of Belgrade. Belgrade has the authority delegated by the Constitution and the law to the municipality and city and by the Law on the Capital, other jurisdictions may also be delegated. A recently passed law on the capital city provides Belgrade with special jurisdiction in the fields of water resources, roads, fire protection and public information.

In February 2010, the Serbian Parliament proposed a law that established five statistical regions: Vojvodina, Belgrade, Šumadija and Western Serbia, Southern and Eastern Serbia, and Kosovo and Metohija.

2.4. POPULATION

In the period from 1990 to 2000, only one census was realised, in 1991. The total population, according to the 1991 census, was 7,595,636 inhabitants. It should be borne in mind that the 1991 census was not fully realised in the municipalities of Bujanovac and Presevo (central Serbia) and in Kosovo and Metohija. In 2000, 52 per cent of the population lived in urban settlements.

According to the 2002 census, the total population was 7,498,001 inhabitants. Those data are only estimation taking into account that census was not realised on the whole territory. Estimates show that during the period 1991–2002, there was a significant increase in population growth due to intense violent migrations during the 1990s.

According to the 2002 census, the largest cities in Serbia are Belgrade (1,576,124 inhabitants), Novi Sad (299,294), Nis (250,518) and Kragujevac (175,802).

The ethnic population of the Republic of Serbia is very diverse as a result of the country's turbulent past. Serbs are the majority, while 37 nationalities live jointly with them in Serbia. All citizens have equal rights and responsibilities and enjoy full national equality.

According to 1991 data, average life expectancy in Serbia was 69 years for men and 74,1 for women. However, the average life expectancy is rising and in 2002 it was 71 years for men and 76 for women.

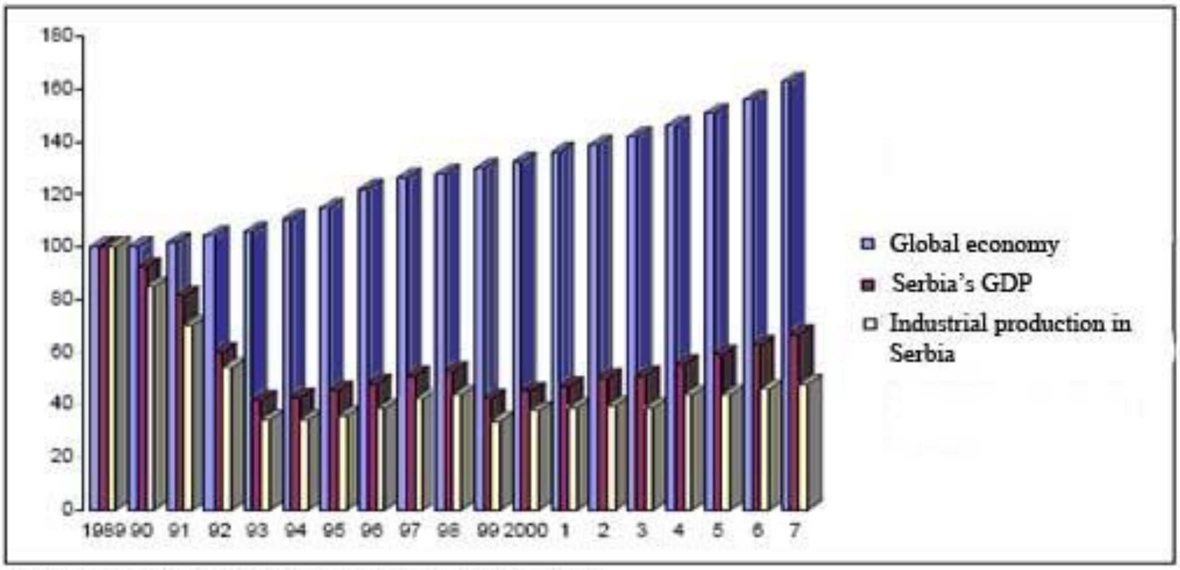
2.5. MAIN CHARACTERISTICS IN RELEVANT SECTORS

2.5.1 ECONOMY

In period from the mid nineties of the last century to the year of 2000, national economy can be characterized by slowdown in industrial production, accompanied by reduced productivity, investment activities and volume of international trade. All of this, together with relatively sharp increase in individual and national consumption, has resulted in even more pronounced liquidity–related problems and drastic reduction of financial resources available for new investment cycle. In addition, foreign direct investments during the period considered were almost non existent.

Particularly bad situation was observed in industrial sector where production capacities were insufficiently employed, contribution of certain industrial braches to the overall industrial production was significantly reduced and industrial products had generally become less competitive. Transport sector was in unenviable situation as well, with reduced physical volume of transportation services (in all branches of the transport sector) and cessation of further transport sector development oriented towards provision of more efficient and competitive services. Agriculture, which is traditionally considered to be one of the key sectors that contribute to economic development of the country, had also experienced a decrease in production as well as alterations in the structure of agricultural production. Construction and other sectors were confronted with heavy downturns as well.

Macroeconomic trends in the Republic of Serbia observed in the period 1989 – 2007 and comparison with global trends are presented in Figure 2.3. The above–mentioned stagnation in economic development of the Republic of Serbia was primarily a result of disintegration and conflicts that had occurred in the former Socialist Federal Republic of Yugoslavia (SFRY). Such situation had led to the foreign market share losses and several year long international isolation of the country, culminating in the late nineties when important infrastructural and industrial facilities in the Republic of Serbia had been targeted during the NATO bombardment. International sanctions imposed upon the country (May 1992 – 1995) had caused complete cessation of foreign investments in industrial production while government institutions and social peace keeping were financed through revenues from the inflation tax. The period addressed was also characterized by huge number of refugees which had fled conflict areas and found shelter in Serbia (between 700.000 and 800.000 people).



Source: Statistical Office of the Republic of Serbia, 2007

Figure 2.3 Macroeconomic trends in the Republic of Serbia – comparison with global trends

Slowdown in the economy and other specific circumstances that had occurred in the period considered had resulted in decreased gross domestic product (GDP) per capita. Starting from 1990 and up to the end of 1991 GDP had decreased by 20%. In 1992 and 1993 GDP was reduced to 50% of the GDP achieved in 1991. After the sanctions imposed by international community had been lifted, a small increase in GDP was recorded. Contribution of industrial sector to the country's GDP was reduced from 41% achieved in 1990 to 38% achieved in 1998.

Unemployment rate had been continuously increasing from 21% in 1991 to 27,9% in 2001. Reduction in average salary was also recorded, starting from 277 USD in 1990 to 237 USD in 1991 and 102 USD in 1992, with totally devalued national currency in 1993. Such situation at the end of 1993 and the beginning of 1994 had pushed more than 85% of working–class families and more than 92% of pensioner households to the very edge of poverty.

National industrial recovery and modest social development started after the international sanctions had been lifted (in November 2000 and January 2001 sanctions imposed by European Union and the United States of America were lifted respectively). Macroeconomic stability was restored, sustainable and stable economic development was continued, large system restructuring and privatization of state–owned enterprises was initiated and legal adaptation of all economic sectors and social areas to new circumstances had commenced. Although national development policy of the Republic of Serbia has been significantly changed since 2001, the main problems and constraints preventing more effective economic recovery and more significant utilization of national resources have remained the same: outdated technologies, degraded infrastructure and low level of domestic investments.

2.5.2. ENERGY INDUSTRY

In contrast to other industrial sectors in the Republic of Serbia, energy sector has not exhibited a drastic decline in production when compared to production levels achieved during the 90's of the last century. Reduced industrial production, lack of imported fuels and unrealistically low electricity price (imposed as a social peace–keeping factor), have led to a change in the electricity consumption structure. General electricity consumption in households and public and commercial sectors has increased significantly at the expense of industrial sector electricity consumption. Reduced share of industrial sector in total electricity consumption is manifested in the fact that the industry's share of 46% recorded in 1990 was decreased to 36% in 1998. In the same time, household share in total electricity consumption was increased from 42% in 1990 to approximately 58% in 1998. In this way electricity production has remained at approximately the same level as during the 90's of the last century (Figure 2.4).

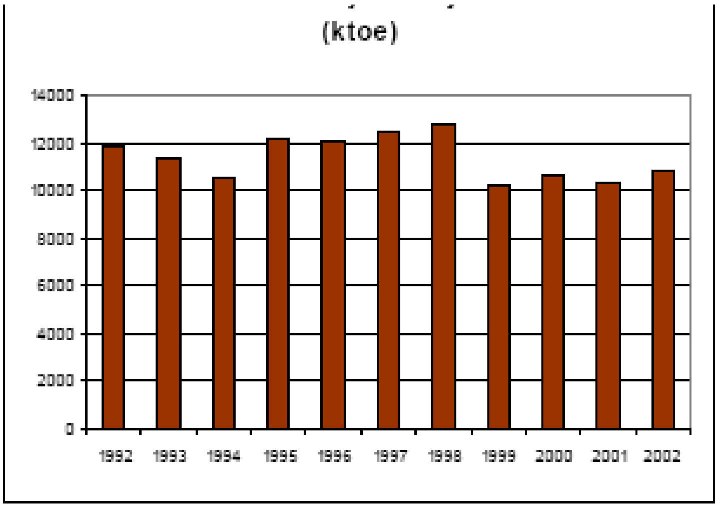


Figure 2.4 Gross primary energy consumption (ktoe), 1992-2002

In general, total electricity consumption per capita was relatively low during the period considered. However, specific consumption per unit of GDP had been increasing significantly in the period considered. Between 1990 and 2000, energy intensity changed from 0,59 toe to 1,35 toe used to generate 100 USD of GDP (Table 2.2). Relatively low efficiency of energy transformation processes still represents one of the key problems facing the energy sector in Serbia.

Year	1990	1992	1994	1996	1998	2000
Energy consumption (toe/1000 USD)	0,59	0,68	0,67	0,69	0,83	1,35

Table 2.1. Energy consumption per unit of GDP

Energy resources in the Republic of Serbia are relatively modest and geographically scattered. Total available energy reserves predominantly represent coal varieties (99%), primarily low calorific value lignite. The remaining energy resources (1%) comprise oil and gas reserves. Since domestic production of crude oil, natural gas and high rank coal was insufficient to meet national demands, additional quantities of specified energy sources were imported, but only in the amounts permitted by economic and political situation of the time. Total electricity production is based on combustion of low–rank domestic coals in thermal power plants and utilization of available hydro potential in run–off–river and pumped storage hydro power plants.

Electricity production was primarily organized through facilities of Public Utility Enterprise „Elektroprivreda Srbije” (EPS). In 1990 Serbia was equipped with modern and up–to–date electricity production system comprising eight lignite–burning thermal power plants (TPP) having 25 production units and three liquid fuel and gas burning combined heat and power (CHP) plants having 6 production units. Total installed capacity of the said production units equalled approximately 9.053 MW, with 2.587 MW installed in hydro power plants.

Approximately 450 MWe is installed in industrial energy plants of more than 30 companies. However, significant portion of these production capacities is currently out of operation. There are fine examples of industrial CHP plant integration in district heating system (company „Zastava” in Kragujevac).

Previously mentioned circumstances encountered during the 1990’s have led to reduced financial resources available for reconstruction and maintenance of existing as well as construction of new energy infrastructure in the Republic of Serbia. Due to the said reason, most of the current production facilities are technologically outdated and characterized by high specific fuel consumption, low efficiency of energy production and poor environmental performance.

However, over the last couple of years a lot has been done to define measures which would provide reduced environmental impact of power generation units. Full implementation of identified measures requires more significant investments.

2.5.3. INDUSTRY

During the 1990’s, industrial sector in the Republic of Serbia, which was already headed for a downfall, had plunged into a deep crisis which was followed by a sharp decrease in both production and employment rate. A 60% decrease in industrial production was recorded in the period 1990 – 2000. During the several years of the period mentioned, industrial facilities had been operating at only 10% capacities, while production in some industrial facilities was completely ceased.

The most significant decrease in production was observed in highly import–dependent and traditionally export oriented industrial branches. Related industrial production indicators are shown in Table 2.4 (compared with 1990 production levels) and in Figure 2.5.

	1994	1995	1996	1997	1998
Industry – total	41	42	45	50	51
Mining	73	77	76	81	83
Production	34	35	39	44	46

Table 2.2. Industrial production indicators, [%] (1990 production level = 100%)

When compared to other sectors, industrial sector still represents a major contributor to GDP. However, during the period 1990 – 2000 the said contribution was in constant decline, reaching 34,2% in 1997 and 33% in 2000.

In spite of the fact that a change in negative industrial production trends was observed from 2001 onwards, the production levels achieved are still below 1990 levels. In general, industrial sector is still characterized by low competitiveness and is primarily based on utilization of imported traditional technologies dating from the 70’s and the 80’s of the last century. Insufficient financial resources and lack of investments, mainlz in 1990s, have prevented much needed industrial reconstruction and modernization, including introduction of clean technologies.

2.5.4. TRANSPORT

Country's poor economic situation, but also by damaged and destroyed transportation infrastructure (road network and bridges) and discontinuation of international traffic in1990s, resulted in reduced physical volume of transportation (in all branches of the transport sector) and cessation of further transport sector development oriented towards provision of more efficient and competitive services.

Physical volume of transportation achieved in 2000 equaled 23% of the volume achieved in 1990. When compared to the 1990 levels, volumes of passenger transport achieved in 2000 were as follows: road transport – 48%, rail transport – 30% and air transport – 13%, all expressed as percentages of the 1990 values. Physical volume of road, rail, air and river freight transport achieved in 2000 equaled 9%, 25%, 6% and 31% of the respective 1990 values (Table 2.3). In 1990 final energy consumption in transport sector equalled approximately 1,93 million toe.

Year	Total	Rail	Road	Pipelines	Municipal	Sea/coastal	River	Air
1989	101	107	113	104	104	97	132	95
1990	100	100	100	100	100	100	100	100
1991	63	69	67	104	88	88	90	48
1992	39	58	59	129	77	52	79	15
1993	21	40	39	40	76	9	9	0
1994	18	31	27	35	94	0	8	0
1995	23	32	29	44	102	0	11	10
1996	29	31	34	69	103	27	46	13
1997	29	33	31	76	99	37	57	14
1998	29	35	31	92	96	45	50	13
1999	18	17	31	48	65	34	24	4
2000	23	27	25	54	58	32	31	13

Table 2.3. Physical volume of transportation [%] (1990 level = 100%)

Road transport traditionally represents the most developed mode of transportation in the Republic of Serbia. Road network in Serbia today, although relatively well developed (total length of roads reaches about 38.000 km), is in quite poor condition. Lack of financial resources starting from 1990 onwards, as well as utilization of all available funds for maintenance and repair of infrastructure damaged during the 1999 bombardment, represent the main reasons for the situation encountered today. Poor condition of road network directly affects the safety of road transport, low level of transportation services provided through the existent and perspective road network, as well as high exploitation costs.

However, a key problem with respect to energy efficiency, environmental protection as well as transportation safety represents the old age of vehicle fleet. In the period 1990 – 1999, an average annual increase in the number of vehicles was about 7%. However, much of the increase was due to importation of used vehicles from the western countries, which had largely influenced the average age of vehicle fleet.

The period 1990 – 2000 was also characterized by „grey economy" associated with the import of low rank fuels (in addition to domestic production of low rank fuels). Use of diesel fuel had rapidly increased. All of this had negatively affected pollutant emission at national level, in spite of the fact that reduced transport sector contribution to the national economy was recorded in the period considered.

Investments in rail transport made since 1990 were insignificant, causing this mode of transportation today to be in particularly unenviable situation. The said is specially reflected in poor condition of rail infrastructure and rail transport vehicles, low service quality, increased debt, high operation costs and business losses and improper system organisation. All of this has led to a decreased share of rail transport starting from 1990 onwards.

In recent years, the state policy changes imply a contribution to the development of this subsector. Therefore, intermodal transport, which takes into account ecological principles, has a special place has intermodal transport that takes into account ecological principles, which led to the intensification of its development in the most European countries (using intermodal transport, reductions of CO2 emissions reduction rangeds from 18 to 55 % compared to road transport, depending on the type of technology which used for intermodal transport is using). Until 2005, intermodal transport in the Republic of Serbia was represented in overall transport with approximately 0.5 % (EU countries 6--9 %). Development of intermodal transport in the Republic of Serbia, as transport of the wider public interest, environmentally acceptable, economically justified and safe, requires support from the government. The role of the government in the development of intermodal transport is very important in order to facilitate its development expansion by developing stimulating measures in order to promote more cost–effective transportation and create alternatives to road transportation. This applies particularly to the creation of a financial support model to stimulate projects for the developing development of infrastructure for intermodal transport (terminals), organization and equipment at the terminals and the transportation itself.

River transport in Serbia is only modestly utilized, mainly due to poor condition of related infrastructure resulting from improper maintenance of waterways and auxiliary infrastructure during the 90's of the last century.

Total length of waterways in the Republic of Serbia, measured at the mean river water levels, equals approximately 1.680 km. The said federal waterways predominantly comprise navigable river streams of the Danube, Sava and Tisa river (960 km in total), as well as a network of navigable canals of the hydro–engineering system Danube–Tisa–Danube (600 km in total).

With respect to the annual volume of river transport and available capacity, the most important river ports are the port of Belgrade, Novi Sad, Pančevo, Smederevo and Prahovo. Most of the river ports are either directly connected or are close to the main railways and roads, which represent a strategic and logistic advantage not sufficiently exploited over the last twenty years. The said is clearly demonstrated in the fact that total traffic that came in Serbian river ports in 2000 equalled about 40% of the traffic achieved in 1989. Such significant decrease was primarily a result of reduced national river transport caused by negative trends in the country's economy.

Given that Serbia has a considerable potential of waterways (rivers and canals), long–term state strategy is to divert, as much as is possible, the flow of goods from road to river traffic. Transport by inland waterways has significant advantages compared to other forms of transportation: it is very effective and energy efficient (energy consumption per ton–km of transported goods is 1/6 of the consumption on the road and 1/2 of that of rail), noise and emissions are significantly less and the total external costs of inland navigation are seven times lower than those of road traffic. Transport on inland waterways provides a high level of security, especially when it comes to transportation of hazardous materials and helps to reduce congestion on the overburdened road network in densely populated regions.

The Republic of Serbia has two airports opened to international flights (Belgrade Airport and Niš Airport) which belong to the primary network of airports, five airports from secondary network (those for bigger aircrafts) and 16 tertiary airports (small airports for sport flying).

During the 90's, advantages of air transport were not utilized, which was reflected in reduced GHG emissions and was therefore associated with positive environmental effects.

Over the last couple of years important changes have occurred in the transport policy adopted in the Republic of Serbia. Results of those changes are still not evident, but implementation of new legislative and strategic framework is expected to improve situation in the sector considered, as well as to reduce associated negative environmental impacts. Some of the priorities identified in transport sector development strategy include decrease of road transport frequency, revitalisation of railways and improvement of waterway transport.

Substitution of road freight transport with railway and water transport will lead to emission reduction of harmful gases, dust and noise, fuel consumption, total time of delivery of goods, the number of traffic accidents, *etc*., and, simultaneously, it will improve traffic safety, service quality and others. The implementation of such a radical concept takes a considerable length of time and substantial financial means. Therefore, it is expected that road traffic will expand in the following short–term period.

2.5.5. AGRICULTURE

Agriculture has been traditionally considered to be one of the key sectors contributing to economic development of the Republic of Serbia. Agriculture sector employs a large number of people, whether directly or indirectly, significantly contributes to the country's revenues from international trade, provides food–supply safety to the population and enables rural development and economic balance. The sector of agriculture traditionally employs more than 10% of working age population and contributes with 26% to the country's export revenues.

During the 90's of the last century revenues from agricultural activities were significantly reduced due to decreased demand and supply. Still, in spite of the complicated situation encountered, an increase in relative contribution of agriculture sector to GDP was recorded i.e. from 16,8% in 1990 to 21,9% in 2000. Data demonstrating increased contribution of agriculture sector to GDP in the period from 1990 to 2000 is shown in Table 2.4. Agriculture sector and food industry together contribute with approximately 40% to GDP.

Year	1990	1997	1998	1999	2000
Contribution of agriculture sector to GDP	16,8	19,3	18,4	20,6	21,9

Table 2.4. Contribution of agriculture sector to GDP [%]

With respect to the revenues from international trade, agriculture has contributed mostly through meat, vegetable and fruit export. Export and production of agricultural products during the 90's were reduced by approximately 20%.

On the other hand, reduced agricultural production has led to reduced strain imposed on natural resources, primarily due to reduced use of chemicals in agricultural production. In the period 1990 – 2000, use of fertilizers was reduced by 73% and use of pesticides by 78%.

Large potential of agricultural sector is still not fully utilized. The not–so–good situation in agriculture sector during the last twenty years was additionally influenced by poorly planed regional development and lack of good agricultural practices. The said has caused a problem of low land accumulation to become even more pronounced, while technical and technological development in agriculture sector was stopped. Final result of such policy was reflected in reduced competitiveness of agricultural products as well as loss of international market share. However, with good agricultural policy the sector is expected to play an important role in future economic development of the country. In the same time, agriculture sector in the Republic of Serbia has a large potential to enable GHG emission reduction, primarily through improved agricultural practices and utilization of agricultural residues for energy generation. Country's intentions towards the achievement of specified objectives are evident, but systematic and continuous work aimed at improving a knowledge base and providing technological development is also required. The said is expected to enable agriculture sector development necessary to slow down the effect of climate change.

2.5.6. LAND–USE CHANGE AND FORESTRY

In the period 1990 – 2000, 1,15% of total land area was subjected to a land use change. The most significant changes had occurred in urban areas, where pastures and agricultural land was converted into construction land. Agricultural land areas were reduced by 8.473,00 ha, while forest areas were increased by 36.419,00 ha.

Land area comprises agricultural land (65%), forest land (29,7% or 26.276 km^2) and other land types (5,3%).

State–owned forestland is currently characterized by insufficient production capacities, unfavourable stand structure with respect to stand age, unsatisfactory stand density, unfavourable forest composition including large number of locations occupied by damaged forest stands and large percentages of weed infested areas, as well as unsatisfactory tree health. Ongoing process of transition to market oriented economy has imposed higher demand on the forestland use change, since additional areas are needed for construction of industrial, infrastructure and recreational facilities. On the other hand, accelerated migration of rural population to towns and cities results in abandoned agricultural land which potentially represents new forest land.

National forest development strategy (2006) defines afforestation/reforestation and fast growing trees planting as the main objectives of the forest sector development. Fulfilment of these objectives definitely requires time, as well as provision of appropriate simulative policy and favorable financial and technical–technological conditions. This Strategy recognized importance of links between forestry and climate change, and made base for further development and improvement of forestry sector for combating climate change. Objectives and measure defined by this document, in direct or indirect way, provide conditions for further development of effective systems of adaptation to climate change and contribution of forestry sector to adaptation.

2.5.7. WASTE MANAGEMENT

A total of 2.5 million tons of municipal and commercial waste, as well as some fractions of other waste (mainly biodegradable) are generated annually in the Republic of Serbia. During the last twenty years, an average waste composition has been continuously changing in accordance with social and social–economic situation in the country. Improved quality of life achieved during the last couple of years, has resulted in increased quantity and „quality" of generated waste.

Approximately 60% of generated municipal waste is collected by organized waste collection systems, which is developed only in urban areas. The share of municipal waste collected by waste collection systems has not exhibited significant fluctuation from 1990 onwards.

Disposal of collected waste at disposal sites which have not been constructed in accordance with relevant standards, therefore considered as dumps, represents the only manner of organized waste handling. Each municipality has its own disposal site/dumps, but there are a large number of unregistered disposal dumps as well. Available capacities of existing municipal disposal sites/dumps have mostly been fully reached. Gas generated by disintegration of disposed waste, representing the main source of methane emissions, is not properly handled or routed in an organized manner.

Inadequate waste handling represents one of the most serious problems that negatively affect human health and state of the environment. Effective national waste management legislation and related strategic directions have been developed and defined over the last couple of years. However, provision of well developed and properly equipped waste collection systems remains one of the main objectives to be achieved in the field of waste management.

2.5.8. INLAND WATERS

The total multi–annual average quantity of available waters on the territory of Serbia is 5,648.34 m^3/s or 178–125.4 million m^3/year. Of the total available waters, 184 mm/year (16,234.3 million m^3/year) originates in the state territory. The remaining 1,832 mm/year (161–891.1 million m^3/year) are transit waters, flowing through Serbia *via* the Danube, the Sava, the Tisa and other waterways.

From the territory of Serbia, the waters gravitate towards the Black Sea (the rivers of the Danube basin), the Adriatic Sea (the Drim and the Plavska Rivers) and towards the Aegean Sea (the Pcinja, the Dragovistica and the Lepenac Rivers).

Southern, south–western and western parts of the country are richer in water than the northern, central and eastern regions. As mountainous areas receive more precipitation, there are specific runoffs above 15 litres per second/km^2 from these areas. In the lowlands and highlands, in the north and central parts, the specific runoff is below 6 litres per second/km^2. The basins of the Rivers Bistrica, Gradac, Lopatnica and Studenica have the most abundant runoffs in Serbia, ranging from 15 to 17 litres per second/km^2. Vojvodina has the lowest water abundance in the basins of the left tributaries to the Great Morava and the Kolubara Rivers (from 2 to 5 litres per second/km^2). The average specific runoffs, calculated on the basis of the average multi–annual flow at 139 hydrological stations of the National Hydrometeorological Service of Serbia (NHMSS) in the period 1946–2006, are shown in Figure 2.6.

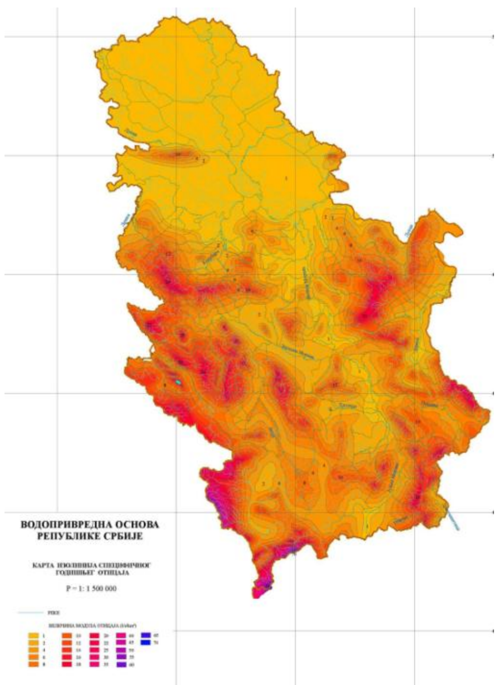


Figure 2.6 Average specific runoff.

Figure 2.6 Average specific runoff

Both surface water and groundwater are used for water supply. Surface water is extracted from streams and accumulations (total water source capacity is approx. 250 million m^3/year). The quality of surface water in Serbia is not satisfactory.

Groundwater is predominantly used for water supply. The total available groundwater potential is estimated at approx. 67.5 m^3/s, of which alluvial aquifers have the greatest capacity of approx. 44 m^3/s, followed by karst aquifers with approx. 14 m^3/s and aquifers that are classified as so–called „slowly renewable" aquifers (tertiary layers) with approximately 9.5 m^3/s.

The used capacity of the existing groundwater aquifers is around 23 m^3/s, *i.e.*, around 1/3 of the available potential. Domestic uses account for around 45 %, around 25 % is used by industry and in municipal consumption, whilst the remaining 30 % is used up in water treatment and losses in the network. The irreversible losses in the water supply are estimated at about 20 % of the abstracted water.

There are around 1,200 mineral, thermal and thermal mineral water springs registered in Serbia. Estimates show that of the total registered hot water potential, only an insignificant portion (1 %) of renewable resources is actually used.

The constructed irrigation systems cover an area of about 149,000 ha, of which around 30,000 ha (90 % are in Vojvodina) are currently in use. The total number of constructed systems is 288, mainly consisting of small systems of 100–500 ha. For the full use of the constructed systems, the requisite water for irrigation is about 270 million m^3 per year, of which around 110 million m^3 per year from the canal network, 36.5 million m^3 per year from rivers, around 22 million m^3 per year from accumulation and more than 100 million m^3 per year from other sources are necessary.

Flood protection is the most important aspect of defence against the harmful effects of water, due to the fact that in the flood–prone areas, the total area of which is about 1.6 million hectares, are situated over 500 larger settlements, more than 500 large commercial building, around the 1,200 km of railway and more than 4,000 km of roads. In order to protect from flooding, over 3,400 km of dams were built and river regulation of about 420 km was realised.

However, long–term/multiannual investment reduction in the maintenance of facilities and of river beds has led to a reduction in the security and level of protection from the destructive effects of water. Due to lack of maintenance of river beds, embankments of waterways under a torrential hydrological regime are threatened.

Approximately 56.000 km^2 of the territory of the Republic of Serbia is affected by erosion processes of varying intensity, with an average annual sediment yield of close to 40 million m^3. During the last few years, a significant volume of work was realised and many facilities to protect against erosion and flood were constructed.

The most important sources of water pollution are untreated industrial and municipal wastewater, agricultural drainage water, as well as pollution related to river shipping and thermal power plants.

Most population (99.6 %) live in households with sanitary facilities of some kind: 88.3 % have sewage or septic tank. In 1991, 66 % lived in residences with either sewage or septic tank. This number rose up to 77 % in 1996 and 88 % in 2000, thus indicating the improvement of sanitary conditions. Urban area is 87.5 % sewage covered, while the same number for rural area is 22.2 %.

Nearly 10 % of the total wastewater originating in Republic of Serbia are municipal and it was constant during 1990's. The total amount of municipal and industry wastewater is about 60 % less than it was at the beginning of 1990's.

Build of municipal and industrial sewage was notably lagging behind during the last decade of 20th century. In the meanwhile, the capacity of wastewater treatment remained almost at the same level and treated amount of wastewater in 2000 was similar to one in 1990. Only 12 % of municipal wastewater is being treated, while 5.3 % is being dumped to recipients with adequate aerobe treatment.

Protection and water management policy in the last few years prescribe various actions in order to improve the general requirements within this sector. The realisation of efficient and continuous measures requires a certain amount of time, as well as adequate encouragement and a penalty policy.

2.5.9. Health

Very little was invested in the health care system, including public health, in the 1990s (until 2000). This led to hospitals being in disrepair, obsolete equipment and health care staff having difficulties in obtaining professional development. All this might have negative effects both on health and on the ability of the health care service and the society as a whole to protect and improve the health of citizens.

According to the results of research „Burden of diseases and injures in Serbia", ischemic hart diseases, cerebrovascular diseases, lung cancer, unipolar depression and diabetes are almost two thirds of the overall burden calculated for 18 health disorders in Serbia in 2000.

The age index in Serbia was 51,5 in 1991 and 99,1 in 2002, indicating that the Serbian population continues to age.

The adopted bad habits (smoking, unhealthy diet, lack of exercise) are also risk factors for chronic communicable diseases

Since 2000, the area of integral planning of health care protection has seen some evident progress. A new health care policy was defined, putting an emphasis on health improvement, reducing health inequality and the importance of preventive and primary health care, as well as introducing concept of public health and principle „health in all (other) policies" which present challenge for all relevant sectors, especially with regard to climate change impact on health. However, environmental effects on the state of health in the Serbian population have not been sufficiently researched, nor is the existing research well organised. The effects of climate change impacts on health require systematic monitoring. Government adopted „Action plan for environment and children health" which envisage drafting of Action plan for health system reaction in cases of heat waves. Deadline for implementation of these activities is 2011. Although, Ministry of Health invests significant effort into the research of climate change impacts to human health in the last few years, the planning and development policy in the health care sector involves obtaining relevant and systematized data and detailed climate change impact analyses, which primarily require capacity building and raising the level of public awareness.

2.5.10. EDUCATION

Compulsory and free–of–charge primary education is provided for everyone under equal conditions by the Constitution, which is also regulated by the Law on the Foundations of Education and Upbringing and the Law on Elementary School of the Republic of Serbia. Since the school year 2006/07, pre–school education for children age six is also compulsory, this is by law an integral part of compulsory primary education with nine–year duration.

The Ministry of Education is main state institution in charge of education in the broadest sense, which among others includes planning and monitoring the development of education, overseeing the work of institutions, compliance with European educational systems, *etc*.

Beside Ministry of Education, responsible for development and quality of education are: Institute for Education Advancement, Institute for Evaluation of Education Quality, National Education Council, the Council for Higher Education and the Council for Vocational and Adult Education.

The education system in the school year 1998/99 (no data for Kosovo and Metohija) consisted of 3623 primary schools and 471 secondary schools. According to official data, 99.4 % of children complete primary school.

Institutions for higher education are divided into university institutions (universities and faculties, and art academies) and non–university education (academies, applied studies, higher education institutions and higher education institutions for applied studies). In Serbia, there are

7 state–founded universities covering 86 faculties, and additional 2 state faculties not belonging to any university. In addition, there are 7 private universities with 44 faculties, and 5 private faculties not belonging to any university. The number of non–university educational institutions is 49, of which 42 are state–founded and 7 are private. Compulsory education and secondary education are free and funded from the state budget of the Republic of Serbia, but parents and students have to cover the expenses for textbooks, stationery, school trips, *etc*. In higher education, students pay a tuition fee which is, however, waived for those who study with good results.

The literacy rate is 96.4 % of the population (men 98.9 %, women 94.1 %). The index of the educational rate of men and women is the highest among the population of uneducated people.

The percentage of the population with higher education has risen from the 1990s onwards. In 2002, the percentage of the population with higher education was about 6.5 % of the total population, which is 1 % more than in year 1991.

3. GREENHOUSE GAS INVENTORY INFORMATION

3. INVENTORY OF EMISSIONS OF GREENHOUSE GASES

3.1. INTRODUCTION

Since ratification of Convention until today, dedicated and systematic data collection on GHG emission was not done, which made inventory development demanding and complicate. Process of preparation of the GHG inventory is significant because it included many of national institutions and local experts, and provided consistent and relatively reliable data base which is necessary to further develop and improve.

With the aim of ensuring the sustainability of the process, the data bases produced during the process of preparation of the GHG inventory are located in the Environmental Protection Agency of the Republic of Serbia.

3.2. METHODOLOGY

The GHG inventory for the Republic of Serbia was prepared according to the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. In accordance with IPCC Guidelines and taking into account national circumstances in regard to the data availability, the Tier 1 Method was employed.

Under the framework of the Tier 1 Method, the internationally recommended values for net calorific values and emission factors for all fossil fuels (solid, liquid and gaseous) were used, except for the low calorific open pit mined lignite. Serbian lignite, due to its characteristics, has a significantly lower net calorific value and a higher emission factor value than the internationally recommended values.

In addition to the IPCC Guidelines, the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, IPCC, 2000, and Good Practice Guidance for Land Use, Land–Use Change and Forestry–GPG for LUCF, IPCC, 2003 were also used for the GHG inventory.

The primary source of the data for the GHG inventory was the Statistical Yearbooks of the Statistical Office of the Federal Republic of Yugoslavia and the Statistical Office of the Republic of Serbia and the Customs Office.

A team of national experts (representatives from various R & D institutions) worked on the GHG inventory, under the coordination of the Institute for Nuclear Sciences VINČA and in collaboration with representatives of government institutions. For each sector, and additionally for the energy sub–sectors, a team of 3 experts was formed who were in charge of acquisition, systematization, documentation and archiving of the data.

The validation of the input data as well as the output documents was performed by specifically appointed experts. The final control and the control of the partial (for each of the sub–sectors) input and calculated data was performed during the integration of the results into the overall inventory of the GHG emissions, for each analyzed year, using IPCC software (http://www.ipcc–nggip.iges.or.jp/public/gl.software.htm).

Taking into account UNFCCC/CP/2002/7/Add.2, Decision 17/CP.8 Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention, and the best available data, the Republic of Serbia prepared a national inventory for the year 1990, as the base year, covering GHG emissions from the energy sector, industrial processes, waste, agriculture, land–use change and forestry. In the course of the preparations for the inventory, all available data in the period 1990–1998 were analysed, but due to irregular working conditions in most sectors and years, and due to missing data, only data for the year

1998 are given, in accordance with the guidelines for national inventories for non-Annex I countries.

3.3. GREENHOUSE GAS (GHG) EMISSIONS AND REMOVALS IN 1990.

In this chapter, the total and sectoral emissions and removed amounts of carbon dioxide (CO_2), methan (CH_4) and nitrous oxide (N_2O) are shown for the base year 1990. The GHG emissions (total, sectoral and net values) are also expressed in CO_2equivalent taking into account the 1995 IPCC global warming potential (GWP) values: 1 for CO_2, 21 for CH_4 and 310 for N_2O. All the estimated values are given in UNFCCC standardized form (Table 3.1) including standard indicators as appropriate, for emissions by sources and removals by sinks of GHG: **NO** (not occurring) for activities that do not occur for a particular source/sink category in Serbia and **NE** (not estimated) for existing emissions and removals which were not estimated.

Republic of Serbia, Inventory Year 1990. Greenhouse gas emissions and removals IPCC Source and Sink Categories	**CO_2 emissions (Gg)**	**CO_2 removals (Gg)**	**CH_4 (Gg)**	**N_2O (Gg)**	**CO_2eq emissions (Gg)**
Total national emissions and removals	**62,970**	**-6,665**	**432.46**	**28.23**	**80,803**
1. Energy	**59,259**	**0**	**157.58**	**0.67**	**62,776**
A. Fuel combustion (sectoral approach)	59,259		13.66	0.67	59,753.5
1. Energy Industries	37,559		0.44	0.47	37,713.9
2. Manufacturing industries and construction	6,309		0.43	0.05	6,333.5
3. Transport	5,678		1.06	0.05	5,715.8
4. Other sectors	9,713		11.73	0.10	9,990.3
5. Other (please specify)	0		0	0	0
B. Fugitive emissions from fuels	0		143.92		3,022.3
1. Solid fuels			61.19		1,285
2. Oil and natural gas			82.73		1,737.3
2. Industrial processes	**3,711**	**0**	**0.53**	**1.77**	**4,270.8**
A. Mineral products	1,831				1,831
B. Chemical industry	268		0.53	1.77	827.8
C. Metal production	1,612		0	0	1,612
D. Other production	0		0	0	0
E. Production of halocarbons and sulphur hexafluoride					
F. Consumption of halocarbons and sulphur hexafluoride					
G. Other (please specify)	NE		NE	NE	NE
3. Solvent and other product use	**NE**			**NE**	
4. Agriculture			**194.13**	**25**	**11,827**
A. Enteric fermentation			158.68		3,332.3
B. Manure management			28.23	2.96	1,510.4
C. Rice cultivation			NO		
D. Agricultural soils				21.84	6,770.4
E. Prescribed burning of savannahs			NO	NO	NO
F. Field burning of agricultural residues			7.22	0.20	213.6
G. Other (please specify)			0	0	0
5. Land-use change and forestry [1]	**0**	**-6,665**	**0**	**0**	**-6,665**
A. Changes in forest and other woody biomass stocks	0	-6,764			
B. Forest and grassland conversion	99	0	0	0	
C. Abandonment of managed lands		NE			
D. CO_2 emissions and removals from soil	NE	NE			
E. Other (please specify)	NE	NE	NE	NE	NE
6. Waste			**80.22**	**0.79**	**1,929.5**
A. Solid waste disposal on land			80.22		1,684.6
B. Waste-water handling			NO	0.79	244.9
C. Waste incineration					NO
D. Other (please specify)			NE	NE	NE
7. Other (please specify)	**NE**	**NE**	**NE**	**NE**	**NE**
Memo items					
International bunkers	**459**		**0**	**0**	**459**
Aviation	459		0	0	459

		Marine	NE		NE	NE	NE
	CO_2 emissions from biomass		2,404				

Table 3.1. The GHG Emissions and Removed amounts, Republic of Serbia, 1990.

The analysis and calculations based on the available data show that the total GHG emissions in the Republic of Serbia in the referent year 1990 (not taking into account the amounts removed by forests) was 80,803 Gg (*i.e.*, thousands tons) CO_2eq.

The largest share, 77.69 % of the total emissions, *i.e.*, 62,776 Gg CO_2eq, came from the energy sector (IPCC Source Category 1), Figures 3.1. and 3.2.

The next in terms of contribution to the total GHG emissions was the agriculture sector (IPCC Source Category 4), which in 1990, due to the relatively intense agricultural production (biochemical processes in stockbreeding and farming), emitted 11,827 Gg CO_2eq or 14.64 % of the total GHG emissions.

The emission of GHG due to chemical reactions from industrial processes (IPCC Source Category 2), including production and consumption of mineral raw material such as cement, lime, limestone and sodium carbonate, production of chemicals (in the first place ammonia), iron and other metals, and other products was in the order of 4,270.8 Gg CO_2eq, *i.e.*, 5.28 % of the total GHG emissions.

The emission of GHG from municipal dumps and from sludge waste (IPCC Source Category 6) contributed the least to the total emissions in 1990 in the Republic of Serbia. These emissions were only 2.39 % of the total GHG emissions, *i.e.*, 1,929.5 Gg CO_2eq.

Taking into account that the assessed amount of the removed CO_2 by the forests (IPCC Source/Sink Category 5) in the Republic of Serbia in 1990 was in the order of 6,665 Gg CO_2eq, the net GHG emissions in the Republic of Serbia in 1990 were in the order of 74,138 Gg CO_2eq.

The GHG emissions by sectors (expressed in GgCO_2eq) are presented in Figure 3.1 and the shares of total GHG emissions by Sector/Sub–sector in the Republic of Serbia, in 1990, in Figure 3.2.

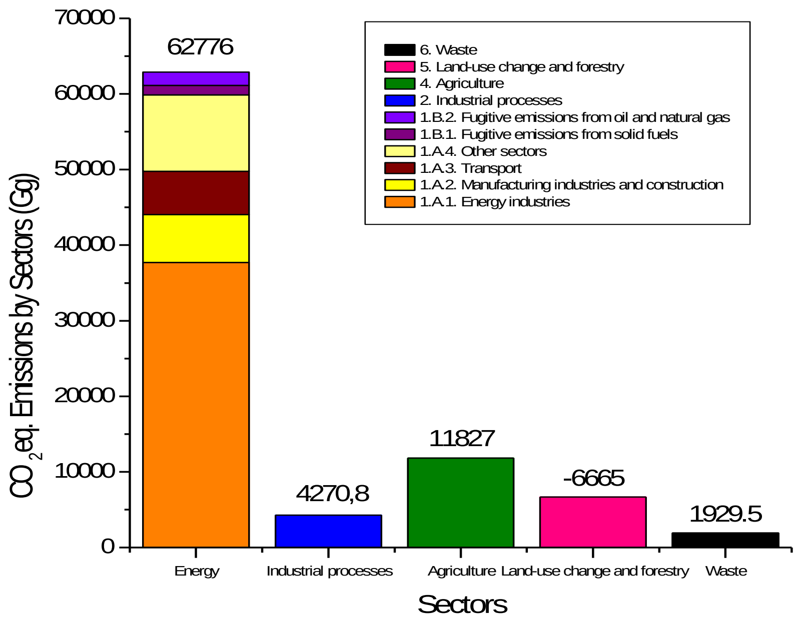
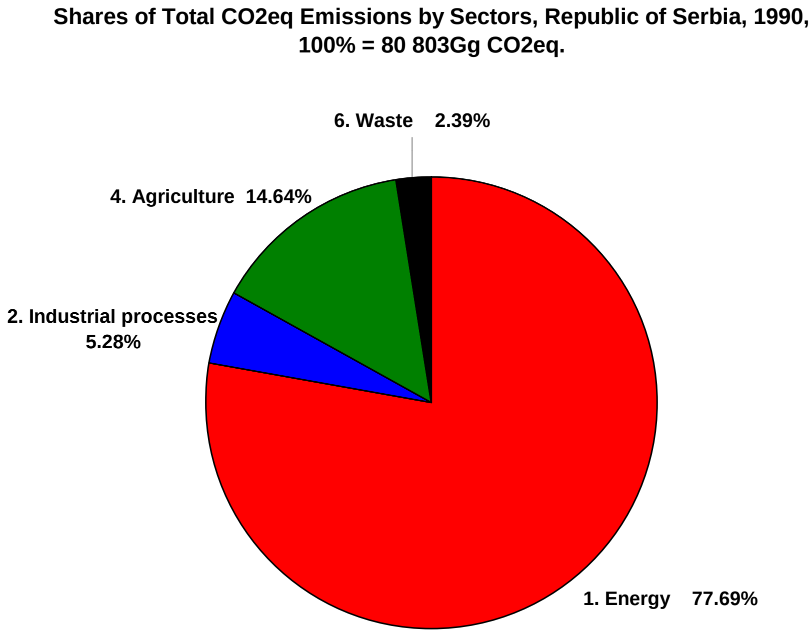


Figure 3.1. Greenhouse Gas Emissions (GHG) by Sector, Republic of Serbia, 1990



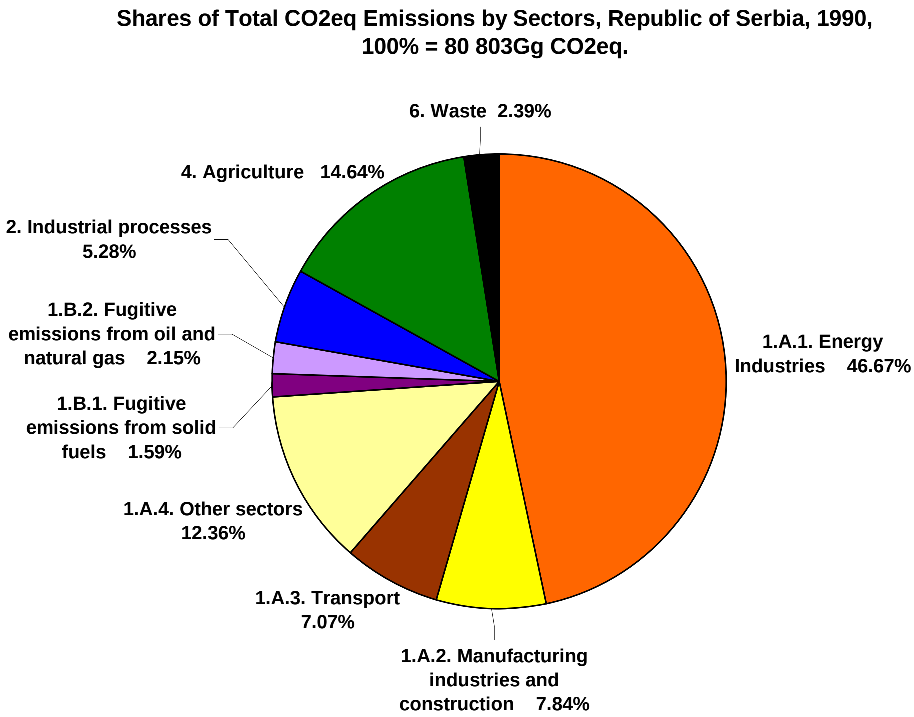


Figure 3.2. Shares of the Total GHG Emissions by Sector/Sub-sector, Republic of Serbia, 1990.

Since it is evident, according to the analysis and calculations, that the greatest contribution to the emissions in 1990 was a consequence of the emissions from the energy sector, special attention was devoted to this sector.

It may be shown that of the total GHG emissions from the energy sector 73.95 % (59,753.5 Gg CO_2eq) was emitted due to combustion of fossil fuels for energy purposes (IPCC Source Category 1.A) and 3.74 % (3022.3 Gg CO_2eq) through fugitive emissions during exploitation and processing/upgrading of the fossil fuels (IPCC Source Category 1.B).

Under the framework of IPCC energy sectors, as in general sectors defined by IPCC method, the greatest emissions were generated in the fossil fuel combustion sub-sector. Within this sub-sector, the energy industries (IPCC Source Category 1.A.1) emitted 46.67 % of the total emissions, *i.e.*, 37,713.9 Gg CO_2eq, of which 36,346.5 Gg CO_2eq, *i.e.*, 44.98 % were the emissions from power generation/heat production and only 1.69 % due to combustion of fossil fuels for energy/heat production, for the production/ processing of oil and gas, and for the upgrading of lignite (by drying).

Fossil fuel combustion in the IPCC Source Category 1.A.4 Other sectors (Public/Commercial, Residential and Agricultural sub-sectors) contributed to the emissions in the order of 9,990.3 Gg of CO_2eq, *i.e.*, 12.36 % of the total GHG emissions.

Due to fossil fuel combustion in the manufacturing industries and construction (IPCC Source Category 1.A.2) were emitted 6,333.5 Gg CO_2eq, i.e., 7.84 % of the total GHG emissions.

At the same time, fossil fuel combustion in the Transport sector (IPCC Source Category 1.A.3) emitted 5,715.8 Gg CO_2eq, *i.e.*, 7.07 % of the total GHG emissions including Road transport (IPCC Source Category 1.A.3.b) with 5,463.3 Gg CO_2eq, *i.e.*, 6.76 % and other modes of transport with 252.5 Gg CO_2eq, *i.e.*, 0.31 % of total GHG emissions.

3.4. CARBON DIOXIDE (CO_2) EMISSIONS IN 1990

The total carbon dioxide emission in the Republic of Serbia in 1990 was 62,970 Gg (not including the 99 Gg of CO_2 emitted as a result of conversion processes by forest fires).

These emissions originated as a result of fossil fuel combustion in the energy sector (IPCC Source Category 1.A.2), 59,259 Gg, *i.e.*, 94.11 % of the total CO_2 emissions and chemical reactions in industrial processes (IPCC Source Category 2), 3,711 Gg, *i.e.*, 5.89 % of the total CO_2 emissions), Figure 3.3. From Table 3.1 and Figure 3.4, it may be seen that the greatest emissions of CO_2 in 1990 originated from the Energy industries, related to energy transformation (IPCC Source Category 1.A.1), 37,559 Gg, *i.e.*, 59.65 % of the total CO_2 emissions.

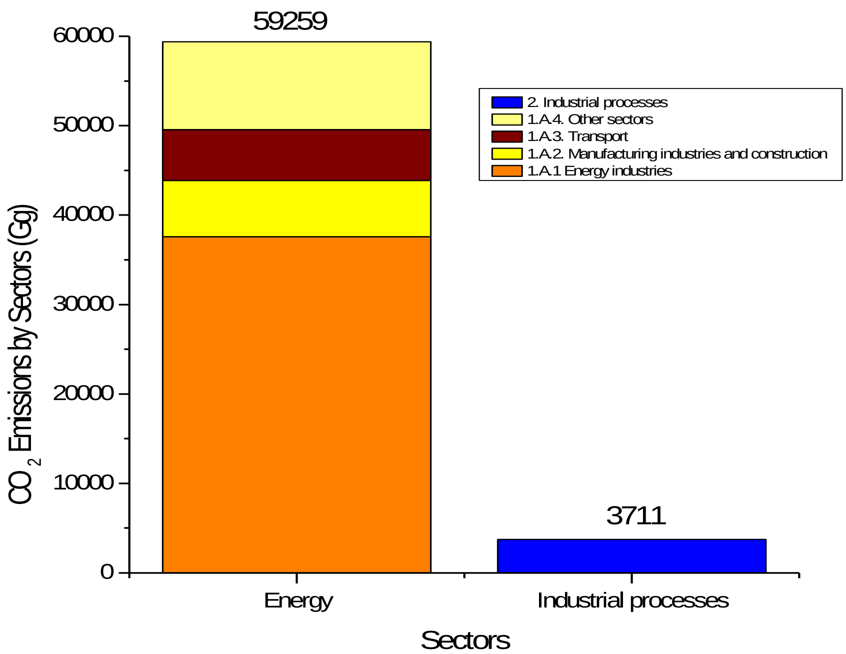


Figure 3.3. CO_2 Emissions by Sector/Sub-sector, Republic of Serbia, 1990.

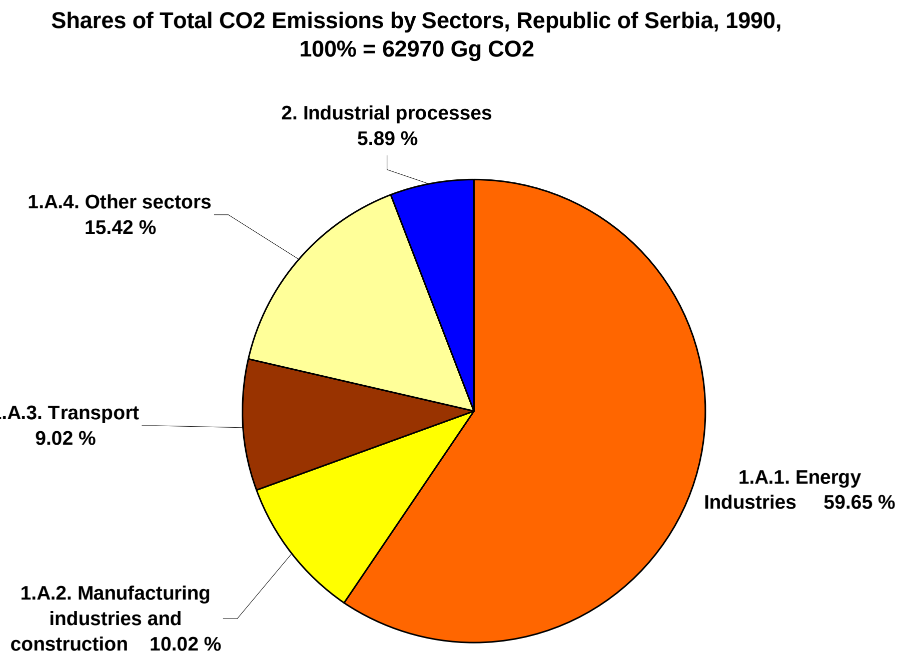


Figure 3.4. Shares of Total CO_2 Emissions by Sector/Sub–sector, Republic of Serbia, 1990.

The greatest part of these emissions were from Public power generation/heat production (IPCC Source Category 1.A.1.a), 36,202.7 Gg, *i.e.*, 57.49 % of the total CO_2 emissions).

By the combustion of fossil fuels, the Other sectors (IPCC Source Category 1.A.4), including the Public/Commercial, Residential and Agricultural sector, emitted 9,713 Gg, *i.e.*, 15.42 %, and the Manufacturing industries and Construction (IPCC Source Category 1.A.2) emitted 6,309 Gg, *i.e.*, 10.0 % of the total CO_2 emissions.

The Transport sector (IPCC Source Category 1.A.3) emitted 5,678 Gg, *i.e.*, 9.0 % of the total CO_2 emissions in 1990.

Although only a minor part of the total emissions in 1990 originated as a consequence of chemical reactions in industrial processes, it is significant to note that most of these emissions (1,831 Gg or 2.91 % of the total CO_2 emissions) was achieved by production/consumption of mineral products (IPCC Source Category 2.A) such as cement, lime, limestone and sodium carbonate. A somewhat lower emission (1,612 Gg, *i.e.*, 2.56 %) occurred from the production of iron and other metals (IPCC Source Category 1.C), while the smallest emissions occurred from the chemical industry (IPCC Source Category 1.B), mainly from the production of ammonia (268 Gg, *i.e.*, 0.4 %).

The assessed net amount of CO_2 removed in the forest complex (IPCC Source Category 5) in 1990 was 6, 665 Gg CO_2.

3.5. METHANE (CH_4) EMISSIONS I IN 1990.

The total methane emissions in 1990 were estimated at the level of 432.46 Gg. Methan emissions by sectors are shown in Figure 3.5.

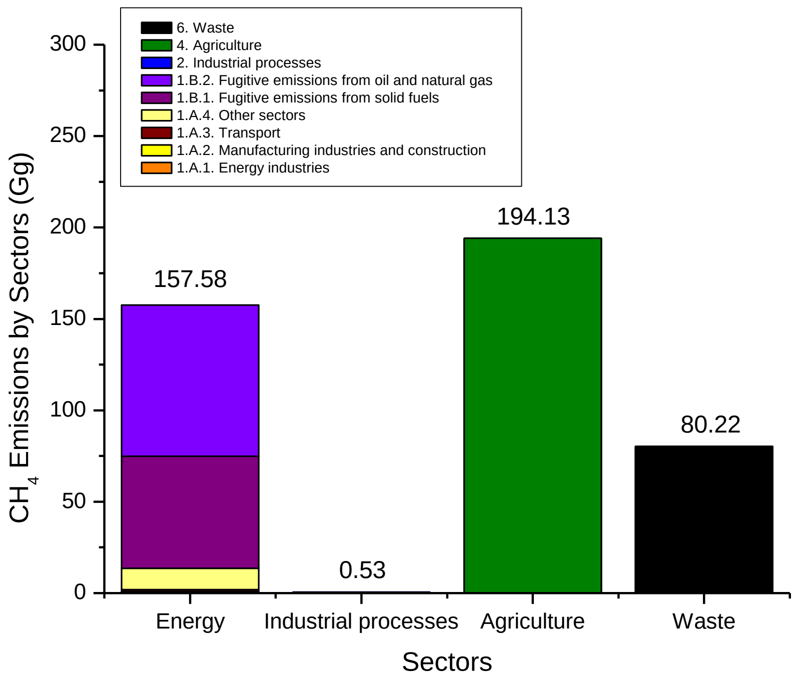


Figure 3.5. Methane (CH_4) Emissions by Sector, Republic of Serbia, 1990.

The greatest part, 194.13 Gg, *i.e.*, 44.89 % of the total CH_4 emissions, occurred from biochemical processes in the agriculture sector (IPCC Source Category 4).

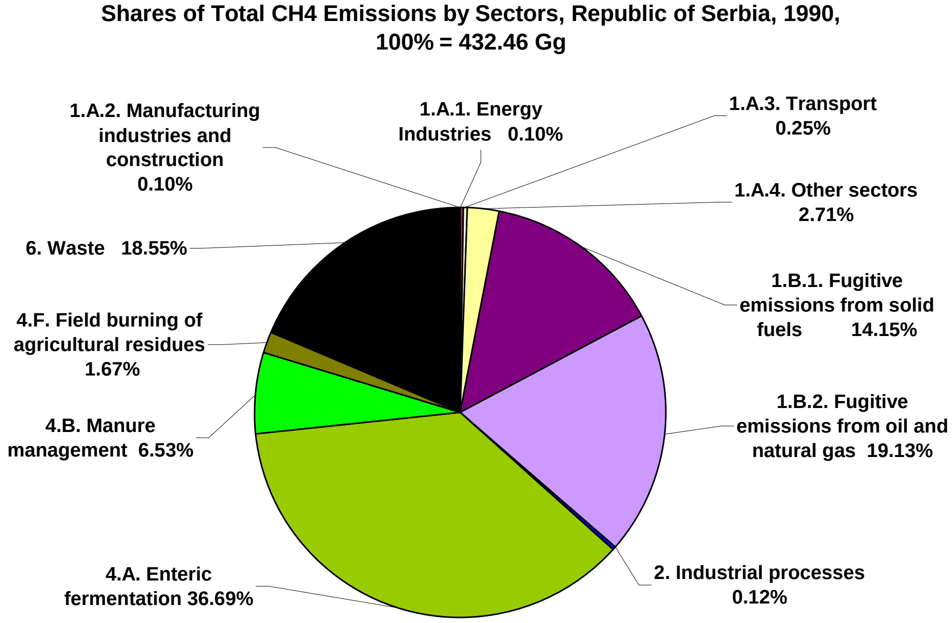


Figure 3.6. Shares of the Total CH_4 Emissions by Sector/Sub-sector, Republic of Serbia, 1990.

The energy sector (IPCC Source Category 1) followed, with 157.58 Gg *i.e.*, 36.44 % of the total CH_4 emissions. Fugitive emissions during the production and processing/upgrading of fossil fuels (IPCC Source Category 1.B) amounted to 143.92 Gg, *i.e.*, 33.28 %, while 13.66 Gg (3.16%) was released due to fossil fuel combustion for energy purposes (IPCC Source Category 1.A).

The contribution of the waste sector (IPCC Source Category 6) or in other words, biochemical processes, related to waste management, contributed to the total emissions of CH_4 with 18.55 % (80.22 Gg).

The lowest contribution, 0.12 % (0.53 Gg) of the total CH_4 emissions in 1990, arose from chemical reactions in Industrial processes (IPCC Source Category 2).

3.6. NITROUS OXIDE (N_2O) EMISSIONS IN THE REPUBLIC OF SERBIA IN 1990.

The total emission of nitrous oxide in 1990 was estimated to be 28.23 Gg.

Four sectors: Agriculture (IPCC Source Category 4), Industrial Processes (IPCC Source Category 2), Waste (IPCC Source Category 6) and Energy (IPCC Source Category 1) contributed to the total emission of nitrous oxide in 1990 (Figures 3.7. and 3.8.).

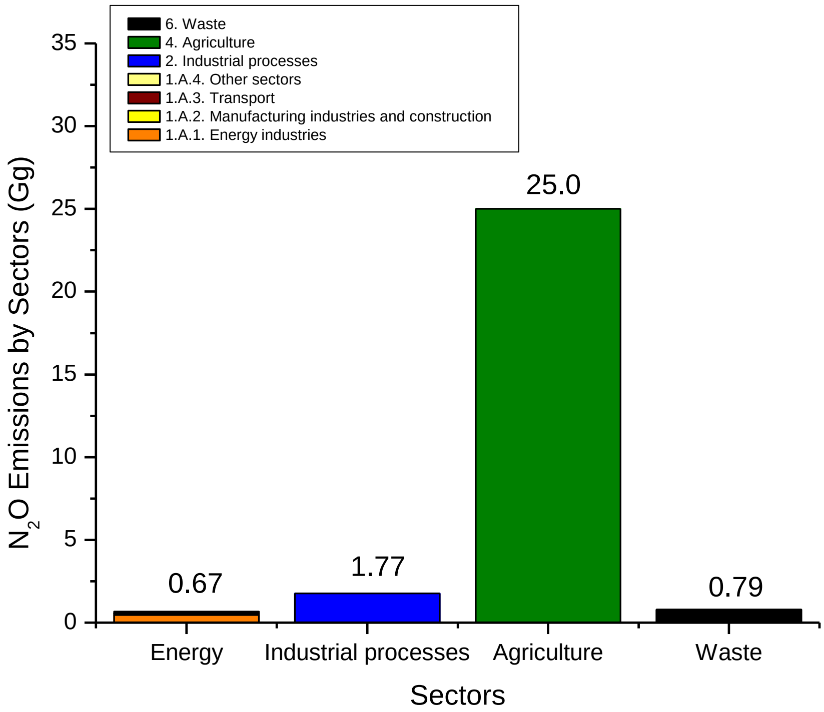


Figure 3.7. N_2O Emissions by Sector, Republic of Serbia, 1990.

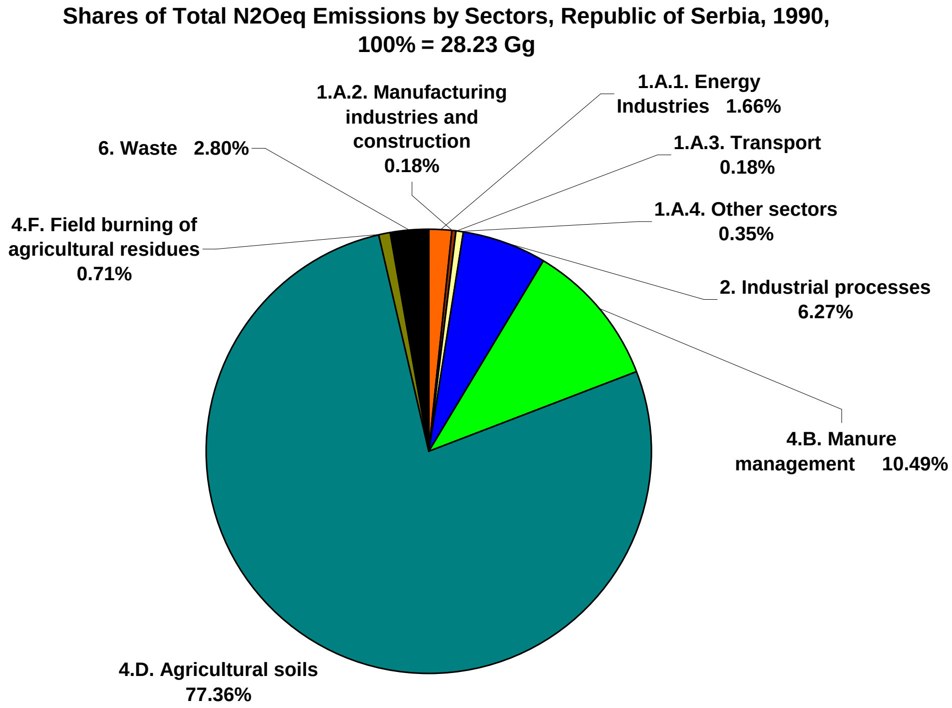


Figure 3.8. Shares of the Total N_2O Emissions by Sector/Sub-sector, Republic of Serbia, 1990.

The largest part of the total N_2O emissions occurred from biochemical processes in agriculture (IPCC Source Category 4), 25 Gg, *i.e.*, an 88.55% share in the total N_2O emissions, mostly resulting from the use of fertilizers (21.84 Gg).

Considerably smaller parts of the total emissions originated from industrial processes (IPCC Source Category 2), in the order of 1.77 Gg, by biochemical processes during the decay of waste (IPCC Source Category 6), in the order of 0.79 Gg, and during combustion of fossil fuels in the energy sector (IPCC Source Category 1), in the order of 0.67 Gg.

3.7. EMISSION OF SYNTHETIC GHG IN 1990

According to the available data, there was no production of synthetic gases (halogenic hydrocarbons: HFC and PFC, or sulphur hexafluoride SF_6) in the Republic of Serbia in 1990.

In the available official documents, there is no record of import and consumption, *i.e.*, the available amounts of synthetic gases, and thus the related emissions could not be estimated according to the international method.

Certain data necessary for determining the emissions of these gases exist starting with the year 2004.

3.8. EMISSIONS OF INDIRECT GHG (NO_X, CO, NMVOC, AND SO_X) IN 1990

The results of the inventory of the indirect GHG (NO_x, CO, NMVOC, and SO_x) in the Republic of Serbia in 1990 are shown in accordance with the requirements of the UNFCCC Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention (Table 3.2).

Republic of Serbia, Inventory Year 1990. Indirect Greenhouse gases – Source and sink categories	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)
Total national emissions	**208**	**644**	**271**	**490**
1. Energy	**197**	**489**	**114**	**466**
A. Fuel combustion (sectoral approach)	197	488	85	461
1. Energy Industries	95	7	2	325
2. Manufacturing industries and construction	18	4	1	54
3. Transport	57	376	71	7
4. Other sectors	27	100	12	76
5. Other (please specify)	0	0	0	0
B. Fugitive emissions from fuels	0	0	29	5
1. Solid fuels	0	0	0	0
2. Oil and natural gas	0	0	29	5
2. Industrial processes	**3**	**2**	**157**	**24**
A. Mineral products	0	0	137	1
B. Chemical industry	3	1	1	22
C. Metal production	0	0	0	0
D. Other production	0	1	19	1
E. Production of halocarbons and sulphur hexafluoride				
F. Consumption of halocarbons and sulphur hexafluoride				
G. Other (please specify)	0	0	0	0
3. Solvent and other product use			**NE**	
4. Agriculture	**7**	**152**	**0**	**0**
A. Enteric fermentation				
B. Manure management			0	
C. Rice cultivation			NO	
D. Agricultural soils			0	
E. Prescribed burning of savannahs	NO	NO	NO	
F. Field burning of agricultural residues	7	152	0	
G. Other (please specify)	0	0	0	
5. Land-use change and forestry [1]	**0**	**1**	**0**	**0**
A. Changes in forest and other woody biomass stocks				
B. Forest and grassland conversion	0	1		
C. Abandonment of managed lands				
D. CO_2 emissions and removals from soil				
E. Other (please specify)	NE	NE		
6. Waste	**0**	**0**	**0**	**0**
A. Solid waste disposal on land	0		0	
B. Waste-water handling	0	0	0	
C. Waste incineration	NO	NO	NO	NO
D. Other (please specify)	NE	NE	NE	NE
7. Other (please specify)	**0**	**0**	**0**	**0**
Memo items				
International bunkers	**2**	**1**	**0**	**0**
Aviation	2	1	0	0
Marine	NE	NE	NE	NE
CO_2 emissions from biomass				

Table 3.2 Emission of indirect GHG, Republic of Serbia, 1990

The analysis of the results, *i.e.*, the contribution of specific sectors to the total emissions per counted indirect GHG is given in the forthcoming text of this chapter.

3.8.1. NITRIC OXIDE (NO_X) EMISSIONS IN 1990

The contribution of key sectors to the total emissions of nitrogen oxides (disregarding nitrous oxide), which was estimated to be in the order of 208 Gg in 1990, are presented in Figures 3.9 and 3.10.

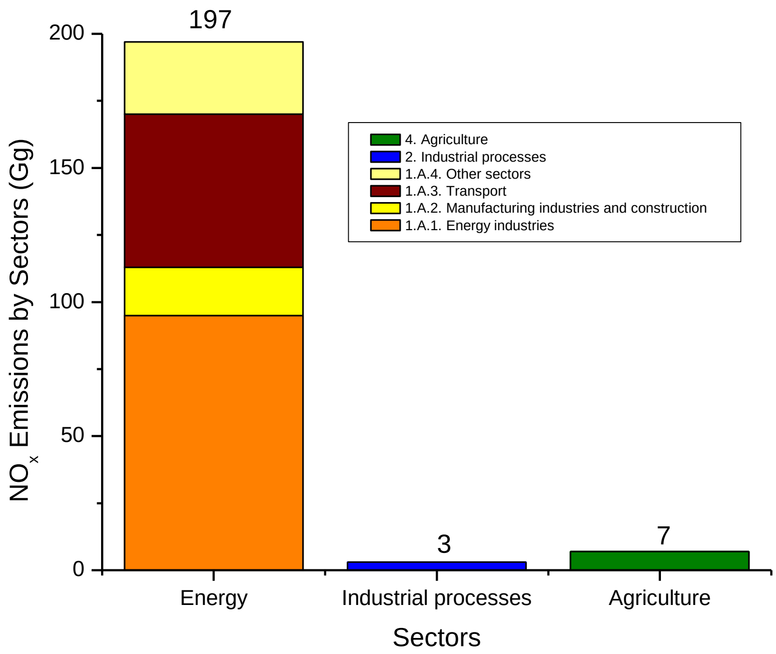


Figure 3.9. NO_x Emissions by Sectors, Republic of Serbia, 1990.

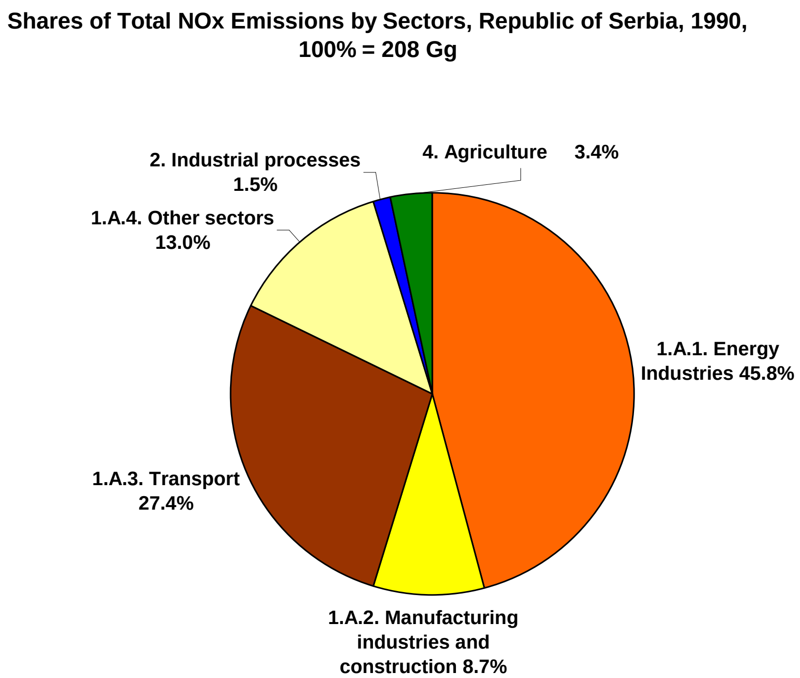


Figure 3.10. Shares of Total NOx Emissions by Sector/Sub-sector, Republic of Serbia, 1990.

The energy sector (IPCC Source Category 1) dominated the emissions of NO_x, emitting 197 Gg, *i.e.*, 95 % share of the total emissions, with the following key sub–sectors also contributing: Energy industries (IPCC Source Category 1.A.1) emitted 95.28 Gg with a 45.8 % share of the total NO_x emissions, Public electricity and heat production (IPCC Source Category 1.A.1.a) emitted 91.13 Gg with a 43.81 % share of the total NO_x emissions, Petroleum Refining (IPCC Source Category 1.A.1.b) emitted 3.44 Gg and Manufacturing/processing and upgrading of solid fossil fuels (IPCC Source Category 1.A.1.c), 0.71 Gg. Transport sector (IPCC Source Category 1.A.3) emitted 57 Gg, *i.e.*, 27.4 %; the Other sectors (IPCC Source Category 1.A.4) including the Commercial/Institutional, Residential and Agriculture sector, emitted 27 Gg, *i.e.*, 13 %, while Manufacturing industries and construction sector (IPCC Source Category 1.A.2) emitted 18 Gg or 8.7 % of the total NO_x emissions.

The remaining amount was generated in agriculture during field burning of biomass leftovers of field production (IPCC Source Category 4.F), 7 Gg or 3.4 % and in industrial processes/chemical industry (IPCC Source Category 2.B) 3 Gg or 1.5 %.

3.8.2. CARBON MONOXIDE (CO) EMISSIONS IN 1990

The contribution of key sectors to the total CO emissions, which was estimated in the order of 644 Gg CO in 1990, are presented in Figures 3.11 and 3.12

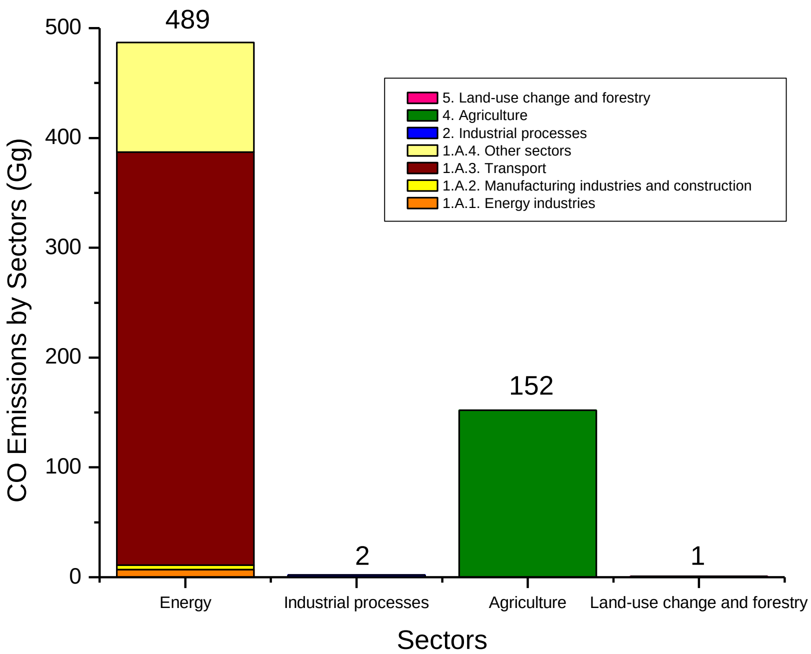


Figure 3.11 Carbon monoxide Emissions by Sector, Republic of Serbia, 1990.

The dominant share, 75.9 %, of the total CO emissions emanated from the energy sector (IPCC Source Category 1.A), amounting to 489 Gg, with the following key sub–sectors also contributing: Transport sector (IPCC Source Category 1.A.3) emitted 376 Gg, *i.e.*, 58.4 %; the Other sectors (IPCC Source Category 1.A.4) including the Commercial/Institutional, Residential and Agriculture sector, emitted 100 Gg, *i.e.*, 15.53 %; the Energy industries (IPCC Source Category 1.A.1) emitted 7 Gg with a 1.09 % share of the total CO emissions; the Manufacturing industries and construction sector (IPCC Source Category 1.A.2) emitted 4 Gg or 0.62 % of the total CO emissions.

The remaining amounts of CO were mostly generated by field burning of biomass waste from agricultural field production (IPCC Source Category 4.F), 23.6 % or 152 Gg, while 0.31 % or 2 Gg was emitted due to chemical processes in industrial facilities (IPCC Source Category 2.).

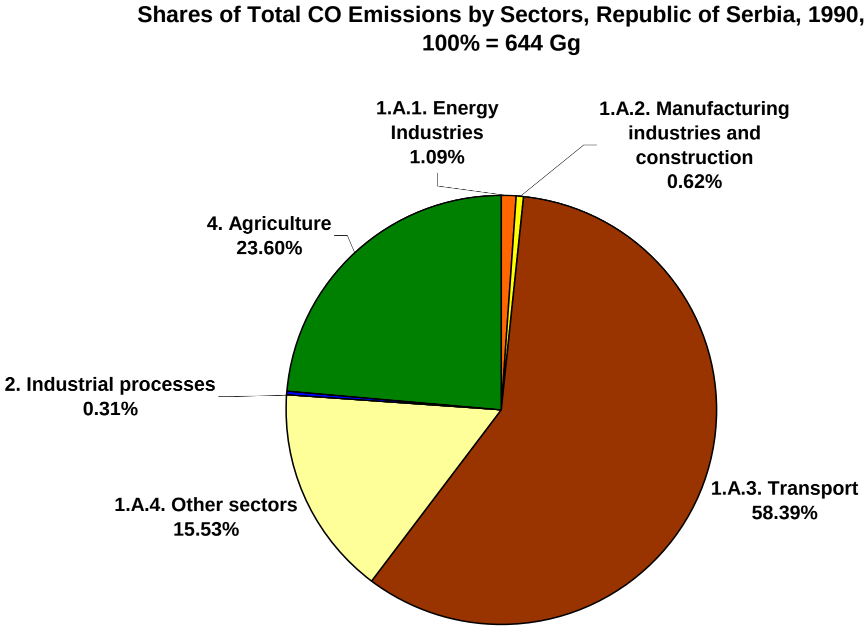


Figure 3.12. Shares of Total CO Emissions by Sector/Sub-sector, Republic of Serbia, 1990.

3.8.3. Non-Methane Volatile Organic Compounds (NMVOCs) Emissions in 1990

The contribution of key sectors to the total NMVOCs emissions are presented in Figures 3.13 and 3.14. The total NMVOCs emission in 1990 was 271 Gg.

The greatest contribution to these emissions, in the order of 157 Gg, originated from industrial processes (IPCC Source Category 2), amounting to 57.9 % share of the total NMVOCs emissions.

From the industrial processes, the dominant emissions with 50.5 % share in total NMVOCs emissions (137 Gg) emanated due to asphalting of roads (IPCC Source Category 2.A.6), followed by 7 % (19 Gg) from the food industry/liquor and food production (IPCC Source Category 2.D.2), and the chemical industry (IPCC Source Category 2.B) 1 Gg, *i.e.*, 0.4 %.

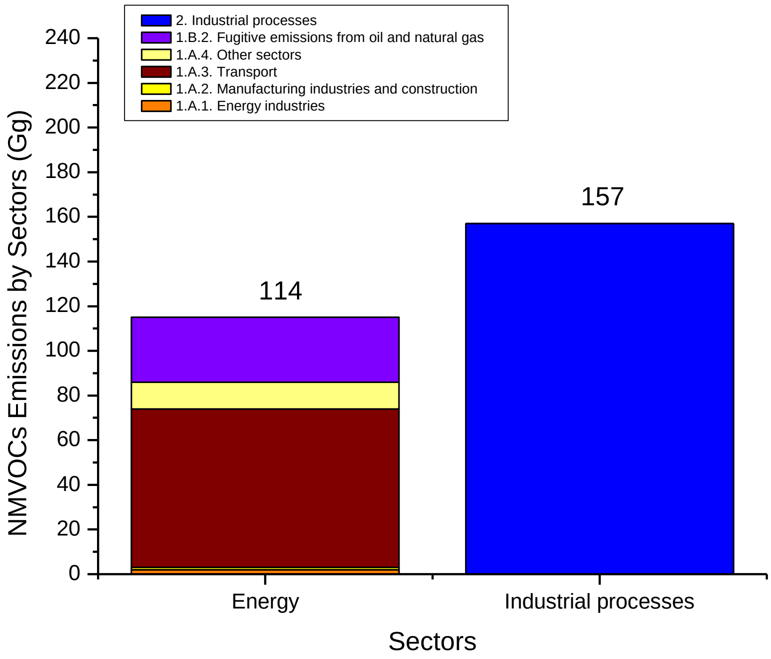


Figure 3.13 NMVOCs Emissions by Sectors, Republic of Serbia, 1990.

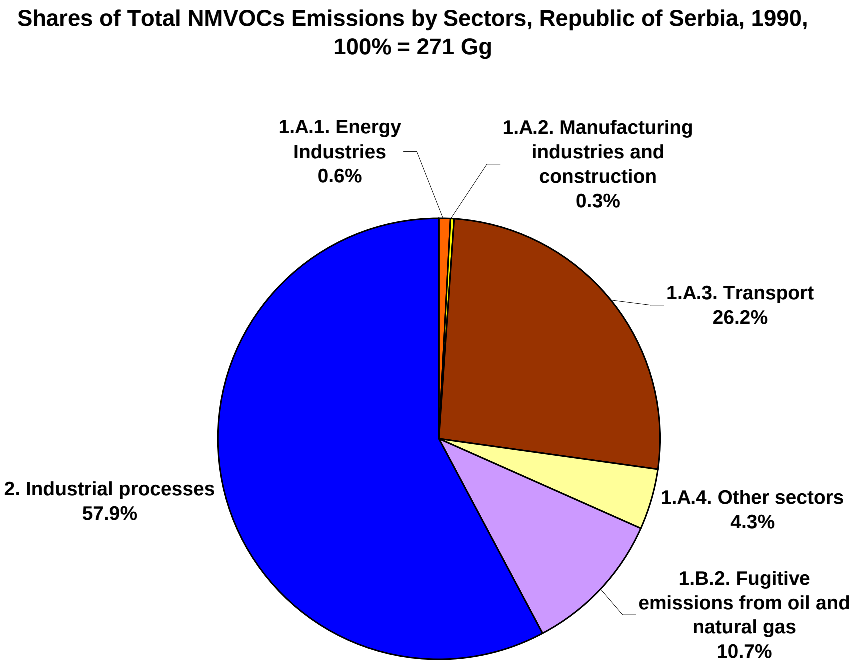


Figure 3.14. Shares of Total NMVOCs Emissions by Sector/Sub-sector, Republic of Serbia, 1990.

The use of fossil fuels in the energy sector (IPCC Source Category 1) resulted in NMVOC emissions in the order of 114 Gg, *i.e.*, 42.1 % of the total NMVOCs emissions.

Key sub-sectors are: Transport (IPCC Source Category 1.A.3) with 26.2 % share in the total NMVOCs emissions (71 Gg); Fugitive emissions due to exploitation and processing/upgrading of fossil fuels (IPCC Source Category 1.B.2), 10.7 % (29 Gg); Other sectors (IPCC Source Category 1.A.4), 4.3 % (12 Gg); Energy industries (IPCC Source Category

1.A.1), 0.6 % (2 Gg) and Manufacturing industries and construction (IPCC Source Category 1.A.2), 0.3 % (1 Gg).

3.8.4. SULPHUR OXIDES (SO_X) EMISSIONS IN 1990

The total emission of the sulphur oxides in the Republic of Serbia in 1990 was in the order of 490 Gg.

The largest share, 95.1 % (466 Gg), of the total sulphur oxides emissions resulted from fossil fuel production/combustion in the energy sector (IPCC Source Category 1).

The key energy sub–sectors (Figures 3.15 and 3.16) are: Energy industries (IPCC Source Category 1.A.1) with 66.3 % share in total SO_x emissions (326 Gg SO_x) of which Public electricity and heat production (IPCC Source Category 1.A.1.a) emitted 314.13 Gg with a 64.1% share of the total SO_x emissions and remaining (representing 2.2 %) in Petroleum Refining (IPCC Source Category 1.A.1.b) and Manufacturing/processing and upgrading of solid fossil fuels (IPCC Source Category 1.A.1.c). Other sectors (IPCC Source Category 1.A.4) emitted 76 Gg or 15.5 %, Manufacturing industries and construction emitted 54 Gg or 11.0 % while Transport sector emitted 7 Gg or 1.4 % and Fugitive emissions (IPCC Source Category **1.B.2**) 5Gg or 1% of the total SO_x emissions in the Republic of Serbia in 1990.

The remaining 4.8 % of the total SO_x emissions, *i.e.*, 24 Gg came from Industrial processes/chemical industry, mainly from sulphuric acid production (IPCC Source Category 1) and, to a lesser extent from other industrial processes (IPCC Source Category 2.A and 2.D).

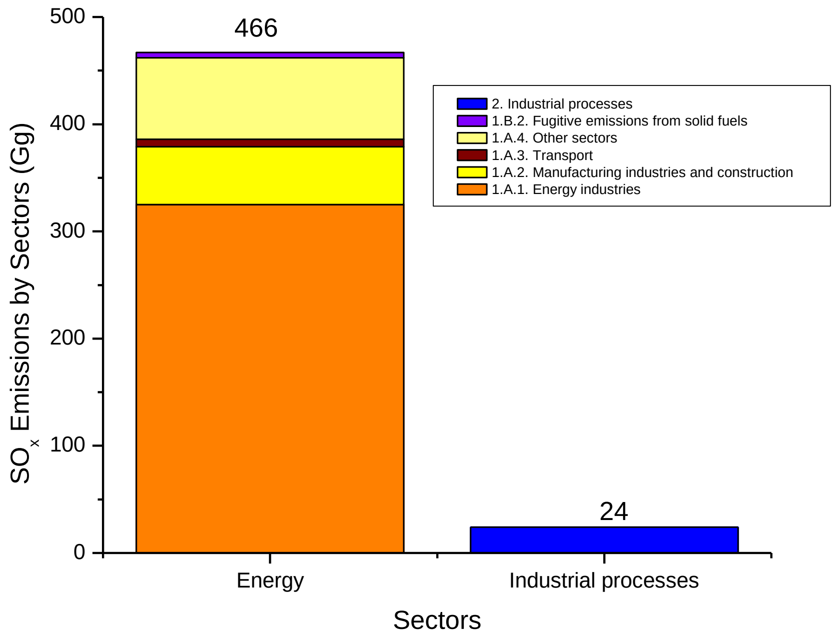


Figure 3.15. Sulphur oxides (SO_x) Emission by Sector/Sub–sector, Republic of Serbia, 1990.

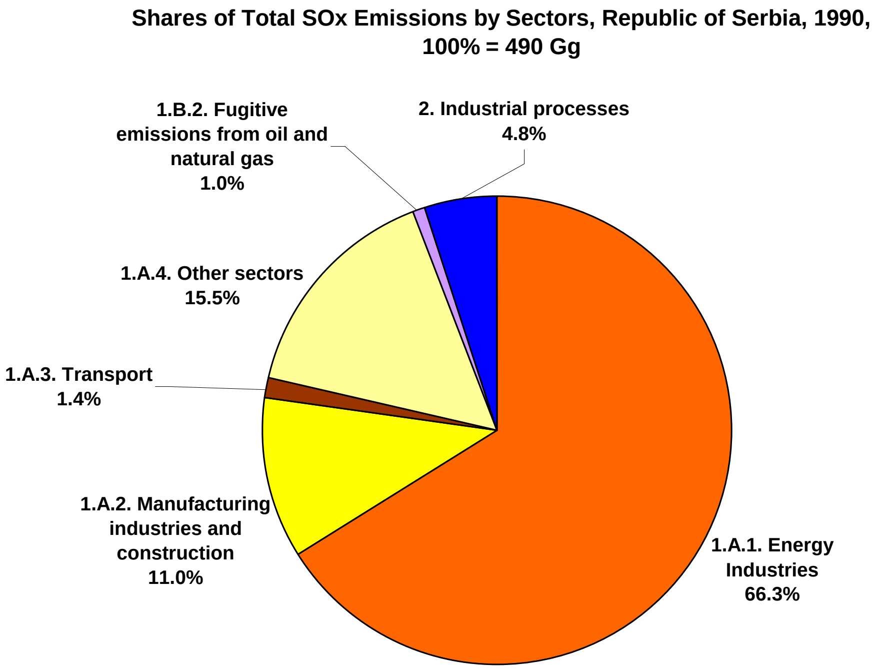


Figure 3.16. Shares of Total SOx Emissions by Sector/Sub-sector, Republic of Serbia, 1990.

3.9. EMITTED AND REMOVED AMOUNTS OF GHG IN 1998

In this chapter, the total and sectoral emissions as well as the removed amounts of CO_2, CH_4 and N_2O in the Republic of Serbia for the year 1998 are shown. In addition, the net emissions of all gases, expressed as CO_2equivalent, are given. All the mentioned values are presented in the UNFCCC standardized form (Table 3.3). Besides the values of the emissions per source and gas, in some cases, notation keys are given in Table 3.3 in the form of standard indicators: NO (not occurring) for emissions from sources that do not exist in the Republic of Serbia and NE (not estimated) for emissions from sources that were not assessed.

The analysis and calculations using the available data show that the total emissions of GHG in the Republic of Serbia in 1998, disregarding the net removed amounts of CO_2 in forests, amounted to 66,346 Gg CO_2eq.

Republic of Serbia, Inventory Year 1998. Greenhouse gas emissions and removals IPCC Source and Sink Categories	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO_2eq emissions (Gg)
Total national emissions and removals	**50,605**	**-8,661**	**424.52**	**22.02**	**66,346**
1. Energy	**47,430**	**0**	**140.57**	**0.54**	**50,549**
A. Fuel combustion (sectoral approach)	47,430		8.12	0.54	47,768
1. Energy Industries	34,675		0.39	0.43	34,816
2. Manufacturing industries and construction	3,434		0.23	0.02	3,445
3. Transport	3,852		0.71	0.03	3,876
4. Other sectors	5,469		6.78	0.05	5,627
5. Other (please specify)	0		0	0	0
B. Fugitive emissions from fuels	0		132.45		2,781
1. Solid fuels			56.13		1,179
2. Oil and natural gas			76.32		1,603
2. Industrial processes	**3,176**	**0**	**0.63**	**1.39**	**3,620**
A. Mineral products	1,514				1,514
B. Chemical industry	257		0.63	1.39	701
C. Metal production	1,404		0	0	1,404
D. Other production	0		0	0	0
E. Production of halocarbons and sulphur hexafluoride					
F. Consumption of halocarbons and sulphur hexafluoride					
G. Other (please specify)	**NE**		**NE**	**NE**	**NE**
3. Solvent and other product use	**NE**			**NE**	
4. Agriculture			**167.61**	**19.29**	**9,500**
A. Enteric fermentation			135.37		2,843
B. Manure management			25.77	2.58	1,341
C. Rice cultivation			NO		
D. Agricultural soils				16.52	5,121
E. Prescribed burning of savannahs			NO	NO	NO
F. Field burning of agricultural residues			6.47	0.19	195
G. Other (please specify)			0	0	0
5. Land-use change and forestry [1]	**0**	**-8,661**	**0**	**0**	**0**
A. Changes in forest and other woody biomass stocks	0	- 8,661			
B. Forest and grassland conversion	NE	NE 0	NE	NE	NE
C. Abandonment of managed lands		NE			
D. CO_2 emissions and removals from soil	NE	NE			
E. Other (please specify)	NE	NE	NE	NE	NE
6. Waste			**115.71**	**0.8**	**2,678**
A. Solid waste disposal on land			115.71		2,430
B. Waste-water handling			0	0.8	248
C. Waste incineration					NO
D. Other (please specify)			NE	NE	NE
7. Other (please specify)	**NE**	**NE**	**NE**	**NE**	**NE**
Memo items					
International bunkers	**186**		**0**	**0**	**186**
Aviation	186		0	0	186
Marine	NE		NE	NE	NE
CO_2 emissions from biomass	**1,815**				

Table 3.3. Emitted and removed amounts of GHG in the Republic of Serbia in 1998.

The greatest share in the total emissions, amounting to 76.19% (50,549 Gg CO_2eq), was contributed by the energy sector (IPCC Source Category 1), Figure 3.17 and 3.18.

The agriculture sector (IPCC Source Category 4) was ranked second according to its contribution, which amounted to 14.32 % of the total emissions, *i.e.*, 9,500 Gg CO_2eq (Figure 3.18). The emissions from this sector resulted from a relatively intensive agricultural production (biochemical processes in stockbreeding and farming).

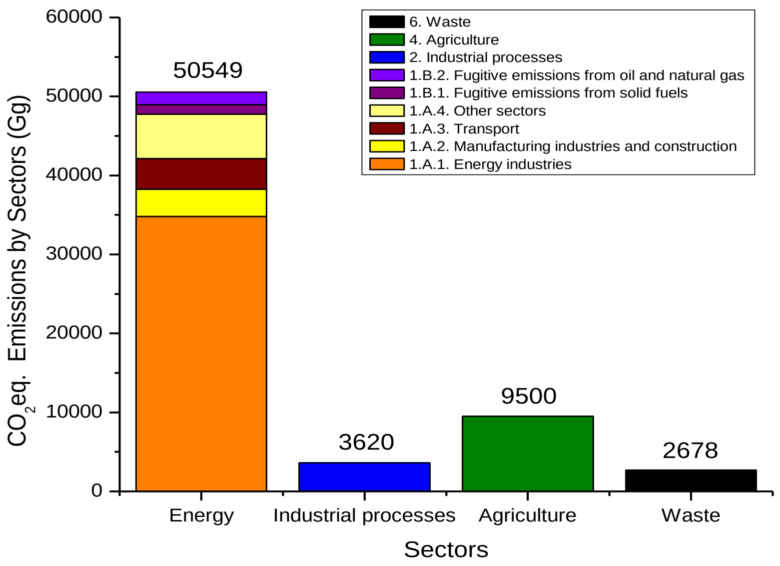
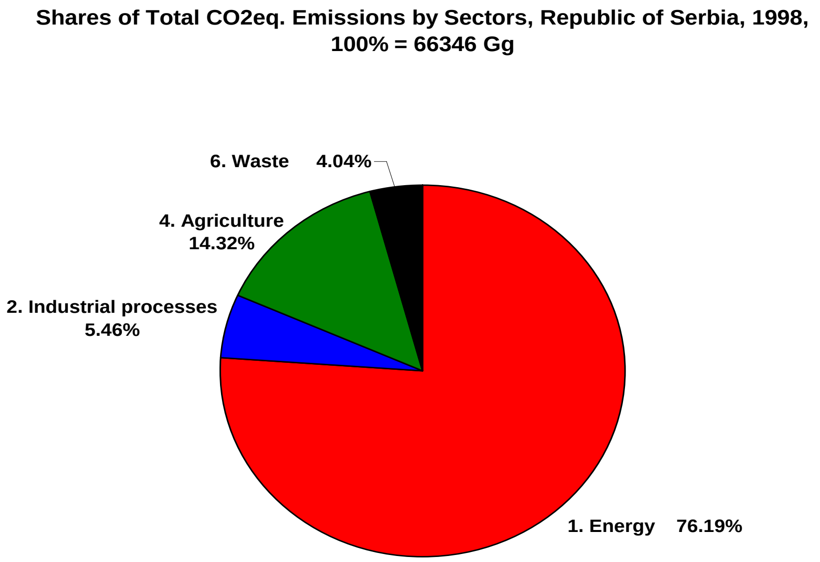


Figure 3.17. Greenhouse Gas Emissions (GHG) by sector, Republic of Serbia, 1998.

The sector of industrial processes (IPCC Source Category 2) (production and consumption of mineral raw materials such as cement, lime, limestone and sodium carbonate, production of chemicals, mainly ammonia, iron and other metals and others) participated in the total yearly emissions with 5.46 %, *i.e.*, with total sectoral GHG emissions of 3,620 Gg CO_2eq in 1998.



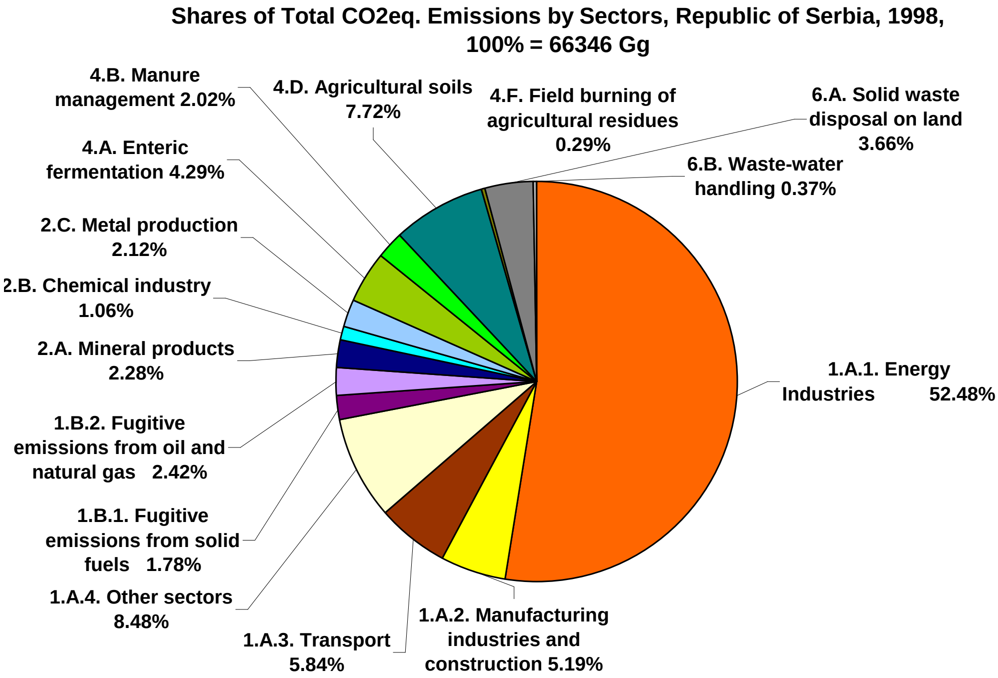


Figure 3.18. Shares of Total GHG Emissions by Sector/Sub–sector, Republic of Serbia, 1998.

As was the case in 1990, the least emissions in 1998 emanated from the communal garbage dumps and sludge waste (IPCC Source Category 6). The total contribution of this sector to the total GHG emissions was 4.04 % or 2,678 Gg CO_2eq.

Since the estimated amount of the removed CO_2 in 1998 in the forest complex of the Republic of Serbia was 8,661 Gg CO_2eq, the net emissions of GHG for the year 1998 in the Republic of Serbia amounted to 57,685 Gg CO_2eq.

During the analysis and calculations, particular attention was devoted to the energy sector as the greatest emitter in the Republic of Serbia, both in 1990 and in 1998. The emissions from the energy sector were primarily a consequence of the combustion of fossil fuels for energy production (IPCC Source Category 1.A), which amounted to 72.0 % or 47,768 Gg CO_2eq, and to a significantly lesser extent as a result of fugitive emissions due to the exploitation and processing/upgrading of fossil fuels (IPCC Source Category 1.B), which amounted to 4.2 % or 2,781 Gg CO_2eq.

Among the sub–sectors that combust fossil fuels to realise their production, the greatest emissions emanated from the energy industry (IPCC Source Category 1.A.1), *i.e.*, 34,816 Gg CO_2eq or 52.48 % of the total GHG emissions. Of the energy industries, most emissions emanated from the production of electricity/heat in the public sector (IPCC Source Category 1.A.1.a), amounting to 50.64 %, while the remaining 1.84 % resulted from production on oil and gas fields and their refining, as well as processing/upgrading of raw lignite by drying.

The combustion of fossil fuels needed to carry out the activities in “Other sectors”, *i.e.*, the Public, Commercial, Residential and Agricultural sector (IPCC Source Category 1.A.4), emitted 5,627 Gg CO_2eq, which is 8.48 % of the total GHG emissions.

Out of the total GHG emissions, 5.19 % was emitted by combustion of fossil fuels in the industrial sectors (IPCC Source Category 1.A.2), *i.e.*, 3,445 Gg CO_2eq.

The combustion of fossil fuels in the transport sector (roads, railways, rivers and domestic aviation; IPCC Source Category 1.A.3) resulted in 3,876 Gg CO_2eq of GHG emissions. Consequently, the contribution of the transport sector to the total GHG emissions was 5.84 %.

The total emission of CO_2 in 1998 was 50,605 Gg, of which the largest share emanated from the energy sector (IPCC Source Category 1), *i.e.*, 93.73 % or 47,430 Gg (Figure 3.19 and 3.20), while the remaining part, 6.27 % or 3,176 Gg of the emissions resulted from industrial processes (IPCC Source Category 2, Figures 3.19. and 3.20).

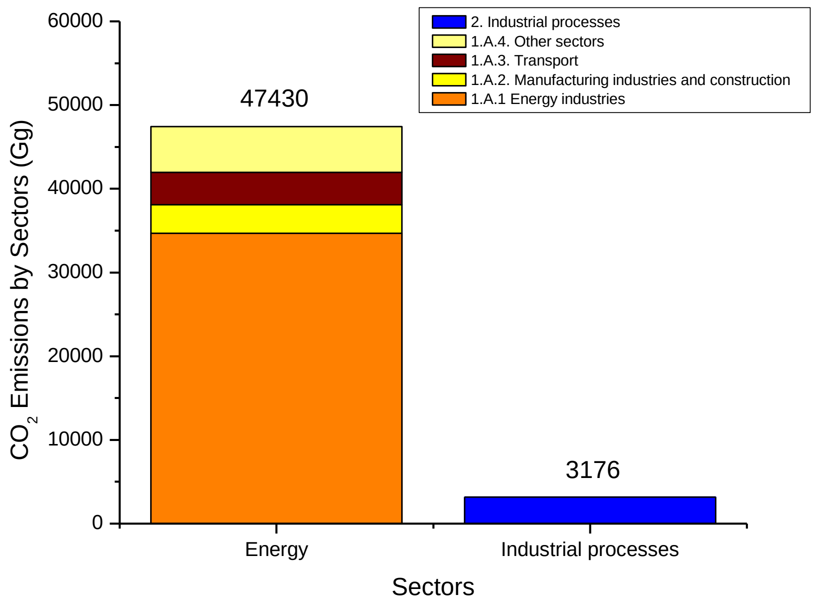


Figure 3.19. CO_2 Emissions by sectors, Republic of Serbia, 1998.

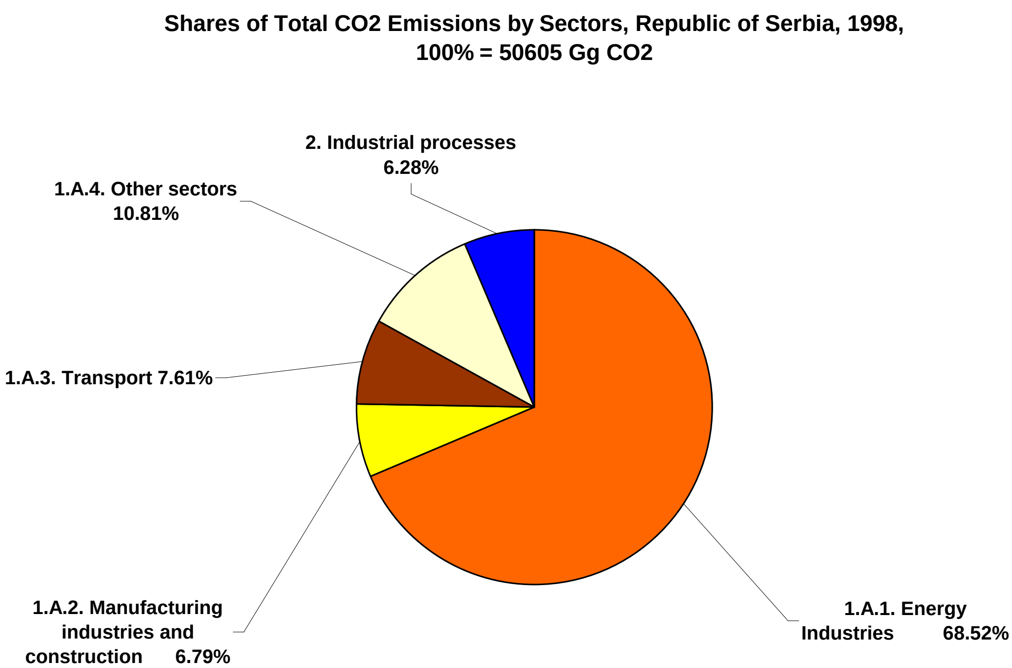


Figure 3.20. Shares of Total CO_2 Emissions by Sector/Sub–sector, Republic of Serbia, 1998.

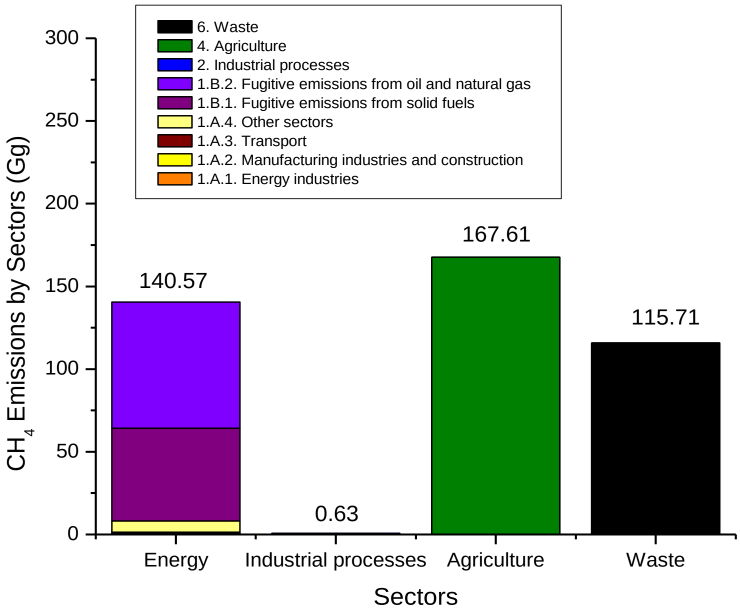


Figure 3.21. Methane (CH_4) Emissions by Sector, Republic of Serbia, 1998

Of the total emission of methane (424.52 Gg) in 1998, the greatest part, 39.48 % or 167.61 Gg, was emitted from the agriculture sector (IPCC Source Category 4), primarily from biochemical processes in stockbreeding (Figure 3.21. and 3.22), 33.11 % or 140.57 Gg, from the energy sector (IPCC Source Category 1), predominantly by fugitive emissions, 27.25 % or 115.71 Gg by emission of waste dump fumes formed during the decomposition of the organic part of communal waste (IPCC Source Category 6.A) and quite a small part of 0.15 % or 0.63 Gg, from industrial chemical processes (IPCC Source Category 2.B).

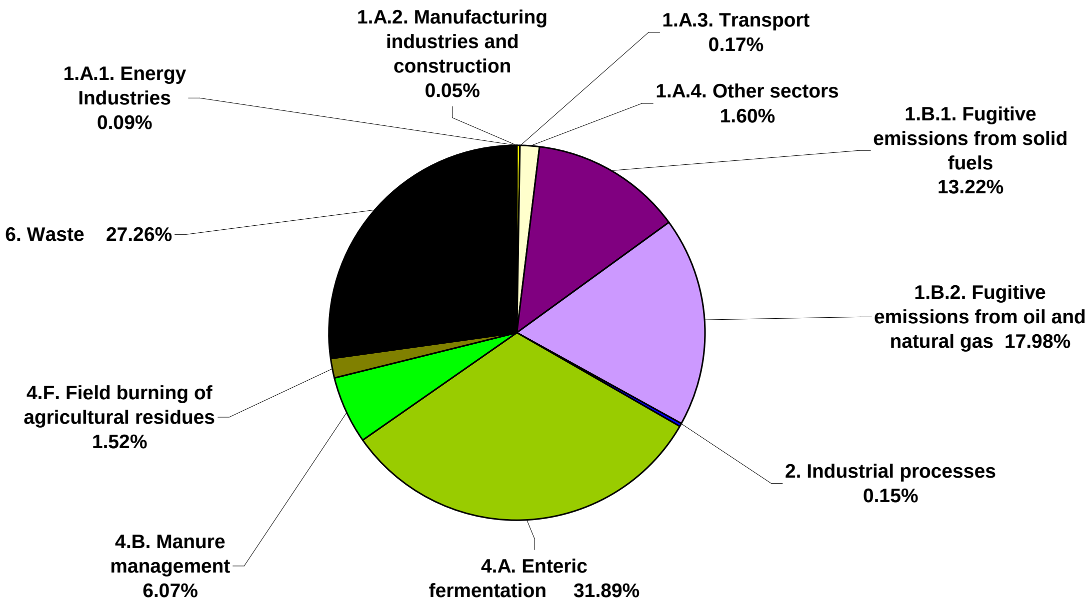


Figure 3.22. Shares of Total CH_4 Emissions by Sector/Sub-sector, Republic of Serbia, 1998

The emissions of nitrous oxide (22.02 Gg) in 1998, as was the case in 1990, originated mostly from the agriculture sector (IPCC Source Category 4), *i.e.*, 87.6 % or 19.29 Gg, while the remaining 13.4 % or 2.73 Gg emanated from industrial chemical processes (IPCC Source Category 2.B), decomposition of the organic matter in waste waters (IPCC Source Category 6.B) and the energy sector (IPCC Source Category 1.A, Figure 3.23. and 3.24).

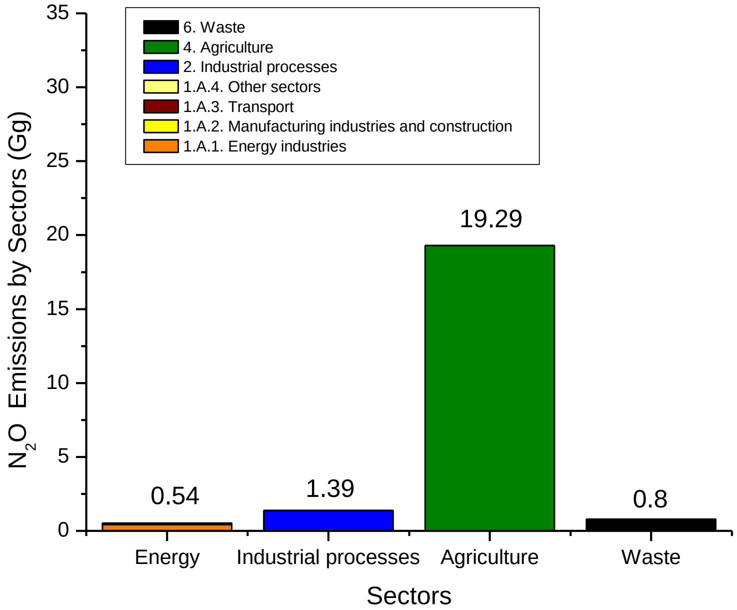


Figure 3.23. N_2O Emissions by Sector, Republic of Serbia, 1998

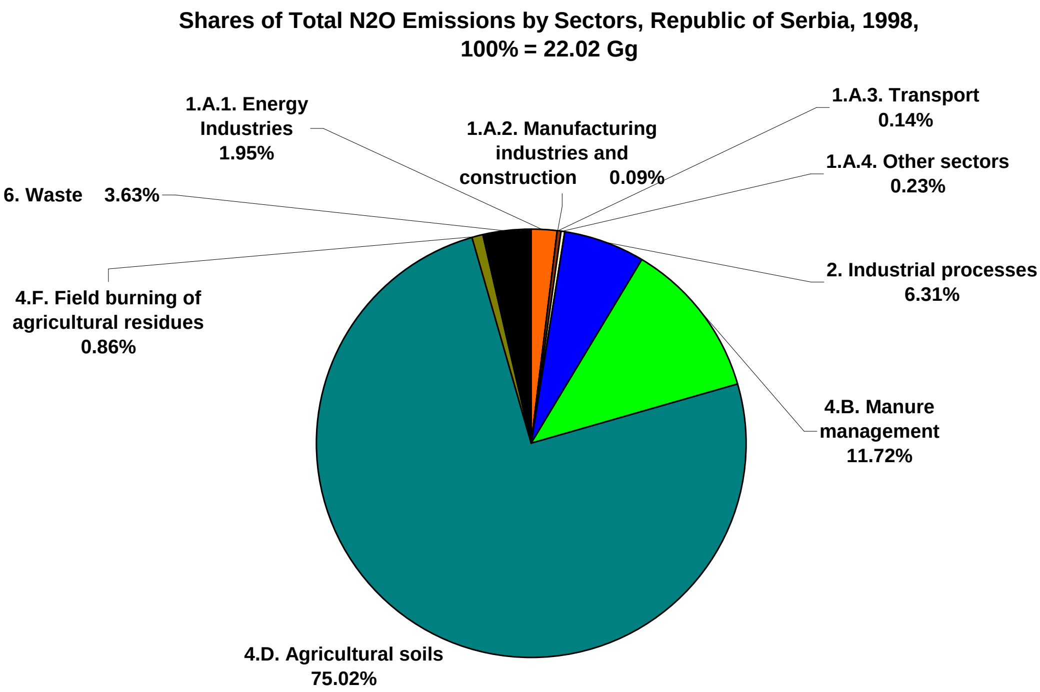


Figure 3.24. Shares of Total N_2O Emissions by Sector/Sub–sector, Republic of Serbia, 1998

There is no record of import or consumption of synthetic gases, *i.e.*, of the available amounts, in the available official documents and, thus, the related emissions could not be estimated according to the international method.

The results of the estimations of indirect GHG (NO_x, CO, NMVOC, and SO_x) in 1998 are shown in Table 3.4. in accordance to the requirements of the UNFCCC Guidelines for the preparation of national communications from Parties not included in Annex I to the Convention.

The total emissions in 1998, per gas, was: nitrogen oxides (disregarding nitrous oxide) 165 Gg, carbon monoxide 465 Gg, NMVOC 115 Gg and sulphur oxides 389 Gg.

Republic of Serbia, Inventory Year 1998. Indirect Greenhouse gas – Source and sink categories	**NO_x (Gg)**	**CO (Gg)**	**NMVOCs (Gg)**	**SO_x (Gg)**
Total national emissions	**165**	**465**	**115**	**389**
1. Energy	**156**	**327**	**74**	**382**
A. Fuel combustion (sectoral approach)	155	327	57	379
1. Energy Industries	96	7	2	319
2. Manufacturing industries and construction	9	2	0	27
3. Transport	39	250	47	5
4. Other sectors	11	69	7	28
5. Other (please specify)	0	0	0	0
B. Fugitive emissions from fuels	0	0	17	3
1. Solid fuels	0	0	0	0
2. Oil and natural gas	0	0	17	3
2. Industrial processes	**2**	**2**	**41**	**6**
A. Mineral products	0	0	32	1
B. Chemical industry	2	1	1	5
C. Metal production	0	0	0	0
D. Other production	0	0	8	0
E. Production of halocarbons and sulphur hexafluoride				
F. Consumption of halocarbons and sulphur hexafluoride				
G. Other (please specify)	NE	NE	NE	NE
3. Solvent and other product use			**NE**	
4. Agriculture	**7**	**136**	**0**	**0**
A. Enteric fermentation				
B. Manure management			0	
C. Rice cultivation			NO	
D. Agricultural soils			0	
E. Prescribed burning of savannahs	NO	NO	NO	
F. Field burning of agricultural residues	7	136	0	
G. Other (please specify)	NE	NE	NE	
5. Land-use change and forestry [1]	**0**	**0**	**0**	**0**
A. Changes in forest and other woody biomass stocks				
B. Forest and grassland conversion	0	0		
C. Abandonment of managed lands				
D. CO_2 emissions and removals from soil				
E. Other (please specify)	NE	NE		
6. Waste	**0**	**0**	**0**	**0**
A. Solid waste disposal on land	0		0	
B. Waste-water handling	0	0	0	
C. Waste incineration	NO	NO	NO	NO
D. Other (please specify)	NE	NE	NE	NE
7. Other (please specify)	**0**	**0**	**0**	**0**
Memo items				
International bunkers	**1**	**0**	**0**	**0**
Aviation	1	0	0	0
Marine	NE	NE	NE	NE
CO_2 emissions from biomass				

Table 3.4 Emission of indirect GHG, Republic of Serbia, 1998

The energy sector (IPCC Source Category 1), mostly by combusting the fossil fuels, primarily participated in the emissions of all indirect GHG (Figure 3.25, 3.26, 3.27. and 3.28).

Thus, the energy sector contributed to 94.55 % of the nitrogen oxides emissions, 70.32 % of the carbon monoxide emissions, 64.35 % of the non–methane organic volatile matter emissions and 98.2 % of the sulphur oxides emissions.

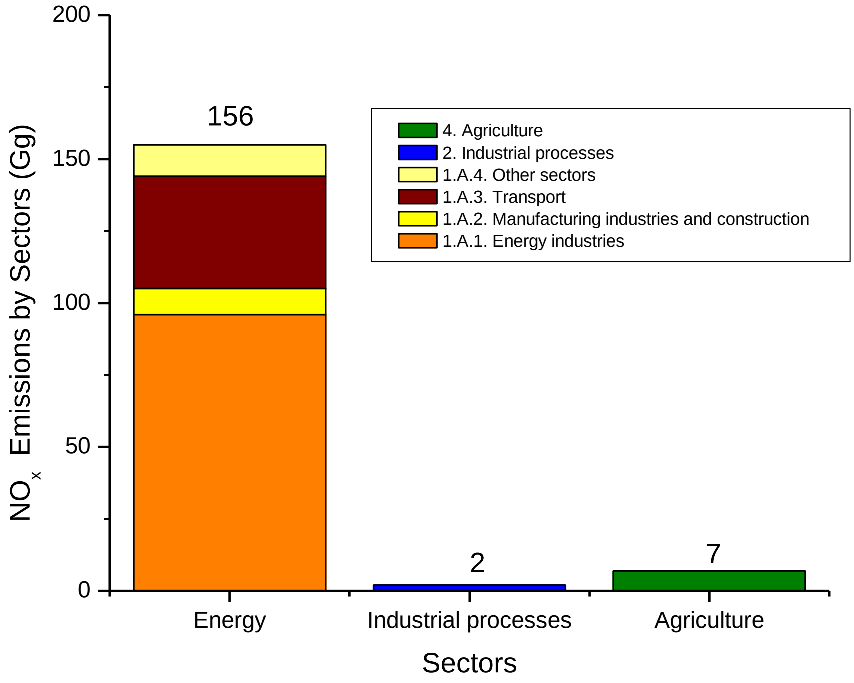


Figure 3.25. NO_x Emissions by Sectors, Republic of Serbia, 1998

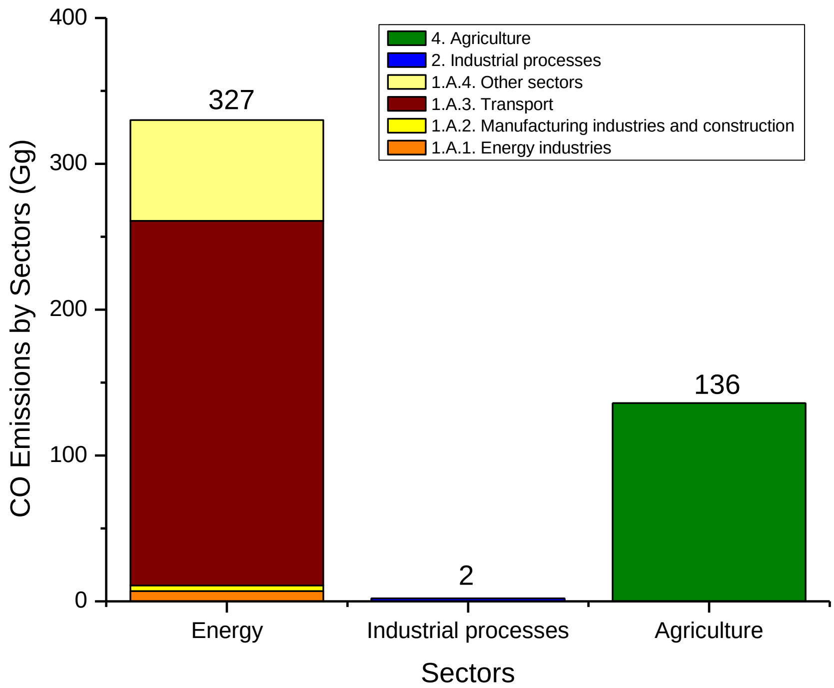


Figure 3.26. Carbon monoxide Emissions by Sector, Republic of Serbia, 1998

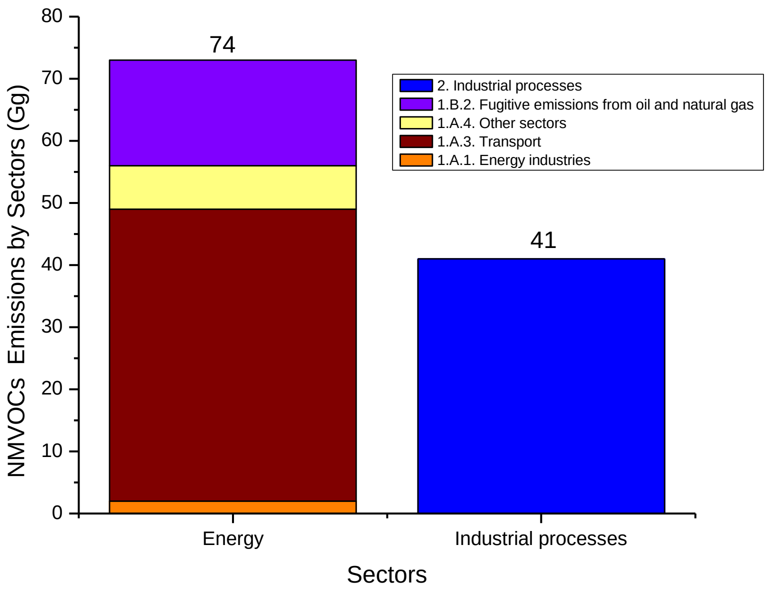


Figure 3.27. NMVOCs Emissions by Sectors, Republic of Serbia, 1998

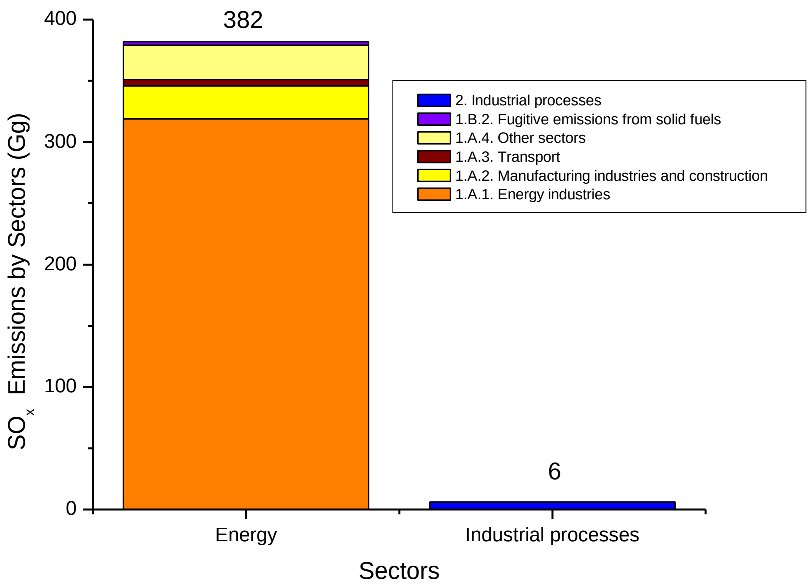


Figure 3.28. Sulphur oxides (SO_x) Emission by Sector/Sub-sector,
Republic of Serbia, 1998

A complete analysis of the trends in the emissions and the removed amounts of GHG period 1990 – 1998 is given in the following section.

3.10. THE TREND OF THE EMISSIONS AND THE REMOVED AMOUNTS OF GHG IN THE PERIOD 1990 – 1998

The trends in the emissions from the key categories of emission sources (Source Category Trend) for the considered greenhouse gases (CO_2, CH_4 and N_2O) and the integral trend (Total Trend) for the cases with and without consideration of the amounts removed by the forest complex (LUCF) were determined using the internationally recommended methodologies (IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Tier 1 Method).

The results of the calculations of the emission Trends and the removed amounts of GHG from the key categories of emission sources (and sinks), as well as the values of the Total trend for the cases with and without consideration of the amounts removed by the forest complex for the year 1998 in comparison with the referent year 1990 are given in Table 3.5.

Source Category Trend (%) **Greenhouse gas source and sink categories**	**CO_2 emissions (%)**	**CO_2 removals (%)**	**CH_4 (%)**	**N_2O (%)**	**Total Trend CO_2eq emissions (%)**
Total national emissions and removals	**-24.4**	**+23,0**	**-1.9**	**-28.2**	**-21.8**
1. Energy	**-24.9**	**0**	**-12.1**	**-24.1**	**-24.19**
A. Fuel combustion (sectoral approach)	-24.9		-68.2	-24.1	-25.1
1. Energy Industries	-8.3		-12.8	-9.3	-8.3
2. Manufacturing industries and construction	-83.7		-87	-150	-83.8
3. Transport	-47.4		-49.3	-66.7	-47.5
4. Other sectors	-77.6		-73.0	-100	-77.5
5. Other (please specify)					
B. Fugitive emissions from fuels			-8.7		-8.7
1. Solid fuels			-9.0		-9.0
2. Oil and natural gas			-8.4		-8.4
2. Industrial processes	**-16.8**	**0**	**15.9**	**-27.3**	**-18.0**
A. Mineral products	-20.9				-20.9
B. Chemical industry	-4.3		15.9	-27.3	-18.1
C. Metal production	-14.8		0	0	-14.8
D. Other production					
E. Production of halocarbons and sulphur hexafluoride					
F. Consumption of halocarbons and sulphur hexafluoride					
G. Other (please specify)	**NE**		**NE**	**NE**	**NE**
3. Solvent and other product use	**NE**			**NE**	
4. Agriculture			**-15.8**	**-29.6**	**-24.5**
A. Enteric fermentation			-17.2		-17.2
B. Manure management			-9.5	-14.7	-12.6
C. Rice cultivation			NO		
D. Agricultural soils				-32.2	-32.2
E. Prescribed burning of savannahs			NO	NO	NO
F. Field burning of agricultural residues			-11.6	-5.3	-9.5
G. Other (please specify)					
5. Land-use change and forestry [1]	**0**	**+23.0**	**0**	**0**	**0**
A. Changes in forest and other woody biomass stocks	0	+21.9			+21.9
B. Forest and grassland conversion	NE	NE 0	NE	NE	NE
C. Abandonment of managed lands		NE			
D. CO_2 emissions and removals from soil	NE	NE			
E. Other (please specify)	NE	NE	NE	NE	NE
6. Waste			**+30.7**	**+1.3**	**+27.9**
A. Solid waste disposal on land			+30.7		+30.7
B. Waste-water handling				0	0
C. Waste incineration					NO
D. Other (please specify)			NE	NE	NE
7. Other (please specify)	**NE**	**NE**	**NE**	**NE**	**NE**
Memo items					
International bunkers	**-146.8**		**0**	**0**	**-146.8**
Aviation	-146.8		0	0	-146.8
Marine	NE		NE	NE	NE
CO_2 emissions from biomass	**-32.5**				

Table 3.5. Trends of the emissions and the removed amounts of GHG in the Republic of Serbia in the period 1990 – 1998

Due to the calculated decrease of the total emissions in 1998 in relation to the referent year 1990, the total trend of the greenhouse gases in the Republic of Serbia in 1998 was –21.8 % for the case without consideration of the amounts removed by the forest complex (LUCF).

This total trend is a consequence of specific national circumstances, characteristic for this period, mainly resulting from the decrease of all industrial and other activities in the Republic of Serbia, *i.e.*, a decrease of GHG emissions. Thus, in the energy sector, the GHG emission trend was on the level of –24.19 %, in the sector of industrial processes, –18 % and in the agriculture sector, of –24.5 %.

An exception from the negative trends was the increase of the GHG emissions from communal waste and waste water management, for which the GHG emission Trend was +27.9 %. This resulted from the increased amount of deposited communal waste due to a population increase.

On the other hand, in 1998 the amount of the removed quantities of carbon dioxide in the forest complex in the Republic of Serbia increased by +23% in relation to the referent year 1990.

Taking this into account, i.e. considering the removed quantities of the carbon dioxide in the forest complex, the Total trend of the GHG emissions in the Republic of Serbia in 1998 in relation to 1990 was –28.5%.

3.11. Uncertainty of the calculations and verification

The uncertainty of the calculations of the GHG for 1990 was determined according to the internationally recommended method (IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Tier 1 Method).

In Annex 2, an overview is given of the key sources of emissions according to the gas species, classified according to their contribution to the total emissions, as well as the corresponding combined uncertainty (calculated on the basis of the uncertainty of the activity/amount of fuel and the uncertainty of the emission factor) for that source.

Based on these calculations, the estimated uncertainty of the total GHG emissions in the Republic of Serbia for the year 1990 is 10.5 %.

The comparison of the results of the calculations of the available/combusted fossil fuels in the energy sector and the emission of the carbon dioxide according to the Reference Approach and Sectoral Approach for 1990 and 1998, given in tabular form in Annex 3, indicates relatively small discrepancies in the emissions of CO_2 by these two methods (1.92 % for 1990 and 1.32 % for 1998).

4. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

4. VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

4.1. OBSERVED CLIMATE CHANGES IN THE REPUBLIC OF SERBIA

Bearing in mind the global trend in climate change as well as various meteorological and hydrological events in Serbia in the past decades, it is evident that global climate change has led to significant changes in the climate characteristics of the Republic of Serbia.

In order to determine the level of climate change on the national level, numerous analyses of basic climate parameters were performed. With this aim, the following were analysed: trends in mean annual air temperatures and precipitation for the period 1950–2004, differences in the mean annual air temperatures and precipitation in the periods 1971–2000 and 1961–1990, and the daily data for Novi Sad, Belgrade and Niš for the period 1949–2009.

4.1.1. TEMPERATURE CHANGES

The results of the above analyses showed that in the period 1950–2004, there was an increase in mean annual temperatures in almost all parts of Serbia, except southeast part of the country. The rises in temperatures were higher in the northern than in the southern parts of Serbia, and the increase was the highest in the spring. For autumn the increase was the lowest and in southeast parts, decrease was recorded.

Compared to the period 1961–1990, the period 1971–2000 was warmer in most of Serbia by 0.7°C. In the far southeast of the country this difference was negative, –0.4°C (Figure 4.3, left panel).

The analysed daily data from Novi Sad, Belgrade and Niš show positive trend on annual level on all three locations, and indicate that the highest increase in the mean annual temperatures was in Belgrade due to urban heat island effect (Table 4.1 and Figure 4.1). Minor drop in temperatures at Novi Sad and Niš was observed during the autumn.

	Novi Sad	Belgrade	Niš
Winter	0.20	0.20	0.09
Spring	**0.26**	**0.32**	**0.19**
Summer	0.13	**0.26**	0.15
Autumn	–0.01	0.04	–0.07
Year	**0.14**	**0.20**	0.09

Table 4.1. Air temperature trends by season (°C/decade) in the period 1949–2009.

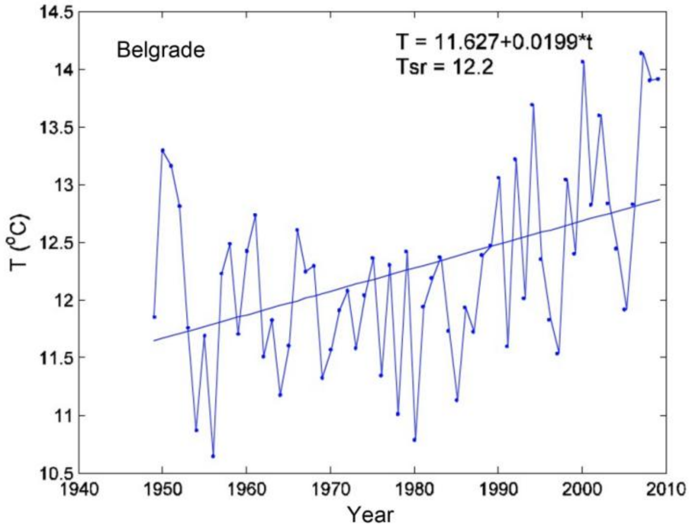


Figure 4.1. Mean annual temperatures (°C) in Belgrade during the period 1949–2009.

4.1.2. PRECIPITATION CHANGES

In the period 1950–2004, most of the territory of Serbia, except the east and south parts, was characterized by a positive precipitation trend. The highest positive trend in annual precipitation was in the west of the country, whilst the highest negative trend was in the southwest. Northern Serbia had a higher increase in precipitation in the summers and autumns as well as annually than southern Serbia. A decrease in precipitation was observed in winter and spring in northern and eastern Serbia.

The number of days with precipitation exceeding 1 mm has dropped since 1976 over the entire country, whilst the annual precipitation sum due to precipitation above the 95^{th} percentile calculated for the reference period 1961–1990 (R95T) went up. In other words, the annual precipitation decreased in these three decades but the number of days with intensive precipitation increased.

The mean annual precipitation over a larger part of Serbia was lower in 1971–2000 than in 1961–1990, whilst in some locations, especially in the west and north of Serbia, a positive change was recorded (Figure 4.3, right panel).

In the past 60 years, a slight rise in precipitation was recorded in Novi Sad, Belgrade and Niš (Table 4.2 and Figure 4.2). A precipitation decrease was observed in winter in these three cities. In the summer and autumn, an increase in precipitation was recorded, the highest one being in Novi Sad in autumn.

	Novi Sad	Belgrade	Niš
Winter	–0.455	–0.101	–0.194
Spring	–0.018	–0.530	0.253
Summer	0.570	0.473	0.142
Autumn	**1.007**	0.486	0.245
Year	1.230	0.361	0.361

Table 4.2. Precipitation trends by season (mm) in the period 1949–2009.

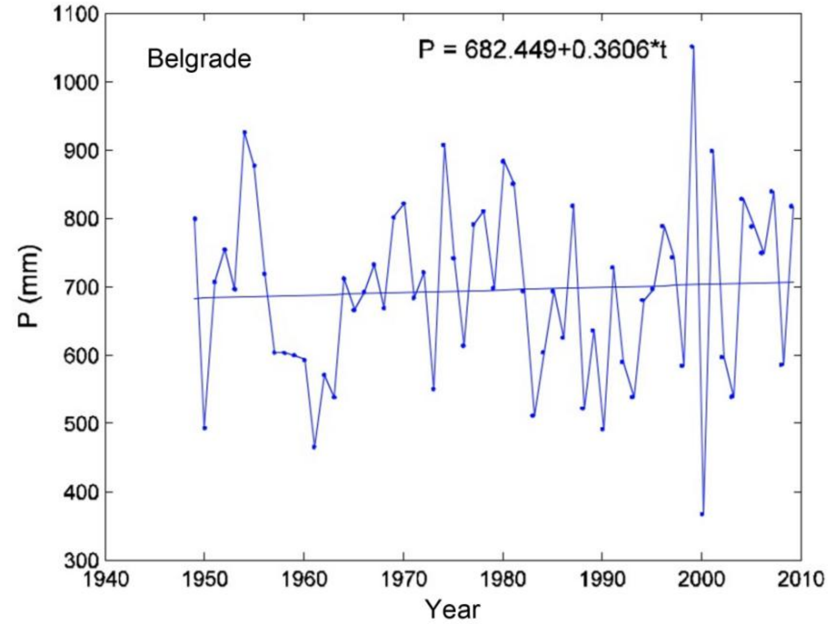


Figure 4.2. Annual precipitation amounts in Belgrade (mm) during 1949–2009.

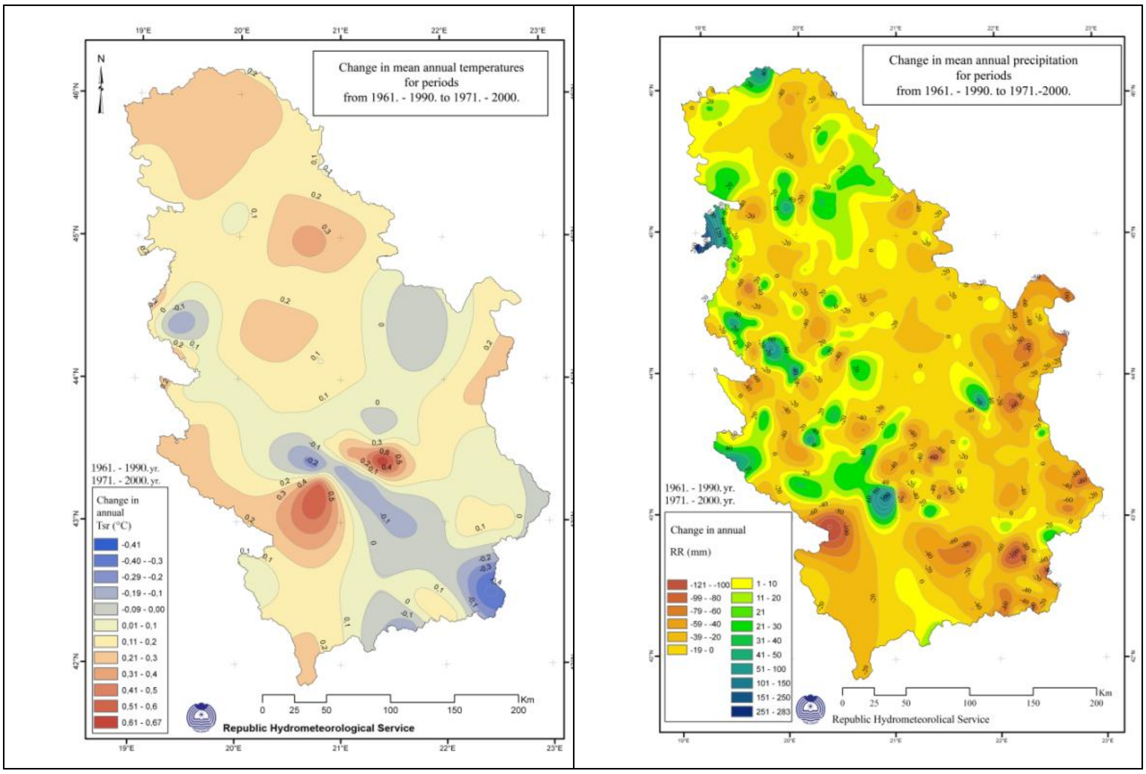


Figure 4.3. Changes in the mean annual temperatures and mean annual precipitation

4.2. CLIMATE CHANGE SCENARIOS

Results of climate change projections obtained using the regional climate model EBU–POM for Serbia are presented as differences in the mean annual values of 2–metre air temperature and accumulated precipitation for 30–year future time slices and the same mean values for the base period 1961–1990. Presented results for two periods in the future (2001–2030 and 2071–2100) are based on the A1B and A2 scenarios.

A1B and A2 are future GHG emission scenarios defined by IPCC (IPCC Special Report on Emission Scenarios – SRES) based on assumed technological and socio–economical trends by the end of this century. Defined scenarios are used to force climate models which enable assessment of possible changes of climate conditions depending on the chosen scenario. In regard to GHG concentration, A1b is characterized as "medium" and A2 as "strong" scenario. Value of CO_2 concentration at the end of 21st century for A1B scenario is close to 690ppm and for A2 scenario close to 850ppm, which is approximately 1.8 and 2.2 times higher value compared to presently observed 385ppm, respectively.

For each scenario, the range of the mean temperature and precipitation changes are presented in Tables 4.3 and 4.4 for each season (winter: December, January, February – DJF; spring: March, April, May – MAM; summer: June, July, August – JJA; autumn: September, October, November – SON), as well as annual value. The results are given in more detail in following subsections.

	A1B 2001-2030	A1B 2071-2100	A2 2071-2100
DJF	0.5 – 1.0	1.8 – 2.2	2.6 – 3.6
MAM	1.0 – 1.2	2.4 – 2.8	3.6 – 4.0
JJA	1.2 – 1.4	3.2 – 3.6	4.2 – 4.6
SON	0.5 – 0.9	1.8 – 2.2	2.6 – 3.2
YEAR	0.8 – 1.1	2.4 – 2.8	3.4 – 3.8

Table 4.3. Seasonal temperature change (°C)

	A1B 2001-2030	A1B 2071-2100	A2 2071-2100
DJF	-10 – 5	-20 – 0	-15 – 15
MAM	-15 – 15	-15 – 10	-30 – 0
JJA	-5 – 30	-30 – 5	-50 – 10
SON	-10 – 20	-30 – 5	-30 – 10
YEAR	-5 – 10	-15 – 0	-15 – 5

Table 4.4. Seasonal precipitation change (%)

4.2.1. SCENARIO A1B FOR THE PERIOD 2001-2030

The change in the mean annual temperature during the first 30 years of the 21st century, compared to the period 1961 – 1990, is positive over the entire territory of Serbia, according to the A1B scenario of climate model projections (Figure 4.4, left panel). Its intensity is 1°C in most parts of Serbia, except in the most eastern Banat and the most southern parts, where it is 0.9°C, and in the northeast part of the Timok Valley, where it is 1.1°C.

The precipitation change is slightly positive (0–5%) over most parts of Serbia and positive (5–10%) in the central parts of Bačka (Figure 4.4, right panel). Negative changes (from 0 to -5%) are present on the east of Serbia, in the Danube Valley, on the mountains bordering with Montenegro and south parts of Kosovo and Metohija.

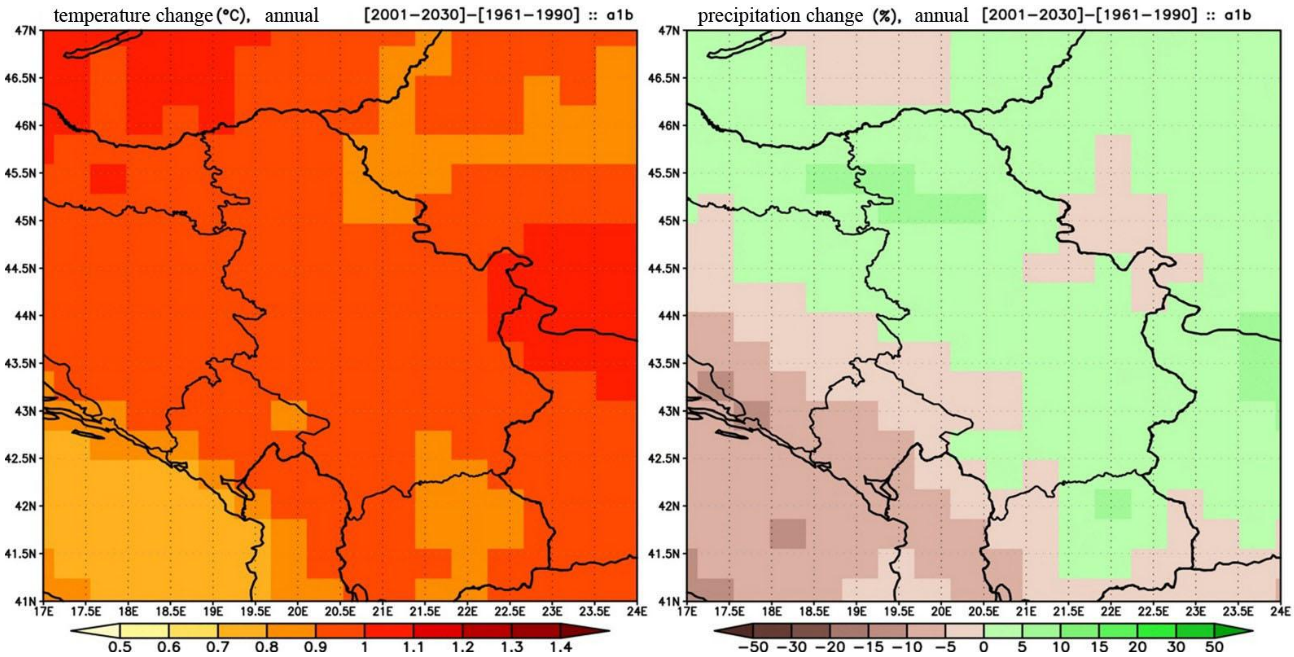


Figure 4.4. Annual changes of the mean 2–metre air temperature and accumulated precipitation.

4.2.2. SCENARIO A1B FOR THE PERIOD 2071–2100

According to the Regional Climate Model projections based on A1B scenarion, the change in the mean annual temperature in the last 30 years of the 21st century is positive over the entire territory of Serbia, mostly in range from 2.4 to 2.8°C and from 2.8 to 3°C in the eastern part of the Danube Valley and in the south–western parts of the country (Figure 4.5, left panel).

The precipitation change is negative, ranging form –10 to –15% over most parts of Serbia and from –5 to –10% in the southern parts of Vojvodina and over smaller areas on the east and southeast of the country (Figure 4.5, right panel).

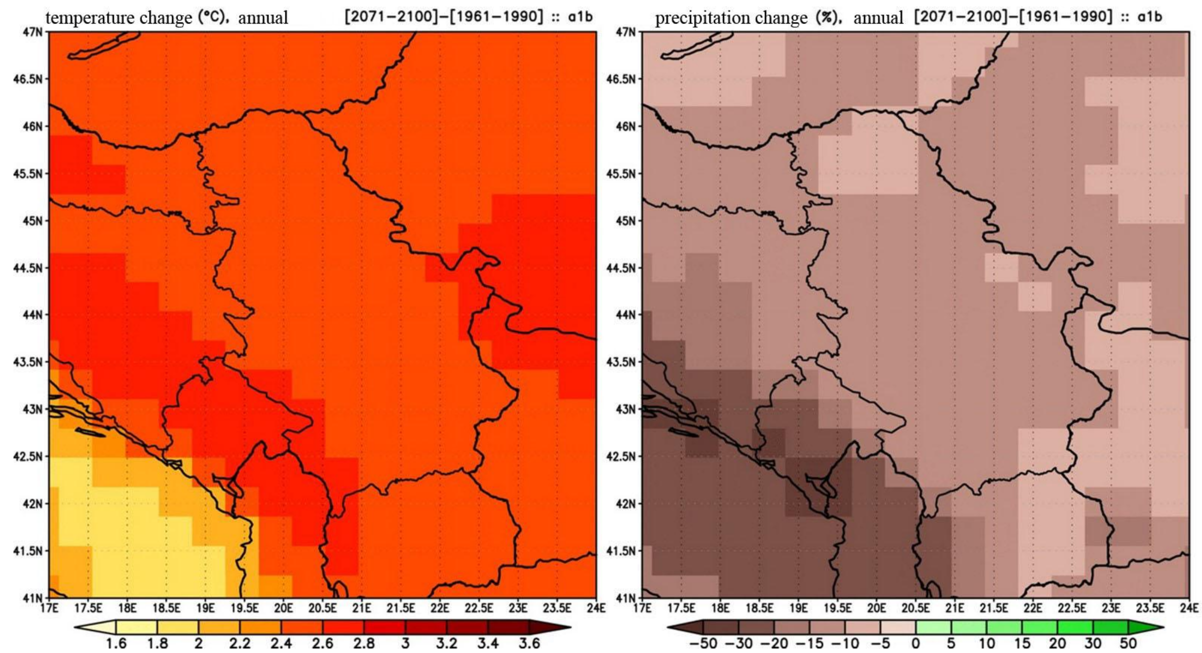


Figure 4.5. Annual changes of the mean 2–metre air temperature and accumulated precipitation.

4.2.3. SCENARIO A2 FOR THE PERIOD 2071–2100

According to scenario A2 that predicts the most extreme GHG concentration, the increase in the temperature for most parts of Serbia is between 3.6 and 3.8°C, with a somewhat

Strategic area	Adaptation measures	Challenges and obstacles

lower increase in most of Vojvodina and smaller, local areas on the west of the country, as well as in the Drina Valley and in the south (Figure 4.6, left panel).

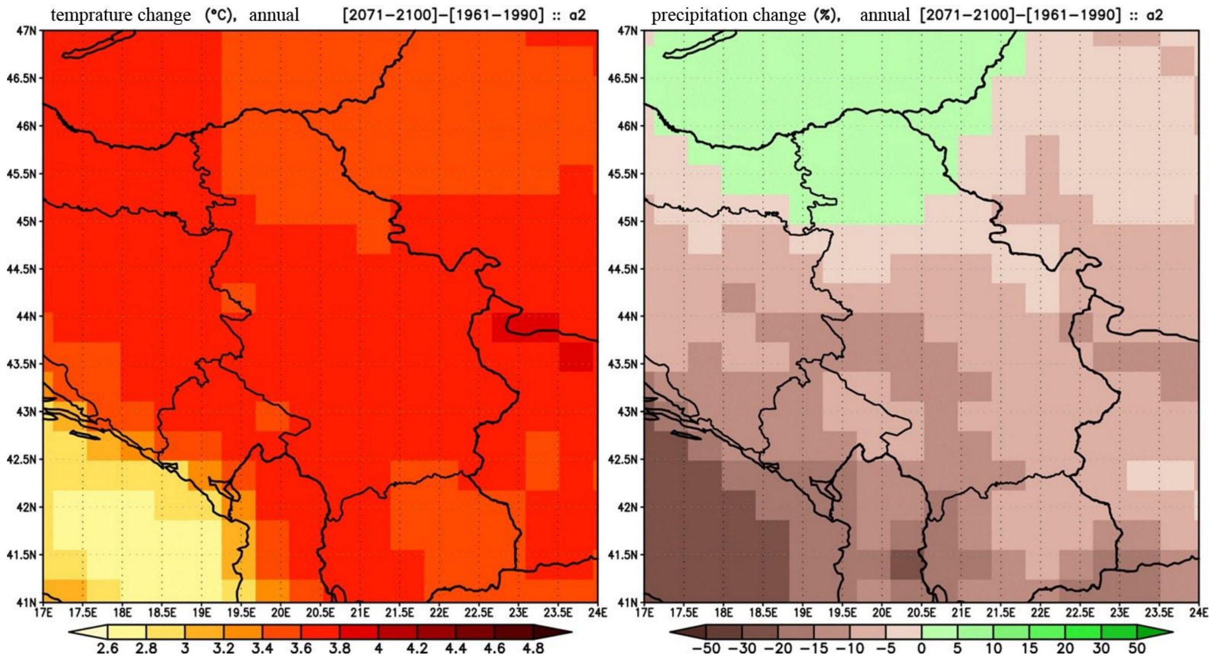


Figure 4.6. Annual changes in the mean 2–metre air temperature and accumulated precipitation.

The precipitation change field is more complex (Figure 4.6, right panel). Precipitation increases (5–10%) in Vojvodina, whilst it decreases in other parts of Serbia. Precipitation change has large gradient increasing from north–east towards south–west, namely between 0 and –5% in the Sava and the Danube valleys; from –5 to –10% in the most parts of the central and east Serbia and on the border with Montenegro; and from –10 and –15% in the west and southwest parts of the country, as well as on the most of Kosovo and Metohija.

4.3. CLIMATE CHANGE EFFECTS AND POSSIBLE ADAPTATION MEASURES

4.3.1. HYDROLOGY AND WATER RESOURCES

A preliminary assessment of climate change effects on the water resources indicate that a decrease of water flow on the national level, is to be expected in the forthcoming period (up to 2100).

The results of numerical models (NCAR, MPI, RegCM) indicate that the average annual discharge in Serbia will drop, only caused by decrease in annual precipitation, namely by 12.5% until 2020 (in the vegetative period by 11.1% and in the rest period by 13.9%) and by 19% until 2100 (in the vegetative period around 5.4% and in the rest period around 32%).

Period until 2020 is characterized by significant decrease of 15% in mean annual precipitation amount (in the vegetative period 16.9% and in the rest period 13.9%) and until 2100 by decrease of 25.1% (in the vegetative period 13.4% and in the rest period 39.6%).

The average annual evapotranspiration sum by 2020 will have decreased by 16.5% (in the vegetative period by 18.5% and in the rest period by 13.9%), and by 27.2% until 2100 (in the vegetative period by 15.7% and in the rest period by 43.6%).

It should also be taken into consideration that the above projections show that climate change might cause more intense flood and drought episodes, greater both in scope and duration.

Based on existing data and information, a list of short–term adaptation measures and challenges and obstacles for their implementation are given in Table 4.5. Further research on the impacts of climate change on the water resources is necessary, as is the adoption of a detailed programme of adaptation measures.

Reducing risks	– Assess vulnerability to climate change – Develop vulnerability map and map of flood risk – Determine need for widening and deepening riverbeds and their additional cleaning – Estimate ability of dams and other constructions, as well as city channel systems for flood control – Improve flood resistance systems – Estimate capability of irrigation and drainage systems – Improve irrigation and drainage systems – Establish vulnerability for important rivers	– Insufficient funds – Lack of awareness
Policy	– Adopt flood control, including financial needs for its implementation – Adopt a special plan for flood managing – Improve inter–sector planning – Improve planning of integral water resource management – Improve regulations and directives – Include climate change impacts in the sector strategy and action plan – Adopt an adaptation plan within the sector	– Insufficient funds – Insufficient technical and technological capacity – Lack of awareness
Monitoring and research	– Improve the climate monitoring system – Improve hydrological observation network – Improve early warning systems for climate and hydrological extreme events – Establish a data base on extreme meteorological and hydrological events and disasters – Improve research in area of numerical modelling of hydrological processes (precipitation/snow–runoff for different time intervals) – Intensify multidisciplinary research on climate change impacts – Intensify research on climate change impacts on water resources	– Insufficient funds
Capacity building And public awareness	– Strengthen capacity of responsible institutions – Strengthen local community capacity – Strengthen research capacity –Raise the public awareness level and improve information on climate change impacts and possible adaptation measures, in general	– Insufficient funds

Table 4.5. Strategic areas and measures of adaptation to climate changes in the water resource sector

4.3.2. FORESTRY

Over the past decades, global warming and large–scale disturbances have caused considerable changes in the forest land in Serbia.

When, in addition to the current situation, the climate projections are taken into consideration, further negative changes are to be expected. Expected long–term effects of climate changes are: increase in intensity and extent of forest fires; shift in the boundaries of forest types relative to latitude and altitude; different natural distributions of forest types and their mutual interconnectivity and change in the way that certain types of trees respond to the light; different composition of certain plant communities (where some disappear and other appear relative to the location and gradual colonisation); and higher risk for relict, rare and endangered forest communities or reduced ability to maintain biological diversity.

In other words, it is possible that, in the long term, climate change will cause transformation of entire forest ecosystems, changing the distribution and composition of Serbian forests.

Detailed analysis of climate change impacts on forest ecosystems is of the utmost importance for the preparation of adequate adaptation measures. Starting from available data and information, short–term adaptation measures, as well as challenges and obstacles in their application, are proposed in Table 4.6.

Strategic area	**Adaptation measures**	**Challenges and obstacles**
Risks reduction	- Detailed forest mapping - Detailed vulnerability assessment to climate change - Improve forest fire protection systems - Increase protection of forests against vermin - and plant diseases - Intensive forestation	- Insufficient funds - Insufficient technical and technological capacities
Policy	- Revise regulations and directives in forest management - Include climate change impact problems into forest sector strategy and Action Plan - Adopt an adaptation plan within the sector, including its financial needs	- Insufficient funds - Inadequate technical capacities - Lack of awareness concerning climate change
Monitoring and research	- Improve integral monitoring of the effects of air, water and soil pollution and climate change on forest ecosystems - Intensify multidisciplinary research of climate change impacts on forests - Develop and apply strategy evaluation methods and adaptation measures, including measures for strengthening the resilience of forests to climate change	- Insufficient funds - Insufficient technical and technological capacities
Capacity building and public awareness	- Capacity building in institutions responsible for forest management - Educate rangers - Strengthen the role of local communities in sustainable forest management - Raise awareness of the scientific community and forest owners - Raise the public awareness level and improve information on climate change impacts and possible adaptation measures	- Insufficient funds

Table 4.6. Strategic areas and measures of adaptation to climate changes in forestry

4.3.3. AGRICULTURE

Increasingly frequent and intensive droughts in the past two decades have caused great damage to Serbian agriculture. According to the evaluation of drought impacts on the crop yield in east Serbia in the period 1989–2000, the average drop in yield was 40.9% in comparison to the average annual yield in the years without drought.

Based on estimates made in Vojvodina (polls conducted in 2007 and 2008), the province in Serbia with the highest contribution of agriculture to the GDP, climate change in the past decade has caused a higher or lower intensity of the following diseases in crops and vegetables: powdery mildew in wheat, Fusarium class, leaf spot in sugar beet, downy mildew in sunflower and potato and tomato blight.

Bearing in mind the projected increase in air temperature and decrease in precipitation, it was concluded that agricultural production will be very vulnerable to climate change in the future. For this purpose, the HadCM3 model was used (A2 and B2 emission scenarios for the period 2031–2060 in comparison to period 1961–1990) and the CropSyst Model for yield simulation. The basic scenario was an increase in the global air temperature of 2°C. The analysis covered the following crops: corn (C4 summer crops), sunflower (C3 crops), soy (legumes), potato (tuber crops) and wheat (cereals), as the main crops.

The results of research of climate change impacts without the carbon dioxide effect generally indicated a yield drop in all the considered crops under both gas emission scenarios. When the effect of carbon dioxide was included, the results showed that in case of climate change according to the A2 scenario, a drop in yield of all crops except corn is to be expected in Serbia. The corn yield would be somewhat higher if irrigation water were increased by 25–40% (Table 4.7).

Crop	Yield change (%) without the CO_2 effect		Yield change (%) with the CO_2 effect	
	A2	B2	A2	B2
C4 summer	–4.43	–2.54	–0.60	0.21
Legumes	–18.59	–8.11	–7.19	0.97
C3 crops	–15.57	–6.92	–5.44	0.96
Tubers	–22.50	–6.80	–9.33	4.39
Cereals	–6.79	3.71	4.39	12.49

Table 4.7. The impact of climate change on crop yield (%)

Climate change impacts on the yields in Vojvodina were assessed using the biometeorological model BAHUS. The results generally indicate a high level of vulnerability of agricultural production to extreme weather conditions and systemically modified weather conditions, as well as of the damage that could cost millions. Also, the results of the crop production model SIRIUS showed that, in case of scenario A2, the yield of winter wheat in Vojvodina in 2040 and in 2080 will have dropped by 5–8% and 4–10%, respectively, relative to the average yield in the period 1981–2005. In this study, the outputs from the ECHAM5, HadCM3 and NCAR–PCM climate models were used.

The negative effect on agriculture was confirmed by the climate change impact assessment on agroecological zones. The agro–climatic classification of Serbia is based on meteorological data of the main climatological stations in Serbia in the period 1961–2004, using the Thornthwaite climatological classification. The analyses showed that if the mean annual temperature were to rise by 2°C, the areas with a dry climate will increase in the lowlands and valleys, which are mostly used as agricultural land.

A reduction of the adverse effects and, if possible, the use of the positive effects of climate change impose an urgent need to include climate change in the agricultural policy agenda, sector strategies and action plans because climate change could limit sustainable development in agriculture. Bearing in mind all these analyses, potential options and adaptation measures were assessed, including challenges and obstacles to their application (Table 4.8).

Strategic area	Adaptation measure	Challenges and obstacles
Risks reduction	– Detailed assessment of vulnerability to climate changes – Improve irrigation and drainage – Invest in new irrigation systems and related infrastructure – Adjust harvest dates and the field work calendar to the new climate conditions – Reduce the share of summer crops and increase the share of winter crops in the harvest structure – Change mulching practices – Improve soil structure with adequate treatment in order to increase its water storage capacity – Introduce measures to protect land from erosion – Change practices concerning the use of fertilisers and chemicals	– Insufficient funds – Insufficient awareness – Farmers not adequately educated or informed – Insufficient technology
Policy	– Include climate change impacts in sector strategies and Action Plans – Create an adaptation plan within the sector – Improve inter–sector planning and integral management of water resources in catchment areas of importance to agriculture – Introduce new insurance mechanism	– Insufficient funds – Lack of awareness.
Monitoring and research	– Improve climate monitoring systems – Establish a data base containing information on extreme weather occurrences and disasters connected with climate change, including information on damage in the agriculture and other sectors – Improve climate monitoring and early warning systems of droughts and other extreme climate episodes of importance to agriculture – Research and development of new sorts and hybrids – Develop and apply methods and models for integral assessment of climate change impacts on agriculture and economic parameters of adaptation options – Develop and apply agro–climate indicators in agro–climate and agroecological zoning	– Insufficient funds – Lack of awareness – Inadequate technical and technological capacity
Capacity building and public awareness	– Improve the advisory service related to crop selection – Strengthen institutional capacity building – Improve the way in which experts and the general public are informed about climate change impacts and possible ways of adaptation	– Insufficient funds – Lack of awareness

Table 4.8. Strategic areas and measures of adaptation to climate changes in agriculture

4.3.4. BIODIVERSITY AND NATURAL TERRESTRIAL ECOSYSTEMS

Systematic collection of data and analyses concerning climate change impacts on biodiversity has not yet been realised. Still, the observed climate change impacts on biodiversity and natural ecosystems in Serbia indicate that climate change may lead to the following: phenological changes (*i.e.*, changes in the periodic plant and animal life cycle events, with considerable shifts in the migration, reproduction and hibernation periods of some species); changes in the morphology, physiology and behaviour of species; loss of existing habitats and emergence of the new ones that the species had not encountered before; changes in the number and distribution of species; increase in the number of vermin and diseases; genetic changes, followed by extinction of species unable to adjust to climate change and changes in the natural fish population (spawning and migration times).

Detailed analysis of climate change impacts on biodiversity is of utmost importance for preparing adequate adaptation measures. Starting from available data and information, short–term adaptation measures, as well as challenges and obstacles in their application, are proposed in Table 4.9.

Strategic area	**Adaptation measures**	**Challenges and obstacles**
Reducing risks	– Develop a biodiversity indicator system – Detailed vulnerability assessment to climate change – Increase protected areas – Ensure corridors for the migration of species – Decrease pressure of other anthropogenic factors to biodiversity	– Insufficient funds – Lack of awareness – Insufficient technical capacity
Policy and institutional framework	– Include climate change in sector strategy and planning – Adopt an adaptation plan within the sector – Adopt protection plans for especially endangered species and ecosystems – Adopt a plan for increasing protected areas	– Insufficient funds – Lack of awareness – Insufficient technical capacity
Monitoring and research	– Organize monitoring of relevant parameters within protected areas – Establish systematized and continuous monitoring – Establish a data base – Commence monitoring of endangered species and ecosystems	– Insufficient funds – Lack of awareness – Insufficient technical capacity
Capacity building and public awareness	– Strengthen scientific and research capacity – Strengthen private and public sector capacity – Strengthen capacity of personnel in protected natural resources – Improve the informing of professionals and the general public on climate change impacts and possible adaptation options	– Insufficient funds – Lack of awareness – Insufficient technical capacity

Table 4.9. Strategic areas and measures of adaptation to climate changes in preserving biodiversity

4.3.5. HEALTH

In the past years, there was no systematized data collection and detailed analysis on climate change impacts on human health. Exiting approximate data indicate an increase in the last few years of the number of heat strokes and mortalities during periods with extremely high daily air temperatures.

Experience on regional and international level and available data indicate the possible spread of vectors (*e.g.*, mosquitoes) and exotic diseases that can be transmitted from tropical regions to Serbia. Since the beginning of the millennium, more introductions have been registered, the latest one being the African virus (Chikungunya) transmitted by the Asian tiger mosquito (*Aedes albopictus*). This invasive species was registered in Serbia in 2009.

The facts indicate that there might be a link between West Nile virus (WNV) infection and neurological disorders in Vojvodina, first registered in 2007. Serology tests conducted in

2009 showed 7.61% of the possible WNV infections in 92 people living in the greater area of Novi Sad were positive. In the same year, 182 individuals were subjected to the ELISA IgG test to determine how many had been in contact with WNV regardless of the time when the contact occurred. The findings showed the presence of the virus in 6.0% of the respondents on the tested territory.

In addition to West Nile fever, the population of Vojvodina and south Serbia might be exposed to the risks of malaria, Rift Valley fever, Chikungunya fever, dengue fever, leishmaniasis and other vector–borne diseases.

The warmer and, in some parts of the country, more humid climate might also initiate epidemics of alimentary (intestine) infections transmitted through food and water, such as diarrhoea and dysentery. The escalation of these diseases may be additionally accelerated by changed practices of storing food and drinking water.

Analysis of available information indicates the need for detailed assessment of influence of climate changes on health sector. Starting with available data and information proposed short–term adaption measures as well as challenges and obstacles in their application, are proposed in Table 4.10

Strategic area	Adaptation measures	Challenges and obstacles
Reducing risks	– Detailed vulnerability assessment to climate change – Ensure the availability of medications, vaccines equipment and diagnostic tests – Improve the heat wave early warning system	– Insufficient funds – Insufficient technical capacity – Lack of awareness
Policy	– Include climate change in sector strategy and Action Plan – Include climate change in spatial and urban planning to reduce risks of heat islands, air pollution and heat waves – Adopt a protection plan for especially vulnerable citizens – Adopt adaptation plan within the sector	– Insufficient funds – Insufficient technical capacity – Lack of awareness
Monitoring and research	– Improve systems for climate monitoring and early warning of climate extreme events – Establish monitoring of vectors, transmitted and infective diseases and establish a national network – Improve bio–monitoring systems – Establish a climate extreme events and disasters data base –Develop methods and models for integral assessment of climate change affects and economic parameters of adaptation options – Improve research of climate change impacts on health	– Insufficient funds – Insufficient technical capacity – Lack of awareness
Capacity building and public awareness	– Strengthen professional capacity – Strengthen capacity of health protection institutions – Strengthen research capacity – Strengthen capacity of institutions responsible for prevention and control programmes	– Insufficient funds – Insufficient technical capacity – Lack of awareness

Table 4.10. Strategic areas and adaptation measures in the public health sector

4.4. METHODOLOGIES USED IN THE ASSESSMENT OF VULNERABILITY AND ADAPTATION

The historic and climatic database of the National Hydrometeorological Service of Serbia (NHMSS) was used in the assessment of current climate variables and extreme events connected with climate changes. In the assessment of the observed climate change tendency and calibration of the regional climate model, the current official period 1961–1990, defined by the World Meteorological Organisation (WMO), was used.

Climate change scenarios for Serbia are based on the regional climate EBU–POM model. Its atmospheric component is the ETA model, developed at Belgrade University, with a horizontal resolution of 0.25° and 32 vertical levels. The ocean component of the EBU–POM model is the Princeton Ocean Model (POM), the horizontal resolution of which is 0.20° and 21 levels in the vertical direction. The results of integration of the global SINTEX–G model were used in downscaling to the regional level, *i.e.*, the results of integration of three periods, i.e., 1961–1990, 2001–2030 and 2071–2100. For the period 2001–2030, only the A1B IPCC/SRES scenario was used as there is negligible difference between the results of the various scenarios for this period, whilst the A2 scenario was used in addition to the A1B scenario to downscale the results of the global model for the period 2071–2100.

In the assessment of vulnerability and adaptation options, two framework approaches were combined – the „top down" approach, and the „bottom up" approach, which was based on vulnerability assessment and developed by the UNDP (Adaptation Policy Frameworks).

The „top down" methodology enabled all directly and indirectly interested parties to better understand the possible long–term bio–physical effects of climate change (to the end of the century) and potential options for long–term adaptation. Various governmental and non–governmental organisations, scientific and research institutions, and eminent experts participated in the „bottom up" approach, as well as individuals who contributed in targeted interviews. When assessing vulnerability to the current climate variability and extreme events, and vulnerability to future climate changes, local experiences in meteorological, climate and hydrological extreme events and disasters were used, as well as information on traditional knowledge and technology and the capacity of vulnerable sectors and communities to fight the current variability of the climate.

For vulnerability assessment in the agricultural sector, two crop production models, SRIUS and CropSyst, were used in order to determine the impacts of the expected climate change on yield components and crop and vegetable yield. BAHUS model was used as a model for the prediction of meteorological conditions that could lead to diseases and pests.

In the assessment of the options and adaptation measures, a sum of all existing development strategies in the observed sectors were taken into consideration, as well as legal and institutional frameworks, demographic and economic indicators. Other studies, expertise, foreign literature and surveys were also used.

Priority sector–related options and adaptation measures were evaluated and ranked with the participation of interested organisations and individuals.

As regards prioritising the adaptation measures, advantage was given to short–term adaptation measures that reduce vulnerability to the present climate variability, and help reduce the damage caused to the Serbian economy by extreme meteorological, climate and hydrological events and disasters. These measures complement traditional adaptation measures that were implemented in Serbia for decades under the national system of civil protection from bad weather, natural disasters and other adversities.

The remaining uncertainties (IPCC, 2007) are primarily connected with the used global and regional climate models, which are still somewhat limited when it comes to the representation of all atmospheric processes and interactions within the climate system. Additional sources of uncertainties are the projections of the socio–economic development used in the assessment of potential climate change impacts.

4.5. PROBLEMS AND NEEDS FOR REDUCING VULNERABILITY TO CLIMATE CHANGE

Some of basic problems and priority needs for efficient definition and implementation activities and adaptation measures to climate change were indicated during the production of section 4 (Table 4.11).

Problems	Needs
Inadequate systematized data collection and lack of a data base	– Strengthen institutional and individual capacity for collecting and reporting – Strengthen multi–sectoral cooperation – Improve existing monitoring systems within the sectors – Ensure up–to–date monitoring equipment – Improve the meteorological and hydrological observation systems – Improve climate monitoring and extreme climate events early warning – Establish systematized and continuous monitoring of climate change impact parameters within the sectors – Establish efficient data exchange among the „data owners” – Establish an integral data base on climate change impacts for the sectors and ecosystems – Ensure funding
Inadequate vulnerability assessment of the sectors	– Improve the understanding of the multi–sectoral character of climate change – Strengthen institutional and individual capacity in the understanding of the importance of climate change impacts to individual sectors – Strengthen the capacity of local communities, private and public sectors – Raise the awareness level – Strengthen the research capacity for the development and application of methods for the general assessment of climate change impact – Improve research of climate change impact in the sectors and systems – Apply integrated sector–climate models for assessment of climate change impacts and vulnerability of systems – Develop socio–economical scenarios – Strengthen international cooperation – Involve climate change impact problems in development strategy within the sectors – Ensure funding
Lack of detailed and specific measures and activities for adaptation	– Improve understanding of the multi–sectoral character of climate change – Strengthen institutional and individual capacity for defining short–term and long–term adaptation measures and activities – Strengthen the capacity of local communities and the private and public sectors – Raise the awareness level – Adopt an adaptation action plan within each sector – Adopt a national adaptation action plan, including financial technological and capacity building needs for its implementation – Include adaptation measures and activities into development strategies within each sector – Develop new encouraging measures

	– Realisation of infrastructural projects – Ensure up–to–date technological solutions – Ensure funding

Table 4.11. Problems and needs for reducing vulnerability to climate change

4.6. PROJECT PROPOSALS CONCERNING ADAPTATION

In the sectoral analysis of climate change effects, vulnerability, options and adaptation measures, some project proposals were identified in this chapter, which are necessary to ensure more efficient adaptation to climate change. Funding is not provided for most of these project proposals, for this reason, their realisation is uncertain.

Sector	Project proposals
Hydrology and water resources	PROVISION OF THE POPULATION WITH DRINKING WATER Build regional systems (Banat, West Bačka, Rzav, *etc.*) Improve maintenance of existing source profiles Reduce loss in water supply systems
	BUILDING CANAL SYSTEMS IN RESIDENTIAL AREAS AND PROTECTION AGAINST WATER POLLUTION Build waste water treatment plants for all residential areas larger than 2000 ES
	IRRIGATION AND DRAINAGE Harmonise the building of new irrigation systems for the needs of agriculture. Priority systems are those that can be quickly operative (*e.g.*, Hydro system Banat – sub–system Kikinda, Hydro system Negotin Plain) Reconstruct the existing drainage system (the Danube region, HS DTD, *etc.*) and build new drainage systems
	PROTECTION AGAINST FLOODS, EROSION AND TORRENTS Develop existing systems and increase protection against flooding, especially in large residential areas (Belgrade, Novi Sad, *etc.*), as well as in the areas with inadequate protection against floods Forestation of areas degraded by erosion Protect capital values from erosion and torrents Revitalise forests in the Danube foreland basin
Forestry	Disturbed forest ecosystems – improve resilience and revitalise Develop dynamic and purpose–oriented conservation of forest biodiversity, areas under forests and urban areas Adaptation of forest trees and mitigation of climate change effects Adaptive management and improved sustainability and multi–functionality of forests under changed climatic conditions Improve the use of biomass for products and energy
Agriculture	Improve the methodology for the assessment of vulnerability based on agro–climatic indices Change soil treatment by using techniques that will conserve the humidity of soil Develop monitoring system for early warning against drought Introduce measures to reduce erosion in hilly and mountainous areas Optimal fertilisation as an adaptation and mitigation measure Install nets for protection against hail and frost Simulate climate change impacts on agricultural production by using plant production models Model the occurrence of plant diseases and vermin under changed climate conditions

Biodiversity and natural ecosystems	Create a data base on biodiversity Introduce monitoring of the effects of climate change on biodiversity Adjust the protection programme at the level of species Develop structures for the scientific evaluation of biodiversity status affected by climate change Develop models for the assessment of the effects of climate change on biodiversity Regulate management plans for protected areas
Sector	**Project proposals**
Human health	Critical temperature research and determination. The establishment of the morbidity and mortality of animal who are reservoirs of arthropod–borne infections would enable the introduction of continuous monitoring of vectors that are present and are of medical importance to the population The research of insect vectors would focus on the effects of higher temperatures on the spread of areas and the adoption of new habitats, changes and speed of physiological processes, increase in food consumption and reproductive capacity, life expectancy and increased capacities for pathogen transmission due to shorter periods of incubation The research of arboviruses as human pathogens would include recording the cases of etiologically proven diseases
Areas of climate change and risk assessment concerning climate change	Implement programmes of multidisciplinary research on the impacts of climate change on the most vulnerable sectors of the economy and natural systems Capacity building and gaining knowledge to cope with adaptation Produce sector strategies that would include adaptation Develop a socio–economic scenario for Serbia Develop climate monitoring system and spatial data bases concerning local and regional climate change, including information about extreme climate episodes and disasters and vulnerability of certain areas so that they may be used in strategic planning

Table 4.12. Proposed adaptation projects according to sector

5. CLIMATE CHANGE MITIGATION

5. ASSESSMENT OF CLIMATE CHANGE MITIGATION

5.1 APPROACH TO CLIMATE CHANGE MITIGATION ASSESSMENT

Taking into account article 3.3 of the Convention, scientific testimony on the causes of climate change, the fact that the Republic of Serbia is located in a region that is already stricken with changed climatic conditions and the projections of climate change on the national level, the incorporation of mitigation actions into the policies on economic development is undoubtedly one of the national priorities.

The assessment of the GHG emissions mitigation is based on: the detailed analysis of GHG emissions in 1990 and 1998 (given in chapter 3); preliminary analysis of GHG emissions (total, sectoral and per gas type) in 2007; the "Business as usual" scenario until 2012 and 2015 and the analysis of the legislative and strategic documents.

The literature survey included analysis of data, books, texts, reports, relevant projects, and strategic and legislative documents prepared and published by the relevant institutions on the national and international level.

The most important national documents used for this purpose were, of course: the National Strategy of Sustainable Development, the Strategy of Energy Sector Development until 2015 and the Program of the Implementation of the Strategy of Energy Sector Development until 2015 for the Period 2007–2012, the National Strategy for Economical Development from 2006 until 2012, the Strategy for the Development of Agriculture, the Strategy for Waste Management in the period 2010–2019, the Strategy for the Implementation of CDM Mechanisms in the Energy Sector and the National Strategy for Inclusion of the Republic of Serbia in the Mechanism of Clean Development in the Sectors Waste, Agriculture and Forestry.

The analysis was also based on the provisions of the valid legislation that regulates the sectors energy, transport, agriculture and environment, with specific attention on the Regulation of Incentive Measures for Power Production Using Renewable Sources and Combined Heat and Power Production.

In addition to the above–stated, the results of relevant projects financed from international sources were taken into account.

With the aim of acquiring additional knowledge and more information, in–depth interviews and discussions were held with representatives from relevant institutions and involved parties (public and private).

5.2. MITIGATION POTENTIALS PER SECTORS

5.2.1. Energy

From 1990 until now, the emissions from the energy sector represent the largest share in total GHG emissions on the national level. Simultaneously, the „Business as usual" scenario indicates further increases in the level of emissions from this sector. This is mainly due to: the increase in fuel consumption with a somewhat decreased participation of coal and increased participation of oil and natural gas, enlargement of the power production capacities using lignite and hydropower, and alternatively on natural gas, and the expected introduction of systems for desulphurization in thermal plants using lignite.

The analyses showed that the greatest potentials for a reduction of GHG emissions from the energy sector until 2015 are:

1. Rational use of energy, *i.e.*, increase in energy efficiency, and

2. Increased use of renewable energy sources.

The significance of these potentials was already recognized in 2001, when the National programme of energy efficiency was formed. Within the framework of this programme, until 2008, numerous projects for increasing energy efficiency in the whole energy chain were financed (from primary energy production to consumption of the final energy in all sectors) as well as surveys for evaluating the potential use of renewable energy sources.

In 2003, the Agency for Energy Efficiency was established with the aim to popularize and enable more efficient implementation of these projects in the final energy consumption sector.

Increasing energy efficiency and the use of renewable energy sources are two, out of five, main priorities in the Strategy of Energy Sector Development in the Republic of Serbia until 2015. A certain legal framework was established.

Prior activities contributed to an increase in the energy efficiency of large energy objects, *i.e.*, the energy industry, through investment projects for the revitalization of existing plants and feasibility studies for specific potentials. Continuation of the activities aimed at increasing the energy efficiency of large energy objects, as well as the realisation of the potential determined by surveys, are of major importance for realising a decrease in GHG emissions until 2015.

Based on studies on the potential employment of renewable energy sources, some demonstrational projects were carried out, but no significant use has yet been realized. Specifically, from the aspect of the use of hydro potential for decreasing GHG emissions in power production, it is most realistic to expect that until 2015, some small hydropower plants will be built and that the capacities of the existing large hydropower plants will be increased during their revitalization. A significant potential may be found in the use of biomass from agricultural production. The main precondition for the utilization of this potential is the creation of a favourable economic framework and existence of efficient technologies and equipment for collecting, storage and combustion of waste biomass from agricultural production.

In the public sector of power production, the main potentials for the mitigation of GHG emissions are: an increase in energy efficiency and an increase in the share of cogeneration.

In the period until 2015, a realistic increase in energy efficiency may be realized by: replacement of old lignite fired thermal power plants with new ones but with best available technology and much higher energy efficiency compared to old units ; construction of new or replacement of old thermal capacities together with fuel substitution (from lignite to natural gas) for cogeneration of heat and electricity, with a gas–steam cycle and a significantly higher over–all energy efficiency and revitalization and modernization of existing thermal capacities for electricity production on lignite together with a decrease in self–consumption, *i.e.*, an increase in energy efficiency.

A decrease of GHG emissions in the public sector for the central distribution of heat and hot water is possible through: an increase of the energy efficiency of the over–all system for distribution of heat; a decrease of the specific consumption of energy per heated area by the introduction of a metering system and payment for the consumed energy; further substitution of coal and heavy oil as energy source with natural gas and biomass and especially by the introduction of contemporary technological solutions with a high energy efficiency, such as combined heat and power production and units with a gas–steam cycle and cogeneration where natural gas is available and if the consumer size and the economic framework allow such solutions.

In the sub–sector of oil refining, mitigation of GHG emissions is possible through measures for the rational use of energy. From the point of view of rational use of energy and the total GHG emissions, an alternative measure is the introduction of combined heat and power production, since the consumption of both energy forms is stable throughout the year, and highly qualified personal exist for such a production. A favourable economic framework, above all the parity of the price of electricity related to the prices of natural gas and oil derivatives, is a necessary precondition for such solutions and measures.

In the sector of industrial processes, possibilities for rationalizations of consumption and increase in energy efficiency (introduction of automation of processes, monitoring, waste energy utilization, *etc*.) exist. A further reduction in GHG emissions may be realized by substitution of liquid fuels with natural gas. Taking into account the large number of old and outdated industrial facilities that must be revitalized or fully replaced in the next period, an additional potential for a reduction of GHG emissions exists in the alternative use of co–generative units based on natural gas or biomass where the required conditions exist.

The most significant measures for the mitigation of the expected increase of road transport and the associated GHG emissions are the following: re–establishment of an efficient international rail transport; refurbishment of the road infrastructure, above all on the most important international corridors; increase of the level and the efficiency of river transport, primarily along the River Danube; modernization of the motor pool with up to date and highly efficient motor vehicles; cessation of the production of leaded gasoline and an increase of the share of TNG; and a suitable economic environment.

In the other sub–sectors (public/commercial sector, residential, agriculture, forestry and water management), a reduction of GHG emissions is primarily possible through additional thermal insulation of the buildings and all aspects of energy consumption rationalization in the domestic, public and commercial sectors.

From the point of view of the rational use of energy and the total GHG emissions in the Republic of Serbia, a significant alternative measure is the substitution of electricity consumption with natural gas wherever conditions allow it. A favourable economic framework, in the first place the parity of the prices of electricity and natural gas, is one of essential preconditions for such measures (apart from financial and technical/technological provisions).

The most significant mitigation measures related to fugitive emissions are in the area of production, processing/upgrading and transport/distribution of natural gas and, to a lesser extent, underground coal mining. The comparison of the available data on fugitive norms, *i.e.*, emission factors, for developed countries indicates a significant potential for decreasing the fugitive emissions of methane in the sector of natural gas.

Underground coal mining is always associated with increased methane emissions and in coal mines, as is the case in the coal mine „Soko"; it stands to reason to apply new technologies. These technologies would introduce combustion of the gas mixture from the ventilation system, along with *in situ* use of the generated heat, which would decrease the fugitive emissions from such coal mines. Potentially, certain project activities may be performed through employment of the CDM mechanism.

The implementation of the above–mentioned measures and activities in the energy sector primarily depend on their viability and feasibility as well as on the availability of the necessary financial support for their realization.

The situation related to securing the necessary financial resources may be partially improved by the establishment of an Energy Efficiency Fund (planned to be formed in 2011). The government has partially formed the necessary financial conditions for a wider implementation of renewable energy sources (by adopting the appropriate bylaws in 2009) through more acceptable purchase prices of electricity from such facilities, *i.e.*, feed–in tariffs. Nevertheless, ensuring financial support from foreign sources has a significant role to play in the implementation of primarily large infrastructural projects, *i.e.*, projects that will ensure the introduction of new technologies and capacity building of their users.

The financial feasibility for the implementation of measures for increasing energy efficiency and for the use of renewable energy sources, may be achieved only by the establishment of an appropriate parity between the prices of electricity produced from domestic sources as well as heat, on the one hand, and the prices of natural gas and liquid fuels on the other. The transition towards a free market in electricity and natural gas had a positive trend until the end of 2007, but the events on the world market of energy sources and the world financial crisis in 2008 have significantly hindered this process.

5.2.2. INDUSTRIAL PROCESSES

The GHG emissions from this sector in 1990 had a relatively small share (5.28 %) of the total GHG emissions. The level of GHG emissions practically remained the same during the 1990s and only after 2003 has a tendency of steady moderate growth been visible. The GHG emissions from this sector mainly result from prime processing/refining, energy intensive, industries.

Thus, in the period up to 2015, there are minimal possibilities for reducing the growth rate of GHG emissions from this sector.

5.2.3. AGRICULTURE

The emissions from the chemical and biochemical processes in agricultural production in 1990 represented a significant portion of the GHG emissions on the national level. During the nineties, agricultural production showed a moderate declining tendency, being in the last 8 years on the level of 90 % in relation to the production in 1990. The emissions from agriculture are primarily the result of the emissions of methane from stockbreeding and emissions of nitrous oxide from farming (due to the use of fertilizers).

The potential for GHG emissions mitigation until 2015 may be primarily found in the use of biogas for heat generation or cogeneration of heat and power for local use, on large cattle and pig farms. The implementation of these activities depends to a large extent on foreign financial and technical/technological support.

5.2.4. FORESTRY

In the past 20 years, the forest cover has been increased and the state of the forests has been partially upgraded, in relation to the referent year (1990). This has been mainly the consequence of regular planned activities on afforestation, but is also due to a population decline in rural areas (especially in hilly and mountainous areas), which has resulted in the discontinuation of extensive agricultural production in these areas.

The draft of the master plan for forests (from 2008) emphasized the significance and possibilities of the forest complex in mitigating climate change and adaptation to the changed climatic conditions. The measures were defined for supporting the realization of a 10–year goal on afforestation on soils (primarily category V and VI) that are not intensively used for agricultural production anticipate certain quantitative measures for increasing the forest cover, as well as optimal use of the production potential of the habitats.

The implementation of these measures would significantly increase the potential for CO_2 capture from the atmosphere.

5.2.5. WASTE MANAGEMENT

The contribution of GHG emissions from the waste sector to the total emissions in 1990

was practically insignificant (2.38 %). According to the “Business as usual” scenario, the GHG emissions will rise in the coming years, until 2015.

Taking into account that the main GHG emissions are a result of poorly organized landfills, which is the only present practice for organized waste disposal, the greatest potential for reduction of emissions are noted in this area. The realization of the potentials for the mitigation of GHG emissions may be accomplished by establishing regional landfills, along with utilization of the fumes, as well as by increasing the degree of recycling and the introduction of co–combustion of selected waste in power and/or heat production facilities.

A large portion of these activities, related primarily to recycling and co–combustion, depend on foreign financial and technical support.

5.3. ANALYSES OF GHG EMISSION REDUCTION OPTIONS IN RELEVANT SECTORS

The analysis of potential opportunities for the mitigation of GHG emissions compared to the baseline scenario (alternative scenarios), *i.e.*, the expected emission trends on the national level, is outlined in the following subheadings.

It is significant that the realization of these potentials until 2015 largely depends on the provision of foreign financial and technical assistance, primarily through cooperation at the bilateral and multilateral level.

5.3.1. ENERGY SECTOR

According to the Energy Development Strategy until 2015 (which was taken as a "Business as usual" scenario), it is envisaged that by 2012, new lignite thermal units will be in operation with a rated power of 700–750 MW_{el}, an annual production of about 4800 GWh and a standard efficiency of such plants of 33.5 %. This would require an additional annual coal production of about 6.91 million tons.

In order to reduce GHG emissions, the alternative scenario implies the construction of a modern power unit running on lignite, but with advanced technology, supercritical steam parameters and an efficiency of 43 %. This would reduce the need for additional coal production from 6.91 to 5.38 million tons per year.

The realization of such a scenario, through the increase of the energy efficiency, would result in an annual reduction of GHG emissions of about 1,268 Gg CO_2eq. In addition, this would lead to a reduction in the amounts of deposited ash.

According to the same Strategy, the construction by 2015 of a new/replacement thermal unit running on lignite with a nominal power of 500 MW_{el}, and an annual production of about 3400 GWh (an additional annual production of 2,200 GWh) is also planned. The efficiency such plants would be 33.5 %. This would require an additional lignite production of about 3.17 million tons per year.

The same alternative scenario implies that by 2015, the old power units running on lignite, having an annual production of 1,200 GWh, will be shut down but that instead of building new/replacement capacities on lignite:

1. A part of the replacement production on lignite be substituted by an additional production of electricity from the hydro potential, at the level of around 710 GWh, through

revitalization (along with a power increase) of the existing hydropower plants and construction of new small hydropower plants of up to 15 MW.

2. The remainder of the replacement production and the needed additional power produced by lignite, in a total amount of 490+2,200 GWh, be realized by building (until 2015) a modern cogeneration unit on natural gas with the best available technology (gas–steam cycle and the corresponding operating parameters). The thermal unit would have a standard power of 380 MW_{el}, while the heat output would be 230 MW_{th}. The annual production of heat, according to the current consumption, would be 615 GWh_{th} and the electricity production 2,690 GWh_{el}, with an additional consumption of natural gas of 420,000 toe.

Through these two investment projects, by substitution of electricity generation from lignite (2,200 +1,200 GWh/yr) with new plants based on hydro potential (710 GWh) and natural gas (2,690 GWh), the total annual reduction of GHG emissions would be 3,209.4 Gg CO_2eq/year.

It is noteworthy that an alternative solution for the new (replacement) thermal unit with natural gas instead of lignite, under current economic conditions and the existing parity of electricity / natural gas prices could possibly be financially feasible in the case of implementation through the Clean Development Mechanism (CDM).

A potential for additional reduction of the GHG emissions lies also in the restoration and modernization of the existing thermal units for power production on lignite (the alternative scenario), *i.e.*, increase of their energy efficiency. The activities would include, primarily:

1. Revitalization/upgrading of the steam turbine, condensation plant and cooling system of the unit, boiler and auxiliary equipment (*e.g.*, low/high pressure feedwater heaters);
2. Revitalization and upgrading of the feeding system and the combustion process by the introduction of„Low NOx" burners, which would increase the power level of the old 300 and 620 MW_{el} thermal power units.
3. The transfer and introduction of new modern technologies for pre–drying of lignite (from 50 % moisture in the raw lignite from the Kolubara Basin to 40 % in the pre–dried coal) with waste heat from the thermal unit.

An increase of the efficiency of the over–all cycle of only 2 percentage points (unit efficiency of 34.2 % to 36.2 %) of a 620 MW_{el} unit, with annual production of 8,000 GWh, would lead to yearly saving of 0.624 Mt of lignite. In this way, the CO_2 emissions would be reduced to 519 Gg CO_2/year.

Increasing the energy efficiency of all the 300 MW_{el} units by two percentage points (from 30.5 % to 32.5 %) would reduce the lignite consumption by 1.28 Mt/year and the emissions of carbon dioxide by 1,070 GgCO_2/year.

The total reduction of the GHG emissions would be 1589 Gg CO_2eq/year.

The realization of the stated alternative scenarios in relation to the baseline scenario in the field of the thermal energy sector for electricity generation by 2015 may contribute to a reduction of lignite consumption of 8.46 Mt/year and of GHG emissions in total of about 6,067 Gg CO_2eq/year.

In the area of fugitive emissions, the alternative scenario envisages the undertaking of numerous measures to reduce losses of natural gas, *i.e.*, the fugitive methane emissions in the field of production, processing, transport and distribution of natural gas, as well as to reduce losses in gas consumption in industry, district heating and combined heat and power production plants.

These measures would lead to a reduction of fugitive emissions of methane by 20 % in relation to the emission levels envisaged by the baseline scenario.

5.3.2. AGRICULTURAL PRODUCTION SECTOR

In the sector of agricultural production, the alternative scenario involves the introduction of biogas production on large cattle and pig farms and electricity/heat production from it for local needs.

Relative to the total methane emissions from livestock manure in the baseline scenario, the introduction of special treatment of livestock manure along with the production and combustion of biogas, a reduction of 14 % (3.92 $GgCH_4$/year) by 2012 or 29 % (6.9 $GgCH_4$/year) by 2015 would be realized.

5.3.3. FOREST MANAGEMENT SECTOR

In the sector for forest management, the alternative scenario implies an increase of forest coverage by 90,000 ha in the following 10 years.

Based on the additional forest coverage of 90,000 ha/year, an additional CO_2 sink of around 110 $GgCO_2$/year would be realized.

At the end of the 10–year investment period, the above measure would cumulatively lead to an additional binding of carbon dioxide from the atmosphere of around 5,000 Gg CO_2, with specific cost of 30 Euro/tCO_2.

5.3.4. WASTE MANAGEMENT SECTOR

In the waste management sector, the alternative scenario anticipates that on the largest landfills, on which around 40 % of the communal waste is stored, systems be built for collecting the landfill gas (with an efficiency of up to 60 %) and combusting it in a flare or in a boiler and generating heat for local use.

In this way, the emission of methane would be reduced by around 43.8 $GgCH_4$/year, i.e., the total GHG emissions would be reduced by 798 $GgCO_2eq$/year when the GHG emissions due to incineration of the landfill gas are also taken into account.

5.4. EMISSION TREND AND GHG REMOVAL UNTIL 2015 PER SECTORS

5.4.1. ENERGY SECTOR

After a decrease in consumption during the nineties, the level of consumption of fossil fuels for energy purposes during the last ten years has constantly increased. The base case projections indicate a growth of +8.23 % in demand in 2012, and +15.69 % in 2015 (Figure 5.1), compared to the reference consumption in 1990.

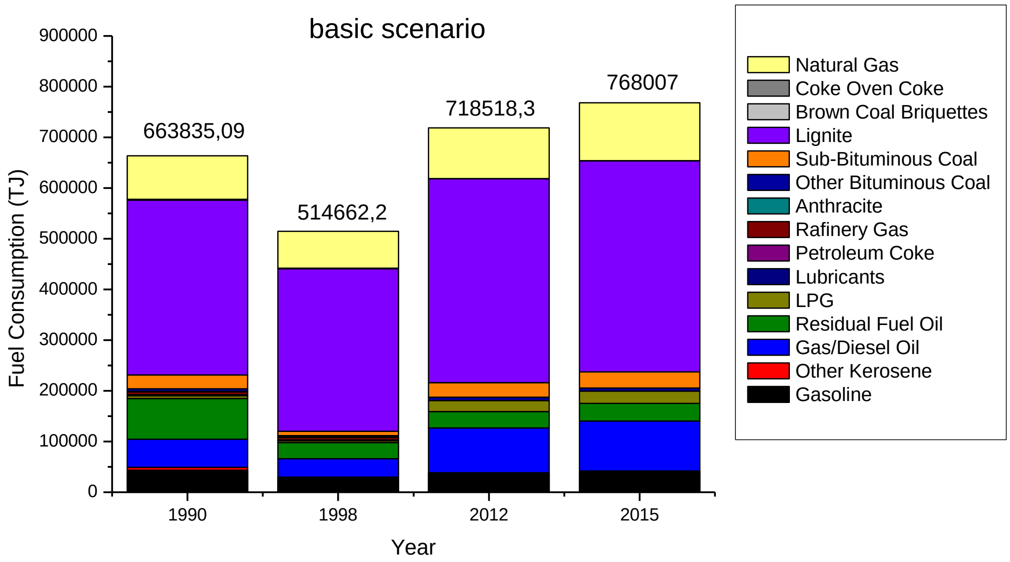


Figure 5.1. The structure of the projected fossil fuels consumption for energy purposes until 2015, baseline scenario

Implementation of the measures proposed by the alternative scenario (Figure 5.2) would reduce this increase to 6.52 % by 2012 and 8.91 % in 2015.

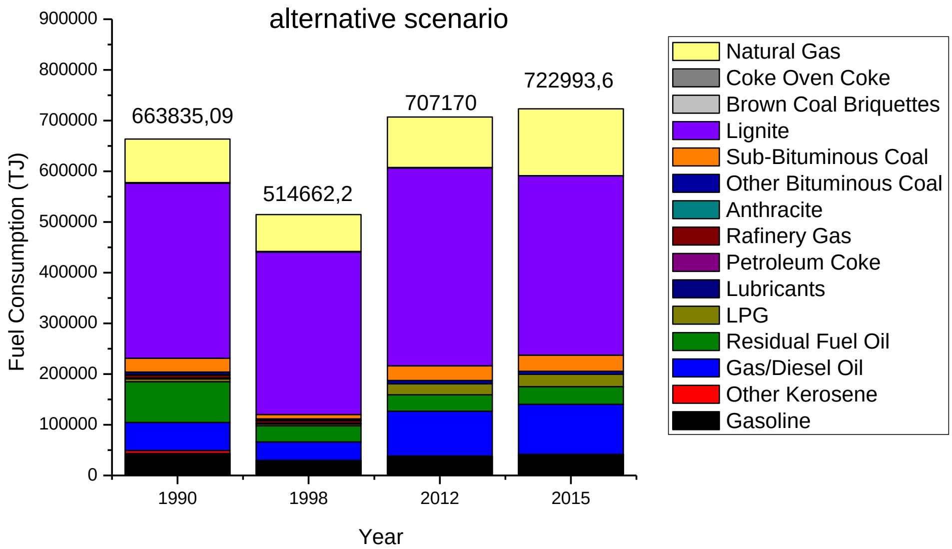


Figure 5.2. The structure of the projected fossil fuels consumption for energy purposes until 2015, alternative scenario

The share in GHG emissions resulting from burning fossil fuels for energy purposes was in 1990 at the level of 74 % and it remained at such a high level (72 % in 1998) to the present.

An estimation of the GHG emissions arising from the combustion of fossil fuels in the energy sector in the period until 2015 is given in Figure 5.3, for both the baseline and the alternative scenario.

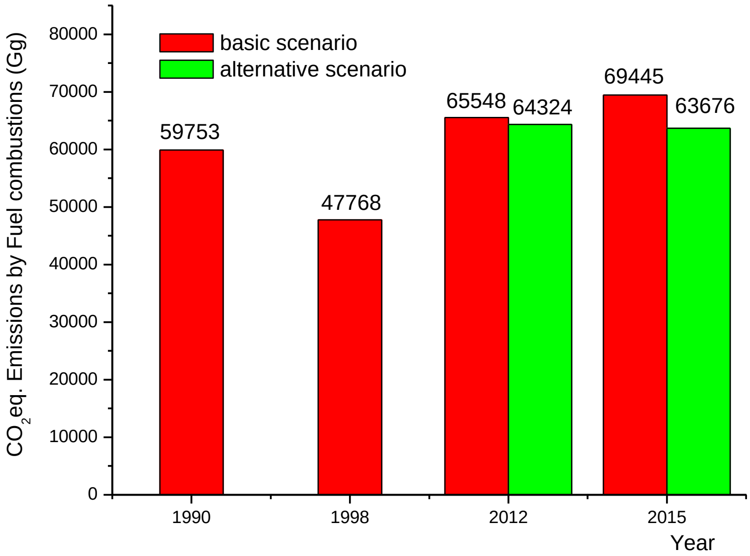


Figure 5.3. The GHG emissions arising from the combustion of fossil fuels for energy generation until 2015, baseline/alternative scenario

According to both scenarios, an increase in GHG emissions is expected in relation to the base year 1990. According to the baseline scenario, this increase will be 9.7 % until 2012 and 16.22 % until 2015. Implementation of the alternative, complementary measures, would limit the increase to 7.65 % until 2012 and 6.56 % until 2015. Implementation of the alternative scenario would reduce growth of GHG emissions in relation to the base year 1990.

1.A.1 Projection of the GHG emissions by energy industries

The energy industries were the largest emitters of GHG in the previous period. They will proportionately contribute the most to the increasing emissions in the future. This primarily applies to the public sector for power generation, which, according to all planning documents, will introduce new/replacement production capacities and increase the production. The trend of increasing GHG emissions is also expected in the oil refining sub–sector (in proportion to the increased volume of processed crude oil). However, taking into account the small share of self consumption in this sub–sector in relation to the total consumption of fossil fuels, the expected rise in the level of GHG emissions is very small. In the public sector for district heating, in spite of the additional heating surfaces in the future, it is expected that energy efficiency measures and the substitution of liquid fuels with natural gas will result in a stagnation of the GHG emissions until 2015. Similarly, a stagnation of the production level and GHG emissions in the sector of solid fuel processing (drying process) is also expected.

Projection of the summarized GHG emissions by energy industries in the period until 2015 for baseline and alternative scenario is shown in Figure 5.4.

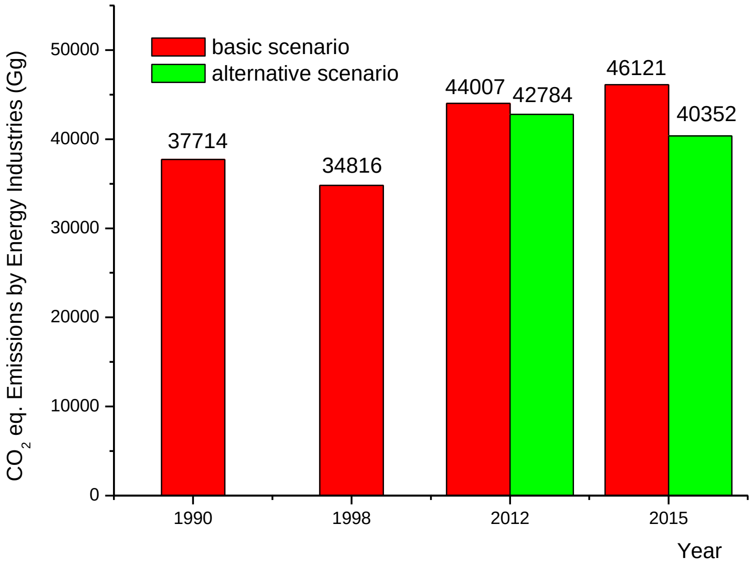


Figure 5.4. The GHG emissions by energy industries until 2015, baseline/alternative scenario

Under the baseline scenario, the expected increase in GHG emissions will be 16.7 % in 2012 and 22.3 % in 2015. According to the alternative scenario, emissions will have increase by 13.4 % in 2012 and 7 % in 2015, compared to the emissions in the base year 1990. Implementation of the alternative scenario would reduce the growth in GHG emissions relative to the base year 1990.

1.A.2. Projections of the GHG emissions by the manufacturing industries and construction

The contribution of industrial activities involving the combustion of fossil fuels to the total amount of GHG emitted in 1990 was 7.84 %. During the nineties, industrial activity drastically decreased and still the recovery is not significant (the physical volume of industrial production in 2005 was on the level of 45.2 % of that in 1990). Nevertheless, energy consumption did not fully decrease in proportion to the reduction in industrial production; thus, in 1998, the GHG emissions were 54.4 % of those in the base year 1990.

Under the baseline scenario, revival of the activities in this sector is anticipated and the expected levels of the GHG emissions will be 58 % in 2012 and 68.2 % in 2015 in comparison to the base year 1990 (Figure 5.5).

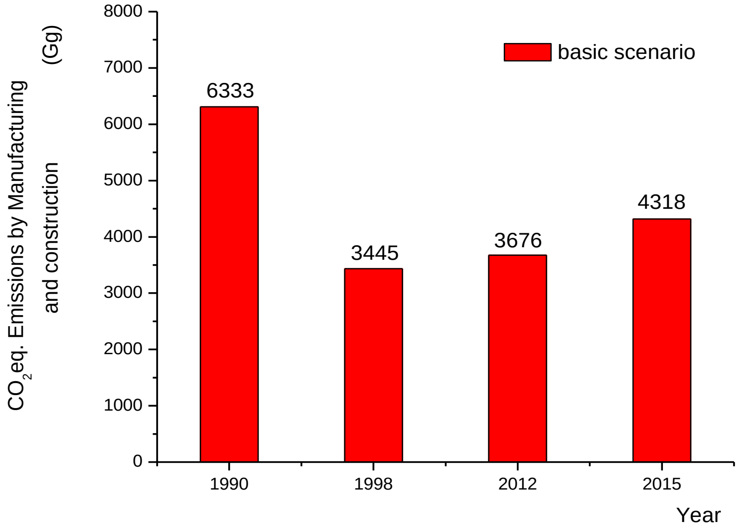


Figure 5.5. Projection of the GHG emissions due to fossil fuels combustion for energy purposes in the manufacturing industries and construction until 2015

Despite the real potential for reducing energy consumption and GHG emissions in the industrial sector, the implementation of additional measures to reduce GHG emissions, through additional investments in energy efficiency and cogeneration plants, is very difficult to achieve in the considered period due to the adverse economic and financial conditions in the country.

1.A.3. Projection of GHG emissions in the transport sector

The transport sector participated with 7.07 % to GHG emissions in 1990, with road transport being dominant (6.76 %). The consumption of fossil fuels in transport significantly decreased during the nineties and with it GHG emissions. This is primarily because the supply of liquid fuels decreased (along with relatively high prices) as did international transit traffic. However, already in 2001, the consumption of petroleum products reached 85 % of that in 1990, and the dynamic growth, especially in road transport, is continuing.

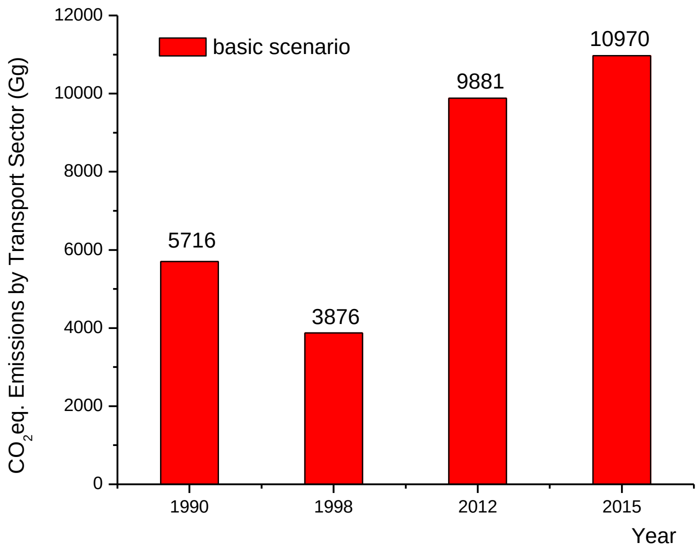


Figure 5.6. Projection of the GHG emissions in the transport sector until 2015

Under the baseline scenario, the GHG emissions will increase up to the level of 172.9 % in 2012 and 191.9 % in 2015 compared to the base year 1990 (Figure 5.6). The implementation of the alternative scenario in the observed period implies great efforts and almost complete reorganization of the existing system, with substantial financial and technical/technological investments.

1.A.4. Projection of the GHG emissions in Other sectors

During the nineties, consumptions of fossil fuels in the Other sectors were mainly substituted with cheap electricity, and as a result the significantly increased GHG emissions were transferred to the energy sector . Such a situation has remained until today.

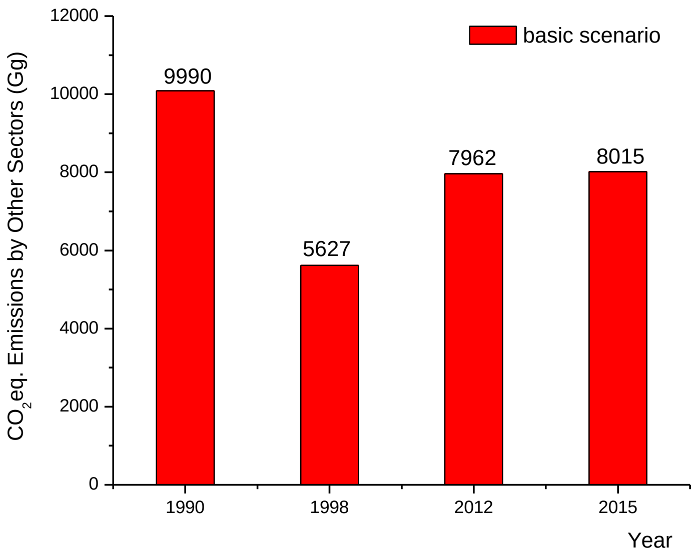


Figure 5.7. Projection of the GHG emissions from Other sectors until 2015

In the basic scenario, a partial substitution of electricity with natural gas and, to a lesser extent, other fuels has been very optimistically planned, along with an increase in GHG emissions in the subsequent period in relation to the present state. Based on this, the projected GHG emissions in this sector would be at the level of 79.7 % in 2012 and 80.23 % in 2015 compared to the level in the base year 1990 (Figure 5.7).

The implementation of additional measures for reduction of GHG emissions are very difficult to achieve in the analyzed period.

1.B. Projection of the fugitive emissions from the production, processing, transport and distribution of fossil fuels (coal, oil and gas)

Proportional to the increase in consumption of fossil fuels, it is expected that fugitive emissions will also rise in the next period (Figure 5.8).

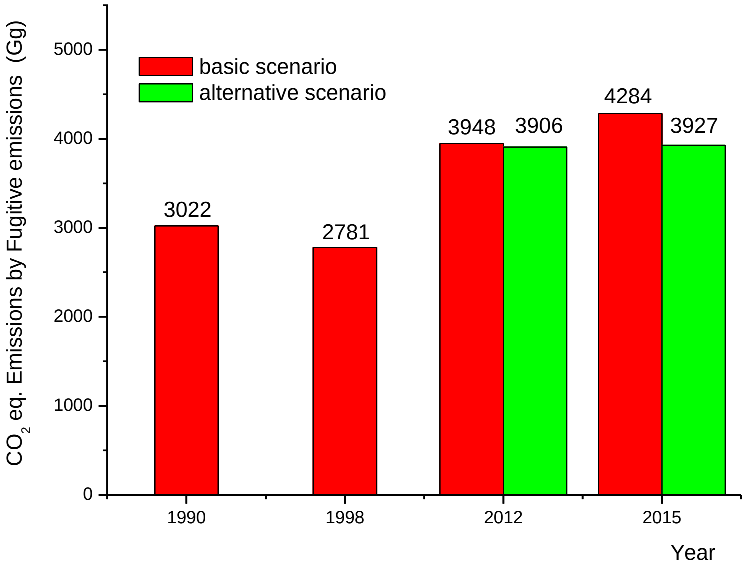


Figure 5.8. Projection of the fugitive emissions until 2015, baseline/alternative scenario

According to the baseline scenario, the methane emissions will increase (expressed in CO_2eq) such that they will be 130.6 % in 2012 and 141.8 % in 2015 in comparison to the fugitive emissions in the base year 1990. As a result of the mitigation measures considered in the alternative scenario, aimed at lowering the methane emissions from the gas distribution grid, the methane emissions may be 129.3 % in 2012 and 129.9 % in 2015 in comparison to the fugitive emissions of methane in the base year 1990. Fulfilment of the alternative scenario would lower the increase of GHG emissions in comparison with the GHG emissions in the base year 1990.

5.4.2 INDUSTRIAL PROCESSES

2.A. Projection of GHG emissions due to the production/consumption of mineral products in industrial processes

Production of mineral products, such as limestone and dolomite, cement, slaked lime and sodium carbonate, is traditionally strong in Serbia because a significant production capacity, domestic raw material base, cheap fuels, experienced workforce and a significant consumption/demand in the country (primarily by the construction industry) have been developed. After the decline of production in the nineties, this industrial branch has rapidly recovered since 2001. In the coming period, in addition to the full utilization of the existing capacity for production/consumption of mineral resources, and as a result of the use of limestone in new facilities for desulphurization of flue gases from power plants using lignite, it is expected that the emissions of CO_2 will additionally increase.

It is expected that the increase in emissions of CO_2 will be at the level of 9 % in 2012 and 20 % in 2015, compared to the reference emissions in 1990 (Figure 5.9).

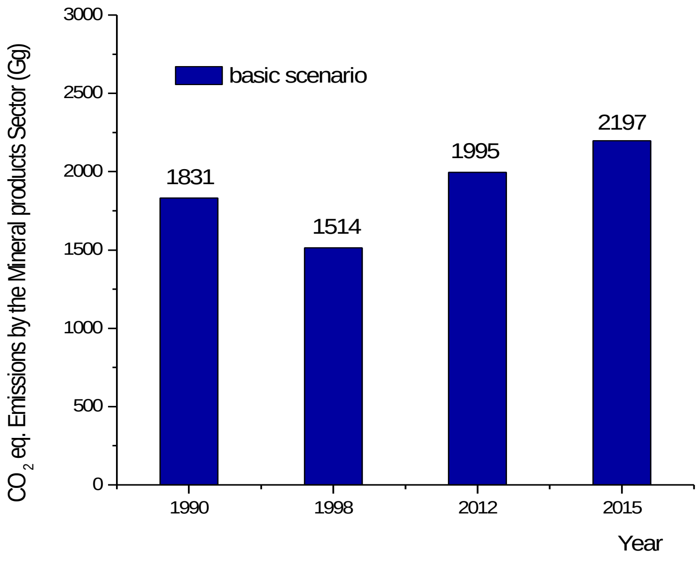


Figure 5.9. Projection of the GHG emissions due to the production/consumption of mineral materials in industrial processes until 2015

It is expected that the increase in emissions of CO_2 will be at the level of 9 % in 2012 and 20 % in 2015, compared to the reference emissions in 1990 (Figure 5.9).

2.B. Projection of the GHG emissions from industrial processes in the chemical industry

The chemical industry is mostly still in transition and its level of production varies from year to year and, thus, it is difficult to predict the level of production and emissions in the future. It is significant that the share of this sub–sector in the total GHG emissions is relatively small (1 % in 1990). Generally, in the future, according to the baseline scenario, it is expected that the market–competitive base chemical industry will stabilize its production at the level corresponding to its maximum production capacity.

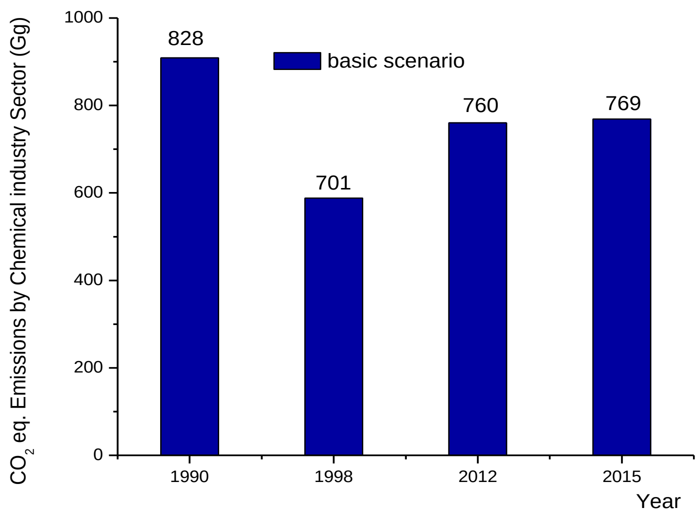


Figure 5.10. Projection of the GHG emissions from industrial processes in the chemical industry until 2015

According to this scenario, the expected GHG emissions from the processes in chemical industries will be on the level of 91.8 % in 2012 and 92.9 % in 2015 in comparison with the referent emissions in the base year 1990 (Figure 5.10).

2.B. Projection of GHG emissions from metal production industrial processes

The metal manufacturing sector, especially steel production, has significant production capacities, which have after privatization (after 2001.) renewed and even significantly raised their production. It is expected that the trend of increasing production, up to the maximum production capacity, will continue in the future.

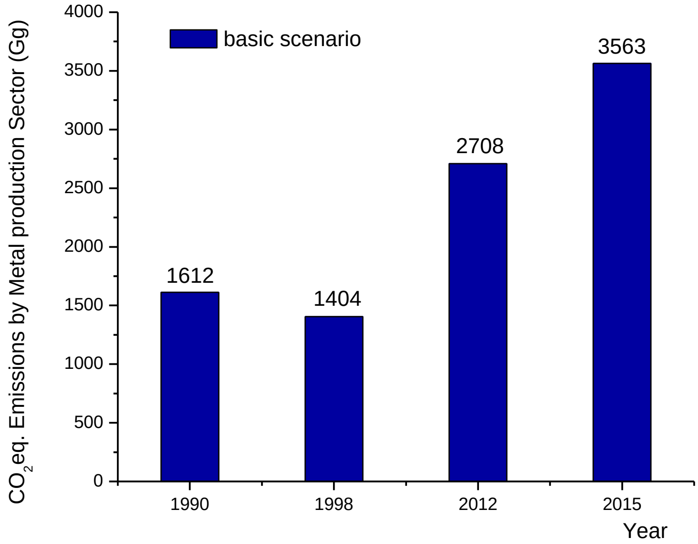


Figure 5.11. Projection of GHG emissions from metal production industrial processes until 2015

With the increase of production, it is expected that GHG emissions will increase from 168 % in 2012 to 221 % in 2015, compared to the reference GHG emissions in the base year 1990 (Figure 5.11).

5.4.3 AGRICULTURE

Despite significant fluctuations in the period from 2002, there has been a clear trend of recovery in crop and livestock production, which is expected to continue in the future.

Under the baseline scenario, the GHG emissions from biochemical processes in agriculture will in 2012 reach the emissions in the base year 1990 and surpass them in 2015 by +8.8 %. According to the alternative scenario, the GHG emissions will be at the level of 99.3 % in 2012 and 107.7 % in 2015, compared to the emissions in the base year 1990 (Figure 5.12).

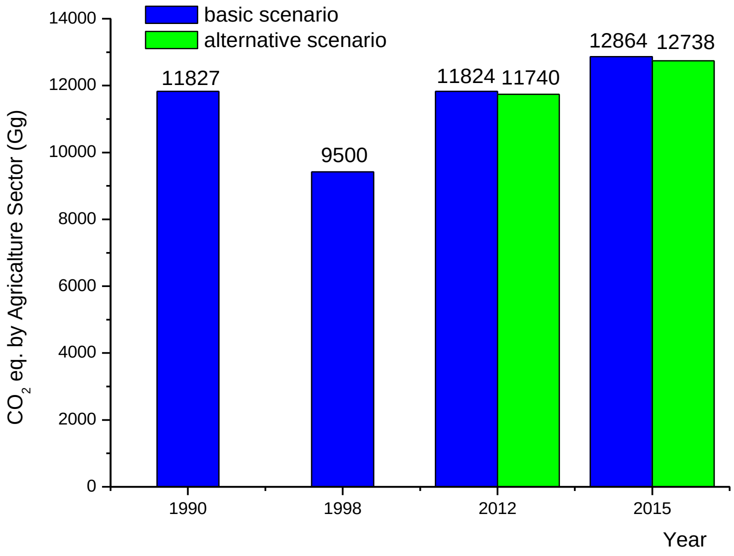


Figure 5.12. Projection of the GHG emissions from agriculture until 2015, baseline/alternative scenario

5.4.4 FORESTRY

The net annual amount of carbon dioxide bound in the timber mass of the forest complex in the last 20 years has been rising. This trend is also expected to continue in the coming period, hence, the amount of removed CO_2 will increase by about 68 % by the end of the analyzed period (according to the baseline scenario), compared to the reference amount of CO_2 removed in the base year 1990 (Figure 5.13).

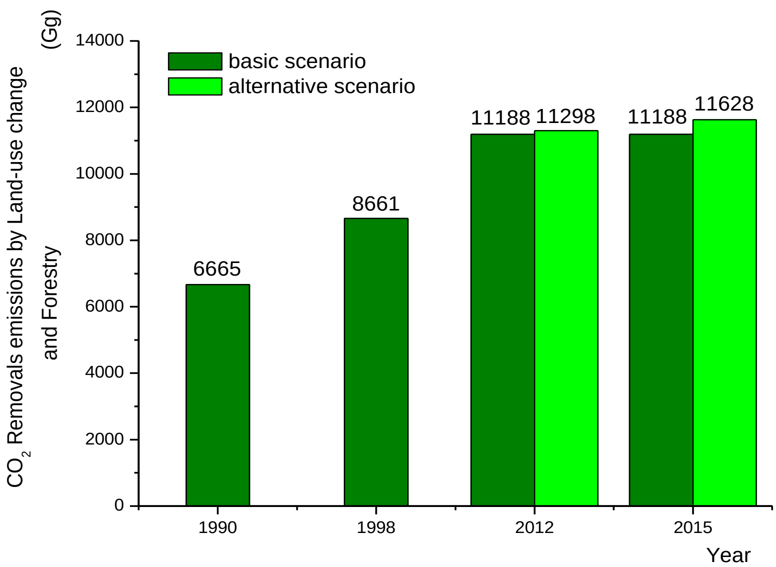


Figure 5.13. Projection of CO_2 removal by the forest complex until 2015, baseline/alternative scenario

According to the alternative scenario, with the provision of providing financial resources for further afforestation of 9,000 ha/year, the amount of removed CO_2 will increase by 69.5 %

in 2012 and 74.5 % in 2015, compared to the reference amount of CO_2 removed in the base year 1990 (Figure 5.13).

5.4.5 WASTE MANAGEMENT

The GHG emissions from the waste management sector have increased steadily in the period since 1990 until today. Under the baseline scenario, this trend will also continue in the future; hence, the estimated emissions in 2012 could be doubled, or in 2015 even 215.2 % compared, to the emissions in the base year 1990 (Figure 5.14).

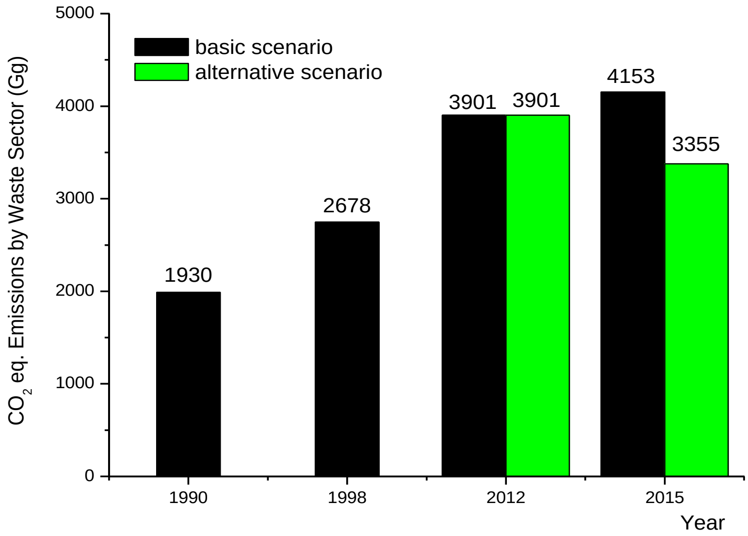


Figure 5.14. Projection of GHG emissions in the waste management sector until 2015, baseline/alternative scenario

Alternatively, the construction of the planned regional landfills with the employment of the landfill gas, and a significant degree of recycling and the introduction of co-combustion of waste in coal power plants by 2015 would limit the GHG emissions in this sector to the level of 179.3 %, compared to the reference emissions in the base year 1990. The implementation of the alternative scenario would reduce the growth in GHG emissions in relation to the ones in the base year 1990.

5.5 SUMMARY OF SCENARIOS

The total GHG emissions per sectors, in the period since 1990 until 2015, are shown in Figure 5.15 according to the baseline scenario and in Figure 5.16 according to the alternative scenario.

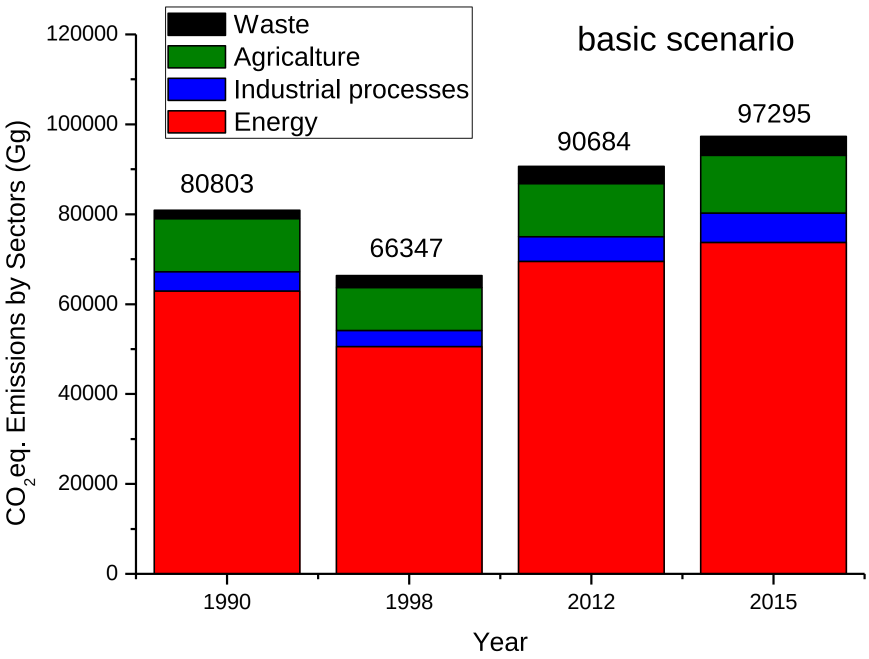


Figure 5.15. Total GHG emissions until 2015 according to the baseline scenario

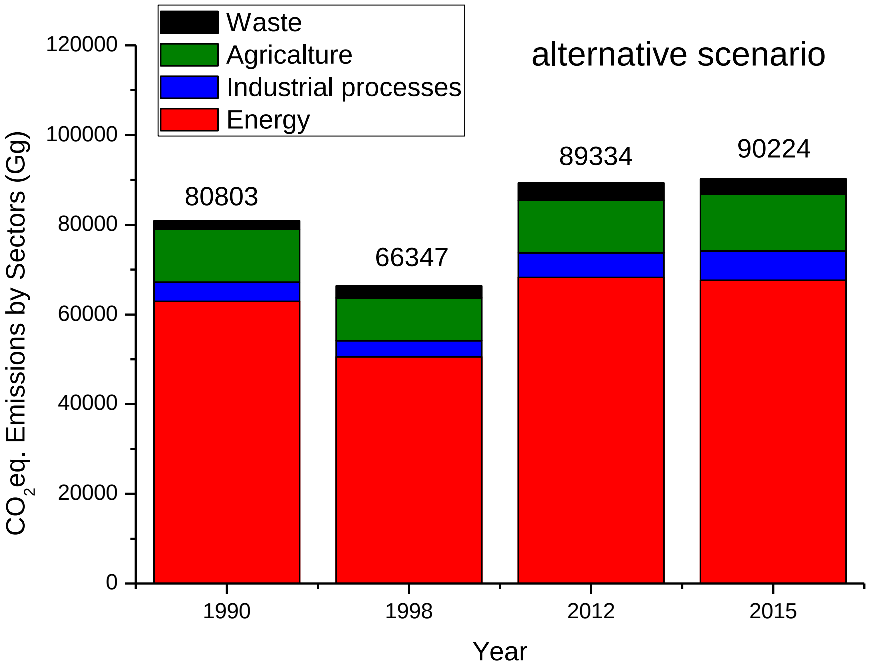


Figure 5.16. Total GHG emissions until 2015 according to the alternative scenario

By comparing the total GHG emissions projected by the baseline and alternative scenario, it may be seen that, due to the additional measures, the expected increase in GHG emissions in the Republic of Serbia in 2015 may be reduced by about 7,000 Gg.

The most important condition for the realisation of the alternative measures is whether the transfer of up-to-date technologies and significant investment resources are accessible through bilateral and multilateral cooperation.

The trend of the total GHG emissions, expressed in percentage of the total GHG emissions in the base year 1990, is shown for the baseline scenario in Figure 5.17, and for the alternative scenario in Figure 5.18.

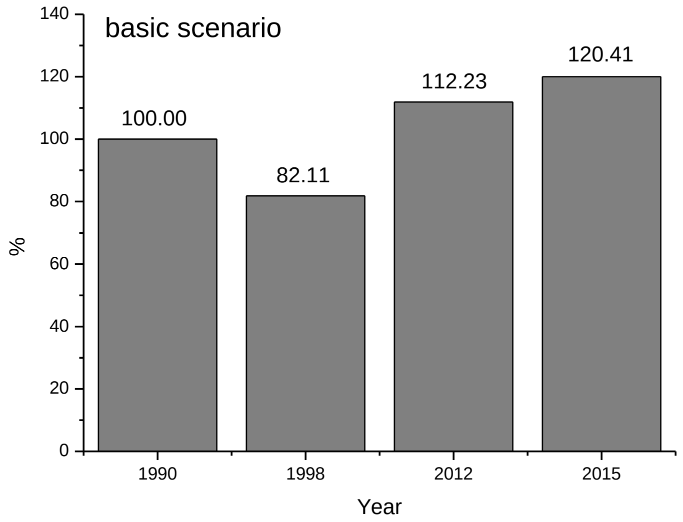


Figure 5.17. Indexes of GHG emissions until 2015 normalized to the 1990 value, baseline scenario

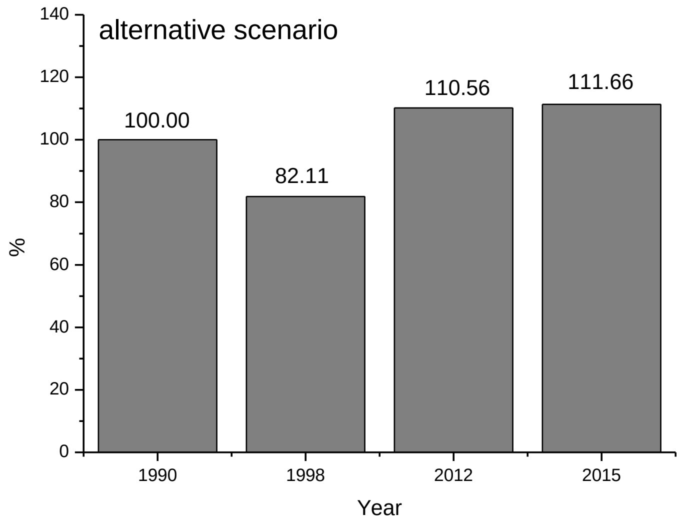


Figure 5.18. Indexes of GHG emissions until 2015 normalized to the 1990 value, alternative scenario

During the nineties of the twentieth century, the total GHG emissions were reduced compared to the emissions in the base year 1990 (in 1998 they were at the level of 82 %). After the year 2001, a steady upwards trend may be noted.

Under the baseline scenario, the total GHG emissions would reach a level of 112.23 % in 2012, and 120.41 % in 2015 of the 1990 value of GHG emissions.

According to the alternative scenario, this upward trend in emissions would be mitigated, *i.e.*, the GHG emissions in 2012 would reach the level of 110.56 %, and in 2015, the level of 111.66 % of the total GHG emissions in the base year 1990.

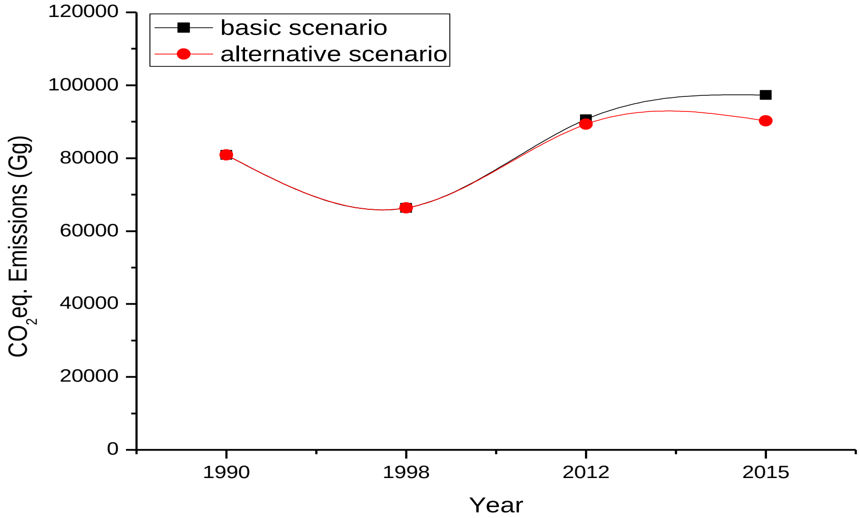


Figure 5.19 GHG emissions projection until 2015 according to the baseline and alternative scenario

The aim of the Government is to slow down the expected upward trend in GHG emissions in a relatively short period of time, until the year 2015 (Figure 5.19).

5.6. PROBLEMS AND NEEDS

The process of assembling this chapter of the Initial National Communication revealed the lack of institutional and individual capacities for a detailed assessment of projections and opportunities for the reduction of GHG emissions. In addition, it became apparent that, for the efficient and systematic implementation of the established and proposed measures to mitigate climate changes, there is a lack of financial and technical/technological capacities at the national level.

Therefore, capacity building in the area of systematic techno–economical analysis of options for mitigating climate changes and projections of possible scenarios, per sector, and evaluation of the needs for relevant technical, technological and financial needs, are principal requirements in the area of climate change mitigation.

Significant improvement of the activities (capacity building and financial support) is also required for a more efficient dissemination of scientific and technical information.

From the point of view of using the Clean Development Mechanism, further capacity building is necessary as well as dissemination of information among the professional community and especially to the private and public sectors.

For the more effective increase of the energy efficiency, in the whole chain of energy use, further capacity building and methodical work is required, especially for the preparation of national documents and action plans for implementation, including assessments of the technological requirements, and also for monitoring and adopting corrective measures in the course of their implementation. Significant bilateral/international financial, professional and technical assistance is also needed as well as the transfer of modern technologies for the realisation of specific actions to reduce GHG emissions.

In the area of increasing the use of renewable energy, some of the priorities are: financial and technical assistance for capacity building and more intense dissemination of important scientific and technical information within the professional community, improving the organization of methodical data collection, analysis and processing in order to prepare national documents, action plans and specific projects for implementation, including assessment of the technological requirements, as well as monitoring and adopting corrective actions during the implementation of the measures, *etc*. Of particular importance for the implementation of measures and actions to reduce GHG emissions is the transfer of modern technologies

In addition to these needs, the specific priority projects that will significantly contribute to the achievement of the objectives of the Convention are given in Chapter 9.

6. RESEARCH AND SYSTEMATIC OBSERVATIONS

6. RESEARCH AND SYSTEMATIC OBSERVATION

6.1. CLIMATE RESEARCH

Serbian experiences in climate monitoring and research date back to the mid–19th century. In his famous astronomical theory of climate change on Earth (1941), Milutin Milanković, a distinguished Serbian scientist (1879–1958) and lecturer at Belgrade University, understood the effect of key factors of natural long–term climate changes. Milanković's theory gave scientific base for studies 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. Since 1970, new generations of researchers at Belgrade University have achieved significant results in numeric modelling of the atmosphere. Great results were also achieved in scientific research in other areas. However, direct research of anthropogenic climate change has been given more attention only in the past few years.

Due to the complex economic and social situation, advanced research on the national level considerably slowed down in the 1990s. In this period, investment in research was almost completely halted, which resulted in many scientists leaving the country. Since 2000, the situation has significantly improved, although investments and promotion of scientific research are still not on a high enough level, which would entirely provide necessary research requirements. Another big problem is that science and economy do not liaise closely, *i.e.*, scientific research is not directed towards the technological and technical requirements of the economy.

The key scientific research today, including those in the area of climate change, is conducted within the national programme of scientific research and is financed from the state budget. Research in the area of climate change and its impacts is a priority for the forthcoming period (2011–2014).

However, despite the poor financial situation in the area of scientific research, highly qualified Serbian scientists have achieved impressive results, especially in the field of numerical modelling of the atmosphere. They have developed a new version of the regional climate EBU–POM model, which was employed in the development of regional climate change scenarios. The results of this model were also utilized in the production of the relevant chapters of this National Communication. In addition, important research of the effects climate change on agriculture was conducted, but research is still lacking in both this and other areas of climate change impacts.

Generally speaking, most of the research realised in the area of climate change was enabled thanks to the participation of scientific, state and other institutions, as well as individuals in scientific and technical programmes of the World Meteorological Organisation, research and development programmes of the European Union, as well as in bilateral and multilateral cooperation programmes.

Thus, the need to allocate considerable budget funds to scientific research is evident. Continuous bilateral and multilateral cooperation is the key in all respects, as it enables the transfer of knowledge and practice.

6.2. GLOBAL CLIMATE OBSERVING SYSTEM (GCOS)

As a member of the World Meteorological Organisation, 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 (NHMSS), as a national hydrometeorological institution, is tasked with meeting Serbia's obligations towards the GCOS.

In this way, Serbia directly meets the obligations arising from the UNFCCC referring to systematic climate observation and international data exchange.

6.3. SYSTEMATIC OBSERVATION AND DATA COLLECTION IN SERBIA

The first meteorological measurements in Serbia commenced in 1848. Systematic measurements through an organised network of 20 meteorological stations began in 1856. The network was expanded to 27 stations in 1857. In 1887, the Meteorological Observatory was founded in Belgrade.

Today, the synoptic, climatological and agrometeorological situations are continuously observed (24 hours a day, 365 days a year) at 28 of the 32 surface synoptic stations (Figure 6.1, right panel). The four remaining stations worked intermittently. The national network of meteorological stations is comprised of an upper air observation station Beograd–Košutnjak, 75 climatological stations and 481 rainfall stations. The observation system was automated in the past two years.

Climate data verified to date are kept in digital form in the CLIDATA data base.

In various forms over the years, since 1952, Serbia has had a national laboratory for testing and calibration of instruments.

In the period 1956–1983, measurements using a radiosonde were realised twice daily (at 00.00 am and 12.00 pm), during 1983–2000 once daily and since 2000, this type of measurement has again been performed twice daily.

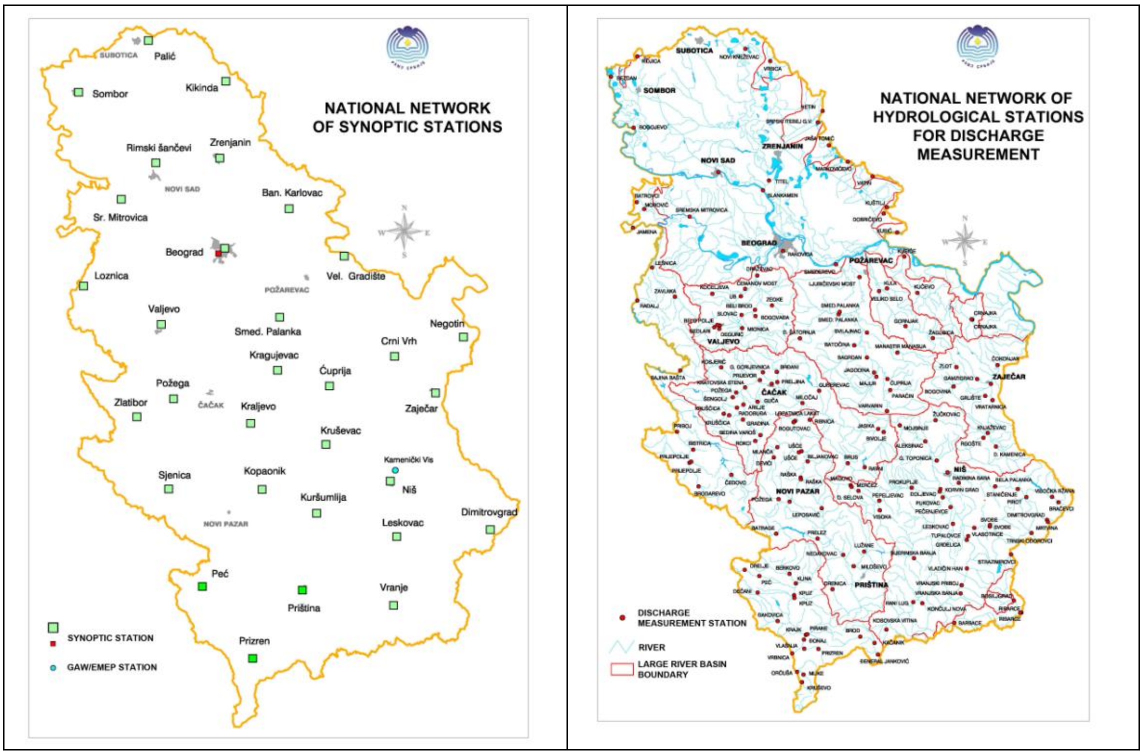


Figure 6.1. National network of synoptic stations (left panel) and hydrological stations measuring water flow (right panel).

The Ministry of Environment and Spatial Planning coordinates the monitoring of air quality. The institutions responsible for air quality monitoring are the Environmental Agency, the National Hydrometeorological Service and local self–government *via* public health institutes and organisations authorised for environmental monitoring.

The Serbian national network of 25 stations for air quality monitoring consists of 24 surface synoptic stations, whilst one (Kamenički Vis) has been implementing the GAW/EMEP monitoring programme for the past 27 years. A network of 30 stationary automated stations for automated air quality measurements is being established.

Radar observations are realised with 15 radars spread over 14 locations.

The RHMSS utilises products of the second generation of Meteosat satellites with multispectral images of the Earth's surface and cloud systems.

The first hydrological observations in Serbia commenced in 1812. The hydrological observation system now consists of a network of 179 surface water hydrological stations and a network of 415 groundwater hydrological stations. All 179 stations observe water levels, 130 also measure water flow, whilst 41 measure water temperature as well. The hydrological data from 61 reporting hydrological stations are collected in real time.

The groundwater hydrological station network is comprised of main stations (18), 1st rank stations (176) and 2nd rank stations (245). The main stations measure the water level and temperature of the groundwater on a daily basis, whilst quality control is performed twice a year. The 1st rank stations measure the groundwater level and temperature six times a month, and quality control is performed once a year at 62 stations. The 2nd rank stations measure the groundwater level three times a month.

Quality monitoring of waters, accumulations and lakes is realised at 22 water supply accumulations, 11 multipurpose accumulations and 5 lakes in Vojvodina. There are three automated stations for water quality control. Comparative monitoring of the results gathered in both traditional and automated measurements is performed at these locations.

Twenty–eight main meteorological hourly reporting stations and 28 hydrological stations are included in international data exchange.

Under the ICP forests programme, the monitoring of forests has been established in Serbia, funded by the Ministry of Agriculture, Forestry and Water Management. Two scientific research projects under this programme concern the effects climate change on and the vulnerability of forest ecosystems. Data on microclimate parameters, soil temperature and humidity, diversity of insects, fungi and soil microorganisms, biomass and carbon in soil are collected through these projects and the obtained data are presented in annual reports. Since 2003, monitoring Level I has been performed with a 16 x 16 km grid, which consists of 103 bioindicative parcels (points). During 2004, 27 parcels with a 4 x 4 km grid were added to the network. The Institute of Forestry, Faculty of Forestry in Belgrade and the Institute of Lowland Forestry and Environment in Novi Sad are involved in conducting this monitoring program.

Realization of the Intensive Monitoring Programme – Level II in Serbia is in its initial stage. The draft Forest Action Plan imposes the establishment of 10 stations adequate for this monitoring level. One such station has been established on the Fruška Gora Mountain (Iriški venac) and the equipping of another (on Kopaonik) is in progress.

6.4 Problems and needs

Effective responses to disturbances resulting from and adaptation to climate change requires that all relevant sectors are involved in research, measurements and analyses.

The Republic of Serbia applies systematic observations in the fields of meteorology and hydrology. However, maintenance and meeting new requirements in the context of climate change remains a challenge.

Due to the limited funding and inadequate equipment, systems of integral monitoring of climate parameters and environmental parameters in forestry, agriculture, public heath, biodiversity and ecosystems are still underdeveloped or even non–existent.

Almost identical problems are present in scientific research.

Imperative is multidisciplinary research of climate change effects in certain sectors and systems.

Capacity building for climate research, use of monitoring data and early warnings of extreme meteorological, climate, hydrological and other adversities caused by climate change is necessary for effective fight against climate change. Capacity building and education are especially required for the use of satellite observation data.

Strengthening the cooperation among sectors and adopting climate change impacts as the priorities of the sectors is one of the key preconditions for efficient and complete implementation of systematic observation

7. EDUCATION, TRAINING AND PUBLIC AWARENESS

7. EDUCATION, TRAINING AND PUBLIC AWARENESS BUILDING

7.1. INTRODUCTION

In recent years, the process of producing strategic documents with regards to climate change, and especially this document, but also intensification of the campaign, training and workshops has led to the popularization of climate change.

The results of these activities are still relatively modest. Therefore, it is necessary to work systematically and in detail to identify opportunities for an efficient and continuous system of organizing training and workshops, development of educational material, dissemination of information, and educational reform that would introduce this issue into the formal education system.

The main goal of the state is, above all, to build and strengthen the existing capacities of national experts, but alsodecision makers, representatives of academia, industry, the private sector, non–governmental organizations and the media.

The key problems in the realization of these activities may be limited financial and human resources.

7.2. EDUCATION

Environmental education, a top priority of both ministries responsible for environmental protection and education, is being realized through the reform of formal education initiated in 2001. In practice, this means the introduction of adequate teaching materials, books and materials related to the environment, and climate change, with the inclusion of the principles of sustainable development, starting from the lower grades of primary school to university level.

Important progress in terms of formal education has been made by the incorporation of environmental and sustainable development issues into the curricula, programmes and textbooks from the first to eighth grade of primary school. These topics have been included in compulsory subjects of elementary education: "The World Around Us" (1st and 2nd grade) and "Nature and Society" (3rd and 4th grade), and optional subjects, such as civil (1–6 grades) and health education (special programme). Ecology and the environment are also contents of subjects such as "Biology" (5–8 grade, with special emphasis in the 8th grade), Geography, Chemistry, Physics, Technical Education and Art.

Starting with the 2003/04 school year, the optional subject "Guardians of Nature" was introduced into primary education from the 1st first to 5th grade, with the aim of developing children awareness of the need and possibilities of their involvement in practical actions concerning environmental protection.

In addition to compulsory and optional subjects, the contents comprising environmental protection and sustainable development are realized through optional activities, such as additional courses in natural sciences or classes in nature in the lower grades (Eco–Action, Eco–Tour and Ecology workshops).

Ecology and environmental protection can be found as a separate subject in somesecondary schools, in which the subjects included mainly depend on the occupations for which the students are being educated. Occupational profiles in secondary education that are directly related to environmental protection are not very numerous and most are directly related to the occupations sanitary–ecological technician, environmental protection technician, chemical–technology technician, laboratory technician and polymer technician. In these profiles, most subjects have ecological issues included.

Bearing in mind that gymnasium is a form of general secondary education, ecology and environmental protection is not a separate subject, but the ecological elements are a part of natural science subjects (chemistry, biology, physics and geography).

In order to introduce innovative programmes into comprehensive schools, experimental classes are formed, for example, the profile "bank employee", in which ecology and environmental protection is significantly represented.

Compared to the 1990s, at the university level, the number of departments, study programmes and sections, in which the field of environmental protection is included in basic studies, specialized studies, magisterial studies and doctoral studies is constantly increasing. Elements of environmental education are present in four state–founded universities, or in other words, 24 faculties. Many private universities are increasingly including subjects, courses and study programmes from the environmental area. One private university is offering a PhD study in climate change.

The integral and essential part of formal education not only includes the education of children and young people but also of teachers and professors. Teacher training is realised through programmes that are accredited by the Ministry of Education (starting 2003). Integral parts of the training are manuals ("Handbook for teacher training on environment and sustainable development") and multimedia environmental education kits for teachers (e.g., the "Green Pack", prepared by the Regional Environmental Centre for Central and Southeast Europe).

Non–formal education is developing slowly, primarily because of a lack of appropriate strategies and approaches, a lack of access to information, only sporadic and sensationalist media interest and a lack of interest and opportunities for citizens to participate in decision–making about the environment.

7.3. TRAINING AND CAPACITY BUILDING

The process of preparation of the Initial National Communication has significantly contributed to strengthening national capacities and knowledge in the field of climate change. During and after the preparation of the Initial National Communication two workshops were held with the aim of public consultation and presentation of INC, especially training for GHG inventory development.

Training and capacity building of decision makers at all levels of government is achieved not only through participation or organization of trainings, seminars and workshops in the country and abroad, but also through participation in the work of the body aof the Convention and Protocol. Training, workshops and conferences are aimed at increasing knowledge on climate change in general, ongoing and planned activities in the field of climate change at the national and international level, and sharing knowledge and experiences.

Partners in the realization of these activities are various international institutions and organizations, such as the World Bank, the OECD, the UNEP, the Regional Environmental Centre for Central and eastern Europe (REC), JICA, the Italian and the German Ministry of Environment in charge for environmental issues, the Government of the Kingdom of Norway, etc.

Due to importance and power of the media, special trainings were organized exclusively for the press, to raise their capacity to properly report in this area. Reporters were and are present at all events, conferences and seminars organized by the Ministry.

Important steps in building the institutional capacity were the establishments of the Climate Change Group which in 2010 became a Climate Change Division within the Ministry of Environment and Spatial Planning, the Department for Sustainable Development in the Ministry of Mining and Energy, and the Group for Sustainable Development in the Deputy Prime Minister's Cabinet.

7.4. PUBLIC AWARENESS

The results of analysis and research show that public awareness about climate change and environmental protection is, in general, unsatisfactory. Research results (year 2009) showed that only 3 per cent of the respondents believed that environmental problems and protection of the environment are the biggest problems in Serbia. In principle, the interest of citizens in environmental issues is high (38 %), but this is not in accordance with their knowledge regarding these problems or their concrete engagement. In order to activate public participation in resolving environmental problems, including climate change, it is necessary to increase the level of knowledge and awareness in this field.

Significant efforts are being invested to organize campaigns that will inform public not only about the causes and threats of climate change, actions and prevention measures and the possible use of flexible mechanisms, but also through public hearings to involve the public in the creation and implementation of strategies, action plans and other strategic documents. The campaign „Let's clean up Serbia"" began in 2009 with the aim of reducing pollution and increasing the capacity of the ECO industry, as well as to raise and improve public awareness about the importance of environmental protection. In order to increase the awareness of the general public, educational materials, printed and electronic (brochures, leaflets, posters, web sites) were printed. In this sector, non–governmental organisations have to date played an important role.

Informing and access to information is an important element in improving and raising public awareness. Therefore, an official web site of the Serbian DNA (Designated National Authority for the implementation of CDM projects under the Kyoto Protocol) was established. The web site contains general information on climate change, documents, links and contacts, and daily activities of the Ministry and the climate change division (see: www.ekoplan.gov.rs/DNA). The activities of the Ministry in the field of climate change have been accompanied by the media and relevant information is available on the website of the Ministry of Environment and Spatial Planning. Therefore, draft National Communication was available on Ministry's web site to all interested parties for comments and suggestions in the period of one month.

In recent years, especially just before the Conference of the Parties of the Convention and Protocol, the number of interviews of representatives of the Ministry for radio and television with regards to climate change has increased substantially. The number of inscriptions in daily newspapers and periodical is increasing but is still at an insufficient level. Mainly these articles appear sporadically.

For efficient dissemination of information, it is certainly necessary to provide adequate continuity and an educational programme that would systematically deal with the climate change problem.

Since the 1990s, environmental non–governmental organizations are becoming more numerous and more frequent. Environmental NGOs are mainly involved in general environmental protection issues, air pollution, energy efficiency and protection of natural resources, while climate change has become a subject of their interest only in recent years. The ministry responsible for the environment financially supports a number of educational programmes, through co–financing NGO projects. The projects are educational, aimed at dissipating knowledge about the need for environmental protection and raising environmental awareness. The role of NGOs in developing and implementing strategies and plans in the field of climate change is insufficient. The strength of their role follows the general level of public awareness on climate change, the raising of which is a major challenge for all levels of government.

7.5. FUTURE ACTIVITIES RELATED TO EDUCATION, TRAINING AND RAISING PUBLIC AWARENESS

Despite the implemented reforms, the formal aspects of environment education have not yet achieved international standards. In this sense, the priority actions that should be implemented are:

- development and integration of education concerning the environment, particularly climate change, into all levels of education;
- improving the capacity of employees in the education sector, training teaching staff to include environmental education in obligatory and extra–curricular programmes;
- preparation and improvement of educational materials in terms of effective inclusion of climate change;
- improvement of university education and increasing the number of scholarships in the field of environmental protection and climate change;
- introduction of contents and methodologies with regard to environmental protection and climate change in university education (Pedagogy academy, Teachers College, teaching groups on Faculty of Physics, Faculty of Chemistry, Faculty of Biology and other faculties);
- increasing the number of subjects and study programmes in the areas of: environmental policy, environmental law, environmental economics and environmental ethics, with special emphasis on climate change.

In order to popularize and ensure a more efficient involvement of climate change in national development strategies, it is crucial to pay more attention to:
training decision makers and all stakeholders;
training about available funds provided for projects directly related to climate change (renewable energy, energy efficiency);
joint training and seminars to strengthen institutional capacity and improve multi–sectoral cooperation.

An effective fight against climate change, to a large extent, depends on the level of public awareness and, therefore, special attention should be paid to:

- organizing seminars and workshops to enhance public awareness;
- organizing campaigns to raise public awareness on climate change, which would be supported by the media (print, electronic);
- preparation of material (print, multimedia) about climate change, which should be adapted to different target groups;
- role of specific population groups (pre–school, junior and senior school level), and use of existing systematic models and resources, such as educational groups, student's parlament, the Office for Youth, etc);
- greater public participation in decision–making on the environment and climate change.

8.

STATE OF IMPLEMENTATION OF THE UNFCCC

8. STATE OF THE IMPLEMENTATION OF THE UNFCCC

8.1. INTEGRATION OF CLIMATE CHANGE INTO THE NATIONAL DEVELOPMENT STRATEGY

Since the ratification and entry into force of the UN Framework Climate Change Convention (2001), considerable efforts have been made in establishing legislation and an institutional and policy framework with the goal of fulfilling the requirements of the Convention. The major part of the initiatives and specific activities were launched only by institutions in charge of environmental issues. Therefore, neither real progress was made nor significant positive results achieved in this period. In this context, it is worth mentioning that the first set of laws in the field of environmental protection, directly related to combating climate change, was adopted in 2004.

The climate change problem has only been recognized in the past few years as a multi–sectoral problem that needs to be included in sector strategies and national development strategies in general.

This was confirmed by the ratification and enforcement of the Kyoto Protocol in 2008. The institutional and legislative framework for the implementation of the Clean Development Mechanism (CDM) was established directly after entry into force of the Kyoto Protocol. In 2010, the Government adopted the National Strategy of Inclusion of the Republic of Serbia in the Clean Development Mechanism in the Sectors of Agriculture, Forestry and Waste Management. With the view of dissipating information about and promotion of CDM projects, a website of DNA was established and a number of trainings and workshops were organized for a wide range of stakeholders.

Nevertheless, due to the lack of awareness and knowledge, the Republic of Serbia does not have any registered CDM projects yet.

Considerable progress in the context of combating climate change was brought about by the beginning of the process of EU accession and the harmonization of national legislation with that of the EU. This is due to the fact that main principles of the relevant EU legislation are actually based on the principle of combating climate change. In response to the goals and preconditions of European partnership, but also recognizing the necessity of sustainable development in the process of economic recovery, over the last couple of years, climate change issues have been included to a great extent in sectoral and development strategies.

A certain number of newly adopted, strategic documents, such as the Sustainable Development Strategy (adopted in 2008) and the National Environmental Protection Programme (2010), treat the climate change problem as being very important.

The Sustainable Development Strategy sees climate change as a top environmental risk factor. One of main goals in the environment sector is to enable exiting institutions to actively implement climate protection policies and to meet the obligations of international agreements (UNFCCC, Kyoto Protocol, *etc.*), as well as to produce an Action Plan for the adaptation of economic sectors to climate change. A number of priority actions contributing to climate change mitigation and adaptation have also been defined in other sectors.

In the National Environmental Protection Programme, priority was given to the activities of climate change mitigation. Simultaneously, the importance and the need to conduct activities of mitigation to modified climate conditions were also outlined.

Sectoral strategic documents, such as the Strategy of Energy Development by 2015, the Strategy of Forestry Development and the Strategy of Scientific and Technological Development, recognize the importance of conducting activities of mitigation and adaptation in the context of the economic development of these sectors.

Increasing energy efficiency and the use of renewable energy resources by 2015 are two from five main priorities in the Serbian Energy Sector Strategy Development.

The Forestry Development Strategy includes the UNFCCC among the most important international obligations within the sector. The need for a constant increase in the forest capacity level is emphasized as an objective to more efficient climate change mitigation.

In the Serbian Strategy for Scientific and Technological Development, environment protection and climate change is one of the seven priority areas to receive funding in the period 2011–2015.

The National Strategy for Biodiversity and the Action Plan affirm the importance of developing a national strategy and mechanisms in order to understand, plan and minimise possible effects of climate change on biodiversity.

Several laws in some sectors (energy, waste, forestry) include measures for climate change mitigation.

In spite of considerable advancement and improvement, the level of environmental investment is still low, especially bearing in mind the state budget.

In the last couple of years, both the public and private sector have recognized the importance of the problem of environmental protection, especially the issue of climate change. Nevertheless, the level of investment from these two sectors is still unsatisfactory.

The major part of the activities hitherto implemented in the area of combating climate change, including the production of the INC, was enabled by fund raising and technical assistance through bilateral cooperation, mainly with EU countries and Japan, UN funds, especially GEF.

A number of trainings and workshops were conducted within the framework of this cooperation, intended for representatives of governmental and scientific institutions, local communities, the commercial sector and the media.

Nevertheless, the level of integration of climate change into sectoral and general development strategies, the level of knowledge, institutional and individual capacities, and the status of available technologies are still far from below that necessary for an effective and fast response to this problem.

For these reasons, strengthening cooperation at both bilateral and multilateral levels, as well as continuing cooperation with GEF in drafting the Second National Communication among the other, is fundamental for the effective national implementation of the Convention.

8.2. INTERNATIONAL COOPERATION IN THE FIELD OF CLIMATE CHANGE

8.2.1. DRAFTING THE INITIAL NATIONAL COMMUNICATION

The economic situation over the last 20 years, as well as the lack of awareness on the issue of climate change at the national level, imposed a need for technical assistance and GEF financial assistance in order to finalize the process of drafting the Initial National Communication (INC).

In accordance with the main requirements and principles of the Convention, in 2008 GEF approved funds for the implementation of the project: “Enabling activities for the preparation of the Initial National Communication of the Republic of Serbia to the United Nations Framework Convention on Climate Change – UNFCCC”. The GEF grant (385,000 US$) was received in the middle of 2008, which marked the official commencement of the process of drafting the Initial National Communication.

The fulfilment of the project goals and preparation of the Initial National Communication were facilitated by bilateral cooperation as well as by the in–kind contribution of the state.

The beginning of the process of drafting the INC may be traced back to 2005, when the production of an inventory of the State Union of Serbia and Montenegro was initiated through bilateral cooperation with the Italian Ministry of the Environment, Land and Sea. Through the implementation of the project "Technical Assistance for the Ratification of the Kyoto Protocol and for the Establishment of a System of Renewable Energy Green Certificates" a partial inventory was made, but it did not include all the IPCC sectors. The reason for this was lack of data, mostly in energy sector, as well as the insecurity of the collected data and calculations.

The baseline for the production of the INC was partially provided by activities within the framework of cooperation with the Kingdom of Norway (Serbia – Bilateral Project Cooperation Programme 2006); more precisely within the project: "Norwegian assistance to Serbia for the introduction of a new energy efficiency policy, energy balance on the local level and implementation of the Kyoto Protocol". Within the framework of this project, a preliminary assessment of the GHG emissions from the energy sector was realised.

Due to delays in the implementation of the GEF project, in mid–2009, the Ministry of Environment and Spatial Planning, in cooperation with the public enterprise „Elektroprivreda Srbije" launched an initiative to produce a provisional inventory of GHG emission projections. This project was an additional contribution by the state to the process of drafting the INC.

From the aspect of the preparation of the climate projections, it is very important to mention the bilateral project SINTA (Simulations of Climate Change in the Mediterranean Area) which lasted from 2006 to 2008. The project was managed by the Euro–Mediterranean Centre for Climate Change and the Italian National Institute for Geophysics and Volcanology, in which the Belgrade University Institute for Meteorology, National Hydrometeorological Service of Serbia and the South East European Virtual Climate Change Centre (SEEVCCC) participated.

The University of Novi Sad, Faculty of Agriculture participated in the ADAGIO project (within the WMO/Cost Action 734/ADAGIO/CECILIA), in which potential impacts of climate change on agronomy and possible adaptation to them were discussed. The results of this project considerably aided the production of the relevant chapters of the INC.

A project entitled "Climate Change Effects on Biodiversity in Southeast Europe", funded by the Spanish Agency for International Cooperation in Development (Agencia Española de Cooperación Internacional para el Desarrollo – AECID), was also significant from the aspect of the preparation of the INC.

Professional training in the field of adaptation to climate change over the past three years should also be mentioned. The training was held in cooperation with the Japanese International Cooperation Agency (JICA).

The contribution of the state to the process of drafting the INC is also reflected in the work of governmental officials and employees of public enterprises in the process of data collection and participation in the preparation of relevant strategic documents (directly or indirectly used) and the INC.

8.2.2. SOUTH EAST EUROPEAN VIRTUAL CLIMATE CHANGE CENTRE

In 2006, following the WMO call to Member States to take measures and strengthen international cooperation through relevant national, sub–regional and regional climate centres, the NHMSS started the initiative on setting up a sub–regional centre for climate change for Southeast Europe.

The initiative was fully supported by the Serbian Government as well as national hydrometeorological services across Southeast Europe at the meeting of directors held in Dubrovnik, Croatia, in 2006, and at the Sixth UNECE Ministerial Conference "Environment for Europe", held in Belgrade in 2006 (Belgrade Initiative on enhancing regional cooperation in Southeast Europe in the field of climate change).

The South East European Virtual Climate Change Centre (SEEVCCC) was set up in 2008, within the NHMSS.

On the sub–regional level, the SEEVCCC performs the following functions: operational issuing of national and sub–regional climate, analytical and prognostic products; research and development; education and training/capacity building, as well as coordination of the production and implementation of sub–regional action plans and programmes in the field of climate change.

As a result of all these activities, the WMO officially included the SEEVCCC in the preparation of a bi–annual implementation plan of basic functions of the RCC Network in RA VI. The SEEVCCC actively participates in all RCC activities with its binding operational functions, capacity building functions, coordination functions and highly recommended research and development functions.

The successful work of the Centre was confirmed at the very beginning by the production of the Framework Adaptation Action Plan for Southeast Europe (SEE/CCFAP), adopted at the Regional Ministerial Conference "Combating Climate Change in South Eastern Europe", in Sarajevo (2008). A Framework Action Plan was produced under a project funded by the Norwegian Government. Representatives of Albania, Bosnia and Herzegovina, Montenegro, FYR Macedonia and Serbia were involved in the production of the Action Plan, whilst the project was coordinated by the SEEVCCC and the Regional Environmental Centre for Central and East Europe.

The production of the Framework Action Plan confirmed the need for regional cooperation in the field of adaptation to climate change.

9.

FINANCIAL, TECHNOLOGICAL AND NEEDS FOR CAPACITY BUILDING

9. FINANCIAL, TECHNOLOGICAL AND CAPACITY BUILDING NEEDS

9.1. INTRODUCTION

The impact of climate change on various sectors and systems, as well as the preparation of adequate and financially viable actions to combat climate changes are still insufficiently explored and defined at the national level. In recent years, somewhat greater importance has been given to this problem but, generally speaking, the level of awareness and knowledge is still insufficient.

The process of preparing the Initial National Communication has contributed to raising awareness and capacity building in addressing the problem of climate change but it is necessary, in the upcoming period, to make additional efforts in order for this problem to take an adequate place in defining the national development strategy. These activities are almost impossible to implement without financial and technological support from and capacity building by the international community.

9.2. PRIORITY FINANCIAL, TECHNOLOGICAL AND CAPACITY BUILDING NEEDS IN DEVELOPING A GHG INVENTORY

The preparation process of a GHG inventory for the Initial National Communication, which included the work of a number of national institutions and local experts, provided a consistent and relatively reliable database, which needs to be further developed and improved. Simultaneously, the importance of this process was reflected in the identification of major problems and deficiencies that adversely affected the preparation of a GHG inventory and in defining the needs necessary for establishing methodical data collection and databases, thus improving the preparation process of a GHG inventory.

Priority needs to improve the process of preparing GHG inventories are shown through the proposed project below.

1. Project title: "Methodical improvement of the process of preparing a GHG inventory".

The aim of the project:
Establishing a sustainable system of data collection and preparation of a national GHG inventory

Project activities:

1. Improving the system of data collection and reporting
   1.1. Evaluation of the existing sectoral data collection process and reporting to the responsible institution for preparing a GHG inventory;
   1.2. Transfer of know–how and experience of the needs of a modern sectoral data collection and reporting system (good international practice);
   1.3. Determining the necessity for the establishment of a modern sectoral data collection and reporting system at the national level;
   1.4. Evaluation of the existing capacity for establishing and maintaining a sectoral data collection and reporting system;
   1.5. Assessment of technical/technological needs for improvement of the system;
   1.6. Assessment of the financial needs for improvement of the system;
   1.7. Preparation of recommendations for the improvement and establishment of a modern sectoral data collection and reporting system.

2. Establishing a database and inventory

2.1. The transfer of know–how and experience on the methods and best software solutions for organizing, maintaining and archiving data;
2.2. The transfer of know–how and experience on the forms of reporting;
2.3. Preparation of recommendations for improving the form of reporting;
2.4. Evaluation of the existing system of data exchange;
2.5. Preparation of recommendations for improving the efficient exchange of data among the "owners" of data;
2.6. Preparation of recommendations for establishing sectoral and integrated databases;
2.7. The transfer of know–how and experience on ways of forming and maintaining GHG inventory databases;
2.8. Preparation of recommendations for improving GHG inventory databases;
2.9. Establishing GHG inventory databases.

3. Development of a plan for improving the legislative framework
3.1. Evaluation of the existing legislative framework which regulates data collection and reporting;
3.2. Defining medium and long term actions of improvements for individual sectors;
3.3. Preparation of recommendations for improvement of the existing legislation.

4. Strengthening institutional and individual capacities
4.1. Evaluation of the existing capacities;
4.2. Training, courses and seminars for the "owners of data" and relevant institutions for data collection;
4.3. Training, courses and seminars for a national network of experts and institutions in charge of preparing a GHG inventory;

Project Duration: 2 years
Estimated Budget: 2 million U.S. dollars.

9.3. PRIORITY FINANCIAL, TECHNOLOGICAL AND CAPACITY BUILDING NEEDS FOR ADAPTATION TO CLIMATE CHANGE CHANGING CLIMATIC CONDITIONS

The process of preparing the chapter on impact and adaptation to the changing climatic conditions indicated a pressing need for the realization of a project for the preparation of a National Action Plan for Adaptation (NAPA).

Project title: "Development of a National Action Plan for Adaptation (NAPA)"

The aim of the project:
Determination of detailed adaptation actions at the national level and training national capacities for the further preparation of adaptation actions;

Project activities:
1. Improvement of the system for monitoring and reporting
1.1. Evaluation of the existing sectoral monitoring and reporting systems
1.2. The transfer of know–how and experience on the needs of a modern sectoral monitoring and reporting system (good international practice); Determining the need for the establishment of modern sectoral monitoring and reporting at the national level
1.3. Evaluation of the existing capacities for establishing and maintaining methodical sectoral monitoring and reporting

1.4. Preparation of recommendations for the establishment and improvement of a modern sectoral monitoring and reporting system.

2. The establishment of sectoral data bases
   2.1. The transfer of know–how and experience on the possibilities of storing and archiving data;
   2.2. The transfer of know–how and experience on the forms of reporting;
   2.3. Establishing effective exchange of information among the "owners" of data;
   2.4. Establishment of integral databases;
   2.5. Establishment of an integral database on climate change impacts on sectors and systems.

3. Capacity building for evaluation of the impact
   3.1. Transfer of know–how and experience on methods of integral assessment of climate change impacts;
   3.2. Improvement of the application of integral climate–sectoral models for assessing climate change impacts and vulnerability of the systems;
   3.3 Transfer of know–how and experience in investigation methods of climate change impact on sectors and systems.

4. The implementation of multidisciplinary research programmes on the effects of climate change on the most vulnerable sectors and systems;
   4.1.Transfer of know–how and experience to address adaptation;
   4.2. Development of a socio–economic scenario for the Republic of Serbia;
   4.3. Transfer of know–how and experience on climate monitoring;
   4.4. Preparation of recommendations for improving climate monitoring;
   4.5. Development of a climate monitoring system;
   4.6. Transfer of know–how and experience on ways of a establishing spatial database and information on local and regional climate changes;
   4.7.The development of spatial databases and information on local and regional climate changes, including information on extreme climate events and disasters and the vulnerability of certain areas, for their use in strategic planning.

5. Preparation of a national adaptation plan
   5.1.Identification of priority sectors;
   5.2.Establish medium– and long–term actions for individual sectors;
   5.3.Assessment of technical capacities for the implementation of the identified actions;
   5.4.Assessment of technological needs for the implementation of the identified actions;
   5.5.Assessment of financial needs for the implementation of the identified actions;
   5.6.Assessment of the availability of financial resources at the national level;
   5.7.Preparation of a national adaptation plan;
   5.8.Preparation of a plan to incorporate adaptation into the framework of sectoral strategies.

Project duration: 3 years
Estimated budget: 3 million U.S. dollars.

9.4. PRIORITY FINANCIAL, TECHNOLOGICAL AND CAPACITY BUILDING NEEDS FOR CLIMATE CHANGE MITIGATION

Besides a number of general requirements given in Chapter 5, in this chapter, priority projects the implementation of which will also substantially affect the achievement of the alternative scenario of GHG emissions by the year 2015 are presented.

The main parameters of the proposed priority projects are given in Table 9.1 and Figure 9.1, while detailed information on these projects is given in Annex 4.

	Project Type	Additional Financial Resources (Mill US$)	Total Investment (Mill US$)	Additional Yearly Costs (Mill US$/yr)	Yearly Decrease in GHG Emissions (Mt CO_2eq)	Costs of GHG Emissions Reduction (US$/t CO_2eq)
1	Infrastructural Thermal Power Project	392	1470	–6.1516	1.268	–4.85
2	Infrastructural Hydro Power Project	592.2	655.2	13.9076	0.967	+14.38
3	Infrastructural Thermal Power Cogeneration Project	–490	280	138.929	2.2425	+61.95
4	Infrastructural Thermal Power Energy Efficiency Project I	161	161	2.7832	0.519	+5.36
5	Infrastructural Thermal Power Energy Efficiency Project II	350	350	0.6334	1.07	+0.59
6	Investment Project in the Forest Complex	210	210	–	0.5	≈+42

By realisation the proposed priority infrastructural projects by the year 2015, a reduction of lignite consumption by 8.46 Mt per year and GHG emissions in total by about 6070 Gg CO_2eq/year may be achieved in the thermal power sector for electricity generation.

The total required investment funds are at the level of 2916 Million US$.

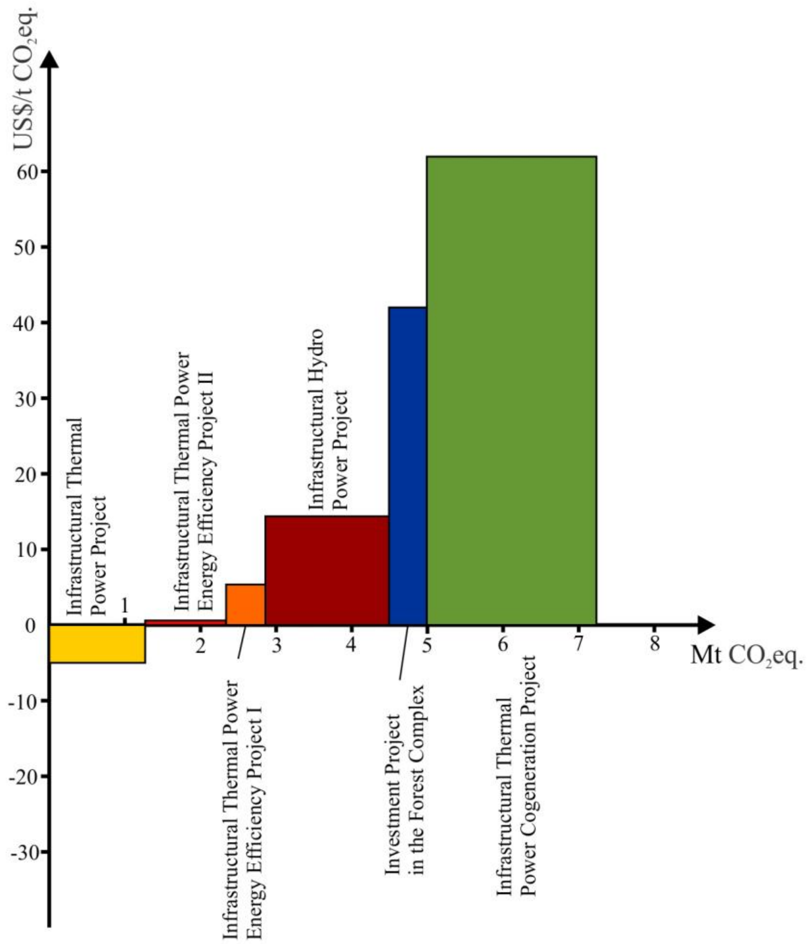


Figure 9.1. Costs of reducing GHG emissions for the proposed priority investment projects

The estimated specific costs of GHG reductions are: –4.85 US$/t$CO_2$eq for Project 1, 0.59 US$/t$CO_2$eq for Project 5; 5.36 US$/t$CO_2$eq for Project 4; 14.38 US$/t$CO_2$eq for Project 2 and maximal 61.95 US$/t$CO_2$eq for Project 3.

Most of these projects, even under the current, relatively unfavourable, economic conditions, have an economic justification (with or without the implementation of the Clean Development Mechanism). The economic justification for the infrastructural thermal cogeneration Project 3 may be questionable, even in case of implementation through the Clean Development Mechanism, due to the unfavourable parity between the prices of natural gas to lignite and electricity.

For implementation of the priority projects, in addition to the significant investment resources required, it is also necessary to ensure the transfer of modern technologies and know–how.

10. ANNEXES

Annex 1

Net calorific value and emission factor of the raw lignite from pit–mine exploitation in the Republic of Serbia

1. Introductory notes

Low calorific, pit–mined lignite is the basic energy source in the Republic of Serbia, with a share of nearly 50 % in the total primary energy consumption and over 90 % of the produced electricity. The pit–mined, raw lignite has a moisture content of around 50 % and a mineral matter content of 10–25 % and, thus, significantly lower values of the net calorific value and higher values of the emission factor in comparison to the values recommended by the international method for the evaluation of GHG emissions.

Aimed at determining the characteristics of the raw lignite, primarily the net calorific value, the carbon contents and their correlation with the emission factor for different grades of lignite from pit–mine exploitation in the Republic of Serbia, a separate expert team was formed, the task of which was data gathering, processing and evaluation (Laboratory for Thermal Engineering and Energy Research of the Institute for Nuclear Sciences – Vinča).

2. Emission characteristics of domestic lignites

For a more detailed illustration of the emission characteristics of domestic lignites, data from one of the more recently made surveys (literature 1) for the basin with the highest share in power production (the Kolubara Basin with a share on the national level of ≈64 %, the other two having ≈18 % each) was used. This survey required specific care in performing the coal sampling (wide range of ash content (A^r = 6.92 %–48.5 %) and moisture (W^r = 31 %–51.7 %), *i.e.*, net calorific value (H^r_d =2850–9940 kJ/kg), as well as other accompanying characteristics of the raw coal) in order to ensure, as far as possible, the simulation of a wide spectre of the expected qualities of coals that are conveyed to the thermal power plants. These samples underwent complete proximate and ultimate analysis and a number of other physical and chemical analyses. In addition, relevant correlations were determined with the aim of obtaining the basis for the introduction of a system for continuous monitoring and homogenization of the quality of the coal delivered to the power stations.

The obtained results, as well as the correlation analysis that was performed, indicated that a well–defined linear correlation exists (correlation coefficients above 0.99, indicating a very small deviation of the obtained results from a linear dependency) between the net calorific value and the ash content, *i.e.*, moisture content, as well as the content of combustible matter in the coal samples, Figure 1.

The analyses clearly indicate a very strong linear dependence (coefficient of correlation above 0.99) between the content of carbon (Figure 2), *i.e.*, the content of hydrogen, and the content of combustible matter in the representative coal samples.

The content of carbon and hydrogen in the pure combustible matter was nearly constant in all the investigated representative coal samples (C = 63.3 % and H = 5.9 %).

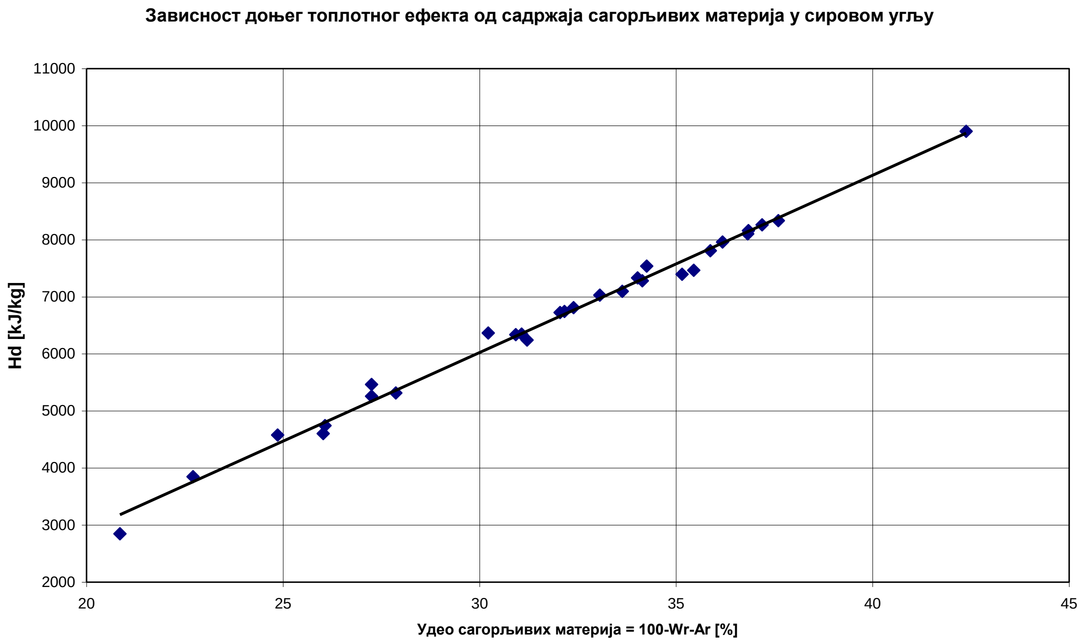


Figure 1. Dependence of the net calorific value, H_d, on the combustible matter content, Sag_r, in the raw coal from the Kolubara Basin:
[H_d [kJ/kg] = 297.8 Sag_r [%] – 2829.6]

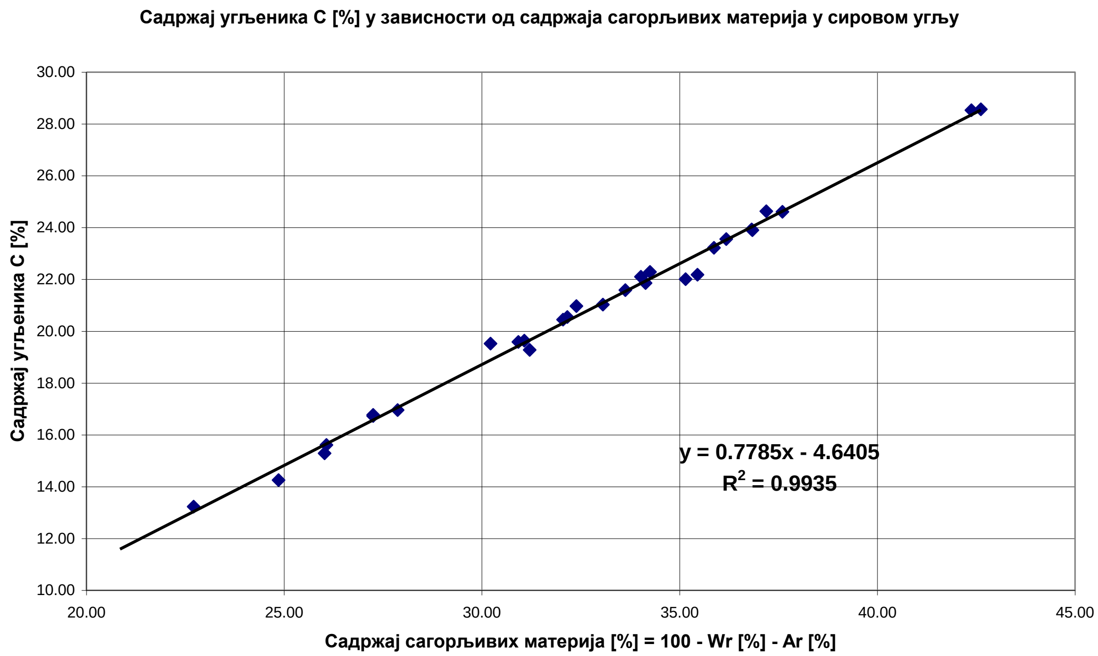


Figure 2. Dependence between the carbon content (C [%]) and the content of combustible matter (100 – W_r – A_r [%]) in the raw coal from the Kolubara Basin.

Based on these analyses of the representative coal samples from the Kolubara Basin, the experimentally determined dependence between the carbon content and the net calorific value is shown on Figure 3.

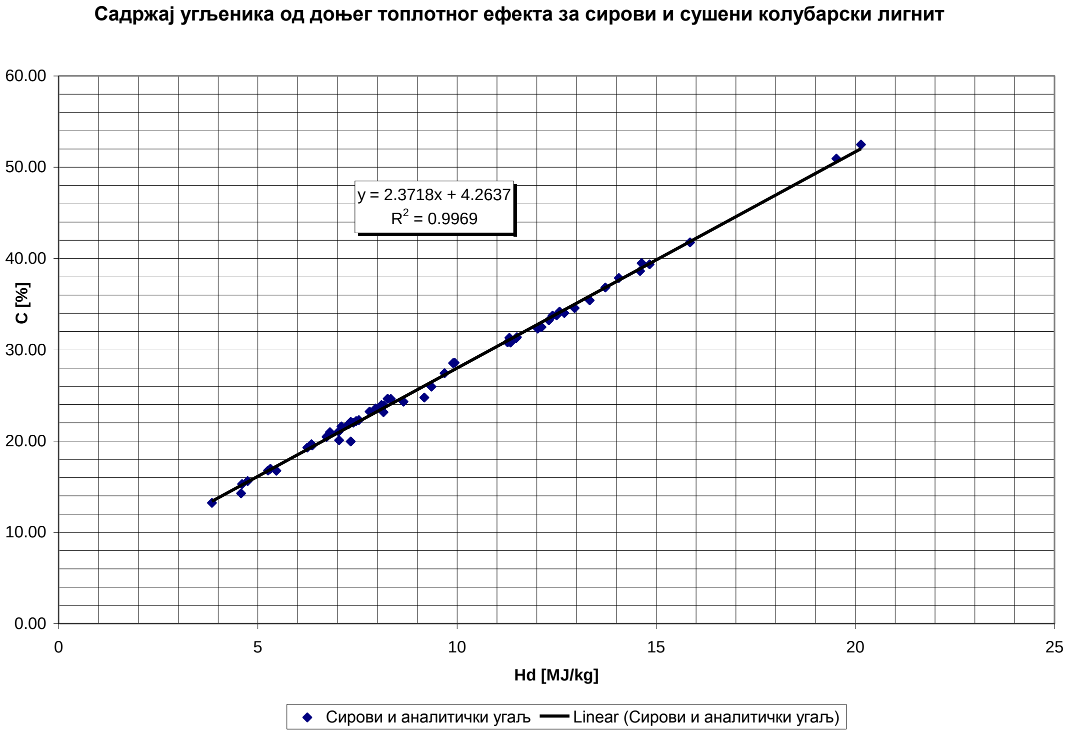


Figure 3. Dependence between the carbon content and the net calorific value for raw and dried lignite from the Kolubara Basin.

The following experimental linear correlation was obtained:

$$C\,[\%] = 2.3718\ H_d\ [\mathrm{MJ/kg}] + 4.2637$$

This correlation is in excellent agreement with the appropriate linear correlations obtained by fitting the numerous data for Czech coals of different quality (ranging from lignite to hard coals):

Series A	$C\ [\%] = 2.333\ H_d\ [\mathrm{MJ/kg}] + 5.511$
Series B	$C\ [\%] = 2.344\ H_d\ [\mathrm{MJ/kg}] + 5.056$
Series C	$C\ [\%] = 2.400\ H_d\ [\mathrm{MJ/kg}] + 4.123$
Series E	$C\ [\%] = 2.334\ H_d\ [\mathrm{MJ/kg}] + 5.786$

The above correlation for series E is recommended for use for all European coals.

Appropriate correlations were also determined for Velenje lignite (literature 3) based on statistical data over a period of several years on the quality of coal used for electricity production in the power station Sostanj, in Slovenia:

$$C\ [\%] = 2.2477\ H_d\ [\mathrm{MJ/kg}] + 5.8216$$

and on specifically performed analysis of 30 representative samples of Velenje lignite:

$$C\ [\%] = 2.3878\ H_d\ [\mathrm{MJ/kg}] + 4.6548$$

The obtained correlations between the carbon content and the net calorific value for both raw and dried Kolubara lignite are in quite a good agreement with the correlations from literature 2, especially with the above correlation for series C (author Pavel Fott) and with the second correlation for the Velenje lignite, based on the analysis of the 30 representative samples (literature 3).

Based on these correlations between the carbon content and the net calorific value, the dependence of the emission factor, *EF*, on the net calorific value for Kolubara lignite may be directly obtained:

$$EF\,[\mathrm{tC/TJ}] = 10C\,[\%] / H_d\,[\mathrm{MJ/kg}] = 23.718 + 42.637 / H_d\,[\mathrm{MJ/kg}]$$

The dependence of the emission factor on the net calorific value is shown on Figure 4, together with the experimental values for 30 representative Kolubara lignite coal samples (in the as–received and dried state).

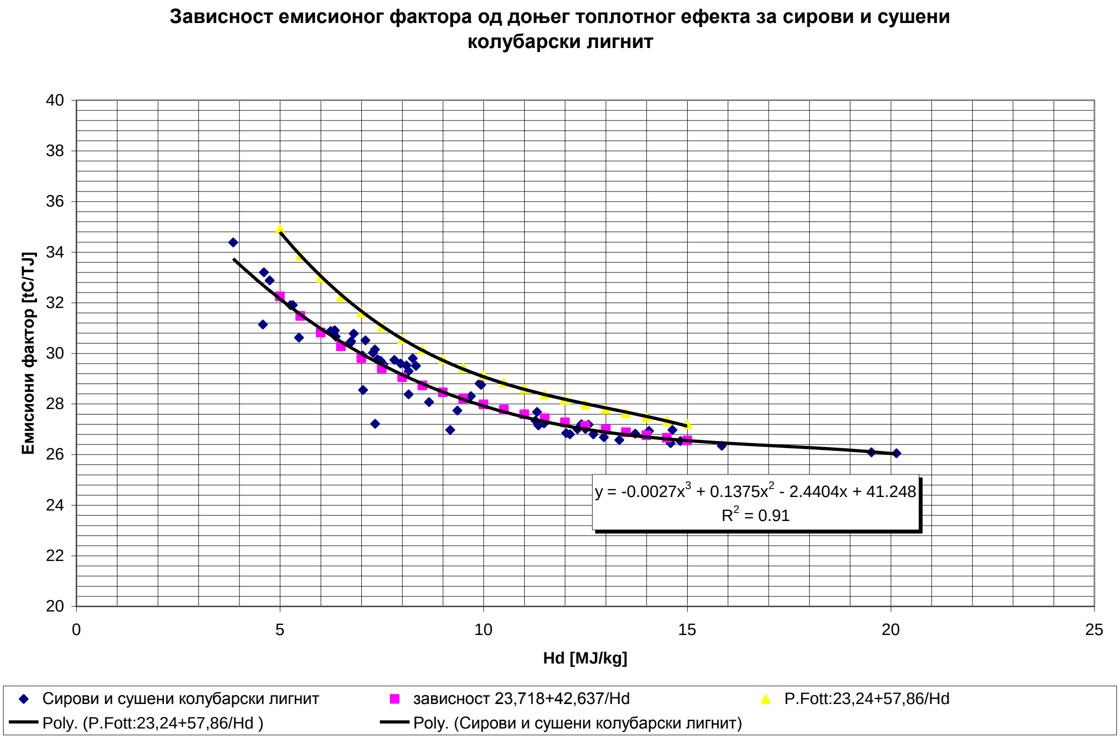


Figure 4. Dependence between the emission factor and the net calorific value for raw and dried Kolubara lignite.

The emission factor is inversely proportional to the net calorific value and with increasing coal quality (*i.e.*, increasing value of the net calorific value), the emission factor decreases and converges to an asymptotic value of 25.42 [tC/TJ] for hard coals (H_d =25 [MJ/kg]), which is somewhat lower value than the standard recommended one (25.8 [tC/TJ]).

In comparison to the standard recommended value of the emission factor for brown coals of 26.2 [tC/TJ], this correlation gives a more appropriate value of 17.18 [MJ/kg] for the net calorific value.

However, for the range of net calorific values of ($6 \le H_d \le 10$ [MJ/kg]) for raw lignite, the correlation gives significantly higher values for the emission factor (30.8 – 28 [tC/TJ]) compared to the standard recommended value for lignite of 27.6 [tC/TJ].

In Figure 4 is also shown a function derived from the recommended correlation for series E for European coals (author Pavel Fott). It is evident that this correlation yields even higher values for the emission factor than the experimental values for Kolubara lignite. The correlation obtained for Velenje lignite lies practically between theses two curves.

The survey on the emission factors for Velenje lignite, based on the statistical data over a period of several years, on the quality of coal used for power production in the power station Sostanj shows that for the values of the net calorific values in the range 6 – 12 MJ/kg, the above mentioned dependence may be approximated with sufficient accuracy with the straight line:

$$\boldsymbol{EF}\,[\mathrm{tC/TJ}] = 35.242 - 0.6941\, \boldsymbol{H_d}\,[\mathrm{MJ/kg}]$$

and based on specific analysis of 30 representative samples of Velenje lignite by:

$$EF\,[\mathrm{tC/TJ}] = 34.454 - 0.5843\, \boldsymbol{H_d}\,[\mathrm{MJ/kg}]$$

In Figure 5, in an analogous manner, are shown the experimental values for 30 representative Velenje lignite samples, the fitted curve for the whole range of H_d values and the fitted linear dependency of the emission factor in the range of H_d = 6–10 MJ/kg. Taking into account the minimal deviation between these two dependencies, the determination of the emission factor in the range of H_d = 6–10 MJ/kg, needed for the estimation of the emission of carbon dioxide released during lignite combustion, may be realised using the following linear dependency:

$$\boldsymbol{EF}\,[\mathrm{tC/TJ}] = 34.407 - 0.5891\, \boldsymbol{H_d}\,[\mathrm{MJ/kg}]$$

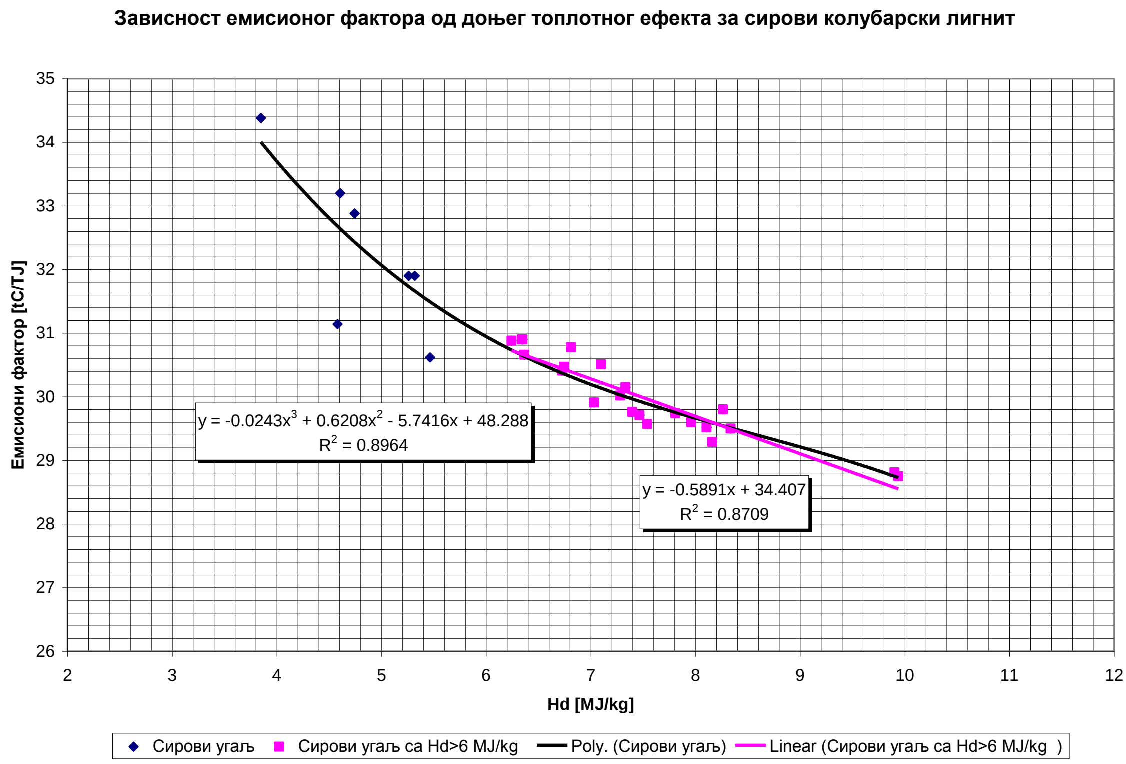


Figure 5. Dependency of the emission factor on the low calorific value for raw Kolubara lignite

Annex 2
Key sources of emissions in the Republic of Serbia in 1990 and the combined uncertainty of their estimated GHG emissions

	Sector	Key Source Category	Gas	$GgCO_2eq$	Level	Cumul	Uncer.
1.A.1	Energy	CO_2 Emissions from Stationary Combustion – Lignite	CO_2	32,611.5	40.3%	40.3%	7%
4.D	Agriculture	N_2O (Direct and Indirect) Emissions from Agricultural Soils	N_2O	6,770.9	8.4%	48.7%	100%
1.A.2	Energy	CO_2 Emissions from Manufacturing Industries and Construction	CO_2	6,309.0	7.8%	56.5%	12%
1.A.3	Energy	CO_2 Mobile Combustion: Road Vehicles	CO_2	5,425.9	6.7%	63.2%	7%
1.A.4	Energy	Other Sectors: Residential CO_2	CO_2	5,278.2	6.5%	69.7%	12%
1.A.4	Energy	Other Sectors: Commercial CO_2	CO_2	3,460.1	4.3%	74.0%	12%
4.A	Agriculture	CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	3,332.2	4.1%	78.1%	50%
1.B.2	Energy	CH_4 Fugitive Emissions from Oil and gas Operations	CH_4	1,737.3	2.1%	80.2%	30%
6.A	Waste	CH_4 Emissions from Solid Waste Disposal Sites	CH_4	1,684.6	2.1%	82.3%	50%
2.C	Industrial Processes	CO_2 Emissions from the Iron and Steel Industry	CO_2	1,611.6	2.0%	84.3%	7%
1.A.1	Energy	CO_2 Emissions from Stationary Combustion - Residual Fuel Oil	CO_2	1,426.3	1.8%	86.1%	7%
2.A	Industrial Processes	CO_2 Emissions from Cement Production	CO_2	1,352.5	1.7%	87.7%	25%
1.B.1	Energy	CH_4 Fugitive Emissions from Coal Mining and Handling	CH_4	1,285.1	1.6%	89.3%	300%
1.A.1	Energy	CO_2 Emissions from Stationary Combustion – Gas	CO_2	1,273.8	1.6%	90.9%	7%
1.A.4	Energy	Other Sectors: Agriculture/Forestry/Fishing CO_2	CO_2	1,095.8	1.4%	92.3%	12%
4.B	Agriculture	N_2O Emissions from Manure Management	N_2O	918.0	1.1%	93.4%	70%
1.A.1	Energy	CO_2 Emissions from Stationary Combustion – Sub-Bituminous Coal	CO_2	868.4	1.1%	94.5%	12%
4.B	Agriculture	CH_4 Emissions from Manure Management	CH_4	592.8	0.7%	95.2%	50%
2.B	Industrial Processes	N_2O Emissions from Nitric Acid Production	N_2O	549.3	0.7%	95.9%	25%
1.A.1	Energy	CO_2 Emissions from Stationary Combustion - Gas/Diesel Oil	CO_2	410.4	0.5%	96.4%	7%
1.A.1	Energy	CO_2 Emissions from Stationary Combustion - Other Bituminous Coal	CO_2	401.5	0.5%	96.9%	
1.A.1	Energy	CO_2 Emissions from Stationary Combustion - Refinery Gas	CO_2	395.0	0.5%	97.4%	

Annex 3

A comparison of the results of the calculations of carbon dioxide emissions in the Republic of Serbia according to the Reference Approach and the Sectoral Approach for 1990 and 1998

In the following tables, a comparative overview of the obtained data is given (according to the Reference Approach and Sectoral Approach) from the national Inventory of the GHG Emissions for 1990 (and 1998). For the liquid, solid and gaseous fuels, a higher consumption occurs (expressed in TJ) according to the Reference Approach method in relation to the Sectoral Approach method due to the difference in the amount of fuel that is stored, primarily for use for non–energy purposes, *i.e.*, as chemical raw materials.

As an example, for the solid fuels, a difference of 565481 t of coke (equivalent to 15211.43 TJ) that was used in the ironworks in Smederevo for processes in the blast–furnace arises because it was registered in the Reference Approach but not in Module 1 of the Sectoral Approach – Manufacturing Industries and Construction. In this case, coke is more a reduction medium, *i.e.*, a reagent, and only partly a fuel; hence, it is difficult to separate its use in the calculations. Simultaneously, a danger exists of taking it doubly into consideration.

Instead of this, it was considered that the total amount of the coke used in the ironworks in Smederevo was consumed as a reduction medium and that all of the CO_2 emissions were only accounted for in Module 2 Industrial Processes.

The difference in liquid fuels between the Reference Approach and the Sectoral Approach in Module 1 arises due to the non–energy use of certain oil derivates, such as naphtha, lubricants, bitumen and other refined semi–products that are used in the chemical industry.

A difference also exists for natural gas due to its non–energy use as a reactant (reagent) in the chemical industry (such as methanol and acetic acid production in MKS – Kikinda and ammonia production in Azotara Pancevo). The total CO_2 emission from ammonia production is accounted for in Module 2 Industrial Processes and thus, the emission of CO_2 in Module 1 Sectoral Approach is smaller by that amount than according to the Reference Approach.

An analogous explanation is also valid for 1998.

1990 Module 1 Fuel Combustion

MODULE 1	TJ			
Fuel Combustion	**Liquid**	Solid	**Nat. Gas**	**Total**
Sectoral Approach				
1A.1 Energy Industries	32593.87	317,578.67	22,819.50	372,992.04
1.A.2 Manufacturing industries and constru.	33,680.07	19,985.95	33,396.77	87,062.79
1.A.3 Transport	80,670.20	0.00	112.00	80,782.40
1.A.4.a. Commer./Inst.	32,198.36	4958.28	9460.09	46,617.33
1A.4.b. Residential	7,352.97	36,853.42	20,232.72	64,439.11
1.A.4.c. Agriculture	14,864.32	23.63	199.67	15,087.61
Total 1.A Sectoral Ap.	201,360.38	379,399.94	86,220.95	666,981.28
Intern Bunkers	6,478,93			6478.93
Reference Approach	248,373.35	393,472.74	93,029.61	734,875.69
Stored	48,297.85	15211.43	6,808.67	70,317.95
Ref–Stored	200,075.50	378,261.31	86,220.94	664,557.74
(Ref–Stored)/Sector –1 (%)	**–0.64** %	**–0.3** %	–	**–0.36** %

MODULE 1	CO_2 (Gg)			
Fuel Combustion	**Liquid**	Solid	**Nat. Gas**	**Total**
Sectoral Approach				
1A.1 Energy Industries	2,404.16	33,881.43	1,273.77	37,559.37
1.A.2 Manufacturing industries and constru.	2,551.51	1,893.30	1,864.19	6,309.00
1.A.3 Transport	5,671.32		6.26	5,677.58
1.A.4.a. Commer./Inst.	2,302.45	508.55	528.06	3,339.06
1A.4.b. Residential	504.31	3,644.48	1,129.38	5,278.18
1.A.4.c. Agriculture	1,082.29	2.34	11.15	1,095.78
Total 1.A Sectoral Ap.	14,516.05	39,930.10	4,812.81	59,258.96
Intern Bunkers	458.61			458.61
Ref. Approach	15,319.32	41,625.20	5,067.45	62,011.97
Emission transferred to Module 2		1,612.46		1,612.46
(RefAppr–Transferred) /Sector–1 (%)	**5.53** %	**0.21** %	**5.29** %	**1.92** %

1998 MODULE 1 Fuel Combustion

MODULE 1	TJ			
Fuel Combustion	**Liquid**	**Solid**	**Nat. Gas**	**Total**
Sectoral Approach				
1A.1 Energy Industries	25,402.98	295,997.05	17,747.00	339,147.04
1.A.2 Manufacturing industries and constru.	17383,93	6198,73	27,259.09	50,841.75
1.A.3 Transport	54,671.02	0.00	88.40	54,759.42
1.A.4.a. Commer./Inst.	3,922.03	9,838.79	9,209.07	22,969.89
1A.4.b. Residential	2,483,87	21,504.63	18,418.14	42,406.64
1.A.4.c. Agriculture	5,123.87	29.71	149.97	5,303.55
Total 1.A Sectoral Ap.	108,987.70	333,568.91	72,871.68	515,428.29
Intern Bunkers	2,628,18			2,628,18
Reference Approach	119,860.92	346,865.65	83,140.20	549,866.77
Stored	9,398.35	13,254.89	9,731.34	32,384.58
Ref–Stored	110,462.57	333,610,76	73,408.86	517,482.19
(Ref–Stored)/Sector –1 (%)	**1.35 %**	**0.01 %**	**0.74 %**	**0.40 %**

MODULE 1	CO_2 (Gg)			
Fuel Combustion	**Liquid**	**Solid**	**Nat. Gas**	**Total**
Sectoral Approach				
1A.1 Energy Industries	1,862.43	31,821.49	990.63	34,674.55
1.A.2 Manufacturing industries and constru.	1,319.52	592.59	1,521.59	3,433.70
1.A.3 Transport	3,847.56		4.93	3,852.49
1.A.4.a. Commer./Inst.	293.14	970.49	514.05	1,777.68
1A.4.b. Residential	166.29	2,114.33	1,028.09	3,308.71
1.A.4.c. Agriculture	371.30	2,80	8.37	382.47
Total 1.A Sectoral Ap.	7,860.24	35,501.70	4,067.66	47,429.60
Intern Bunkers	186.04			186.04
Ref. Approach	8,083.88	37,094.35	4,461.59	49,639.82
Emission transferred to Module 2		1,405.06	179.77	1,584.83
(RefAppr–Transferred) /Sector–1 (%)	**2.85 %**	**0.53 %**	**5.04 %**	**1.32 %**

Annex 4

Specification of priority infrastructure projects in the energy sector

<u>*1 Infrastructure thermal power project*</u>

According to the "Business as usual" scenario and in line with the Development Strategy of the Energy Sector of the Republic of Serbia until 2015, it is envisaged that a new lignite thermal power unit of nominal power 700–750 MW_{el}, annual production of about 4800 GWh and with the standard efficiency for such plants of 33.5 % will go into operation by the year 2012. The necessary investments are estimated at 1078 million U.S. $.

The alternative scenario envisages that, instead of the above–mentioned, a contemporary and advanced lignite–fired thermal unit with supercritical steam parameters and an efficiency of 43 % be considered. Investments needed for such a facility are at the level of 1470 million U.S. $.

	Units	Baseline option	Mitigation option		
Unit size	MW_{el}	710	710		
Annual Power Generation	GWh/year	4800	4800		
Annual operational hours	h/year	6760	6760		
Efficiency	%	33.5	43		
Availability	%	77.18	77.18		
Unit annual energy consumption	TJ/year	51582.09	40186.05		
Fuel		Lignite	Lignite		
H_d	(GJ/t)	7.466	7.466		
Fuel Costs	US$/GJ	2.1	2.1		
Unit fuel annual consumption	Mt/year	6.909	5.3825		
				Change	
Unit investment Cost	M US$	1078	1470	+392	
Lifetime	Years	35	35		
Unit Annualized Investment	M US$	65.835	89.775	+23.94	
Total Annual O & M Costs	M US$	33.04	26.88	–6.16	
Annual Fuel Costs	M US$	108.3222	84.3906	–23.9316	
Total Annual Costs	M US$	207.1972	201.0456	–6.1516	
Annual GHG Emissions				Reduction	
Fuel CO_2 (*EF*=107.8315 t CO_2/TJ)		t CO_2	5 562 177	4 333 324	1 228 853
Fuel N_2O (*EF*=1.4 kg N_2O/TJ)	t N_2O	72.21	56.26	15.95	
Fuel CH_4 (*EF*=1 kg CH_4/TJ)	t CH_4	51.58	40.18	11.4	
Fugitive CH_4 (*EF*=158 kg CH_4/TJ)		t CH_4	8149.64	6349.39	1800.24
Total CO_2eq.	t CO_2eq	5 756 788	4 488 285	1 268 503	

Mitigation (Emission reduction) specific cost: –6.1516 M US$/1 268 503 = **–4.85 US$/ t CO_2eq**

2 Infrastructure hydropower project

According to the basic "Business as usual" scenario, a new/replacement lignite thermal unit is planned to be built by the year 2015 (which is to replace the annual production of about 1200 GWh in the old units) with a nominal capacity of 500 MW_{el}, annual production of about 3400 GWh, *i.e.*, an additional annual production of 3400–1200 = 2200 GWh and a standard efficiency for such units of 33.5 %.

According to the alternative scenario, the shutting down of old units with an annual production of 1200 GWh by the year 2015 is also envisaged, which would mean a reduction in coal consumption of 1.96 Mt and a reduction of GHG emissions by about 1634 Gg CO_2eq/year, but with a different approach in supplying the necessary replacement and new–missing electricity production. Part of that production would be substituted by the additional production of electricity from hydropower at the level of ≈710 GWh, by revitalization (with upgrading of power) of the existing hydropower plants and construction of new small hydropower units up to 15 MW. The specific investment in these hydro units are at the level of 2730 U.S. $ / kW_{el}.

	Units	Baseline option	Mitigation option	
Unit size	MW_{el}	150	240	
Annual Power Generation	GWh/year	710	710	
Annual operational hours	h/year	4800	3000	
Efficiency	%	29.5	100	
Availability	%	54.8	34.25	
Unit annual energy consumption	TJ/year	8664.41		
Fuel		Lignite	Hydro/Renewable	
H_d	(GJ/t)	7.466		
Fuel Costs	US$/GJ	2.1		
Unit fuel annual consumption	Mt/year	1.16		
				Change
Unit investment Cost	M US$	63	655.2	+592.2
Lifetime	Years	15	35	
Unit Annualized Investment	M US$	6.72	40.0134	+33.2934
Total Annual O & M Costs	M US$	2.31	1.12	–1.19
Annual Fuel Costs	M US$	18.1958	0	–18.1958
Total Annual Costs	M US$	27.2258	41.1334	+13.9076
Annual GHG Emissions				Reduction
Fuel CO_2 (*EF*=107.8315 t CO_2/TJ)		t CO_2	934 296	0 934 296
Fuel N_2O (*EF*=1.4 kg N_2O/TJ)	t N_2O	12.13	0	12.13
Fuel CH_4 (*EF*=1 kg CH_4/TJ)	t CH_4	8.664	0	8.664
Fugitive CH_4 (*EF*=158 kg CH_4/TJ)		t CH_4	1368.977	0 1368.977
Total CO_2eq.	t CO_2eq	966 987	0	966 987

Mitigation (Emission reduction) specific cost: 13.9076 M US$/966 987 = **14.38 US$/ t CO_2eq**

3 Infrastructure thermal cogeneration project

Instead of securing the remainder of the replacement and new–missing electricity production by the year 2015 (in total of 490+2200 GWh) by building a new lignite thermal unit with a nominal capacity of 500 MW_{el}, the alternative scenario takes into account a modern cogeneration unit on natural gas with the best available technology (gas–steam cycle and the corresponding operating parameters). The thermal unit would be with a standard power of 380 MW_{el} while the heat output would be 230 MW_{th}. The annual production of heat to the existing consumers would be 615 GWh_{th} and the production of electricity would be 2690 GWh_{el}, with an additional consumption of natural gas in the order of 420.000 toe. The investments in such a plant are estimated at 280 million U.S. $. Unfortunately, there is no financial justification for the proposed alternative solution for the new (replacement) thermal unit with natural gas instead of lignite under the current economic conditions and the existing parity price of electricity / natural gas, even in the case of implementation of financial incentives under the Clean Development Mechanism (CDM).

	Unit	Baseline option	Mitigation option
Unit size	MW_{el}	500	380
Annual Power Generation	GWh/year	2690	2690
Annual operational hours	h/year	5380	7080
Efficiency	%	33.5	55
Availability	%	61.42	80.8
Unit annual energy consumption	TJ/year	28 907.46	17607.27
Fuel		Lignite	Natural gas
H_d	(GJ/t)	7.466	34. MJ/m^3
Fuel Costs	US$/GJ	2.1	14.0
Unit fuel annual consumption	Mt/year	3.872	517.860 Mm^3

				Increase
Unit investment Cost	M US$	770	280	–490
Lifetime	Years	35	35	
Unit Annualized Investment	M US$	47.0246	17.0996	–29.925
Total Annual O & M Costs	M US$	19.04	2.1	–16.94
Annual Fuel Costs	M US$	60.704	246.498	185.794
Total Annual Costs	M US$	126.7686	265.6976	138.929

Annual GHG Emissions				Reduction
Fuel CO_2 (*EF*=107.8315 t CO_2/TJ)	t CO_2	3 117 136	982 829	2 134 307
Fuel N_2O (*EF*=1.4 kg N_2O/TJ)	t N_2O	40.47	1.7607	38.71
Fuel CH_4 (*EF*=1 kg CH_4/TJ)	t CH_4	28.91	17.607	11.4
Fugitive CH_4 (*EF*=158 kg CH_4/TJ)	t CH_4	4567.38		4567.38
Total CO_2eq.	t CO_2eq	3 226 204	983 745	2 242 459

Mitigation (Emission reduction) specific cost: 138.929 M US$/2 242 459 = **61.95 US$/ t CO_2eq**

4 Infrastructure thermal energy project with efficiency I

According to the alternative scenario, the restoration and modernization of the existing thermal power units on lignite for electricity production is planned to increase their energy efficiency primarily through:

- revitalization/modernization of the steam turbine, condensing plant and cooling system unit, boiler and auxiliary equipment (*e.g.*, low / high pressure feedwater heaters),
- revitalization and improvement of the firing system and the combustion process by introducing "Low NOx" burners and increasing the efficiency of the old thermal units of 620 MW_{el},
- transfer and introduction of new modern technologies of lignite pre–drying (with 50 % moisture in the raw lignite from Kolubara Basin down to 40 % in the pre–dried coal) with the waste heat from the thermal unit.

The increase of the overall cycle efficiency by only 2 percentage points (thermal unit efficiency from 34.2 % to 36.2 %) on the 620 MW_{el} thermal units with an annual production of 8000 GWh would save 0.624 Mt of lignite, *i.e.*, a reduction of the CO_2 emissions by 519 Gg CO_2/year.

	Units	Baseline Option	Mitigation option	
Unit size	MW_{el}	2x618	2x618	
Annual Power Generation	GWh/year	2x4000	2x4000	
Annual operational hours	h/year	6500	6500	
Efficiency	%	34.2	36.2	
Availability	%	74.2	74.2	
Unit annual energy consumption	TJ/year	2x42105.26	2x39779.0	
Fuel		Lignite	Lignite	
H_d	(GJ/t)	7.466	7.466	
Fuel Costs	US$/GJ	2.1	2.1	
Unit fuel annual consumption	Mt/year	2x5.640	2x5.328	
	Increase			
Unit investment Cost	M US$			
	161	+161		
Lifetime	Years	15	15	
Unit Annualized Investment	M US$	0.0	17.1738	+17.1738
Total Annual O & M Costs	M US$	48.44	43.82	–4.62
Annual Fuel Costs	M US$	176.8424	167.0718	–9.7706
Total Annual Costs	M US$	225.2824	228.0656	2.7832

Annual GHG Emissions				Reduction
Fuel CO_2 (*EF*=107.8315 t CO_2/TJ)		t CO_2	9 080 551	8 578 862 501 689
Fuel N_2O (*EF*=1.4 kg N_2O/TJ)	t N_2O	117.895	111.381	6.514
Fuel CH_4 (*EF*=1 kg CH_4/TJ)	t CH_4	84.2105	79.558	4.6525
Fugitive CH_4 (*EF*=158 kg CH_4/TJ)		t CH_4	13305.26	12570.16 735.1
Total CO_2eq.	t CO_2eq	9 398 277	8 879 034	519 243

Mitigation (Emission reduction) specific cost: 2.7832 M US$/519 243 = **5.36 US$/ t CO_2eq**

5 Infrastructure thermal energy project with efficiency II

According to the alternative scenario, the restoration and modernization of the existing thermal power units on lignite for electricity production is planned to increase their energy efficiency primarily through:

- revitalization/modernization of the steam turbine, condensing plant and cooling system unit, boiler and auxiliary equipment (e.g., low / high pressure feedwater heaters),
- revitalization and improvement of the firing system and the combustion process by introduction of "Low NOx" burners and increasing the efficiency of the old thermal units of 300 MW_{el},
- transfer and introduction of new modern technologies of lignite pre–drying (with 50 % moisture in the raw lignite from Kolubara Basin down to 40 % in the pre–dried coal) with the waste heat from the thermal unit.

The increase of the overall cycle efficiency of only 2 percentage points on all 300 MW_{el} thermal units (from 34.2 % to 36.2%) would decrease the lignite consumption by 1.28 Mt/year and reduce the CO_2 emissions by 1070 Gg CO_2/year.

	Units	Baseline option	Mitigation option	
Unit size	MW_{el}	8x308	8x308	
Annual Power Generation	GWh/year	8x1650	8x1650	
Annual operational hours	h/year	5800	5800	
Efficiency	%	30.5	32.5	
Availability	%	66.2	66.2	
Unit annual energy consumption	TJ/year	8x19475.41	8x18276.92	
Fuel		Lignite	Lignite	
Hd	(GJ/t)	7.466	7.466	
Fuel Costs	US$/GJ	2.1	2.1	
Unit fuel annual consumption	Mt/year	8x2.608	8x2.448	
	Increase			
Unit investment Cost	M US$	350	+350	
Lifetime	Years	15	15	
Unit Annualized Investment	M US$	0.0	37.333	+37.333
Total Annual O & M Costs	M US$	104.44	87.878	–16.562
Annual Fuel Costs	M US$	327.1856	307.048	–20.1376
Total Annual Costs	M US$	431.6256	432.259	0.6334

				Reduction	
Annual GHG Emissions				Reduction	
Fuel CO_2 (EF=107.8315 t CO_2/TJ)		t CO_2	16 800 509	15 766 629	501 689
Fuel N_2O (EF=1.4 kg N_2O/TJ)	t N_2O	218.125	204.702	6.514	
Fuel CH_4 (EF=1 kg CH_4/TJ)	t CH_4	155.803	146.215	4.6525	
Fugitive CH_4 (EF=158 kg CH_4/TJ)		t CH_4	24616.92	23102.03 735.1	
Total CO_2eq.	t CO_2eq	17 388 355	16 318 300	1 070 055	

Mitigation (Emission reduction) specific cost: 0.6334 M US$/1070 055 = **0.59 US$/ t CO_2eq**

It may be concluded that the realization of the suggested priority projects until the year 2015 aimed at mitigating the climate changes in the energy sector for electricity production may contribute to a reduction of the yearly lignite consumption by 1.5265 + 1.16 + 3.872 + 0.624 + 1.28 = 8.4625 Mt and GHG emissions in total by about 1268.5 + 967.0 + 2242.4 + 519.2 + 1070 = 6067.1 Gg CO_2eq/year.

The required overall investment resources are on the level of 2916 M US $ which the economic subjects in the Republic of Serbia can not secure and thus foreign investments are expected.

The majority of the evaluated projects are economically viable even in the present relatively unfavourable economic conditions (with or without implementation of the financial incentives under the Clean Development Mechanism – CDM) except Project 3 which, due to unfavourable parity of prices for lignite and electricity in comparison to the price of natural gas, is not economically feasible even in the case of implementation of the financial incentives under the Clean Development Mechanism (CDM).

The estimated specific costs of GHG mitigation, per project, are as follows:

Project 1: – 4.85 US $/ t CO_2eq.

Project 5: + 0.59 US $/ t CO_2eq.

Project 4: + 5.36 US $/ t CO_2eq.

Project 2: + 14.38 US $/ t CO_2eq.

Project 3: + 61.95 US $/ t CO_2eq.

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