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Ministry of Environmental Protection, Physical Planning and Construction

Second, Third and Fourth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change

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Second, Third and Fourth National Communication of the Republic of Croatia under the United Nations Framework Convention on Climate Change

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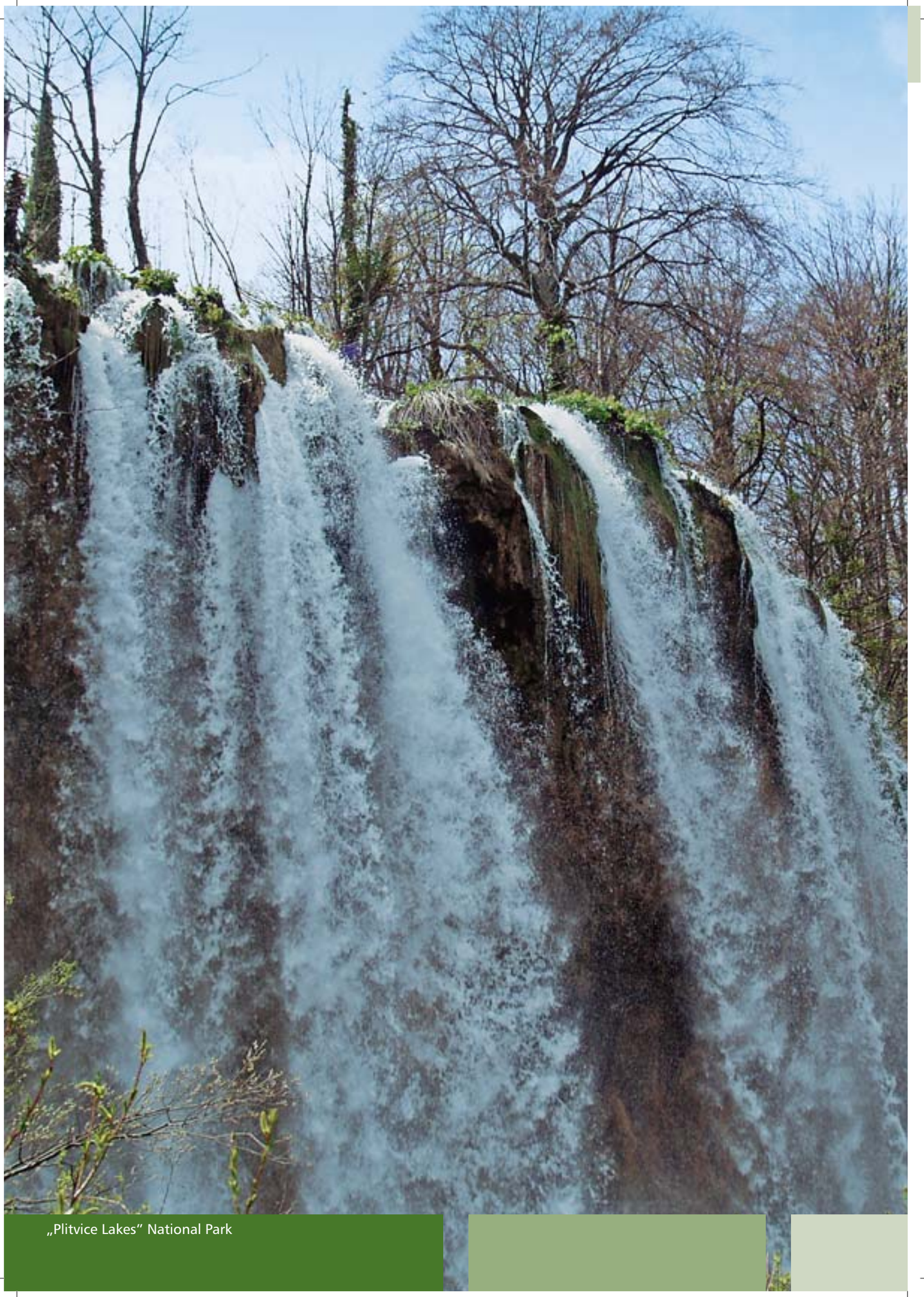


„Plitvice Lakes“ National Park

The United Nations Framework Convention on Climate Change (UNFCCC) was signed at the UN Conference on Environment and Development held from 4-14 June 1992 in Rio de Janeiro. The Convention came into force on 21 March 1994 and has presently 189 parties.

The Republic of Croatia became a party to the UN Framework Convention on Climate Change on 17 January 1996 when the Croatian Parliament passed the law on its ratification (Official Gazette – International Treaties No. 2/96). For the Republic of Croatia the Convention came into force on 7 July 1996. As a country undergoing the process of transition to market-oriented economy, Croatia has, pursuant to Article 22, paragraph 3 of the Convention, assumed the commitments of countries included in Annex I. By the amendment that came into force on 13 August 1998 Croatia was listed among Parties included in Annex I to the Convention.

By the Decision 1/CP.3 taken at the Third Session of the Conference of Parties (COP 3) a protocol to the UN Framework Convention on Climate Change was adopted in Kyoto on 11 December 1991. Presently there are 163 parties to the Kyoto Protocol, including 37 countries included in Annex I whose emissions contribute with 61.6% to total 1990 greenhouse gas emissions of countries included in Annex I. Following the ratification of the Kyoto Protocol by the Russian Federation in October 2004, it globally entered into force on 16 February 2005. The Republic of Croatia signed the Kyoto Protocol on 11 March 1999 as the 78th signatory country. Once ratified by the Croatian Parliament, it will make it obligatory to the Republic of Croatia to reduce its greenhouse gas emissions by 5% in the first commitment period between 2008 and 2012 compared to the base year.

At the session of the Conference of Parties (COP 7) held in Marrakesh in 2001 the Republic of Croatia submitted a request for recognition of specific circumstances under Article 4.6 of the Convention with regard to the emission level increase of 14% or rather 4.46 million tonnes CO_2 eq in the base year 1990.

At the session of the Conference of Parties (COP 11) held in Montreal in 2005 the Decision 10/CP.11 was adopted allowing Croatia a certain degree of flexibility with regard to its historical level of anthropogenic emissions of greenhouse gases

At the session of the Conference of Parties (COP 12) held in Nairobi in 2006 the decision was adopted to recognize specific circumstances of Croatia with regard to greenhouse gas emissions before and after 1990, and the structure of the electricity generation sector of the former Yugoslavia, to allow to add 3.5 million tonnes CO_2 eq to its 1990 level of greenhouse gas emissions not contolled by the Montreal Protocol.

The provisions of Articles 4 and 12 of the Convention make it obligatory to the Republic of Croatia to prepare a national greenhouse gas inventory annually and national communications on climate change periodically so as to report on implementation of commitments under the UN Framework Convention on Climate Change (UNFCCC). The form and the time frame for the submission of emission inventories and national communications are laid down by the decisions and guidelines of the Conference of Parties.

The first Croatian National Communication under the UN Framework Convention on Climate Change was prepared in 2001 as a purpose of the project of the Government of the Republic of Croatia and the UNDP/GEF "Enabling Croatia to Prepare First National Communication in Response to Commitments under the UNFCCC" with the financial assistance of the Global Environmental Facility (GEF). The Convention Secretariat received the First National Communication on 7 February 2002 and the in-depth review followed in March 2002.

Viewing the fact that most of the parties included in Annex I to the Convention have already submitted the second and the third and have been preparing or have submitted the fourth national communication, an explanation was requested from the Convention Secretariat in Bonn as to the time schedule and structure of the national communication. The Republic of Croatia was instructed to prepare the present national communication using the 1996-2003 data as a consolidated second, third and fourth national communication so as to be able to submit the same within the time frame set by the Decision 4/CP.8 for the Parties included in Annex I to the Convention.

This National Communication of the Republic of Croatia was prepared according to FCCC/CP/1997/7, Part II-*Guidelines for the Preparation of National Communications by Parties included in Annex I to the Convention*.

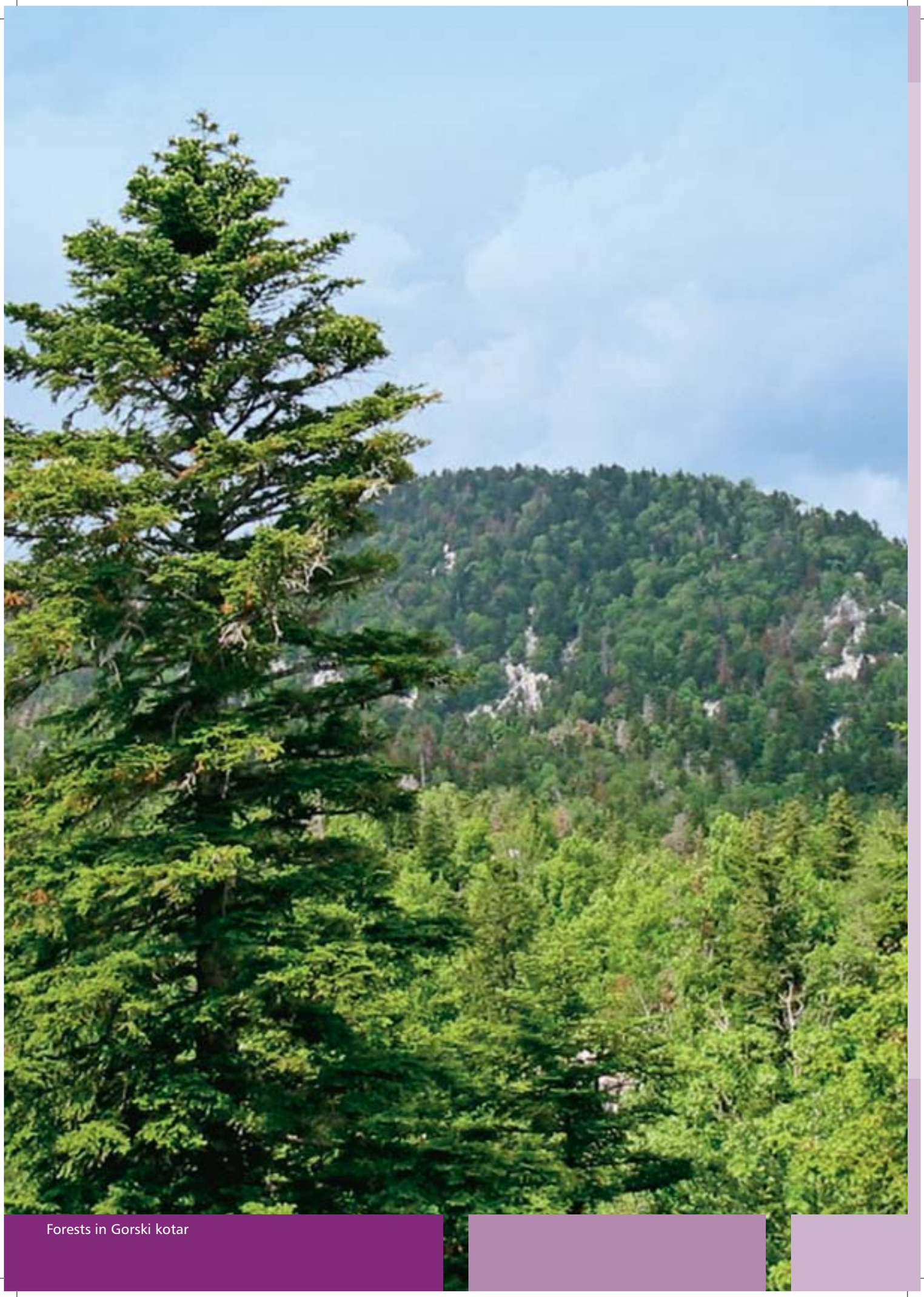
The assessment of measures and technological needs was carried out within the framework of implementing the project "Climate Change Enabling Activity; Additional Financing for Capacity Building in Priority Areas" representing the second stage of the project of preparing the First National Communication.

Within the context of implementing the European Commission LIFE-Third Countries project "Capacity Building for Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol in the Republic of Croatia" the following chapters were prepared:

- Chapter 3. Greenhouse Gas Inventory Information
- Chapter 4. Policy and Measures
- Chapter 5. Projections and the Total Effects of Policies and Measures
- Chapter 8. Education, Training and Public Awareness

For the purpose of preparing Chapter 6 Vulnerability Assessment, Climate Change Impacts and Adaptation Measures and Chapter 7 Research and Systematic Observation, contracts were signed with five institutions (Faculty of Science, Faculty of Forestry, Faculty of Agriculture, Meteorological and Hydrological Service in Zagreb and the Institute for Oceanography and Fisheries in Split) and two authors. Experts who are employees or associates of those institutions participated previously in the preparation of the First National Communication on Climate Change. With the aim to ensure continuity and in view of the words of praise for the First National Communication expressed by the reviewing Commission of the Convention Secretariat, it was decided to continue the co-operation between the Ministry and the experts mentioned in preparation of the present national communication too.

By the decision of the Minister of Environmental Protection, Physical Planning and Construction adopted on 28 October 2004, the Committee for Monitoring the Preparation of the National Communication on Climate Change was appointed.



Forests in Gorski kotar

1. Executive Summary

1.1 Introduction

The Republic of Croatia became a party to the UN Framework Convention on Climate Change (UNFCCC) in 1996. As a country with economy in transition it assumed the responsibilities under Annex I to the Convention. The Republic of Croatia signed the Kyoto Protocol in 1999. After its ratification by the Croatian Parliament the Republic of Croatia will have to reduce the greenhouse gas emissions by 5% in the first commitment period between 2008 and 2012 in relation to the base year. The First Croatian National Communication under the UN Framework Convention on Climate Change was submitted to the Convention Secretariat in 2002. Following the guidelines of the Convention Secretariat, this national communication comprises the consolidated second, third and fourth communication and covers the period from 1996 to 2003.

1.2 National Circumstances

Government Profile

The Republic of Croatia gained independence in 1991 and has been a member of the United Nations Organization since 1992. In 2004 it acquired the status of an EU candidate country and on 3 October 2005 the EU accession negotiations started. The state authority is organized on the principle of separation of powers in the legislative (Croatian Parliament), the executive (the President of the Republic, the Government) and the judicial. The government bodies comprise 13 ministries, 4 central state administration offices, 9 state bureaus and county offices of government bodies. The territorial and administrative structure of the Republic of Croatia consists of 20 counties and the City of Zagreb as district (regional) self-government units and 127 towns and 429 municipalities as local self-government units.

Population Profile

According to the 2001 census the total number of inhabitants in the Republic of Croatia is 4,437,560. The natural growth rate is negative (-2.9‰). The average population density is 78.4 inhabitants per km^2. 124 urban settlements are inhabited by 51.1% of the total population. The largest towns are Zagreb (779,145 inhabitants), Split (188,694), Rijeka (144,043) and Osijek (114,616).

Geographic Profile and Land Use

The mainland area of the Republic of Croatia is 56,594 km^2, with the territorial waters and inland marine waters covering 31,067 km^2. The total length of the land border with the neighbouring countries is 2,373 km. The national border at sea is 948 km long, followed by a protected ecological and fishing zone covering an area of 25,207 km^2. The highest mountain peak in Croatia is Dinara (1831 m). The karst area covers 54% of Croatia's territory. Protected areas cover 5,125 km^2 (i.e. 9.05 %) of the mainland and 283 km^2 of the marine area. Natural values are protected under nine categories of protection, among which there are eight national and eleven nature parks.

Climate Profile

For the most part Croatia belongs to the climate type C, moderately warm rainy climate, and only the areas above altitude of 1,200 m belong to humid snowy forest climate type D. The mean annual air temperature in the lowland area is 10-12°C, in the highland 3-4°C and in the coastal area 12-17°C. The absolute minimum air temperature measured is -35.5°C and the absolute maximum 42.8°C. The least precipitation in Croatia is recorded in the open part of the central Adriatic (304 mm) and in the eastern Slavonia and Baranja (Osijek, 650 mm). Central Croatia and the coastal zone have 800-1200 mm precipitation per year. Most of the precipitation is recorded on the slopes and peaks of the coastal Dinarides, from Gorski Kotar (Risnjak, 3,470 m) to the southern Velebit. The coastal zone from Dugi otok to Prevlaka is the fairest part of Croatia; the islands of the central and southern Adriatic (Hvar, Vis, Korčula) have some 2,700 hours of sunshine per year.

Economic Profile

In 2005 the gross domestic product (GDP) amounted to 229.03 million kunas (38.5 million US$) or 8,677 US$ (6,972 EUR) per capita. The GDP growth rate has accelerated and amounted to 4.3% in 2005. In 2009 it is expected to reach 5%. The 2005 inflation was 3.3%. The Republic of Croatia has been a member of the World Trade Organization (WTO) since 2000 and a party to the Central European Free Trade Agreement (CEFTA) since 2003. With the share of 68% in Croatia's total foreign trade in 2004, the European Union is the country's major foreign trade partner.

Energy

In 2004 the energy consumption in Croatia totalled 412.04 PJ or 2,128 kg of oil equivalent per capita. In the period between 2004 and 2030 it is forecast to rise by 1.6% annually. In the structure of the total consumption of primary energy liquid fuels account for 43.6%, natural gas for 25.4% and water resources for 16.7%. The major contribution to the immediate energy consumption comes from general consumption (47.7%), with the 30.3% share of transport and 22.4% of industry. In 2004 49.6% of the country's energy supply was covered by domestic sources. Of fossil fuels Croatia produces crude oil and natural gas and uses renewable energy sources too.

Transport

The Republic of Croatia has 2,726 km of railways of which 948 km are electrified. In 2004 the length of public roads totalled 28,274 km. At the end of 2005 the network of motorways amounted to 1,020.5 km. The number of motor vehicles is enlarging (1.75 million in 2004), which is accompanied by a permanent rise in the petrol consumption. The number of passenger cars per 1000 inhabitants increased from 164.6 (1995) to 301.3 (2004). The Adriatic ports of Rijeka, Zadar, Šibenik, Split, Ploče and Dubrovnik are of particular economic interest. The network of navigable inland

waterways includes 804.1 km of the rivers Danube, Sava, Drava, Kupa and Una. There are seven international airports, which registered 3.3 million passengers in 2004.

Industry

Industry employs 276,000 workers and accounts for 19.1% in the GDP structure. Various processing sectors account for some 80% of Croatia's industrial production. Agriculture and fisheries including the food and beverages industry contribute 11.1% to the total GDP, chemical industry 8,11%, manufacture of machinery, equipments and means of transport 8.03% and metal processing activities 6.45%. In 2004 Croatia hosted 9.4 million tourists accounting for 47.8 million overnight stays and revenues generated by foreign tourism reached 7 billion US$.

Waste

The volume of municipal waste generated in Croatia in 2004 amounted to 1.3 million tonnes or 290 kg/year per inhabitant. The share of biodegradable waste in municipal waste is 35-45% or 70-150 kg/year per inhabitant. The quantity of waste on landfills totals 1 million tonnes. In Croatia there are in total 187 active landfills with a capacity of 68 million m^3 and a large number of illegal landfills. Separate collection and disposal cover glass, PET, cans, paper etc. The largest portion of hazardous waste is being generated by the processing industry and includes mostly waste oils, waste generated by crude oil processing and inorganic waste from thermal processes.

Building Stock and Urban Structure

Urban land covers 7.6% of the mainland area of Croatia. In Croatia there are 6,759 settlements, falling mostly (43%) into the category of 100-149 inhabitants. The urban settlement density is 2.2 per 1,000 km^2 of the territory. The construction industry contributed 5.7% to GDP in 2004 and the value of construction works completed amounted to 16.9 billion kunas (2.25 billion EUR), of which the road construction accounts for 47.5% and building construction for 41%. In 2001 the housing stock included 1.9 million flats.

Agriculture

The total agricultural land area is 3.1 million ha or 55.6% of the mainland area of Croatia. The share of agricultural population in the total population is 5.54%. Wheat and corn are prevailing on 50% of the arable land. In 2000 the consumption of mineral fertilizers was 505,000 tonnes or 253 kg/ha of arable land. Livestock breeding accounts for 41% of agricultural production; the number of all livestock types decreased significantly and the productivity is low. In 2003 the sea fish catch was 29,000 tonnes and in 2004 5.6 tonnes of freshwater fish were produced in fishponds.

Forestry

Forests cover 37% of the mainland area of Croatia and together with the forest land they constitute a unique forest management area of 2.5 million ha. 81% of forests are owned by the state and 19% are privately owned. About 95% of forests originated by the natural regeneration and the rest are artificial forest cultures and plantations. In 1996 the total timber stock of Croatia's forests amounted to 324.2 million m^3, with the total annual stock increment of 9.6 million m3. The portion of timber stock intended for cutting was 4.9 million m^3 or 51.2% of the annual stock increment. Croatia's flora of higher plants includes 5,347 species and subspecies of which 326 are endemic.

Inland Waters and Coastal Area

The total length of all natural and artificial watercourses of Croatia is 21,000 km. Croatia's rivers belong to the Black Sea (62%) and the Adriatic (38% of the territory) catchment area. The Danube is the largest river flowing through Croatia over a length of 137.5 km. Other major rivers are the Sava (562 km) and the Drava (505 km), and the Kupa is the longest and flows entirely (296 km) through Croatia. Natural lakes are few; the largest are the Vransko Lake near Pakoštane (30.7 km^2) and the Prokljansko Lake (11.1 km^2). Croatia also has numerous multipurpose storage lakes and 3,883 sites of integrated wetland areas. The Adriatic Sea is the northernmost part of the Mediterranean Sea. Croatia has a 6,278 km long coastline of which 1,880 km account for the mainland and 4,398 km for the island coastline. The largest peninsulas are Istria and Pelješac. With its 78 big and 524 small islands and 640 cliffs and reefs Croatia's Adriatic coast ranks among the most indented European coasts. The largest islands are Cres (405.68 km^2), Krk (405.24 km^2) and Brač (394.57 km^2).

Specific Circumstances of Croatia under Article 4.6 of the Convention

At the session of the Conference of Parties (COP 7) held in Marrakesh in 2001 the Republic of Croatia submitted a request for recognition of specific circumstances under Article 4.6 of the Convention. The request did not relate to the selection of another base year, but to the increase in emission level by 4.46 million t CO_2 eq. It resulted from the fact that the total greenhouse gas emission of the base year 1990 amounting to 31.7 million t CO_2 eq, does not reflect the specific feature arising from Croatia's having been integrated into the common economic, energy and infrastructural framework of the former state. The emission level for Croatia showing no flexibility in the segment relating to energy consumption corresponds to emission from the 1974 energy consumption. However, in the period between 1995 and 2001 the average emission growth rate was 3.2% and the GDP growth has accelerated, so that in 2005 it might exceed the volume limits laid down by the Kyoto Protocol. At the session of the Conference of Parties (COP 11) held in Montreal in 2005 the Decision 10/CP.11 was adopted allowing Croatia a certain degree of flexibility in determining the reference value of greenhouse gas emission levels compared to the historical level. At the session of the Conference of Parties (COP 12) held in Nairobi in 2006 the decision was adopted to recognize specific circumstances of Croatia with regard to greenhouse gas emissions before and after 1990, and the structure of the electricity generation sector of the

former Yugoslavia, to allow to add 3.5 million tonnes CO_2 eq to its 1990 level of greenhouse gas emissions not controlled by the Montreal Protocol. The approval of the request means that Croatia will be able to ratify the Kyoto Protocol in the course of 2007.

1.3 Greenhouse Gas Inventory Information

This National Communication presents the inventory of greenhouse gas emissions and removals in the Republic of Croatia in the period from 1990 to 2003 (Table 1-1). The inventory includes direct greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs, PFCs) and sulphur hexafluoride (SF_6), and indirect greenhouse gases: carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2). In 2003 the total greenhouse gas emission in the Republic of Croatia amounted to 29.8 million t CO_2 eq, which are a 5% rise compared to 2002 and a 6.3% lower compared to 1990 emissions. The main greenhouse gas is CO_2 (77%), followed by CH_4 (12.1%), N_2O (10.8%) and HFC, PFC and SF_6 (0.1%).

The highest emissions of greenhouse gases in 2003 (Fig.1-1) originate from energy sector (75.8%), agriculture (10.8%), industrial processes (9.0%) and waste management (4.3%). The total CO_2 removal (sinks) in forestry amounted to 15,373 Gg CO_2 in 2002 and 2003. With its share of 91.3% energy sector is the major source of CO_2. CO_2 emissions from this sector are permanently increasing and are 58.7% higher than in 1995, which is due to the sharp increase in the number of cars, fuel consumption and traffic intensity. The major sources of CO_2 emissions in the sector of industrial processes (90.7% of emissions) are the production of cement, ammonia and nitric acid. Emissions coming from agricultural sector include CH_4 and N_2O emissions. Due to the reduction in the number of livestock the CH_4 emission dropped in the period from 1990 to 2003, but increased again by 2003.The highest N_2O emission (70.2% of the total emission) originates from the agricultural sector and relates to the use of mineral fertilizers, the stable manure management and agricultural land cultivation methods. Emissions of synthetic greenhouse gases (HFCs, PFCs and SF_6) account for 0.09% of total greenhouse gas emissions.

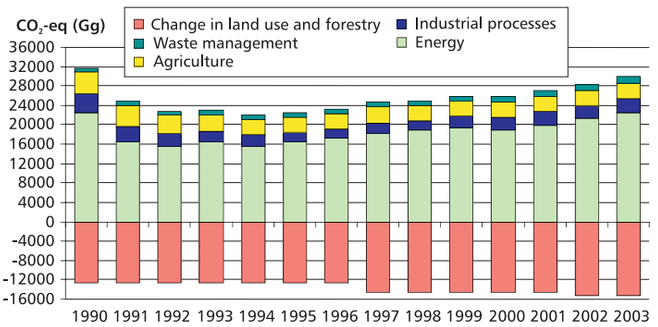


Fig. 1-1: Greenhouse gas emissions and removals in Croatia by sectors, 1990-2003 (Gg CO_2 eq)

1.4 Policy and Measures

The Republic of Croatia has established a legislative framework laying down principles, objectives and environmental protection implementation methods, which are being brought in line with the EU legislation in the course of accession negotiations. The 2004 Air Protection Act provides for the establishment of mechanisms and instruments in the field of climate change: preparation of the plan for distribution of greenhouse gas emission quotas, emission quotas trading system, establishment of a greenhouse gas emission register and projects for common implementation of emission reduction. Croatia's energy sector is governed by the 2001 package of laws including the amendments passed in 2004. Based on the Energy Act, the *Energy Sector Development Strategy of the Republic of Croatia* was formulated in 2002, defining energy policy objectives and measures required for their accomplishment. The main objectives of energy sector development are upgrading energy efficiency, energy supply security, diversification of energy forms and sources, use of renewable energy sources, development of energy market and entrepreneurship and environmental protection. Concrete results of using renewable energy sources in Croatia are seen in the start of operation of the first wind power plant on the island of Pag (2004) and the completion of the second one in the Šibenik hinterland (2006), the construction of the first landfill gas fired power plant, certification of hydropower plants belonging to Croatian Electric Power Industry for production based on renewable sources and realization of plans of Croatian Forests for the construction of 16 centralized heating systems using

Table 1-1: Emissions/removals of direct greenhouse gases, 1990-2003 (Gg CO_2 eq)

Greenhouse gas	1990	1995	2000	2001	2002	2003
Carbon dioxide (CO_2)	23 035	16 251	19 378	20 454	21 576	23 000
Methane (CH_4)	3809	3107	3233	3383	3452	3611
Nitrous oxide (N_2O)	3982	3163	3284	3254	3316	3230
Hydrofluorocarbons (HFC, PFC) and SF_6	939	8	23	49	49	27
Total emission	**31 765**	**22 530**	**25 917**	**27 140**	**28 393**	**29 867**
Carbon dioxide (CO_2) removal	-12 688	-12 688	-14 442	-14 442	-15 373	-15 373
Net emission	**19 077**	**9842**	**11 475**	**12 698**	**13 020**	**14 494**

forest biomass. Energy efficiency promotion projects are being implemented in the household and service sector in order to reduce energy consumption.

In the transport sector motor vehicle exhaust gases have been tested (ECO test) as a part of the mandatory technical inspection of vehicles since 2001, and in 2004 a special environmental charge was imposed on all motor vehicle owners. Promotional activities for biodiesel production have intensified. The Government's regulation of 2005 set the national indicative target of reaching 5.75% of biofuels in the total share of fuels for transport put on domestic market by 2010. Croatian Railways are constructing a Ro-La terminal for trucks to be transported by flat wagons between Spačva and Ljubljana. The cement industry is bound to reduce emissions of greenhouse gases in the period between 2008 and 2012. For the purpose of reducing N_2O emissions it is planned to apply non-selective catalytic reduction to the nitric acid production. Measures to be taken in the agricultural sector include improvements in application of organic and mineral fertilizers, adjustments in the way of using agricultural land and the use of organic fertilizers in biogas production. Forest management covers maintenance and enhancement of forest ecosystems, increasing the carbon stock in existing forests, afforestation and increased usage of forest biomass as a supplement for fossil fuels. Waste management is regulated by the 2004 Waste Act and the 2005 *Waste Management Strategy of the Republic of Croatia*. Implementation of integrated waste management, remediation and closing of existing landfills and establishment of waste management centres will contribute to reduction of methane emissions coming from landfills.

The Environmental Protection and Energy Efficiency Fund was established in 2003 to finance programs, projects and other activities in the field of environmental protection, energy efficiency and renewable energy sources. By its 2005 work program the Fund allocated 26.6 million kunas for projects and programs of energy efficiency and renewable energy sources, 2.1 million kunas for national energy programs and 143.8 million kunas for landfills remediation. The Croatian Environment Agency was founded in 2002 as a central institution for the collection and consolidation of environmental data, monitoring the state of environment and environmental reporting. The Agency is the administrator of the national registry of greenhouse gas emissions.

Priority measures for the reduction of greenhouse gas emissions in the Republic of Croatia as laid down in the present national communication include: construction and use of wind power plants, use of forest and agricultural biomass and thermal treatment of waste in the generation of thermal energy and electricity by cogeneration plants, thermal insulation improvement and energy efficient construction, increased use of biodiesel and non-selective catalytic reduction of N_2O in the production of nitric acid. Great deal of these measures will prove the effectivity during the second commitment period after year 2012. *The Strategy and Action Plan for Climate Change Mitigation in the Republic of Croatia* will be adopted in 2006.

1.5 Projections of Emissions and the Total Effects of Policies and Measures

Total projections of greenhouse gas emissions in the Republic of Croatia from 1990-2025 are shown in Fig. 1-2. Projections have been prepared before the adoption of decision on the level of emissions for the base year of Croatia at COP 12 in Nairobi (2006). Therefore, text and the graphic in this chapter do not include effects of this decision. According to the "with measures" scenario the total emission in the first commitment period (2008-2012) will be 5.22 million t CO_2 eq above the commitment under the Kyoto Protocol. The "with additional measures" scenario predicts the emission reduction by a total of 10 million t CO_2 eq in 2020, thus exceeding the Kyoto limit by 1.3 million t CO_2 eq.

As regards the energy sector in the period from 2000-2020 the total energy requirements are predicted to rise by 2%, the consumption by 3% and CO_2 emissions by 3%. The use of renewable energy sources and energy efficiency will be additionally encouraged by imposing the obligation on each energy producer to include a certain amount of renewable energy into the investment programme. The total potentials for the reduction of greenhouse gas emissions in the energy sector, including additional measures, amount to 2.9 million t CO_2 eq in 2010 and 7.7 million t CO_2 eq in 2020. In the sector of industrial processes it has been assumed that in the further development of Croatia no extra heavy industry capacities will be installed. By introducing the additional measure of non-selective catalytic reduction in the nitric acid production in 2010 the total potential of emission reduction measures will amount to 0.8 million t CO_2 eq. The development of agricultural production according to the "with additional measures" scenario is based on the increase in plant production yields and in the share of larger livestock farms. The total emission reduction potential in the agricultural sector, including additional measures, amounts to 0.7 million t CO_2 eq in 2010. In the period until 2010 no major effect of measures from the forestry sector is expected. The exact calculation of effects of afforestation and use of forest biomass to increase carbon stocks is an issue widely discussed within the framework of the Convention. The afforestation of an area of 331,000 ha would increase the sink by 2 million t CO_2 per year. Emission

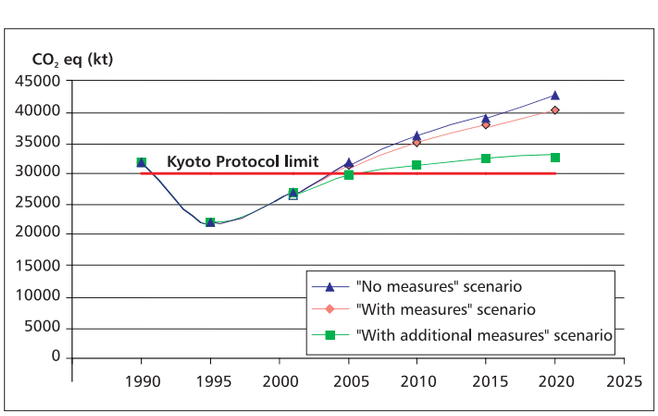


Fig. 1-2: Projections of greenhouse gas emissions in the Republic of Croatia from 1990-2020

projections in the waste management sector depend upon the predicted 2% rise of waste amounts on average in the period from 2001-2020. By constructing solid waste incineration plants it is planned to incinerate 20% of the total waste amounts in 2010 and 40% in 2020. Total potential for the reduction of greenhouse gas emission in waste management, including additional measures amounts to 0.3 million t CO_2 eq in 2010 and 0.5 million t CO_2 eq in 2020.

1.6 Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

Observed Climate Changes in Croatia

The decade from 1991-2000 was the warmest recorded in the 20th century and in Croatia. The rise in mean annual temperature of air recorded between 1901 and 2004 was higher on the coast than on the mainland owing to summer and autumn temperatures. Among the seasonal temperatures in the mainland area of Croatia the highest rise was recorded in winter temperatures. The number of cold nights and cold days is decreasing, with a marked upward trend in the number of warm days and warm nights. During the 20th century annual amounts of precipitation felled throughout Croatia, which is in line with the long-term desiccation trend in the Mediterranean. The reduction in annual precipitation amounts is the result of the changed frequency of days with low rain intensity and a higher frequency of dry days. The fall in amount of precipitation is more marked in northern Adriatic, on Dalmatian islands and in eastern Slavonia than in the highlands and north-western part of Croatia. Due to the simultaneous presence of high temperatures and precipitation reaching a quarter of average mean values, the year 2003 was extremely warm in 80% and extremely dry in 90% of the area of Croatia.

Climate Change Scenario for Croatia

According to the 2040-2050 climate change scenario for Croatia, the temperature, especially the ground-level temperature (up to a height of 2 m), is forecast to rise regardless of the season. Warming will be higher in summer than in winter, in some places even exceeding the seasonal mean by more than 2.5 degrees. As a result of increased ground-level pressure over central and southern Europe in winter, the winters in Croatia will be more stable than at present. The scenario predicts reduced precipitation amounts in summer; however, no amplitude of decrease may be identified with certainty. An overall temperature rise and fall of humidity, especially in winter, will result in reduced snowfall and less snow on the ground. The cloudiness is expected to decrease, even by up to 15% in winter.

Impacts and Adaptation on Hydrology and Water Resources

Climate changes will cause alterations in evapotranspiration, soil humidity and water infiltration. Changes in the precipitation pattern will have an effect on the size, time of occurrence, frequency and intensity of floods and droughts. Changes in the flood pattern in Croatia are not so much seen in their size as in the time of their occurrence. Between 1961 and 1990 a downward trend of some 7 mm in the annual amount of precipitation in Croatia was observed. Climate changes and anthropogenic activities affected considerably the hydrological regime of open watercourses. The decrease in watercourse discharge will result in water shortages in summer. A shift from the glacial to the pluvial discharge regime has been observed on the river Drava. In highland zones of catchment areas intensified processes of water erosion will cause damage area on the flish base (central Istria, Kvarner littoral, Dalmatia).

Impacts and Adaptation on Agriculture

In the crop production gradual warming will have a positive impact on winter crops whose yields will increase due to the more favourable growing conditions. The adaptation to new climatic conditions implies the introduction of new varieties of field crops that benefit from the extended vegetation season and endure the summer water shortages in the soil. Spring crops will be more endangered by high temperatures and water shortages during summer months. The disappearance of very cold winters and late spring frosts in the continental part of Croatia will result in the expansion of areas covered by fruit plantations and vineyards and in the introduction of some new varieties in fruit-growing. The climatic scenario envisaged for southern Croatia makes it possible to extend areas intended for growing Mediterranean kinds of fruit. Conditions unfavourable for the development of pests will reduce considerably the application of pesticides. The rise in daily mean air temperatures and the precipitation decline during the vegetation period, including the necessary irrigation, will result in a more cost-effective and, from the aspect of health safety, in more acceptable production. Despite the fact that livestock breeding on large farms contributes to global warming by emissions of methane (mostly from cattle), nitrous oxide (N_2O) from mineral fertilizers and liquid manure and CO_2, climate change will have an indirect impact through lower yields and quality of pasture, forage crops and cereals. The increased frequency of high-intensity rainfalls and stronger winds will cause soil salinization in the coastal area and impoverishment of pastures with an adverse effect on lactiferousness and growth of small ruminants. Several-days lasting strong wind (*bora*) in the Dinarides may kill weaker and undernourished sheep, goats and their young. Warming is favourable for propagation of various pathogenic microorganisms and parasites hazardous to animals.

Impacts and Adaptation on Forestry

Changes in the spatial distribution of Croatia's forest vegetation will be reflected in the disappearance of the existing or appearance of new forest types, resulting in changes of ecological stability, forest production values and forest values of general benefit.

The model of spatial distribution of Croatia's main forest types by the year 2030 envisages the extension of lowland

forests, reduction in areas of Dinaric beech and fir forests and a wider belt of sub-Mediterranean thermophilic deciduous forests. The long duration of dry periods during summer months poses a great threat in terms of forest fires along the Adriatic coast. The largest number of forest fires (590) between 1996 and 2004 was recorded during summer months of 2000. Phenomenon of forests desiccation in the lowland area of central Croatia is the result of the changed water regime of catchment areas and the decline of level of groundwaters.

Impacts and Adaptation on Biodiversity and Natural Terrestrial Ecosystems

Plant, fungal and animal species will be exposed to three types of impacts: phenological, distributional and genetic. Phenological changes, i.e. biological cycles related to seasons, are closely connected with climatic indicators. In Croatia (like in Europe, too) changes have been observed as to the extension of the plant growing season by 10.8 days, a shift in freshwater fish spawning-time and an earlier return of migratory bird species from the wintering grounds.

Climate changes affect the physiology and plant interactions causing changes in the areas of occurrence of a taxon or a community. The migrating speed for the areals of plant species is estimated at 2.1 km/year in a milder and 3.9 km/year in an extremer form. Approximately 45% of species will retain or extend the present area of occupancy, whereas the others, following the north-north-eastern direction of migration, will reduce their areas of occupancy moderately or drastically, or become extinct. Due to a limited possibility of migration, herbaceous plants of circumpolar (40 taxa), prealpine (266) and alpine (607) distribution in the highest regions, as well as the endemic flora of southern and central Adriatic islands, will be endangered and exposed to disappearance. A certain part of invertebrates capable of migrating and widely distributed will succeed in adapting to changes. For species adapted to colder living conditions a temperature rise causes disturbance in their life cycle. Vertebrates show in general high migratory abilities and may move their areas of occupancy more rapidly than vegetation entities. Species exposed to climate changes, whether natural or human-induced, may try to migrate following their life optimum, adapt to newly arisen conditions or become extinct (locally or wider). Populations of numerous animals are expected to be exposed to fragmentation to smaller subpopulations, especially on the edges of the areas of occupancy.

Impacts and Adaptation on Coast and Coastal Zone

Results of the surveys of climate change impacts in the Adriatic coastal zone for the islands Cres and Lošinj, and for the Kaštela Bay, predicts the rise of mean sea level for 65+35 cm. Croatian Adriatic coast is mainly consists of rocks, it is steep, and it do not belong to those parts of the world seriously endangered by the rising of sea level. The sea flooding in shallow and densely populated areas of the coastal zone could destroy or make disfunctional many residential and harbour buildings, roads, energy and telecommunication cables and sewage systems. Infiltration of the salt water could increase salinity of the freshwaters in the coastal zone, which has an adverse effect on water supply and agriculture, including the traditional salt production on the island of Pag, in Nin and Ston. A 2°C temperature rise may extend the tourist season in the coastal zone from the present three to five months.

Impacts and Adaptation on Marine Ecosystems and Fish Resources

Fluctuation and changes in oceanographic and hydrographical characteristics of the Adriatic Sea influence the composition of Adriatic ichthyofauna. The number of immigrant thermophilous fish species in the Adriatic is increasing and the findings of the Red Sea and Indo-Pacific species are increasingly frequent. Some of the immigrant fish species represent an alternative for exploitation in commercial fishing and mariculture. Changes in spawning sites and in distribution of fish populations affect considerably the fishing industry.

Impacts and Adaptation on Human health

Increasingly frequent heat waves will pose a serious threat to human health in the future, especially for older people and chronic patients. Less frequent winter colds will cause a decline in the number of coronary attacks, cerebrovascular insults and asthma attacks in winter. The predicted warming will raise the risk of occurrence and spread of diseases borne by insects and mites: malaria (in the coastal zone), tick-borne virus meningoencephalitis, and Lyme boreliosis. The presence of "tiger" mosquito transmitting the *dengue* virus has been recorded. A warmer and drier climate will favour the spread of alergogenic plants and the increase in the number of patients suffering from allergic respiratory diseases.

1.7 Research and Systematic Observation

The Meteorological and Hydrological Service is the principal institution dealing with meteorology and hydrology in the Republic of Croatia. It has been conducting meteorological observations since 1851 and maintaining continuously the meteorological database, whose data are processed and published. Croatia is a member of the Global Climate Observing System (GCOS) and the Global Earth Observation System of Systems (GEOSS).

The research guidelines in the sector of hydrology and water resources relate to a precise assessment of climate change impacts on the protection and development of water resources, water balance and water supply, protection from floods and droughts mitigation. In the agricultural sector it is necessary to carry out further intensive research into agricultural crops and possibilities to cultivate varieties adapted to climate conditions predicted by scenarios, and to study new soil cultivation, fertilization and irrigation systems. The response of forest ecosystems to climate changes expected

will be studied in the long-term systematic monitoring of phenological phenomena of forest trees; changes in dendroflora of park facilities; the occurrence and number of forest pests and plant diseases; the incidence of forest fires, groundwater table and selected biological, physical and chemical variables in selected types of forest ecosystems. The climate change impact assessment and implementation of adaptation measures in the sector of biodiversity and terrestrial ecosystems requires the development of prognostic models according to scenarios selected, with respect to biogeographical characteristics of Croatia; mapping the distribution of threatened plant, animal and fungal species; identification of migration directions of the most threatened species; monitoring migration of invasive species and consequences on flora and fauna. Apart from collecting mareographic data, it is necessary to monitor the effects of the sea level rise on erosion and on the groundwaters and surface freshwaters in the coastal zone. Multidisciplinary oceanographic and hydrographical research into the Adriatic Sea will help identify the processes of interaction between the climate and marine ecosystems. A systematic study of the Adriatic ichthyofauna, commercial catch fluctuations and the biology and ecology of thermophiluous immigrating fish species is a precondition for preparation of a plan for adaptation of Croatia's sea fishery to climate changes.

In Croatia biometeorological research has been carried out for 50 years now. It is focused on studying the connection between individual meteorological parameters and human health in terms of the incidence of cerebrovascular diseases, myocardial infarction, neurovegetative disorders and respiratory diseases. Bioforcasts and pollen calendars are published regularly in the daily press and appear in radio and television programmes so as to enable patients avoid unfavourable weather conditions by adjusting their activities correspondingly.

1.8 Education, Training and Public Awareness

Education for environmental protection and sustainable development is an important subject of regular education and all-life learning.

Institutional education lies within the competence of the Ministry of Science, Education and Sport. The educational system of the Republic of Croatia consists of the pre-school, compulsory primary, secondary and university education. The contents of environmental education and knowledge of climate change are integrated in the contents of compulsory and elective curricula and other school activities. A large number of primary and secondary schools in Croatia are involved in international GLOBE programmes (130) and Eco-schools (184). At institutions of higher education the issue of environmental protection and climate change is addressed within the compulsory or elective courses of undergraduate and postgraduate studies. The Ministry of Environmental Protection, Physical Planning and Construction publishing periodically printed materials and supplies multimedia information on environmental protection in general, climate change and ozone layer protection for the purpose of their use in the process of teaching.

Croatia's daily and weekly newspapers report on climate change, harmful consequences of natural disasters, the use of renewable energy sources and biofuel and international activities in connection with implementation of the Kyoto Protocol. In their information, scientific and educational programme radio and television stations inform about the climate change concerns. The website of the Ministry of Environmental Protection, Physical Planning and Construction contains a site entitled "Let's Save the Climate" providing information on climate change and an overview of related activities. Since 2002 the "European Mobility Week" has been held in Croatia each year from 16-22 September in order to launch initiatives that will contribute to diminishing pollution caused by use of motor vehicles. In Croatia's university towns the "Festival of Science" has been held since 2003 with the aim to make the importance and achievements of science known to the general public. "Climate Change" were the main topic of the 2005 Festival.

At present Croatia has 270 non-governmental organizations registered in the field of environmental protection. Systematic actions relating to climate change and use of renewable energy sources are being undertaken by "Green Action" that has organized a number of public forums, mass media conferences and public events.

2. National Circumstances

Old city of Dubrovnik

2.1 Government Profile

The Republic of Croatia gained independence in 1991 in the course of the dissolution of ex-Yugoslavia. On 22 May 1992 the Republic of Croatia became a member of the United Nations Organization. It established and maintains diplomatic relations with a total of 167 countries worldwide.

The Constitution of the Republic of Croatia was proclaimed on 22 December 1990. The state authority is organized on the principle of distribution of powers into the legislative (Croatian Parliament), the executive (the President of the Republic, the Government) and the judicial. The Croatian Parliament is the body of elected representatives and is vested with the legislative power in the Republic of Croatia. It is a unicameral parliament with no less than 100 and no more than 160 representatives elected for a term of four years. The working bodies of the Croatian Parliament for individual sectoral issues are committees and commissions, one of them being the Committee for Physical Planning and Environmental Protection.

The President of the Republic of Croatia is vested with the representative and executive function. The President of the Republic is elected on the basis of direct elections for a term of five years and can be re-elected. The President presents and represents the Republic of Croatia in the country and abroad, calls elections for the Croatian Parliament and calls the Parliament into the first session, calls referendums and gives the mandate for the setting up the government to a person enjoying the confidence of the majority of the members of the Parliament. The President of the Republic of Croatia is the commander-in-chief of the armed forces and co-operates with the Government in formulation and implementation of the foreign policy. The President of the Republic of Croatia exercises also other functions as determined by the Constitution.

The Government of the Republic of Croatia exercises the executive power in conformity with the Constitution and the law. The Government consists of the Prime Minister, Deputy Prime Ministers and Ministers and assumes the office when given a vote of confidence by the majority of all members of the Croatian Parliament. The organization, operation and decision-making are regulated by the Law on the Government of the Republic of Croatia and its Rules of Procedure. The Government of the Republic of Croatia proposes laws, the state budget and other documents to the Croatian Parliament. In accordance with the Constitution it is vested with independent regulatory powers to adopt regulations for the enforcement of laws. It is responsible for implementation of laws and decisions of the Croatian Parliament, conducts the foreign and domestic policy, directs and controls the work, activities and development of the state administration and public services, is responsible for the economic development of the country and conducts other affairs as determined by the Constitution and the law.

The government bodies comprise 13 ministries, 4 central state administration offices, 9 state bureaus and county offices of government bodies. The Ministry of Environmental Protection, Physical Planning and Construction is the central government authority in charge of administrative and expert environmental protection activities relating to the horizontal legislation, air quality and climate changes, waste management, protection of the sea and marine environment, industrial pollution control and risk management. Apart from the central government bodies there are other bodies dealing with environmental protection issues such as the Croatian Environment Agency established in 2002, the Environmental Protection and Energy Efficiency Fund established in 2003, the State Institute for Nature Protection and the Croatian Waters.

The local self-government units of the Republic of Croatia are municipalities and towns responsible for issues of local importance that do not fall within the competence of government bodies. Major towns are local self-government units with over 35,000 inhabitants and development centres of a wider region. District (regional) self-government units are counties responsible for activities of the regional importance.

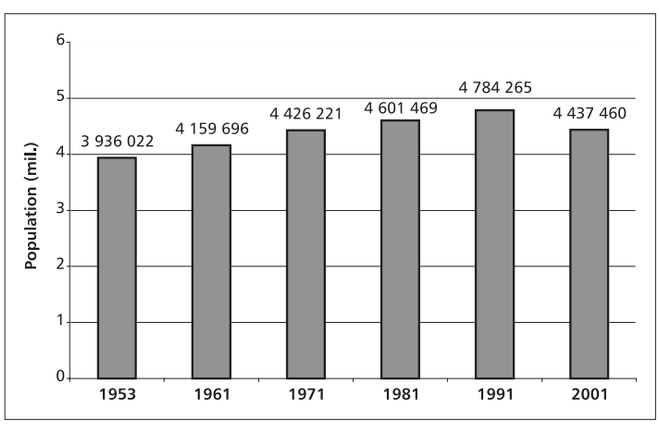
The Republic of Croatia has 21 district (regional) self-government units - 20 counties and the City of Zagreb – and 556 local self-government units – 127 towns and 429 municipalities.

After the adoption of the Resolution on the EU Accession of the Republic of Croatia by the Croatian Parliament on 18 December 2002, Croatia applied for the EU membership in Athens on 21 February 2003. On 18 June 2004 Croatia was granted the status of the EU candidate country and the accession negotiations started in Luxembourg on 3 October 2005.

2.2 Population Profile

According to the 2001 census the Republic of Croatia has 4,437,460 inhabitants (Fig. 2-1).

The average life expectancy is 71 years for men and 78 years for women. The 2003 birth rate was 8.9 per thousand and the death rate was 11.8 per thousand of the population.



(Source: Central Bureau of Statistics)

Fig 2-1: Population trend according to censuses between 1953 and 2001

The natural growth rate is negative, i.e. -2.9 per thousand of the population. Croatia's area is unevenly populated. The average population density is 78.4 persons per km^2. The population density is the largest in the central (115 persons/km^2) and the smallest (13 persons/km^2) in the highland Croatia. Over 90% of the population inhabit lowland areas and hills up to 300 m above sea level. Of the total population 51.1% live in 124 urban settlements.

2.3 Geographic Profile and Land Use

The total land area of the Republic of Croatia is 56,594 km^2. The territorial waters and internal marine waters cover an area of 31,067 km^2. By its position Croatia belongs to the Central-European, Adriatic-Mediterranean and Pannonian-Danube basin group of countries.

The total length of the land borders of the Republic of Croatia with the neighbouring countries is 2,373 km. It borders on Slovenia (670 km) in the northwest, on Hungary (355 km) in the north, on Serbia (322 km) and Montenegro (25 km) in the northeast and southeast, and has the longest border with Bosnia and Herzegovina (1001 km). The national sea border is 948 km long and stretches along the outer edge of the territorial sea. It is followed by a protected ecological and fishing zone covering an area of 25,207 km^2 and reaching the continental shelf border between Croatia and Italy.

Three large geomorphological sections may be distinguished in Croatia: the Pannonian basin, the mountain range of the Dinarides and the Adriatic basin. Lowland areas up to 200 m above sea level account for 53%, the rolling hills up to 200-500 m for 26% and the highland and mountainous areas above 500 m for 21% of Croatia's land area.

(Source: AZO CORINE Land Cover 2000 – Croatia)
Fig. 2-2: The structure of Croatia's land use and intended use.

The highest mountain peak in Croatia is Dinara (1831 m). The karst area covering 54% of Croatia's territory represents relief specificity. Karst phenomena and forms have developed primarily in limestone of the mountainous and coastal zone of Croatia and also as an isolated phenomenon of the Sava and the Danube basin.

Agricultural land covers an area of 55.6 % and the forest land 37% of Croatia's mainland area. Urbanized land used for housing, sport, infrastructure systems and economic and social activities accounts for 7.6% of the mainland. The structure of land use and intended use is shown in Fig. 2-2. The total surface of Croatia's protected areas is 5,125 km^2 (9.05 % of the mainland) and 283 km^2 of the marine area. Pursuant to the 2005 Nature Protection Act they are classified into nine categories, among which there are 8 national parks and 10 parks of nature.

2.4 Climate Profile

According to Köppen classification for a standard period 1961-1990, the largest part of Croatia belongs to the climate type C, a moderately warm rainy climate. The southernmost part of the island of Lošinj, the Dalmatian coast and islands have the Mediterranean climate with dry and hot summers (Csa), whereas the coastal areas of Istria, the Kvarner littoral and the Dalmatia's interior have a moderately warm and humid climate with hot summers (Cfa). The moderately warm and humid climate with warm summers (Cfb) prevails in the major part of Croatia, in the continental Pannonian region and the interior of Istria. Only the regions of Gorski kotar, Lika and the Dinarides above altitude of 1200 m belong to the climate type D, subtype Df, a humid snowy forest climate.

The annual mean air temperature in the lowland area of northern Croatia is 10-12°C, at altitudes above 400 m it is under 10 °C and in the mountains it is 3-4°C. In the coastal area it is 12-17°C. January is the coldest month on average, with the temperature in the Pannonian region ranging from 0 to -2°C.

Along the Adriatic coast winters are milder; January temperatures are 4-6°C. In the north and east of Croatia average July temperatures are 20-22°C and on the Adriatic coast 23-26°C. The absolute minimum temperature of -35.5°C was measured in Čakovec on 3 February 1929 and the absolute maximum of 42.8°C in Ploče on 5 August 1981.

The least precipitation in Croatia is recorded in the open part of the central Adriatic (Palagruža, 304 mm) and in the eastern Slavonia and Baranja (Osijek, 650 mm). Central Croatia and the coastal zone have annual precipitation between 800 and 1,200 mm. The amount of precipitation in the Pannonian region decreases from the west towards the east. From the coast towards the inland the precipitation increases. Most of the precipitation is recorded on the coastal slopes and peaks of the Dinarides (Risnjak, 3,470 m), from Gorski Kotar in the northwest to the southern Velebit in the southeast.

In Croatia's inland the north-easterly winds prevails. Bora (*bura*) is a cold descending wind blowing from the north-eastern direction on the eastern Adriatic coast. It blows in gusts over 110 km/h, which sometimes can exceed 250 km/h. It is more frequent and stronger in winter than in other seasons. Sirocco (*jugo*) is a warm and wet, moderate or strong south-easterly wind accompanied by cloudy and rainy weather. It is the most frequent and the strongest in the cold half of the year. It is stronger on the open sea, making the waves up to 10 m high.

The duration of sunshine depends directly on the cloudiness. The coastal zone from Dugi otok to Prevlaka is the fairest part of Croatia with the annual cloudiness of 4/10. The islands of the central and southern Adriatic (Hvar, Vis and Korčula) have 2,700 hours of sunshine per year. The majority of inland places in Croatia have 1,800-2,000 hours of sunshine. The annual largest cloudiness is recorded in Gorski kotar (6-7/10), which has the least hours of sunshine yearly – about 1,700.

2.5 Economic Profile

In 2005 the annual growth rate of Croatia's economy was 4.3%, with the gross domestic product (GDP) reaching 229 million kunas (38.5 million US$) or 8,677 US$ (6,972 EUR) per capita. By accelerating the GDP growth rate it is expected to reach 5.0% in 2009. The inflation of 3.3% is among the lowest in the region

At the end of 2005 the foreign debt amounted to 30.2 billion US$ (25.5 billion EUR). In 2005 the foreign trade balance was -9.73 billion US$. The average exchange rate of Croatian currency kuna was 7.40 HRK/EUR or 5.94 HRK/US$ in 2005 (Table 2-1).

With its share of 68% in the country's total foreign trade, the European Union is Croatia's major foreign trade partner. The Republic of Croatia has been a member of the World Trade Organization (WTO) since 2000 and a party to the Central European Free Trade Agreement (CEFTA) since 2003.

2.6 Energy

In 2004 the energy consumption in Croatia totalled 412.04 PJ or 2,128 kg of oil equivalent per capita, which is a 37.8% increase compared to the minimum of 1992 (Table 2-2). In the period between 2004 and 2030 the energy consumption is forecast to rise by an annual rate of 1.6%. In 2004 49.6% of the country's energy supply was covered by domestic sources. Liquid fuels account for 43.6%, natural gas for 25.4% and water resources for 16.7% (Fig. 2-3). The major contribution to the immediate energy consumption by sectors in 2004 comes from general consumption (47.7%), with the 30.3% share of transport and 22.4% of industry.

Among the fossil fuels, Croatia extracts crude oil and natural gas, while the coal exploitation stopped in 1999. In 2004 1,085,360 tonnes oil were produced on 35 oil fields,

Table 2-1: Selected macro-economic indicators, 1996-2005

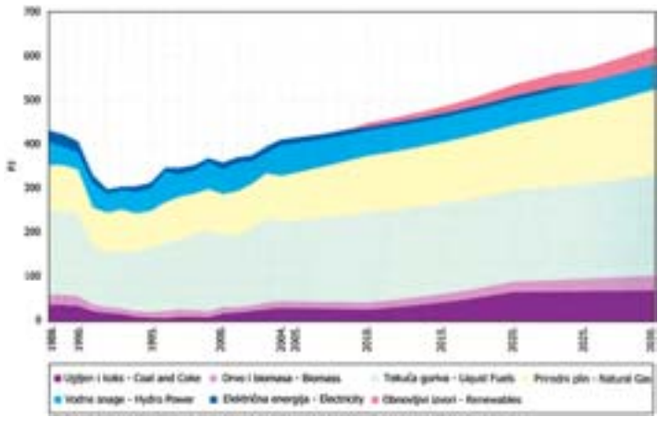
	1996	2000	2001	2002	2003	2004	2005
GDP (million HRK)	107.9	152.5	165.6	181.2	198.4	212.8	229.03
GDP (million US$)	19.8	18.4	19.8	23.0	29.6	35.2	38.5
GDP per capita (US$)	4421	4152	4476	5193	6672	7946	8677
Real GDP growth rate (%)	5.9	2.9	4.4	5.6	5.3	3.8	4.3
Inflation (%)	3.5	4.6	3.8	1.7	1.8	2.1	3.3
Exports (million US$)	4.6	4.4	4.6	4.9	6.1	8.0	8.8
Imports (million US$)	7.8	7.8	9.1	10.7	14.2	16.5	18.5
Gross foreign debt (billion US$)	5.3	11.2	11.8	15.6	24.7	31.0	30.2

(Source: Croatian National Bank, Central Bureau of Statistics)

Table 2-2: Total energy consumption, 1990-2004 (PJ)

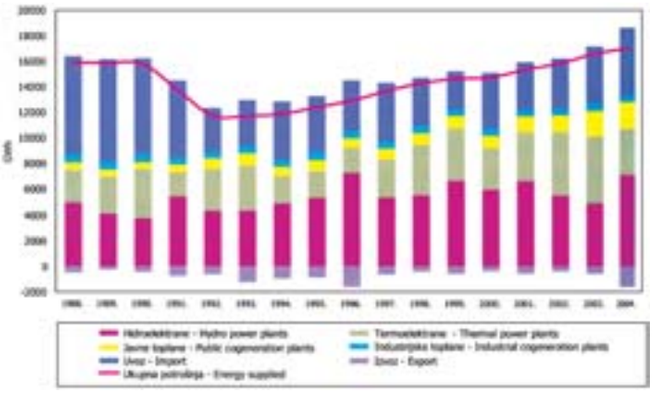
	1990	1995	2000	2001	2002	2003	2004
Coal and coke	34.07	7.42	17.15	19.36	22.89	26.18	29.70
Wood and biomass	22.68	13.52	15.64	12.24	12.39	15.96	15.88
Liquid fuels	188.57	146.03	160.52	164.25	175.16	192.85	179.62
Natural gas	98.22	82.77	94.98	98.87	101.10	100.45	104.66
Water resources	38.55	51.75	5.,93	65.51	52.01	46.48	69.00
Electricity	25.42	12.59	14.40	11.36	12.68	14.01	13.19
TOTAL	**407.51**	**314.08**	**359.62**	**371.58**	**376.23**	**395.93**	**412.04**

(Source: Energy in Croatia, 2004)



(Source: Energy in Croatia, 2004)

Fig. 2-3: Total energy supply in Croatia from 1988 and projected up to 2030.



(Source: Energy in Croatia, 2004)

Fig. 2-4: Available electricity consumption in Croatia in the period 1988 - 2004

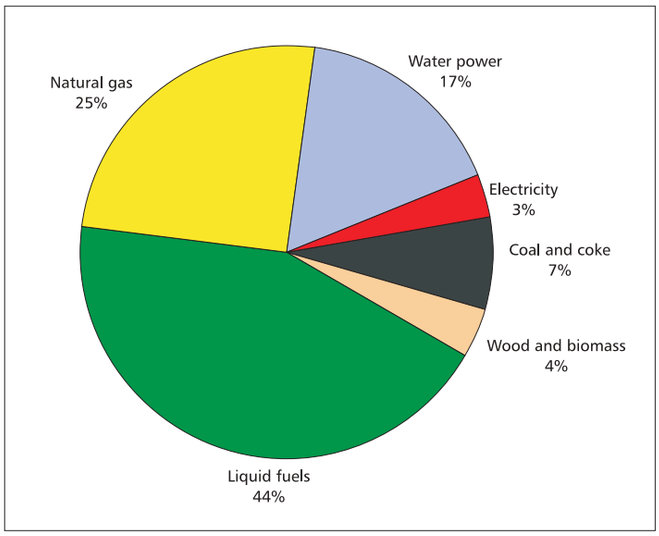
covering 35% of domestic needs. The natural gas production from 20 gas fields amounted to 2,198,100 m³ in 2004, covering 60% of domestic needs. The largest portion of gas comes from gas fields in the Drava basin. In northern Adriatic 9 off-shore gas fields were discovered, containing 23.5 million m³ of exploitable gas reserves.

During the first stage of constructing the gas grid system in Croatia (2002-2006) the main gas pipelines Zagreb east–Kutina and Kutina-Slavonski Brod have been completed. The main gas pipeline Pula-Karlovac intended for the direct supply of natural gas from northern Adriatic, which will enable the gas supply of the Istria County, Primorsko-goranska County and Karlovačka County, is under construction. The key facilities of the second stage (2007-2011) are the main gas pipeline Bosiljevo-Split, the construction of the gas supply system in Lika and Dalmatia and the gas pipeline Slavonski Brod-Donji Miholjac-Hungarian border.

The renewable energy sources used in Croatia are water resources, firewood and wood waste, biomass, geothermal energy and, lately, solar and wind energy. The first wind farm in Croatia, Ravna 1 on the island of Pag, with the installed production capacity of 5.95MW was put into operation late in 2004. In 2006 a Trtar-Krtolin wind farm with 14 wind turbines and total production capacity of 11.2 MW was completed in the hinterland of Šibenik.

Three companies are licensed for electricity generation in the Republic of Croatia: HEP Proizvodnja d.o.o. (a company of the HEP group), TE Plomin d.o.o. and INA d.d.

HEP Proizvodnja d.o.o generates electricity by 25 hydro-power plants, 4 thermal power plants and 3 heat and power plants with the total available production capacity of 4,049.1 MW in 2004 (2,078.6 MW in hydropower plants, 1,632.5 MW in thermal power plants). The rest of Croatia's electricity supply comes from a half of the production capacity (338 MW) of Krško nuclear power plant (in Slovenia), 14 industrial thermal power plants and privately-owned power plants: 5 small hydropower plants, two solar and one wind power plant. The power plants belonging to industrial plants and other privately-owned power plants have a total installed



(Source: Energy in Croatia, 2004)

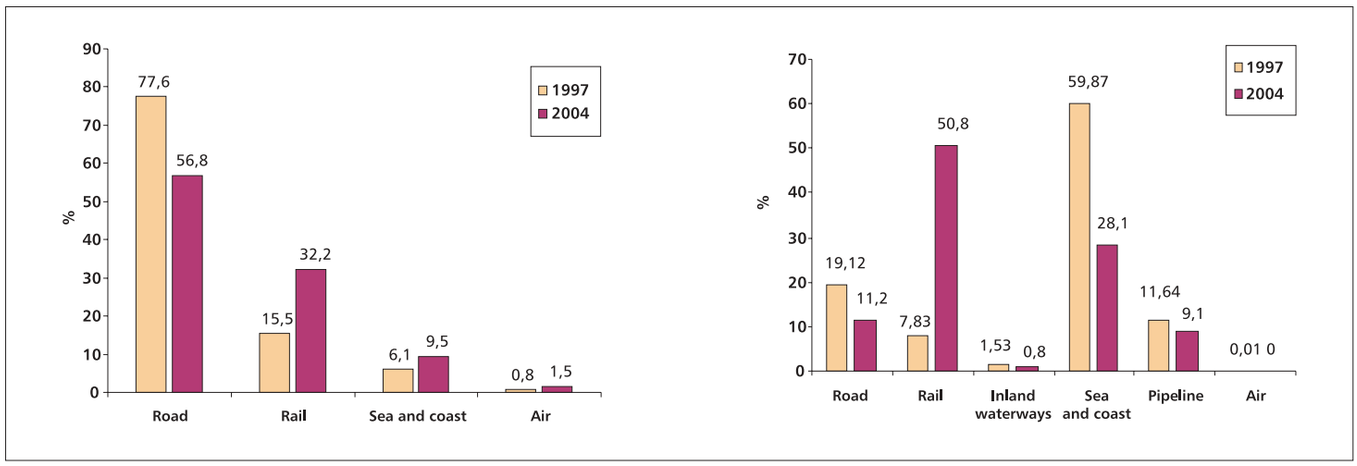
Fig. 2-5: Shares of individual forms of energy in the total 2004 consumption of Croatia

production capacity of 231.1 MW (Fig. 2-4). The shares of individual forms of energy in the total 2004 consumption of Croatia are shown in Fig. 2-5.

2.7 Transport

As regards Croatia's geographical and transport-related position it is located at the crossroads of transit routes between western and south-eastern Europe and between the central Europe and the Mediterranean. The territory of the Republic of Croatia is crossed by two traffic corridors:

- Pan-European traffic corridor V: Venice–Trieste/Kopar-Ljubljana-Budapest-Lavov, with a V/B branch Rijeka-Zagreb-Goričan-Budapest and the V/C branch Ploče-Sarajevo-Osijek-Budapest;
- Pan-European traffic corridor X: Salzburg-Ljubljana-Zagreb-Belgrade-Skopje-Thessalonica with a X/A branch Graz-Maribor-Macelj-Zagreb;
- Pan-European traffic corridor VII: the Danube river corridor.



(Source: Central Bureau of Statistics)

Fig. 2-6: Structure of passenger (left) and freight transport (right) by transport modes in 1997 and in 2000

The international and interstate freight and passenger transport takes place through 109 permanent border crossings: 57 road, 19 railway, 10 airport, 19 seaport and 4 river port international border crossings.

The passenger transport by rail, sea, river and air is increasing, but the road transport has decreased. There has been a strong growth in total annual freight transport in 2000. The comparative structure of passenger and freight transport by transport modes in 1997 and 2004 is shown in Fig. 2-6.

The total length of railway lines in the Republic of Croatia is 2,726 of which 2,478 km are single-track and 248 km double-track lines, and 984 km or 36% are electrified.

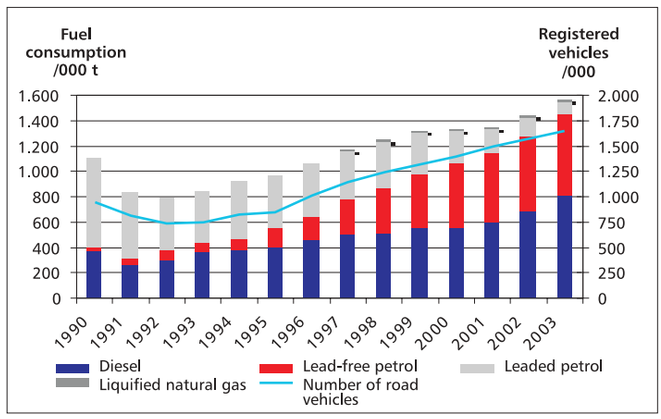
In 2004 the total length of public roads in the Republic of Croatia was 28,274 km of which 7,012 km were trunk roads, 10,509 km county roads and 10,298 km local roads. At the end of 2005 the constructed network of motorways in Croatia amounted to 1,020.5 km. The construction of the motorways Goričan-Zagreb, Rijeka-Zagreb (completed in 2004) and Zagreb-Split (completed in 2005) provided an important link between the Croatian coast and the country's inland and contributed to the integration into the European transport system.

The number of motor vehicles is markedly enlarged and amounted to 1,751,951 in 2004, of which 76.3% are passenger cars. While in 1995 there were 164.4 cars per 1,000 inhabitants, in 2004 this number was 301.3 (Fig. 2-7).

The consumption of fuel is continuously increasing and consumption of diesel fuel exceeded the petrol consumption for the first time in 2003 (1.1:1 ratio). The rise in the diesel fuel consumption is a result of prices and the specific consumption of diesel fuel.

This is, however, an unfavourable trend from the aspect of air pollution due to a higher emission of particulate matter and sulphur dioxide by diesel engines.

The position of the Adriatic Sea and its navigation characteristics has always attracted transit cargos from countries of



(Source: Hrvoje Požar Energy Institute, Central Bureau of Statistics)

Fig. 2-7: Number of vehicles and fuel consumption in road transport, 1990-2003

central and south-eastern Europe into Adriatic ports. The Republic of Croatia has six ports of special (international) economic interest in the cities of Rijeka, Zadar, Šibenik, Split, Ploče and Dubrovnik. In 2004 the ship registries in the Republic of Croatia registered 1,575 ships and 102,916 yachts and boats. The merchant shipping fleet of 14 shipping companies consists of 187 ships. 8 harbourmaster's offices are responsible for navigation control in inland marine and territorial waters.

The network of inland waterways of the Republic of Croatia is 804.1 km long of which 286.9 km are international waterways. The length of navigable inland waterways of Croatia's rivers is the following: the Danube 137.5 km (1295.5-1,433 river kilometre, rkm), the Sava 447.7 km (203.3-651 rkm), the Drava 198 km (0-198.6 rkm), the Kupa 5.9 km (0-5,9 rkm) and the Una 15 km (0-15 rkm). Inland waterway ports open for international public transport are Sisak, Slavonski Brod, Osijek and Vukovar.

There are seven international airports in the Republic of Croatia: Zagreb, Split, Dubrovnik, Zadar, Rijeka, Pula and

Osijek, including three airports on the islands of Brač and Lošinj and in Vrsar intended to accommodate smaller aircrafts. The annual throughput of passengers in Croatia's airports is some 3.3 million.

2.8 Industry

In the early 1990s the physical volume of industrial production dramatically decreased. A significant increase of industrial production at an annual growth rate of 3.6% has been registered since 1997 (Fig. 2-8). Currently industry employs 276,000 persons in 10,000 active companies and accounts for 19.1% of the GDP structure.

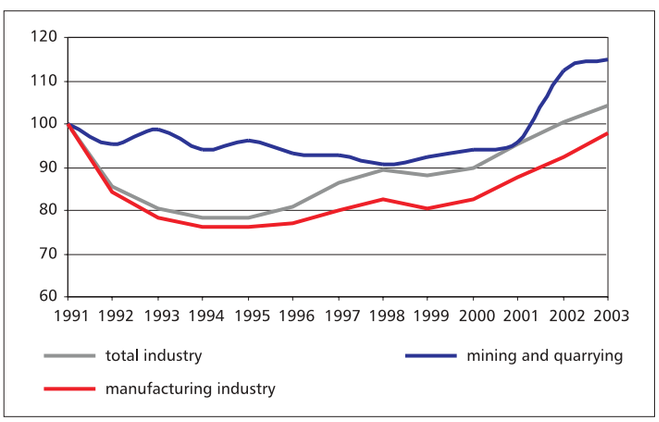
Agriculture, fisheries and supporting industries account for 11.1% of the total gross domestic product. The most important segments are various manufacturing branches that make 80% of the total industrial production of Croatia.

In 2004 the production of food and beverages had the largest share in the total industrial production Croatia's, i.e. 20.8%, and employs about 46,700 workers.

With its 8.11% share in the GDP structure chemical industry ranks second and the share of plastic and rubber products is 2.47%. The largest growth is registered in the production of pesticides, industrial gases and mineral fertilizers, packaging material and other products.

Due to the intensive construction of transport infrastructure the extraction of building stone increased from 10.8 million tonnes in 2000 to 20.6 million tonnes in 2004, of quartz sand from 211,075 tonnes in 2000 to 226,615 tonnes in 2004 and the cement production from 2.8 million tonnes in 2000 to 3,8 million tonnes in 2004.

The share of metal and metal products manufacture in the GDP structure was 6.45% in 2004. As a result of increased production in construction industry and shipbuilding the steel consumption rose by some 3% between 2001 and 2004. In the metal processing industry 1,514 companies was registered, which is 15.6% of all companies registered in the processing industry. In 2004 the share of manufacture of machinery, equipment and transport equipment in the total industrial production of Croatia amounted to 8.03%.



(Source: Central Bureau of Statistics)

Fig. 2-8: Industrial production index, 1991-2003 (1991 = 100)

The production of office equipment and computers, electrical machinery and devices, radio, television and communication devices and equipment, medicine, precise and optical instruments accounted for a total of 5.12% of the 2004 GDP. The total revenues earned by the manufacture of electrical and optical equipment in 2003 account for 9.62% of the total revenues of the processing industry.

The revenues from tourism accounting for 20.3% to the Croatian GDP in 2004.Total revenues earned by international tourism amounted to 6.9 billion US$ or 1,570 US$ per capita. In 2004 Croatia hosted 9.4 million tourists accounting for 47.8 million overnight stays. The number of overnight stays is the largest in Istria (35%), Kvarner (24%), Dalmatia (30%) and Dubrovnik (8%).

2.9 Waste

In 2004 a total of 1,310,643 tonnes or 290 kg municipal waste per inhabitant were generated in the Republic of Croatia. By way of comparison, this amount was 978,542 tonnes in 1995 and 1,172, 534 tonnes in 2000. In 2004 1,037,500 tonnes of municipal waste were disposed in landfills.

The amount of waste collected separately and intended for recycling was some 27,000 tonnes of which 48% paper, 42% glass and 10% other types of waste. Currently there are 187 active landfills with the total capacity of 68,089,070 m^3 possessing the necessary building and operating permits and 918 illegal landfills recorded. In 2005 the Environmental Protection and Energy Efficiency Fund invested 19,4 million EUR for the remediation of 165 active dumps and 235 illegal municipal waste landfills. At present there are 73 plants for mechanical (sorting, recycling), 3 for biological (bio-composting), 30 for thermal and 2 for chemical and physical treatment of waste.

The amount of car wrecks in 2003 was estimated at 65,650 tonnes which is three times the amount of 26,247 tonnes registered in 2000. The Ordinance on Handling Obsolete Vehicles will define the system of collection, treatment, recycling and charges for the disposal.

The majority of hazardous waste is generated by the processing industry, which includes waste oils, crude oil processing waste and inorganic waste from thermal processes. In 2003 waste processing companies collected 21,072 tonnes of hazardous waste.

2.10 Building Stock and Urban Structure

The mainland area of the Republic of Croatia is 56,594 km^2. Urban land used for housing, economic and social activities, infrastructural systems and sport and recreational facilities covers 7.6% of the mainland territory.

Table 2-3: Housing construction in the Republic of Croatia, 1992-2004

	1992	2000	2001	2002	2003	2004
No. of flats completed	8,115	17,487	12,862	18,047	18,460	18,763
Area in 1,000 m²	643	1,397	1,098	1,438	1,529	1,568
Average flat size (m²)	79.2	79.9	85.4	79.7	82.8	83.6

(Source: Central Bureau of Statistics)

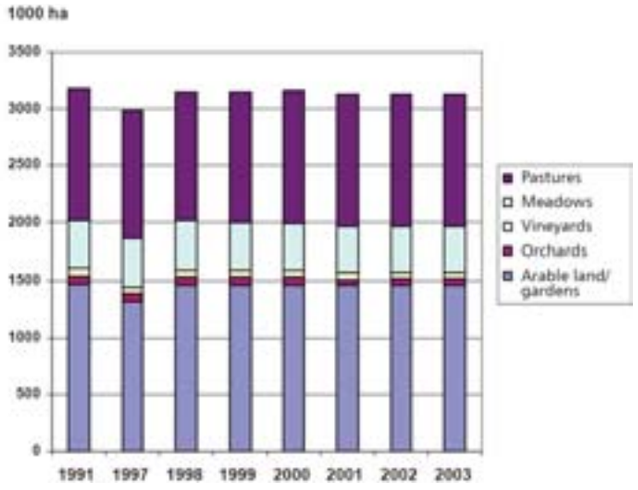
The Republic of Croatia has a total of 6,759 registered settlements. The largest number of settlements (2,916 or 43%) belongs to the category of 100-499 inhabitants, which is followed by settlements with less than 100 inhabitants (2,470 or 35%). Only 1.2% (79) of settlements has more than 5,000 inhabitants, but they accommodate as much as 50% of Croatia's population.

The density of urban settlements in Croatia is low: 2.2 per 1,000 km² of the territory. Most of the urban settlements have 2,000-5,000 inhabitants. 25% of Croatia's population is concentrated in Zagreb being the largest city (779,145 inhabitants) and in the County of Zagreb, followed by Split (188,694), Rijeka (144,043) and Osijek (114,616).

Positive trends in construction industry started in 2001 and are reflected in a continuous rise in the value of works, number of employees and productivity in the period by 2004. The value of construction works completed in 2004 amounts to 16.9 billion kunas (2.25 billion EUR). Within this value traffic infrastructure accounts for 47.5%, pipelines, communication and power supply lines for 11.7% and building construction for 41% of which again 13.9% account for the construction of residential buildings. The 2004 share of the construction industry in the GDP was 5.7%. In 2001 the housing stock of the Republic of Croatia totalled 1,877,126 flats and 1,477,377 private households consisting of 3 persons on average. In 2004 a total of 18,763 flats with a total area of 1,568,000 m² were built, which relates to housing construction of both the construction companies and individual owners (Table 2-3).

2.11 Agriculture

In 2003 the total agricultural land in Croatia was 3,143,000 ha or 55.6% of the total mainland area. It includes



(Source: Ministry of Agriculture, Forestry and Water Management)
Fig. 2-9: Land use between 1991 and 2003

arable land and gardens (1,457,469 ha), orchards (53,904 ha), olive-groves (15,616 ha), vineyards (58,813 ha), meadows (407,898 ha) and pastures (1,161,990 ha). Agricultural land not used due to the landmines accounts for 26.39% of 1,174.1 km² of land suspected to be contaminated by explosives in 2005.

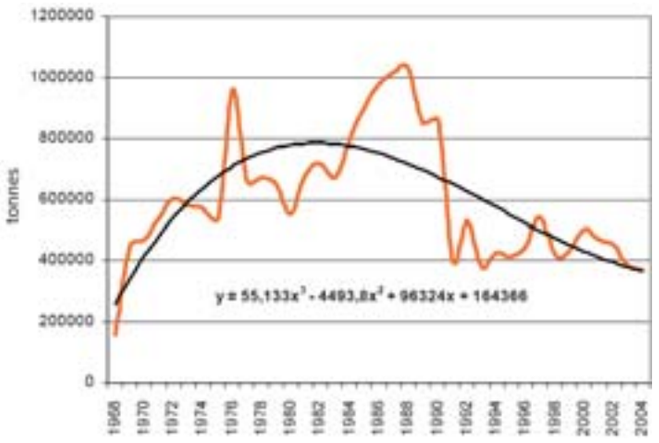
The way of using the agricultural land is shown in Fig. 2-9.

The share of agricultural in the total population of Croatia dropped from 8.56% in 1991 to 5.54% in 2001 because of the upward trend of rural population get old. In 2004 448,532 family farms owned 80% of the agricultural land and the livestock and are the main subjects of agricultural production in Croatia.

Table 2-4: Production of major crops, 1990-2003 (in 000 tonnes)

	1990	1995	2000	2001	2002	2003
Wheat	1,602.4	876.5	1,032.0	965.1	988.1	609.2
Corn	1,950.0	1,735.8	1,526.1	2,211.5	2,501.7	1,569.1
Barley	196.5	103.2	151.4	161.4	170.9	134.2
Oil rape	33.2	24.4	29.4	22.4	22.5	28.5
Soya	55.4	34.3	65.2	91.8	129.4	82.5
Sunflower	52.9	37.0	53.9	42.9	62.9	69.2
Tobacco	12,394	8,548	9,714	10,502	10,905	9,680
Sugar beet	1,205.9	690.7	482.2	964.8	1,118.3	677.5

(Source: Central Bureau of Statistics)



(Source: Petrokemija d.d. Kutina).

Fig. 2-10: Consumption of mineral fertilizers, 1968-2004

Wheat and corn are predominant crops on some 50% of the total arable land, with barley, rye and oats covering smaller areas. The average corn yields do not exceed 6 t/ha and the yield of wheat is 4 t/ha, which is unsatisfactory viewing the possibilities of this crop. The production of major crops between 1990 and 2003 is shown in Table 2-4.

In 2000 the consumption of mineral fertilizers amounted to 505,000 tonnes or 253 kg/ha of arable land on average, which lies below the 1991 consumption (Fig. 2-10). Considering the amount of active substance, nitrogen is the leading, followed by potassium and phosphorus.

In 2004 3,840 tonnes of pesticides were produced. Their consumption is estimated at 2.5-3 kg of active substance per hectare of arable land, of which 5-6% account for insecticides, 35-45% for fungicides and 50-60% for herbicides.

Ecological growing of agricultural and food products has been regulated by law since 2001. In 2005 the area used for ecological growing was 7,299.2 ha.

Only 0.86% of arable land was irrigated in Croatia in 2003. The national irrigation project foresees the construction of irrigation systems on an area totalling 35,000 ha in the period between 2006 and 2010.

The total number of livestock dropped considerably in the last decade. As compared to 1991, the number of cattle dropped by 38%, pigs by 8%, horses by 72% and poultry by 32%, whereas the number of sheep increased by 23% (Table 2-5). Livestock breeding has a share of 41% in the value of agricultural production. Family farms keep over a half of the total number of cattle, pigs, sheep, goats and horses.

The largest producers of organic manure are the cattle with over 70% and pigs with 15% of the total volumes. Large livestock farms use the manure produced to fertilize the land without the risk of soil and water pollution. Due to the decline in the number of livestock bred in Croatia, the amount of 10 million tonnes of organic manure produced in 2003 is by one third lower in comparison with 15 million tonnes in1991.

The fishing sea of the Republic of Croatia consists of the external and the internal fishing sea divided into 11 fishing zones. 3,680 fishing vessels used for sea fishing are owned by professional fishermen or companies. The fishing fleet structure is unfavourable, because small fishing vessels are not capable of fishing in the open sea, which makes the coastal sea exposed to the entire pressure of fishing activities. In 2003 the sea fish catch amounted to 29,000 tonnes.

The mariculture includes fish farms for Atlantic tuna, sea bass and gilthead, as well as shell-fish farms of oysters and mussels. The freshwater fishery is mainly recreational, with a small number of traditional fishermen on the river Sava downstream Jasenovac and on the Danube. The main catching species are carp, European catfish, zander and pike. In 2004 the total fish-pond production was 5.6 tonnes of which the controlled warm-water carp breeding accounted for 3.3 tonnes. The cold-water breeding relates primarily to Californian trout.

2.12 Forestry

The Republic of Croatia is a medium-forested country. According to the 1996 data forests and forest land cover an area of 2,468,830 ha or 43.7%, with forests covering 37% of the country's mainland area. New Forest Management Plan for the area in the period from 2006 to 2015 is in the process of preparation. Details on forest and forest land areas will be provided by the National Forest Inventory (CRONF) late in 2008.

81% of forests and forest land are owned by the state and managed by Croatian Forests with the Directorate in Zagreb, 16 forest administrations and 171 forestry offices, while the remaining 19% are privately owned.

Table 2-5: Livestock number in the Republic of Croatia, 1991-2004 (in 000)

	1991	1995	2000	2001	2002	2003	2004
Cattle	757	494	427	438	417	444	466
Horses	36	21	11	10	8	9	10
Pigs	1,621	1,175	1,233	1,234	1,286	1,347	1,489
Sheep	753	453	528	539	580	587	721
Poultry	16,512	12,024	11,256	11,747	11,665	11,778	11,185

(Source: Central Bureau of Statistics)

In 1996 the total timber stock amounted to 324,256,137 m^3 (Table 2-6) of which 85% account for the broadleaves and 15% for the deciduous trees. The total annual stock increment of all forests in Croatia amounted to 9,643,117 m^3. The prescribed portion of timber stock intended for annual cutting is 4,934,199 m^3 or 51.2% of the annual increment.

The presence of landmines in forests is an important factor affecting forest management. According to the 2004 estimate, the land suspected of mines and therefore excluded from the management covers an area of 181,762 ha or 9% of the total forest and forest land area.

The Republic of Croatia lies at the crossroads of two large phytogeographical regions – the Euro-Siberian-North-American and the Mediterranean, which gives the country a great variety of ecosystems, habitat types, and plant and wildlife species. The former includes 45 forest communities of the lowland, hilly, highland, mountain and pre-mountain vegetation belt and the latter 17 thermophilous, evergreen and deciduous forest communities of the Mediterranean coastal and insular Croatia. Croatia's higher plants flora which includes pteridophytes and spermatophytes, comprises 5,347 species and subspecies, of which 326 are endemic. The Red List of Vascular Flora of Croatia mentions 420 taxa considered threatened or at risk of extinction.

2.13 Inland Waters and Coastal Area

The amount of water per inhabitant places the Republic of Croatia among the best endowed countries in Europe. The average volume of the country's own and transit waters is 25,160 m^3/cap/year of which the own waters account for 5,880 m^3/cap/year (Table 2-7). The total renewable amounts

Table 2-6: Timber stock (in m^3) of ten main tree species in 1986 and 1996

	Type	1986	1996
Common beech	*Fagus sylvatica* L.	105,297,612	118,197,958
Common oak	*Quercus robur* L.	41,598,258	44,980,967
Durmast oak	*Quercus petraea* (Matt.) Liebl.	27,971,54	32,386,239
Silver fir	*Abies alba* Mill.	34,360,233	30,475,088
Hornbeam	*Carpinus betulus* L.	23,043,099	24,892,301
Narrow-leaved ash	*Fraxinus angustifolia* Vahl.	9,336,373	10,280,248
Spruce	*Picea abies* (L.) H. Karst.	4,918,592	6,525,657
Holm oak	*Quercus ilex* L.	5,864,256	5,091,853
Pubescent oak	*Quercus pubescens* Willd.	5,662,204	4,317,504
Aleppo pine	*Pinus halepensis* Mill.	3,624,268	3,880,114
Other conifers		4,368,468	6,201,959
Other broadleaves		32,336,445	37,026,249
Evergreen underbrush, garigues and thickets (estimate)		2,361,660	3,299,460
TOTAL (m^3/ha)		**163**	**185**

(Source: Forest Management Plan for the area of the Republic of Croatia, 1996-2005)

Table 2-7: Characteristics of Croatia's waters by catchment areas

Hydrological unit	Black Sea catchment area	Adriatic catchment area	Croatia total
Area A (km^2)	35,131.5	21,406.6	56,538.1
Precipitation P (mm)	1000	1,426	1,162
Flow-rate Q (m^3/s)	376	451	827
Volume V (m^3/god)	1.186×10^{10}	1.422×10^{10}	2.608×10^{10}
Discharge Q* = V/A	337,514	664,428	461,287
Specific discharge (l/s/km^2) q = Q/A	10.70	21.07	14.63
Population N	3,045,640	1,391,541	4,437,181
Water volume per capita V* = V/N (m^3/cap/year)	3,896	10,221	5,879

(Source: Croatian Waters)

of groundwater are 9.13 km^3/ year. About 30% are bounded to quaternary coarse-clastic deposits of the Drava and Sava plains, and the karst areas of southern parts of the Kupa and the Una catchment areas.

The total length of all natural and artificial watercourses in the area of Croatia is 21,000 km. The rivers belong to the Black Sea (62% of the territory) and the Adriatic catchment area (38%). The watershed runs along the Dinarides barrier close to the Adriatic coast.

The Black Sea catchment area is more abundant in water if the own and transit waters are taken into consideration. The water resources of the Adriatic catchment area are, however, more abundant if the specific flow-rate is considered. External contributions to the Adriatic catchment area from Bosnia and Herzegovina are not transit waters, because they drain into the Adriatic Sea. The specific discharge of the Adriatic catchment area waters is twice as large as that of the Black Sea catchment area, due to considerably larger amounts of precipitation (by over 40%) and the karst nature of the base causing higher discharge coefficients.

The river Danube, the largest and richest in water, flows through the eastern borderland of Croatia over a length of 137.5 km. Other major rivers are the Sava (562 km) and the Drava (505 km). The Kupa is the longest river (296 km) and flows entirely through Croatia. The rivers of the Adriatic catchment area are short, have rapids and canyons. The largest rivers are the Mirna, the Dragonja and the Raša in Istria and the Zrmanja, the Krka, the Cetina and the Neretva in Dalmatia. Shorter non-stagnant waters in the karst area tend to sink and go on flowing together with underground watercourses. Croatia's largest sink river, the Lika, belongs also to the Adriatic catchment area.

There are not many lakes in Croatia. The largest natural lakes are Vransko Lake near Pakoštane (30.7 km^2), Prokljansko Lake (11.1 km^2), Visovačko Lake (7.7 km^2) and Vransko Lake on the island of Cres (5.8 km^2). The most famous and the most beautiful Plitvice Lakes are the course of the river Korana transformed into 16 cascade lakes interconnected by travertine downstream beds. The artificial storage lakes with a total volume of 1,050 million m^3 have been created as a part of hydropower plants. They are Dubrava Lake (17.1 km^2) on the river Drava near Varaždin and Peruča Lake (13 km^2) on the river Cetina.

Wetland habitats cover an area of 390,885 ha and 50,516 km of watercourses and canals in the flooded areas of the Drava, the Danube, the Sava, the Mura and the Neretva catchment areas. 3,883 sites have been singled out as integrated wetland areas and four of them: Kopački rit, Lonjsko and Mokro polje, Crna Mlaka and the lower Neretva are listed on the Ramsar list of wetlands of international importance.

The Adriatic Sea is the northernmost part of the Mediterranean Sea. It is 870 km long, 170 km wide on average and has an area of 138,595 km^2. It is connected with the Ionian Sea by the 72-km wide Strait of Otranto. In term of relief the Adriatic basin is an intermountain depression between the Apennines, the Dinarides and the Alps, for the most part flooded by sea in the Quaternary. The Adriatic Sea is the shallowest by the western coast of Istria and in the Rijeka Bay (20-60 m) and the deepest (1,233 m) in the southern Adriatic valley. Given the average salinity of 38.3 per thousand, it belongs to more saline seas.

The total length of Croatia's coast is 6,278 km of which 1,880 km belong to the mainland and 4,398 km to the island coastline. The largest peninsulas are Istria and Pelješac. With its 78 islands, 524 islets and 640 cliffs and reefs Croatia's Adriatic coast ranks among the most indented in Europe. The islands are divided into the Istrian, the Kvarner, the northern Adriatic, the central Adriatic and the southern Adriatic group, with the largest islands being Cres (405.68 km^2), Krk (405.24 km^2), Brač (394.57 km^2) and Hvar (299.66 km^2).

The coastal area of Croatia is separated from the inland by high mountains. The coast is mostly made of rocks and relatively steep. It is lower and slopes gently in the western part of Istria and in the area to the south of Zadar. Low-lying parts of the coast especially vulnerable to the sea level rise due to climate changes are relatively few.

2.14 Specific Circumstances of Croatia under Article 4.6. of the Convention

The United Nations Framework Convention on Climate Change and the Kyoto Protocol determine the level of greenhouse gas emissions of the base year for each country (1990 as a standard), to serve as a reference value for the existing and future commitments to reduce greenhouse gas emissions.

Article 4, paragraph 6 of the Convention allows a certain degree of flexibility to Parties included in Annex I undergoing the process of transition to a market economy with respect to implementation of their commitments under the Convention and the Kyoto Protocol, in order to enhance their ability to address climate change. By selecting the year with the highest emissions between 1985 and 1990 to be the base year instead of 1990, the following countries took advantage of this flexibility; Bulgaria (base year 1988), Hungary (the average of 1985-1987), Poland (1988), Romania (1989) and Slovenia (1986). The degree of the emission rise approved ranges from 10 to 23%.

The Republic of Croatia was unable to use the same flexibility model, because in the period between 1985 and 1990 the greenhouse gas emission was equal or below the 1990 level. Therefore at the session of the Conference of Parties (COP 7) held in Marrakesh in 2001 the Republic of Croatia submitted a request for the recognition of specific circumstances under Article 4.6 of the Convention. In doing this Croatia requested the increase in emission level of the base year 1990 by 4.46 million t CO_2 eq.

According to the recent inventory for the period between 1990 and 2003 the total greenhouse gas emission in the Republic of Croatia amounted to 31.7 million t CO_2 eq.

The specifics of the request submitted by the Republic of Croatia lies in the fact that it did not imply the selection of another base year, but rather the increase in the emission level of the base year 1990.

It results from the fact that the greenhouse gas emission of the base year 1990 calculated according to the instructions given by the Convention Secretariat does not reflect specific circumstances with regard to Croatia's having been integrated into the common economic, energetic and infrastructure system of former Yugoslavia. The base year emission determined by the country's electricity generation in 1990 is not an appropriate basis, because this generation corresponds to Croatia's level of development in the 1970s and cannot suffice for the contemporary socio-economic life of Croatia. The non-recognition of the flexibility proposed, means for the Republic of Croatia lagging thirty years behind and experiencing a slowdown in economic growth. From 1995 to 2001 the average emission growth rate amounted to 3.2%, which is in correlation with the GDP growth. In 2005 the greenhouse gas emission is likely to exceed the volume limits laid down by the Kyoto Protocol.

Despite the fact that during negotiations held in Kyoto in 1997 Croatia did not have the First National Communication on Climate Change prepared and could not provide integral data on greenhouse gas emissions and cost-effective possibilities of their reduction, the estimates indicated the emission rise. The obligation to reduce the emission by 5% in relation to the base year was assumed taking into account the possibility of using the flexibility under Article 4.6 of the Convention and in light of such a viewpoint the Republic of Croatia signed the Kyoto Protocol on 11 March 1999.

At the session of the Conference of Parties (COP 11) held in Montreal in 2005 the Decision 10/CP.11 was adopted considering the request of the Republic of Croatia for recognition of specific circumstances when determining the emission level of the base year. Pursuant to Article 4.6 of the Convention Croatia was allowed a certain degree of flexibility with regard to the historical level of anthropogenic emissions of greenhouse gases chosen as a reference.

The negotiations about Croatia's request were completed at the session of the Conference of Parties (COP 12) in Nairobi in 2006, when the Decision was adopted to recognize specific circumstances of Croatia with regard to greenhouse gas emissions before and after 1990, and the structure of the electricity generation sector of the former Yugoslavia, to allow to add 3.5 million tonnes CO_2 eq to its 1990 level of greenhouse gas emissions not contolled by the Montreal Protocol.

The adoption of this Decision will make it possible for the Croatian Parliament to ratify the Kyoto Protocol in the course of 2007.

As the Kyoto Protocol came into force on 16 February 2005, the 1st meeting of the Parties to the Kyoto Protocol (COP/MOP 1) took place in Montreal. It was decided that for the Parties to the Protocol whose emissions in the period 2008-2012 would exceed the amounts inscribed in Annex B (for Croatia 95 % of the base year emission) the amount of emission exceeding the assigned amount would be multiplied by 1.3 and subtracted from the assigned amount in the second commitment (*post-Kyoto*) period from 2012 to 2020.

The Republic of Croatia submitted a request for raising the limit (*forest cap*) of the LULUCF sector (*Land Use, Land Use Change and Forestry*) by which a portion of CO_2 would be withdrawn due to absorption into the forest growing stock. By the Decision 22/CP.9 adopted at the session of the Conference of Parties (COP 9) in 2003 Croatia was allowed to use a sink of 0.265 million t carbon per year for the first commitment period, amounting to 4.5 million t CO_2.

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The vineyard and olive grove in Dalmatia

3. Greenhouse Gas Inventory Information

3.1 Introduction

The first annual inventory of greenhouse gas emissions of the Republic of Croatia has been made for the First National Communication, and from 2003 it is prepared annually in conformity with the guidelines of the Convention Secretariat and the methodology of the Intergovernmental Panel on Climate Change (IPCC).

The preparation and submission of the National Inventory Report falls within the competence of the Ministry of Environmental Protection, Physical Planning and Construction that has so far entrusted these activities to domestic specialized institutions having necessary experienc and capacities for the collection of data and calculation of emissions. The quality of the inventory of greenhouse gas emissions is ensured by technical reviews arranged by the Secretariat with the assistance of nominated international experts in this field. The main objective of the development and review of the inventory is to enhance its quality in terms of accurateness, completeness, integrity, clarity and consistency.

For the preparation of the inventory of greenhouse gas emissions the methodology described in the *IPCC Guidelines for National GHG Inventories, Revised 1996* and *Good Practice Guidance and Uncertainty Management in National GHG Inventories, 2000* is used.

An important component of the inventory development is the assessment of inventory uncertainty and verification of input data and outputs aiming to enhance the quality and reliability of the inventory.

This National Communication presents the inventory of emissions and greenhouse gas removals in the Republic of Croatia in the period between 1990 and 2003.

The inventory includes emissions resulting from human activities and comprise the following direct greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs, PFC-s) and sulphur hexafluoride (SF_6), as well as the indirect greenhouse gases such as carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2). The inventory does not include greenhouse gases controlled under the Montreal Protocol on Substances that Deplete the Ozone Layer (e.g. Freon), which are, as such, a subject of separate communications.

The sources and sinks of greenhouse gas emissions are divided into six main sectors:

- Energy
- Industrial processes
- Dissolvent use
- Agriculture
- Land-use change and forestry
- Waste management.

In general, the methodology of emission calculation consists in multiplying a certain economic activity (e.g. fuel consumption, cement production, livestock number, growing stock increment, etc) by corresponding emission factors. It is recommended to apply specific national emission factors wherever justified and possible, because otherwise the methodology gives typical emission factor values for all relevant activities of individual sectors.

It was agreed to present the greenhouse gas emissions by a derived unit of weight gigagram (Gg) that corresponds to a million kilograms or a thousand tonnes.

The inventory of greenhouse gas emissions is a key component of the so-called *National System* defined under Article 5.1 of the Kyoto Protocol as a "system for the estimation of anthropogenic emissions of sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol to be established no later than one year prior to the start of the first commitment period (1 January 2007)".

The inventory of greenhouse gas emission will play an important role during the first commitment period of the Kyoto Protocol (2008-2012), or rather in monitoring the implementation of the commitment to reduce emissions by 5% as compared to the base year (1990) which will be formally assumed by Croatia after the ratification of the Kyoto Protocol.

3.2 Institutional and Organizational Structure of Developing the Greenhouse Gas Inventory

An important pre-condition for an efficient data management system and development of the inventory is a clearly defined organization, competences and responsibilities of institutions involved in the process of developing the inventory, which includes a number of steps to be taken in the collection and processing of data, calculation, control and verification of emission inventories and documentation and communication to competent international institutions. It may be said that Croatia, or rather the Ministry of Environmental Protection, Physical Planning and Construction as a body responsible for the development of the inventory, uses a decentralized model in which it delegates authorizations for the performance of individual tasks in the process of developing the inventory to collaborating institutions, partly public or governmental and partly privately-owned.

The main sources of data for the inventory of greenhouse gas emissions are the Hrvoje Požar Energy Institute that prepares the national energy balance; the Central Bureau of Statistics that, on the basis of the statistic survey programme, collects data on the amounts of raw materials and products relating to activities defined by the National Classification of Business Activities; the Croatian Centre for Vehicles and the Ministry of Interior that keep databases of road and off-road vehicles, and the Ministry of Agriculture, Forestry and Water Management that keeps data on forested areas. Data provided through questionnaires completed directly by individual emission sources or other specialized institutions are used in the development of the inventory to calculate and check data provided by official publications.

The Energy and Environmental Protection Institute is the executive institution in charge of data collection, emission

calculation and development of annual inventories of greenhouse gas emissions based on the contract signed with the Ministry of Environmental Protection, Physical Planning and Construction. The necessary finance for the development of the inventory in the previous period was secured mostly by grants of the European Commission "LIFE-Third Countries" programme and the GEF. Such an organization of the system shows certain advantages, primarily in an efficient utilization of existing resources, but has also drawbacks with respect to the medium-term and long-term inventory planning and enhancement.

Considering the former practices and the need for a sustainable monitoring system for greenhouse gas emissions, including the obligation to establish the National System for the needs of the Kyoto Protocol, the Ministry of Environmental Protection, Physical Planning and Construction has, pursuant to Article 46 of the Air Protection Act (Official Gazette No. 178/04), started preparing the Regulation on Monitoring the Greenhouse Gas Emissions in line with the requirements of the Kyoto Protocol and the EU legislation. The Regulation is expected to be adopted by the end of 2006, which would create conditions for implementation of the National System as defined in Article 5.1 of the Kyoto Protocol.

3.3 Overview of Greenhouse Gas Emissions, 1990-2003

The results of the inventory of greenhouse gas emissions in the Republic of Croatia between 1990 and 2003 are shown as a total emission of all greenhouse gases converted into carbon dioxide equivalent emission by sectors and as emissions of individual greenhouse gases also by sectors.

Table 3-1: Global warming potentials of certain gases

Gas	Global warming potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
HFC-32	650
HFC-125	2,800
HFC-134a	1,300
HFC-143a	3,800
CF_4	6,500
C_2F_6	9,200
SF_6	23,900

Viewing the differing contributions of individual greenhouse gases to the greenhouse effect and with the aim to enable their summing up, the emission of each greenhouse gas was multiplied by the relevant global warming potential (GWP).

The global warming potential is a measure of how much a given mass of greenhouse gas is estimated to contribute to greenhouse effect as compared to the CO_2 contribution agreed upon as a reference value. The global warming potentials of individual gases in a period of 100 years are shown in Table 3-1.

The greenhouse gas emission is shown as the CO_2 equivalent emission (CO_2 eq). The greenhouse gas removals, e.g. CO_2 absorption by growing stock increment in forests, are called greenhouse gas sinks and the amount is shown bearing the negative sign.

3.3.1 Aggregate Greenhouse Gas Emissions

Total greenhouse gas emissions/removals between 1990 and 2003 and trends by sectors are shown in Table 3-2. The contribution of individual greenhouse gases is shown in Table 3-3.

Contributions of individual greenhouse gases to the total 2003 emission were as follows: CO_2 (77%), CH_4 (12.1%), N_2O (10.8%), HFC, PFC and SF_6 (0.1%). Fig. 3-1 shows the contribution of individual sectors to the total greenhouse gas emission and sinks.

The major contributor to 2003 greenhouse gas emission was the energy sector with 75.8%, followed by agriculture (10.8%), industrial processes (9.0%) and waste management (4.3%). With some slight changes, this structure remained during the entire period 1990-2003.

The "coverage" of greenhouse gas emissions by carbon dioxide removals in the forestry sectors amounted to 57% in 2003.

In 2003 the total energy consumption of the energy sector as the major contributor to greenhouse gas emission increased by 5.2% as compared to 2002.

Table 3-2: Greenhouse gas emissions/removals by sectors, 1990-2003 (Gg CO_2 eq)

Sector	1990	1995.	2000	2001	2002	2003
Energy	22,489	16,393	18,843	19,958	21,202	22,637
Industrial processes	3,932	2,021	2,815	2,785	2,717	2,702
Agriculture	4,411	3,121	3,097	3,195	3,235	3,238
Waste management	933	995	1,162	1,201	1,239	1,289
Total emission	**31,765**	**22,530**	**25,917**	**27,140**	**28,393**	**29,867**
Land-use change and forestry	-12,688	-12,688	-14,442	-14,442	-15,373	-15,373
Net emission	**19,077**	**9,842**	**11,475**	**12,698**	**13,020**	**14,494**

Table 3-3: Greenhouse gas emissions/removals by individual gases, 1990-2003 (Gg CO_2 eq)

Greenhouse gas	1990	1995	2000	2001	2002	2003
Carbon dioxide (CO_2)	23,035	16,251	19,378	20,454	21,576	23,000
Methane (CH_4)	3,809	3,107	3,233	3,383	3,452	3,611
Niutrous oxide (N_2O)	398	3,163	3,284	3,254	3,316	3,230
Hydrofluorocarbons (HFC, PFC) and SF_6	939	8	23	49	49	27
Total emission	**31,765**	**22,530**	**25 ,17**	**27,140**	**28,393**	**29,867**
Carbon dioxide (CO_2) removal	-12,688	-12,688	-14,442	-14,442	-15,373	-15,373
Net emission	**19,077**	**9,842**	**11,475**	**12,698**	**13,020**	**14,494**

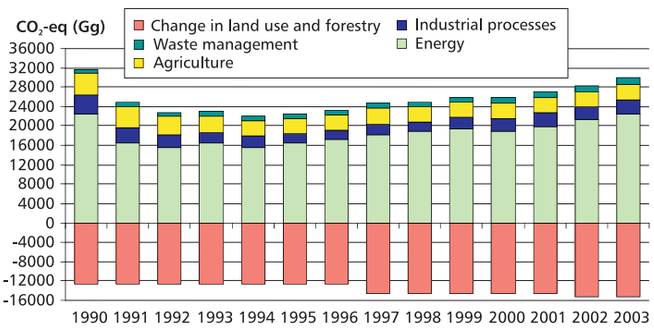

Fig. 3-1: Greenhouse gas emissions and removals in Croatia by sectors, 1990-2003 (Gg CO_2 eq)

The highest increase (13.4%) was recorded in consumption of coal, being at the same time the major producer of CO_2 emissions (92, 7 t/TJ). Due to extremely unfavourable hydrological conditions in 2003, the utilization of water energy showed a downward trend. In 2003 the CO_2 emission from generation of electricity and thermal energy by thermal power plants, public district heating plants and public boiler houses amounted to 5.8 million tonnes or 19.4% of the total greenhouse gas emission of Croatia.

In the agricultural sector the CH_4 and N_2O emissions are dependent on various agricultural activities. The CH_4 emission is predominantly connected with livestock breeding (enteric fermentation). The downward trend in the number of livestock since 1990 resulted in the drop in the CH_4 emission by 2000, but then the emission increased again and the trend continued until 2003. The N_2O emission is seen as a direct emission related to cultivation of agricultural land and decomposition of animal waste (fertilizer management) and as an indirect emission. Similar to the CH_4 emission since 2000, the N_2O emission shows an upward trend caused by the increased use of mineral nitrogen fertilizers.

Key sources of emission in the sector of industrial processes are the production of cement, ammonia and nitric acid, which aggregately accounted for 90.7% of the emission from this sector in 2003.

The ironworks with blast furnaces and the aluminium plants were shut down in 1992, as was the ferroalloys plant in 2002.

In the period between 1997 and 2003 the cement production was constantly rising and exceeded the 1990 values. The manufacturers' objective is to reach the maximum utilization of existing capacities. So in 2003 they produced 3.8 million tonnes of cement. In 2003 the production of ammonia and nitric acid was 22% lower (as seen through natural gas consumption).

The manufacturers' objective is again the utilization of existing capacities, while the production and the related emission primarily depend on the demand for individual types of mineral fertilizers on the market.

Municipal waste disposal in landfills is the predominant source of CH_4 emissions from this sector in Croatia. The emission depends on the amount and composition of waste, landfill arrangement and application of measures for landfill gas collection and treatment. The emission rises mostly as a consequence of an ever-increasing amount of waste disposed of in landfills and the absence of secondary measures for emission reduction in landfills (torch incineration, electricity generation from landfill gas).

3.3.2 Carbon Dioxide

Carbon dioxide is the major greenhouse gas of anthropogenic origin. As in majority of countries, major anthropogenic sources of CO_2 emissions in Croatia are fossil fuel combustion processes in the generation of electricity and/or thermal energy, transport and industrial processes (cement and ammonia production). The inventory of CO_2 emissions in Croatia is shown in Table 3-4.

3.3.2.1 Energy

This sector includes all activities that involve consumption of fossil fuels (fuel combustion and use of fuel for non-energy purposes) and the fugitive emission from fuels. The fugitive emission arises from the production, transmission, processing, storing and distribution of fossil fuels. Energy sector is the major source of anthropogenic emissions of greenhouse gases accounting for 77% of the total emission of greenhouse gases. The CO_2 emission from fuel combustion accounts for the largest portion, i.e. over 90% of emissions coming from the energy sector. Emissions by energy subsectors are shown in Table 3-5.

Table 3-4: CO_2 emissions and removals by sector, 1990-2003 (Gg CO_2)

Sector	1990	1995	2000	2001	2002	2003
Energy	20,985	15,082	17,446	18,443	19,611	20,988
Industrial processes	2,050	1,170	1,932	2,011	1,965	2,012
Forestry (sink)	-12,688	-12,688	-14,442	-14,442	-15,373	-15,373
Total emission	**23,035**	**16,251**	**19,378**	**20,454**	**21,576**	**23,000**
Net emission	**10,347**	**3,564**	**4,936**	**6,012**	**6,203**	**7,627**

The emission inventory is based on data on fuel consumption and supply as set forth in detail in the annual national energy balance, which makes it possible to prepare a detailed variant of the inventory by sub-sectors within the IPCC methodology prescribed (*Sectoral approach*). A simpler variant (*Reference approach*) that was also applied takes into consideration the total fuel balance only, without any sectoral analysis. Relative deviations of CO_2 emissions calculated for Croatia by using the sectoral and reference approach do not exceed 5%, which lies within the limits of acceptable values (Table 3-6).

Two most intensive sub-sectors are transformation of energy (thermal power plants, district heating plants, refineries and combustion in oil and gas fields) and fuel combustion in industry. In the sub-sector of fuel combustion in industry the highest CO_2 emissions come from the combustion in building material industry, followed by the industry of iron, steel and non-ferrous metals, chemical industry, pulp and paper industry, production of food, beverages and tobacco, etc. This sub-sector includes also power and heat generation in industrial plants.

Traffic is also a major source of CO_2 emissions accounting for 17.8% of the total emission of greenhouse gases in 2003. A larger portion of the emission comes from road transport (86-94%), followed by railway and domestic air and marine transport. The emission from fuel sold for the purpose of international air and marine transport is shown separately and not included in the total national emission balance.

This sector included also the CO_2 emission coming from not energy-related fuel consumption, when fossil fuels do not burn out completely or when the total carbon contained in the fuel is incorporated in the product for a longer period of time and the remaining carbon oxidises and is released in the atmosphere. Not energy-related consumption includes the consumption of natural gas in ammonia production and the consumption of virgin naphtha, ethane, paraffin and wax in the chemical industry, bitumen in the construction and other industries, and oil and grease for various purposes. The use of bitumen in the construction industry produces no CO_2 emission, because the total carbon links with the product. The emission coming from not energy-related consumption of fuel is shown in the sub-sector 'Other'. To avoid the double calculation of the emission, the CO_2 emission produced by not energy-related consumption of natural gas in the ammonia production was calculated and shown within the sector of industrial processes rather than the energy sector.

Table 3-5: CO_2 emission by energy sub-sectors, 1990-2003 (Gg CO_2)

Sub-sector	1990	1995	2000	2001	2002	2003
Thermal power plants and energy transformation	6,823	5,176	5,882	6,294	7,213	7,877
Fuel combustion in industry	5,645	2,901	3,078	3,223	3,110	3,163
Transport (road and off-road)	4,041	3,330	4,396	4,562	4,871	5,284
Small combustion plants (households, institutions)	3,620	2,785	3,357	3,574	3,653	3,880
Other (non-energy consumption)	439	193	99	102	98	100
Natural gas scrubbing	416	697	633	688	665	684
Total emission	20,985	15,082	17,446	18,443	19,611	20,988

Table 3-6: Comparison of CO_2 emissions resulting from fuel consumption

	1990	1995	2000	2001	2002	2003
Reference approach R (Gg)	21,230	15,477	17,906	18,678	19,926	21,307
Sectoral approach S (Gg)	20,569	14,385	16,813	17,755	18,946	20,304
Relative deviation (S-R)/S (%)	3.22	7.59	6.50	5.20	5.17	4.94

The emission of greenhouse gases is also produced by biomass combustion (firewood and combustible scraps, biodiesel, biogas, etc.). The CO_2 emission coming from biomass is not included in the balance, because it is assumed that CO_2 emitted has been previously absorbed in the life-cycle for biomass growth and generation. CO_2 sinks or emissions resulting from the change in the forest biomass are calculated in the sector of land-use change and forestry.

The fugitive emission of greenhouse gases coming from coal, liquid fuels and natural gas due to mineral extraction, production, processing, transport, distribution and activities during use is also a part of this sector. Although typical of CH_4 rather than of CO_2, in Croatia CO_2 emissions are discharged at purification of natural gas from the gas fields in Podravina region. From gas rich in carbon dioxide (over 15%) CO_2 is scrubbing up to the maximum 3% volume share before being discharged into the commercial gas pipeline. The emission resulting from such separation was estimated by using the method of material balance and amounts to maximum 5% of the total CO_2 emission in the energysector.

3.3.2.2 Industrial Processes

The emission of greenhouse gases is a by-product of various industrial processes in which the input substance is chemically transformed into the final product. Industrial processes contributing substantially to CO_2 emission are the production of cement, lime, ammonia and ferroalloys and the use of limestone and dehydrated soda in various branches of industry.

The general methodology used in calculating emissions from industrial processes as recommended by the Convention consists in multiplying the volume of product or material produced or consumed per year by corresponding emission factors per unit of such a production or consumption. The data on annual production or consumption relating to individual industrial processes originate from industrial monthly reports published by the Central Bureau of Statistics. A certain portion of data was collected by a direct poll among individual enterprises. The inventory of CO_2 emissions from industrial processes is shown in Table 3-7.

The major sources of CO_2 emissions in industrial processes are the production of cement and ammonia. Depending on the year, the CO_2 emission from cement production contributes with 40-70% to the total CO_2 emission from the industrial sector and that from ammonia production with 20-40% of the total emission of the sector.

In general, in the period between 1990 and 1995 emissions from industrial processes decreased as a consequence of the reduction or termination of certain industrial activities, but in the following period they approximated the 1990 emission levels. So, the 2003 cement production exceeded by as much as 138% the production of the year 1995.

The amount of CO_2 emitted from cement production is directly proportional to the CaO content of clinker. Therefore the CO_2 emission is calculated by multiplying the emission factor (shown in tonnes of CO_2 emitted per tonne of clinker produced) by the total annual production of clinker corrected by the amount of clinker lost from the rotary kiln in form of clinker dust. The emission factor and the correction factor for clinker loss are defined according to *Revised 1996 IPCC Guidelines* and *Good Practice Guidance*. Data on clinker production were collected by conducting a poll among cement plants in Croatia and verified by industrial monthly reports of the Central Bureau of Statistics.

The CO_2 emission from ammonia production was determined stoichiometrically on the basis of carbon content of natural gas. A portion of CO_2 thus obtained in the ammonia production is further used as a raw material in the production of mineral fertilizers. In this way the temporarily "linked" carbon is only emitted as CO_2 after using a mineral fertilizer in agriculture. However, since the IPCC methodology does not distinguish such an approach, the total CO_2 emission from natural gas in ammonia production is shown in the first place.

3.3.2.3 Carbon Dioxide Sinks

According to the Forest Management Plan for the area covering the period between 1996 and 2005, forests and forest land cover 43.7% of the total area of Croatia. Approximately 95% of the forests are a result of natural regeneration

Table 3-7: CO_2 emissions from industrial processes, 1990-2003 (Gg CO_2).

Sub-sector	1990	1995	2000	2001	2002	2003
Cement production	1,022.9	584.9	1,242.2	1,419.6	1,395.6	1,392.2
Lime production	159.8	62.3	124.3	143.5	164.0	161.0
Use of limestone and dolomites	43.2	11.2	8.4	9.2	9.6	11.8
Production and use of Na_2CO_3	25.7	14.4	11.0	12.4	12.2	14.7
Ammonia production	491.6	462.9	525.2	425.8	383.7	431.8
Iron and steel production	0.9	0.1	0.3	0.3	0.2	0.2
Ferroalloys production	194.9	34.0	20.5	0.5	0.0	0.0
Aluminium production	111.4	0.0	0.0	0.0	0.0	0.0
Total emission	**2,050.4**	**1,169.6**	**1,932.0**	**2,011.3**	**1,965.2**	**2,011.6**

and the rest are artificially cultivated forest crops and plantations. The annual increment is 9,643,117 m^3. Total annual cutting is 4,934,199 m^3 or 51.2% of the annual stock increment. There is no problem of deforestation in Croatia.

According to the data available the forest area in Croatia has not decreased over the last hundred years. Clear cutting as a forest regeneration measure is prohibited and natural regeneration is the principal way of forest renewal.

The methodology used to calculate CO_2 sinks corresponds to the IPCC methodology and is based on data on annual increment and cutting. The estimation of CO_2 emission includes presently only the changes in the amount of forest and other wood biomass, because there were not sufficient reliable inputs available for other segments in the sector of land use, land use change and forestry, e.g. the change in the intended use of forest land and grassland to arable land and pastures and vice versa, and the change in the carbon content of the soil.

Total carbon dioxide removals (sinks) in the sector of forestry amounted to 12,688 Gg CO_2 between 1990 and 1996, 14,442 Gg CO_2 (1997-2001) and 15,373 Gg CO_2 in 2002 and 2003.

3.3.3 Methane

Major sources of methane emissions in Croatia are the fugitive emission from the production, processing, transport and use of fuel in the energy sector, agriculture and waste disposal. CH_4 emissions by sectors are shown in Table 3-8.

The fugitive methane emission is mostly a consequence of exploration and extraction, processing, transport and distribution of natural gas (about 97%). The fugitive emission of oil and oil derivatives accounts for approximately 1% and the share of de-aeration and torch incineration in gas/oil production amounts to 2%. By closing Istrian coal mines in 1999 considerable fugitive methane emissions were avoided that would have resulted from coal extraction, processing and transport.

In the agricultural sector there are two important sources of methane emissions: enteric fermentation during the digestion of ruminants (milk cows as the major source) and various procedures relating to storage and use of organic fertilizers.

The methane emission coming from landfills results from anaerobic degradation of organic waste caused by methanogenic bacteria. The amount of methane discharged during the degradation is directly proportional to the share of degradable organic carbon defined as a share of carbon in various types of organic biodegradable waste.

Over 1 million tonnes of municipal waste are generated in Croatia yearly. The average composition of its biodegradable portion is the following: paper and textile (21%), green waste (17%), food waste (22%), scrap wood and straw.

As to the wastewater treatment in Croatia, no anaerobic treatment methods are applied, but only the aerobic ones, which, if adequately managed, produce no methane emissions.

3.3.4 Nitrous Oxide

Major sources of N_2O emissions in Croatia are agricultural activities and nitric acid production, but they are also traffic-related in the sector of energy and waste management. Table 3-9 shows N_2O emissions by sectors.

Three sources of N_2O emissions are identified in the sector of agriculture: direct emissions from agricultural soils, direct emissions from livestock breeding and indirect emissions

Table 3-8: CH_4 emissions in Croatia, 1990-2003 (Gg CH_4)

Sector	1990	1995	2000	2001	2002	2003
Energy	67.8	58.4	59.2	64.5	67.0	68.4
Industrial processes	0.8	0.4	0.3	0.3	0.3	0.3
Agriculture	75.0	48.0	43.1	43.6	42.7	46.3
Waste management	37.8	41.1	51.3	52.7	54.5	56.9
Total emission	**181.4**	**148.0**	**153.9**	**161.1**	**164.4**	**171.9**

Table 3-9: N_2O emissions in Croatia, 1990- 2003 (Gg N_2O)

Sector	1990	1995	2000	2001	2002	2003
Energy	0.3	0.3	0.5	0.5	0.6	0.7
Industrial processes	3.0	2.7	2.8	2.3	2.2	2.1
Agriculture	9.1	6.8	7.1	7.4	7.5	7.3
Waste management	0.5	0.4	0.3	0.3	0.3	0.3
Total emission	**12.8**	**10.2**	**10.6**	**10.5**	**10.7**	**10.4**

caused by agricultural activities. The emission calculation under the IPCC methodology includes the application of mineral nitrogen, nitrogen from organic fertilizers, nitrogen amounts fixed by nitrogen-fixers and the amount produced by decomposition of plant residues. The highest N_2O emission comes directly from agricultural soils and includes total nitrogen amounts appearing in plant growing systems.

In the sector of industrial processes N_2O emissions come from the production of nitric acid used as a raw material in the production of mineral fertilizers. In the context of analysing measures for the reduction of N_2O emissions the possibility was investigated to use devices for non-selective catalytic reduction which would practically eliminate the impact of nitric acid production on N_2O emissions.

In the energy sector the emission was calculated on the basis of fuel consumption and corresponding emission factors. Increased N_2O emissions in the energy sector are a consequence of an ever-increasing use of three-way catalysts in road vehicles with 30 times as high N_2O emissions as vehicles containing no catalyst.

N_2O emissions from the waste sector come chiefly directly from human sewage and are calculated on the basis of the total population and annual consumption of proteins per capita. In default of data on protein consumption between 1990 and 1995, the average East European consumption was applied. The 1996-2001 data on annual consumption of proteins per capita in Croatia are available in the Statistical Database of the UN Food and Agriculture Organization (FAO).

Table 3-10: Emissions of indirect greenhouse gases and SO_2, 1990-2003 (Gg)

	1990	1995	2000	2001	2002	2003
Total NOx emissions	91.8	65.2	76.7	76.7	77.1	73.9
Power plants	18.8	14.0	16.6	17.8	20.4	15.8
Industry and construction industry	15.5	8.2	8.6	9.0	8.7	8.9
Transport	38.8	30.0	33.7	33.0	32.0	32.2
Other sectors (households, services)	17.6	12.3	17.2	16.3	15.5	16.4
Industrial processes	0.5	0.3	0.3	0.3	0.3	0.2
Fugitive emissions from fuel	0.4	0.3	0.3	0.3	0.3	0.3
Total CO emissions	435.0	255.1	285.2	240.4	226.5	230.4
Power plants	1.6	1.2	1.4	1.5	1.8	1.4
Industry and construction industry	10.9	6.5	5.8	5.4	5.4	6.5
Transport	290.5	178.5	193.4	166.4	152.3	138.9
Other sectors (households, services)	118.2	65.2	80.7	64.0	64.0	80.4
Industrial processes	13.1	3.3	3.3	2.7	2.5	2.8
Fugitive emissions from fuel	0.6	0.5	0.5	0.4	0.4	0.4
Total NMVOC emissions	525.0	285.5	236.7	195.2	317.9	446.1
Power plants	0.5	0.4	0.4	0.4	0.5	0.5
Industry and construction industry	0.8	0.4	0.4	0.4	0.4	0.4
Transport	54.8	32.6	31.6	28.3	25.8	22.3
Other sectors (households, services)	14.8	8.4	10.5	8.5	8.4	10.4
Industrial processes	419.4	212.9	165.3	130.6	245.8	373.5
Fugitive emissions from fuel	4.3	3.4	3.3	3.0	3.1	3.0
Solvents use	30.4	27.4	25.2	23.9	33.9	36.0
Total SO_2 emissions	191.6	82.0	73.5	68.8	74.6	75.7
Power plants	96.0	44.1	37.3	31.1	31.2	33.8
Industry and construction industry	53.6	18.1	15.1	18.8	21.5	19.0
Transport	7.6	6.0	6.0	4.9	6.3	7.4
Other sectors (households, services)	21.7	4.2	5.8	6.2	7.6	7.6
Industrial processes	6.3	4.7	4.4	3.3	3.5	3.3
Fugitive emissions from fuel	6.4	5.1	4.9	4.6	4.6	4.5

Table 3-11: Qualitative analysis of uncertainty

High degree of certainty:
- CO_2 emission from combustion of fuel
- CO_2 emission from purification of natural gas (scrubbing)
- CO_2 emission from industrial processes (cement and ammonia production)

Medium degree of certainty:
- CH_4 emission from combustion of fuels
- CO_2 emission from industrial processes (lime production, use of limestone and dolomites, production and use of Na_2CO_3, production of iron, steel, ferroalloys, aluminium)
- CH_4 emission from industrial processes (production of other chemicals)
- N_2O emission from industrial processes (production of nitric acid)
- N_2O emission from human sewage

Low degree of certainty:
- N_2O emission from combustion of fuel
- Fugitive CH_4 emissions from coal
- Fugitive CH_4 emission from natural gas, oil and oil derivatives
- HFC emission due to HFC consumption
- CH_4 emission from enteric fermentation
- CH_4 and N_2O emissions from stable manure management
- N_2O emission from agricultural soils
- CH_4 emission from municipal waste disposal

3.3.5 Fluorinated Gasses

Synthetic greenhouse gases are perfluorocarbons and hydrofluorocarbons (PFCs and HFCs) and sulphur hexafluoride (SF_6). Despite their low emissions in absolute terms, their contribution to global warming is considerable due to a high greenhouse potential.

On the basis of HFC import and export data provided by the Ministry of Environmental Protection, Physical Planning and Construction the emission inventory is expressed in Gg CO_2 eq and shown in Table 3-3.

3.3.6 Indirect Greenhouse Gas Emissions

Photochemically active gases such as carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOCs) contribute indirectly to greenhouse effect.

They are called greenhouse gases or ozone precursors, because they participate in the formation and depletion of ozone which is also one of the greenhouse gases. As a

Table 3-12: Key sources of emission

IPCC category of sources	Greenhouse gas	Criterion Level/Trend
ENERGY		
Stationary sources - coal	CO_2	Level, Trend
Stationary sources – liquid fuel	CO_2	Level, Trend
Stationary sources – natural gas	CO_2	Level, Trend
Stationary sources – all fuels	CH_4	Trend
Mobile sources – road transport	CO_2	Level, Trend
Mobile sources – domestic air transport	CO_2	Trend
Mobile sources – agriculture/forestry/fisheries	CO_2	Level, Trend
Mobile sources – road transport	N_2O	Trend
Fugitive sources – natural gas, oil and oil derivatives	CH_4	Level, Trend
Natural gas purification – GTS Molve	CO_2	Level, Trend
INDUSTRIAL PROCESSES		
Cement production	CO_2	Level, Trend
Ammonia production	CO_2	Level
Ferroalloys production	CO_2	Trend
Nitric acid production	N_2O	Level, Trend
AGRICULTURE		
Enteric fermentation in ruminants	CH_4	Level, Trend
Fertilizer management	N_2O	Level
Direct N_2O emission from agricultural soils	N_2O	Level, Trend
Indirect N_2O emission caused by agricultural activities	N_2O	Level
WASTE		
Municipal waste landfills	CH_4	Level, Trend

sulphate and aerosol precursor, sulphur dioxide (SO_2) is considered to have a negative impact on the greenhouse effect (the so-called cooling effect).

The inventory of emissions of indirect greenhouse gases and SO_2 is shown in table 3-10.

3.4 Emission Inventory Uncertainty

The estimation of inventory uncertainty is one of the essential elements of the national inventory of emissions. The information on uncertainty does not question the inventory accurateness, but rather helps both in identifying priority measures to enhance the inventory accurateness and in selecting methodological options.

There are several reasons why actual emissions and sinks differ from inventory values. The total estimated uncertainty of emissions from individual sources is a combination of individual uncertainties of emission estimation elements: uncertainty with regard to emission factors (references or measurement) and uncertainty with regard to data on activities.

The reliability of inventories of individual emissions from specific sectors/sub-sectors is shown qualitatively in Table 3-11 and classified into several degrees: up to ±10% – a high degree of certainty, from ±10 to ±50 – medium degree of certainty and over ±50% - low degree of certainty.

3.5 Key Sources of Emission

The Parties included in Annex I to the Convention must identify their key sources of emission for the base year, for the last inventory year and for the emission trend.

Key sources of emission are those that contribute considerably to total emissions of greenhouse gases (95%), whereby all emissions are summed up starting from the major source to less important sources.

Table 3-12 shows key sources of greenhouse gas emissions in Croatia identified by analysing the total emission of the last year covered by the balance (*Level Assessment*) and by analysing the trend (*Trend Assessment*) in conformity with the methodology described in the "*Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*".

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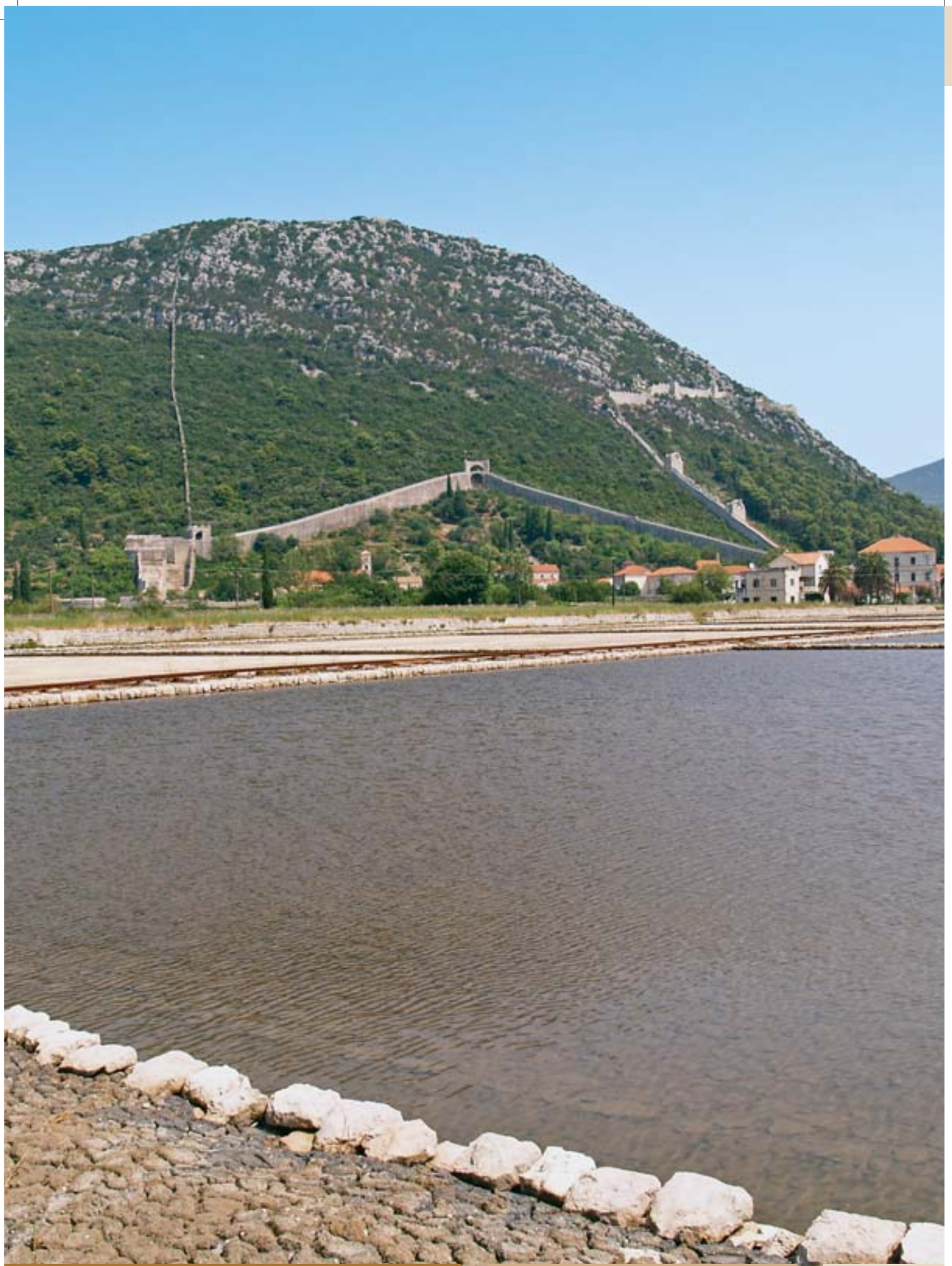
4. Policy and Measures



The salt pans and walls in Ston

4.1 Introduction

In the period between 2002, when the Croatian First National Communication on Climate Change was submitted to the Secretariat of the Convention, and 2006, the Parties to the Convention intensified activities of addressing climate changes at the international level, which eventually resulted in the coming into force of the Kyoto Protocol on 16 February 2005.

At the same period, and especially after acquiring the status of the EU candidate country, Croatia started the process of harmonizing the national legislation – including that of the environmental protection and energy sector – with the EU *acquis communautaire*, which will, in the forthcoming period and despite the complexity of the process, undoubtedly help in defining a common and co-ordinated policy and measures for mitigation of climate changes and accelerate their implementation.

At the same time Croatia continued negotiating with the international community about allowing of flexibility according to Article 4.6 of the Convention with regard to the emission level of the base year. Croatia's main view is that the existing emission of greenhouse gases in 1990, selected for the base year, does not reflect specific circumstances relating to Croatia's involvement and role in the common economic and particularly energy system of the former Yugoslavia. The non-allowing of flexibility that the majority of countries with economies in transition have taken advantage of, puts Croatia more than thirty years back, for example, in the segment of security of electricity supply only, which is unacceptable from the aspect of a planned economic development.

In conformity with recommendations of the First National Communication, the Ministry of Environmental Protection, Physical Planning and Construction initiated the activities of capacity-building of the system and establishment of necessary institutional, legislative and organizational capacities as defined in the draft National Programme for Mitigation of Climate Changes.

The key political document intended to define the position, objectives and manners of implementing the commitments under the Convention and the Kyoto Protocol is the *Strategy and Action Plan for Mitigation of Climate Changes in the Republic of Croatia,* scheduled for adoption by the end of 2006.

From the institutional aspect, the Environmental Protection and Energy Efficiency Fund was established in 2003 with the aim to secure necessary finance for projects and programs in the field of environmental protection, energy efficiency enhancement and wider utilization of renewable energy sources.

Croatia is undoubtedly facing a highly active and relatively short period of time in which the policy and measures for adaptation to the requirements under the Convention and particularly under the Kyoto Protocol are to be adopted and launched, provided that the decision on its ratification is taken.

In this connection the National Communication plays an important role, because it provides a systematic overview of the applied, adopted and/or planned policy and measures aiming at the reduction of greenhouse gas emissions and increase of removal by sinks.

This chapter presents the policy and measures with the direct or indirect objective to reduce emissions of greenhouse gases or to increase removal by sinks. In the first part the general and development policy and the fundamental legislative framework of environmental protection in Croatia are outlined. In the second part the policy and measures by sectors of influence, the intersectoral policy and relevant project activities are described.

4.2 General and Development Policy

The policy and measures for mitigation of climate changes cannot be effectively implemented if isolated from the general and development political framework, primarily due to their marked cross-sector impact. In the course of developing the National Communication the Croatian Government adopted the *Strategic Framework of Development from 2006 to 2013* and the *National Programme of the Republic of Croatia for the Accession to the EU*, which may be considered relevant to this communication and which define medium-term and long-term priority strategic objectives of the Republic of Croatia.

The Central Government Office for Development Strategy and Coordination of EU Funds prepared a document entitled the *Strategic Framework of Development from 2006 to 2013*. This document represents the general framework of Croatia's development in the following areas: human resources, knowledge and education, infrastructure, information linkage and social cohesion, macroeconomic stability, efficient financial market and sustainable development, all this accompanied by an entrepreneurial climate, restructuring and a new role of the state undergoing the transformation into an effective and efficient service to citizens and entrepreneurs. For each area specific objectives have been established, including measures and activities to be undertaken for the purpose of their accomplishment and reaching the fundamental strategic goal: growth and employment in a competitive market economy operating in the European social state of the 21st century.

From the aspect of economic development, the main objectives expressed through macroeconomic indicators are as follows:

- to raise the average GDP growth rate in real terms over the next seven years to a level of 6% p.a., or specifically by 5.1% from 2006 to 2009 and by 7% p.a. from 2010 to 2013;
- to keep the inflation low within the range of 2.0-2,5% p.a.;
- to reduce the unemployment rate to less than 9% immediately after the EU accession;
- to further increase the ratio of the net foreign capital inflow to the GDP, especially the ratio of the direct to portfolio investments;

- to stop the growth of foreign debt at the current level and
- to keep the public debt/GDP ratio permanently below 60%.

The strategic framework of the development emphasizes the integration of environmental concerns into all forms of political, economic and other activities, which means that environmental protection must be an integral dimension of the development of infrastructure, energy, agriculture and industry.

The legislative and other measures should promote energy efficiency in all segments of energy consumption and increase the use of the solar, wind and biomass energy. At the same time, due to a high dependence on imported energy, it is necessary to increase electricity generation capacities, replace the worn-out facilities and diversify energy supply routes in accordance with environmental protection restrictions.

Considering the general policy, the achievement of the full membership in the European Union is one of the priority objectives of the Republic of Croatia in the forthcoming period, as set out in the Programme of the Government of the Republic of Croatia in its term of office from 2003 to 2007.

The accomplishment of this objective requires the meeting of political, economic, institutional and legal criteria set by the EU, which is in progress through implementation of a number of internal structural reforms in the areas mentioned. For the purpose of planning and implementing this process the Ministry of Foreign Affairs and European Integration develops a *National Programme for the Accession of the Republic of Croatia to the EU* on a yearly basis.

This comprehensive document gives an overview of the status of individual areas and defines priorities, short-term objectives, time frames of implementation and implementing agencies, thus defining eventually a large portion of the policy and measures detailed in the following sections.

Energy and environment are key sectors in the context of climate changes in which the process of harmonizing the legal framework with the relevant EU legislative framework is underway. In the energy sector the harmonization process is expected to be completed by the end of 2006 and in the environmental sector by the end of 2007.

4.3 Environmental Policy in the Context of Mitigating Climate Change

In the Republic of Croatia executive and legislative bodies participate in the process of adopting and implementing the environmental policy with clearly apportioned responsibilities.

The Ministry of Environmental Protection, Physical Planning and Construction have a key role in creating the policy in accordance with the strategic priority objectives of environmental protection and in drafting bills and enforcement regulations. In the previous period a legislative framework was established laying down the principles, objectives and methods of implementing environmental protection in all of its components. It is presently undergoing the process of alignment with the EU legislation. Administrative and specialized activities relating to implementation of measures for climate protection fall within the competence of the Department for Atmosphere Protection and are operationally carried out by the Section for the Climate and Ozone Layer Protection.

The Environmental Protection Act (Official Gazette Nos. 82/94, 128/99) is the basic law regulating general issues of environmental protection in the Republic of Croatia, which includes objectives, principles and implementation methods, as well as the liability for environmental pollution. This law provides for the preparation of environmental protection documents and subordinate legislation for each individual area of influence. New Environmental Protection Act is under preparation.

The National Environmental Protection Strategy and the *National Environmental Action Plan* (Official Gazette No. 46/02) are documents intended to enable an integrated, effective and efficient implementation of environmental protection in the Republic of Croatia. The Strategy highlights two processes of vital impact on environmental protection in Croatia: the adaptation to the sustainable development concept and the EU accession process. The Strategy establishes short-term and long-term environmental protection objectives and priority issues. Climate changes belong to the second priority group due to the fact that there are issues at the national level that have been neglected for many years and therefore must be addressed promptly and be given priority, such as waste and wastewater management and air quality in urban areas with excessively polluted air.

The Action Plan elaborates objectives established by the Strategy by sectors and thematic units or rather sets out the measures for the accomplishment of objectives, responsibilities and time frames for implementation. In the segment relating to climate changes the Action Plan envisages the development of the Programme for the Reduction of Greenhouse Gas Emissions and the conditions and rules for the application of flexible mechanisms of the Kyoto Protocol. A number of measures for the reduction of greenhouse gas emissions have been determined too, relating primarily to energy efficiency enhancement and increasing the share of renewable energy sources.

The Air Protection Act (Official Gazette No. 178/04) determines measures and methods of organizing the implementation and control of air quality protection and improvement. The Act provides for the development of the Strategy and Plan for Air Quality Protection and Improvement.

The Act defines the methods of monitoring and determining the air quality, emissions and emission sources; measures for the prevention and reduction of pollution affecting among other things the climate change; activities of monitoring the air quality and emissions in the atmosphere; air quality information system; sources of funds for financing air quality protection and improvement; and economic incentives, administrative control, inspection and penalty regulations.

The Air Protection Act provides following mechanisms and instruments for the prevention and reduction of pollutions that affects the climate change, including:

- National allocation plan for greenhouse gas emission allowances trading;
- National greenhouse gas emission registry;
- flexible mechanisms of the Kyoto Protocol

Pursuant to the *Act on Environmental Protection and Energy Efficiency Fund* (Official Gazette No. 107/03) the Environmental Protection and Energy Efficiency Fund was established, with the aim to finance preparation, implementation and development of programs and projects in the field of environmental protection, energy efficiency and use of renewable energy sources, including mitigation of climate changes. The Fund has been operating since 1 January 2004. The necessary finance is secured from revenues raised by charges on environmental polluters, which includes charges on the emission of nitrogen oxides, sulphur dioxide and carbon dioxide (in preparation), charges on users of the environment, on environmental load by waste and special environmental charges on motor vehicles. In 2005 the Fund raised the revenues of 214.7 million kunas. It invested 26.6 million kunas for projects and programs of energy efficiency and renewable energy sources, 2.1 million kunas for national energy programs and 143.8 million kunas for landfills remediation.

From the aspect of climate protection the following subordinate acts have an indirect effect on the reduction of greenhouse gas emissions:

- *Regulation on Limit Values of Pollutant Emissions from Stationary Sources into the Air* (Official Gazette Nos.140/97, 100/04) lays down emission limit values in accordance with the best available techniques depending on the size (capacity) and type of the plant. For small combustion plants maximum heat losses are prescribed and all combustion plants must measure emissions of hazardous substances, thus identifying indirectly the energy efficiency too;
- *Ordinance on Environmental Impact Assessment* (Official Gazette Nos. 59/00, 136/04) provides for the obligation of environmental impact assessment for a number of various activities. The procedure of environmental impact assessment covers all industrial plants, power plants over 50 MW, electric power plants with non-conventional energy sources, hydropower plants, landfills and waste thermal treatment plants. The impact assessment procedure includes the public hearing and the decision on eligibility of the activity is taken on the basis of conclusions drawn by an independent expert commission appointed by the Government at the proposal of the Ministry. As a rule, the issue of CO_2 emissions is considered in case of large facilities such as thermal power plants or industrial plants with regard to the existing and future commitments;
- *Regulation on Substances that Deplete the Ozone Layer* (Official Gazette No. 120/05) provides for the phasing-out of the consumption of ozone depleting substances, the handling of such substances and products in which they are contained, methods of collection, recovery and permanent disposal of such substances. The Regulation applies also to synthetic greenhouse gases (HFC, PFC, and SF_6) and prohibits their selling, import/export and release into the air without a special permit.

Within the framework of the EuropeAid/116671/C/SV/HR project "Strategy for EU Environmental Law Approximation" the *National Strategy for Environmental Approximation* was formulated covering the horizontal legislation, air quality and climate changes, waste management, industrial pollution control and risk management. The Strategy includes the proposed framework for policy development and decision-making in the pre-accession period; an overview of proposed approximation activities and proposed priorities with the time frame for implementation of activities.

For the purpose of harmonization with the Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading, the following laws and regulations are in the process of preparation:

- Act on Ratification of the Kyoto Protocol (scheduled for 2007);
- Regulation on Monitoring Greenhouse Gas Emission in the Republic of Croatia (scheduled for the end of 2006);
- Regulation on the Procedure of Allocating Emission Allowances to Individual Sources of Pollution, the Method of Emission Allowance Trading and Procedures of Reporting and Entering into the Register (scheduled for 2007).
- National Allocation Plan (scheduled for 2008);

4.4 Sectoral Policies and Measures

This Section gives an overview of the relevant policy and measures, including project activities, in the following sectors: energy, transport, industry, agriculture, forestry and waste management.

4.4.1 Energy

Energy policy falls within the competence of the Ministry of Economy, Labour and Entrepreneurship. The main objectives of energy development in conformity with the *2002 Energy Development Strategy of the Republic of Croatia* (Official Gazette No. 38/02) are:

- upgrading energy efficiency;
- security of energy procurement and supply;
- diversification of energy forms and sources:
- use of renewable energy sources;
- achievement of real energy prices and development of energy market and entrepreneurship;
- environmental protection.

Croatia's energy sector reform started in July 2001 and resulted in a package of laws in the field of energy:

- Energy Act (Official Gazette Nos. 68/01, 177/04);
- Act on Regulating Energy Activities (Official Gazette No. 177/04);

- Electric Energy Market Act (Official Gazette No. 177/04);
- Oil and Oil Derivative Market Act (Official Gazette Nos. 68/01, 57/06);
- Gas Market Act (Official Gazette Nos. 68/01, 87/05) and
- Act on Generation, Distribution and Supply of Thermal Energy (Official Gazette No. 42/05).

Given new EU Directives adopted in the meantime and covering new issues in the field of energy, the above-mentioned laws were amended in 2004.

The *Energy Act* (Official Gazette Nos. 68/01, 177/04) is the basic law in the sector laying down measures for a secure and reliable supply of energy and its effective generation and use. It is a legislative act determining and underlying the energy policy and energy development planning, performance of energy-related activities either on the market or in form of public services, and basic issues of conducting energy activities taking into account environmental protection measures.

In the segment relating to energy policy and planning energy development, the *Act Amending the Energy Act* (Official Gazette No. 177/04) declares the Energy Development Strategy the basic act for setting up the energy policy and planning the energy development. The Strategy determines the use of renewable energy sources ensures environmental protection in all areas of energy-related activities and defines incentives for investing in renewable sources and cogeneration and for upgrading energy efficiency.

In conformity with the Energy Development Strategy the Government of the Republic of Croatia will initiate implementation of national energy programmes that will, among other things, secure investments in renewable energy sources and facilities for their use and in the efficient energy use accompanied by the reduction of environmental loads.

The approximation process in the area of energy efficiency, cogeneration and renewable energy sources includes the adoption and enforcement of subordinate acts based on previously specified laws and the alignment with the Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market and the Directive 2001/77/EC on the promotion of electricity production from renewable energy sources in the internal electricity market.

The Ministry of Economy, Labour and Entrepreneurship adopted the *Ordinance on Energy Efficiency Labelling of Household Appliances* (Official Gazette No. 133/05) determining which household appliances must bear the energy efficiency label and stipulating the form and contents of the energy efficiency marking on household appliances.

The *Energy Development Strategy of the Republic of Croatia* (Official Gazette No. 38/02) is a segment of the overall economic development strategy of the Republic of Croatia, covering the period until 2030. The Strategy consists of the energy-related, economic, legislative, organizational, institutional and educational dimension. The Strategy establishes energy policy objectives and measures necessary for the achievement of those objectives. The Energy Development Strategy is particularly important in light of international commitments assumed in the field of environmental protection and the adjustment of energy sector to energy management conditions in the European Union.

The Strategy considers and elaborates three energy development scenarios:

- *S1 scenario:* classic technologies, no active measures of the state; based on the assumption of a slowed down inclusion of new technologies and insufficient involvement of the state in energy sector restructuring, lack of support to energy efficiency, renewable energy sources and environmental protection;
- *S2 scenario:* new technologies and active measures of the state; the political and economic admission of Croatia into the European Union is expected, apart from good economic effects, to have also positive effects with regard to transfer of technology; the organizational level of the state is expected to reach relatively fast the level that allows an efficient and socially beneficial intervention of the state;
- *S3 scenario*: a markedly environmentally oriented scenario starting from the assumption that global problem of greenhouse effect and the sustainable development concept at the global level will cause the re-orientation of the overall worldwide industry and economy in general to markedly energy efficient technologies and renewable energy sources, including hydrogen.

One of the essential components of sustainable development is a permanent concern for enhancement of energy efficiency. Energy efficiency contributes substantially to the reduction of environmental impacts of energy sector, to employment growth and ultimately to a higher competitiveness of the overall national economy. An organized and systematic concern for energy efficiency in Croatia will be implemented through national energy programmes covering key areas of production, transmission, transport, distribution and consumption of energy whose efficiency may be upgraded.

In 1997 the Government of the Republic of Croatia adopted the Decision on Launching the Project of National Energy Programs within the framework of the Development Program and Organization of Croatian Energy Sector (PROHES). The project was launched with the aim to establish such an energy management system which would especially promote clean technologies, gas grid development, energy efficiency, use of renewable sources and environmental protection. The project execution is based on implementation of 12 programs, each of them addressing a specific area of energy management and underlying the organized and systematic care of energy efficiency and use of renewable energy sources.

The first concrete results of promoting the usage of renewable energy sources in Croatia are seen from the examples of the Ravna 1 wind farm, with the installed production capacity of 5.9 MW constructed and put into commercial operation on the island of Pag late in 2004, and the Trtar-Krtolin wind farm with the installed production capacity of 11.1 MW in the Šibenik hinterland, which will be completed in 2006.

The first 2-MW landfill-gas-fired power plant in Croatia was put into operation on the remedied municipal waste landfill of Prudinec (Jakuševac). The Croatian Electric Power Industry entered into long-term contracts with the owners of the facilities mentioned relating to the collection of electricity generated and its distribution to the market.

The Croatian Electric Power Industry (HEP) continued developing and investing in renewable energy sources and cogeneration units. Furthermore, all HEP hydropower plants (a total of 25 hydropower plants with the capacity of 2,078 MW) have been awarded certificates of production using renewable energy sources and thus classified among large-scale certified producers of renewable energy in Europe. Besides, a highly efficient natural-gas-fired combined cycle cogeneration power plant with electricity production capacity of 202 MW and thermal energy production capacity of 150 MW was put into commercial operation in Zagreb in 2003.

Project Activities in the Process of Implementation

• Energy Efficiency Promotion Project

This 4-year project of the Ministry of Economy, Labour and Entrepreneurship and the United Nations Development Programme (UNDP) was launched in July 2005 with the principal objective to promote application of energy efficient technologies and procedures in Croatia's sectors of households and services so as to reduce energy consumption and the related emissions of greenhouse gases.

The project is financed by the Global Environmental Facility (GEF) with the amount of 4.4 million US$ and by domestic financial institutions with the amount of 7.9 million US$. The project target groups are households, service trade facilities and public facilities accounting for 40% of the total energy consumption in Croatia. In 2006 two pilot projects of upgrading energy efficiency started: "A Systematic Energy Management in Towns – the town of Sisak" and "Put Your House in Order".

• Energy Efficiency Project

The Energy Efficiency Project for Croatia was initiated by the International Bank for Reconstruction and Development (IBRD) and the Global Environmental Facility (GEF) in collaboration with the Croatian Electric Power Industry (HEP) and the Croatian Bank for Reconstruction and Development (HBOR).

The project objective is to increase the consumers' demand and the market-based supply of services and energy efficiency projects. For this purpose HEP established a company for the provision of energy services (HEP ESCO) responsible for preparation, funding and implementation of energy efficiency projects, using domestic companies as main suppliers. The total project value, including the share of domestic banks, is estimated at 40 million US$ during 6 years of implementation. HEP ESCO was granted a loan by the World Bank to the amount of 4.4 million EUR and received a GEF grant of 5 million US$. The project beneficiaries are owners and tenants of various types of buildings, thermal energy consumers, construction industry associations, manufacturers of construction equipment and materials, contractors for reconstruction of buildings, local offices for public lighting, etc. HEP ESCO is currently running more than 50 projects in the area of public lighting, building construction, industry and energy supply systems at various stages of development, execution and funding.

4.4.2 Transport

The Transport Development Strategy of Croatia (Official Gazette No. 139/99) identifies environmental improvement and preservation of ecological balance as some of the main objectives of the transport system development. The document insufficiently highlights ecological determinants of the transport development, i.e. the need for a sustainable development of the transport sector, although it mentions the need to develop combined transport as one of the environmental protection measures.

The Public Roads Construction and Maintenance Program for the Period 2005-2008 (Official Gazette No. 3/05) states in the introductory section that, in addition to traffic safety, account should also be taken of environmental preservation criteria.

A special environmental charge for motor vehicles was introduced on 1 March 2004 by the *Regulation on Unit Charges, Corrective Coefficients and Detailed Criteria and Benchmarks for Determination of the Special Environmental Charge for Motor Vehicles* (Official Gazette No. 02/04). Legal and physical entities as motor vehicle owners pay the charge to the Environmental Protection and Energy Efficiency Fund. The amount of the charge is determined according to the type of vehicle, engine properties and the type of drive and is payable when registering or rather verifying road-worthiness of the vehicle in stations for technical inspection of vehicles. In 2005 the Environmental Protection and Energy Efficiency Fund earned 196.3 million kunas on the account of this charge.

Testing of exhaust gases (ECO test) has been carried out within mandatory technical inspections of motor vehicles driven by a petrol engine since 18 April 2001 and of those driven by a diesel engine since 18 April 2002. In conformity with the *Ordinance on Technical Inspection of Vehicles* (Official Gazette No. 136/04) from 1 October 2004 the results obtained by ECO test affect the certification of vehicle road-worthiness. In stations for technical inspection of vehicles 1.2 million vehicles underwent testing of exhaust gases in 2005.

The Ministry of Environmental Protection, Physical Planning and Construction in collaboration with the United Nations Industrial Development Organization (UNIDO) is implementing the project "Promotion of Biodiesel Production in the Republic of Croatia", which started in September 2003 and is scheduled to be completed in 2006. The main project objective is the preparation for introduction of biodiesel production in the transport sector with the aim to reduce the consumption of imported fossil fuels and the CO_2 emission,

to ensure the supply of various energy forms and to encourage economic activities in the agricultural sector and processing industry.

The Regulation on Biofuel Quality (Official Gazette No. 141/05) lays down the limit values of quality properties of biofuel to be placed on the domestic market, the method of identifying the biofuel quality and the method of proving conformity with the standards set. The regulation defines the national indicative target for biodiesel to reach a share of 5.75% of the total volume of fuels to be put on the domestic market by 31 December 2010. Certain major towns in Croatia are investigating the possibility of introducing biodiesel as a replacement fuel for diesel in buses used for public transport. The largest progress in implementation of this measure has been made by the City of Zagreb, where the City Government adopted a decision based on a feasibility study to introduce biodiesel in public transport as of the beginning of 2007.

In 2005 the Croatian Railways started constructing a Ro-La terminal for loading the trucks on flat wagons in Spačva close to the motorway Zagreb-Lipovac on the pan-European transport corridor X. The terminal will be completed in 2006 and it is planned that on the route Spačva-Ljubljana 13,000 heavy-duty trucks will be transported by railway from the direction of Serbia and Bosnia and Herzegovina.

4.4.3 Industrial Processes

The sector of industrial processes includes production processes and fuel consumption processes in cases of a direct contact between combustion products and raw materials (e.g. cement production). Key sources of emission in this sector are cement, ammonia and nitric acid production accounting for 87% of the total emission from this sector in 2003. It should be noted that the shutdown of the Sisak Ironworks, the Šibenik Aluminium Industry and the Bakar Coke Oven Plant in the early 1990s caused by the war and the decline in economic activities further cut emissions from this sector.

In order to remain competitive on the market, the cement industry switched from natural gas and heavy fuel oil to coal and petrol coke and thus increased emissions coming from this sub-sector. The Ministry of Environmental Protection, Physical Planning and Construction ordered therefore the cement producers to develop an action programme for the reduction of greenhouse gases emissions by at least 5% compared to the current state between 2008 and 2012 and to start implementing the programme before 2008. The measures relate to upgrading energy efficiency, reducing the share of clinker in cement and using alternative fuels coming primarily from the waste.

Given the nature of ammonia production itself using natural gas, no measures, i.e. no production processes have been developed so far that would be technically feasible and cost-effective on one hand and capable of cutting emissions of carbon dioxide as the process by-product on the other. It is indeed possible to intensify the use of carbon dioxide as a raw material for mineral fertilizer production (UREA) or other products (e.g. "dry ice"), but the arrangements are still lacking as to the monitoring and verification of emission reductions. In the nitric acid production it is possible to apply the non-selective catalytic reduction to cut emissions of dinitrogen oxide (N_2O) or rather its reduction to N_2 with an efficiency degree ranging from 80-90%. The nitric acid producer is planning to implement this measure in the following medium-term period (2008-2012).

4.4.4 Agriculture

The agricultural policy falls within the competence of the Ministry of Agriculture, Forestry and Water Management. The basic starting point of all agricultural activities is the legislation, or rather the *Agriculture Act* (Official Gazette No. 66/01) as the basic law laying down objectives and measures of the agricultural policy that include promotion of effective production and market mechanisms in agriculture with the aim to raise competitiveness on the domestic and global market and preserve natural resources through promotion of a sustainable ecologic agricultural production.

In 2003 the total agricultural area in Croatia was 3.1 million ha or 55.6% of the total mainland area. The agricultural land-use changes over the past 10 years were caused by the war and the transition to market economy. According to the official statistics, the share of agriculture in the total gross domestic product has dropped recently, mostly as a result of the drop in the number of all types of domestic animals.

At present Croatia has approximately 700,000 CH (CH = conditional head of livestock, a hypothetical animal weighing 500 kg), with the load per 1 ha of agricultural land amounting to 0.22 CH, which places Croatia close to the bottom of the European scale. The drop in the livestock number in Croatia correlates with the drop in the consumption of organic fertilizers: from 16 million tonnes in 1991 to less than 10 million tonnes in 2001.

The consumption of mineral fertilizers in Croatia varies between 400,000 and 500,000 tonnes yearly, which is slightly below the 1991 consumption. The amount of fertilizers per unit of agricultural land is some 253 kg/ha of arable land.

The measures to reduce emissions of greenhouse gases in the agricultural sector of Croatia include:

- improvements in use of organic and mineral fertilizers in order to reduce N_2O emissions such as reduction in fertilization by nitrogen, increase in its utilization and introduction of a system to include this plant feed into the economy balance;
- measures to enhance carbon uptake by agricultural soils, such as the way of using the soil to change the organic matter content, crop rotation and the organic matter content in the soil, impact of fertilization on the organic matter content, use of lime materials and soil cultivation (*no-tillage*, minimum cultivation, areas lying fallow);
- use of stable manure for the production of biogas and electricity.

4.4.5 Forestry

The forestry policy falls within the competence of the Ministry of Agriculture, Forestry and Water Management. *The Forestry Act* (Official Gazette No. 140/05) regulates the growing, protection, use and management of forests and forest land as a natural resource. According to one of the most important provisions of this law in the context of climate protection, forests must be managed in conformity with the sustainable management criteria, implying the maintenance and enhancement of forest ecosystems and their contribution to the global carbon cycle.

Considering the current state of affairs in the Croatia's forestry, the modalities of management and the habitat and structural conditions of the forests, the rise in the carbon stock of forests may be achieved by:

- increasing carbon stocks in existing forests;
- increasing efficiency of timber use and
- increasing exploitation of forests and using growing stock as a replacement for fossil fuels.

Afforestation measures on the existing accessible forest soils have a large potential and ecological and social benefit, but cannot be of any major effect in the first commitment period of the Kyoto Protocol from 2008 to 2012.

In the context of measures for the reduction of greenhouse gas emissions from renewable energy sources, the use of forest biomass (firewood, bark and logging residues) has the largest potential. In Croatia 60-70% of the growing stock of mature and 50% of younger components are exploited in the classic manner and large quantities of scrap wood are generated by the wood processing industry.

The forest biomass as a form of energy is estimated at 1.3-4.1 million m^3. In 2002 the Croatian Forests launched the program of using forest biomass as an energy form and plan to install 16 biomass-fired district heating plants in 16 Forest Administrations. The first central heating system with a 1-MW biomass-fired boiler was installed in Ogulin in 1995, the second forest biomass-fired district heating plant was put into operation in Gospić in 2005 and further pilot-projects are planned in Delnice, Našice and Đurđevac. By using 1 million m^3 of forest biomass in Croatia, the use of fossil fuels would be cut by some 0.2 million t/year and the carbon dioxide emissions by some 0.75 million t/year, accompanied by the growth of employment and revenues.

The role of forest management in implementation of the objectives of the Convention and the Kyoto Protocol is of vital importance, considering particularly the function of forests as a carbon sink. Here mention should be made of Articles 3.3 and 3.4 of the Kyoto Protocol defining activities in the forestry sector. Article 3.3 provides that changes in greenhouse gas emissions and removals by sinks resulting from human-induced forestry activities, afforestation, reforestation and deforestation since 1990 and measured as verifiable changes in carbon stocks will be used to meet the commitments of Parties included in Annex I in each commitment period. Article 3.4 provides that prior to the first session of the COP/MOP, or rather prior to 31 December 2006, each Party included in Annex I shall provide data needed to establish its level of carbon stocks in 1990 and to enable the estimate of its changes in carbon stocks in subsequent years. The Conference of Parties shall after that decide upon modalities as to how and which human-induced activities related to changes in greenhouse gas emissions in the forestry sector will be added to or subtracted from the amounts assigned to Parties included in Annex I. This decision will apply in the second and subsequent commitment periods. Afterwards Parties to the Protocol may decide to apply such a decision to the first commitment period, provided that these activities have taken place since 1990.

4.4.6 Waste Management

The waste management policy falls within the competence of the Ministry of Environmental Protection, Physical Planning and Construction. The basic law of this sector is the *Waste Act* (Official Gazette Nos. 178/04, 153/05) regulating the way of managing waste: waste management principles and objectives, planning documents including the waste management strategy, competences and responsibilities relating to waste management, costs, information system, requirements to be met by facilities used for waste management, the method of performing activities, transboundary movement of waste, concessions and waste management control.

The Waste Management Strategy of the Republic of Croatia (Official Gazette No. 130/05) adopted in 2005 established the framework for Croatia to reduce the waste generation and to manage the generated waste in a sustainable manner.

The Strategy defines the management of various types of waste on the territory of the Republic of Croatia, from its generation to final disposal according to the following principles:

- waste management hierarchy (priority is given to avoiding and reducing waste generation and reducing its hazardous properties; if waste generation can neither be avoided nor reduced, waste must be re-used – recycled and/or recovered; reasonably unusable waste must be permanently deposited in an environmentally friendly way);
- use of best available technologies with regard to costs and ecological acceptability;
- manufacturer's liability;
- independence and vicinity;
- support to approaching and joining the EU;
- polluter pays principle.

The Strategy defined main waste management objectives for the period 2005-2025:

- establishment of an integrated waste management system;
- remediation and closure of existing landfills;
- remediation of environment highly polluted by waste – hot spots;

- development and establishment of 21 waste management centres, including waste pre-treatment prior to final disposal or deposition;
- establishment of a waste management information system.

The Strategy defined also quantitative objectives including the assumed time-lags with respect to relevant EU legislation as shown in Table 4-1:

By 2025 the organized collection of municipal waste is planned to cover the total population, the amount of recycled and treated municipal waste is planned to grow considerably and the amount of deposited municipal and biodegradable waste to drop. Although not expressly stated, the impact of waste management on climate changes is an indirect strategic goal, since the concept of an integrated waste management contributes to the reduction of methane emissions from landfills.

As regards economic instruments of waste management, charges for environmental load by waste were introduced and their collection started in 2004. According to the 2005 *Ordinance on Packaging and Packaging Waste* (Official Gazette Nos. 97/05, 115/05) the manufacturers pay a waste disposal charge, a refundable charge for disposable beverage containers and an incentive charge. A deposit system is also introduced under which the shops pay a refundable charge of 0.50 kunas to consumers for each packaging unit returned.

The Ordinance on Waste Tyre Management (Official Gazette No. 40/06) defines the system of disposal of all waste tyres in the area of Croatia and determines charges to be paid by manufacturers and importers of tyres or rather products containing tyres as components. When recovering waste tyres priority is given to recycling over the use for energy purposes. *The Ordinance on the Waste Oils Management* (Official Gazette No. 124/06) is adopted too. Scheduled for the adoption in 2006 are also: *The Ordinance on End-of-Life Vehicles Management*, and *The Ordinance on Waste Batteries and Accumulators Management.*

4.5 Cross-Sectoral Policies and Measures

The most important result of joint implementation of environmental and energy policies is the establishment of the *Environmental Protection and Energy Efficiency Fund* in 2003 with the aim to finance programmes, projects and similar activities in the field of environmental protection, energy efficiency and renewable energy sources. This includes particularly:

- mediation in funding environmental protection and energy efficiency provided by foreign countries, international organizations, financial institutions and bodies as well as domestic and foreign legal and physical entities;
- keeping a database on programmes, projects and similar activities in the field of environmental protection and energy efficiency, including necessary and available financial resources for their implementation;
- promotion, establishment and implementation of cooperation with international and domestic financial institutions and other legal and physical entities to secure necessary finance for environmental protection and energy efficiency in accordance with the National Environmental Protection Strategy and the National Environmental Action Plan. the Energy Development Strategy and the Implementation Program for the Energy Development Strategy, national energy programmes, other programmes and documents in the field of environmental protection and energy efficiency, and international treaties to which the Republic of Croatia is a party.

The Croatian Environment Agency was founded by the Regulation adopted by the Government of the Republic of Croatia (Official Gazette No. 75/02) in June 2002 as an agency centrally responsible for collection and consolidation of environmental data at the national level, for keeping databases, monitoring the state of the environment and environmental reporting. The Agency provides government bodies, the Government and the Parliament with all information necessary for an efficient implementation of environmental policy; it develops and coordinates a unique information system for monitoring the state of the environment and prepares reports on the environment, tendencies, implementation of the policy on performance of instruments in priority issues of environmental protection and priority sectors. The Agency's organizational setup includes a department for air and climate changes responsible for expert activities relating to the monitoring of greenhouse gas emissions and is appointed as the administrator of the National Greenhouse Gas Emissions Registry.

Within the UNDP/GEF project "Climate Change Enabling Activity; Additional Financing for Capacity Building in Priority Areas" the *Report on Assessment of the Need for Transfer of Technologies for the Reduction of Greenhouse Gas Emissions*

Table 4-1: Quantitative objectives for waste amounts (%)

Objectives	2010	2015	2020	2025
Population covered by organized municipal waste collection	85	90	95	99
Amount of separately collected and recycled municipal waste	8	12	18	25
Amount of treated municipal waste	10	20	25	30
Amount of deposited municipal waste	80	68	58	45
Amount of deposited biodegradable municipal waste within the amount generated in 1995	85	75	55	35

was prepared as the initial step in the technology transfer process. Within the context of project implementation workshops were organized covering thematic areas of energy efficiency and renewable energy sources, agriculture and waste management. The purpose of these workshops was to establish a common framework and criteria for identification of measures and activities for transfer of technologies and identification of main barriers to the process of technology transfer.

Basic criteria and their objectives as to the selection of priorities among 39 measures for the reduction of greenhouse gas emissions in all sectors are:

- development benefits: they define technologies for mitigation of and adaptation to climate changes that are of the highest benefit (value) to the achievement of national development priorities;
- application potential: it defines the technology application degree that may be achieved if main barriers are overcome;
- contribution to objectives of the climate change policy: it defines technologies that are main contributors to the reduction of greenhouse gas emissions.

Priority measures (technologies) for the reduction of greenhouse gas emissions as identified by this national communication are:

- wind power plants;
- use of biomass for generation of thermal energy;
- improvement of thermal insulation and energy efficient construction;
- use of biomass in cogeneration;
- increased use of biodiesel.

According to the results of the vulnerability analysis there are two additional measures that might also be considered in the process of technology transfer:

- non-selective catalytic reduction of N_2O in the production of nitric acid;
- thermal treatment of waste including energy generation.

Great deal of these measures will prove the effectivity during the second commitment period for reduction of greenhouse gas emissions, after year 2012.

Following the recommendations of the First National Communication, the Ministry of Environmental Protection, Physical Planning and Construction initiated activities of the system capacity-building and establishment of institutional, legislative and organizational capacities. Implementation of the project "Capacity Building for Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol in the Republic of Croatia" co-funded by the European Commission LIFE-Third Countries project started in 2004.

This comprehensive project includes all key components of the system of capacity building for implementation of international treaties:

- assessment of the needs for capacity building of the system for implementation of the Convention and the Protocol;
- formulation of the strategy and action plan for mitigation of climate changes in the Republic of Croatia;
- drafting subordinate legislation for implementation of the Convention and the Protocol;
- drawing up technical and economic guidelines for the preparation of sectoral operational programmes for the reduction of greenhouse gas emissions;
- establishment of a mechanism for monitoring the greenhouse gas emissions;
- capacity building for application of flexible mechanisms under the Kyoto Protocol.

The key political document intended to define the position, objectives and methods of fulfilling the commitments assumed under the Convention and the Kyoto Protocol is the *Strategy and Action Plan for Mitigation of Climate Changes in the Republic of Croatia,* scheduled for adoption by the end of 2006.

Wind power plant „Trtar – Krtolin" in Šibenik hinterland

5. Projections of Emissions and the Total Effects of Policies and Measures

5.1 Introduction

The First National Communication of the Republic of Croatia under the UN Framework Convention on Climate Change (2001) identified 39 measures for the reduction of emissions in all sectors.

Emission reduction potentials are values to be pursued; sometimes they are maximum achievable values and sometimes realistically feasible potentials. The fundamental criterion for the selection of priority actions, measures and adequate implementation instruments is the cost-effectiveness of a measure. As a rule, priority is given to measures entailing the lowest cost per unit of emission avoided.

5.2 Projections of Greenhouse Gas Emissions

The estimation of future trends in greenhouse gas emissions/removals was prepared to cover three various scenarios: "no measures", "with measures" and "with additional measures" representing various assumptions with respect to implemented, adopted or planned policy and measures:

- **"No measures"** scenario is based on the assumption of a slow inclusion of new technologies in the economy and on insufficient involvement of the state in the institutional and organizational reform, on the absence of support to energy efficiency and renewable energy sources, changes in industry, agriculture, forestry and environmental protection in general. However, this scenario does not imply a fully "frozen" state and continuation of the past practices; it includes certain process improvements regardless of the climate programme;
- **"With measures"** scenario is based on assumptions identical to the "no measures" scenario, with the exception of the time schedule for introduction of renewable energy sources and upgrading energy efficiency. The Energy Development Strategy is the adopted planning document. There are some thirty documents governing and supporting implementation of the Strategy, five of which relate to the use of renewable energy sources. Except the energy sector, no other sector has any strategy or documents to regulate the measures for mitigation of effects on climate change;
- **"With additional measures"** scenario starts from the assumption that climate change issues and the sustainable development concept will have a marked effect on re-orientation of the overall industry and economy of Croatia. This scenario implies the inclusion of a maximum potential of analysed emission reduction measures. Substantial effects of these measures are expected after 2010.

5.3 Total Projections of Greenhouse Gas Emissions

Total projections of greenhouse gas emissions for "no measures", "with measures" and "with additional measures" scenarios, including the commitment of the Republic of Croatia under the Kyoto Protocol, are shown in Fig. 5-1. Projections have been prepared before the adoption of decision on the level of emissions for the base year of Croatia at COP 12 in Nairobi (2006). Therefore, text and the graphic in this chapter do not include effects of this decision.

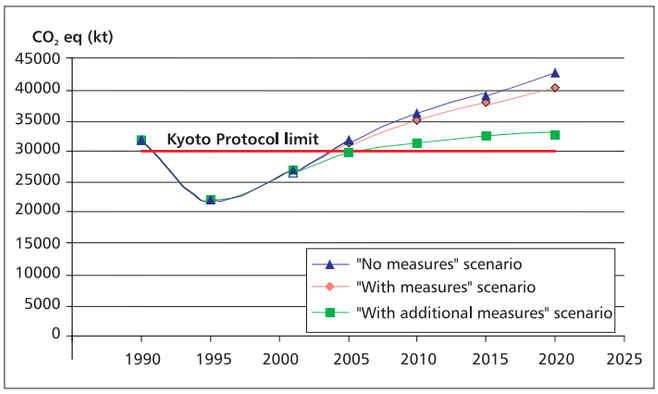


Fig. 5-1: Projections of greenhouse gas emissions in the Republic of Croatia, 1990-2020

The analyses of the scenarios mentioned show that even with the application of all additional measures Croatia will not succeed in stabilizing the greenhouse gas emissions at the level determined by the Kyoto Protocol.

According to the "with measures" scenario, in the first commitment period (2008-2012) the total emission of greenhouse gases in 2010 will exceed the commitment under the Kyoto Protocol by 5.22 million tonnes CO_2 eq or by 4.2 million tonnes CO_2 eq if forest sink of 976 kilotonnes CO_2 is included.

The "with additional measures" scenario assumes that in the same period emissions will fall by 4.8 million tonnes CO_2 eq and by 10 million tonnes CO_2 eq in 2020. This scenario, including even the use of the total emission reduction potential, exceeds the limit under the Kyoto Protocol by 1.3 million tonnes CO_2 eq and is hardly feasible.

5.4 Projections of Emission by Sectors

5.4.1 Energy

The energy sector development depends on a large number of important factors, especially on the economic growth, power sector reform and government measures, the development of international energy market and international influences, technological development and global limitations in environmental protection. Each of these factors has its own dimension of influence and the consequences will be seen in various levels of consumption and various energy generation structures. In the energy sectors three various scenarios were analysed ("no measures", "with measures", "with additional measures").

The "with measures" scenario takes into consideration total energy requirements and implementation of diverse

measures, such as the use of renewable energy sources and energy efficiency measures: wind power plants, small hydropower plants, biomass-fired cogeneration plants, fuel cells, biodiesel and hydrogen, solar and thermal energy and upgrading the heat generation efficiency. Potentials of the said measures to reduce greenhouse gas emissions by 2010 and 2020 are shown in Table 5-1.

Implementation of relevant measures has been adopted through the *Energy Development Strategy* and enforcement laws and subordinate legislation are in the process of preparation and/or adoption. Regulations concerning the use of renewable energy sources (wind, small hydropower plants, biomass and geothermal energy) will ensure their competitiveness by granting subsidies. Each energy producer will be bound to include a certain amount of renewable energy into its investment programmes and the annual revenues needed for the financial support will be earned by energy taxation.

According to major indicators for the period 2000-2020 the total energy requirements will rise by 2.0%, the CO_2 emission by 2.8 % and electricity consumption by 3.0% (Table 5-2).

The "no measures" scenario arises from the "with measures" scenario by subtracting the potential of the adopted measures to reduce greenhouse gas emissions. Despite having simulated a large number of measures in the "with measures" scenario, only those of relevance as to their reduction potentials were chosen for preparation of the "no measures" scenario (Table 5-1). The "no measures" scenario is therefore not a "frozen" scenario, which means that projections of energy requirements are not based on the current state of energy production technologies.

Similarly, the simulated gradual improvements of energy efficiency did not include any special incentive, which means that under the "no measures" scenario energy requirements will be slightly lower than indicated in the fully "frozen" scenario. Consequently, the greenhouse gas emission would be higher under the "frozen" than under the analysed "no measures" scenario.

Additional measures for the reduction of emissions were analysed in the *Energy Development Strategy* and the First National Communication underlying the development and formulation of the reduction potential of measures for energy sector and energy consumption sector (Table 5-3).

Projections of greenhouse gas emissions under above-mentioned scenarios of the energy sector development are shown in Fig. 5-2. The projections are based on the data on fossil fuel consumption contained in the Energy Development Strategy. In the projections the 2001 amount of the fugitive emission was assumed. The scenario analysis shows the increase in greenhouse gas emissions. Under "with additional measures" scenario the greenhouse gas emission will be 10.5% higher in 2010 than in 1990, and under the "no measures" scenario as much as 22.5%. It should be noted that "with additional measures" scenario includes 300 MW of installed production capacities of renewable energy sources (wind power plants, small hydropower plants and biomass-fired cogeneration plants).

5.4.2 Industrial Processes

Considering projections of emissions coming from industrial processes it was assumed that in further development no

Table 5-1: Potentials of measures for the reduction of greenhouse gas emissions in the energy sector

Emission reduction measures	2010				2020			
	CO_2 (kt)	CH_4 (t)	N_2O (t)	CO_2 eq (kt)	CO_2 (kt)	CH_4 (t)	N_2O (t)	CO_2 eq (kt)
Wind power plants	108.9	2.1	1.3	109.4	285.1	3.6	3.4	286.3
Small hydropower plants	64.2	1.2	0.8	64.4	125.1	1.6	1,5	125.6
Use of biomass in cogeneration	44.1	1.1	0.2	44.2	204.9	5.1	0.8	205.2
Fuel cells	14.0	0.3	0.2	14.0	48.8	0.6	0.6	49.0
Biodiesel and hydrogen	53.8	4.4	0.4	54.1	261.7	27.7	2.2	263.0
Solar energy	311.6	15.4	3.4	313.0	624.8	32.7	6.0	627.3
Geothermal energy	239.1	11.0	2.6	240.1	539.2	25.8	5.3	541.4
More efficient heat generation	33.7	2.7	0.5	33.9	78.6	6.5	1.2	79.1
TOTAL	**869.4**	**38.2**	**9.4**	**873.1**	**2168.2**	**103.6**	**21.0**	**2176.9**

Table 5-2: Expected rise in major indicators, "with measures" scenario

	1990	1995	2000	2005	2010	2015	2020
Total energy requirements (PJ)	408	314	370	411	453	503	552
CO_2 emission according to "with measures" scenario (kt)	20,959	15,082	17,447	21,678	24,959	27,674	30,390
Electricity consumption (GWh)	14,749	11,404	13,836	16,048	19,127	22,103	24,865

Table 5-3: Reduction potential of additional measures to reduce greenhouse gas emissions in the energy sector

Emission reduction measures	2010				2020			
	CO_2 (kt)	CH_4 (t)	N_2O (t)	CO_2 eq (kt)	CO_2 (kt)	CH_4 (t)	N_2O (t)	CO_2 eq (kt)
ELECTRIC POWER SUPPLY	**727.3**	**13.9**	**8.5**	**730.2**	**1225.4**	**15.3**	**14.5**	**1230.2**
Savings in electricity transmission and distribution	39.6	0.8	0.5	39.8	99.2	1.2	1.2	99.6
Wind power plants	451.1	8.6	5.3	452.9	762.1	9.5	9.0	765.1
Small hydropower plants	62.7	1.2	0.7	62.9	105.9	1.3	1.3	106.3
Use of biomass in cogeneration (electricity generation)	174.0	3.3	2.0	174.7	258.2	3.2	3.1	259.2
INDUSTRY	**258.8**	**12.6**	**3.4**	**260.1**	**795.6**	**19.0**	**12.2**	**799.8**
Motor drive regulation	12.2	0.2	0.2	12.3	470.7	5.9	7.4	473.1
Contribution of cogeneration plants	52.8	0.9	0.9	53.1	150.1	2.7	2.7	151.0
More efficient generation of low-temperature heat	115.2	5.4	1.1	115.7	102.1	4.8	1.0	102.5
More efficient generation of high-temperature heat	78.5	6.0	1.2	79.0	72.7	5.6	1.1	73.1
TRANSPORT	**59.4**	**4.1**	**0.5**	**59.6**	**910.2**	**70.4**	**34.5**	**922.3**
Measures in long-distance passenger transport	0.0	0.0	0.0	0.0	93.0	21.5	16.6	98.6
Measures in public passenger transport	0.0	0.0	0.0	0.0	77.0	15.4	11.9	81.0
Measures in goods transport	0.0	0.0	0.0	0.0	458.5	14.4	3.7	460.0
Increase in biodiesel use	59.4	4.1	0.5	59.6	281.6	19.2	2.3	282.7
SERVICES	**406.8**	**21.4**	**4.4**	**408.6**	**835.5**	**44.3**	**7.9**	**838.8**
Savings on electricity for non-heating purposes	14.4	0.3	0.2	14.5	32.1	0.4	0.4	32.2
Increased use of solar energy	78.5	3.9	0.8	78.8	140.2	7.3	1.3	140.7
Increased use of thermal energy	16.4	0.8	0.2	16.4	27.9	1.3	0.3	28.0
Increased use of central heating systems and cogeneration	66.8	3.6	0.7	67.1	145.6	8.0	1.4	146.2
Thermal insulation improvements	230.8	12.8	2.5	231.8	489.6	27.2	4.6	491.6
HOUSEHOLDS	**586.8**	**22.4**	**4.4**	**588.6**	**1789.2**	**87.0**	**13.9**	**1795.3**
Increased use of solar energy	28.4	1.8	0.2	28.5	286.7	21.3	1.9	287.7
Savings on electricity for non-heating purposes	12.4	0.2	0.1	12.5	192.3	2.4	2.3	193.0
Increased use of central heating systems and cogeneration	20.7	2.2	0.1	20.8	156.8	17.2	1.1	157.5
Thermal insulation improvements	73.0	2.5	0.7	73.2	376.4	18.7	3.1	377.8
Use of biomass for generation of heating energy (cogeneration + boiler houses)	452.2	15.6	3.1	453.5	777.0	27.4	5.5	779.3
TOTAL EMISSION REDUCTION POTENTIAL	**2039.1**	**74.3**	**21.2**	**2047.2**	**5555.8**	**236.1**	**83.1**	**5586.5**

additional heavy industry capacities will be installed in Croatia and that ironworks and primary production of aluminium will not be revived after the shutdown of 1991. Industrial processes with the highest share in the total emission of the sector (92%) and with a medium-term or long-term business strategy were analysed: cement, ammonia and nitric acid production. As no policy of measures for the reduction of emissions from industrial processes has been adopted in Croatia so far, the "with measures" and "no measures" scenarios coincide.

The projections of emissions "with no measures" and "with measures" coming from industrial processes assume that in the period 2005-2020 the production of selected

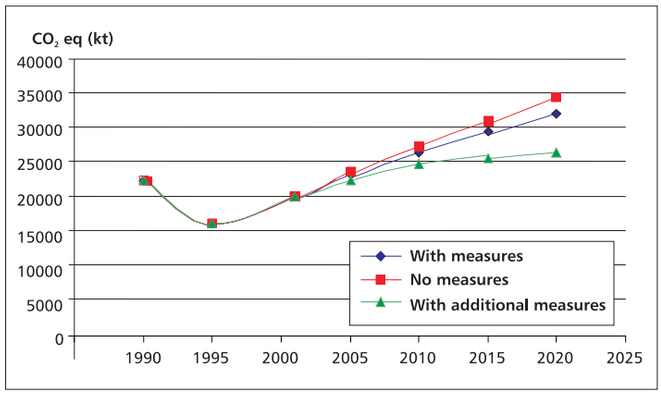


Fig 5-2: Greenhouse gas emission projections for the energy sector

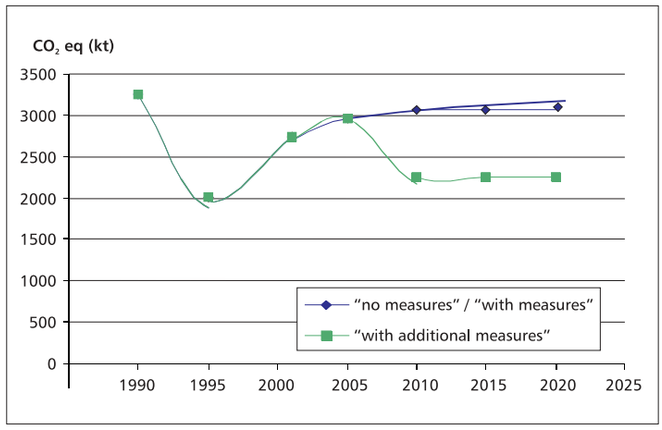


Fig 5-3: Projections of greenhouse gas emissions from industrial processes

products (cement, ammonia, nitric acid) will reach the values planned and that no measures for the reduction of greenhouse gas emissions will be implemented. For less important industrial processes it is assumed that emissions will remain at the 2001 level.

The only measure for the reduction of emissions from industrial processes considered "additional measure" is the installation of non-selective catalytic reduction in nitric acid production. This measure is included in the manufacturer's business strategy as a medium-term goal if a special charge for N_2O emission is introduced (not planned yet) or for the purpose of reaching the approved limit of greenhouse gas emissions according to the national emission scheme (still not developed). It is therefore assumed that this measure will be implemented in 2010 and that its efficiency is 85%.

Potentials of measures for the reduction of greenhouse gas emissions in the period 2005-2020 are shown in Table 5-4. Projections of greenhouse gas emissions for the scenarios analysed are shown in Fig. 5-3.

5.4.3 Agriculture

As the measures implemented and adopted in the sector of agriculture cannot be recognized, the "no measures" and "with measures" scenarios coincide.

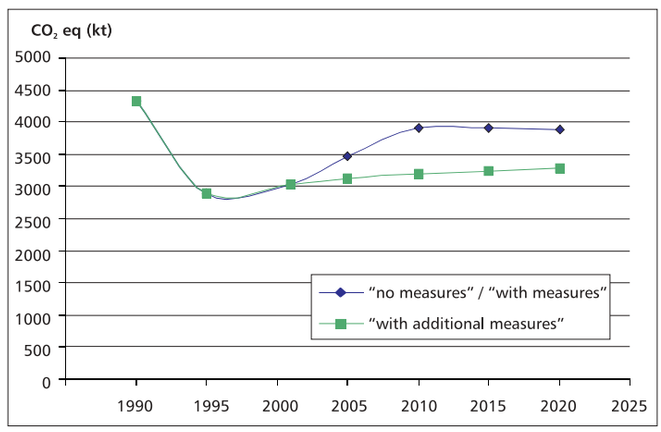


Fig. 5-4 Projections of greenhouse gas emissions for the agricultural sector

The production is focused on meeting a lower level of demand, which will be achieved under the conditions of a slower growth of purchase power and a markedly slow development of agriculture. The planned technical progress lower by 25-38% was measured by the plant production yield. The livestock breeding productivity measured by the

Table 5-4: Potentials of measures for the reduction of greenhouse gas emissions in the sector of industrial processes (kt CO_2 eq)

Scenario	1990	1995	2000	2005	2010	2015	2020
"No measures" "With measures"	3,892.4	2,020.7	2,785.0	3,026.9	3,118.5	3,118.5	3,118.5
"With additional measures"	3,892.4	2,020.7	2,785.0	3,026.9	2,300.1	2,300.1	2,300.1
Emission reduction	0	0	0	0	818.4	818.4	818.4

Table 5-5: Potentials of measures for the reduction of greenhouse gas emissions in the agricultural sector (kt CO_2 eq)

Scenario	1990	1995	2001	2005	2010	2015	2020
"No measures" "With measures"	4,320.6	2,890.7	3,035.6	3,579.2	3,92.3	3,909.7	3,899.0
"With additional measures"	4,320.	2,890.7	3,035.6	3,218.5	3,197.8	3,236.	3,281.1
Emission reduction	**0,0**	**0,0**	**0,0**	**360.7**	**722.5**	**672.8**	**617.9**

Table 5-6: Potentials of measures for the reduction of greenhouse gases in the waste sector (kt CO_2 eq)

Scenario	1990	1995	2001	2005	2010	2015	2020
"No measures" "With measures"	932.9	994.6	1,163.2	1,399.3	1,553.0	1,458.1	129.3
"With additional measures"	932.9	994.6	1,163.2	1,224.8	1,205.9	973.4	741.5
Emission reduction	0.0	0.0	0.0	174.5	347.1	484.7	552.8

liveweight gain is by some 30% lower. Production of milk per head of cattle is relatively high, because the share of larger farms is assumed to rise considerably even without any additional economic incentive (an average of 2,672 kg/year in 2020)

The growth of agricultural production according to the "with additional measures" scenario is based on the increased plant production yield. In the livestock breeding the lactiferousness is expected to increase to some 3,360 kg milk per year from about 55% dairy head of cattle on larger farms. The average rise in the livestock productivity measured by the liveweight gain is some 30% (production of pork and beef, eggs, etc.).

Potentials of measures in the period 2005-2020 are shown in Table 5-5. Projections of greenhouse gas emissions for the scenarios analysed are shown in Fig. 5-4.

5.4.4 Forestry

Measures of afforestation and a better use of forest biomass for energy purposes are the major contributors to increase of carbon stocks. Since these measures do not produce results in a short period of time and viewing the effect of implementation of the measures mentioned on the economy and the complexity of the inventory of CO_2 emissions/removals in the forestry sector, the issues of land use and forestry are widely analysed and discussed even within the framework of the Convention.

With the aim to address this problem area in the best possible way, Croatia participates in the international programme IEA Bioenergy, Task 38 "GHG Emission Balances of Bioenergy Systems".

No major effect of measures in the forestry sector is expected in the period by 2010.

The afforestation of an area of 331,000 ha of the productive unwooded forest land might result in the rise in the annual increment of 2.2 million m^3, which implies the sink increase by 2 million tonnes CO_2 per year.

5.4.5 Waste Management

Projections of emissions coming from the waste management sector include only emission balances caused by degradation of solid municipal and production waste deposited in landfills, since there are currently no plans in Croatia

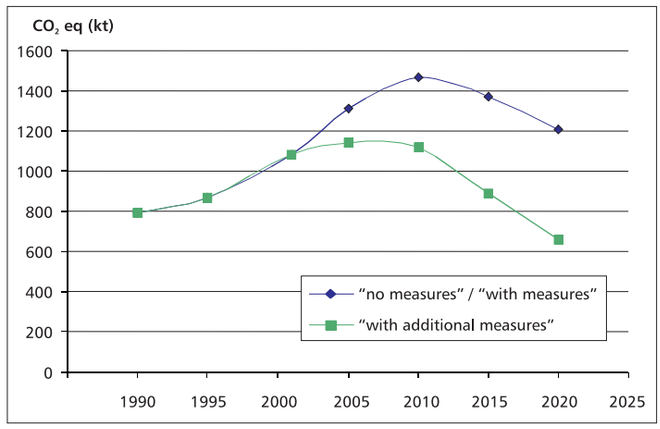


Fig. 5-5: Projections of greenhouse gas emissions from the waste sector

for application of anaerobic procedures of wastewater treatment and waste incineration without energy recovery.

As neither policy nor measures for the reduction of emissions from this sector have been adopted in Croatia so far, it is assumed that "no measures" and "with measures" scenarios coincide.

Projections of emissions coming from solid waste disposal according to "no measures" and "with measures" scenarios start from the assumption that amounts of municipal solid waste would constantly rise as a result of the growth in the living standard, but this rise would gradually decline due to effects of measures undertaken to avoid/reduce and recycle waste.

In the period 1990-2000 the amounts of waste were increasing 2.7% per year on average. The increase between 2001 and 2010 is estimated at 1.5-2.5% and between 2011 and 2020 at 1-2%. Projections "with additional measures" include the construction of power plants where waste will be burnt as an alternative fuel.

According to present plans for the construction of the first solid waste incinerator it is envisaged that 20% of the total amount of waste will be incinerated in 2010 and 40% in 2020.

Potentials of measures for the reduction of greenhouse gas emissions in the period 2005-2020 are shown in Table 5-6. Projections of greenhouse gas emissions for the scenarios analysed are shown in Fig. 5-5.

6. Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

Kitaibeli's columbine (*Aquilegia kitaibelii*)

6.1 Global Climate Change

Meteorological data confirm that the Earth's global temperature has been rising since the beginning of the 20th century. There are two main periods of warming: 1910-1945 and 1976-2000, with deviation from the average being twice higher in the second period. The warmest year at the global level (since the start of instrumental measuring in 1861) was 1998 when the El Niño effect caused the temperature rise of 0.54°C. The second warmest year was 2005 with a temperature exceeding by 0.48°C the long-time average of 14°C (1961-2000).

The present climate change is mostly attributed to human activities. The warming observed is connected with the rise in the greenhouse gas concentration in the atmosphere. So the carbon dioxide concentration increased by 35% as compared to the pre-industrial era (1750-1850), from 280 ppm in 1750 to 368 ppm in 2003, the concentration of methane by 151% and that of nitrous oxide by 17%. Over the last 200 years more than 2.3 trillion tonnes CO_2 resulting from fossil fuel combustion and land-use change were emitted into the atmosphere. Major sources of greenhouse gas emissions by sectors at the global level are electricity and heat generation (24.6%), land-use change and forestry (18.2%), transport (13.5%), agriculture (13.5%) and industry (10.4%).

If the current trend of greenhouse gas emissions into the atmosphere persists, the global temperature is expected to rise between 1.4 and 5.8°C by 2100. To keep the warming at a rise of up to 2°C as compared to the pre-industrial era, global emissions needs to be reduced by 40-45% by 2050 as compared to the 1990 level.

In Europe the temperature rise will be 0.1-0.4°C per decade. The greatest warming is predicted in southern and north-eastern Europe. By the 2080s each summer will be hot in comparison with summers presently described as such, and cold winters (at present one out of 10) will be rare by the 2020s and disappear by the 2080s. Northern Europe will have more precipitation and southern Europe less, with increasing duration of dry periods. The snow line and the upper forest line will move to higher altitudes, which will have an impact on the living world. The reduction in distribution of mountain glaciers in non-polar areas was observed. As a result three quarters of the present glaciers in Switzerland will disappear by 2100. The thickness of the Artic Sea ice dropped by 40% and is predicted to decrease by 80% by 2050 and disappear completely by 2100. In the last 100 years the annual duration of ice on European lakes and rivers shortened by approximately two weeks.

As a result of warming the mean global sea level has risen. Recent results gained from the satellite measurements indicates global sea level rise with a rate of 3 cm per decade. The scenarios of the 2001 IPCC report yielded a rise of 9-88 cm (48 cm in average) from 1990 to year 2100.

6.2 Observed Climate Changes in Croatia

Temperature and precipitation variations recorded in Croatia in the 20th century were identified by processing data for the periods 1901-2000 and 1901-2004 at five meteorological stations: Osijek (continental climate), Zagreb-Grič (continental climate under a mild maritime influence), Gospić (continental climate of highland Croatia under a strong maritime influence, 1924-2004), Crikvenica (maritime climate of eastern coast of the northern Adriatic) and Hvar (maritime climate of the Dalmatian area). According to data covering the periods observed, there are differences in trends during the 20th century and changes that occurred in the first years of the 21st century (Fig. 6-1).

Both globally and in Croatia, the period between 1991 and 2000 was the warmest decade of the 20th century. Among ten warmest years five were recorded in Zagreb-Grič, three in Osijek and Hvar and two in Gospić and Crikvenica. Including data for 2000-2004 it may be noted that 2002 falls under the 10 warmest years across the entire area of Croatia, the years 2001 and 2003 in all parts of Croatia excepting eastern lowland part, and the year 2004 on the island of Hvar. In the period 1901-2000 the rise in the mean annual temperature recorded on the coast was higher than on the mainland. The only exception is Zagreb-Grič where heat island effects of urban environment cannot be excluded (Table 6-1). The greatest contribution to warming in the coastal part is from temperatures of the warm season: autumn on the island of Hvar and summer in Crikvenica, while in the mainland areas the winter temperatures increased most.

During the 20th century annual amounts of precipitation (R_g) showed a downward trend in all aprts of Croatia, thus joining the trend of drying across the Mediterranean. It is more marked in the northern Adriatic (Crikvenica -18%), on Dalmatian islands (Hvar -12%) and in eastern Slavonia (Osijek -13%) than in the mountains (Gospić -8%) and in north-western Croatia (Zagreb-Grič -3%). This is a result of seasonal precipitation trends which differ among regions.

The fall in annual amounts of precipitation in the area north of the Sava River results from decline in spring (Osijek -41%; Zagreb-Grič -11%) and autumn precipitation (Osijek -30%; Zagreb-Grič -14%). In the mountains and on the Dalmatian islands the fall results from decline in winter (Gospić -27%; Hvar -27%) and spring precipitation (Gospić i Hvar -20%). On the northern Adriatic the fall in precipitation amount (Crikvenica -9% to -27%) is evident in all seasons (Table 6-2).

To explain the results of climate scenarios secular variants of the incidence of extreme temperature events and the incidence and intensity of precipitation were determined.

In the period 19001-2000 cold temperature indices show a negative trend in all parts of Croatia, i.e. decreasing in number of cold nights and cold days (Fig. 6-2); the number of cold nights increased on the island of Hvar only.

The trend of the cold days as defined by the absolute threshold $t_{min}<0$ °C, shows a rise in Osijek, a decline in Zagreb and Crikvenica, while in Gospić and Hvar the number of cold days has practically not changed. The warming experienced at the beginning of the 21st century resulted in changes in the

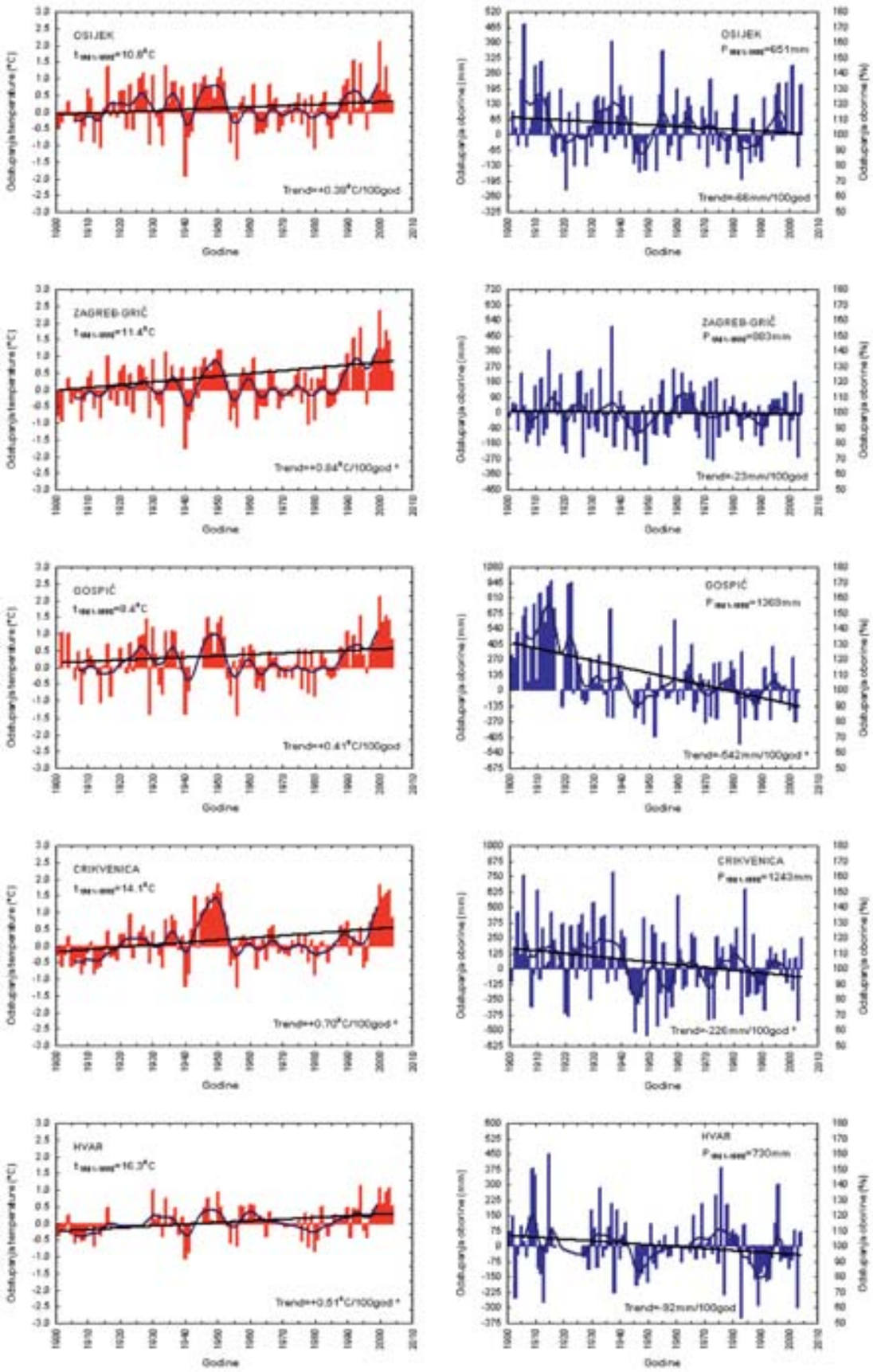


Fig. 6-1: Mean air temperatures deviations (left), amounts of precipitation deviation (right) and trends for years in the period 1901-2004 (* significant at the level $\alpha=0.05$)

Table 6-1: Air temperature trends by seasons and for the year Trends in bold type are significant at the level α=0.05

	Osijek	Zagreb-Grič	Gospić	Crikvenica	Hvar
Air temperature trend 1901-2000 (°C/100 years)					
Winter	+0.4	+0.9	+1.1	+0.6	+0.4
Spring	+0.2	+0.7	0.0	-0.1	+0.2
Summer	+0.3	+0.5	-0.3	+0.7	+0.3
Autumn	+0.3	+0.5	0.0	+0.6	+0.5
YEAR	+0.3	**+0.7**	+0.2	**+0.5**	**+0.4**
Air temperature trend 1901-2004 (°C/100 years)					
Winter	+0.4	+1.0	+1.1	+0.7	+0.4
Spring	+0.4	+0.9	+0.3	+0,2	+0.4
Summer	+0.4	+0.8	+0.2	+1.1	+0.6
Autumn	+0.3	+0.6	+0.2	+0.8	+0.6
YEAR	+0.4	**+0.8**	+0.4	**+0.7**	**+0.5**

Table 6-2: Precipitation amount trends by seasons and for the year Trends in bold type are significant at the level α=0.05.

	Osijek	Zagreb-Grič	Gospić	Crikvenica	Hvar
Precipitation amount trend 1901-2000 (%/100 years)					
Winter	+6	-3	-27	-18	**-29**
Spring	**-41**	-11	-20	-22	-20
Summer	+7	+12	+9	-27	+28
Autumn	-30	-14	+1	-9	-4
YEAR	-13	-3	-8	**-18**	-12

trend of all warm temperature indices which are more marked than changes in the cold indices trend. So, apart from Zagreb, the positive trend of warm nights became significant in Gospić too. On the Adriatic, in Crikvenica and Hvar the rise in the number of warm days is even more marked than in the 20th century (Fig. 6-3). The absolute temperature indices (warm days with $t_{max} \geq 25$ °C) show a significant positive trend on the Adriatic only.

The analysis of trends in precipitation extreme indices showed a positive trend in the annual number of dry days ($R_d < 1.0$ mm) significant at the level of 5% in the area of Adriatic and Zagreb. At the same time the negative trend of wet days (Rd≥R 75%) is negligible and the number of wet days remained unaltered. Large amounts of precipitation that fall on very wet days (R 95% T) almost do not change. Absolute annual, one-day and five-day maximums show a high variability among years, with a negative sign for five-day maximums across Croatia and one-day maximums in lowland and highland areas.

As seen from above, in the area of drying such as Croatia there are no major secular changes as to the extremes relating to large amounts of precipitation and the incidence of wet and very wet days. The reduction in the annual amounts of precipitation can be attributed to changes in the incidence of low-intensity rain days and the increased incidence of dry days.

6.3 Climate Changes Scenario for Croatia

The traditional knowledge of climate is mostly linked with climate parameters affecting the everyday life: mean, maximum, and minimum air temperatures, rainfalls, surface wind, air humidity, cloudiness and solar radiation. The climate is determined by the state of atmosphere, the oceans, the ice and snow cover, soil, biosphere and their interactions. It is also determined by physical characteristics of the space: orography, latitude and longitude and human activities, which are presently a significant factor of climate changes.

Due to the complexity of processes going on within the climate system, climate changes and projections cannot be extrapolated from trends of individual climate parameters observed in the past. The behaviour and interactions between climate system components are presently studied by numeric climate models and simulations, with the aim to identify changes in relation to scenarios that provide an image of future, including the demographic, social, economic and technological development underlying the greenhouse gas emission.

This Communication presents the results of simulating the 20th century climate by means of a global model (EH5OM)

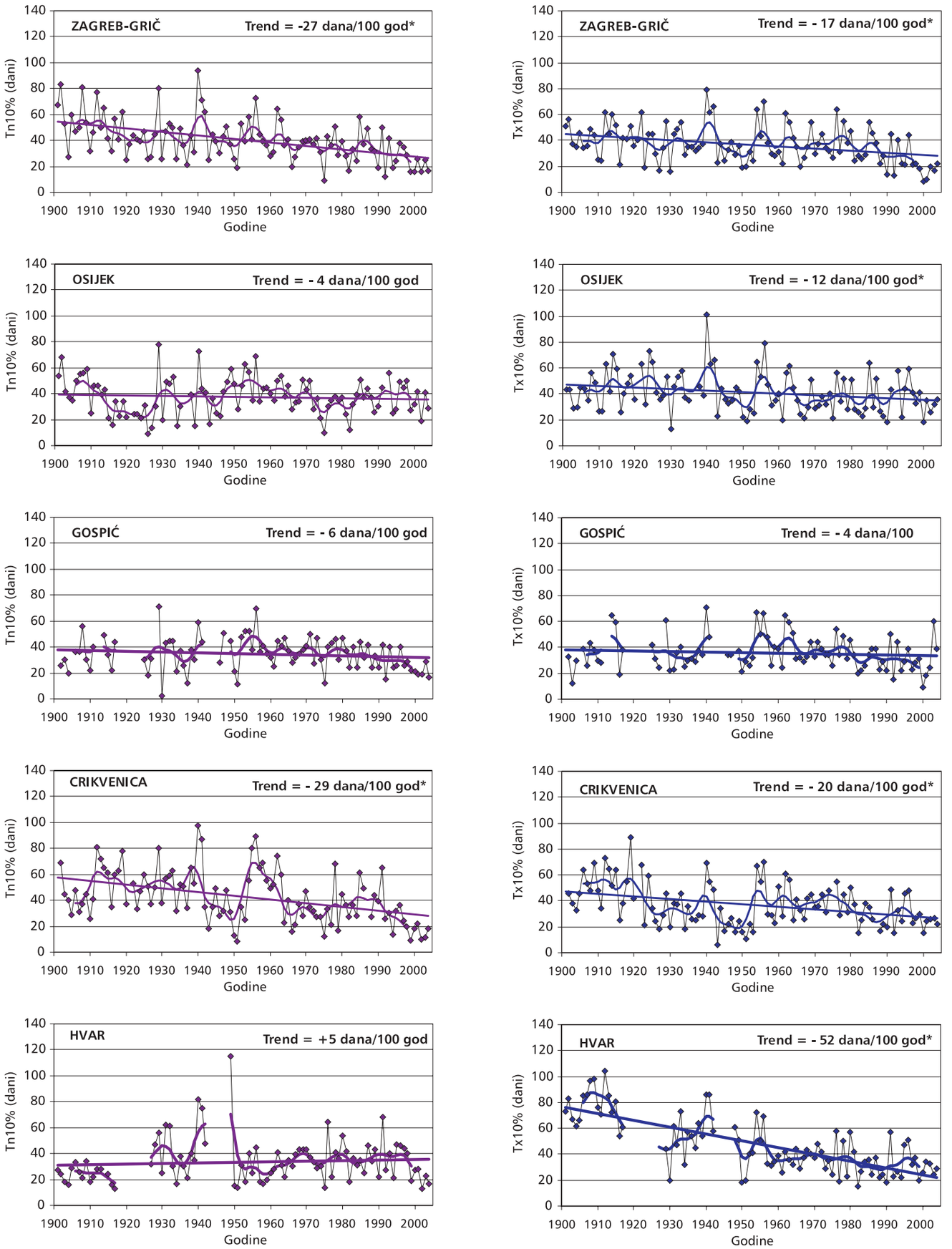


Fig. 6-2: Left: no. of days with minimum (Tn10%) and right: no. of days with maximum (Tx10%) air temperatures lower than the 10th percentile and trends between 1901-2004 (* significant at the level α=0.05).

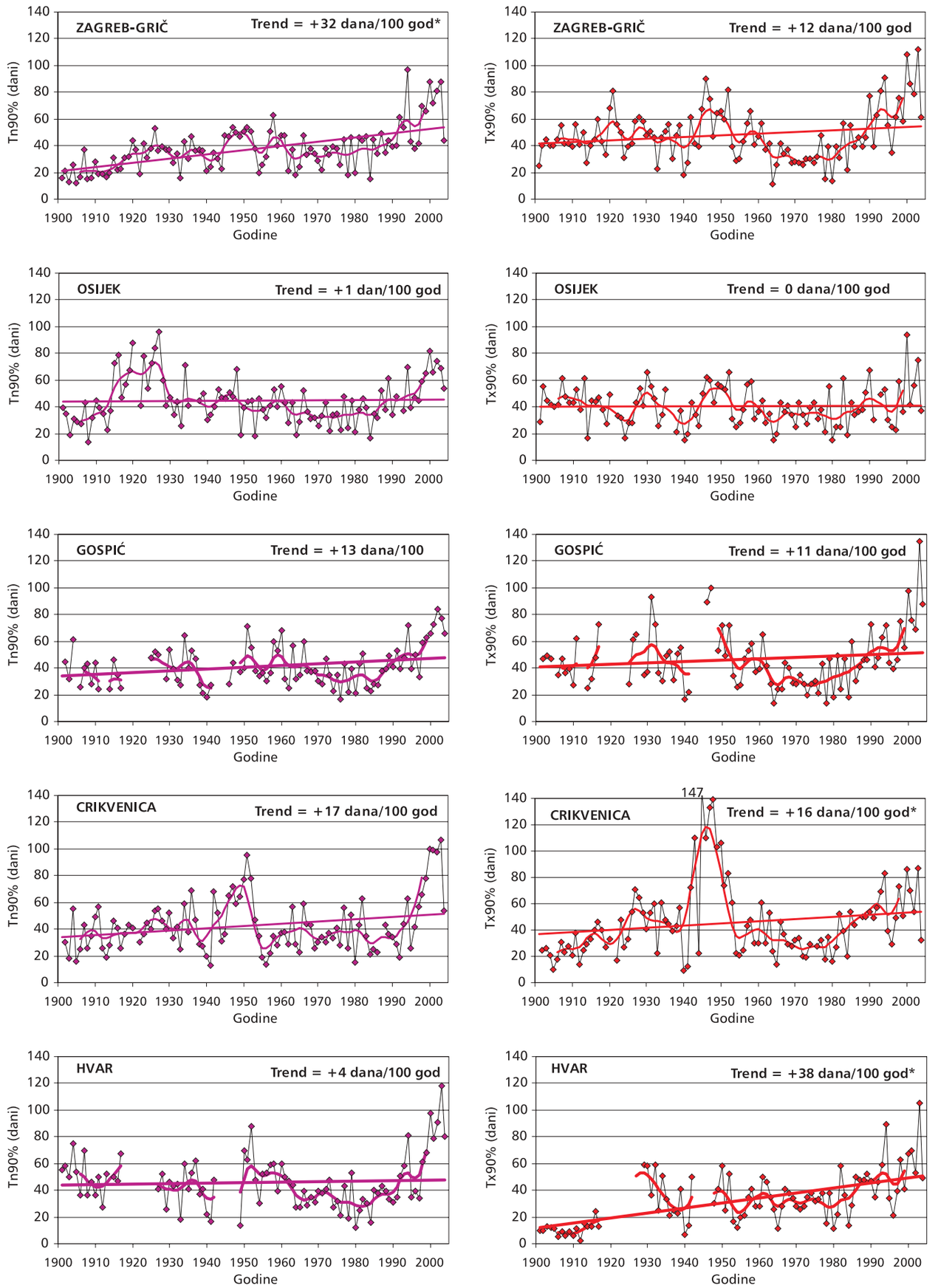


Fig.6-3: Left: no. of days with minimum (Tn 90%) and right: no. of days with maximum (Tx 90%) air temperatures exceeding the 90th percentile and trends in the period 1901-2004 (*significant at the level α=0.05)

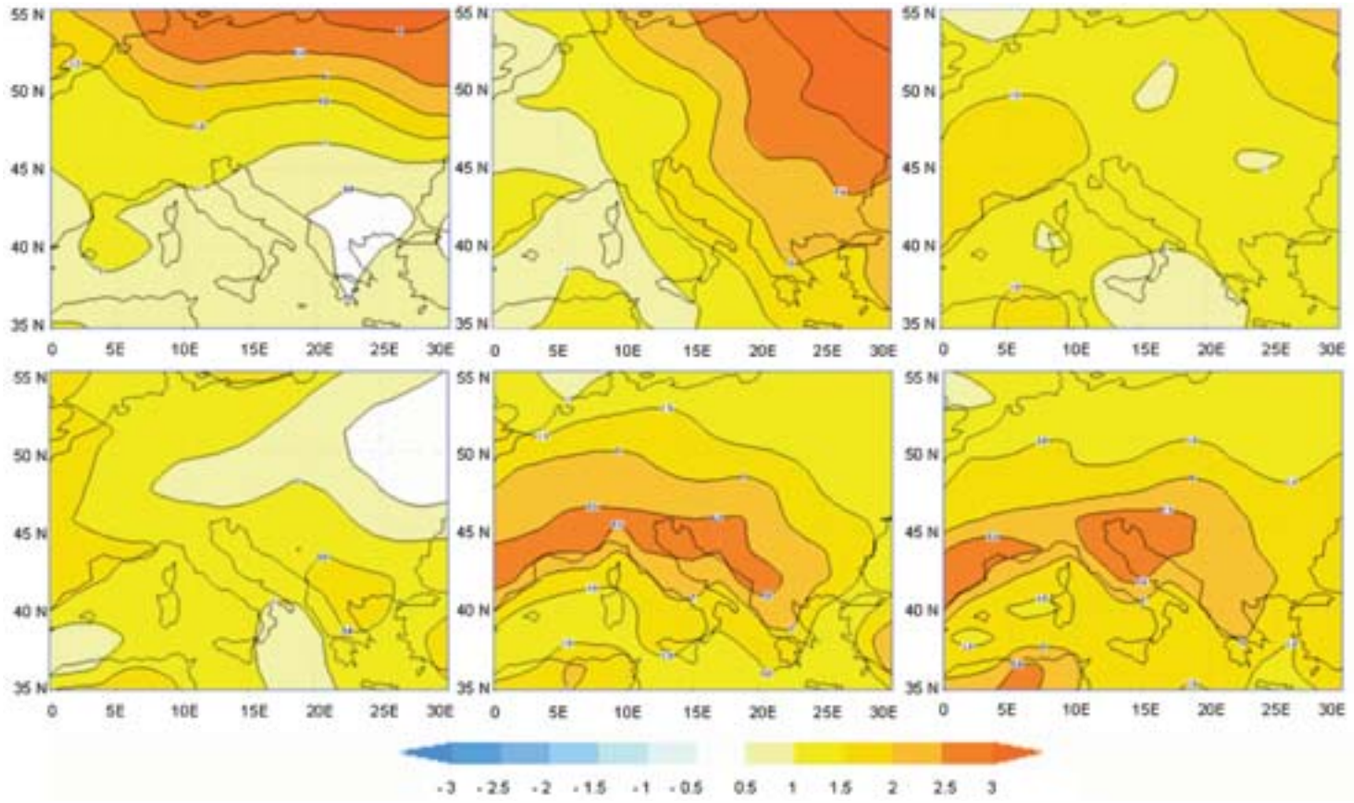


Fig. 6-4: Seasonal means of temperature differences at 2 m (T2m) between future (2040-2050) and current (1980-1990) climate in winter (upper row) and summer (lower row) under three EH5OM model performance. Isoline each 0.5 degree

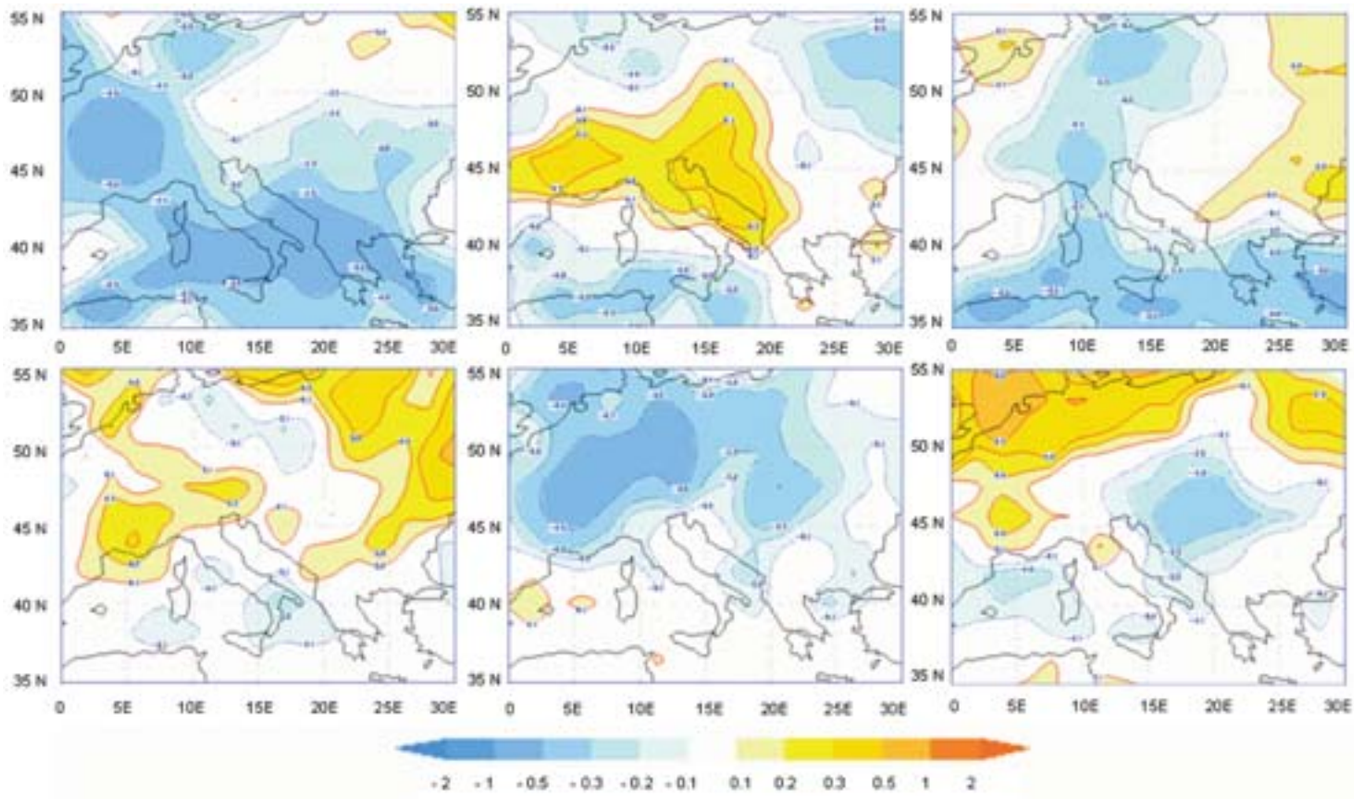


Fig. 6-5: Seasonal means of differences between future (2040-2050) and present (1980-1990) climate relating to total precipitation in winter (upper row) and summer (lower row) for three EH5OM model performances. Isoline each 0.1, 0.2, 0.3, 0.5, 1 and 2 mm/day

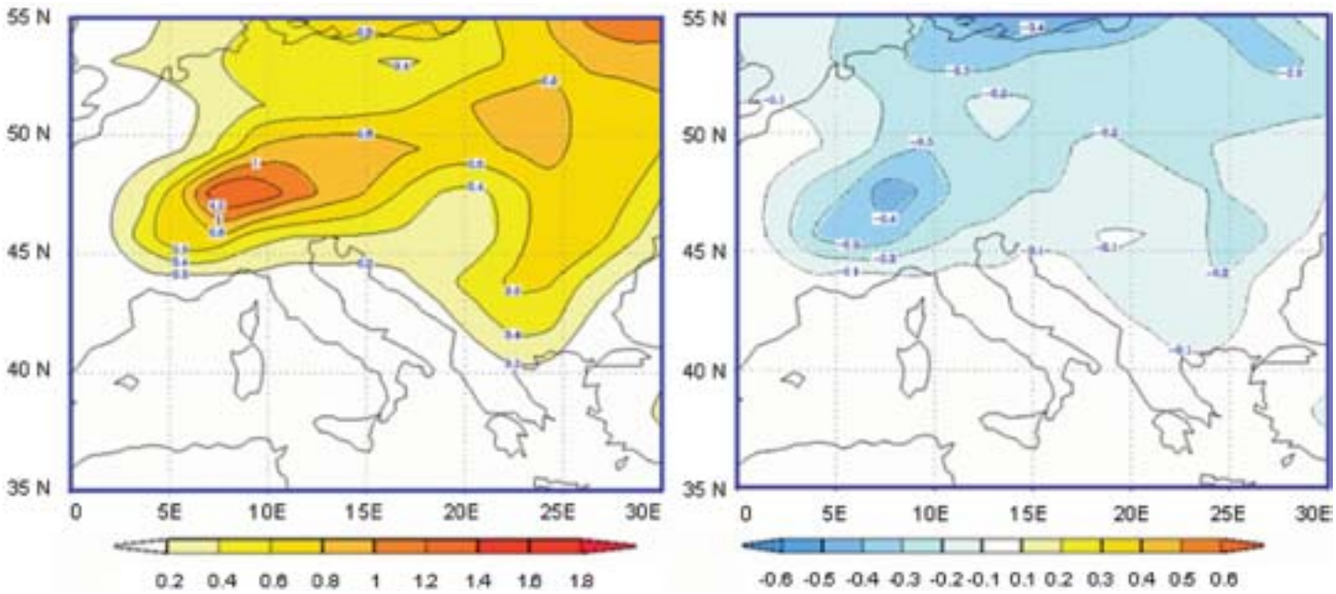


Fig. 6-6: Seasonal mean for snow under present climate (1980-1990) (left) and difference between future (2040-2050) and present climate (right). Isoline each 0.2 mm/day (left), and 0.1 mm/day (right)

developed by the Max Planck Institute for Meteorology (Hamburg, Germany) which includes a dynamic interaction between atmosphere, ocean and ice crust.

The simulation was carried out for three cases of initial conditions of models that simulate best the present climate conditions. The outputs of globally integrated atmospheric and oceanic model EH5OM were analysed for two seasons (winter and summer) and two 11-year periods across the area of Croatia. The first period 1980-1990 corresponds to the present climate and was selected because it represents the 20th century climate better than the last decade in which the warmest years were recorded. The second period 2040-2050 gives a projection of a future climate under the A2 scenario of IPCC: global population growth to 15 billion by 2100, moderate economic growth, very high energy consumption and variable fossil fuel consumption. By comparing mean values for both periods it is possible to monitor the changes at the global and regional (local) domain. The climate simulation for the area of Croatia was carried out by applying the regional climate model (RegCM, version 3) as one of the models most frequently used for a dynamic downscaling of climate variables.

Over a wider area of Croatia (central and southern Europe and the northern Mediterranean) the future climate will bring a rise in the ground-level pressure in winter. This may be due to an increased number and/or duration of high-pressure or a decreased number and/or duration of low-pressure situations. In other words, future winters are likely to be more stable than presently.

In the future climate surface winds in the area of Croatia (normally weak) would slightly intensify and get a slightly more marked northern component, which is statistically insignificant. Regardless of the season the ground-level temperature (T2m) will rise in the area of Croatia in the future climate (Fig. 6.4). Warming will be higher in summer than in winter, in some places exceeding the seasonal mean values by over 2.5 degrees.

The prevailing signal of a changed precipitation under three model performances (Fig. 6.5) for the area of Croatia indicates its decline in summer; with a neutral signal for the winter mean. Given the fact that differences exists between data of certain meteorological station, the amplitude of the decrease in summer precipitation cannot be identified with certainty.

Climate changes, primarily the general temperature rise, will result in less snowfall and lesser amounts of snow on the ground (Fig. 6-6).

Despite a global trend of humidity rise in lower layers of the atmosphere, Croatia is partly under the influence of humidity decrease, which is more marked in winter. This is also reflected in the fall of soil humidity. The air humidity in summer will slightly rise or remain unaltered.

In the future climate Croatia may generally expect decline of cloudiness, even up to 15% in winter, but this does not imply the rise in the number of clear days.

6.4 Impacts and Adaptation to Climate Changes by Areas

4.4.1 Hydrology and Water Resources

Waters fall among major natural resources of the Republic of Croatia. Although it belongs to a group of countries for which water issues are not a limiting factor of development, climate changes will cause problems in water supply and meeting the ever-growing drinking water requirements.

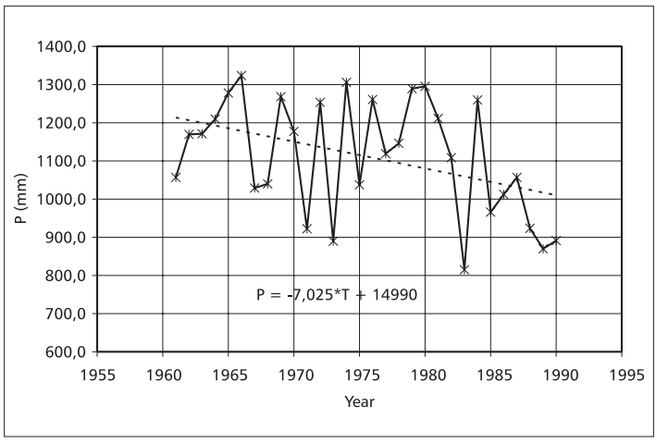


Fig. 6-7: Sequence of annual precipitation amount P (mm) in Croatia with linear trend 1961-1990

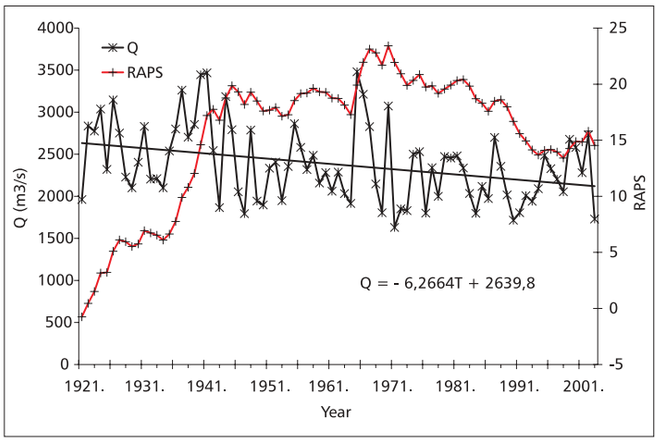


Fig. 6-8: Sequence of annual mean flow rates Q in m^3/s, and linear trend of the Danube at Bezdan (1921-2001)

According to scenarios predicting a temperature rise of 0.8-0.9°C, the Pannonian part of Croatia will be faced with a 10% decline in annual precipitation amounts and the rise in annual evapotranspiration. The annual sequence of precipitation in Croatia between 1961 and 1990 was determined by using the Thiessen method as shown in Fig. 6-7. The total annual precipitation varied from a minimum of 815 mm in 1983 to a maximum of 1,324 mm in 1966, or rather within a range of 509 mm or about 45% of the average value. The figure shows the downward trend of about 7 mm per year on average, which means that annual precipitation dropped by some 210 mm. Changes in the precipitation regime will affect the size, time of occurrence, incidence and intensity of floods and droughts.

Climate changes or variations combined with man-made activities affected the changes in hydrological regime of open watercourses. Catchment areas of different sizes, geological and pedological base and different vegetation will differently respond to climate changes. Possible reduction in discharge of watercourses will cause shortage of water in summer.

The rise in average monthly flow rates of the Drava River in the period 1976-2000 was recorded in October only, as a result of a change in the discharge regime (Table 6-3). The river Drava used to follow the glacial regime of discharge over its entire course. In the last 20 years the Alpine glaciers melted considerably and the snow cover declined or currently melts more rapidly, making the characteristics of the rain regime more pronounced. The largest decline in the flow rate was observed in June, July and August when the Drava waters are intensively fed by glacier and snow melting in the upper part of the catchment area. Similar processes, although not so pronounced, are observed along the course of the Sava River.

The frequent occurrence of extremely high water levels and floodings is a clear indication of major climate changes. The record water wave of the Danube that flooded the Central European countries in August 2002 was recorded in Croatia too. On 22 August 2003, at the water wave peak, the water level of the Danube at Batina amounted to +731 cm. The sequence of annual mean flow rates of the Danube at Bezdan (river km 1425) in the period 1921-2001 is shown in Fig. 6-8.

Large parts of the Croatian territory are threatened by water and partly by wind erosion too. Erosion processes may cause extremely high damages. On one hand, they wash off fertile soils from steep and unprotected agricultural areas of

Table 6-3: Differences in average monthly flow rates ($\Delta\bar{Q}$) of the river Drava at water gauging stations of Botovo and Donji Miholjac in periods 1976-2000 and 1951-1975

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Station	Drava – Botovo											
$\bar{Q}_{1976\text{-}2000}$	321	317	391	511	681	676	606	480	439	501	484	403
$\bar{Q}_{1951\text{-}1975}$	350	369	449	586	740	846	728	600	511	465	500	410
$\Delta\bar{Q}$	**-8,29**	**-14,1**	**-12,9**	**-12,8**	**-7,97**	**-20,1**	**-16,8**	**-20,0**	**-14,1**	**7,74**	**-3,20**	**-1,71**
Station	Drava – Donji Miholjac											
$\bar{Q}_{1976\text{-}2000}$	378	366	415	531	696	703	634	506	467	523	508	449
$\bar{Q}_{1951\text{-}1975}$	412	405	467	599	749	866	758	618	525	472	517	436
$\Delta\bar{Q}$	**-8,25**	**-9,63**	**-11,1**	**-11,4**	**-7,08**	**-18,8**	**-16,4**	**-18,1**	**-11,0**	**10,8**	**-1,74**	**2,98**

highland parts of catchment areas and thus contribute directly to lower yields of agricultural production, and on the other they reduce the soil retention capacity and thus facilitate the creation of torrents.

Intensive water erosion processes including a great number of destructive torrents may be found especially in Adriatic catchment areas with a flish base (central Istria, parts of the Kvarner littoral and Gorski kotar, parts of Lika, Dalmatia and islands), while in continental parts of Croatia they are less pronounced, but still very harmful. The strongest wind erosion may be found in the coastal zone and islands, and partly in the northern Croatia.

4.4.2 Agriculture

Agriculture is an activity generally suffering most from the climate change. Given the natural and geographical special features and diversity of Croatia, in climate change scenarios account should be taken of the predominant way of using space in certain parts of Croatia.

The predicted increase in the annual number of active vegetation days (temperature above 5°C) in lowland areas of Croatia by 35-84 days and the extension of the period with a temperature above 20°C by 45-73 days will have a positive effect on the increase in yields and quality of agricultural crops. The increase of cardinal temperatures (number of days with physiologically active temperatures) facilitates the growing of late-ripening crops that show higher yields and storage suitability.

In crop farming the extension of the vegetation period will cause higher yields of winter crops. Spring crops with a life cycle covering one vegetation year will be threatened by higher air temperatures and the shortage of water during summer months. Such a change requires gradual adaptation in terms of time frames and methods of soil cultivation, feeding and protecting crops, and development of new varieties better adapted to new climate conditions, primarily to a longer vegetation period and a pronounced shortage of water in soil in June and July. From a long-term aspect, there is a need for experimental introduction of new crops currently not grown at all or grown on a limited scale in Croatia; Sudan Grass (*Sorghum vulgare)*, for example, has a high economic value as a fodder plant.

The predicted climate scenario for southern Croatia will enable the extension of cultivation to new arable land and the increase in the production of Mediterranean species presently accounting for a considerable segment of fruit imports.

In future, damages caused by very cold winters or late spring frosts, which are nowadays a limited factor for fruit and vine growing in continental Croatia, will be minimised. Positive effects may be expected in the plantation production of grapes and apples, which will extend to areas presently unsuitable. It is also possible to introduce certain varieties in the fruit production which are not traditional, but may have positive market effects. Something similar is known to have happened with the introduction of certain vegetable crops into a (profitable) production owing to the technology of production under closed-space conditions.

A warmer and drier climate will reduce the outbreaks of natural infections by mycoses that depend on frequent precipitation and high humidity of air inside the plantations, and thus cut considerably the use of infection control agents.

The predicted increase in daily mean air temperatures and the rainfall reduction during the vegetational season, accompanied by irrigation, will result in a considerably more cost-effective and, from the aspect of health, more acceptable production.

The total amount, distribution, form and intensity of precipitation are highly important for the soil water balance. If the soil is not irrigated during a dry period, the yields of crops grown will drop. In Croatia droughts occurs every three to five years on average, and may, depending on the intensity and duration, cut the yields of various crops by 20-92%. Severe droughts were recorded in 1992, 1995 and 1998, and those of the years 2000 and 2003 were proclaimed natural disasters. Irrigation can help to completely avoid damage caused by drought. According to the 2005 *National Project for Irrigation and Management of Agricultural Land and Waters in the Republic of Croatia* it is planned to construct irrigation systems for further 35,000 ha in the period 2006-2010, or rather further 65,000 ha by the year 2020, whereby the share of irrigated areas in the total area of arable land would rise from 0.86% to 6%.

The growth, behaviour and health of domestic animals depend on their heredity and ecological factors of their environment. Weather conditions and climate changes affect directly the appetite and health of animals and indirectly the profitability of livestock production.

The direct influence of climate includes the heat exchange between the animal and the environment and is linked with air temperature and humidity, air circulation speed and heat radiation. All this affects the quality of each head of cattle (increment, lactiferousness, production of wool, eggs, fertility, etc.), health and welfare of animals. Warming favours the spread of diverse pathogenic microorganisms and parasites, including certain insects not directly hazardous to animals, but likely to be carriers of certain diseases.

Indirect influence of climate changes is reflected in the yield and quality of pastures, fodder plants and cereals. As autotrophic organisms, plants are the main source of feed for ruminants in food chains of all ecosystems worldwide. Pastures meet 95% of food requirements of wild ruminants. An elevated CO_2 concentration affects the quality and conversion of fodder. A high rise in water-soluble carbohydrates under the conditions of an elevated CO_2 concentration leads to a faster digestion in the rumen, whereas the decline in nitrogen content of the plant results in a lower protein value of the plant. The livestock feeding on grass with low protein content is therefore far more exposed to harmful influence of the increased carbon-nitrogen ratio than the livestock fed by grass rich in proteins.

According to the regional climate scenario for Croatia an increased fequency of heavy rainfalls (storms) is expected, which will make wind more important in salinization/alkalization of soils of the coastal zone. This will result in further impoverishing of pastures in such areas, lower production of plant mass and lower quality of fodder plants with a negative impact on lactiferousness and growth, especially as regards small ruminants. In the coastal mountains of Biokovo, Dinara and Velebit several-days gale-force wind blowing at a speed of 80 km/h has killed weaker and undernourished sheep, goats and particularly their young on many occasions.

6.4.3 Forestry

The assumed climate changes may lead to changes in spatial distribution of forest vegetation reflected in the altered share of current forest types, possible disappearance of the existing or appearance of new types, change in the

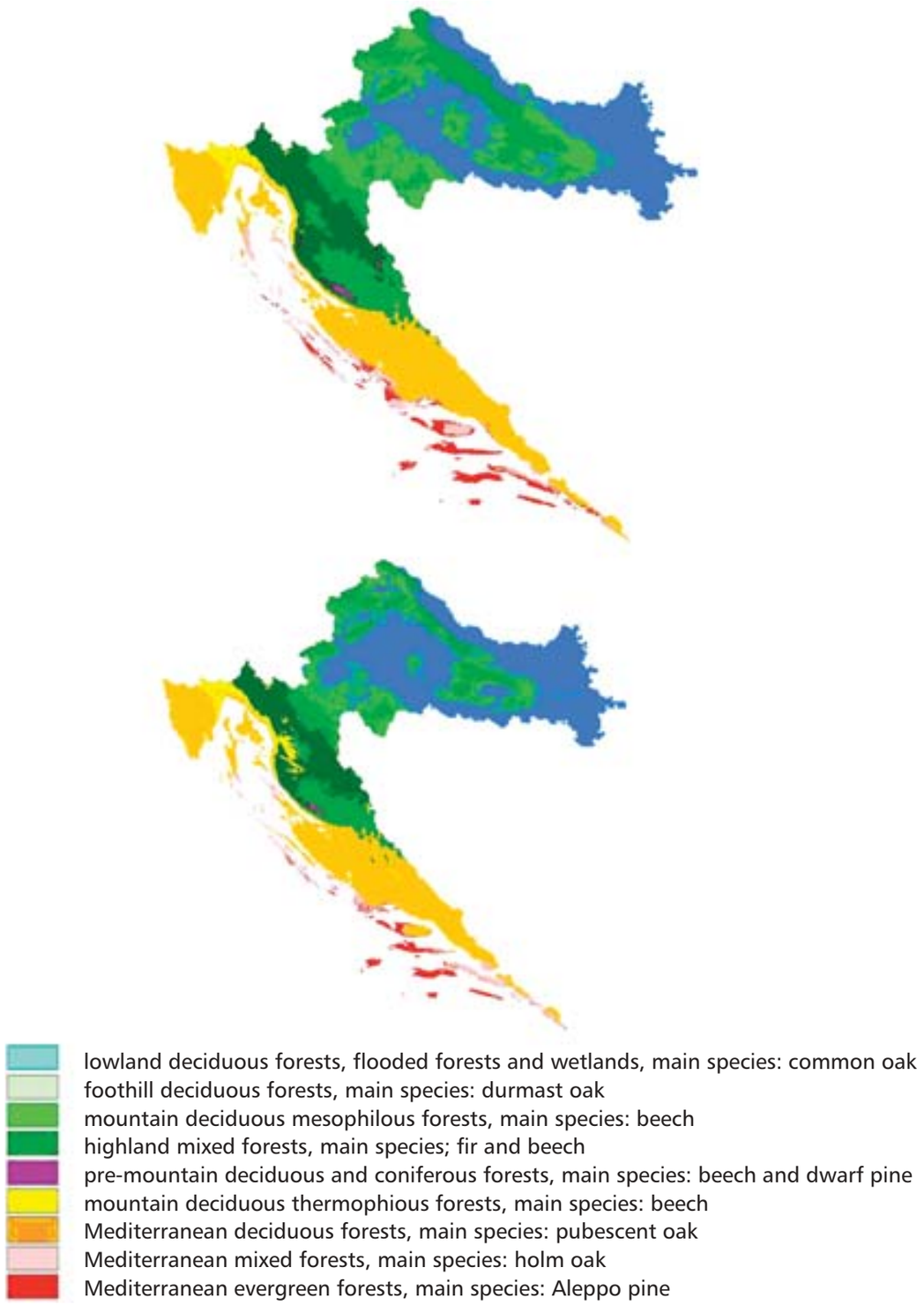


Fig. 6-9: Potential spatial distribution of main forest types in Croatia; present state (up) and the state in 2030 (below)

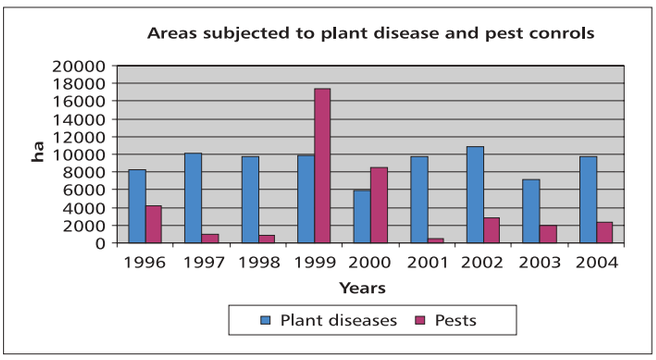
density of population of certain tree species, productivity of forest ecosystems, ecological stability, forest health condition, and the change in the overall productive and universal forest value.

The empirical model of assessing climate change impacts on the spatial distribution of main forest types in Croatia was preliminary applied for the purpose of this Communication.

In the model the actual forest vegetation of Croatia was reduced to nine main forest types conditioned by macroclimate. Spatial interpolations of data measured at 127 meteorological stations throughout Croatia were used. The estimated hypothetical future spatial distribution of main forest types, provided that the existing linear trends will persist, is shown in Fig. 6-9.

The comparison of the results obtained for the year 2030 and the current state shows the following changes in the spatial distribution of main forest types, which may be interpreted at the preliminary level despite the model limitations:

1. Increased areas covered by lowland forests. This is disputable, because the occurence of this forest type in the Pannonian part of Croatia is conditioned both by macroclimate and extra moistening of root system zone by floods and groundwater, making the expansion of this forest type often impossible beyond the range of this additional influence. Moreover, a potential impact of climate change on the hydrological regime in the plains represents an additional problem;
2. Reduced distribution area of beech and fir forests in Gorski Kotar. As beech is a species of a wider ecological amplitude and the edificator tree of other main forest types, this result might primarily be a new motive in studying the causes of deterioration of fir in Croatia;
3. Expansion of sub-Mediterranean deciduous thermophilous forests, was expected
4. Reduced distribution area of Mediterranean evergreen forests. It is difficult to explain, but here the result might be unreliable



(Source: Croatian Forests)

Fig. 6-10: Areas subjected to plant disease and pests controls from 1996 to 2004

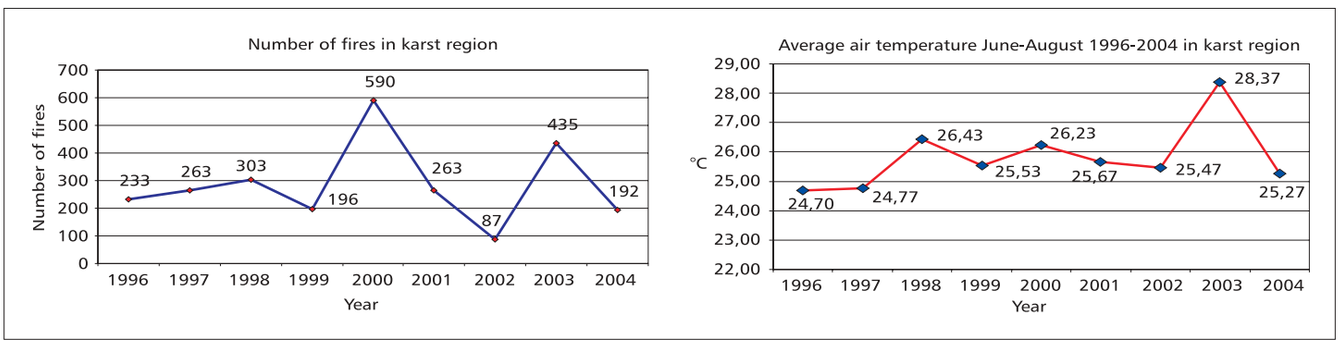
Air pollution is one of the stress factors leading to the reduced vitality and drying of forests in Croatia. The monitoring of the damage level caused to tree crowns in the period 1995-2004 showed a further increase in the share of the category of highly damaged trees of all types from 23.2% in 2003 to 26.8% in 2004, or rather by 3.5%.

A high level of damage caused to broadleaves increased from 17.6% in 2003 to 21.1% in 2004, while with conifers it increased from 46.8% in 2003 to 48.8% in 2004.

Direct correlation between climate changes and the appearance of plant diseases and pests on forest trees in the period 1996-2004 has been observed. Occurence of bark beetles in fir and spruce forests is most indicative after dry periods when physiologically weakened trees become easily accessible to bark beetles as secondary pests.

In urbanized settlements areas the average temperature is 2-3 degrees higher than in the surroundings. The dendroflora of parks and lines of trees in settlements where climatic conditions are favourable to vegetation of a colder climate may be supplemented by newly arrived types of trees and shrubs whose natural distribution area belongs to the areas with the Mediterranean, subtropical or tropical climate. The knowledge of the biology and ecological parameters of these species and the monitoring of their number make it possible to assess their adaptability to the environment and to register the impact of climate change on their spread.

Duration of long dry periods in summer months and the shortage of rainfalls may cause the outbreak and spreading



(Source: Croatian Forests)

Fig. 6-11: Number of fires (left) and average air temperatures from June to August (right) in the karst region of Croatia between 1996 and 2004

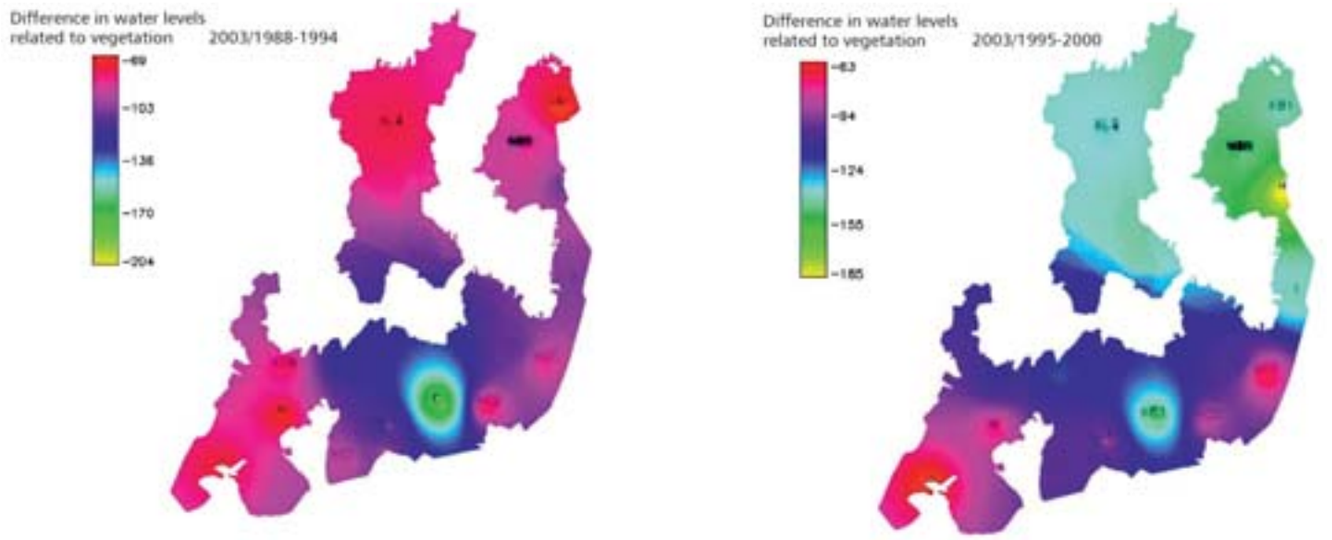


Fig. 6-12: Comparison of spatial distribution of decline in vegetation-related water levels in the forests of Česma and Bolčanski in 2003 and 1988-1994 (left) and 1995-2000 (right)

of forest fires. Extremely fragile are forests in the karst region of the Croatian Adriatic coast, where the plant cover is mainly consists of the Aleppo pine (*Pinus halepensis*) and evergreen maquia. The largest number of fires in period 1996-2004 was recorded during summer months of 2000, i.e. 590 fires that affected 66,785 ha of forest and forest land. The average air temperature during summer months amounted to 26.2°C and the rainfalls was very low, only 8.53 mm (Fig. 6-11).

Forests play an important role in the hydrological cycle by influencing the evaporation and precipitation increase. The groundwater level in forests is changed seasonaly and shows the connectivity to the catchment area regime.

Decline of the groundwater level in the forests, caused by the more frequent occurence of drought years, endangers common oak forests of the Spačva basin, in the wider surroundings of Našice and Osijek, and in Podravina region. The time-related and spatial dimension of the groundwater level decline in oak forests of Česma and Bolčanski lug is shown in Fig. 6-12 shows. Deviations recorded in 2003 from the average vegetation-related water levels are between -63 and -165, compared to 5-year average (1995-2000).

6.4.4 Biodiversity and Natural Terrestrial Ecosystems

Biodiversity consists of the genetical diversity, species diversity and diversity of habitats and ecosystems. In the area of Croatia three various interconnected impacts of climate changes on species are expected: phenological, distributional and genetic.

Phenological changes, i.e. seasonally linked biological cycles, are immediately related to climate indicators. Since early 1960s the vegetation season has extended by 11 days in some parts of the Northern Hemisphere. In the period 1951-1996 the spring phenological processes in Europe shifted by -0.28 to 0.02 day/year. Some of the changes are associated with milder winters that have been a segment of an overall global warming field since 1970. A shift of -0.11 to 0.34 day/year has been recorded in the freshwater fish spawning time. The arrival of migratory birds from the wintering grounds occurs earlier for 31% of species. Similar changes may be observed in Croatia, too.

Climate changes affect the physiology and interactions between plants causing changes in their distribution areas (areals) in terms of increasing or decreasing the area of a species or a community and shifting the areal (horizontal and vertical migration). The migrating speed of areals is estimated at 2.1 km/year under a milder and 3.9 km/year under the extremer scenario.

Habitats are subject to all the changes described, because the vegetation component comprises species individually exposed to a more or less stronger impact of climate changes. Especially vulnerable to climate changes are those habitats which do have limited temperature range for the occurence. Applying the Hopkins' Bioclimate Law saying that a temperature rise of 3°C corresponds to the shift of vegetation by altitude of 500 m, it is predicted that the vegetation of the pre-mountain region of the Dinarides will be replaced by the vegetation of a temperate climate zone. The most endangered will be plant species of a circumpolar (40 species), pre-Alpine (266 species) and of the Alpine (607 species) distribution. These are herbaceous plants of a narrow ecological valence that will not be able to adapt their respective areals quickly enough, such as *Arabis alpina* L., *Arctostaphylos alpinus* (L.) Spreng., *Arctostaphylos uva-ursi* (L.) Spreng., *Hieracium alpinum* L., *Pinguicula alpina* L., *Veronica alpina* L. , etc.

A successful adaptation is only possible under conditions of a slow climate change, up to 0.1°C/10 years and the absolute climate change lower than 1°C. The temperature is likely to be the eliminating ecological factor in higher and the precipitation in the low-lying continental areas.

Table 6-4: Three scenarios of climate changes used to analyse the distribution of plant species and communities

Scenario	2050.a	2050.b	2080
Mean temperature of air	+1.8 °C	+1.8 °C	+2.3 °C
Winter precipitation	+5%	+10%	+15%
Summer precipitation	+10%	-10%	-15%

The shift of vegetation belts of specific climate zones is expected to be accompanied by the disappearance of poorly adaptable species, while the invasion dynamics of allochthonous species may increase and those more aggressive may force the autochthonous taxa out of their natural habitats. The rich and endemic flora of small southern and central Adriatic islands will be especially endangered due to limited possibilities of migration in view of the dispersion mechanisms available.

Populations of numerous species, especially those on the edges of the areals, are expected to be exposed to fragmentation to smaller subpopulations. The populations possessing large and numerous subpopulations and migrating slowly will lose the least genetic diversity and vice versa. Taxa failing to adapt genetically to climate changes will extinct.

A part of invertebrates with a wide distribution will adapt to changes by migrating. The temperature rise may disrupt life-cycles of species adapted to colder conditions (e.g. mountain massifs). As a rule, vertebrates possess good migratory abilities (although locally they may be narrowly

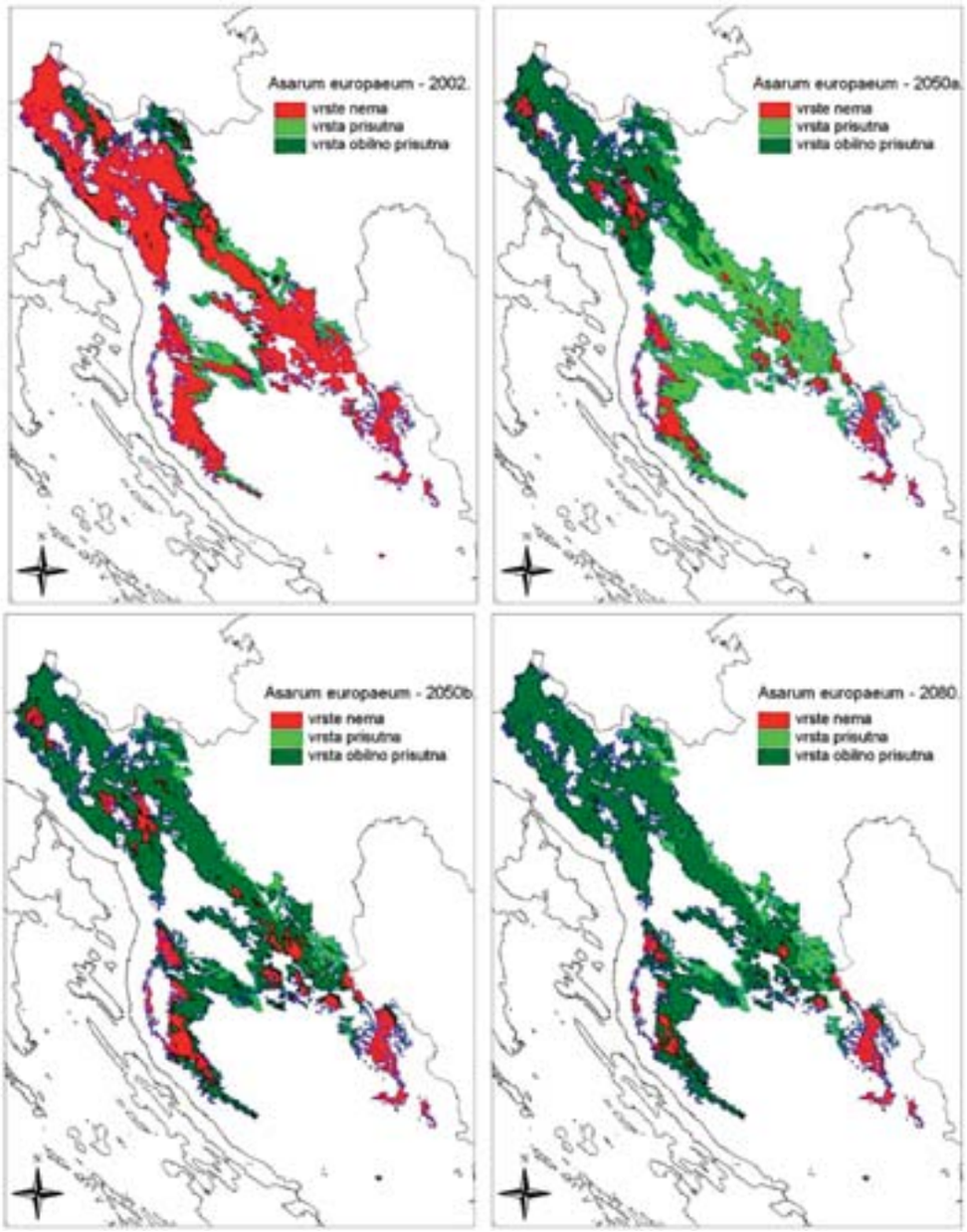


Fig. 6-13: Modelled distribution of European wild ginger (*Asarum europaeum* L.): recent status in 2002, and modelled distribution for the scenario 2050a, 2050b and 2080. Colour description: dark green – abundantly present; light green – present, red – disappeared

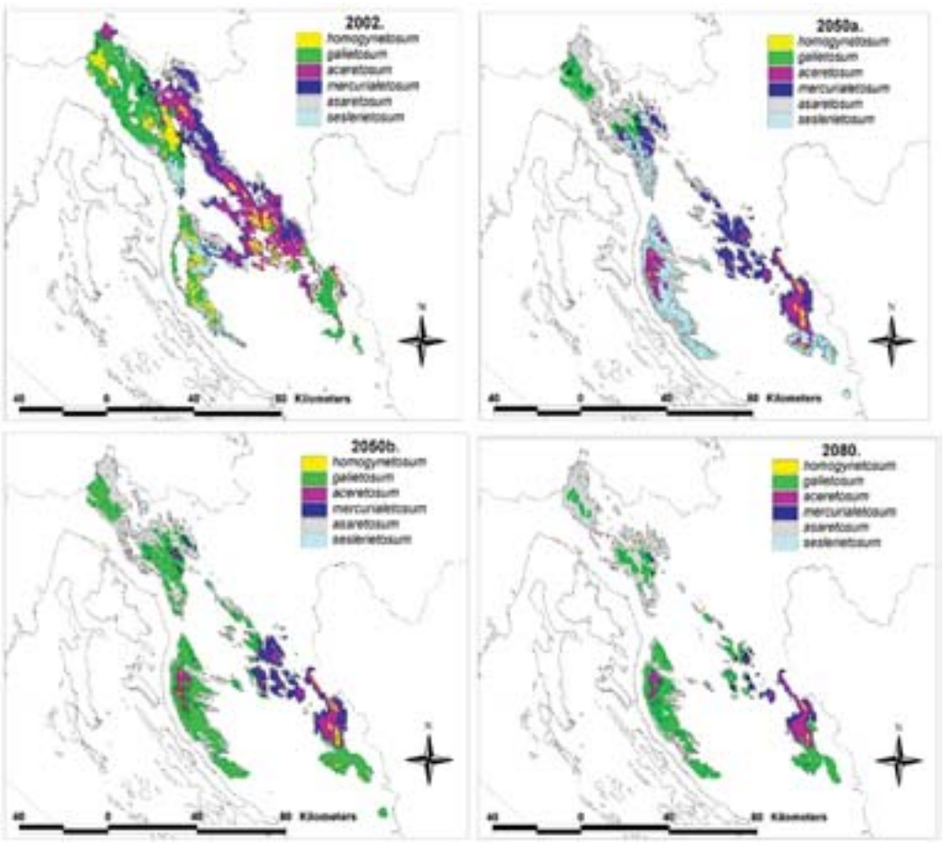


Fig. 6-14: Recent distribution (year 2002) of sub-associations of Dinaric beech and fir forests (*Omphalodo-Fagetum*) in Croatia (up left) and modelled distribution for the scenario 2050a, 2050b and 2080

distributed) and move their areals quicker than vegetation entities.

Under the scenarios analysed for assessing the impacts of climate changes on biodiversity (Table 6.4), distribution of species, sub-associations and forest association of Dinaric beech and fir forests were modelled

The comparison between the 2002 status and the 2080 predictions shows an increase in the area of distribution with all species modelled.

Areas of an abundant presence of species increase only in case of the European wild ginger, *Asarum europaeum* L., (Fig.6-13), they stagnate for spurge laurel (*Daphne laureola* L.), decrease for *Prenanthes purpurea* L. or disappear completely, such as for the Italian maple (*Acer obtusatum* Waldst. et Kit. ex Willd.) caused by the decline in summer precipitation.

The analysis of climate change impact on distribution of sub-associations of Dinaric beech and fir forests (community of *Omphalodo-Fagetum*) in Croatia is shown in Fig. 6-14.

Dinaric beech and fir forests, syntaxonomically regarded as association *Omphalodo-Fagetum,* covers an area of 3,000 km^2 or 5.3% of the mainland territory of the Republic of Croatia. They comprise most part of the primeval forests and are inhabitated by three large carnivores: bear, wolf and lynx, a rarity on the European scale.

Applying the scenario for year 2050 the area of distribution of the Dinaric beech and fir forest will decrease by 15% and by even 42% according to the scenario for 2080 (Fig. 6-14). The share of sub-associations of *asaretosum* is predicted to incrise markedly, while that of *homogynetosum* and *aceretosum* will decline.

The success of adapting to life in new habitats resulting from climate changes is hardly predictable. The ideal case of the species survival, including a migratory shift, is only sometimes realistic due to isolated ecological niches (insular populations, types of watercourses, etc.), and natural and artificial barriers. Anthropogenic impacts on the space, primarily fragmentation of habitats and interruption of migratory ways, increase the risk of the reduction of areals or disappearance of species. Species exposed to climate changes may try to migrate following their life optimum, adapt to newly arisen conditions or become extinct (locally or wider).

Aquatic and wetland habitats are especially important at the national and international level. They provide and/or participate in a number of critical ecological functions such as water regime regulation and creation of the habitat for a number of stenovalent plant and animal species. Since particularly dependent upon the water regime, wetland habitats will be vulnerable to changes in the amount and distribution of precipitation, including secondary effects on related species.

Main indirect measures for the protection of terrestrial ecosystems and biodiversity are:

- *ex-situ* and *in-situ* protection of threatened species, especially endemics, in order to protect the gene fund;
- preservation of migratory corridors for species able to survive by changing the area and scope of appearance;
- adjustment of spatial plans and protected areas management plans;
- planning/predicting changes in boundaries of protected areas;
- adjustment of protection programmes at the species level;
- development of infrastructure for scientific evaluation of the status, forecast and monitoring of changes in terrestrial ecosystems and biodiversity.

6.4.5 Coast and Coastal Zone

As a part of the large United Nations Environmental Programme (UNEP) international project entitled "Climate Change and Mediterranean: Environmental and Socio-economic Impacts of Climate Change and Sea-level Rise in the Mediterranean Region", during the period 1990-1996 at the Croatian Adriatic coast two pilot-projects of researching the impact of global climate changes has been done for the Islands Cres and Lošinj (North Adriatic) and for the Kaštela Bay (Middle Dalmatia). According to results of these projects, regarding the configuration of the coastal and insular parts of Croatia, the most probable scenario estimates rising of the mean sea level for 65+35 cm.

Since the Croatian Adriatic coast is mostly rocky and relatively steep, it does not belong to those areas which are particularly in high risk of sea level rise. Low-lying coastal areas covered with alluvial or flish deposits and sandy beaches can be endangered. The urban settlements along the west coast of Istria (towns of Rovinj and Pula), areas of Zadar, Split, Neretva River delta and Rijeka dubrovačka Bay, can be affected by sea flooding, and many economical and historical or cultural important buildings can be submerged or devastated.

A result of the aforementioned projects indicates that sea level rise would flood an area inhabited by about 13% of the population of the islands of Cres and Lošinj. As to small islands, Košljun on the island of Krk and Krapanj in the Šibenik archipelago may be threatened.

The increased salinity of freshwaters caused by diffusion of seawater will have an adverse effect on the freshwater supply and agriculture activities in the coastal zone. The sea level rise will adversely affect the salt panes in Pag, Nin and Ston, where salt is produced in a traditional way by evaporation of salt water in shallow pools.

A higher incidence of stormy weather and blustery showers, high vawes and sea flood will affect, substantially a part of facilities situated close to the sea level, energetic and transport connections and communications, and sewerage systems in the majority of coastal settlements and all ports and marinas. A number of beaches would be flooded, but again remedied in the course of time.

The temperature rise of some 2°C will make it possible to extend the tourist season from the present three to five months. Table 6-5 shows aggregately the effect of climate changes on tourism in the coastal zone of Croatia.

Table 6-5: Effects of climate changes on coastal zone tourism

Factor	Immediate effect		Final effect	Size/importance
	Primary	Secondary		
Temperature change	Increase in number of hot days in summer	Increase in water consumption	Water shortage	Poor/moderate
		Increase in consumption of energy for cooling of closed spaces		Moderate/moderate
		Increase in number of health problems	Increase in number of tourists per summer season	Moderate/great
	Increase in number of warm days in spring and autumn	Greater possibility of using open infrastructure and sea bathing	Extension of tourist season to spring and autumn	Moderate/great
Change in precipitation amounts				None
Extreme meteorological changes	Higher incidence of gale-force winds			Poor/poor
	Higher incidence of heavy rainfall			Poor/poor
	Higher incidence of twisters			Poor/poor

6.4.6. Marine Ecosystems and Fish Resources

Oceans and seas are the most important long-term carbon dioxide sinks. Driven by the difference in the partial pressure of CO_2 between the atmosphere and seawater, a portion of the anthropogenic CO_2 dissolves in the surface layer of the sea and, over periods ranging from decades to centuries, is finally transported into the deep sea by ocean currents.

The ocean is presently taking up 2 Gt of carbon annualy, which is equivalent to about 30% of the CO_2 anthropogenic emissions. Carbon dioxide that dissolves in seawater is found in three main forms: dissolved CO_2, bicarbonate ion (HCO_3^-) and carbonate ion (HCO_3^{2-}). The sum of these forms constitutes dissolved inorganic carbon (DSI).

Fluctutation and changes in oceanographic and hydrographic parameters of the Adriatic Sea has an impact on the diversity of Adriatic ichthyofauna. Extension of the area of distribution of thermophilous immigrant fish species from the Red Sea (Lessepsian migrants), the Indo-Pacific and the Atlantic Ocean and the Mediterranean has been recorded (Fig. 6-15).

The species *Saurida undosquamis* registered in the Adriatic is being caught in large quantities in the Aegean Sea. At the same its main food, the species *Leiognathus klunzingeri,* was found in the Adriatic, too. The fish *Saurida undosquamis* might become the alternative species for exploitation, but only after having examined potential effects on the food chain in the Adriatic in light of the possible impact of this predator on autochthonous species such as the pilchard (*Sardina pilchardus*) and European anchovy (*Engraulis encrasicolus*).

The bluefish (*Pomatomus saltator*), so far has been caught individually in the southern Adriatic only, but now considerable quantities are being caught in the southern and central Adriatic, too. The caught in the cove Tarska near Novigrad in Istria in December 2003 is the northernmost discovery of this species in the Adriatic. With the inflow of ingression waters into the Adriatic the number of two further species rises too: the common dolphinfish (*Coryphaena hippurus*) and the ribbon fish (*Trachypterus trachipteurs*), also potential species for catching.

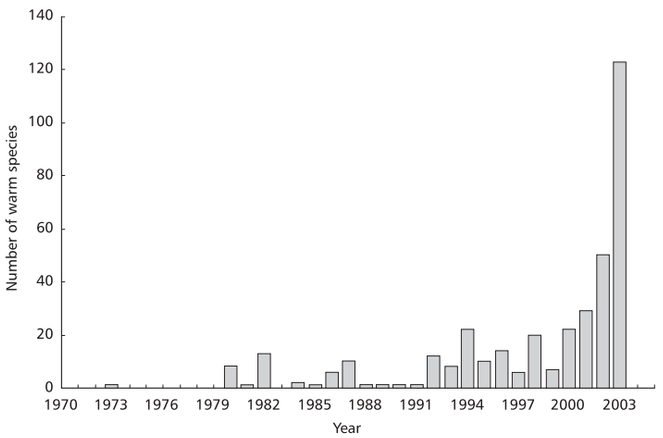


Figure 6-15: The cumulative number of thermophilic immigrant fish species in the Adriatic between 1973 and 2003

Changes were also identified as to the spawning of commercially very important fish species, primarily the pilchard and the sprat, which might have a substantial effect on the marine fishery. The pilchard spawning season is extended from September to June, while previously it took place from October till May. The sprat as a boreal species is moving the spawning site from the northern Adriatic (Kvarner, Kvarnerić) to areas further to the south. The Spanish sardine (*Sardinella aurita*) displays the areal extension by arriving into the northern Adriatic even in commercial volumes, despite a narrow temperature valence (it suffers a thermal shock at a temperature <10°C).

A large number of species is used as a biological indicator of changes in hydrological characteristics of the sea: triggerfish (*Balistes carolinensis*), Turkish wrasse (*Thalassoma pavo*), parrotfish (*Sparisoma cretense*), imperial blackfish (*Schedophilus ovalis*), bluefish (*Pomatomus saltator*), pompano (*Trachinotus ovatus*). The increase in number of these species and their moving towards the northern part of the Adriatic were recorded in 2002 and 2003. Therefore it is important to continue monitoring and researching into the biology and ecology of these species, because some of them can have an important share in the commercial catch and mariculture

6.4.7. Human Health

According to climate scenarios, a higher incidence of hot and dry summers with maximum daily and high night temperatures (over 25°C) is expected. A more frequent occurrence of heat waves will pose a serious threat to human health in future, especially as regards older people and chronic patients.

In winter vascular patients suffer most from situations of low air pressure, the air streaming southwards and unstable weather with rain, clouds and wind as a consequence of frontal bursts. The predicted decline in frequency of winter cold weather will cause the reduction in the number of coronary failures, cerebrovascular insults and asthmatic attacks in winter.

Low air temperatures affect adversely the respiratory diseases. Asthmatic attacks are more frequent in winter during cold high-pressure periods and in other seasons, especially in summer they are associated with the movements of a cold front.

Warmer and drier conditions as projected by climate scenarios may favour the spread of diseases borne by food or water, such as diarrhoea and dysentery.

A consequence of warmer summers and an extended vegetation season will be the rise in the number of patients becoming sensitized to and affected by respiratory allergies: seasonal allergic rhinitis and allergic asthma caused by pollen from the trees, grasses and weeds. It is estimated that every tenth inhabitant of Croatia suffers from pollen allergy caused by Ambrosia (*Ambrosia artemisiifolia* L.). During blooming one mature plant can release up to 80 million grains of

pollen, whose concentration may reach as much as 500 grains per m^3 of air and already 30 may cause a violent allergic reaction.

Climate changes stimulate the spread of diseases outside their natural seats. Due to global warming malaria is increasingly occurring in traditionally cool mountainous areas of Africa, Asia and South America inhabited by some 10% of the world's population. The coastal area of Croatia might also be threatened by malaria. The "tiger" moth (*Aedes albopictus*) which spreads from South-Eastern Asia and Oceania to other continents by trade and transport of used tyres and is a proved viral vector causing the fatal Dengue hemorrhagic fever, has been found for the first time in Croatia in October 2004.

In Croatia the tick-borne virus meningoencephalitis, caused by a forest ticks (*Ixodes ricinus*), occurs seasonally from spring to autumn, which correlates to tick activities. A warmer and longer autumn time contributes to extension of tick activities and mild winters favour the tick survival. The rise of the annual mean temperature shifts altitudinal limit for tick occurrence.

Little is known about the distribution of Lyme boreliosis, because this disease clarified only recently has been monitored for ten years only.

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7. Research and Systematic Observation

Danube River by the Batina

7.1 Global Climate Observing System (GCOS)

The Global Climate Observing System (GCOS) was established in 1992 and the Republic of Croatia, represented by the Meteorological and Hydrological Service, has since been its member. This system addresses all parts of the climate system – the atmospheric, oceanic, marine and terrestrial processes. It is intended to define and cover all the observations required for monitoring the climate system including satellite observations at the global, regional and national levels, and to ensure conditions for observation enhancement.

The Global Earth Observing System of Systems (GEOSS) is a new initiative taken with the objective to co-ordinate and enhances all current observing systems on the global level in support of the requirements of user areas: natural disasters, health, energy, climate, water, weather, ecosystems, agriculture and biodiversity. The Republic of Croatia joined the GEOSS in 2004.

Within the framework of the UNDP/GEF project CRO/03/G31/A/1G/99 "Climate Change Enabling Activity; Additional Financing for Capacity Building in Priority Areas" the Meteorological and Hydrological Services printed the publication *Croatian Climate Observing System*. In this publication all observations carried out, their methodology and the implementing agencies were specified in conformity with the GCOS methodology.

The observing systems existing in Croatia suffer from numerous deficiencies and barriers that are to be overcome. While some of the systems have reached an enviable organizational, qualitative and operational level, others are yet to be established or included in those existing.

The basic guidelines for future planning of observing systems in Croatia are:

- to participate actively and continuously in the GCOS and its partnership systems, with the principal aim to promote and cooperate in systematic observations and development of data archives related to all segments of the climate system (atmosphere, sea, land);
- to ensure cooperation between various observing systems at the national level;
- to plan actions for ensuring collection, exchange and use of data, to extend the area of their application in support of the local, regional and international requirements for data;
- to enhance the quality of observing, maintaining equipment and verifying and keeping data archives in the existing networks related to the climate system;
- to modernize the current observing networks and renew or establish observations not yet functional;
- to upgrade current climate databases and to develop a system that will improve access to data and facilitate their use and exchange;
- to continuously make efforts to save historical sets of data, to restore old records and to enter them into the machine processing medium, process and store;
- to develop strategies for the introduction of cosmic (satellite) observation programmes in all segments of the climate system (atmosphere, sea, land).

7.2 Data Collection and Systematic Observations in Croatia

The Republic of Croatia has a long tradition of monitoring elements in all segments of the climate system. The Meteorological and Hydrological Service is the fundamental institution for meteorology and hydrology and has been carrying out meteorological observations for operational needs, verifying, storing and publishing data since 1851.

Croatian institutions that maintain observing systems in the climate segments of atmosphere, sea and land are:

- Meteorological and Hydrological Service;
- Ministry of Sea, Tourism, Transport and Development (airports and road transport);

Table 7-1: Types and number of stations observing atmospheric parameters (state of 31 December 2004)

Type of stations	Number of stations
Ground-level meteorological stations	651
Ground-level main meteorological stations	38
Aeronautical meteorological stations	5
Climatological stations	109
Rain measuring stations with totalizers	326
Automatic meteorological stations with transfer of data to information system of the Meteorological and Hydrological Service	58
Automatic meteorological stations not included in the information system of the Meteorological and Hydrological Service	> 115
High-altitude weather stations	11
Radio-sonde stations	2
Pilot balloon stations	1
Radar stations	8
Atmospheric composition (pollution) measuring stations	50 + > 250
Ozone measuring stations	3
Sulphur dioxide etc. • by analysing daily precipitation samples • by automatic station	25 19 6
Nitrogen dioxide etc. • by analysing daily air flow through solution • by automatic station	16 12 4
Fume and aerosol properties	3
Greenhouse gases	4
Measuring air pollution parameters at local level	> 250

- Ministry of Environmental Protection, Physical Planning and Construction;
- Ministry of Health, Institute for Medical Research, Public Health Institute;
- Institute for Oceanography and Fishery;
- Hydrographic Institute;
- "Ruđer Bošković" Institute – Marine Research Centre;
- "Andrija Mohorovičić" Geophysical Institute, College of Science.

Apart from the institutions listed, numerous institutions and branches of economy run their own observing systems or individual stations. Table 7-1 shows all stations in Croatia involved in measuring atmospheric parameters.

7.3 Research into the Climate Change Impacts by Areas

7.3.1 Hydrology and Water Resources

The assessment of climate change impacts on waters, in a small, but from the aspect of geology and climate highly heterogeneous country as Croatia, depends on the assessment of changes in precipitation, on evapotranspiration and determination of future water requirements.

Present knowledge does not allow any precise assessment of climate change impacts in this sector. The preservation and development of water resources and agrotechnical systems, including the application of the water management strategy, are necessary preconditions for adaptation and factors that the economic progress of the state depends upon.

Extreme hydrological phenomena such as floodings, for example, are unavoidable, but the consequences may be mitigated. A single large flood may cause damage equivalent to 30-years investment in flood defence. A new strategic approach requires further investments in flood defence and an integrated approach to water resources management. Droughts are not a sporadic phenomenon. In Croatia the shortage of water is expected in the long run during the vegetation period and the tourist season, when water requirements reach their peak. It is therefore recommended to carry out research and to cooperate with other countries whose positive experiences in combating drought may be applied.

Within the framework of the hydrology and water resources sector the following activities of studying the impacts and adaptation to climate changes are recommended:

- monitoring and recording of hydrological and meteorological data ;
- assessment of climate change impacts on evapotranspiration and discharge;
- assessment of climate change impacts on water balance;
- assessment of climate change impacts on water management activities;
- preparation of regional studies of expected climate change impacts on water resources.

7.3.2 Agriculture

The guidelines for research in agriculture are:

- to identify areas in the world having already the climate profile similar to that predicted for Croatia and analyse the agricultural production technology and the product range in such areas;
- to initiate (finance) improvement projects focused on the development of populations and varieties adapted to soil types and climate conditions in Croatia's agricultural regions that will meet new requirements in the future;
- to initiate permanent research into existing agricultural crops (maize, wheat, potato, apple, wine grape) in the areas of Croatia or abroad (through international cooperation) containing already elements of the model predicted (e.g. testing maize or soya bean for drought under the conditions of the Dalmatian hinterland and islands);
- to investigate new systems of tillage, sowing (planting), sowing density, cultivation forms and fertilization that will maximally economize on humidity in the soil.

7.3.3 Forestry

The response of forest ecosystems to expected climate changes will be investigated by monitoring systematically:

- phenological manifestations of foliation, blooming, fruit-bearing, leaf-losing of certain characteristic tree species and the overall duration of the vegetation period;
- emergence, activities and number of certain forest pests;
- defoliation of crowns of major tree species;
- incidence of forest fires;
- changes in the floristic composition of urban forests;
- groundwater level oscillations;
- frequency and scope of occurrence of certain plant diseases;
- frequency of stormy weather and range of forest damages caused by wind;
- selected biological, physical and chemical variables of forests ecosystems, especially in zones of physical contact between the Mediterranean and continental climate;
- adaptation of individual provenances of forest tree species in provenance tests.

An efficient monitoring is only possible within the framework of a system for funding scientific and research projects of national importance and in cooperation with scientific institutions of neighbouring countries so as to ensure the coverage of an as wide as possible area of possible climate change effects.

The following research projects are recommended for implementation with the support of the Government of the Republic of Croatia, scientific institutions and Croatian Forests:

- Modelling changes in forest ecosystems of Croatia under the influence of climate change;
- Investigation of heavy metal content in forest ecosystems of Croatia;
- Natural regeneration of forests under the conditions of exposure to harmful impacts;
- Monitoring climate changes in testing the provenance of domestic and foreign forest tree species;
- Forest pests as an indicator of changed climate conditions.

In parks, public gardens and lines of trees found in settlements whose climate conditions favour plant communities of a colder climate it is recommended to investigate the composition of dendroflora and register the emergence of species naturally inhabiting the areas of warmer climates. The following species are suitable indicators of climate change impacts on dendroflora of urban forests of the continental area of Croatia: *Albizzia julibrissin* Durazz., *Caesalpinia gilliesii* (Wall. ex Hook.) Benth., *Camelia japonica* L., *Cedrus deodara* (Roxb.) G. Don, *Colutea arborescens* L., *Cupressus bakeri* Jeps., *Cupressus cashmeriana* Royle ex Carrière, *Cupressus lusitanica* Mill., *Cupressus sempervirens* L., *Cycas revoluta* Thunb., *Eriobotrya japonica* (Thunb.) Lindl., *Ficus carica* L., *Fraxinus ornus* L., *Juniperus oxycedrus* L., *Magnolia grandiflora* L., *Pinus halepensis* Mill., *Pinus pinaster* Aiton, *Poncirus trifoliata* (L.) Raf., *Punica granatum* L. etc.

Changes in forest ecosystems that occurred under the influence of climate changes may be monitored and quantified by a direct long-term monitoring of selected biological, physical and chemical variables *in situ*. Since a permanent long-term monitoring cannot cover all forest ecosystem types in Croatia it is recommended to monitor:

- forest types in zones of physical contact of the Mediterranean and continental climate;
- forest types on the tree-line in physical contact with mountain grasslands;
- forest types in which vulnerable species dominate (e.g. *Abies alba*);
- lowland forest types dependent upon additional wetting by floods and groundwater.

7.3.4 Biodiversity and Natural Terrestrial Ecosystems

The assessment of climate change impacts on terrestrial ecosystems is based on two groups of data: climatic prognostic models of global changes relating to the given area and data on terrestrial ecosystems in the widest context.

For the purpose of overcoming the shortage of adequate amounts and quality of data on thematic areas of biodiversity and natural terrestrial ecosystems it is necessary:

- to develop climate change models under one or more selected scenarios specifically for the area of Croatia, respecting national climatic and orographic peculiarities and applying sufficient resolution of basic data for the entire national territory (approx. 100 m pixel);
- to map current distribution of target indicator flora and fauna groups using the adequate methodology as a basis for monitoring changes and developing prognostic models;
- to increase resolution of Croatia's map of habitats from a scale of 1:100 000 to a scale of 1:25 000 as a basis for monitoring changes and for predictive models;
- to monitor the development, to acquire and apply in time the latest methodological achievements in the field of ecological modelling with the aim to develop as reliable prognostic scenarios as possible;
- to evaluate appropriateness of migratory ways for the most threatened flora and fauna taxa;
- to evaluate the migration of invasive flora and fauna taxa on the national territory;
- to establish a seed-bank for keeping the collected plant seed material and to collect samples of animal taxa, all this for the purpose of conserving the gene fund of endemic and vulnerable plant and wildlife taxa

7.3.5 Coast and Coastal Zone

The existing system for the collection of data relating to the sea level changes, sea current directions and forecasts of wind waves along the eastern Adriatic coast is to be improved.

A mareographic station founded in Bakar in 1929 and completely renewed in 2005 operates within the Geophysics Institute of the College of Science in Zagreb. The data registered by this station are regularly processed, published and used in preparation of scientific and specialized papers.

In addition to permanent measuring along the coast, periodic measurements are also carried out in coastal waters and the open sea. In 1998 hydrographic parameters and currents were measured in the area of the Velebit channel and during six months of 2002 and 2003 sea properties and the vertical profile of currents were monitored at the testing site in front of the island of Dugi otok.

The Geophysics Institute carries out research in the field of physical oceanography within the framework of domestic projects such as, for example, "Interactions of the Atmosphere and the Sea" and "System of Atmospheres – the Adriatic", and a number of international projects. The research work was focused on physical processes in the Adriatic and their dependence on atmospheric effects, and evolved from the empirical and theoretical analysis into the first attempts to forecast processes in the Croatian coastal zone.

The Croatian Hydrographic Institute in Split is implementing the project entitled "Web Presentation of Tides and Sea Levels along the Croatian Coast of the Adriatic Sea and Construction of the Corresponding Database" and providing the users with information on real (measured) sea level at the tide gauge station in Split and with scientific analyses of data measured.

In view of climate change impacts and the sea level rise, the coastal area management requires preparation of de-

tailed scientific and expert studies to estimate the maximum area of the coast that will be overflown or periodically flooded, the population exposed to flooding effects and the penetration of salt water into freshwater reservoirs.

These outputs will be used to formulate a national strategy and action plan for the prevention and mitigation of negative socio-economic effects, which should be adopted by competent government bodies. The strategy and action plan is to cover two main areas: protection of existing natural assets and man-made structures and facilities and instructions for the construction of new structures and facilities in the coastal zone.

7.3.6 Marine Ecosystems and Fish Resources

The research into marine ecosystems and fish resources is supplemented by oceanographic and hydrographic researches into the Adriatic Sea.

The following activities are recommended:

- implementation of multidisciplinary oceanographic and hydrographic research into the Adriatic Sea and identification of the process of interaction between the climate and marine ecosystems;
- investigation of changes in the composition and number of Adriatic fish populations;
- monitoring the commercial catch fluctuations for the purpose of preparing the action plan for adaptation of Croatia's sea fishery to climate changes;
- establishment of permanent monitoring of fish species that are biological indicators of changes in hydrographic properties of the sea with the final aim to get to know their biology and ecology.

7.3.7 Human Health

The investigation into the connection between individual meteorological parameters and the incidence of hospitalization of patients with cerebrovascular insult and myocardial infarction in Zagreb hospitals and the monitoring of blood coagulation parameters showed the adverse effect of cold winter periods and summer situations with warm and sulky weather.

In February 1999 the Zagreb polyclinic "Srčana" started investigating the effects of a meteorological stress on patients suffering from cardiac difficulties. The investigations performed in the Urgent Medicine Institute of Zagreb showed a considerable rise in the incidence of neurovegetative disorders accompanied by the drop in blood pressure, dizziness and collapse in situations of high temperatures of air, especially if persisting several days.

Meteorological and aerobiological parameters affect mostly the incidence of symptoms with pulmonary and cardiovascular patients. It is therefore of outmost importance to provide timely information on the atmospheric state and effects of such a state on the organism.

Biometeorological researches have been performed in Croatia for some 50 years now.

A bioforecast means monitoring the effects of atmospheric parameters on human health, informing the public daily on expected meteorological conditions and advising the public on how to protect health and prevent symptoms. Bioforecasts regularly appear in daily press and radio and television news broadcasts.

Pollen calendars provide information on the presence of (especially increased) concentrations of pollen of alergogenic plants in the air of a specific climate area based on data obtained by measuring continuously pollen concentrations in the air at measuring stations. This enables the patients to adapt their activities and thus minimize the contact with allergens.

The first expert conference on climate changes and their effects on health was organized by the Croatian Society for Environmental Health and took place in Zagreb on 24 May 2001.

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8. Education, Training and Public Awareness

School children

8.1 Education and Training

Education is of vital importance for implementation of sustainable development that implies economic and social growth and development, preservation of environmental quality and rational exploitation of natural resources. Environmental education and sustainable development represent the essential components of life-long learning. The school is tasked with designing and introducing environmental education lessons with the aim to help pupils acquire environmental knowledge and formulate positive attitudes and behaviour towards the environment.

The education system of the Republic of Croatia consists of the pre-school, primary, secondary and university education. In 2005 various programmes carried out in 1,106 kindergartens covered 106,111 pre-schoolers. Primary education is provided by 837 primary schools and secondary by 411 secondary schools with a total of 577,613 schoolchildren. High education is provided by universities and professional courses of studies through 109 institutions of higher education, of which there are 6 universities comprising 72 faculties, academies of arts and schools of higher education, 10 public polytechnics, 4 independent schools of professional higher education, 2 private polytechnics and 14 private institutions of higher education. In 2005 a total of 132,952 students entered institutions of higher education and 18,190 students graduated. Since 2003 Croatia has been rapidly carrying out reforms in university education so as to bring the system in line with national requirements and European standards.

It is the view of the Ministry of Science, Education and Sports, responsible for institutional education that all school subjects and activities must contribute to the development of ecological awareness and environmental education of students.

In the Republic of Croatia the primary school syllabus determines programmes of compulsory and optional courses for schoolchildren from the first to the eighth grade and guidelines for other forms of educational activities of primary schools. Environmental and sustainable development education is an activity integrated into teaching and other forms of work. The knowledge of climate changes is acquired through regular primary school lessons in nature and society, nature, biology, chemistry and geography, including numerous out-of-school activities.

Since 1996 130 schools of Croatia have been included in the scientific and educational programme GLOBE (Global Learning and Observation to Benefit the Environment), with schoolchildren performing systematic measurements in the environment (atmosphere: weather and climate; water: physical and chemical properties; soil: structure and chemism; vegetation cover and biological characteristics of the relevant area). The application of information technology tools ensures connectivity and information exchange among over 16,000 schools in 109 countries worldwide. Among 34 best schools in the world by the quality of measurements 4 come from Croatia.

Eco-schools represent the international programme of the Foundation for Environmental Education (FEE) that the Republic of Croatia joined as a member in full standing in 1999. In implementing programmes at the level of entire schools in cooperation with parents and the local community special attention is given to waste reduction and disposal, reasonable use of energy and water and arrangement of schoolyards. The NGO Nature Friends Movement "Our Beautiful Homeland" acts as a national coordinator of this programme. In 2004 a total of 184 schools with 67,700 schoolchildren or some 11.7% of the total schoolchildren population had the status of an "Eco-school".

The eco-quiz "Our Beautiful Homeland" is a competition in knowledge, a meeting of schoolchildren of Croatia's primary and secondary schools organized by the Nature Friends Movement "Our Beautiful Homeland" and the Education and Teacher Training Agency of the Republic of Croatia.

The objective of the quiz is to develop the awareness of environmental protection and sustainable development at the level of primary and secondary schools. The competition takes place at the school, county and national level and the schoolchildren compete in the knowledge of nature, biology, chemistry and geography.

The Ministry of Environmental Protection, Physical Planning and Construction issues periodically printed materials (manuals, educational booklets, picture-books) and supplies multimedia information on climate change issues and ozone layer protection to be used for teaching in primary and secondary schools. So in 2005 a school guide on climate changes was published with the aim to improve knowledge and raise awareness of climate changes among the young population.

In implementing the project "Educational Campaign for Raising Awareness and Knowledge of Climate Changes 2002", the Croatian centre "Environmental Knowledge" developed the first educational tool in form of presentations showing some thirty slides on causes and consequences of climate changes in the world and Croatia. In cooperation with the Education and Teacher Training Agency this tool was presented and tested at several meetings with secondary school teachers in 2003.

The implementation of the European Commission LIFE-Third Countries project "Capacity Building for Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol in the Republic of Croatia" is accompanied by the development of a new educational tool "Climate Changes – the World and Croatia" that will consist of an introductory informative and educational presentation, a booklet on causes and consequences of climate changes in the world and in Croatia and an interactive CD for the youth.

Considering the permanent progress in knowledge, environmental education at the level of the universities, polytechnics, scientific and research institutes and other institutions is not sufficient. At institutions of higher education the area of environmental protection, sustainable development and climate change is addressed through

natural, technical, biomedicine, biotechnical, social and humanistic sciences within the framework of numerous compulsory or elective courses of undergraduate and post-graduate studies.

The postgraduate scientific studies in environmental protection are organized at the University of Zagreb: Ecology, in the field of Biology (Faculty of Science); Environmental Protection (Faculty of Mining, Geology and Petroleum Engineering) and Eco-Engineering (Faculty of Chemical Engineering and Technology), and Protection of Nature and Environment at the Josip Juraj Strossmayer University of Osijek.

8.2 Raising Public Awareness

Activities in the field of information and education undertaken in the period between 2002 and 2005 relate to somewhat improved mass media coverage and to periodic, but constant activities of certain environmental associations in the field of non-institutional education. With the start of implementing the LIFE project "Capacity Building for Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol in the Republic of Croatia" in 2005, the Croatian centre "Environmental Knowledge" from Zagreb organized activities of education and raising public awareness.

The Meteorological and Hydrological Service informs the public, users and expert community about climate evaluation on the web portal www.meteo.hr and by mass media releases on a monthly, seasonal and yearly basis. It also publishes the monthly "Meteorological and Hydrological Bulletin" and the yearbook "Review" containing data on climate monitoring and evaluation for the relevant calendar year.

In Croatia daily and weekly press cover various areas of environmental protection such as climate and climate changes, harmful effects of natural disasters (drought, heat, floods, storms), the use of renewable energy sources and biofuel and international commitments and activities of the Republic of Croatia in implementing the Framework Convention (UNFCCC) and the Kyoto Protocol. In doing this the daily "Vjesnik" is particularly systematic.

In August 2004 the daily newspaper "Večernji list" in cooperation with the Ministry of Environmental Protection, Physical Planning and Construction and the UN Environment Programme (UNEP) published an educative booklet of 16 pages "Ozone Layer Protection and Climate Changes" as a supplement to a daily issue. A part of the total print run of 150,000 issues was distributed to primary and secondary schools throughout Croatia.

In their news, scientific and educational broadcasts, radio and television stations occasionally provide information on climate changes.

In the context of the web portal of the Ministry of Environmental Protection, Physical Planning and Construction the web pages "Let's Save the Climate" were launched, dealing with climate changes and projects implemented towards their mitigation. The web portal „www.MojaEnergija.hr" created by the Society for Sustainable Development Design promotes sustainable development in all segments of the society, especially in energy sector, as well as the web portal of the Hrvoje Požar Energy Institute. The web portal of the "Green Action" organization contains web pages with information on activities of the association relating to climate changes and promotion of renewable energy sources.

In 2002 the Ministry of Environmental Protection, Physical Planning and Construction published a book "Renewable Energy Sources and Environmental Protection in Croatia" with the aim to popularize renewable energy sources. The Hrvoje Požar Energy Institute published a booklet "A Guide through Energy Efficient Building" in 2005.

Since 2002 the European Mobility Week has been held in Croatia each year from 16-22 September. The end of the week, 22 September, was proclaimed "No-car Day" with the aim to raise public awareness of the seriousness of pollution caused by excessive use of cars, with an emphasis on the return of pedestrians, cyclists and public transport to the town centre.

Under the sponsorship of the Ministry of Science, Education and Sport a "Festival of Science" has been held in four university cities - Zagreb, Osijek, Rijeka and Split - since 2003 with the aim to make the importance and achievements of the science known to the general public. Climate changes were the topics of the Festival of Science that took place from 18-24 April 2006 and included educational exhibitions and lectures on monitoring the climate in Croatia, climate changes and international commitments of Croatia under the UN Framework Convention on Climate Change and the Kyoto Protocol. At a workshop organized for schoolchildren the greenhouse effect was demonstrated and explained using simple laboratory exercises.

8.3 Activities of Non-governmental Organizations

According to the data provided by the Ministry of Environmental Protection, Physical Planning and Construction there are presently 270 non-governmental organizations registered for environmental protection and conservation activities in Croatia.

The climate change issues are from time to time systematically dealt with by the "Green Action" organization from Zagreb, a branch of the international organization „Friends of the Earth". In the period between 2002 and 2005 several public forums, street events and conferences took place.

The forum "Let's Prevent the Climatic Chaos and Launch Solarization of Croatia" was organized in September 2004. On that occasion a carbon dinosaur, a 10-m tall balloon touring numerous European cities "visited" Zagreb and Rijeka.

A forum "Effects of Oil Crisis and Climate Changes on Transport Development of Croatia" was held in December

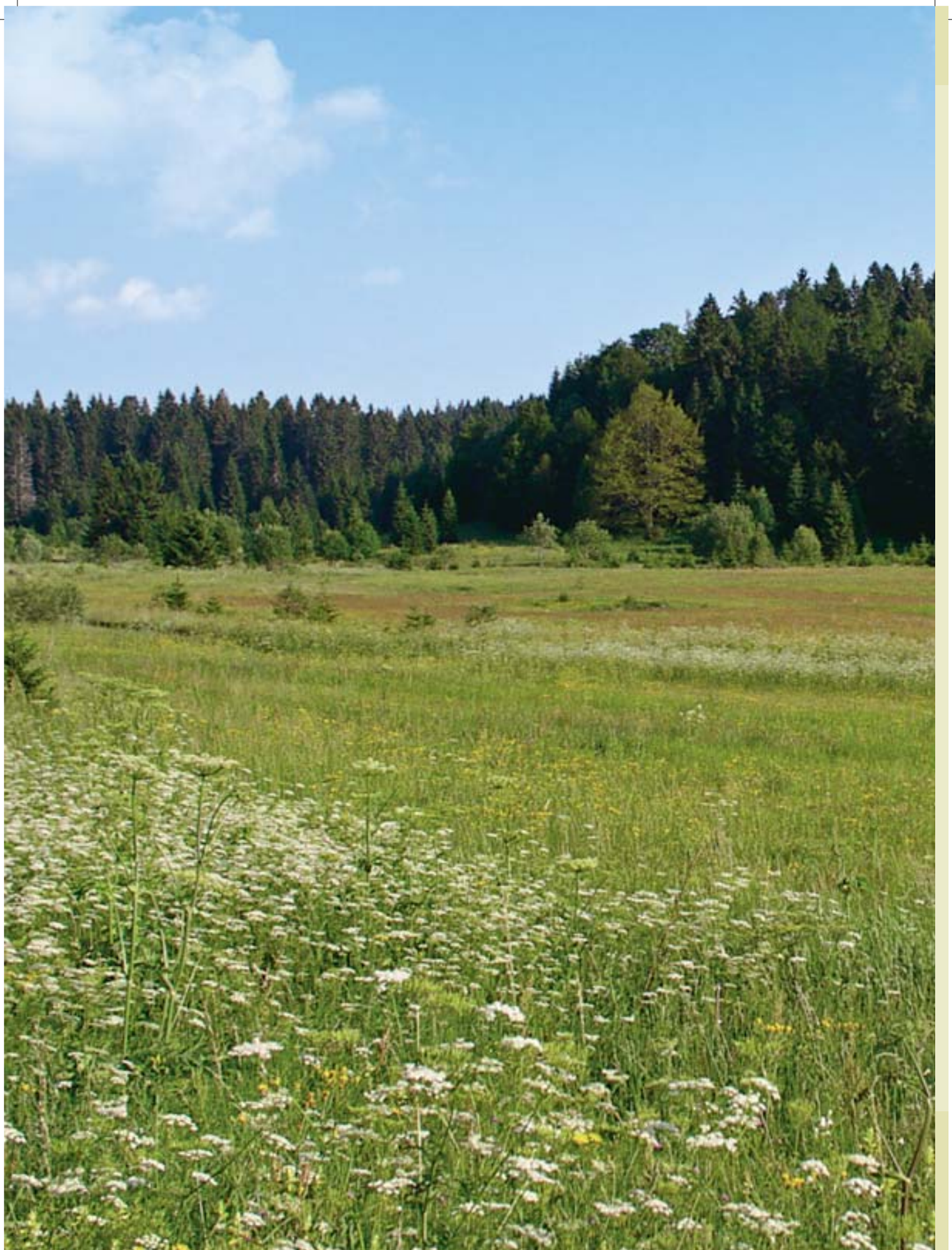
2004. At the press conference the public was informed of the entering into force of the Kyoto Protocol on 16 February 2005.

Particularly lively and systematic activities of "Green Action" are focused on the issue of renewable energy sources and on advocating publicly the solarization of Croatia: the "Burin" newspaper, the Solar Academy, energy guidance centre, practical projects etc.

Highly productive activities towards recognition of renewable energy sources are performed by the "Green Network of Activist Group" (Z.M.A.G.) from Zagreb.

The first major Greenpeace action took place in Osijek and Vukovar from 27-28 July 2005 and was hosted by the "Green Osijek" organization from Osijek. Within the framework of the European campaign "Energy Revolution Tour 2005" the Greenpeace vessel "Anna" sailed the river Danube presenting the educational exhibition on climate changes and advantages of using renewable energy sources.

In comparison with the period preceding the First National Communication, activities of education and raising public awareness may be said to have been launched to a certain degree, but without coming in full swing. In the context of the Kyoto Protocol entering into force the domestic interest in education in climate changes and the related financial support are expected to assume even greater public importance.



Gorski kotar

APPENDIX: Greenhouse Gas Inventory Information – Tables

Croatia Year 1990	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**20984.8**	**67.823**	**1424.3**	**0.258**	**79.9**	**NO**	**NO**	**22488.9**	**70.8**
A. Fuel Combustion (Sectoral Approach)	20568.8	9.013	189.3	0.258	79.9	NO	NO	20838.0	65.6
1. Energy Industries	6823.4	0.224	4.7	0.053	16.4	NO	NO	6844.5	21.5
2. Manufact. Industries and Construction	5645.3	0.482	10.1	0.059	18.2	NO	NO	5673.5	17.9
3. Transport	4041.4	0.777	16.3	0.040	12.5	NO	NO	4070.3	12.8
4. Comm./Inst.., Resid., Agric., Forestry	3619.8	7.520	157.9	0.106	32.7	NO	NO	3810.5	12.0
5. Other	438.9	0.009	0.2	0.000	0.1	NO	NO	439.2	1.4
B. Fugitive Emissions from Fuel	415.9	58.810	1235.0	NO	NO	NO	NO	1651.0	5.2
1. Soid Fuels	NO	2.3	48.8	NO	NO	NO	NO	48.8	0.2
2. Oil and natural Gas	415.9	56.488	1186.3	NO	NO	NO	NO	1602.2	5.0
2. Industrial Processes	**2050.4**	**0.752**	**15.8**	**2.992**	**927.6**	**0.140**	**938.600**	**3932.3**	**12.4**
A. Mineral Products	1251.6	NO	NO	NO	NO	NO	NO	1251.6	3.9
B. Chemical Industry	491.6	0.752	15.8	2.992	927.6	NO	NO	1434.9	4.5
C. Metal Production	307.2	NO	NO	NO	NO	0.140	938.600	1245.8	3.9
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**75.032**	**1575.7**	**9.147**	**2835.5**	**NO**	**NO**	**4411.2**	**13.9**
A. Enteric Fermentation	NO	64.036	1344.8	NO	NO	NO	NO	1344.8	4.2
B. Manure Management	NO	10.996	230.9	1.215	376.7	NO	NO	607.6	1.9
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	7.932	2458.8	NO	NO	2458.8	7.7
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-12687.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-12687.9**	**-39.9**
A. Forest and Woody Biomass Change	-12687.9	NO	NO	NO	NO	NO	NO	-12687.9	-39.9
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**37.774**	**793.3**	**0.450**	**139.7**	**NO**	**NO**	**932.9**	**2.9**
A. Solid Waste Disposal on Land	NE	37.774	793.3	NO	NO	NO	NO	793.3	2.5
B. Wastewater Handling	NO	NE	NE	0.450	139.7	NO	NO	139.7	0.4
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**10347.3**	**181.381**	**3809.0**	**12.847**	**3982.6**	**0.140**	**938.600**	**19077.5**	**60.1**
Total Emissions without LULUCF	**23035.1**	**181.381**	**3809.0**	**12.847**	**3982.6**	**0.140**	**938.600**	**31765.4**	**100.0**
Share of Gases in Total Em./Rem.	**54.2**		**20.0**		**20.9**		**4.9**	**100.0**	
Share of Gases in Total Emissions	**72.5**		**12.0**		**12.5**		**3.0**	**100.0**	

Memo Items:									
International Bunkers	310.8	0.009	0.2	0.007	2.0	NO	NO	313.0	
Aviation	202.3	0.001	0.0	0.006	1.8	NO	NO	204.1	
Marine	108.5	0.007	0.2	0.001	0.3	NO	NO	109.0	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	2436.8							2436.8	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 1991	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**15200.1**	**59.736**	**1254.5**	**0.196**	**60.7**	**NO**	**NO**	**16515.2**	**66.6**
A. Fuel Combustion (Sectoral Approach)	14744.2	6.063	127.3	0.196	60.7	NO	NO	14932.3	60.2
1. Energy Industries	4599.8	0.149	3.1	0.036	11.1	NO	NO	4614.1	18.6
2. Manufact. Industries and Construction	3979.2	0.372	7.8	0.043	13.4	NO	NO	4000.4	16.1
3. Transport	2912.6	0.627	13.2	0.045	14.1	NO	NO	2939.8	11.8
4. Comm./Inst.., Resid., Agric., Forestry	3006.9	4.916	103.2	0.071	22.1	NO	NO	3132.3	12.6
5. Other	245.7	NO	NO	NO	NO	NO	NO	245.7	1.0
B. Fugitive Emissions from Fuel	455.8	53.673	1127.1	NO	NO	NO	NO	1583.0	6.4
1. Soid Fuels	NO	2.1	43.5	NO	NO	NO	NO	43.5	0.2
2. Oil and natural Gas	455.8	51.604	1083.7	NO	NO	NO	NO	1539.5	6.2
2. Industrial Processes	**1520.1**	**0.547**	**11.5**	**2.628**	**814.7**	**0.100**	**648.300**	**2994.5**	**12.1**
A. Mineral Products	790.0	NO	NO	NO	NO	NO	NO	790.0	3.2
B. Chemical Industry	471.5	0.547	11.5	2.628	814.7	NO	NO	1297.7	5.2
C. Metal Production	258.6	NO	NO	NO	NO	0.100	648.300	906.9	3.7
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**71.784**	**1507.5**	**9.276**	**2875.7**	**NO**	**NO**	**4383.2**	**17.7**
A. Enteric Fermentation	NO	60.991	1280.8	NO	NO	NO	NO	1280.8	5.2
B. Manure Management	NO	10.793	226.7	1.165	361.3	NO	NO	587.9	2.4
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	8.111	2514.4	NO	NO	2514.4	10.1
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-12687.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-12687.9**	**-51.1**
A. Forest and Woody Biomass Change	-12687.9	NO	NO	NO	NO	NO	NO	-12687.9	-51.1
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**37.025**	**777.5**	**0.450**	**139.4**	**NO**	**NO**	**916.9**	**3.7**
A. Solid Waste Disposal on Land	NE	37.025	777.5	NO	NO	NO	NO	777.5	3.1
B. Wastewater Handling	NO	NE	NE	0.450	139.4	NO	NO	139.4	0.6
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**4032.3**	**169.092**	**3550.9**	**12.550**	**3890.4**	**0.100**	**648.300**	**12121.9**	**48.9**
Total Emissions without LULUCF	**16720.1**	**169.092**	**3550.9**	**12.550**	**3890.4**	**0.100**	**648.300**	**24809.8**	**100.0**
Share of Gases in Total Em./Rem.	**33.3**		**29.3**		**32.1**		**5.3**	**100.0**	
Share of Gases in Total Emissions	**67.4**		**14.3**		**15.7**		**2.6**	**100.0**	

Memo Items:									
International Bunkers	88.4	0.005	0.1	0.001	0.3	NO	NO	88.9	
Aviation	17.1	0.000	0.0	0.000	0.1	NO	NO	17.3	
Marine	71.3	0.005	0.1	0.001	0.2	NO	NO	71.6	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1680.4							1680.4	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 1992	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**14186.5**	**58.777**	**1234.3**	**0.195**	**60.5**	**NO**	**NO**	**15481.3**	**67.8**
A. Fuel Combustion (Sectoral Approach)	13709.2	4.946	103.9	0.195	60.5	NO	NO	13873.5	60.7
1. Energy Industries	5178.7	0.162	3.4	0.040	12.4	NO	NO	5194.5	22.7
2. Manufact. Industries and Construction	3065.5	0.299	6.3	0.033	10.1	NO	NO	3081.9	13.5
3. Transport	2777.0	0.602	12.6	0.062	19.3	NO	NO	2809.0	12.3
4. Comm./Inst.., Resid., Agric., Forestry	2498.9	3.883	81.5	0.060	18.6	NO	NO	2599.0	11.4
5. Other	189.1	NO	NO	NO	NO	NO	NO	189.1	0.8
B. Fugitive Emissions from Fuel	477.3	53.831	1130.5	NO	NO	NO	NO	1607.8	7.0
1. Soid Fuels	NO	1.6	33.8	NO	NO	NO	NO	33.8	0.1
2. Oil and natural Gas	477.3	52.223	1096.7	NO	NO	NO	NO	1574.0	6.9
2. Industrial Processes	**1578.4**	**0.464**	**9.7**	**3.436**	**1065.2**	**NO**	**NO**	**2653.4**	**11.6**
A. Mineral Products	854.4	NO	NO	NO	NO	NO	NO	854.4	3.7
B. Chemical Industry	606.8	0.464	9.7	3.436	1065.2	NO	NO	1681.7	7.4
C. Metal Production	117.3	NO	NO	NO	NO	NO	NO	117.3	0.5
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**66.906**	**1405.0**	**7.734**	**2397.6**	**NO**	**NO**	**3802.6**	**16.7**
A. Enteric Fermentation	NO	56.477	1186.0	NO	NO	NO	NO	1186.0	5.2
B. Manure Management	NO	10.429	219.0	1.090	338.0	NO	NO	557.0	2.4
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.644	2059.6	NO	NO	2059.6	9.0
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-12687.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-12687.9**	**-55.6**
A. Forest and Woody Biomass Change	-12687.9	NO	NO	NO	NO	NO	NO	-12687.9	-55.6
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**36.593**	**768.4**	**0.428**	**132.8**	**NO**	**NO**	**901.3**	**3.9**
A. Solid Waste Disposal on Land	NE	36.593	768.4	NO	NO	NO	NO	768.4	3.4
B. Wastewater Handling	NO	NE	NE	0.428	132.8	NO	NO	132.8	0.6
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**3077.1**	**162.740**	**3417.5**	**11.794**	**3656.1**	**0.000**	**0.000**	**10150.8**	**44.4**
Total Emissions without LULUCF	**15765.0**	**162.740**	**3417.5**	**11.794**	**3656.1**	**0.000**	**0.000**	**22838.6**	**100.0**
Share of Gases in Total Em./Rem.	**30.3**		**33.7**		**36.0**		**0.0**	**100.0**	
Share of Gases in Total Emissions	**69.0**		**15.0**		**16.0**		**0.0**	**100.0**	

Memo Items:									
International Bunkers	127.0	0.006	0.1	0.002	0.6	NO	NO	127.7	
Aviation	46.4	0.000	0.0	0.001	0.4	NO	NO	46.8	
Marine	80.6	0.005	0.1	0.001	0.2	NO	NO	80.9	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1462.3							1462.3	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 1993	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**15146.0**	**63.568**	**1334.9**	**0.216**	**67.0**	**NO**	**NO**	**16547.9**	**72.1**
A. Fuel Combustion (Sectoral Approach)	14469.9	4.633	97.3	0.216	67.0	NO	NO	14634.2	63.8
1. Energy Industries	5850.7	0.182	3.8	0.041	12.7	NO	NO	5867.3	25.6
2. Manufact. Industries and Construction	2992.0	0.291	6.1	0.031	9.7	NO	NO	3007.9	13.1
3. Transport	2944.6	0.637	13.4	0.087	27.1	NO	NO	2985.1	13.0
4. Comm./Inst.., Resid., Agric., Forestry	2488.2	3.524	74.0	0.056	17.4	NO	NO	2579.6	11.2
5. Other	194.3	NO	NO	NO	NO	NO	NO	194.3	0.8
B. Fugitive Emissions from Fuel	676.1	58.935	1237.6	NO	NO	NO	NO	1913.8	8.3
1. Soid Fuels	NO	1.5	32.3	NO	NO	NO	NO	32.3	0.1
2. Oil and natural Gas	676.1	57.397	1205.3	NO	NO	NO	NO	1881.5	8.2
2. Industrial Processes	**1253.6**	**0.499**	**10.5**	**2.590**	**803.0**	**NO**	**NO**	**2067.0**	**9.0**
A. Mineral Products	730.9	NO	NO	NO	NO	NO	NO	730.9	3.2
B. Chemical Industry	471.3	0.499	10.5	2.590	803.0	NO	NO	1284.8	5.6
C. Metal Production	51.3	NO	NO	NO	NO	NO	NO	51.3	0.2
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**55.547**	**1166.5**	**7.262**	**2251.2**	**NO**	**NO**	**3417.7**	**14.9**
A. Enteric Fermentation	NO	47.157	990.3	NO	NO	NO	NO	990.3	4.3
B. Manure Management	NO	8.390	176.2	0.907	281.2	NO	NO	457.4	2.0
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.355	1970.0	NO	NO	1970.0	8.6
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-12687.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-12687.9**	**-55.3**
A. Forest and Woody Biomass Change	-12687.9	NO	NO	NO	NO	NO	NO	-12687.9	-55.3
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**37.185**	**780.9**	**0.424**	**131.5**	**NO**	**NO**	**912.4**	**4.0**
A. Solid Waste Disposal on Land	NE	37.185	780.9	NO	NO	NO	NO	780.9	3.4
B. Wastewater Handling	NO	NE	NE	0.424	131.5	NO	NO	131.5	0.6
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**3711.7**	**156.799**	**3292.8**	**10.492**	**3252.6**	**0.000**	**0.000**	**10257.1**	**44.7**
Total Emissions without LULUCF	**16399.6**	**156.799**	**3292.8**	**10.492**	**3252.6**	**0.000**	**0.000**	**22945.0**	**100.0**
Share of Gases in Total Em./Rem.	**36.2**		**32.1**		**31.7**		**0.0**	**100.0**	
Share of Gases in Total Emissions	**71.5**		**14.4**		**14.2**		**0.0**	**100.0**	

Memo Items:									
International Bunkers	245.2	0.009	0.2	0.005	1.4	NO	NO	246.8	
Aviation	130.7	0.001	0.0	0.004	1.1	NO	NO	131.9	
Marine	114.5	0.008	0.2	0.001	0.3	NO	NO	115.0	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1384.9							1384.9	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 1994	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**14235.0**	**57.965**	**1217.3**	**0.234**	**72.6**	**NO**	**NO**	**15524.9**	**70.5**
A. Fuel Combustion (Sectoral Approach)	13630.1	4.830	101.4	0.234	72.6	NO	NO	13804.2	62.7
1. Energy Industries	4590.5	0.151	3.2	0.030	9.3	NO	NO	4603.0	20.9
2. Manufact. Industries and Construction	3149.0	0.283	5.9	0.030	9.2	NO	NO	3164.1	14.4
3. Transport	3118.5	0.729	15.3	0.115	35.6	NO	NO	3169.4	14.4
4. Comm./Inst.., Resid., Agric., Forestry	2573.1	3.668	77.0	0.060	18.5	NO	NO	2668.6	12.1
5. Other	199.1	NO	NO	NO	NO	NO	NO	199.1	0.9
B. Fugitive Emissions from Fuel	604.9	53.135	1115.8	NO	NO	NO	NO	1720.7	7.8
1. Soid Fuels	NO	1.4	29.0	NO	NO	NO	NO	29.0	0.1
2. Oil and natural Gas	604.9	51.756	1086.9	NO	NO	NO	NO	1691.7	7.7
2. Industrial Processes	**1438.9**	**0.479**	**10.1**	**2.801**	**868.3**	**NO**	**NO**	**2317.3**	**10.5**
A. Mineral Products	884.2	NO	NO	NO	NO	NO	NO	884.2	4.0
B. Chemical Industry	474.7	0.479	10.1	2.801	868.3	NO	NO	1353.1	6.1
C. Metal Production	80.0	NO	NO	NO	NO	NO	NO	80.0	0.4
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**50.685**	**1064.4**	**7.041**	**2182.8**	**NO**	**NO**	**3247.2**	**14.7**
A. Enteric Fermentation	NO	42.294	888.2	NO	NO	NO	NO	888.2	4.0
B. Manure Management	NO	8.391	176.2	0.836	259.1	NO	NO	435.3	2.0
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.206	1923.7	NO	NO	1923.7	8.7
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-12687.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-12687.9**	**-57.6**
A. Forest and Woody Biomass Change	-12687.9	NO	NO	NO	NO	NO	NO	-12687.9	-57.6
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**38.411**	**806.6**	**0.421**	**130.7**	**NO**	**NO**	**937.3**	**4.3**
A. Solid Waste Disposal on Land	NE	38.411	806.6	NO	NO	NO	NO	806.6	3.7
B. Wastewater Handling	NO	NE	NE	0.421	130.7	NO	NO	130.7	0.6
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**2986.1**	**147.540**	**3098.3**	**10.498**	**3254.5**	**0.000**	**0.000**	**9338.9**	**42.4**
Total Emissions without LULUCF	**15674.0**	**147.540**	**3098.3**	**10.498**	**3254.5**	**0.000**	**0.000**	**22026.8**	**100.0**
Share of Gases in Total Em./Rem.	**32.0**		**33.2**		**34.8**		**0.0**	**100.0**	
Share of Gases in Total Emissions	**71.2**		**14.1**		**14.8**		**0.0**	**100.0**	

Memo Items:									
International Bunkers	337.8	0.011	0.2	0.007	2.1	NO	NO	340.1	
Aviation	199.5	0.001	0.0	0.006	1.7	NO	NO	201.2	
Marine	138.3	0.009	0.2	0.001	0.3	NO	NO	138.9	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1407.5							1407.5	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 1995	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**15081.9**	**58.409**	**1226.6**	**0.272**	**84.4**	**NO**	**NO**	**16392.9**	**72.8**
A. Fuel Combustion (Sectoral Approach)	14384.9	5.019	105.4	0.272	84.4	NO	NO	14574.8	64.7
1. Energy Industries	5176.4	0.183	3.9	0.038	11.8	NO	NO	5192.1	23.0
2. Manufact. Industries and Construction	2900.5	0.264	5.6	0.028	8.8	NO	NO	2914.9	12.9
3. Transport	3329.5	0.807	17.0	0.144	44.8	NO	NO	3391.2	15.1
4. Comm./Inst.., Resid., Agric., Forestry	2785.4	3.764	79.0	0.061	19.0	NO	NO	2883.5	12.8
5. Other	193.1	NO	NO	NO	NO	NO	NO	193.1	0.9
B. Fugitive Emissions from Fuel	696.9	53.391	1121.2	NO	NO	NO	NO	1818.1	8.1
1. Soid Fuels	NO	1.1	23.1	NO	NO	NO	NO	23.1	0.1
2. Oil and natural Gas	696.9	52.292	1098.1	NO	NO	NO	NO	1795.1	8.0
2. Industrial Processes	**1169.6**	**0.400**	**8.4**	**2.694**	**835.0**	**0.006**	**7.800**	**2020.8**	**9.0**
A. Mineral Products	672.7	NO	NO	NO	NO	NO	NO	672.7	3.0
B. Chemical Industry	462.9	0.400	8.4	2.694	835.0	NO	NO	1306.3	5.8
C. Metal Production	34.0	NO	NO	NO	NO	NO	NO	34.0	0.2
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	0.006	7.800	7.8	0.0
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**48.016**	**1008.3**	**6.816**	**2113.0**	**NO**	**NO**	**3121.3**	**13.9**
A. Enteric Fermentation	NO	40.431	849.1	NO	NO	NO	NO	849.1	3.8
B. Manure Management	NO	7.585	159.3	0.796	246.9	NO	NO	406.2	1.8
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.020	1866.1	NO	NO	1866.1	8.3
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-12687.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-12687.9**	**-56.3**
A. Forest and Woody Biomass Change	-12687.9	NO	NO	NO	NO	NO	NO	-12687.9	-56.3
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**41.148**	**864.1**	**0.421**	**130.5**	**NO**	**NO**	**994.6**	**4.4**
A. Solid Waste Disposal on Land	NE	41.148	864.1	NO	NO	NO	NO	864.1	3.8
B. Wastewater Handling	NO	NE	NE	0.421	130.5	NO	NO	130.5	0.6
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**3563.6**	**147.974**	**3107.4**	**10.203**	**3163.0**	**0.006**	**7.800**	**9841.8**	**43.7**
Total Emissions without LULUCF	**16251.4**	**147.974**	**3107.4**	**10.203**	**3163.0**	**0.006**	**7.800**	**22529.6**	**100.0**
Share of Gases in Total Em./Rem.	**36.2**		**31.6**		**32.1**		**0.1**	**100.0**	
Share of Gases in Total Emissions	**72.1**		**13.8**		**14.0**		**0.0**	**100.0**	

Memo Items:									
International Bunkers	277.2	0.008	0.2	0.006	1.8	NO	NO	279.2	
Aviation	175.2	0.001	0.0	0.005	1.5	NO	NO	176.8	
Marine	102.0	0.007	0.1	0.001	0.3	NO	NO	102.4	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1458.0							1458.0	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 1996	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**15722.9**	**61.483**	**1291.1**	**0.319**	**98.9**	**NO**	**NO**	**17112.9**	**73.8**
A. Fuel Combustion (Sectoral Approach)	15078.8	5.947	124.9	0.319	98.9	NO	NO	15302.6	66.0
1. Energy Industries	5107.0	0.175	3.7	0.035	10.7	NO	NO	5121.4	22.1
2. Manufact. Industries and Construction	2965.9	0.266	5.6	0.028	8.8	NO	NO	2980.3	12.9
3. Transport	3668.1	0.921	19.3	0.182	56.6	NO	NO	3744.0	16.1
4. Comm./Inst.., Resid., Agric., Forestry	3132.1	4.585	96.3	0.074	22.9	NO	NO	3251.2	14.0
5. Other	205.8	NO	NO	NO	NO	NO	NO	205.8	0.9
B. Fugitive Emissions from Fuel	644.0	55.536	1166.3	NO	NO	NO	NO	1810.3	7.8
1. Soid Fuels	NO	0.9	18.6	NO	NO	NO	NO	18.6	0.1
2. Oil and natural Gas	644.0	54.650	1147.7	NO	NO	NO	NO	1791.7	7.7
2. Industrial Processes	**1249.7**	**0.378**	**7.9**	**2.508**	**777.5**	**0.019**	**60.150**	**2095.3**	**9.0**
A. Mineral Products	733.1	NO	NO	NO	NO	NO	NO	733.1	3.2
B. Chemical Industry	502.7	0.378	7.9	2.508	777.5	NO	NO	1288.2	5.6
C. Metal Production	13.9	NO	NO	NO	NO	NO	NO	13.9	0.1
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	0.019	60.150	60.2	0.3
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**45.335**	**952.0**	**6.583**	**2040.8**	**NO**	**NO**	**2992.9**	**12.9**
A. Enteric Fermentation	NO	37.860	795.1	NO	NO	NO	NO	795.1	3.4
B. Manure Management	NO	7.475	157.0	0.743	230.4	NO	NO	387.4	1.7
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	5.840	1810.4	NO	NO	1810.4	7.8
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-12687.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-12687.9**	**-54.7**
A. Forest and Woody Biomass Change	-12687.9	NO	NO	NO	NO	NO	NO	-12687.9	-54.7
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**42.887**	**900.6**	**0.268**	**83.2**	**NO**	**NO**	**983.8**	**4.2**
A. Solid Waste Disposal on Land	NE	42.887	900.6	NO	NO	NO	NO	900.6	3.9
B. Wastewater Handling	NO	NE	NE	0.268	83.2	NO	NO	83.2	0.4
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**4284.7**	**150.084**	**3151.8**	**9.679**	**3000.5**	**0.019**	**60.150**	**10497.1**	**45.3**
Total Emissions without LULUCF	**16972.6**	**150.084**	**3151.8**	**9.679**	**3000.5**	**0.019**	**60.150**	**23185.0**	**100.0**
Share of Gases in Total Em./Rem.	**40.8**		**30.0**		**28.6**		**0.6**	**100.0**	
Share of Gases in Total Emissions	**73.2**		**13.6**		**12.9**		**0.3**	**100.0**	

Memo Items:									
International Bunkers	288.9	0.009	0.2	0.006	1.8	NO	NO	290.8	
Aviation	173.9	0.001	0.0	0.005	1.5	NO	NO	175.5	
Marine	114.9	0.008	0.2	0.001	0.3	NO	NO	115.4	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1734.1							1734.1	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 1997	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**16605.4**	**64.626**	**1357.2**	**0.375**	**116.2**	**NO**	**NO**	**18078.8**	**73.1**
A. Fuel Combustion (Sectoral Approach)	16005.6	6.068	127.4	0.375	116.2	NO	NO	16249.3	65.7
1. Energy Industries	5589.4	0.181	3.8	0.041	12.7	NO	NO	5606.0	22.7
2. Manufact. Industries and Construction	2999.6	0.292	6.1	0.031	9.5	NO	NO	3015.2	12.2
3. Transport	4013.2	1.047	22.0	0.230	71.2	NO	NO	4106.5	16.6
4. Comm./Inst.., Resid., Agric., Forestry	3178.2	4.547	95.5	0.073	22.8	NO	NO	3296.5	13.3
5. Other	225.2	NO	NO	NO	NO	NO	NO	225.2	0.9
B. Fugitive Emissions from Fuel	599.8	58.558	1229.7	NO	NO	NO	NO	1829.5	7.4
1. Soid Fuels	NO	0.6	13.6	NO	NO	NO	NO	13.6	0.1
2. Oil and natural Gas	599.8	57.910	1216.1	NO	NO	NO	NO	1815.9	7.3
2. Industrial Processes	**1450.1**	**0.340**	**7.1**	**2.636**	**817.2**	**0.043**	**91.180**	**2365.6**	**9.6**
A. Mineral Products	872.0	NO	NO	NO	NO	NO	NO	872.0	3.5
B. Chemical Industry	546.2	0.340	7.1	2.636	817.2	NO	NO	1370.5	5.5
C. Metal Production	31.8	NO	NO	NO	NO	NO	NO	31.8	0.1
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	0.043	91.180	91.2	0.4
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**44.503**	**934.6**	**7.511**	**2328.4**	**NO**	**NO**	**3263.0**	**13.2**
A. Enteric Fermentation	NO	37.168	780.5	NO	NO	NO	NO	780.5	3.2
B. Manure Management	NO	7.335	154.0	0.729	226.1	NO	NO	380.1	1.5
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.782	2102.3	NO	NO	2102.3	8.5
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-14441.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-14441.9**	**-58.4**
A. Forest and Woody Biomass Change	-14441.9	NO	NO	NO	NO	NO	NO	-14441.9	-58.4
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**45.334**	**952.0**	**0.266**	**82.5**	**NO**	**NO**	**1034.5**	**4.2**
A. Solid Waste Disposal on Land	NE	45.334	952.0	NO	NO	NO	NO	952.0	3.8
B. Wastewater Handling	NO	NE	NE	0.266	82.5	NO	NO	82.5	0.3
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**3613.6**	**154.804**	**3250.9**	**10.788**	**3344.3**	**0.043**	**91.180**	**10299.9**	**41.6**
Total Emissions without LULUCF	**18055.5**	**154.804**	**3250.9**	**10.788**	**3344.3**	**0.043**	**91.180**	**24741.8**	**100.0**
Share of Gases in Total Em./Rem.	**35.1**		**31.6**		**32.5**		**0.9**	**100.0**	
Share of Gases in Total Emissions	**73.0**		**13.1**		**13.5**		**0.4**	**100.0**	

Memo Items:									
International Bunkers	218.6	0.006	0.1	0.005	1.5	NO	NO	220.2	
Aviation	145.0	0.001	0.0	0.004	1.3	NO	NO	146.3	
Marine	73.6	0.005	0.1	0.001	0.2	NO	NO	73.9	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1794.3							1794.3	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 1998	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**17591.8**	**56.777**	**1192.3**	**0.410**	**127.2**	**NO**	**NO**	**18911.4**	**75.7**
A. Fuel Combustion (Sectoral Approach)	17002.7	5.687	119.4	0.410	127.2	NO	NO	17249.3	69.0
1. Energy Industries	6248.2	0.209	4.4	0.047	14.5	NO	NO	6267.1	25.1
2. Manufact. Industries and Construction	3291.0	0.297	6.2	0.031	9.7	NO	NO	3306.8	13.2
3. Transport	4162.6	1.178	24.7	0.267	82.9	NO	NO	4270.2	17.1
4. Comm./Inst.., Resid., Agric., Forestry	3105.3	4.004	84.1	0.065	20.2	NO	NO	3209.7	12.8
5. Other	195.5	NO	NO	NO	NO	NO	NO	195.5	0.8
B. Fugitive Emissions from Fuel	589.2	51.090	1072.9	NO	NO	NO	NO	1662.0	6.6
1. Soid Fuels	NO	0.7	14.3	NO	NO	NO	NO	14.3	0.1
2. Oil and natural Gas	589.2	50.411	1058.6	NO	NO	NO	NO	1647.8	6.6
2. Industrial Processes	**1362.9**	**0.316**	**6.6**	**1.985**	**615.2**	**0.012**	**17.544**	**2002.3**	**8.0**
A. Mineral Products	937.3	NO	NO	NO	NO	NO	NO	937.3	3.7
B. Chemical Industry	409.7	0.316	6.6	1.985	615.2	NO	NO	1031.6	4.1
C. Metal Production	15.9	NO	NO	NO	NO	NO	NO	15.9	0.1
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	0.012	17.544	17.5	0.1
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**43.650**	**916.6**	**6.729**	**2086.0**	**NO**	**NO**	**3002.6**	**12.0**
A. Enteric Fermentation	NO	36.421	764.8	NO	NO	NO	NO	764.8	3.1
B. Manure Management	NO	7.229	151.8	0.715	221.5	NO	NO	373.3	1.5
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.014	1864.5	NO	NO	1864.5	7.5
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-14441.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-14441.9**	**-57.8**
A. Forest and Woody Biomass Change	-14441.9	NO	NO	NO	NO	NO	NO	-14441.9	-57.8
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**47.747**	**1002.7**	**0.255**	**79.1**	**NO**	**NO**	**1081.8**	**4.3**
A. Solid Waste Disposal on Land	NE	47.747	1002.7	NO	NO	NO	NO	1002.7	4.0
B. Wastewater Handling	NO	NE	NE	0.255	79.1	NO	NO	79.1	0.3
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**4512.8**	**148.490**	**3118.3**	**9.379**	**2907.6**	**0.012**	**17.544**	**10556.2**	**42.2**
Total Emissions without LULUCF	**18954.7**	**148.490**	**3118.3**	**9.379**	**2907.6**	**0.012**	**17.544**	**24998.1**	**100.0**
Share of Gases in Total Em./Rem.	**42.8**		**29.5**		**27.5**		**0.2**	**100.0**	
Share of Gases in Total Emissions	**75.8**		**12.5**		**11.6**		**0.1**	**100.0**	

Memo Items:									
International Bunkers	229.4	0.006	0.1	0.005	1.5	NO	NO	231.1	
Aviation	148.4	0.001	0.0	0.004	1.3	NO	NO	149.8	
Marine	81.0	0.005	0.1	0.001	0.2	NO	NO	81.3	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1575.1							1575.1	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 1999	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**17963.5**	**56.583**	**1188.2**	**0.454**	**140.7**	**NO**	**NO**	**19292.4**	**74.2**
A. Fuel Combustion (Sectoral Approach)	17438.2	5.835	122.5	0.454	140.7	NO	NO	17701.4	68.1
1. Energy Industries	6468.3	0.219	4.6	0.048	15.0	NO	NO	6487.8	25.0
2. Manufact. Industries and Construction	2959.9	0.250	5.3	0.026	8.1	NO	NO	2973.3	11.4
3. Transport	4394.4	1.294	27.2	0.312	96.6	NO	NO	4518.1	17.4
4. Comm./Inst.., Resid., Agric., Forestry	3510.9	4.072	85.5	0.068	21.0	NO	NO	3617.4	13.9
5. Other	104.8	NO	NO	NO	NO	NO	NO	104.8	0.4
B. Fugitive Emissions from Fuel	525.2	50.747	1065.7	NO	NO	NO	NO	1590.9	6.1
1. Soid Fuels	NO	0.2	4.3	NO	NO	NO	NO	4.3	0.0
2. Oil and natural Gas	525.2	50.543	1061.4	NO	NO	NO	NO	1586.6	6.1
2. Industrial Processes	**1713.1**	**0.273**	**5.7**	**2.342**	**726.0**	**0.005**	**9.090**	**2453.9**	**9.4**
A. Mineral Products	1193.7	NO	NO	NO	NO	NO	NO	1193.7	4.6
B. Chemical Industry	519.1	0.273	5.7	2.342	726.0	NO	NO	1250.8	4.8
C. Metal Production	0.4	NO	NO	NO	NO	NO	NO	0.4	0.0
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	0.005	9.090	9.1	0.0
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**44.475**	**934.0**	**6.928**	**2147.6**	**NO**	**NO**	**3081.6**	**11.9**
A. Enteric Fermentation	NO	36.477	766.0	NO	NO	NO	NO	766.0	2.9
B. Manure Management	NO	7.998	168.0	0.729	225.9	NO	NO	393.9	1.5
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.199	1921.7	NO	NO	1921.7	7.4
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-14441.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-14441.9**	**-55.6**
A. Forest and Woody Biomass Change	-14441.9	NO	NO	NO	NO	NO	NO	-14441.9	-55.6
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**51.099**	**1073.1**	**0.283**	**87.7**	**NO**	**NO**	**1160.8**	**4.5**
A. Solid Waste Disposal on Land	NE	51.099	1073.1	NO	NO	NO	NO	1073.1	4.1
B. Wastewater Handling	NO	NE	NE	0.283	87.7	NO	NO	87.7	0.3
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**5234.7**	**152.430**	**3201.0**	**10.006**	**3102.0**	**0.005**	**9.090**	**11546.8**	**44.4**
Total Emissions without LULUCF	**19676.6**	**152.430**	**3201.0**	**10.006**	**3102.0**	**0.005**	**9.090**	**25988.7**	**100.0**
Share of Gases in Total Em./Rem.	**45.3**		**27.7**		**26.9**		**0.1**	**100.0**	
Share of Gases in Total Emissions	**75.7**		**12.3**		**11.9**		**0.0**	**100.0**	

Memo Items:									
International Bunkers	202.9	0.005	0.1	0.004	1.4	NO	NO	204.4	
Aviation	137.2	0.001	0.0	0.004	1.2	NO	NO	138.4	
Marine	65.7	0.004	0.1	0.001	0.2	NO	NO	65.9	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1496.3							1496.3	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 2000	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**17445.7**	**59.235**	**1243.9**	**0.496**	**153.9**	**NO**	**NO**	**18843.5**	**72.7**
A. Fuel Combustion (Sectoral Approach)	16812.7	6.325	132.8	0.496	153.9	NO	NO	17099.4	66.0
1. Energy Industries	5882.3	0.166	3.5	0.049	15.1	NO	NO	5900.8	22.8
2. Manufact. Industries and Construction	3078.3	0.258	5.4	0.027	8.5	NO	NO	3092.2	11.9
3. Transport	4396.0	1.355	28.4	0.346	107.2	NO	NO	4531.7	17.5
4. Comm./Inst.., Resid., Agric., Forestry	3357.2	4.546	95.5	0.075	23.1	NO	NO	3475.8	13.4
5. Other	98.9	NO	NO	NO	NO	NO	NO	98.9	0.4
B. Fugitive Emissions from Fuel	633.0	52.910	1111.1	NO	NO	NO	NO	1744.1	6.7
1. Soid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	
2. Oil and natural Gas	633.0	52.910	1111.1	NO	NO	NO	NO	1744.1	6.7
2. Industrial Processes	**1932.0**	**0.288**	**6.0**	**2.756**	**854.3**	**0.011**	**23.147**	**2815.5**	**10.9**
A. Mineral Products	1385.9	NO	NO	NO	NO	NO	NO	1385.9	5.3
B. Chemical Industry	525.2	0.288	6.0	2.756	854.3	NO	NO	1385.6	5.3
C. Metal Production	20.8	NO	NO	NO	NO	NO	NO	20.8	0.1
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	0.011	23.147	23.1	0.1
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**43.086**	**904.8**	**7.070**	**2191.7**	**NO**	**NO**	**3096.5**	**11.9**
A. Enteric Fermentation	NO	35.660	748.9	NO	NO	NO	NO	748.9	2.9
B. Manure Management	NO	7.426	156.0	0.706	218.9	NO	NO	374.8	1.4
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.364	1972.9	NO	NO	1972.9	7.6
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-14441.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-14441.9**	**-55.7**
A. Forest and Woody Biomass Change	-14441.9	NO	NO	NO	NO	NO	NO	-14441.9	-55.7
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**51.328**	**1077.9**	**0.271**	**84.0**	**NO**	**NO**	**1161.9**	**4.5**
A. Solid Waste Disposal on Land	NE	51.328	1077.9	NO	NO	NO	NO	1077.9	4.2
B. Wastewater Handling	NO	NE	NE	0.271	84.0	NO	NO	84.0	0.3
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**4935.7**	**153.937**	**3232.7**	**10.593**	**3283.9**	**0.011**	**23.147**	**11475.5**	**44.3**
Total Emissions without LULUCF	**19377.6**	**153.937**	**3232.7**	**10.593**	**3283.9**	**0.011**	**23.147**	**25917.4**	**100.0**
Share of Gases in Total Em./Rem.	**43.0**		**28.2**		**28.6**		**0.2**	**100.0**	
Share of Gases in Total Emissions	**74.8**		**12.5**		**12.7**		**0.1**	**100.0**	

Memo Items:									
International Bunkers	171.8	0.005	0.1	0.004	1.1	NO	NO	173.1	
Aviation	114.8	0.001	0.0	0.003	1.0	NO	NO	115.8	
Marine	57.0	0.004	0.1	0.000	0.1	NO	NO	57.2	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1680.4							1680.4	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 2001	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**18442.8**	**64.475**	**1354.0**	**0.521**	**161.6**	**NO**	**NO**	**19958.3**	**73.5**
A. Fuel Combustion (Sectoral Approach)	17755.1	5.351	112.4	0.521	161.6	NO	NO	18029.1	66.4
1. Energy Industries	6293.7	0.161	3.4	0.049	15.1	NO	NO	6312.2	23.3
2. Manufact. Industries and Construction	3223.3	0.256	5.4	0.027	8.5	NO	NO	3237.2	11.9
3. Transport	4561.6	1.369	28.7	0.383	118.6	NO	NO	4709.0	17.4
4. Comm./Inst.., Resid., Agric., Forestry	3574.5	3.565	74.9	0.062	19.3	NO	NO	3668.6	13.5
5. Other	102.0	NO	NO	NO	NO	NO	NO	102.0	0.4
B. Fugitive Emissions from Fuel	687.6	59.124	1241.6	NO	NO	NO	NO	1929.2	7.1
1. Soid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	
2. Oil and natural Gas	687.6	59.124	1241.6	NO	NO	NO	NO	1929.2	7.1
2. Industrial Processes	**2011.3**	**0.305**	**6.4**	**2.318**	**718.5**	**0.022**	**48.998**	**2785.2**	**10.3**
A. Mineral Products	1584.7	NO	NO	NO	NO	NO	NO	1584.7	5.8
B. Chemical Industry	425.8	0.305	6.4	2.318	718.5	NO	NO	1150.8	4.2
C. Metal Production	0.7	NO	NO	NO	NO	NO	NO	0.7	0.0
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	0.022	48.998	49.0	0.2
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**43.594**	**915.5**	**7.354**	**2279.8**	**NO**	**NO**	**3195.3**	**11.8**
A. Enteric Fermentation	NO	36.128	758.7	NO	NO	NO	NO	758.7	2.8
B. Manure Management	NO	7.466	156.8	0.713	221.1	NO	NO	377.9	1.4
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.641	2058.7	NO	NO	2058.7	7.6
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-14441.9**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-14441.9**	**-53.2**
A. Forest and Woody Biomass Change	-14441.9	NO	NO	NO	NO	NO	NO	-14441.9	-53.2
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**52.709**	**1106.9**	**0.303**	**93.9**	**NO**	**NO**	**1200.8**	**4.4**
A. Solid Waste Disposal on Land	NE	52.709	1106.9	NO	NO	NO	NO	1106.9	4.1
B. Wastewater Handling	NO	NE	NE	0.303	93.9	NO	NO	93.9	0.3
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**6012.1**	**161.083**	**3382.7**	**10.496**	**3253.8**	**0.022**	**48.998**	**12697.7**	**46.8**
Total Emissions without LULUCF	**20454.0**	**161.083**	**3382.7**	**10.496**	**3253.8**	**0.022**	**48.998**	**27139.6**	**100.0**
Share of Gases in Total Em./Rem.	**47.3**		**26.6**		**25.6**		**0.4**	**100.0**	
Share of Gases in Total Emissions	**75.4**		**12.5**		**12.0**		**0.2**	**100.0**	

Memo Items:									
International Bunkers	203.9	0.007	0.1	0.004	1.2	NO	NO	205.2	
Aviation	114.5	0.001	0.0	0.003	1.0	NO	NO	115.5	
Marine	89.4	0.006	0.1	0.001	0.2	NO	NO	89.7	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1315.1							1315.1	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 2002	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**19610.9**	**66.952**	**1406.0**	**0.597**	**185.1**	**NO**	**NO**	**21202.0**	**74.7**
A. Fuel Combustion (Sectoral Approach)	18945.6	5.399	113.4	0.597	185.1	NO	NO	19244.0	67.8
1. Energy Industries	7213.2	0.186	3.9	0.058	18.0	NO	NO	7235.1	25.5
2. Manufact. Industries and Construction	3110.2	0.251	5.3	0.027	8.5	NO	NO	3123.9	11.0
3. Transport	4871.4	1.317	27.7	0.448	138.8	NO	NO	5037.9	17.7
4. Comm./Inst.., Resid., Agric., Forestry	3653.3	3.644	76.5	0.064	19.7	NO	NO	3749.6	13.2
5. Other	97.6	NO	NO	NO	NO	NO	NO	97.6	0.3
B. Fugitive Emissions from Fuel	665.3	61.553	1292.6	NO	NO	NO	NO	1957.9	6.9
1. Soid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	
2. Oil and natural Gas	665.3	61.553	1292.6	NO	NO	NO	NO	1957.9	6.9
2. Industrial Processes	**1965.2**	**0.257**	**5.4**	**2.250**	**697.5**	**0.022**	**49.315**	**2717.4**	**9.6**
A. Mineral Products	1581.3	NO	NO	NO	NO	NO	NO	1581.3	5.6
B. Chemical Industry	383.7	0.257	5.4	2.250	697.5	NO	NO	1086.6	3.8
C. Metal Production	0.2	NO	NO	NO	NO	NO	NO	0.2	0.0
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	0.022	49.315	49.3	0.2
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**42.699**	**896.7**	**7.544**	**2338.7**	**NO**	**NO**	**3235.4**	**11.4**
A. Enteric Fermentation	NO	35.112	737.3	NO	NO	NO	NO	737.3	2.6
B. Manure Management	NO	7.587	159.3	0.699	216.7	NO	NO	376.1	1.3
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.845	2122.0	NO	NO	2122.0	7.5
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-15373.0**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-15373.0**	**-54.1**
A. Forest and Woody Biomass Change	-15373.0	NO	NO	NO	NO	NO	NO	-15373.0	-54.1
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**0.0**	**54.494**	**1144.4**	**0.304**	**94.3**	**NO**	**NO**	**1238.7**	**4.4**
A. Solid Waste Disposal on Land	NE	54.494	1144.4	NO	NO	NO	NO	1144.4	4.0
B. Wastewater Handling	NO	NE	NE	0.304	94.3	NO	NO	94.3	0.3
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**6203.1**	**164.402**	**3452.4**	**10.695**	**3315.5**	**0.022**	**49.315**	**13020.4**	**45.9**
Total Emissions without LULUCF	**21576.1**	**164.402**	**3452.4**	**10.695**	**3315.5**	**0.022**	**49.315**	**28393.4**	**100.0**
Share of Gases in Total Em./Rem.	**47.6**		**26.5**		**25.5**		**0.4**	**100.0**	
Share of Gases in Total Emissions	**76.0**		**12.2**		**11.7**		**0.2**	**100.0**	

Memo Items:									
International Bunkers	171.6	0.006	0.1	0.003	1.0	NO	NO	172.7	
Aviation	98.3	0.001	0.0	0.003	0.9	NO	NO	99.2	
Marine	73.2	0.005	0.1	0.001	0.2	NO	NO	73.5	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1331.6							1331.6	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)

Croatia Year 2003	CO_2	CH_4		N_2O		HFC, PFC & SF_6		Total	Share
	(Gg)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg)	(Gg CO_2eq)	(Gg CO_2eq)	%
1. Energy	**20988.0**	**68.431**	**1437.1**	**0.685**	**212.4**	**NO**	**NO**	**22637.5**	**75.8**
A. Fuel Combustion (Sectoral Approach)	20304.0	6.380	134.0	0.685	212.4	NO	NO	20650.4	69.1
1. Energy Industries	7876.9	0.215	4.5	0.064	19.7	NO	NO	7901.1	26.5
2. Manufact. Industries and Construction	3163.1	0.275	5.8	0.030	9.4	NO	NO	3178.3	10.6
3. Transport	5284.0	1.258	26.4	0.514	159.4	NO	NO	5469.9	18.3
4. Comm./Inst.., Resid., Agric., Forestry	3879.6	4.630	97.2	0.077	23.9	NO	NO	4000.7	13.4
5. Other	100.4	NO	NO	NO	NO	NO	NO	100.4	0.3
B. Fugitive Emissions from Fuel	684.0	62.051	1303.1	NO	NO	NO	NO	1987.1	6.7
1. Soid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	
2. Oil and natural Gas	684.0	62.051	1303.1	NO	NO	NO	NO	1987.1	6.7
2. Industrial Processes	**2011.6**	**0.285**	**6.0**	**2.121**	**657.4**	**0.018**	**26.705**	**2701.8**	**9.0**
A. Mineral Products	1579.6	NO	NO	NO	NO	NO	NO	1579.6	5.3
B. Chemical Industry	431.8	0.285	6.0	2.121	657.4	NO	NO	1095.3	3.7
C. Metal Production	0.2	NO	NO	NO	NO	NO	NO	0.2	0.0
D. Other Production	NE	NO	NO	NO	NO	NO	NO	NE	
E. Production of Halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO	NO	
F. Consumpt. of Halocarbons and SF_6	NO	NO	NO	NO	NO	0.018	26.705	26.7	0.1
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NE**	**NE**	**NO**	**NO**	**NE**	
4. Agriculture	**NO**	**46.306**	**972.4**	**7.309**	**2265.7**	**NO**	**NO**	**3238.1**	**10.8**
A. Enteric Fermentation	NO	37.780	793.4	NO	NO	NO	NO	793.4	2.7
B. Manure Management	NO	8.525	179.0	0.735	227.8	NO	NO	406.8	1.4
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	
D. Agricultural Soils	NO	NO	NO	6.574	2037.9	NO	NO	2037.9	6.8
E. Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	
F. Field Burning of Agricult. Residues	NO	NE	NE	NE	NE	NO	NO	NE	
G. Other Agriculture Activities	NO	NO	NO	NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	**-15373.0**	**NE**	**NE**	**NE**	**NE**	**NO**	**NO**	**-15373.0**	**-51.5**
A. Forest and Woody Biomass Change	-15373.0	NO	NO	NO	NO	NO	NO	-15373.0	-51.5
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NO	NO	NE	
C. Abandonment of Managed Lands	NE	NO	NO	NO	NO	NO	NO	NE	
D. CO_2 Emissions/Removals from Soil	NE	NO	NO	NO	NO	NO	NO	NE	
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	
6. Waste	**NE**	**56.910**	**1195.1**	**0.304**	**94.3**	**NO**	**NO**	**1289.4**	**4.3**
A. Solid Waste Disposal on Land	NE	56.910	1195.1	NO	NO	NO	NO	1195.1	4.0
B. Wastewater Handling	NO	NE	NE	0.304	94.3	NO	NO	94.3	0.3
C. Waste Incineration	NE	NE	NE	NE	NE	NO	NO	NE	
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	
Total Emissions/Removals with LULUCF	**7626.7**	**171.932**	**3610.6**	**10.419**	**3229.8**	**0.018**	**26.705**	**14493.8**	**48.5**
Total Emissions without LULUCF	**22999.7**	**171.932**	**3610.6**	**10.419**	**3229.8**	**0.018**	**26.705**	**29866.8**	**100.0**
Share of Gases in Total Em./Rem.	**52.6**		**24.9**		**22.3**		**0.2**	**100.0**	
Share of Gases in Total Emissions	**77.0**		**12.1**		**10.8**		**0.1**	**100.0**	

Memo Items:									
International Bunkers	143.4	0.005	0.1	0.003	0.8	NO	NO	144.3	
Aviation	74.7	0.001	0.0	0.002	0.7	NO	NO	75.3	
Marine	68.7	0.005	0.1	0.001	0.2	NO	NO	68.9	
Multilateral Operations	C	C	C	C	C	NO	NO	C	
CO_2 Emissions from Biomass	1714.5							1714.5	

NO (*not occuring*)
NE (*not estimated*)
IE (*included elsewhere*)
C (*confidental*)