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
ţ ʉ	Population equivalent
EU	European Union
GDP	Gross Domestic Product
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GEF	Global Environmental Facility
GHG	Green House 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
Nϕʃ ϕ	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 ţ PS	Public enterprise ĂElectric power industry of Serbiaò

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
ʊɽ	Power plant
ʊɽ -ʊʃ	Power plant ï 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

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.

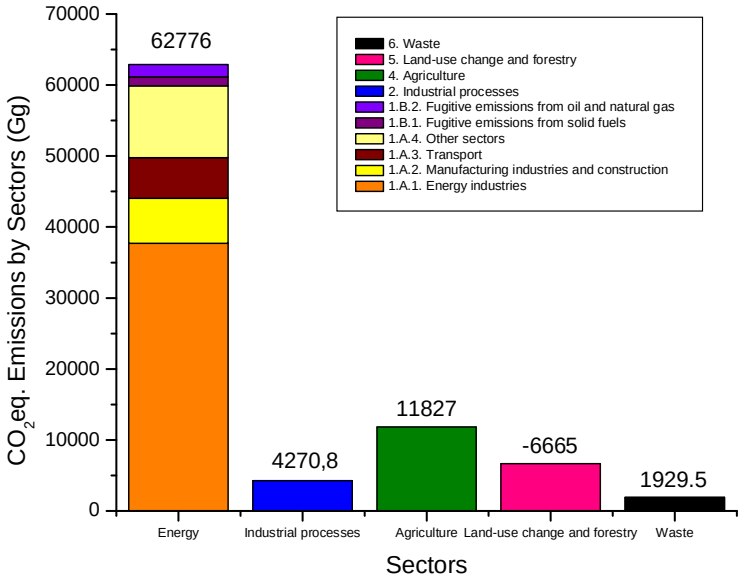


Figure 1.1. Greenhouse Gas Emissions (GHG) by sector, Republic of Serbia in 1990.

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.

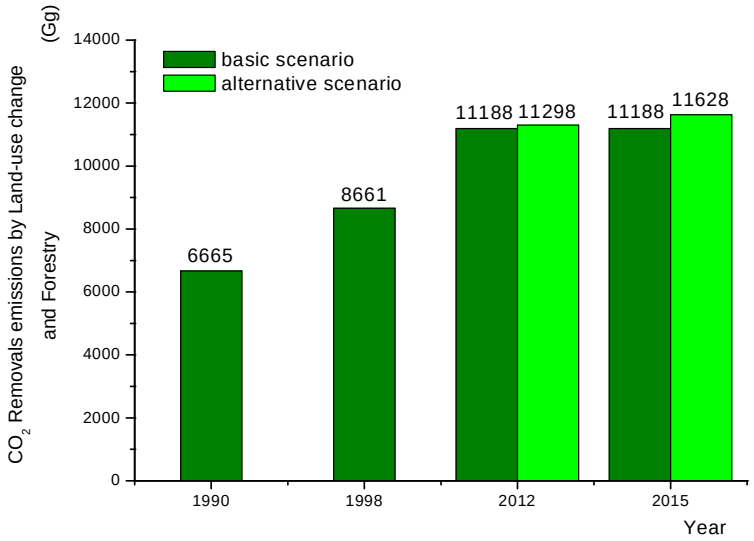


Figure 1.2. Greenhouse Gas Emissions (GHG) by sector, Republic of Serbia in 1998.

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.

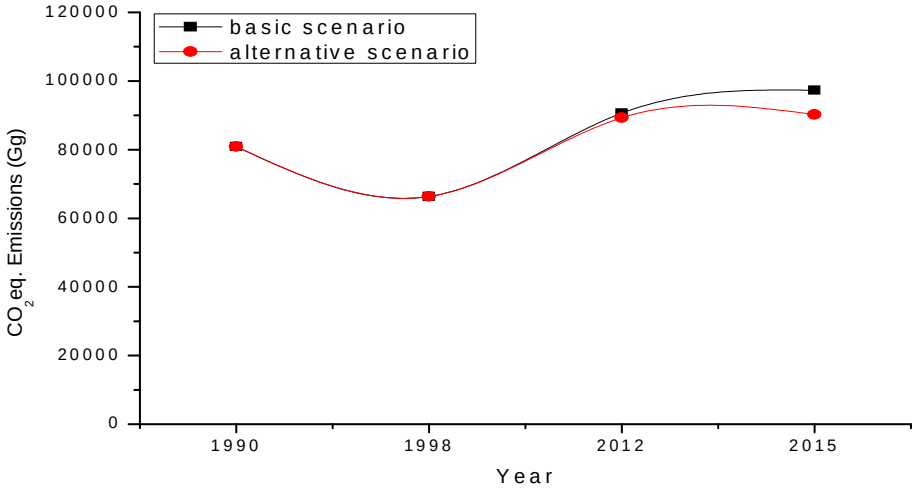


Figure 1.3. GHG emissions projection until 2015 according to the baseline and alternative scenario

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 Milankoví, 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

2.1. 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 Maḷva, 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: ṇerdap, 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.

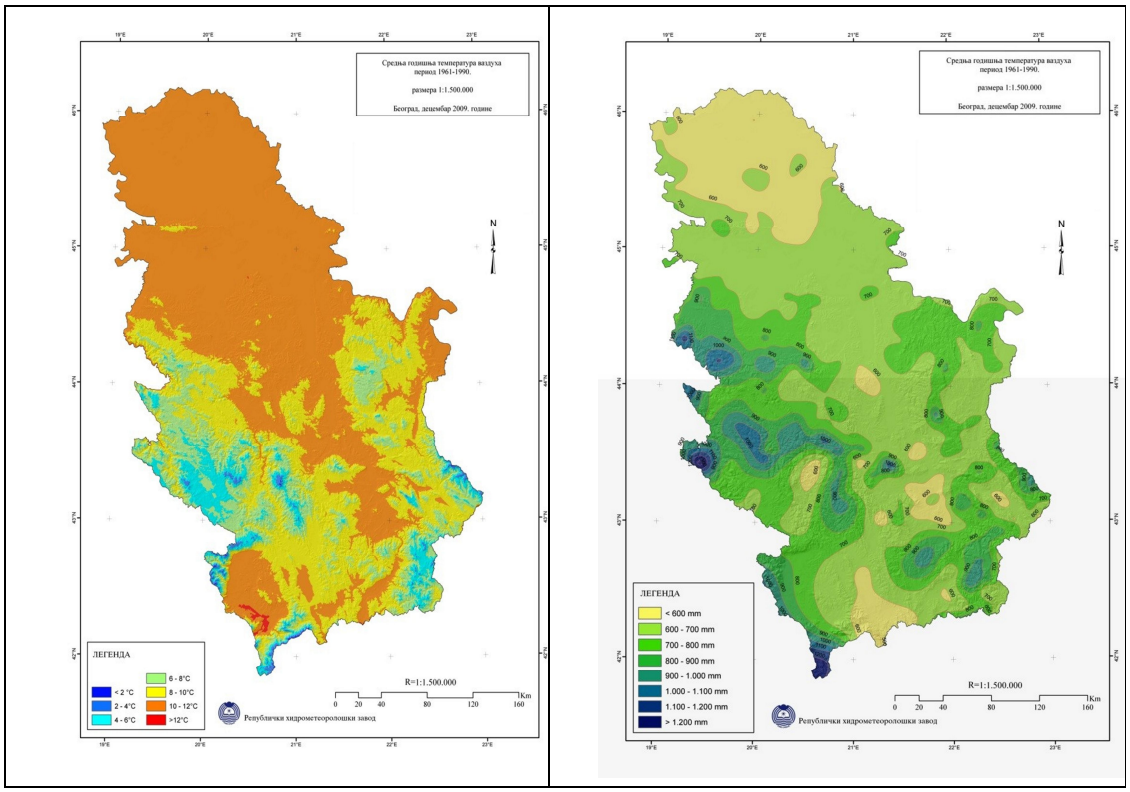


Figure 2.1 Mean annual air temperature (°C) and accumulated precipitation (mm) for the period 1961–1990.

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.

2.4.1. 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

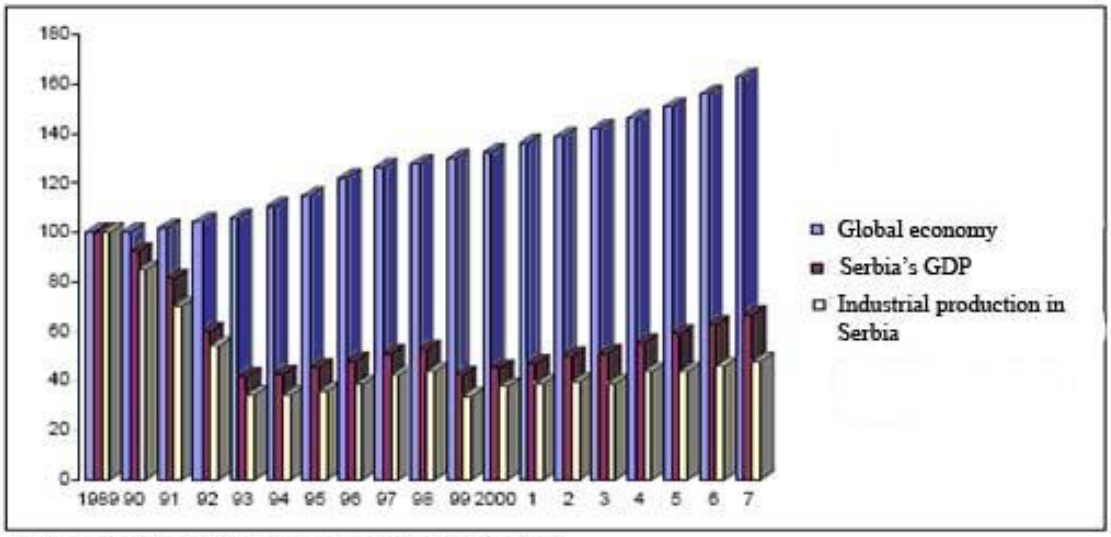
2.5.1 ECONOMY

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).

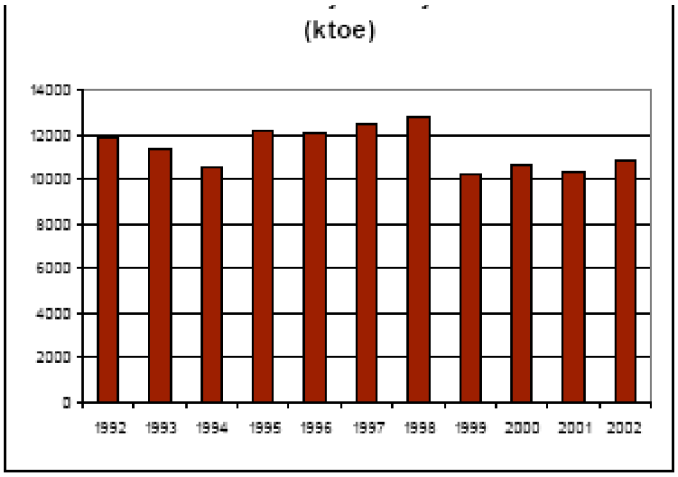


Figure 2.4 Gross primary energy consumption (ktoe), 1992-2002

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, Pan̦evo, 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.

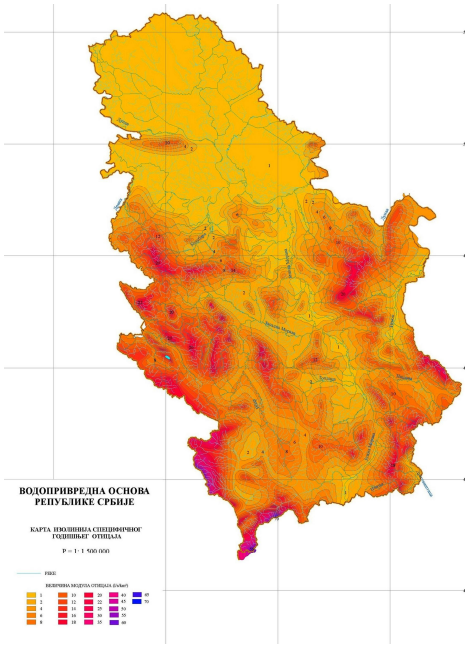


Figure 2.6 Average specific runoff.

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 20^{th} 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 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 VINĻA 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 removal (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 stock	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.

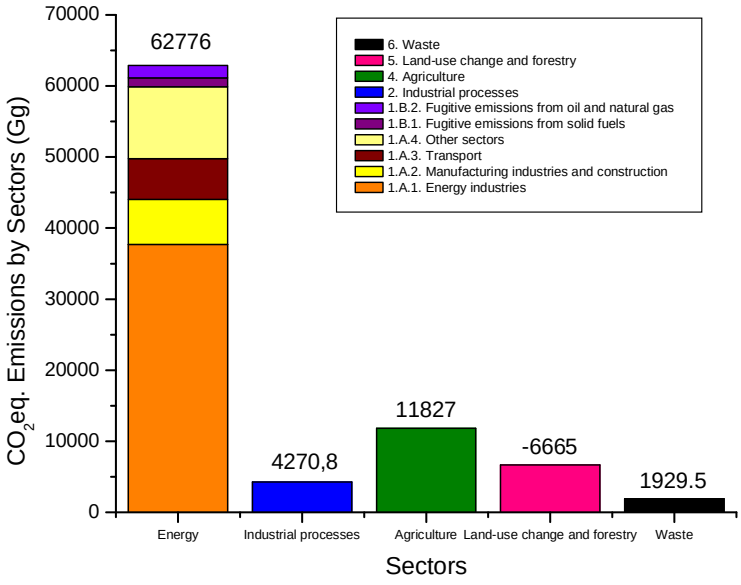


Figure 3.1. Greenhouse Gas Emissions (GHG) by Sector, Republic of Serbia, 1990

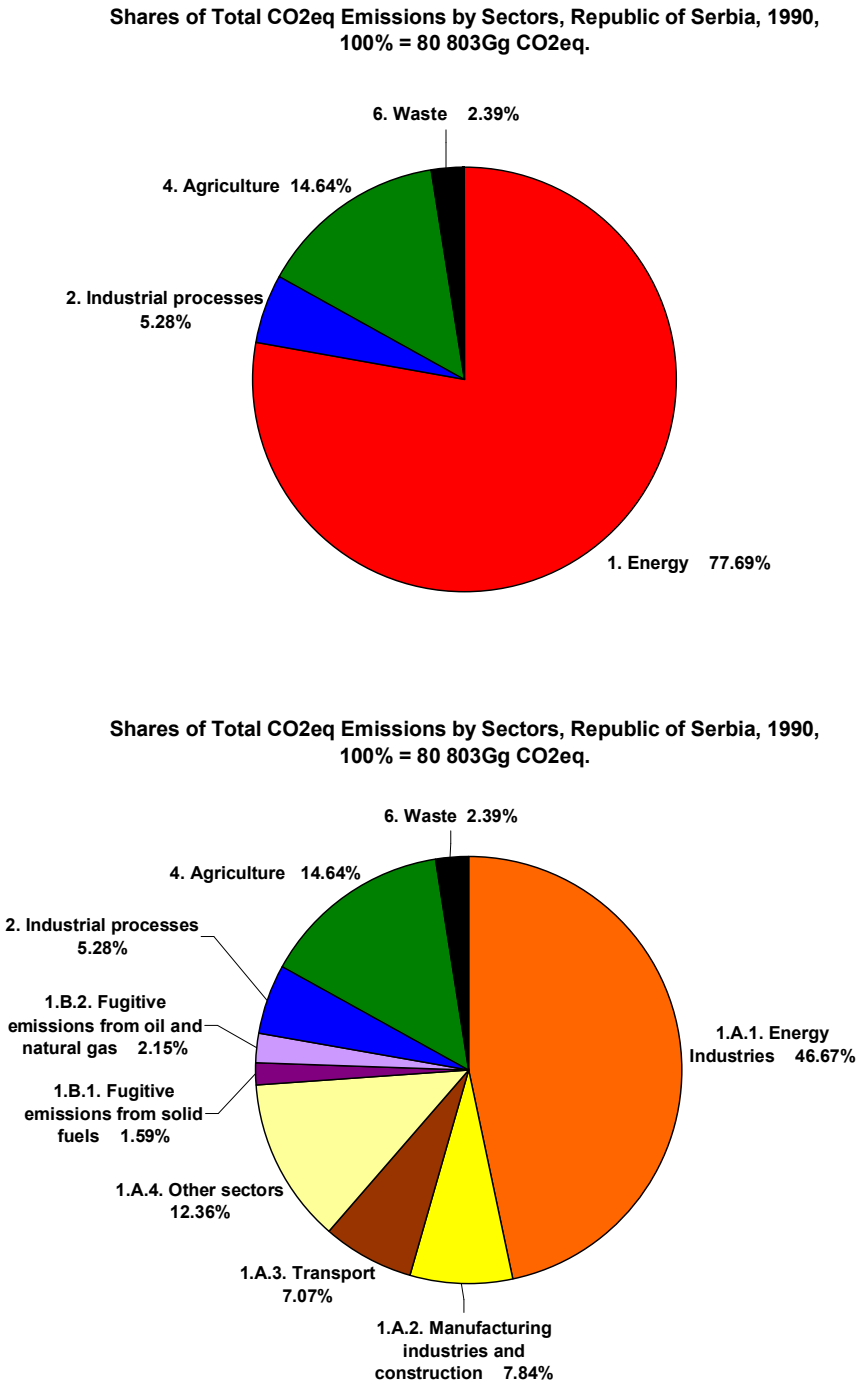


Figure 3.2. Shares of the Total GHG Emissions by Sector/Sub–sector, Republic of Serbia, 1990.

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.

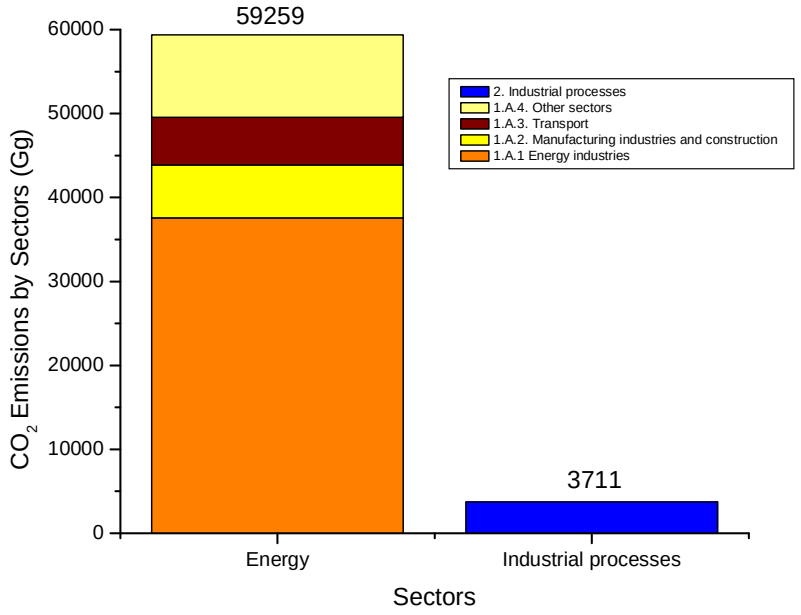


Figure 3.3. CO_2 Emissions by Sector/Sub–sector, Republic of Serbia, 1990.

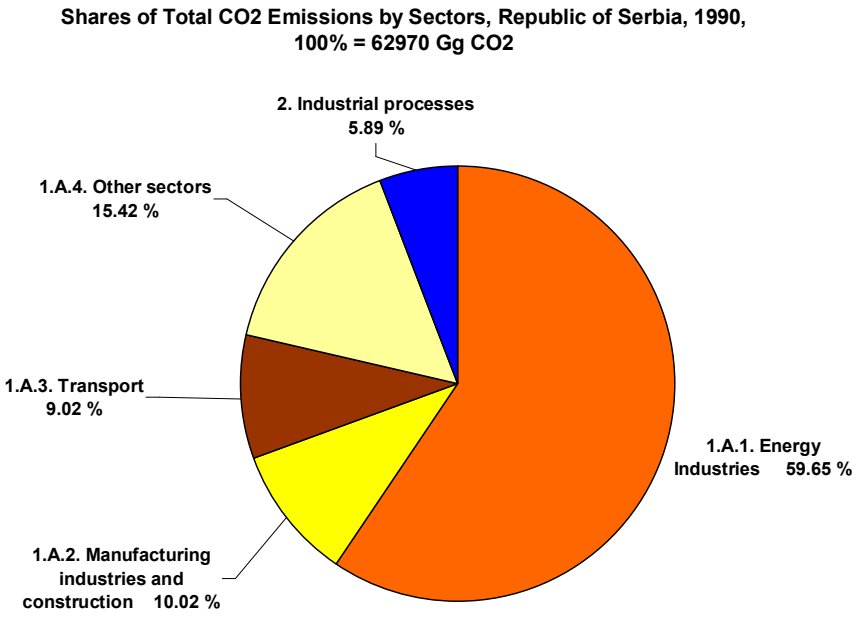


Figure 3.4. Shares of Total CO_2 Emissions by Sector/Sub–sector, Republic of Serbia, 1990.

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.

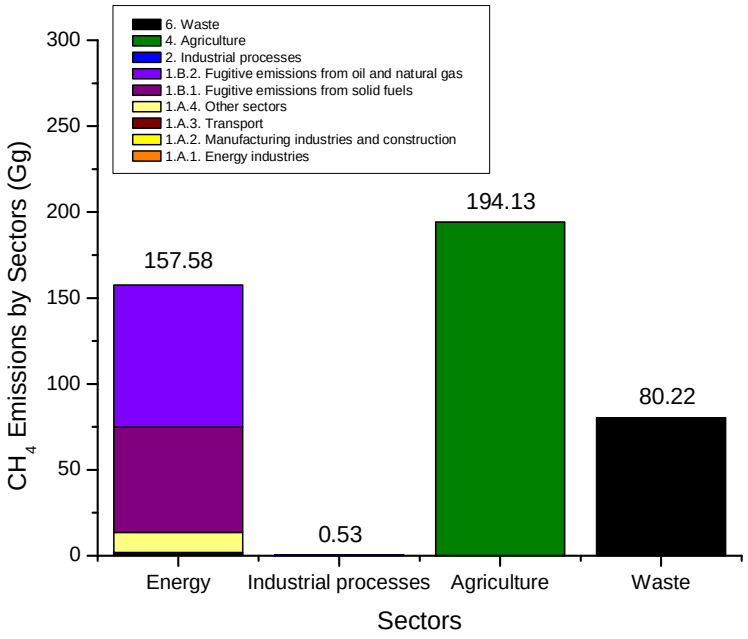


Figure 3.5. Methane (CH_4) Emissions by Sector, Republic of Serbia, 1990.

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).

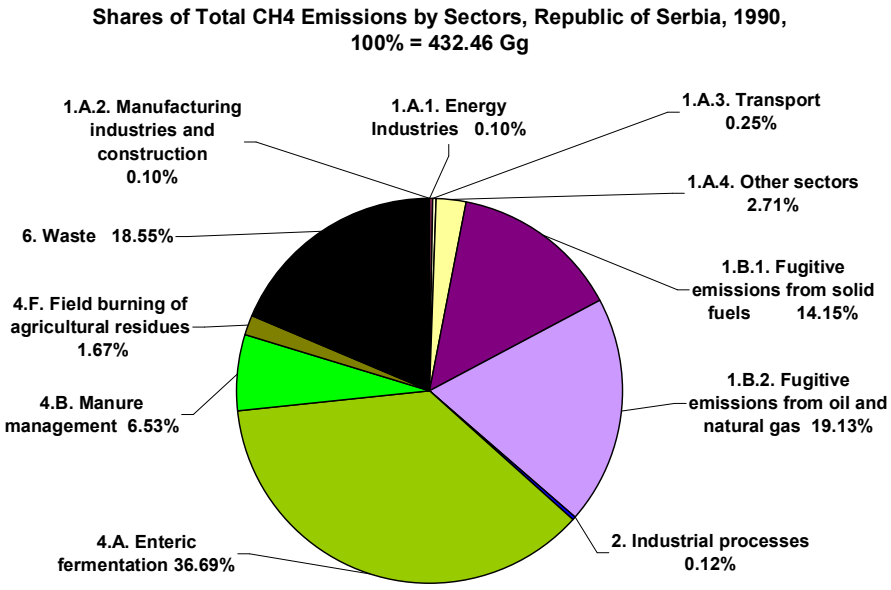


Figure 3.6. Shares of the Total CH_4 Emissions by Sector/Sub–sector, Republic of Serbia, 1990.

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.).

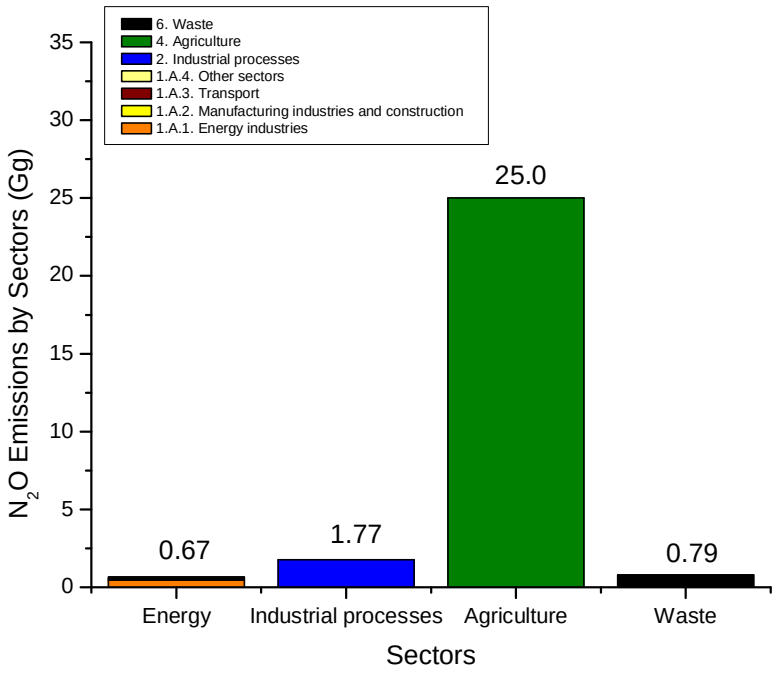


Figure 3.7. N_2O Emissions by Sector, Republic of Serbia, 1990.

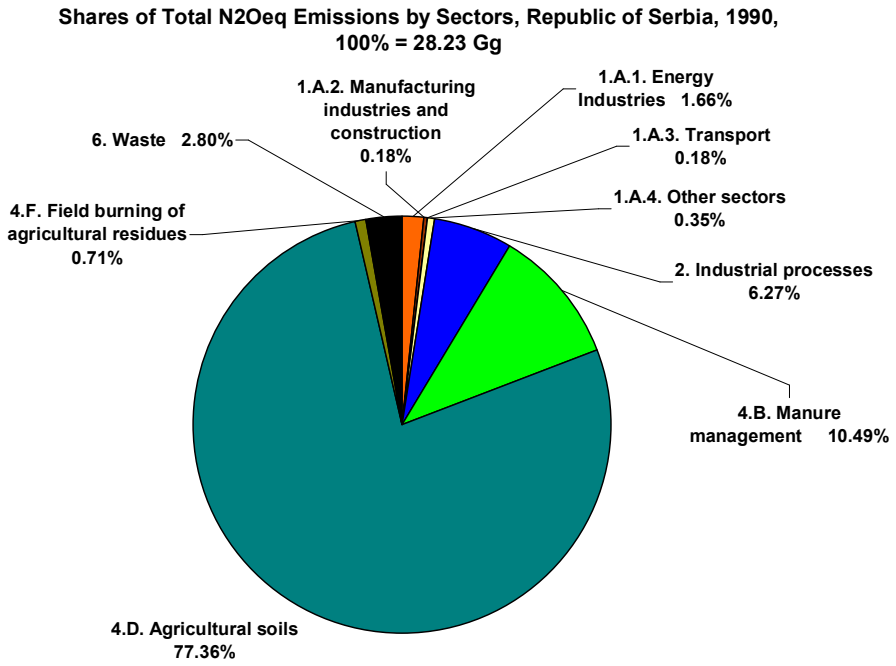


Figure 3.8. Shares of the Total N_2O Emissions by Sector/Sub–sector, Republic of Serbia, 1990.

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.

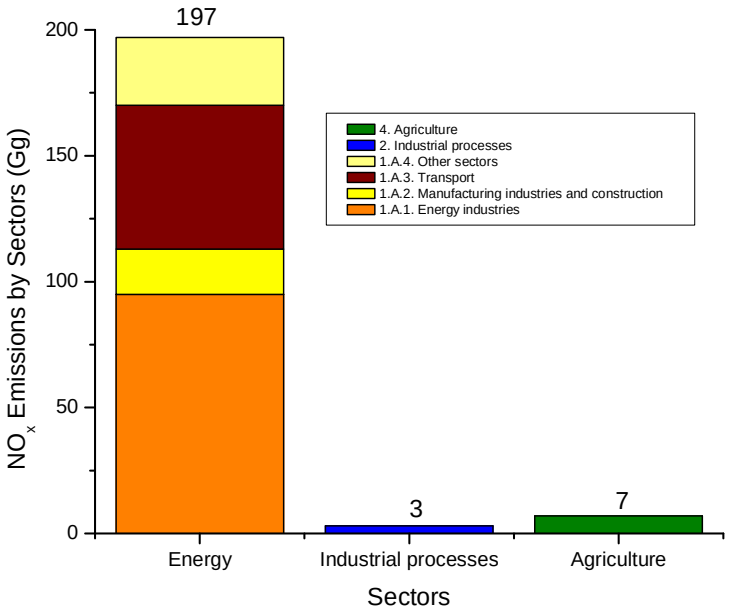


Figure 3.9. NO_x Emissions by Sectors, Republic of Serbia, 1990.

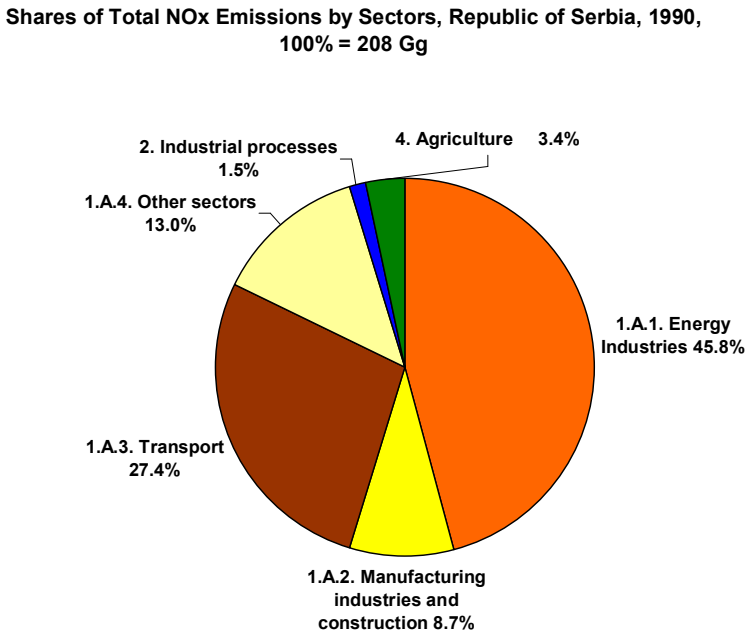


Figure 3.10. Shares of Total NOx Emissions by Sector/Sub-sector, Republic of Serbia, 1990.

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

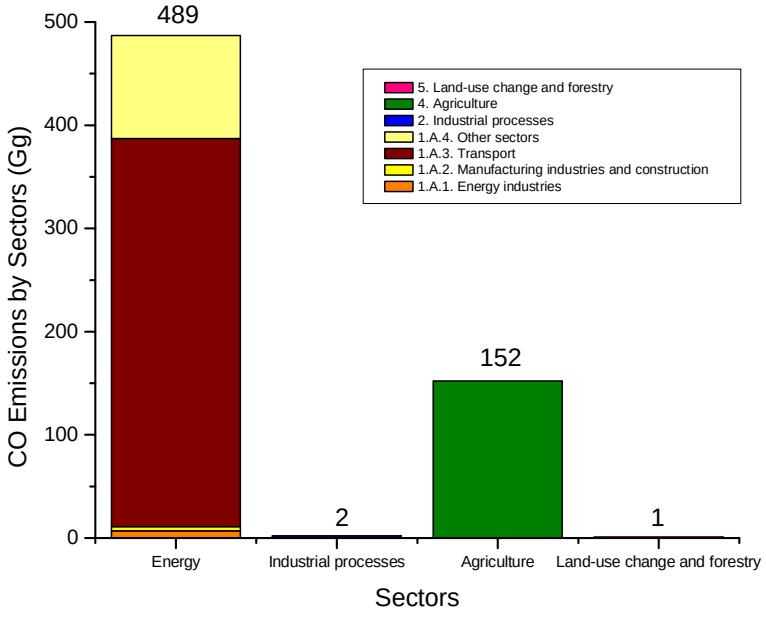


Figure 3.11 Carbon monoxide Emissions by Sector, Republic of Serbia, 1990.

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.).

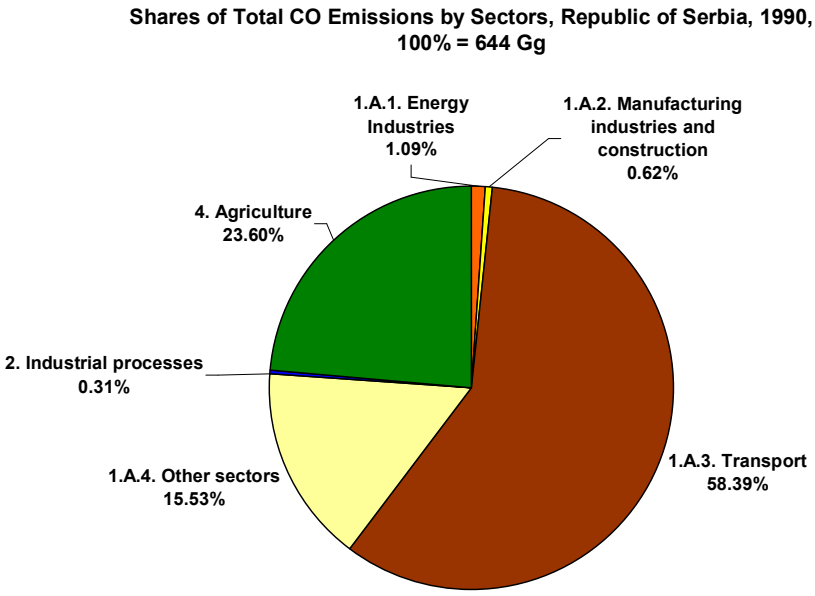


Figure 3.12. Shares of Total CO Emissions by Sector/Sub–sector, Republic of Serbia, 1990.

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 %.

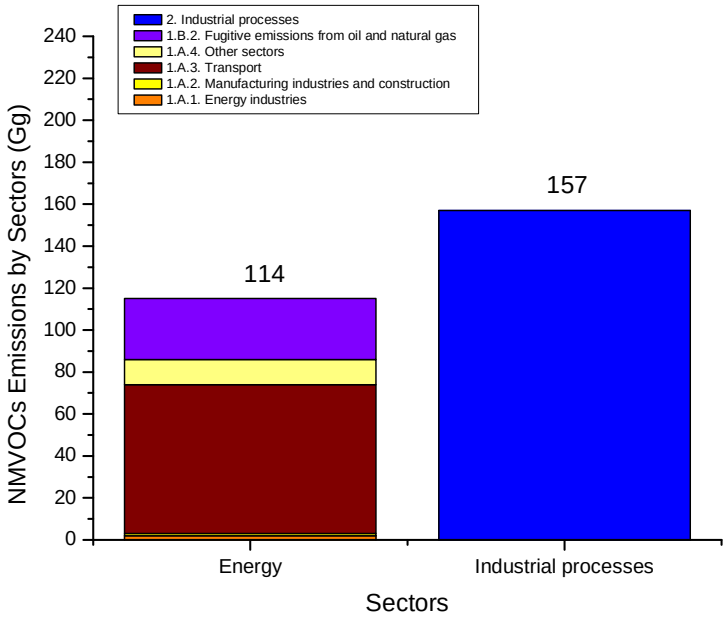


Figure 3.13 NMVOCs Emissions by Sectors, Republic of Serbia, 1990.

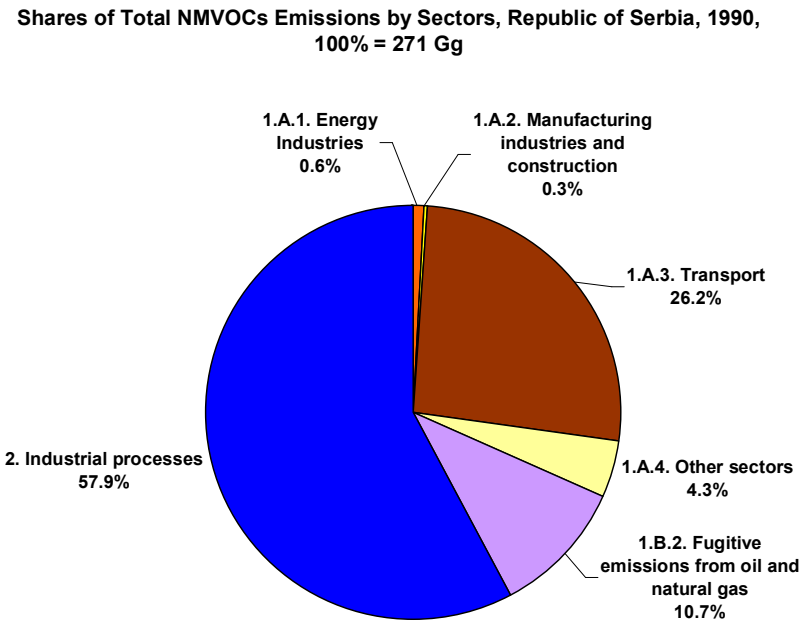


Figure 3.14. Shares of Total NMVOCs Emissions by Sector/Sub–sector, Republic of Serbia, 1990.

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).

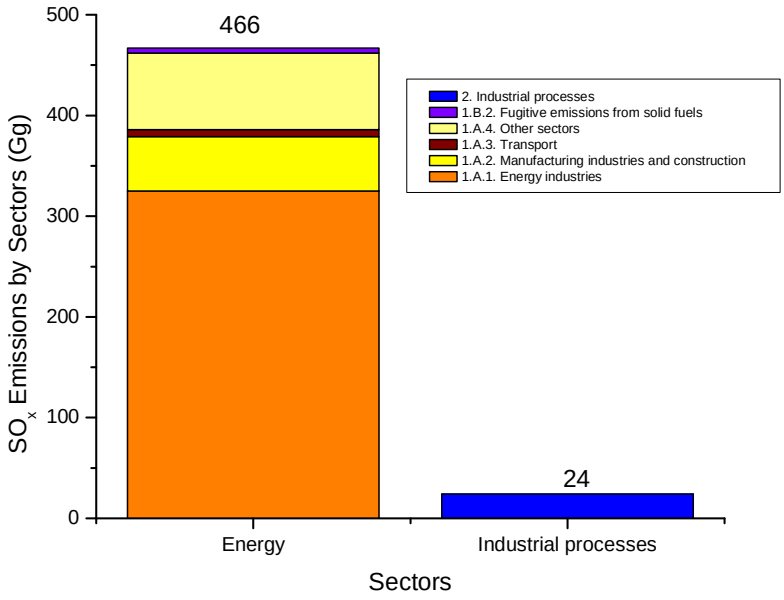


Figure 3.15. Sulphur oxides (SO_x) Emission by Sector/Sub–sector, Republic of Serbia, 1990.

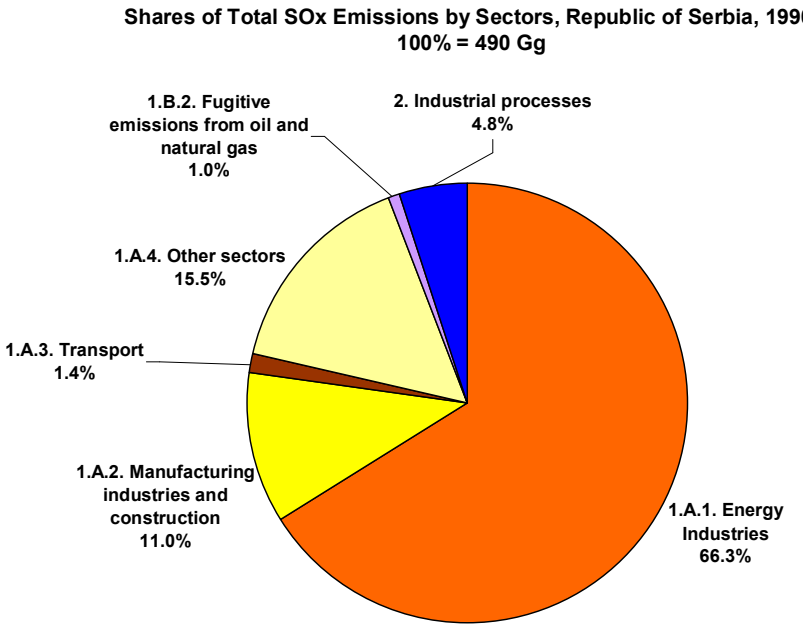


Figure 3.16. Shares of Total SOx Emissions by Sector/Sub–sector, Republic of Serbia, 1990.

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).

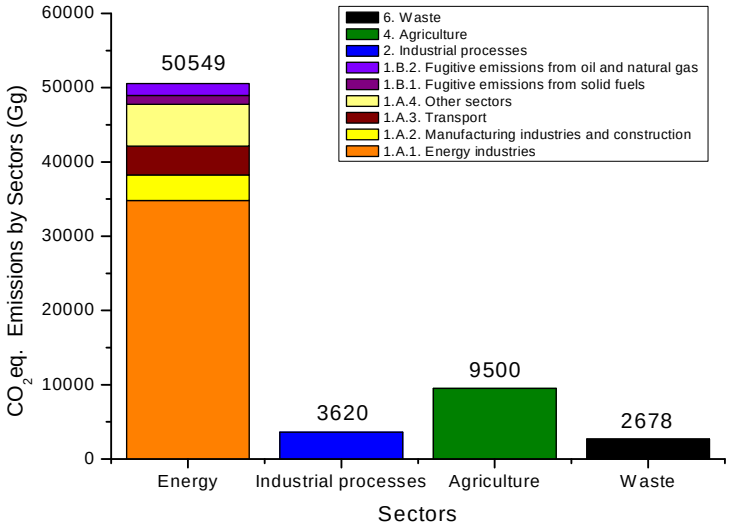
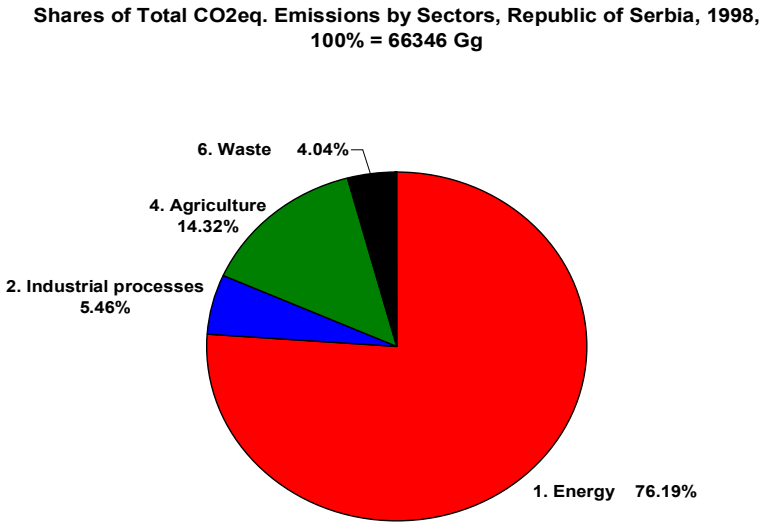


Figure 3.17. Greenhouse Gas Emissions (GHG) by sector, Republic of Serbia, 1998.

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.



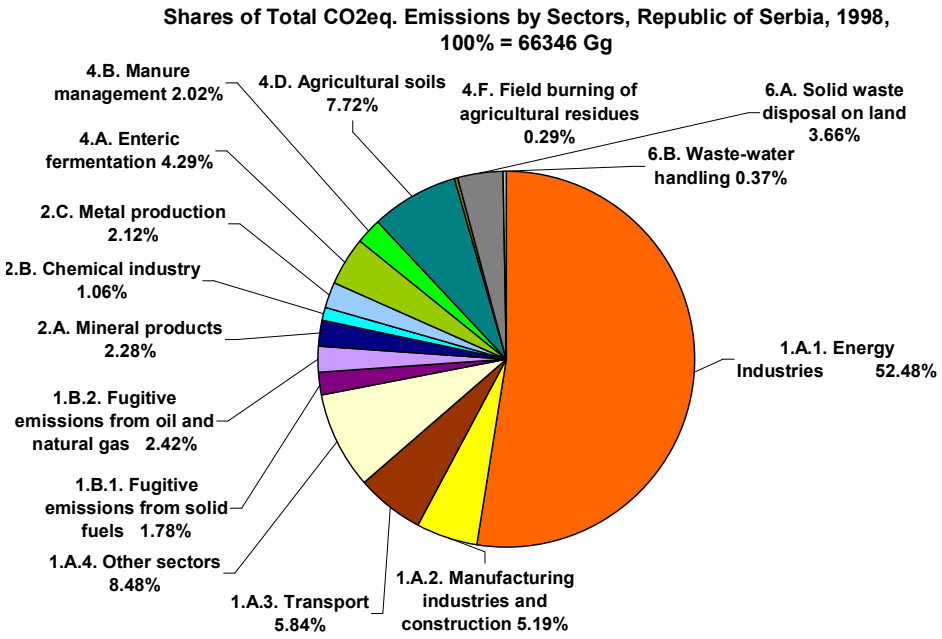


Figure 3.18. Shares of Total GHG Emissions by Sector/Sub–sector, Republic of Serbia, 1998.

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).

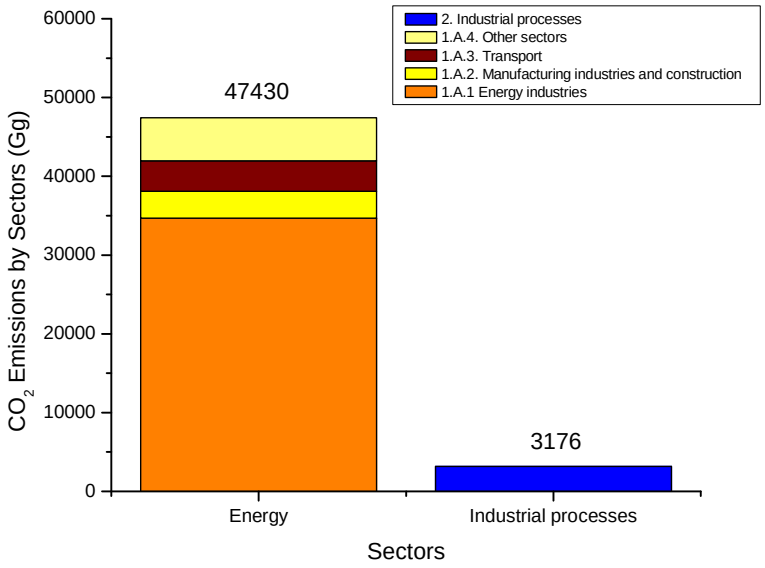


Figure 3.19. CO_2 Emissions by sectors, Republic of Serbia, 1998.

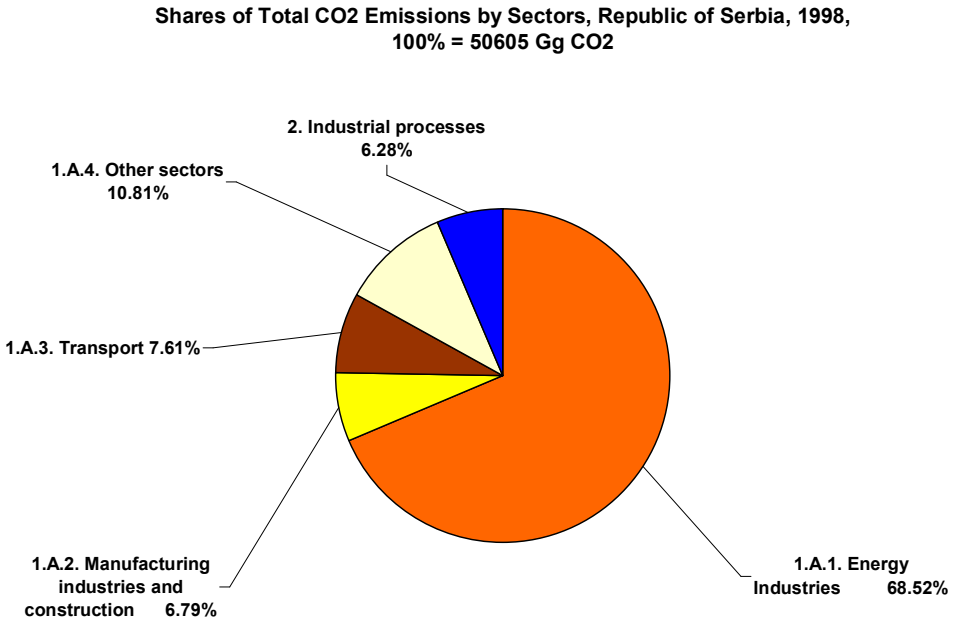


Figure 3.20. Shares of Total CO_2 Emissions by Sector/Sub-sector, Republic of Serbia, 1998.

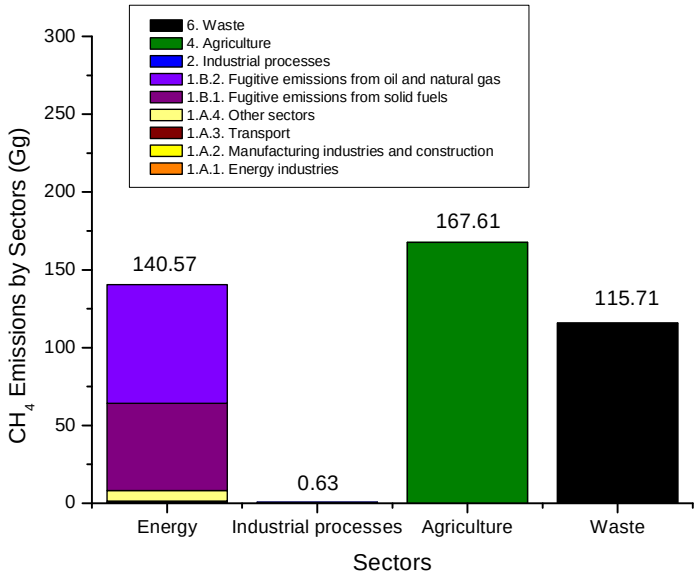


Figure 3.21. Methane (CH_4) Emissions by Sector, Republic of Serbia, 1998

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).

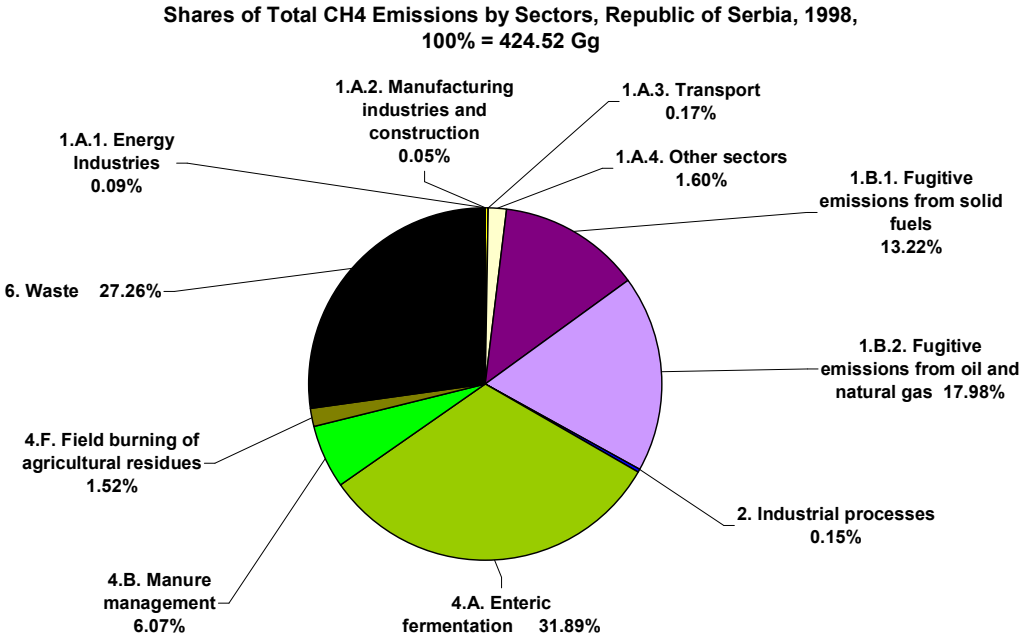


Figure 3.22. Shares of Total CH_4 Emissions by Sector/Sub-sector, Republic of Serbia, 1998

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).

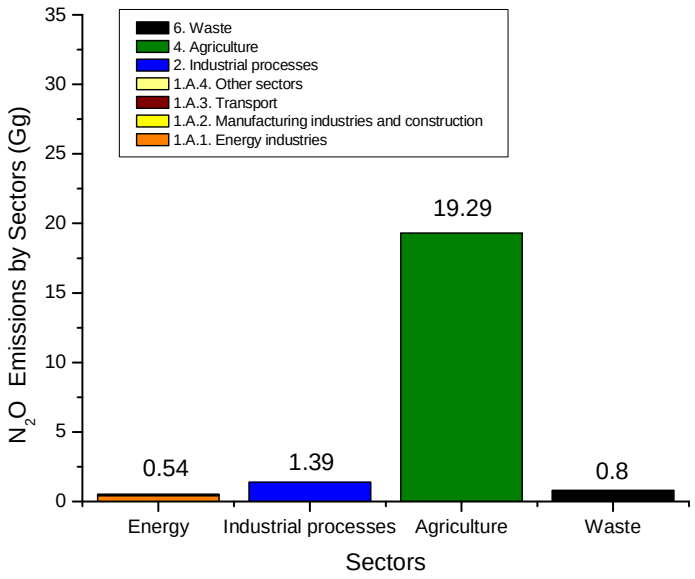


Figure 3.23. N_2O Emissions by Sector, Republic of Serbia, 1998

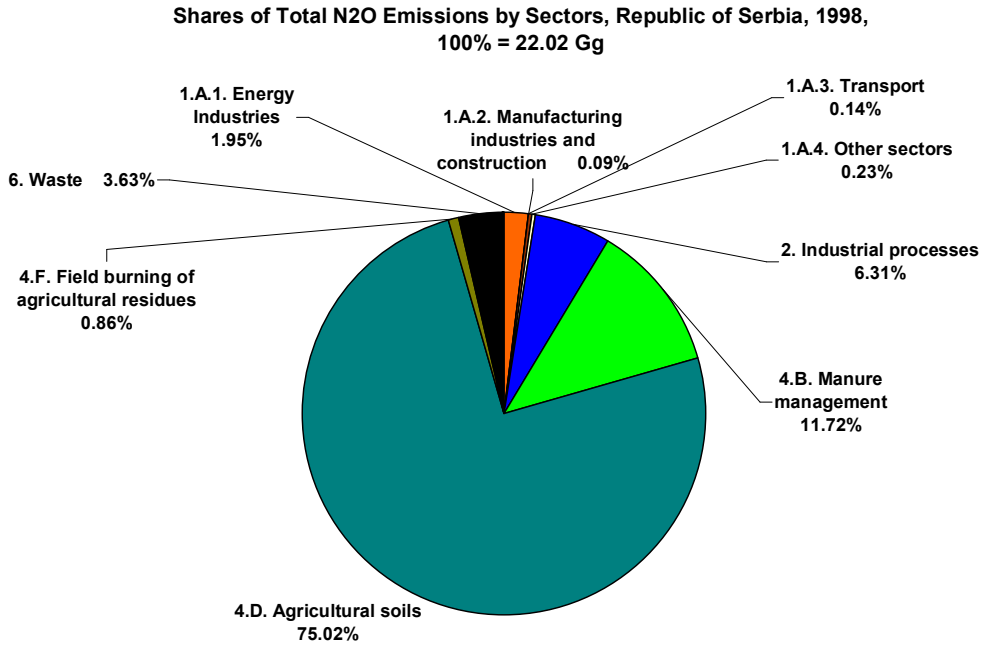


Figure 3.24. Shares of Total N_2O Emissions by Sector/Sub–sector, Republic of Serbia, 1998

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.

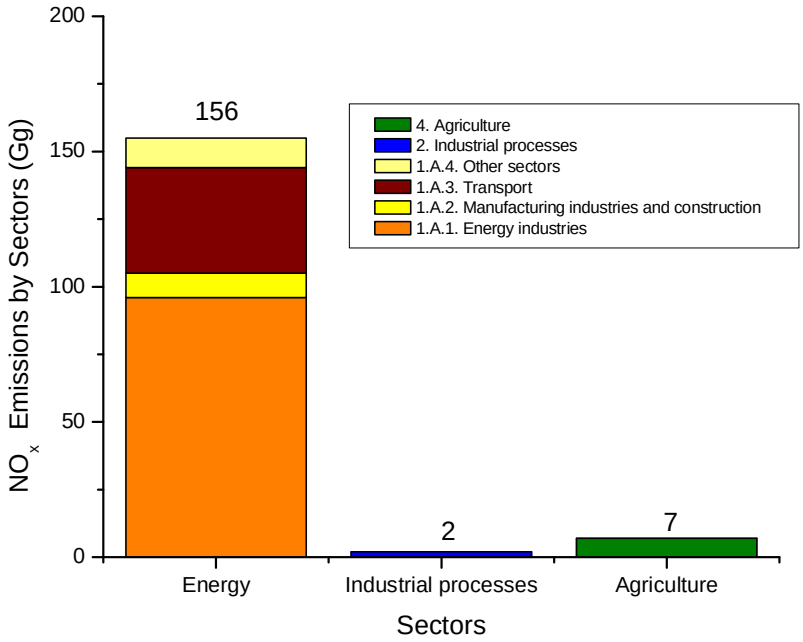


Figure 3.25. NO_x Emissions by Sectors, Republic of Serbia, 1998

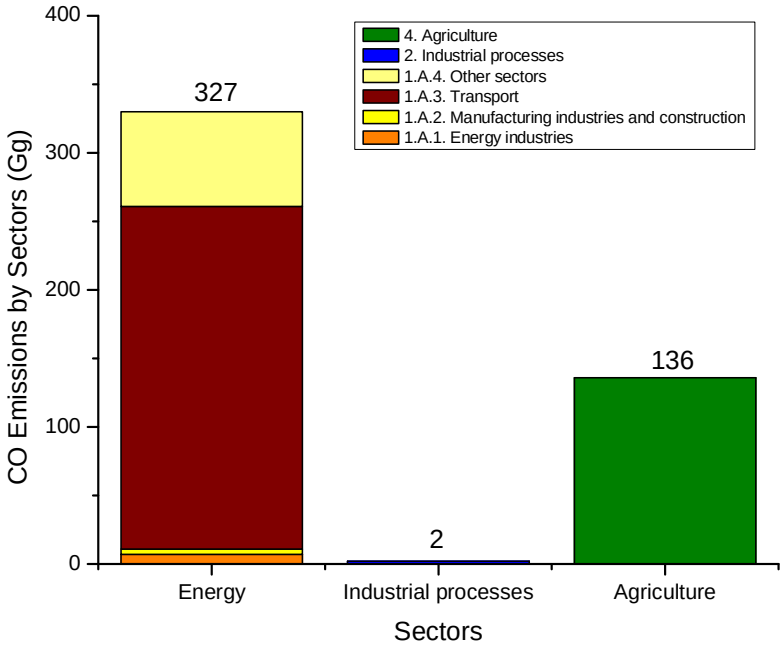


Figure 3.26. Carbon monoxide Emissions by Sector, Republic of Serbia, 1998

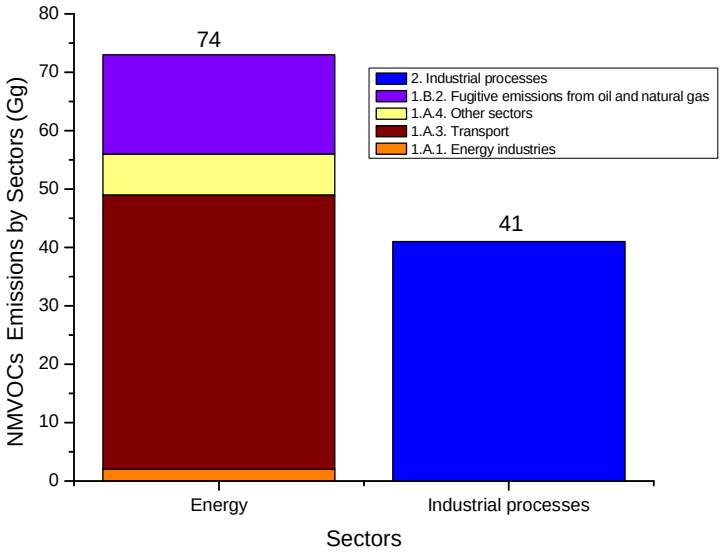


Figure 3.27. NMVOCs Emissions by Sectors, Republic of Serbia, 1998

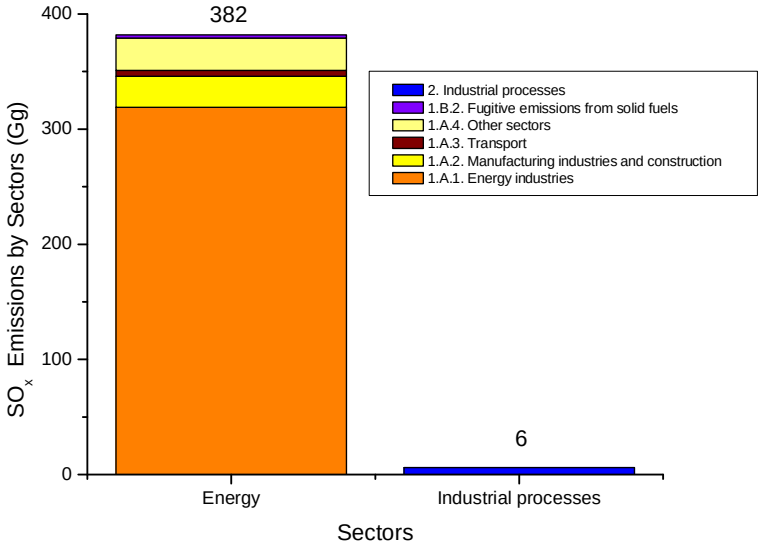


Figure 3.28. Sulphur oxides (SO_x) Emission by Sector/Sub–sector, Republic of Serbia, 1998

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

4.1. 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.

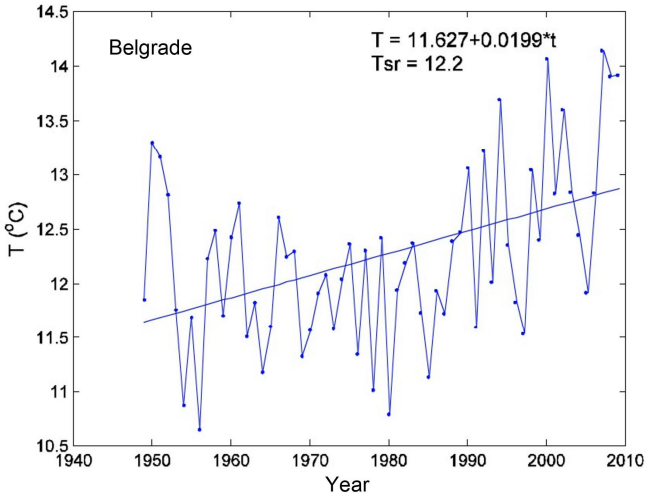


Figure 4.1. Mean annual temperatures (°C) in Belgrade during the period 1949–2009.

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 95th percentile calculated for the reference period 1961–1990 (R95ϖ) 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.

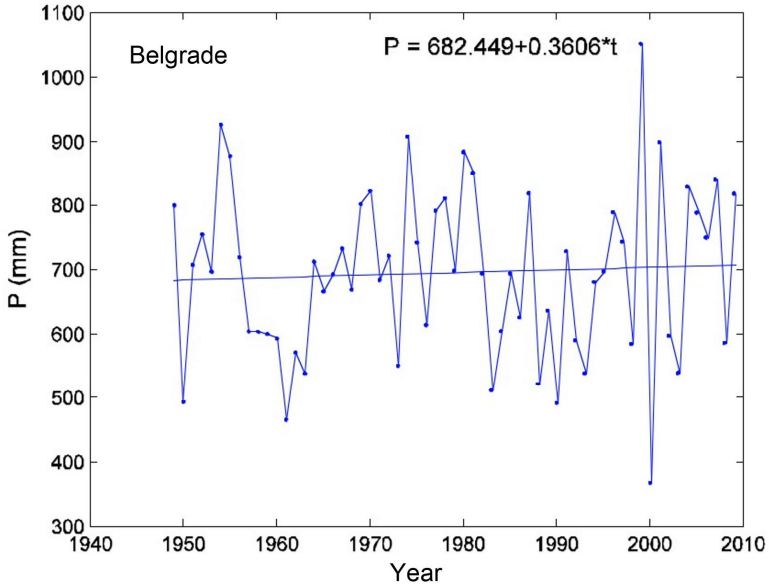


Figure 4.2. Annual precipitation amounts in Belgrade (mm) during 1949–2009.

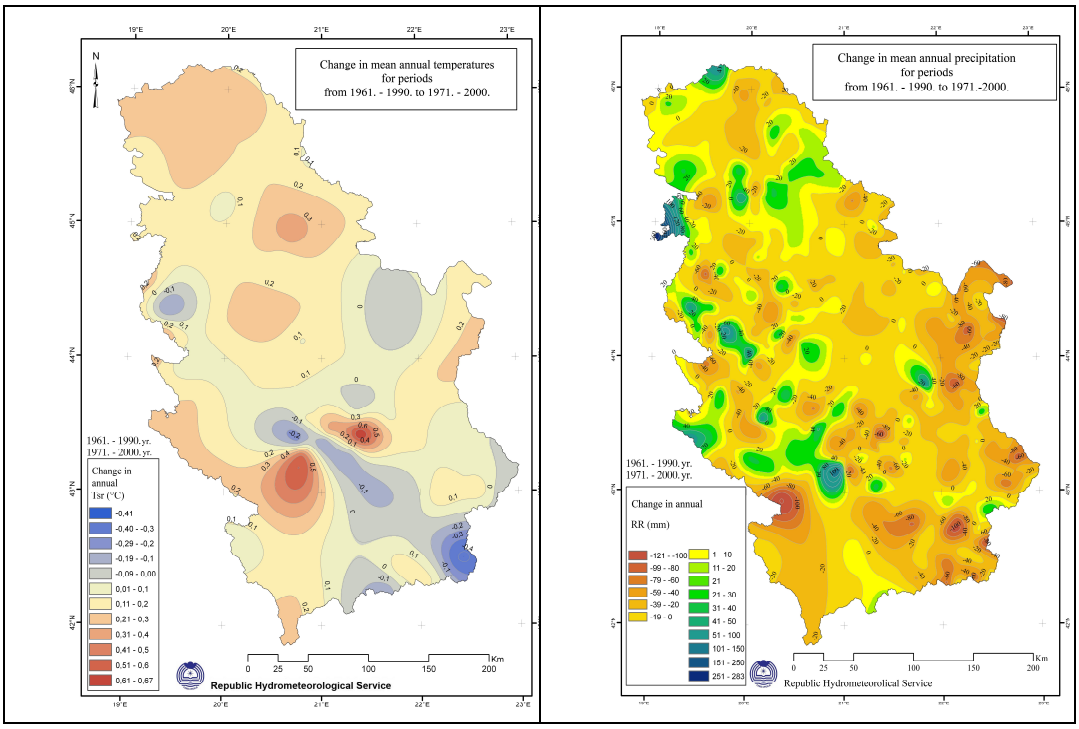


Figure 4.3. Changes in the mean annual temperatures and mean annual precipitation

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 Baḷka (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.

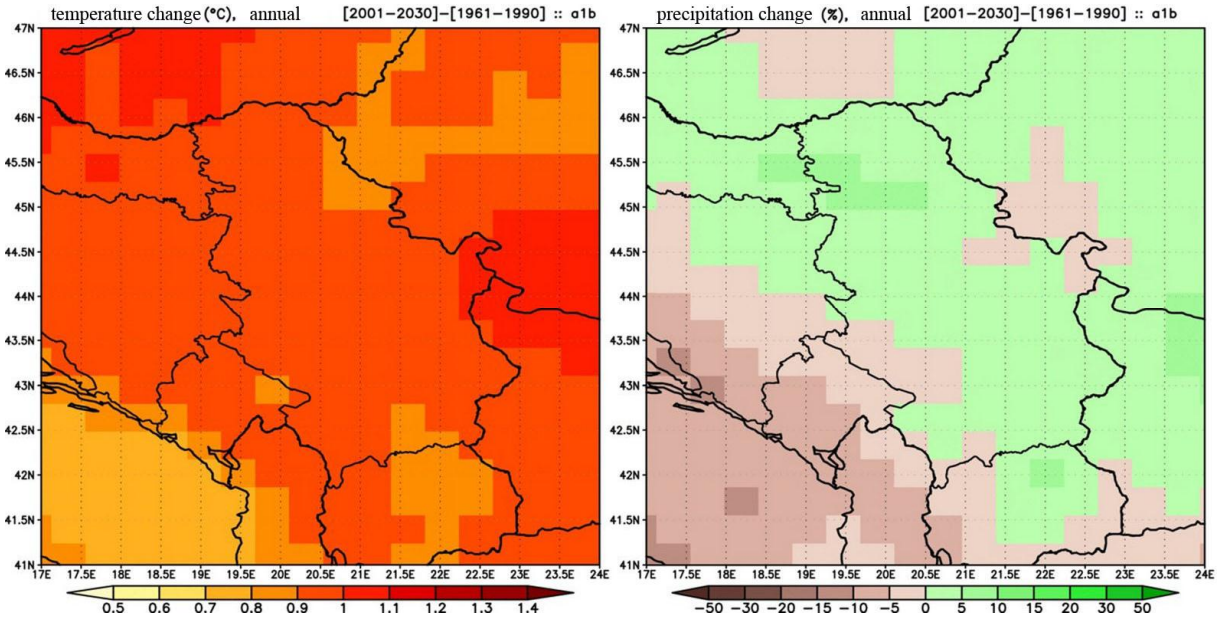


Figure 4.4. Annual changes of the mean 2–metre air temperature and accumulated precipitation.

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).

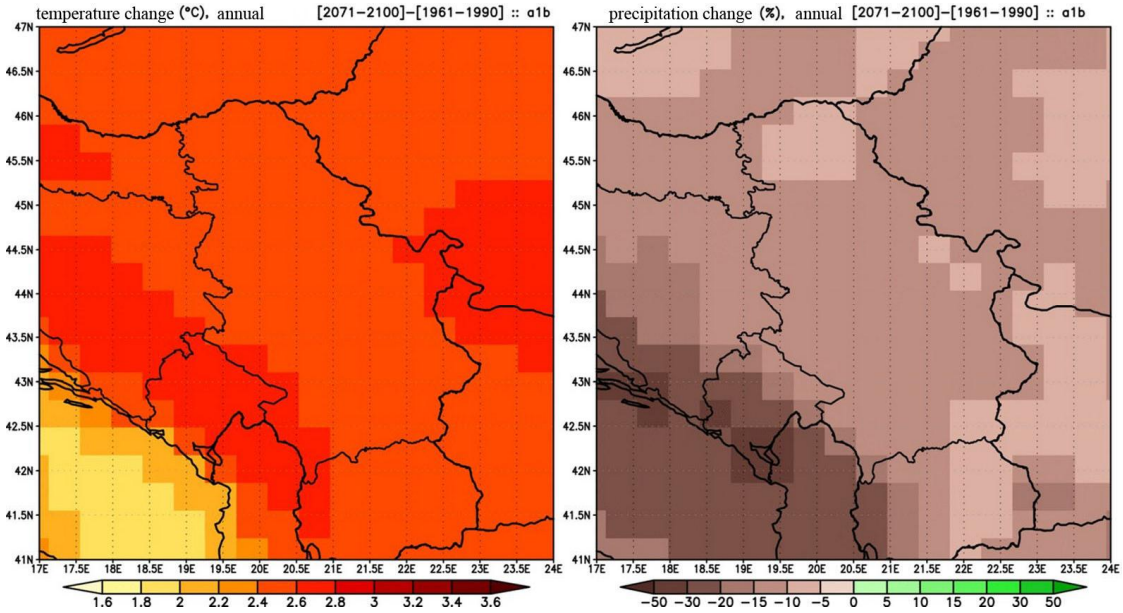


Figure 4.5. Annual changes of the mean 2–metre air temperature and accumulated precipitation.

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 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).

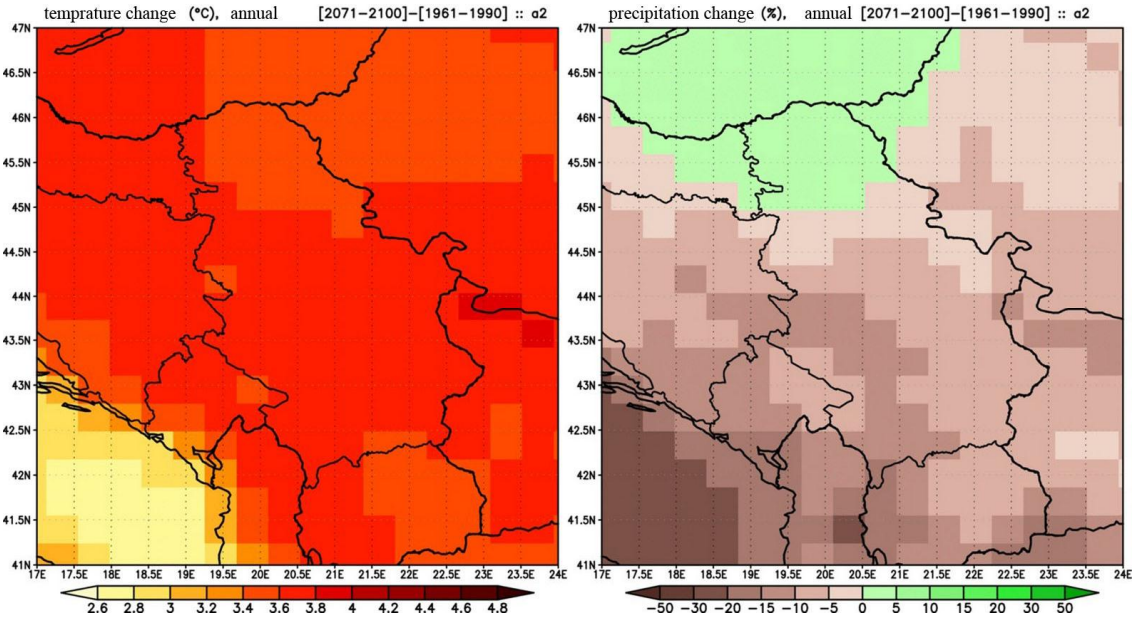


Figure 4.6. Annual changes in the mean 2–metre air temperature and accumulated precipitation.

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.