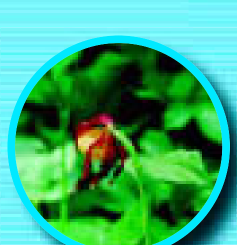
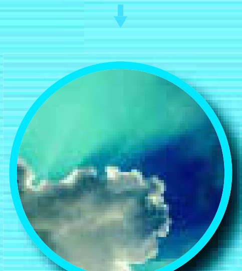
ESTONIA'S THIRD NATIONAL COMMUNICATION

ESTONIA'S THIRD NATIONAL COMMUNICATION

Under the UN Framework Convention on Climate Change

Estonia, November 2001

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EXECUTIVE SUMMARY OF THE THIRD ESTONIA'S NATIONAL COMMUNICATION FOR THE UNFCCC

1.1. Introduction

On 20 August 1991, the Supreme Council of the Republic of Estonia passed a resolution on national independence. After that Estonia started to take part in the international life as independent country. Many international agreements that were in force before 1940 have been reactivated.

In 1994, Estonia has ratified the United Nations Framework Convention on Climate Change and in 1998 signed the Kyoto protocol of the UNFCCC. In this protocol Estonia, like the European Union, committed to reduce greenhouse gas emissions by 8% 2001-2012 against 1990.

Estonia's transition from planned to market economy started in the early 1990s, with major reforms launched after the monetary reform in 1992. Estonia has been determined and decisive in implementing necessary reforms. Successful reforms have resulted in achieving early macroeconomic stabilisation and the creation of a favourable environment for economic development. Estonia has achieved a high level of commercial and financial integration with the European and global economy.

Estonia's first and Second National Communications have been submitted in 1995 and 1998.The Third Communication was elaborated according to the new UNFCCC guidelines.

1.2. National circumstances

Estonia is situated in the northwestern part of the flat East-European plain between latitudes 57°30´N and 59°49´N and 21°46´E and 28°13´E. It is entirely within the drainage area of the Baltic Sea. To the west and north, it has a long coastline on the Baltic Sea, with numerous bays, peninsulas, and straits between islands. With a total area of 45.216 km^2 Estonia is the smallest of the three Baltic states.

Estonia belongs to the Atlantic continental region of the temperate zone. The mean annual temperature at the westernmost point is 6.0°C and at the easternmost point 4.2°C. Summers are moderately warm (mean air temperature in July is 16-17°C) and winters moderately cold (mean air temperature in February is between –3.5°C and –7.5°C).

The climate of Estonia is humid because precipitation exceeds evapotranspiration. Nevertheless, there are often droughts during the summer period. Mean annual precipitation ranges from 550 to 750 mm. Due to a very intense cyclonic activity in northern Europe, the mean wind speed is comparatively high (5-7 m/s in the coastal zone).

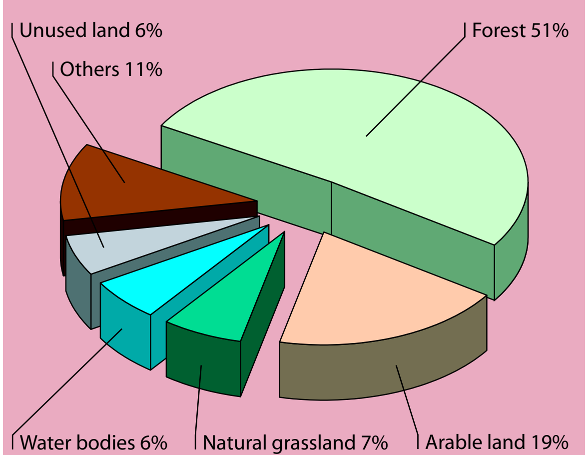
Estonia is one of the smallest and least populous countries in Europe – its total population is 1.37 million, about 70% live in urban areas. The population density is 31.8 inhabitants km^2.

The main industrial sector in Estonia is energy production. The energy, as well as chemical industry, is based on oil shale. Oil shale is a specific fuel in Estonia, which met 58% of the primary energy demand in 1998. Primary energy use and energy consumption by end users have decreased since 1990. The biggest decline in energy consumption has occurred in industry and agriculture.

Estonia is quite rich in renewable resources. Today about 51% of the country is covered by forest. In the early 1990s the area of forest increased rapidly, mainly due to the abandonment of agricultural land. Forests with conifers as the dominant tree species make up 61% and forests with deciduous trees as the dominant species constitute 39% of the total forest. Forest industry and forestry have been and still are important contributions to the economy and employment in Estonia. In 1995 forestry accounted for 1.3% of GDP, by 1998 for 1.7%.

In 1999, area of agricultural land and natural grassland comprised 1.433 million hectares, 32% of the total land stock. Arable land accounted for 1.120 million hectares, representing 78% of the total agricultural area (Figure 1.2.1).

Figure 1.2.1. The structure of land use



1.3. Emission inventories

Estonia's share in global anthropogenic greenhouse gases (GHG) emission is naturally insignificant, but according to GHG emission per capita, Estonia belongs among intensively emitting countries. In aggregated CO_2 equivalents the per capita GHG emission was 27 t in 1990 and 8 t in 1999. The essential decrease in the GHG emission during the last decade is typical of all countries in transition, it was mainly caused by the decrease in energy consuming economic activities and demonstrates the effectiveness of the transformation of economic systems towards sustainable development.

1.3.1. CO_2 emission

Energy related activities are the most significant contributors to GHG in Estonia, particularly to carbon dioxide emissions. In 1999 Estonia emitted a total of 16.424 Gg of CO_2 from fossil fuel combustion. The transport sector is also an important source of carbon dioxide and in 1999, CO_2 emission from transport was 1203 Gg, accounting for about 7% of Estonia's total CO_2 emissions, although it was 55% less than in 1990 (Figure 1.3.1).

In the Estonian industry, carbon dioxide is emitted mainly by cement and lime production. By thermal processing of calcium carbonate ($CaCO_3$) from limestone, chalk or other calcium-rich materials, calcium oxide (CaO) and carbon dioxide (CO_2) are formed. In 1999, CO_2 emissions from industrial processes were approximately 347 Gg, which accounts for about 2.1% of total CO_2 emissions. In 1990 it was 614 Gg, accounting for 1.6% of Estonia's total emissions of CO_2.

1.3.2. CO_2 removals

Forest is the most important terrestrial sink for CO_2. Due to the sharp decrease of agricultural activity in Estonia the share of abandoned lands is increasing. Also the regulations in the peat production and decreased effectiveness of meliorative networks, created during the Soviet time, are reasons why the sink of carbon dioxide by biological systems has increased since 1990 by ca 30%.

Table 1.3.1. Sources of CO_2 emissions/ removals, Gg

Sources/Sinks	CO_2 emissions, Gg 1990	1999
Total fossil fuel consumption	**37493**	**16424**
Energy industries	29753	13478
Manufacturing	2655	660
Transport	2693	1203
Residential	1556	1036
Agriculture	386	13
Commercial	450	34
Industrial processes	**614**	**347**
Cement production	468	321
Lime production	146	26
Land use change and forestry	**-6320**	**-8107**
Total net emissions	**31787**	**8664**

1.3.3. Methane emissions

In Estonia, the major sources of methane emission are waste management, particularly landfills, domestic and commercial wastewater treatment, industrial wastewaters and agriculture. The structure of methane emissions by sources has changed since 1990. In 1990, the share of methane emitted from agriculture was ca 30 % from the total, in 1999, it was 20% and the methane from waste management gave ca 52% of the total emission (Table 1.3.2).

Figure 1.3.1. CO_2 emissions from fuel combustion, Gg

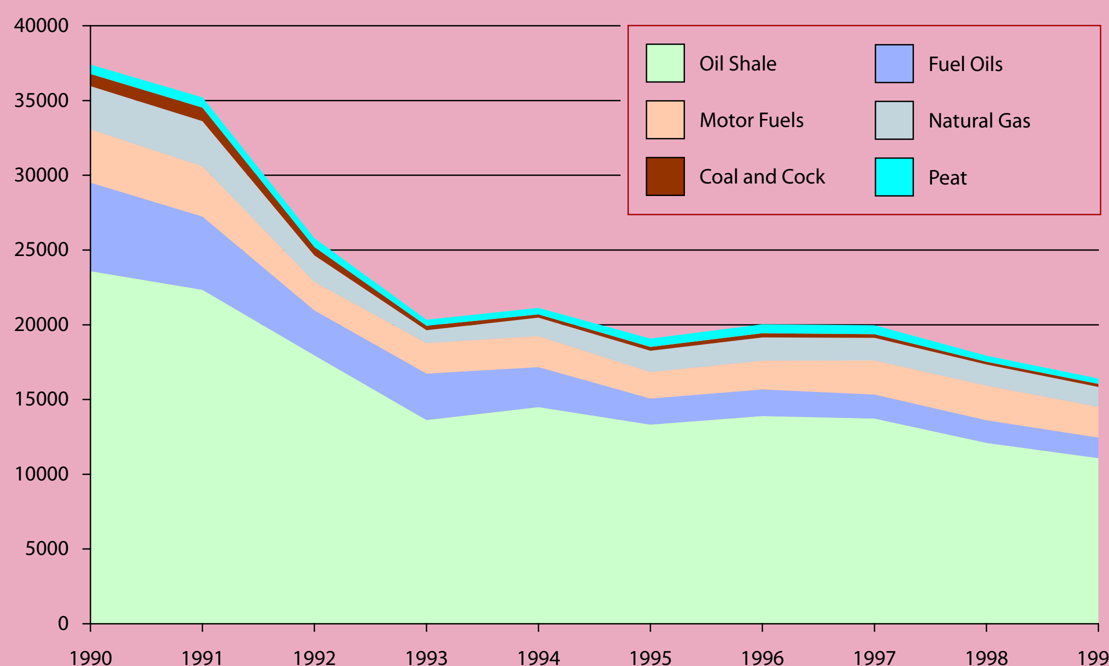


Table 1.3.2. Sources of methane emissions, Gg

Source	1990	1999
Waste management	76.57	62.10
Agriculture	69.89	25.54
Energy, incl.		
Fugitive emission	57.13	27.50
Fuel combustion	4.13	5.33
Total	**207.72**	**120.47**
Total (CO_2 eq GWP=21)	**4362.12**	**2529.87**

1.3.4. Nitrous oxide emissions

Nitrous oxide emissions contribute about 3% to Estonia's total GHG emissions. In Estonia, main emissions of N_2O are connected with agriculture. Restructuring of agricultural production, loss of the traditional eastern market for agricultural products and rising prices of fuel and fertilizers have influenced immensely the whole agricultural sector. Thus, the total area of growing field crops decreased from 1.116 million ha in 1990 up to 0.861 million ha in 1998. As a consequentce nitrous oxide emissions have decreased (Table 1.3.3).

Table 1.3.3. Sources of nitrous oxide emissions, Gg

Source	1990	1999
Fuel combustion	0.15	0.13
Agriculture	3.15	1.02
Total	**3.30**	**1.15**
Total (CO_2 eq GWP=310)	**1023.0**	**356.5**

1.3.5. Other gases

There are no such industrial activities from which the new gases such as HFCs, PFCs and SF_6 could be emitted into the atmosphere. Such gases are brought to Estonia with some imported equipment. The Statistical Office is currently in the process of organizing collection of data concerning the emission of these gases. The major NO_x, CO and NMVOC sources are fuel combustion and industrial processes. On average the total amount of emissions has decreased twice since 1990.

1.4. Greenhouse gas emission mitigation measures

During the reporting period the Republic of Estonia has made relatively fast progress in the field of environmental policy and legislation. Several new legal acts, both primary and secondary, have been enforced, also some strategic documents and development programmes have been elaborated and adopted. The legal acts related to environment are mainly initiated by the Government, especially by the Ministry of the Environment and by the Ministry of Economic Affairs. According to the Constitution, committees of the Riigikogu (Estonian Parlament) have the right to initiate laws as well.

The *Sustainable Development Act* sets the most general principles for sustainable development and therefore forms the basis for formulation of national and regional programmes, including action plans to reduce emissions into the air.

The *Estonian National Environmental Strategy*, approved by the Riigikogu (Estonian Parlament) in 1997, is the major basic document for the policy-making process in the field of environment. The *National Environmental Action Plan* (NEAP) defines concrete conceptual, legislation, organisational, educational, training and also investment measures for reaching the objectives set in the National Environmental Strategy. The new NEAP was adopted by the Government on 05.06.2001.

Concerning air quality, progress in introducing the necessary legislation has continued with Estonia's accession to several international conventions.

On 3 Detsember 1998 Estonia signed the *Kyoto Protocol of the United Nations Framework Convention on Climate Change.*

Estonia signed *The Energy Charter Treaty* (ECT) in 1994. The ECT, together with the *Protocol of Energy Charter on the More Efficient Energy Use and the Related Environmental Aspects*, was ratified by the Riigikogu (Estonian Parlament) in February 1998.

Estonia has signed the European Agreement and applied for membership of the EU in 1995. In December 1997, the European Council of Ministers made the decision to invite Estonia to negotiations to join the EU. At the beginning of 1998, elaboration of the Estonian National Programme for the Adoption of the *acquis communautaire* was completed and approved by the Government. The approximation of EU legislation in all fields, including environmental issues related to pollution of ambient air, is in progress.

Some policies have been reflected in different programmes, projects and measures. For example, increased use of biomass, especially of wood fuel. As a fiscal instrument the *Pollution Charge Act* was passed by the Riigikogu (Estonian Parlament) in 1999. The new Act introduced (since 01.01.2000) a pollution charge on CO_2 emission. The CO_2 charge has to be paid by all enterprises with the total capacities of boilers over 50 MW, excluding those firing renewable energy sources. Excise duty is the only specific tax that is applied directly to fuels, mainly to motor fuels. Hence, since December 1997 the excise tax is levied on light fuel as well.

During last years, several important for Estonia projects have been financed from different foreign sources, such as the EU programmes Phare and ISPA, as well as by aid programmes from neighbouring countries (e.g. Denmark, Finland, Sweden). The Centre for Environmental Investments will play an important role when becoming an implementing agency of the ISPA environmental projects in Estonia.

1.5. Emission projections

The task to forecast the GHG emissions in Estonia for the next twenty years is a difficult and complicated one due to several uncertainties. The first and major reason of uncertainties is the lack of long-term forecasts for the national economy as a whole. In the process of compiling Estonia's Second National Communication (ENC2) significant efforts were made and results of a comprehensive modelling process involved. This was possible thanks to the studies carried out by Estonian (Tallinn Technical University, Estonian Energy Research Institute) and international (Stockholm Environment Institute, Netherlands Energy Research Foundation) teams in the elaboration process of the *Long-Term Development Plan for the Estonian Fuel and Energy Sector* (LT Plan). As the main tool in these studies, the MARKAL model, a demand-driven multi-period linear programming model of the energy sector was used. During the last years significant changes have taken place in the Estonian economy, including the energy sector. According to analysts Estonia has almost completed the transition to market economy and several uncertainties associated with the transitional period have started to disappear gradually. As energy sector is the major contributor to GHG emission in Estonia is the, the main effort has been made to estimate emission trends in that sector. Seven development scenarios up to the year 2015 were drafted by the researchers for the Estonian Energy Research Institute and emission figures were calculated for CO_2. The results of the study have been taken into account for elaboration of the energy sector emission projection.

As the result of analysis of previous studies together with expert assessments considering the latest developments in the energy sector and in economy as a whole, three projections for GHG emission up to the year 2020 have been elaborated in the framework of the current Communication.

The three projections elaborated were:

- WOM-projection (baseline, business as usual, "without measures" projection), the GHG projections were elaborated on the basis of macroeconomic forecasts, mainly on the projection of GDP;
- WM-projection ("with measures" projection), which reflects the impact of planned measures and the policies and measures implemented in the period of 1995-2000;
- WAM-projection ("with additional measures" projection), which encompasses additional policies and measures, that may be taken in future.

Using the data given in the Forest Act (Table 1.5.1) it is possible to calculate the carbon stock changes and make inventories for CO_2 for the next decades. Two scenarios have been compiled: one using the data given by the Forest Department and the other prepared by interpolation of forestry data for the next year. Differences between the scenarios are significant and mainly due to differences in harvesting. Thus in 1999, according to official data (issued by Statistical Office), the total harvest was 6.7 million m^3. However, according to experts' opinion (Forest Survey Centre), the actual total felling was at least 2 million m^3 bigger (10.8 million m^3).

Table 1.5.1. Carbon stock changes and areas related to forestry activities per period

Activity data	Area, ha	CO_2, Gg	Area, ha
	1990-1995	1990-1995	1990-1998
Deforestation	40620	15657	83190
Afforestation	3700	34.4	4600
Reforestation	35640	284.9	53940

Activity data	CO_2, Gg	Area, ha	CO_2, Gg
	1990-1998	1990-2012	2008-2012
Deforestation	29037	389010	134889
Afforestation	42.9	109132	437.3
Reforestation	431.1	200240	429.6

1.6. Vulnerability analysis and adaptation strategy

Climate change scenarios for the 21st century were compiled following the methodology recommended for regional climate change impact studies. Air temperature and precipitation projections were compiled using a climate model – Model for the Assessment of Greenhouse-Gas Induced Climate Change (MAGICC) – and a regional climate change database – (SCEN)ario (GEN)erator (SCENGEN). The baseline climate was defined as that prevailing between 1961 and 1990. Climate change scenarios were created for the years 2050 and 2100. Basied on the climate change scenarios the vulnerability analysis was provided for different sectors.

Estonian agriculture is specialized in animal husbandry, which depends on the yield of crops. Since meteorological conditions during the growth period of plants substantially vary from year to year, the yields of crops and grasslands are unstable. The impact of climate change on barley, potato and clover-timothy mixture yields was also considered.

As the modelling results show, a temperature rise would decrease the crop yields everywhere in Estonia. Most vulnerable would be the cultivated areas on dry sandy soils. The fields on gleyic and gley soils would be less affected. However, the yields on these soils are so low (1.42-3.20 t/ha) and unstable that cultivation of barley is not profitable at all.

Earlier experiments using biophysical models for the productivity of various crops showed that the effect of climate warming is more favourable on herbage cultivation than on cereals. Climate warming would make the potato yield very unstable and it may dercrease especially on infertile and overmoist soils. Various potato cultivars have different disease-resistance, which, in our conditions, is of great importance in the formation of potato yield. Unlike herbage, the soil and climatic conditions for the cultivation of potato are relatively unfavourable in western Estonia.

The RipFor forest-soil-atmosphere model was used to analyse the potential influence of climate change on forest biomass production and nutrient cycling in Estonian forests. The objective of this exercise was to estimate the changes in nutrient availability and nutrient fluxes in soil-vegetation system. Changes in forest productivity were estimated according to the HadCM2 and ECHAM3TR climate change scenarios.

The simulations based on the climate change scenarios imply increased productivity due to (1) increased atmospheric CO_2, (2) increased evapotranspiration, (3) increased allocation of photosynthate to foliage, and (4) increased rates of nutrient cycling (increased net primary production implies increased nutrient uptake, litterfall, litter decomposition and mineralization).

To study the influence of climate change on river runoff after a hundred years, a point model Water Balance (WatBal) was chosen. All climate scenarios predicted a significant increase in river runoff during autumn caused by increased precipitation. In the western part of Estonia, the runoff maximum in autumn (November) was expected to exceed the spring maximum. In eastern Estonia, typical snow cover conditions would remain, but the duration of winter and its stability would decrease.

The results of analysis of water supply and demand indicated no effect of climate change on water use in Estonia. The groundwater resources can guarantee a sufficient supply of good quality domestic water in all regions of the country. Water consumption in towns and other settlements would be independent of the quantity and quality fluctuations of rivers. Climate warming would also have a positive influence on the ecological state of water-bodies in Estonia.

The results of the Estonian vulnerability assessment for coastal areas were obtained from a hypothetical 1.0 m sea-level rise with respect to the Kronstadt benchmark from 1990 to 2100. The data from isostatic uplift measurements were taken into account in land loss estimates at each site. When calculating relative sea-level rise by the year 2100 the rate of land uplift was taken into account.

Total loss of potential inundation and storm surge zones was calculated according to current average prices in Estonia. Three different types of losses were accounted in monetary values: cost of submerged and temporarily damaged land; cost of actually existing properties in these two zones today; and profit theoretically missed from the damaged meadows and forests. The overall price of potential loss for the whole coastal zone of Estonia was calculated by multiplying the prices of study areas by four (the coastline length of the study areas provides 25% of the total coastline length of Estonia), and adding the prices of losses in the coastal towns. Total economic losses due to 1.0 m sea-level rise were estimated at approximately 980 million USD.

1.7. Research, education and public awareness

Estonian scientists have a long tradition of the environmental studies, including climate forming and development related studies. During the reporting period many scientific groups from the Institute of Ecology at Tallinn Pedagogical University, Institute of Geography and Institute of Marine Research at the University of Tartu, National Institute of Hydrology and Meteorology, Estonian Energy Research Institute, Estonian Agricultural University and Tartu Observatory continued their basic research on global climate change impacts and adaptation in agriculture, water resources, forestry, the Baltic Sea and the Estonian coast. The basic research was financed mainly by the grants of the Estonian Science Found. Every year about 8-10 grants issued, allocated on the topic of global warming in total amount ca 1-1.5 million EEK. Beside that there are many target-financed projects funded by the Estonian Ministry of Education.

Serious attention has been paid to environmental education, especially to problems connected with possible global warming. Special measures are envisaged in the National Environmental Action Plan for the improvement of environmental education, environmental research and environmental awareness of the public . The Ministry of Education has prepared special curricula “Environmental Sciences” for the general schools and gymnasiums. In recent years a lot of translated and original materials and workbooks have been issued for schools.

In addition to the obligatory study program every school may add lessons to their study plan. For instance, the environmental program is obligatory, but the schools can add lessons about consumption, environmental management, ecology, global environmental problems or something else.

Students have possibilities for different kinds of environmental activities inside and outside the class or school area. There are NGO's, nature clubs and environmental projects that pupils can join voluntarily. These include for instance the GLOBE project, Young Reporters for the Environment, etc. Altogether 96 countries are participating in the GLOBE project.

Universities have increased the number of courses concerning the environment and modernized the curricula. There are faculties or chairs responsible for climate related curricula's at the University of Tartu, Tallinn Pedagogical University, Estonian Agricultural University and Tallinn Tehnical University. All these universities offers programmes at bachelor's, master's and doctor's level.

The public is primarily made aware of global climate change through mass media (television, radio, newspapers, etc). Additional information is provided by newspapers, e-mail lists, Ministry of the Environment homepage, etc.

2 NATIONAL CIRCUMSTANCES

2.1. Introduction

On 20 August 1991, the Supreme Council of the Republic of Estonia approved a resolution on national independence.

Fifty years of development under the conditions of unbalanced economic relations in an economic system planned and controlled by the state and a closed society had resulted in underdeveloped machinery and technology and irrational use of natural resources.

During the last decade Estonia has moved towards a liberal free market economy. Privatization of state owned land and technical assets havs been practically complete. Today, environmental requirements are taken into consideration when establishing new enterprises. The use of natural resources, as well as environmental protection, is regulated by administrative means. Application of resource and pollution charges has provided a solid basis for integrating the principles of environmental protection into economic activities.

The principles of Estonia's environmental policy are included in a number of legislative acts on nature management, nature conservation, etc. Numerous conventions having importance from the point of view of Global Climate Change have been ratified by the Riigikogu (Estonian Parlament).

Estonia ratified the United Nations Framework Convention on Climate Change in 1994, and the Kyoto protocol, which foresees the reduction of GHG emissions by 8% by the years 2008-2012 from the 1990 level.

2.2. Geographic, climatic and demographic profiles

Estonia is situated in the north-western part of East-European plain, remaining entirely within the drainage area of the Baltic Sea. It lies between the latitudes of 57°30´N and 59°49´N and longitude of 21°46´E and 28°13´E. In the west and north, it has a long coastline on the Baltic Sea, which has numerous bays, peninsulas, and straits between islands. With a total area of 45216 km^2 Estonia is the smallest of the three Baltic states.

Estonia is characterized by a flat topography (Figure 2.2.2). The average elevation is about 50 m, and the highest point is 318 m above sea level. The country may be divided into two regions: Lower Estonia in the north and west and Upper Estonia in the central and southern parts.

Estonia belongs to the Atlantic continental region of the temperate zone. The mean annual temperature in the western area, influenced by the sea, is 6.0°C and between 4.2 and 4.5°C in the more continental eastern and south-eastern regions. These differences can be observed because Estonia's territory lies in a transitional belt with the maritime type of climate in the West-Estonian Archipelago and the continental one in eastern Estonia. Summers are moderately warm (mean air temperature in July is 16-17°C) and winters are moderately cold (mean air temperature in February is between –3.5°C and –7.5 °C).

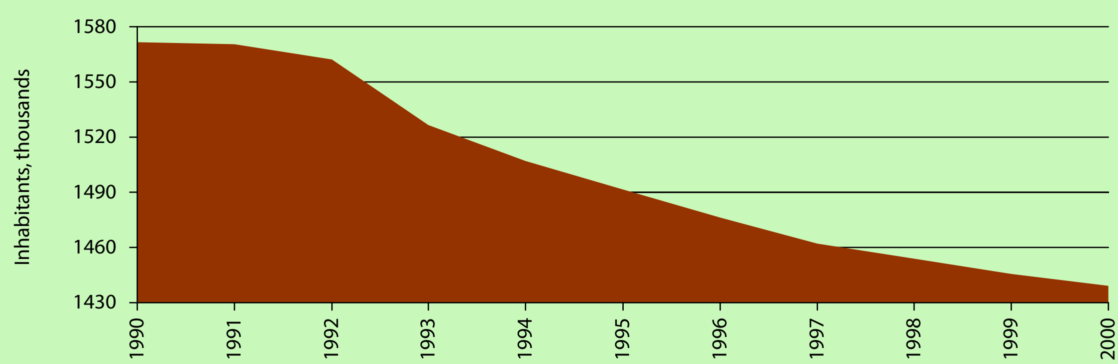
The climate of Estonia is humid because precipitation exceeds evapotranspiration. Nevertheless, there are often droughts during the summer period. Mean annual precipitation ranges from 550 to 750 mm.

Mean annual total solar radiation in Estonia is 1.300-1.400 W/m^2. Due to a very intense cyclonic activity in Northern Europe, the mean wind speed is comparatively high: 5-7 m/s in the coastal zone.

Estonia is one of the smallest and least populous countries in Europe – its total population is 1.37 million (based on 2000 population census).

The population number in Estonia has fallen every year since 1990 at an average annual rate of –0.94%. In part, this is due to net emigration, but more notably to a dramatic fall in the birth rate, which almost halved between 1989 and 1999 (Figure 2.2.1).

Figure 2.2.1. Mean annual population

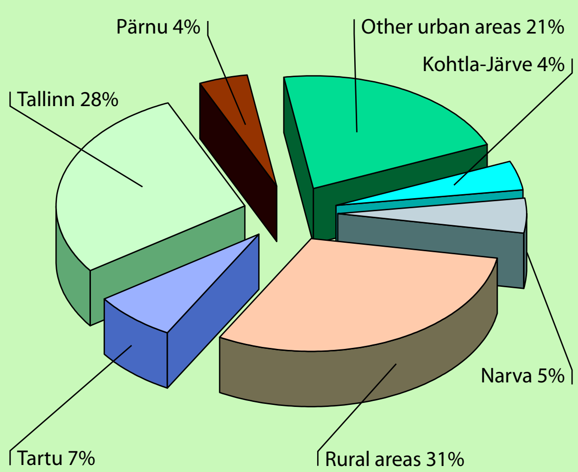


	Võru	Viljandi	Valga	Tartu	Tallinn	Rapla	Rakvere	Pärnu	Põlva	Petseri	Paide	Otepää	Narva	Kärdla	Kuressaare	Jõhvi	Jõgeva
Haapsalu	308	193	255	268	102	99	200	111	312	343	164	269	314	36	157	266	222
Jõgeva	124	77	142	53	153	132	76	156	101	159	74	95	159	258	299	110	
Jõhvi	201	189	219	133	164	220	69	253	178	236	154	173	49	301	385		
Kuressaare	355	253	301	331	220	194	316	163	359	390	244	316	433	192			
Kärdla	344	229	281	305	137	134	235	146	349	379	199	305	349				
Narva	251	238	268	180	212	268	117	300	235	285	202	221					
Otepää	48	81	50	42	220	189	167	159	43	83	134						
Paide	173	77	160	102	92	65	82	99	151	208							
Petseri	35	164	107	104	291	271	231	233	60								
Põlva	25	124	86	48	234	231	173	201									
Pärnu	198	98	139	183	129	91	184										
Rakvere	196	143	214	126	98	150											
Rapla	236	116	198	170	56												
Tallinn	257	163	245	188													
Tartu	71	76	86														
Valga	72	82															
Viljandi	129																

Figure 2.2.2. Estonia

The population density in Estonia is 31.8 inhabitants km[2]. Nearly 70% live in urban areas and 49% in five largest cities: Tallinn (415.300), Tartu (101.000), Narva (74.600), Kohtla-Järve (52.600) and Pärnu (52.000) (Figure 2.2.3).

Figure 2.2.3. Distribution of population in 1999



2.3. Natural resources and land use

Estonia is rather rich in natural resources. Their excavation and processing give a considerable share of the GDP. The active deposits at the beginning of 1999 and their excavation in 1998 are given in Table 2.3.1.

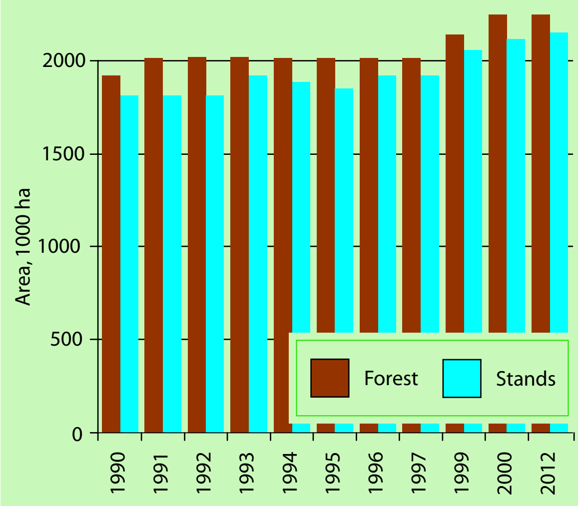
Table 2.3.1. Active deposits of some mineral resources and their utilisation

Mineral resource	Active deposits	Excavation
	1999	1998
Oil shale, million t	2 203	11
Limestone for cement, million m^3	100	0.4
Building limestone, million m^3	396	0.9
Peat, million t	970	0.3

Estonia is quite rich in renewable resources. During the past half-century the area of forest stands has more than doubled and the growing stock on it has increased 2.7 times (Figure 2.3.1).

Forest is one of Estonia's most important natural resources and is the basis of the wood processing industry. Approximately 26.500 people are engaged in forestry and forest industry. Forestland covers about 22.494 km[2], corresponding to 51.5% of the tenestrid mea. About 21.148 km[2] of this area is productive forestland. The predominant tree species are Scotch pine (34%), birch (30%) and Norwegian spruce (18%). Other tree species include grey alder, aspen and black alder. Despite its small territory of, the forests growing in Estonia are rather diverse. The variability brought about by natural conditions (parent material of soil, relief, climatic differences) is in its turn increased by the circumstance that the majority of the forests of Estonia have been affected by human activities in various degrees and ways (cutting, drainage, fires, etc.).

Figure 2.3.1. Changes in forest resources

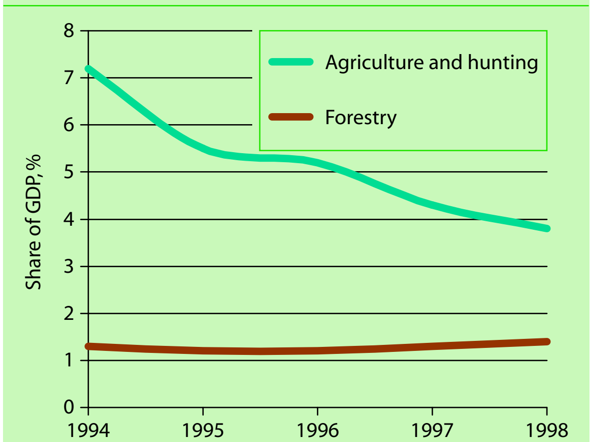


In the 20th century Estonian forestry policy was characterised by abrupt changes due to the several drastic changes in the political system, ownership and economy strategies. During the last decade the area of forestland has been continuously increasing (Figure 2.3.1).

Until 1995, most of the forest was state owned. When the ongoing land reform is completed, 40-50% of forest will belong to the private sector. Today approximately 26% of the forestland is in private ownership.

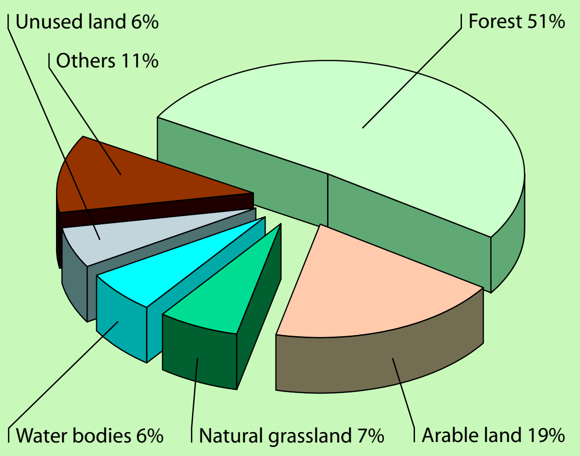
Forest industry and forestry have been and still are important contributors to the economy and employment of Estonia. In 1995, forestry accounted for 1.3% of GDP, which increased to 1.7% by 1998 (Figure 2.3.2).

Figure 2.3.2. Contribution of forestry and agriculture to the GDP



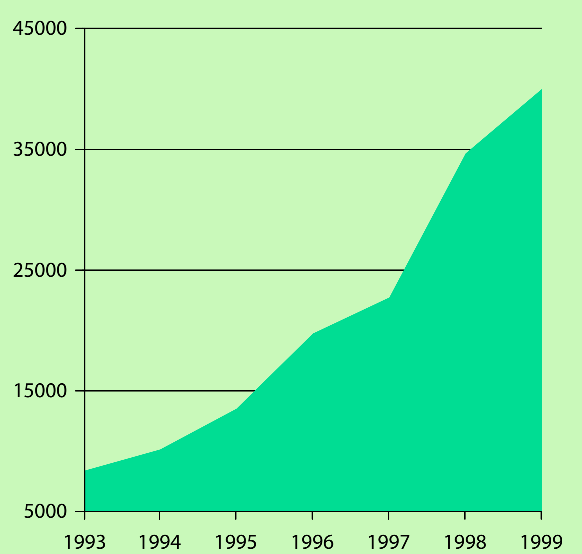
The share of gross agricultural output has decreased constantly while the share of forestry has maintained the same level. The area of agricultural land and natural grassland area is over 20% of the total land area. Arable land accounts for 1.120 million hectares representing over 70% of the total agricultural land (Figure 2.3.3).

Figure 2.3.3. The structure of land use



In 1990, the bulk of the arable land belonged to collective and state farms. In 1991, the land reform began and since then the large farms began to breaking into private farms (Figure 2.3.4).

Figure 2.3.4. Dynamics of the number of farms



Nearly two-thirds of the arable land was drained during 40 years since the 1950's but as collective farms were dismantled after 1991, the drainage system has not been well maintained. It is estimated that around 60% of Estonia's most fertile lands are excessively moist.

Crop production and livestock production are the main fields of activity in agriculture (Table 2.3.2). In livestock breeding the cattle breeding is the most important.

Table 2.3.2. Gross agricultural output, million kroons

Year	Crop production	Livestock production	Gross agricultural output
1995	2847.30	3120.40	5967.70
1996	2724.60	2864.30	5588.90
1997	2669.30	2836.20	5505.50
1998	2312.40	2918.30	5230.70
1999	2103.90	2697.20	4801.10

Grasslands make up 55% of the total arable land of Estonia and the main cereal is barley, the share of which constitutes over 60% of the total area sown to cereals.

The peatland area is approximately 10.000 km^2, corresponding to 22% of the territory. Wetlands are the biggest sources for carbon dioxide sink but it is very difficult to estimate the share of the anthropogenically derived processes here. Estonian peatlands are used for eco-tourism, hunting, but also for peat mining, extraction of mud and are drained to gain agricultural land. About 70% of Estonian peat-covered lands have been drained or influenced by drainage to an extent which does not allow peat accumulation any more. The area of untouched or virgin mires in Estonia can hardly be more than 300.000 ha. In 1997, the total area of peat fields under excavation was ca 18.600 ha and the area of abandoned cut-away mires may be about 15.000 ha. The amount of cutted peat decreased from 2.080 thousand tons in 1990 to 1.124 thousand tons in 1996.

2.4. Economic profile

Estonia's transition from planned to market economy started in the early 1990s, with major reforms launched after the monetary reform in 1992. Estonia has been determined and decisive in implementing necessary reforms. Successful reforms have resulted in achieving early macroeconomic stabilisation and the creation of a favourable environment for economic development. Estonia has achieved a high level of commercial and financial integration with the European and global economies.

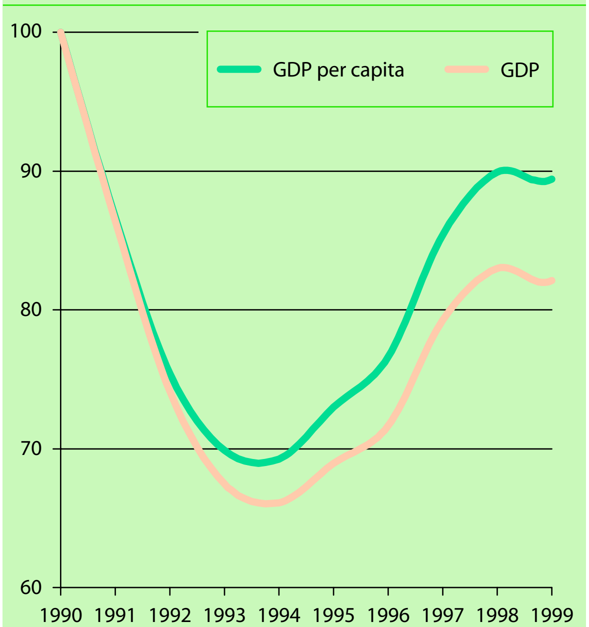
With independence in 1991, Estonia inherited an economy the structure and the trade relations of which were dominated by the Soviet Union. The economy had to go through heavy restructuring as in the new situation its structure was inappropriate and unbalanced. The strategy of international contacts was completely changed. If in 1990 the main trade partners were the Soviet Republics, then now the trade contacts with northern and western European countries dominate.

In 1991, Estonia started to establish a simple and efficient tax system. The process was supported by a broad political consensus that tax reform and improved control of expenditures were necessary to achieve a successful transition to the market economy.

Several shocks and radical reforms in liberalising the economy had a great impact on the real sector. Estonia suffered a deep fall in GDP up to the mid-1990s, as did most of the transition countries (Figure 2.4.1).

The Estonian GDP dropped by one-third in the four years between 1990 and 1994. As a result of appropriate policy choices and their implementation the general economic situation stabilised by the beginning of 1994, with the increase in efficiency and macroeconomic stabilisation creating a favourable environment for economic growth in the coming years. The downward trend in economic activity stopped in 1995.

Figure 2.4.1. Dynamics of GDP, 1990=100%

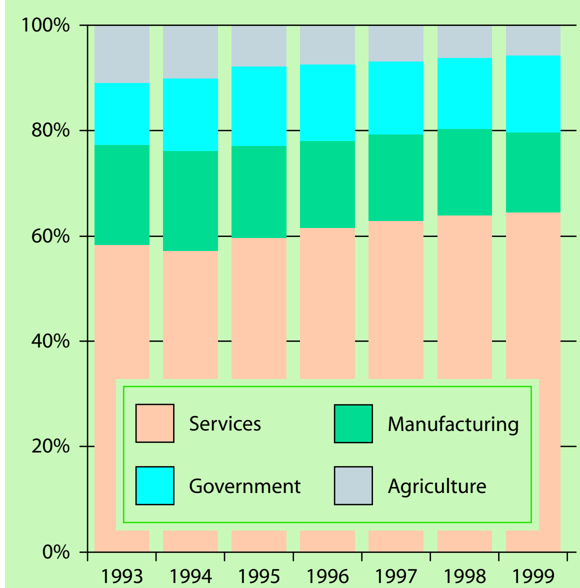


In order to restructure the enterprise sector and to improve domestic corporate governance structures, it was necessary to create an appropriate legislative framework and carry out ownership reform. Estonia enacted essential economic legislation during a relatively short time-span. In 1991-93 small-scale privatisation started. In 1993 the Privatisation Act was adopted and large scale privatisation started.

The GDP recovered gradually in 1995 and 1996 before surging forward by more than 10% in 1997. After the Russian economic crisis in August 1998, Estonia experienced the first decline in its economic growth since the initial stabilisation period. This was reinforced by the deceleration of growth in western Europe. This crisis had a severe impact on general economic conditions in Estonia and in 1999, the GDP fell slightly. Short-term indicators suggest that in 2000 the Estonian economy recovered strongly with GDP growth estimated at 6%, implying that by 2000 GDP recovered to 87% of its 1990 level. Over the same period the population number in Estonia fell steadily, by a cumulative 8% between 1990 and 1999, so that GDP per capita recovered more rapidly (Figure 2.4.1).

The share of the Estonian manufacturing industry in GDP has decreased and the growth of value added is faster in the service and finance sectors than in the industrial sector (Figure 2.4.2). The reason for the shifts in GDP structure is primarily the weak industrial sector, which is largely characterised by market specific goods and low productivity. The changes in the Estonian value added structure intensified during the last two years because the service sector is, as a rule, less sensitive to fluctuations in the economic situation. In the 9 months of 1999, 13.1% of value added was created in the manufacturing industry and 15% in wholesale and retail.

Figure 2.4.2. Share of GDP by sectors



The growth of value added in these sectors slowed down already at the beginning of 1998, but in the manufacturing industry this trend has been the fastest. The contradiction of growth rates inside the sector is deepened by different orientation of enterprises to export markets. The slow growth rate of the world economy aggravated the access of all Estonian exporting companies to EU markets and reduced the volume of foreign investments.

Investments growth rate to fixed assets in the manufacturing industry was extremely rapid before the Russian economic crisis (1998), since export opportunities were better and profitability was growing. This process accelerated also because of the need for applying EU standards and quality norms. In the first half of 1999, enterprises of the manufacturing industry were forced to restrain, beside

Table 2.4.1. Estonian macroeconomic indicators

Indicator	1995	1996	1997	1998	1999	2000
GDP (in 1995 constant prices), billion EEK	40.9	42.5	46.9	49.3	48.9	52.4
Unemployment, %	9.7	10	9.7	9.9	12.3	13.7
Average wage, EEK	2375	2985	3573	4125	4440	4907
EEK/USD annual exchange rate, EEK	11.464	12.031	13.881	14.065	14.695	16.981
Investments in fixed assets, at current prices, million EEK	8760.7	12313.2	16466.8	19528.6	17538.6	14427.4
Foreign direct investment flow, million EEK	2312.9	1814.4	3694.1	8071.4	4448	6807.3
Exports, million EEK	19008.9	21246.9	31607.4	37545.0	36774.3	55502.3
Imports, million EEK	27425	34666.5	48868.9	55215.4	50494.7	72236.2
Foreign trade balance, %	-44.3	-63.2	-54.5	-47.1	-37.3	-30.1
Current account balance, million EEK	-1810.6	-4806.9	-7810.2	-6760.2	-4334.9	-5709.1

production expenses, also investments into fixed assets. Investments to fixed assets declined in the manufacturing industry on the average 32%. The greatest decrease in the investments occurred in the most important field of the Estonian exports – wood industry (70%).

The structural changes in the economy in the 1990s are best characterized by the decrease in the importance of agriculture and industries predominating in the Soviet period, and a rapid emergence of the services sector and new branches of industry, which are of special importance in the analysis of GHG inventory data.

Following a sharp decline at the beginning of the 1990s, the manufacturing sector became the main engine of growth in the 1994-1998 recovery period, fuelled by strong growth in exports. The services sector also grew markedly in the recovery period, with a particularly rapid growth in construction, wholesale and retail trade, hotels and restaurants, transport and communications, and real estate, renting and business services. The services sector accounted for over 60% of total Estonian GDP in 1999. Output in the agricultural sector has more or less stagnated at its 1994 level while the government sector (which includes public administration, health and education) has grown at a very modest rate.

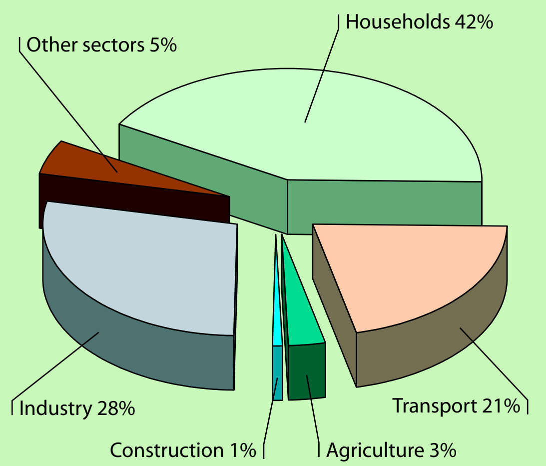
2.5. Energy and industry profile

Although small in area, Estonia is relatively rich in natural resources, both mineral and biological (Table 2.3.1), which have been the basis of the economy, and particularly of industry. The most important natural resource is oil shale. Both main important industries in Estonia - the energy and chemical industries are based on oil shale.

Primary energy use and energy consumption by end users have decreased since 1990 when the bulk of energy was used by industry and agriculture. In 1999 the biggest consumers are households and industry (Figure 2.5.1).

Like in the whole Estonian economy, essential changes have taken place in the energy sector during the last years.

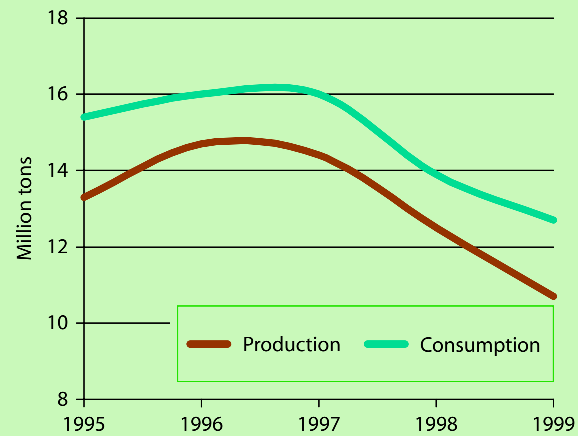
Figure 2.5.1. Total energy demand by branches of economy in 1999



Both the primary energy demand and the final consumption have decreased almost twice. From 1993 onward the level of energy consumption has gradually become more stable. In 1996 about 72% of the primary energy demand was covered by indigenous energy sources. The changes in the energy sector reflect reduction in the country's industrial output, but energy consumption has also become more economical during the last years.

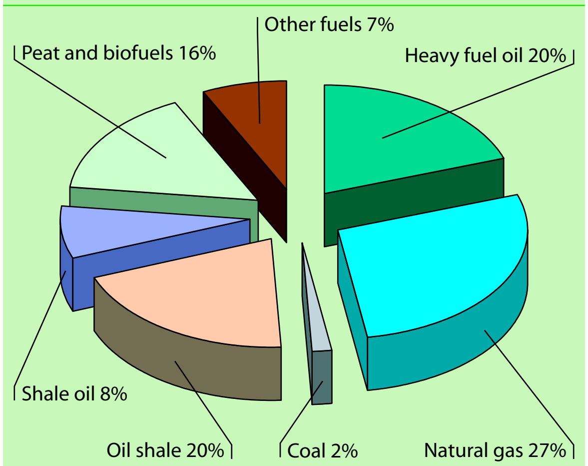
In 1999, 92% of electricity was generated on the base of oil shale. The Estonian oil shale as a fuel is characterized by a high ash content (45-50%), moderate moisture (11-13%) and sulphur contents (1.4-1.8%) and a low net caloric value (8.5-9 MJ). The production of oil shale in Estonia peaked in 1980 and fell by 8 million tons from 1980 to 1990. The extraction of oil shale decreased throughout the 1990s and fell to 12 million tons by 1999. The decrease in oil shale production (Figure 2.5.2) is caused by several processes ongoing in the Estonian economy. The most important was a rapid decrease in energy export to Russia and Latvia and changes in the structure of primary fuel consumption. Also the crisis in oil-shale based chemical industry was a reason for decreasing the use of oil shale.

Figure 2.5.2. Production and consumption of oil shale



In heat production the share of oil shale is lower (Figure 2.5.3). Here the proportion of natural gas will be increased significantly, mostly due to the low environmental impact of this fuel. Its share in the primary energy balance is expected to increase twofold in the next 10-15 years.

Figure 2.5.3. Structure of fuel used for heat production in 1999

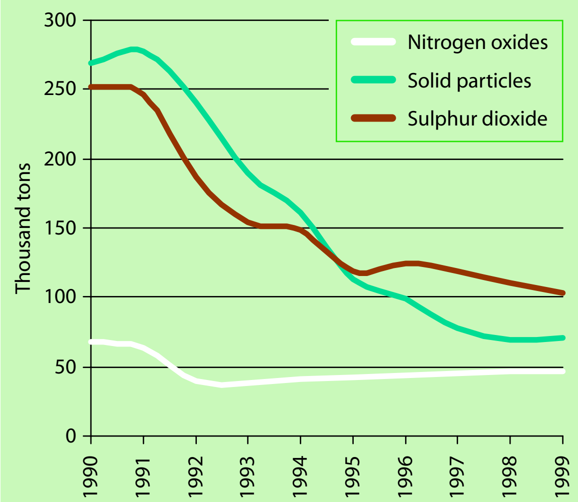


Estonia has developed a network for natural gas linking the largest towns and industrial centres and covering around 70% of the Estonian population. Consumption of natural gas in Estonia in 1999 was 719 cubic metres, which represents 12% in the national energy balance. Of this, 40.9% was used to produce thermal heat, 27.7% in the chemical industry, 17.7% in other industry, 5.3% by households, 4.72% in the production of electricity and 3.7% commercially. Also the contribution of peat and biofuels is permanently increasing, especially in heat production.

The energy sector in Estonia is the largest user of water and mineral resources as well the major generator of waste. Power and heat production based on combustion of fossil fuels (oil shale, heavy fuel oil and natural gas) and imported motor fuels cause the greatest share of national GHG emissions, particulates and volatile organic components (VOC).

Oil shale mining and combustion put a severe load on the environment, giving about 81% of the total harmful emissions in Estonia (Figure. 2.5.4).

Figure 2.5.4. Harmful emissions in Estonia



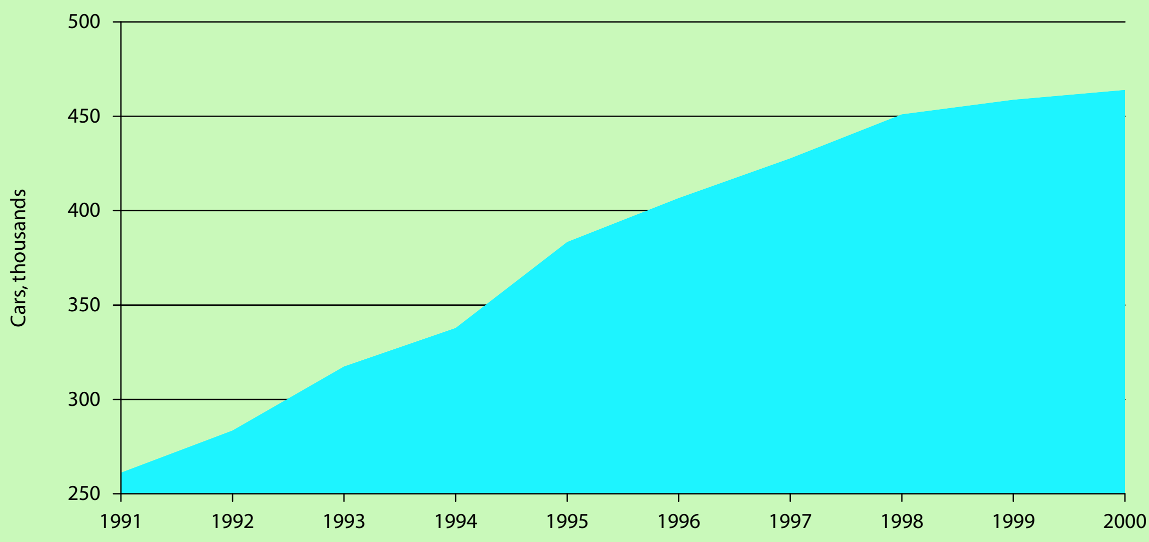
In 1999, a new economic instrument to limit CO_2 emissions was introduced in Estonia. On 21 March 1999 the Act on Pollution Charges entered into force, introducing pollution charges for the release of CO_2 into ambient air – 5 EEK/t in 2000 and 7.5 EEK/t from 2001 onward.

Energy production is wasteful, providing 80% of the total solid waste generation in 1999. Out of more than 11 million tons of wastes generated in 1999, 5 million tons was oil-shale combustion ashes and 3.8 million tons was mining residuals.

2.6. Transport

Significant changes have been taken place in the car park in Estonia. They reflect the processes that are typical of countries in transition going from a closed system to an open market. The number of motor vehicles has increased about two times during the last ten years. At the same time the road infrastructure in towns has remained almost unchanged. The most essential decrease in the number of motor vehicles took place in public transport and increase is the biggest in the number of cars (Figure 2.6.1). The average age of cars in Estonia - 13 years - is higher than in EU countries. Older cars, which are not in good order, emit more harmful compounds. The share of public transport in the passenger traffic volume in 1999 was more than two times smaller compared to 1990. Passenger kilometres by bus and rail have decreased 50-80%, mainly due to reorganisation of the previously state-owned transport enterprises. The growing number of cars has an easy to mea-

Figure 2.6.1. Dynamics of the number of passenger cars, thousands



sure effect on air quality, energy consumption, noise emissions and road use intensity, which requires more road infrastructure in the future.

Road transportation accounts for the majority of mobile sources of fuel consumption, and the majority of mobile sources of emission. Due to the decrease in the share of public transport since 1990 the number of cars increased dramatically. This process seems to continue yet more because due to the privatisation of the railways the share of railway transport has decreased essentially.

3

INVENTORIES OF ANTHROPOGENIC EMISSIONS AND SINKS OF GREENHOUSE GASES

3.1. Introduction

This chapter summarises the sources and sinks of Estonian's GHG emissions. For estimating the emissions of GHG and sinks, as well as the uncertainties associated with them, the IPCC top-down method according to the IPCC Guidelines (IPCC Greenhouse Gas Inventory Reporting Instructions: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volumes I, II and III, 1997) was used.

Six gases play a key role in contributing to the intensification of the greenhouse effect: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). The most important of them are carbon dioxide, methane and nitrous oxide.

According to the IPCC reporting guidelines on national communications, information on all other gases whose 100-year global warming potential (GWP) values have been identified by the IPCC and adopted by the COP should be included into the national inventory.

In the Estonian inventory are also included carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOCs). This chapter also reports Estonia's emissions of sulphur dioxides (SO_2). Sulphur gases - primarily SO_2 - are believed to contribute negatively to the greenhouse effect.

The Third National Communication should include GHG inventories of the years 1997, 1998 and 1999 according to the base year 1990. In reality the current inventory covers the whole period from 1990 to 1999, including also the years for which inventories have been reported earlier but have now been recalculated. The purpose of all recalculations was to improve accuracy and completeness. Now, the inventory of all years is estimated using the same methodology, adjusted statistical data and emission factors.

Uncertainty

By expert opinions the uncertainty of activity data could differ from 10% up to 25% depending on the sector and years. During 1993–1999 great changes took place in statistical data collection, in processing methods and publications of the Estonian Statistical Office and several other governmental institutions. In the early 1990s, uncertainties were much higher than in recent years.

3.2. Carbon dioxide

Table 3.2.1 summarises the principal changes in Estonian emissions and uptake of carbon dioxide in 1999 against the base year 1990.

Table 3.2.1. Sources of CO_2 emissions, Gg

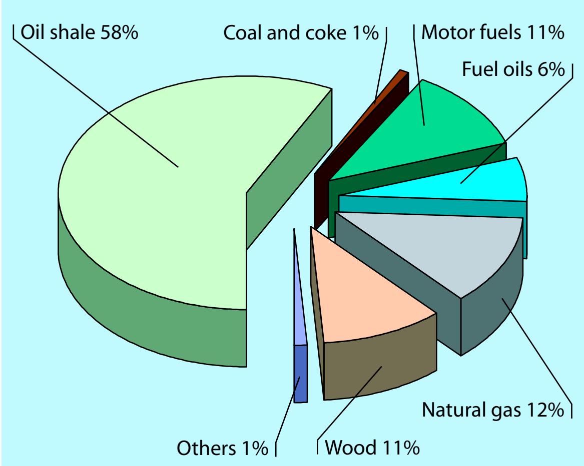
Source/Sinks	CO_2 emissions	
	1990	**1999**
Total fossil fuel consumption	**37493**	**16424**
Energy industries	29753	13478
Manufacturing	2655	660
Transport	2693	1203
Residential	1556	1036
Agriculture	386	13
Commercial	450	34
Industrial processes	**614**	**347**
Cement production	468	321
Lime production	146	26
Land use and forestry	**-6320**	**-8107**
Total net emissions	**31787**	**8664**

3.2.1. Energy sector

Energy related activities are the most significant contributors to the emission of GHG in Estonia, particularly of carbon dioxide emissions. The production, transmission, storage and distribution of fossil fuels also serve as sources for GHG.

Approximately 89% of energy in Estonia is produced through combustion of fossil fuels. The remaining 11% comes from biomass; the share of other renewables, such as small-scale hydro and wind energy, is inconsiderable in the energy balance (Figure 3.2.1).

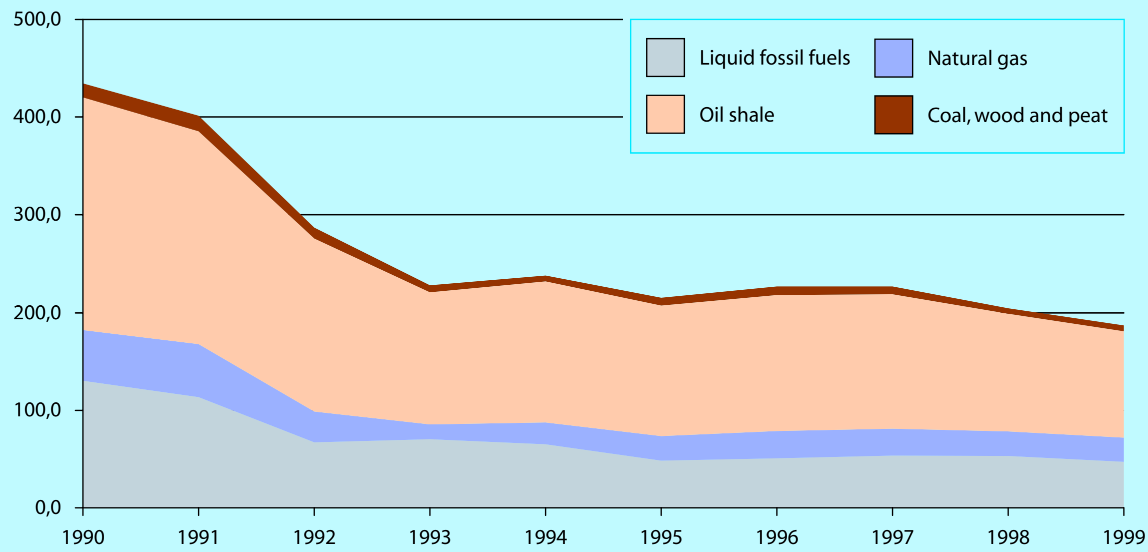
Figure 3.2.1. The proportion of different fuels in the total primary energy supply in 1999



Fossil fuel consumption

The energy related activities producing carbon dioxide emissions include the production, transmission and distri-

Figure 3.2.2. Changes in the structure of fuel supply in Estonia



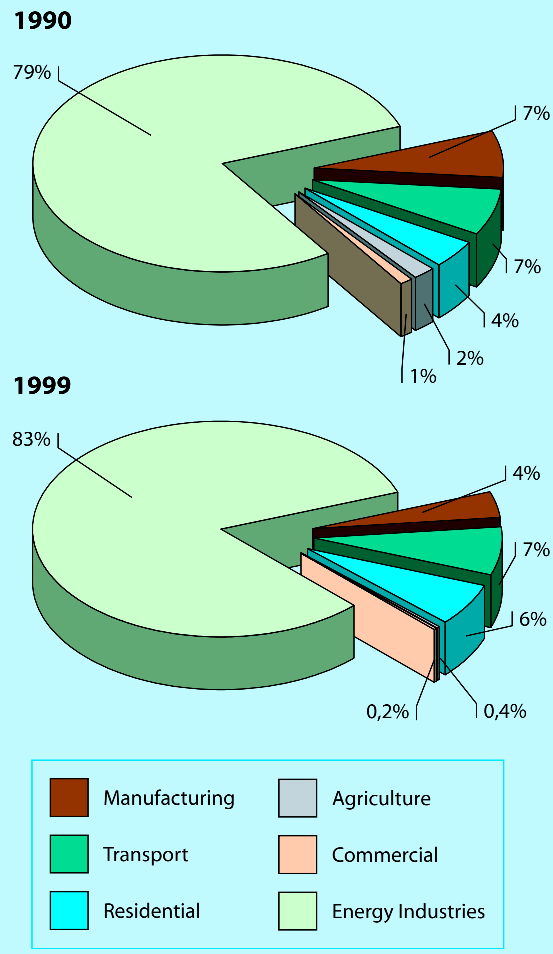
bution of electricity, gasoline consumption in automobiles and other vehicles and heating of residential and commercial buildings and steem production for industrial processes.

In 1999 Estonia emitted a total of 16424 Gg of CO_2 from fossil fuel combustion (Table 3.2.2). It follows that compared with the base year 1990, the total emission of carbon dioxide decreased approximately by 44%.

Estonia satisfies most of its energy demand by oil shale (Fig. 3.2.2) and approximately 67% of CO_2 emissions come from its combustion. The remaining 33% comes from heavy fuel oil, natural gas, coal, light fuel oil and other fuels. It is important to note that during the combustion of pulverised oil shale CO_2 is not formed as a burning product of organic carbon only, but also as a decomposition product of the mineral fuel part. The oil shale carbon emission factor (CEF) with taking into account the decomposition of its mineral carbonate part is relatively high - 29.1 tC/TJ. Without the decomposition of mineral carbon part, oil shale could be qualified as a fuel with a medium carbon emission factor - CEF=22 tC/TJ.

Among imported fuels, the share of *heavy fuel oil (HFO)* is the largest. In 1999, 10.53 PJ of HFO and 27.62 PJ of *light fuel oil (LFO)* were used. The consumption of *natural gas* in 1999 was 24.15 PJ[1] . In Estonia *coal* is used in small boilers up to 1 MW where fuel handling and ash removal are performed manually. In 1999, 1.9 PJ of coal was used in Estonia[1]. The Estonian road, railway, air and water transport are completely dependent on imported *motor fuels* (gasoline, diesel oil and jet kerosene). In 1999 the consumption of motor fuels was at 28.74 PJ[1].

Figure 3.2.3. CO_2 emissions by sector in 1990 and 1999



[1] Energy Balance 1999, Statistical Office of Estonia, 2000

Table 3.2.2. CO_2 emission by energy sources, Gg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Natural gas liquids	95.2	91.5	36.6	21.6	30.3	21.2	20.9	24.5	25.0	23.9
Gasoline	1570.9	1390.3	681.7	694.6	858.1	738.8	829.5	1081.3	1043.7	944.0
Jet kerosene	102.4	114.0	37.4	57.4	47.4	52.5	49.0	67.6	48.2	67.2
Other kerosene	335.8	256.6	83.4	157.6	147.2	70.4	122.2	140.7	160.4	196.5
Shale oil	287.1	152.9	630.9	505.4	549.6	579.6	469.3	472.2	334.7	386.4
Diesel oil	1883.6	1856.2	1199.1	1280.1	1174.7	976.0	1043.4	1137.8	1218.4	1029.1
Residual fuel oil*	5302.4	4498.3	2291.1	2452.8	1975.0	1095.3	1194.4	990.1	1025.5	798.4
Liquid fossil fuels	9577.4	8359.8	4960.2	5169.5	4782.3	3533.8	3728.7	3914.2	3855.9	3445.5
Coal	810.1	863.7	544.7	282.5	211.6	243.7	272.1	231.8	176.3	190.6
Oil shale	23586.8	22337.9	17953.9	13621.6	14491.8	13319.5	13890.0	13728.8	12096.7	11078.0
Peat	207.8	345.3	325.3	197.4	276.8	339.5	401.7	492.8	347.0	307.0
Peat briquette	415.8	341.6	268.2	209.3	164.1	222.6	207.3	114.3	57.7	52.9
Coke	0.0	36.9	12.4	8.4	6.3	3.3	3.7	3.04	3.3	3.2
Solid fossil fuels	25020.5	23925.4	19104.5	14319.2	15150.6	14128.6	14774.8	14570.7	12681.9	11631.7
Natural gas	2895.9	3015.2	1763.7	871.9	1230.3	1431.2	1553.4	1513.7	1413.3	1347.8
Gaseous fossil	**2895.9**	**3015.2**	**1763.7**	**871.9**	**1230.3**	**1431.2**	**1553.4**	**1513.7**	**1413.3**	**1347.8**
Fossil fuels total**	**37493.8**	**35300.3**	**25828.4**	**20360.6**	**21163.2**	**19093.5**	**20056.9**	**19998.6**	**17950.2**	**16425.0**
Solid biomass	847.2	881.8	844.1	793.5	1291.3	2150.5	2510.4	2632.1	2303.5	2272.5

* Heavy fuel oil

** Biomass is not included into the total fossil fuel

Figure 3.2.2 shows the changes in the structure of fuel consumption. The major factor in the decrease of CO_2 emission was the reduction of fossil fuel consumption, especially that of imported fuels. CO_2 emissions according to fuel types decreased in 1990-1999 as follows: natural gas 54%, coal 76%, gasoline 40%, kerosene 35%, heavy fuel oil 75%, and diesel oil 46%. The decrease of CO_2 from domestic oil shale was approximately 53%. The total emission of CO_2 from solid biomass increased 268% (Table 3.2.2).

3.2.2. Transport sector

The transport sector is also an important source of carbon dioxide. In 1999 CO_2 emissions from the transport sector made up 1203 Gg accounting for about 7% of Estonia's CO_2 emissions and being 55% less than in 1990 (when the corresponding figure was 2693 Gg) (Figure 3.2.4). As it follows from the Table 3.2.3, in the period 1990-1999 the number of passenger cars increased significantly (241 thousand cars in 1990 and 459 thousand in 1999). At the same time the consumption of motor fuels in the transport sector decreased from 34.5 PJ in 1990 to 16.1 PJ in 1999 due to the decline in the freight traffic as well as to the increasing share of new and more economical vehicles. While at the beginning of 1993 the proportion of passenger cars registered for the first time was only 4.9% of the total number of these vehicles, in 1999 the corresponding figure was 28.3%. The following measures may have contributed to the reduction of the consumption of motor fuels as well: stricter rules for motor vehicle inspection and engineering supervision; support to public transport; drawing up a public transport target programme, etc.

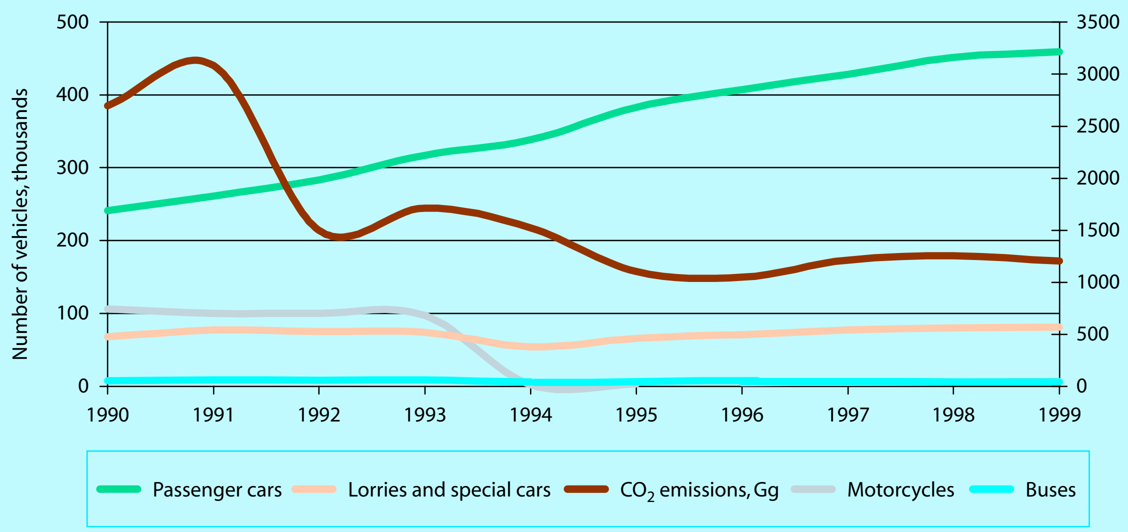
The following measures could contribute to the reduction of the consumption of motor fuels also: stricter rules for motor vehicle inspection and engineering supervision; support to the public transport and drawing up a public transport target programme, alternatives for passenger cars, etc. All these measures will contribute to making the environment of the transport sector friendlier and have treated in the new development plan - The *Development Plan of the Transport Sector for 1999-2006.*

Table 3.2.3. Total number of motor vechicles, fuel consumption and CO_2 emission

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Number of motor vehicles (thousand)	316	355	389	398	456	485	511	534	538	546
incl. Passenger cars	241	261	283	317	338	383	406	428	451	459
Fuel consumption, PJ*	37.1	42.1	20.7	23.6	21.1	15.3	14.5	17.8	18.8	16.8
CO_2 emissions, Gg	2693	3078	1497	1713	1522	1102	1047	1212	1251	1203

* Including motor fuels used in agriculture

Figure 3.2.4. Dynamics of the motor vehicles park and CO_2 emissions, Gg



3.2.3. Industrial processes

Emissions in the industrial sector are often produced as a by-product of various non-energy related activities. For example, in the industrial sector, raw materials are chemically transformed from one state to another. This transformation often releases such GHG as carbon dioxide.

In the Estonian industry emissions of carbon dioxide are released mainly by cement and lime production (Table 3.2.4). By thermal processing of calcium carbonate ($CaCO_3$) from limestone, chalk or other calcium-rich materials, calcium oxide (CaO) and carbon dioxide (CO_2) are formed.

In 1999 CO_2 emissions from industrial processes were approximately 347 Gg, which accounts for about 2.1% of the total CO_2 emissions. In 1990 it was 614 Gg, accounting for 1.6% of Estonia's total emissions of CO_2.

3.2.4. Forestry and land use

The net carbon flux between terrestrial ecosystems and the atmosphere is the result of a balance between uptake by photosynthesis and release by various return processes. In Estonia the carbon release by the terrestrial ecosystems has increased continuously since the 1990s in connection with essential land reforms and restructuring of the economy.

The inventory of carbon uptake and losses connected with changes in land use is much more complicated than in the energy sector because of a large variety of natural processes leading the carbon cycling in ecosystems. An attempt is made to analyse two major areas: forest and cropland ecosystems. Forests contain a large part of the carbon stored on land in the form of biomass. On a time scale of years, most forests accumulate carbon through the growth of trees and an increase in soil carbon. In cropland ecosystems, carbon stocks are primarily in the form of belowground plant organic matter and soil. Most of these ecosystems have large annual carbon uptake rates, but much of the gain is exported in the form of agricultural products and associated waste materials. Abandoned lands are also known as carbon accumulating ecosystems.

In Estonia the use of agricultural land decreased at the beginning of the 1990s, stabilising by the 1997. The area under crops was 809000 ha in 1999, which was only 6% less than in 1998. About half of the unused lands have overgrown with bushes or become wetlands in 3-4 years, as the drainage system was not maintained any longer. Therefore the total CO_2 sink calculated by IPCC guidelines was especially important at the beginning of the 1990s (Table 3.2.5). Note that due to the big variety of soil conditions the calculations were made with certain uncertainties.

Table 3.2.4. Sources of CO_2 emissions from industrial processes, Gg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cement production	467.5	451.1	240.8	176.5	200.7	208.2	193.3	210.6	342.3	321.4
Lime production	146.2	163.5	72.7	16.6	14.2	13.3	13.7	15.4	25.3	25.4
Total	613.7	614.6	313.5	193.1	214.9	221.5	207.0	226.0	367.6	346.8

Table 3.2.5. Removals/emissions of CO_2 in land use and forestry, Gg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Total removals by forests, Gg	**-12193**	**-12332**	**-12471**	**-12608**	**-12180**	**-12517**	**-13523**	**-13520**	**-13718**	**-14541**
Total increment, Gg CO_2	-10208	-10341	-10474	-10606	-10739	-11178	-11802	-11940	-12106	-12245
CO_2 removed by regrowth, Gg	-1985	-1991	-1997	-2002	-1441	-1339	-1721	-1580	-1612	-2296
Total emission by forests, Gg	**2821**	**2601**	**1970**	**2153**	**3162**	**3325**	**3496**	**4760**	**5237**	**5787**
Total harvest, Gg CO_2	2746	2531	1905	2093	3106	3277	3457	4723	5200	5752
CO_2 released by burning, Gg	37	33	28	24	20	2	2	1	1	0
CO_2 released by decay, Gg	38	37	37	36	36	46	37	36	36	35
Total emissions from soils	**3053**	**2569**	**2685**	**761**	**1413**	**1410**	**420**	**-347**	**-43**	**646**
CO_2 emissions from mineral soils, Gg	2904	2464	2464	660	1254	1239	359	-374	-81	616
CO_2 emissions from organic soils, Gg	149	105	221	101	159	171	61	27	38	30
Net CO_2 removals, Gg	**-6319**	**-7162**	**-7816**	**-9694**	**-7605**	**-7782**	**-9607**	**-9107**	**-8524**	**-8108**

Table 3.2.6. Forest resources and management

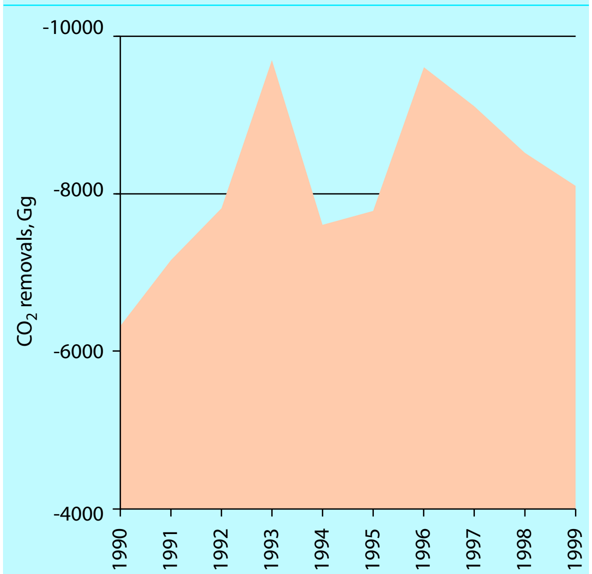
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Area of managed forests, thousand ha	1875	1878	1899	1920	1855	1850	1919	1919	1943	2059
Total increment, thousand t dm^3	7391	6267	6348	6428	6508	6774	7153	7236	7337	7421
Total harvest, thousand t dm^3	1664	1534	1154	1268	1883	1986	2095	2862	3152	3486

Forests, which cover about 51% of Estonian land area, are an important terrestrial sink for carbon dioxide (CO_2). Because approximately half the dry mass of wood is carbon, as trees add mass to their stems, branches and roots more carbon is accumulated and stored in the trees than is released to the atmosphere through respiration and decay. Soils and vegetative cover in forest also provide a potential sink for carbon emissions.

The removals of CO_2 by forest were calculated using volume data of the growing stock increment and felling (Table 3.2.6). The volume data were converted to biomass using default factors (0.65 t dm m^{-3} for deciduous trees and 0.45 t dm m^{-3} for coniferous trees) suggested by IPCC Guidelines (1994). The proportion of coniferous forests was found from different sources and it ranged from 67.4% to 62.9%. Part of tops, branches and stumps was taken as 35% and was added to volume data of growing stock increment. Biomass carbon fraction was taken 0.45 – default value of IPCC Guidelines (1996).

The state of the Estonian forests has been inventoried and reported regularly by the Forest Survey Centre. All calculations of CO_2 removals and emissions, conducted according to the IPCC guidelines, base on the official data issued annually by the Statistical Office of Estonia. During the last 10 years, the removals and emissions of CO_2 by forests have been mostly affected by increase in forestland area, growing stock increment, and forest fellings. The area of managed forests has steadily increased from 1856800 ha in 1990 to 2059000 ha in 1999, but this has had little effect on CO_2 removals/emissions (Table 3.2.6). The extent of annual fellings was very variable in 1990-1999. In the first two years of the period the total felling decreased by 1 million m^3 and remained at a relatively low level for 1992-1993. In 1994, total felling increased sharply having a negative impact on CO_2 removals. Since then, the extent of annual fellings has steadily increased, which has caused the net removals of CO_2 to decrease (Figure 3.2.5.).

Figure 3.2.5. Net CO_2 removals by forest



The increase in CO_2 emissions due to more extensive fellings has partly been mitigated by greater growing stock increment in the second half of the period. Forest growing stock increment increased from 3.98 t dm^3 ha^{-1} in 1990 to 4.28 t dm^3 ha^{-1} in 1999. This can be explained by the changes in the age structure and species composition of Estonian forests. Due to extensive felling of mature coniferous stands, the proportion of deciduous tree species has increased. Abandoned agricultural lands, which have been partly added to forestland, have been naturally covered with young fast-growing birch and grey alder stands.

The forest conversion has only a marginal effect on

CO_2 emissions as compared with fellings. The main reason is that the road building and drainage in forests have stopped and there is no need for new ditches in Estonia. Besides, as Estonian agriculture is declining, there is also no need for new agricultural land. Abandoned managed lands are afforested or cover with natural regrowth. Twenty year total area abandoned lands ranges from 198000 ha in 1995 to 325100 ha in 1999 and CO_2 uptake by regrowth fluctuates between 1352 and 2317 Gg.

3.3. Methane

Methane's overall contribution to global warming is significant because it is 21 times more effective at trapping heat in the atmosphere than carbon dioxide over a one hundred year time horizon. Methane's concentration in the atmosphere has more than doubled over the last two centuries. These atmospheric increases are largely due to increasing emissions from anthropogenic sources, such as landfills, agricultural activities, fossil fuel combustion, coalure mining, the production and processing of natural gas and oil, and wastewater treatment.

In Estonia the major sources of methane emission are waste management, particularly landfills, domestic and commercial wastewater treatment and industrial wastewater, agriculture and energy production (Table 3.3.1).

Domestic waste makes up only 3.5% of the total waste generated in Estonia (oil shale industry and energy industry as well as the construction materials industry produce the major share of the total waste), but its share is constantly growing. Increasing volume of domestic waste (the growth in 1993-1999 reached about 40%) can be explained with the constant consumption growth and several new package materials and types in the Estonian market. Also dumping of waste in landfills has increased, since recycling of domestic waste has been insignificant. In 1998 and 1999 the generation amount of domestic waste decreased for about 5% against 1997 and thus the growth retarded to some extent (Figure 3.3.1).

The most important source of CH_4 emission in agriculture is domestically raised animals. Animals produce methane through enteric fermentation. Manure management is also an important source of CH_4, but methane emission from enteric fermentation forms 75% of total CH_4 emission in agriculture. In Estonia methane emission is calculated for dairy cattle, non-dairy cattle, swine, sheep, horses and poultry (Figure 3.3.2). Dairy and non-dairy cattle account for the largest part of global methane emission from livestock manures. After cattle, swine wastes make the second largest contribution. CH_4 emission from enteric fermentation and manure management are calculated according to IPCC methodology, where different emission coefficients were applied to different animal types. As it can be seen in Figure 3.3.2 during the last decade the total number of livestock has decreased about 60%.

Table 3.3.1. Generation and deposition of domestic waste

	1993	1994	1995	1996	1997	1998	1999
Generation of domestic waste, thousand tonnes	337.1	472.6	522.1	564.7	593.2	557.1	568.2
Deposition, thousand tonnes	317.0	468.9	518.5	563.7	591.9	557.1	568.2
Total population, million inhabitants	1.52	1.50	1.49	1.47	1.46	1.45	1.45
Generation per capita, kg/y	220.8	313.6	350.0	382.5	405.7	383.0	393.3

Figure 3.3.1. Generation and deposition of domestic waste

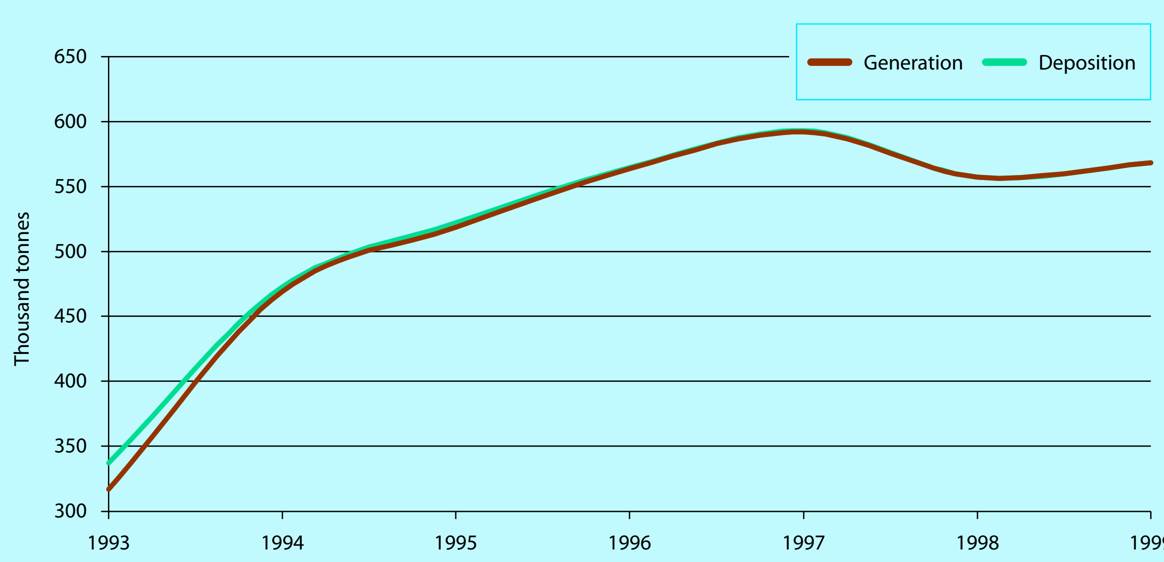
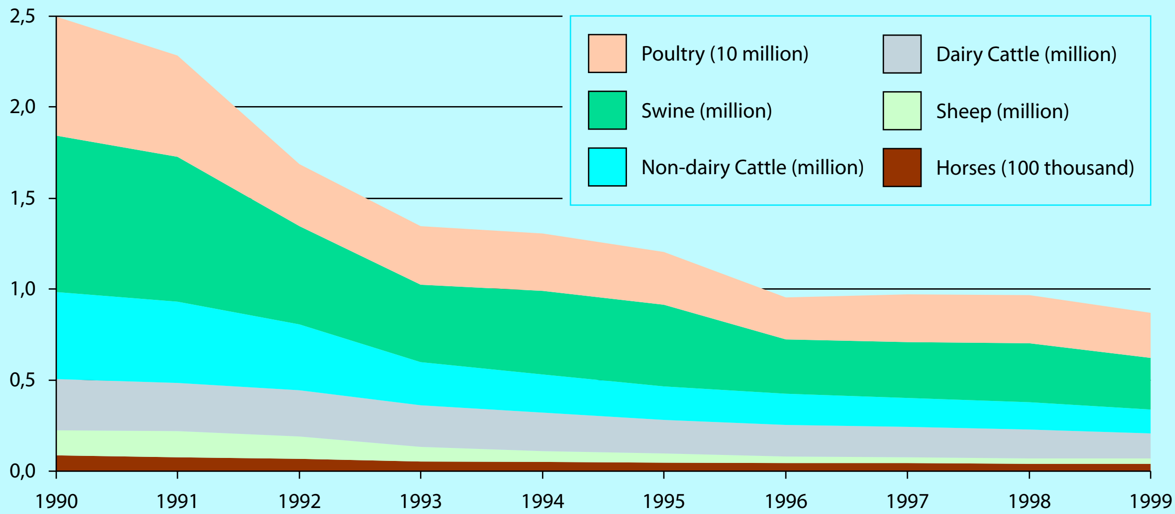


Figure 3.3.2. Number of livestock in Estonia



Considering the methane emission amounts by sources (Figure 3.3.3; Table 3.3.2) we can see that the share of methane generated in waste has increased from 37% in 1990 to 52% in 1999. Agriculture contributed 21% and fugitive emission of fuels about 28%. The domestic waste deposited in landfills has increased in Estonia year by year. However, the total emission of methane has still decreased, first of all due to the reduction of agricultural production.

Table 3.3.2. Sources of methane emissions, Gg

	1990	1999
Waste management	76.57	62.10
Agriculture	69.89	25.54
Energy, incl.		
fugitive emission	57.13	27.50
fuel combustion	4.13	5.33
Total	**207.72**	**120.47**
Total (CO_2 eq: GWP=21)	**4362.12**	**2529.87**

3.4. Nitrous Oxide

Nitrous oxide (N_2O) is an active GHG, although its actual emissions are much smaller than those of CO_2. At the same time, N_2O is approximately 310 times as powerful as CO_2 at trapping heat in the atmosphere over a 100-year horizon.

The main source of N_2O emission from agriculture is the use of N-fertilisers. Restructuring of agricultural production, development of the private sector, partial loss of the traditional eastern market and a rise in the prices of fuels and fertilisers have influenced immensely the whole agricultural sector.

During the last two decades the structure of sown area has changed because of the restructuring of agricultural production. In 1990 the total sown area of field crops was

Figure 3.3.3. CH_4 emissions by main sources, Gg

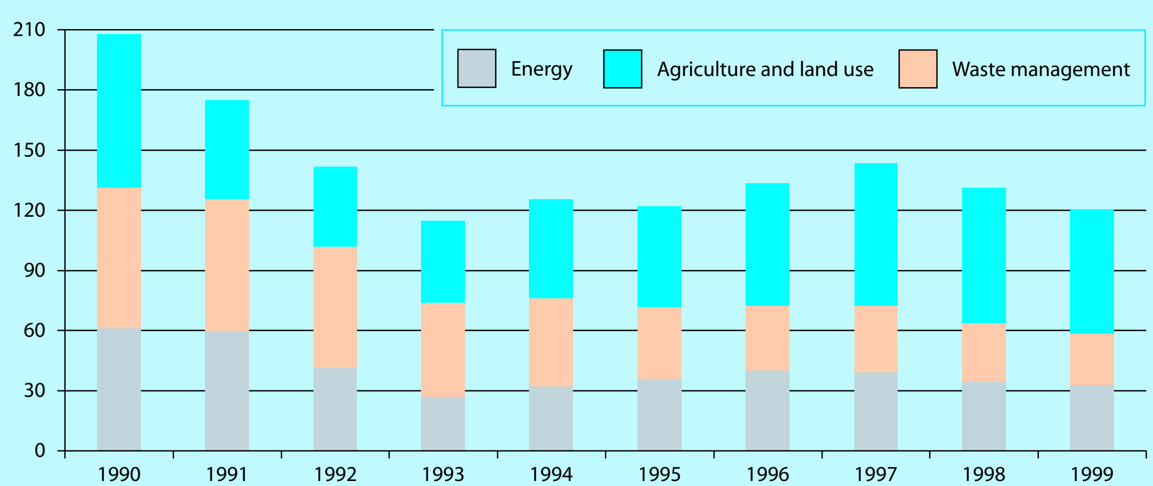
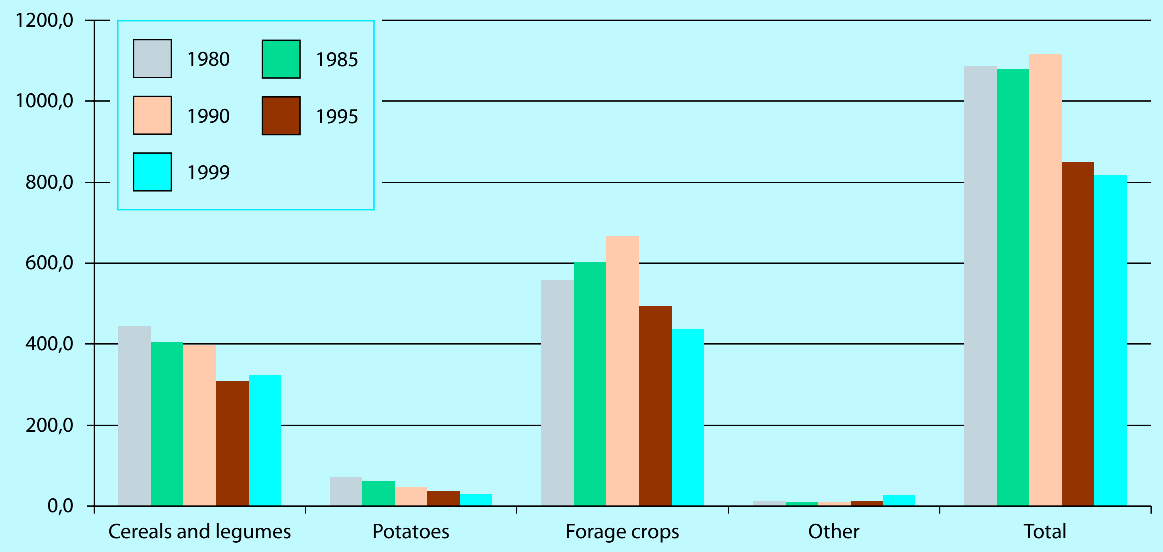


Figure 3.4.1. Sown area of field crops, thousand hectares



1116 thousand hectares of which forage crops covered 59.6%, cereals and legumes 35.6%, potatoes 4.1% and other crops (industrial crops and vegetables) 0.8% (Figure 3.4.1). During the following years the area of field crops decreased rapidly. At the same time the level of agricultural production decreased too. It can be explained by economic factors - the prices of fertilisers, machinery and fuels have risen, but the prices of agricultural products are relatively low. In comparison with 1990 the total sown area was about 25% smaller in 1999 and was 819 thousand hectares. Forage crops covered 53.2%, cereals and legumes 39.6%, potatoes 3.8% and other crops 3.5% of the total sown area.

The use of N-fertilisers has decreased during the last decade about 60-70% and the emission of N_2O from agriculture has decreased more than 60%. For example in 1993 144 kg of mineral fertilisers were used per hectare, in 1999 same number was 77 kg per hectare (Figure 3.4.2). As compared with developed agricultural countries, the application of fertilisers in Estonia is very low. Small amount (about 2%) of N_2O emission is also coming from manure management.

The main activities producing emissions of N_2O in Estonia are soil management and fertilizers used in agriculture, but also fossil fuel combustion (Table 3.4.1).

Figure 3.4.2. Use of N-fertilisers during last decade (kg N yr^{-1})

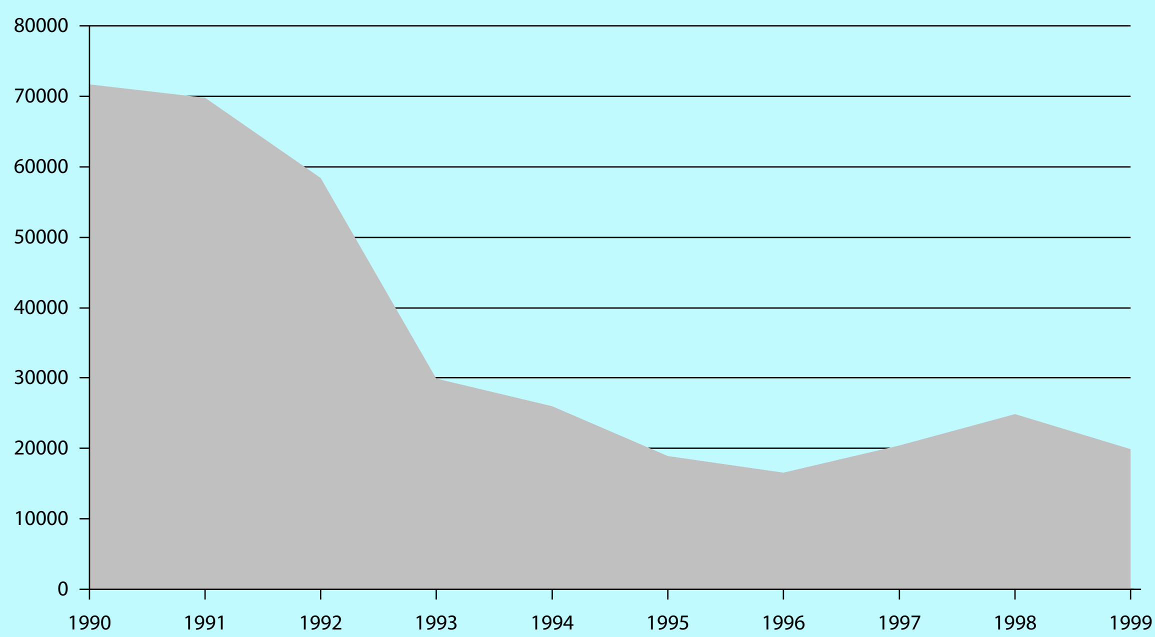


Figure 3.4.3. Sources of nitrous oxide emissions, Gg

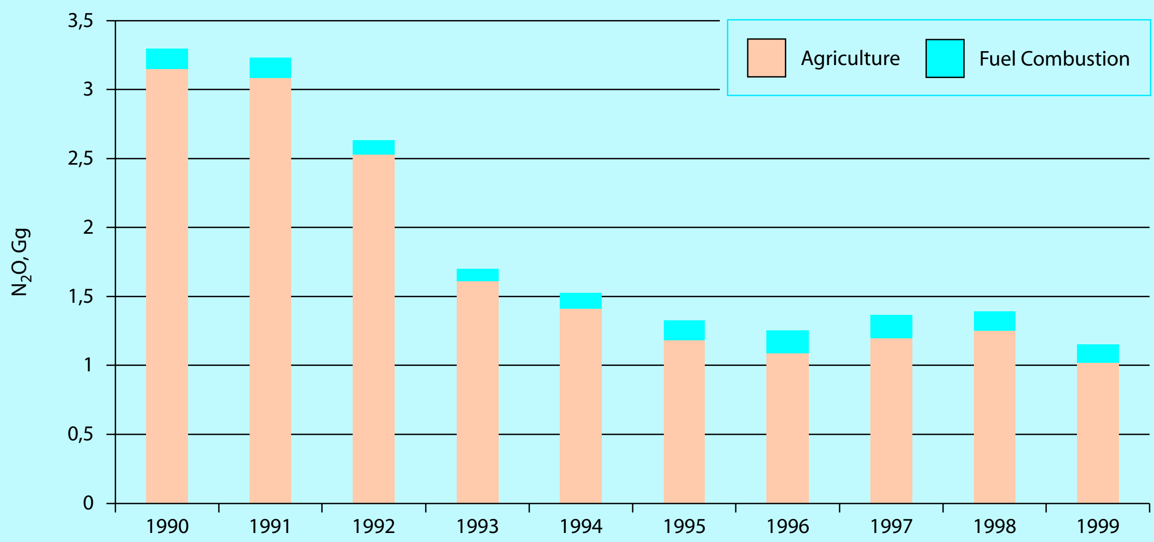


Table 3.4.1. Sources of nitrous oxide emissions, Gg

Source	1990	1999
Fuel Combustion	0.15	0.13
Agriculture	3.15	1.02
Total	**3.30**	**1.15**
Total (CO_2 eq: GWP=310)	**1023.0**	**356.5**

Nitrous oxide emissions contribute about 3% to Estonia's total GHG emissions. Figure 3.4.3 shows a rapid decrease of N_2O emission from 1990 to 1993 and the following stabilisation.

3.5. HFCs, PFCs and SF_6

According to *the Guidelines for the Preparation of National Communications by Parties Including in ANNEX I to the Convention* a national GHG inventory should include three new greenhouse gases: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). These gases are not directly harmful to the stratospheric ozone layer; they are not controlled by the *Montreal Protocol*. However, these compounds are powerful greenhouse gases and are, therefore, considered under the Framework Convention on Climate Change.

There are no such industrial branches in Estonia (for example aluminium production) from where the new gases (HFCs, PFCs and SF_6) could emit into the atmosphere.

However, small amount of these gases could be brought in Estonia with some imported equipment (mainly household and industrial refrigerators, ice machines, drinking water coolers, etc). Unfortunately Estonia has no data available on the leakage of these gases from imported facilities today, but a data collection system is under development.

3.6. Indirect GHG

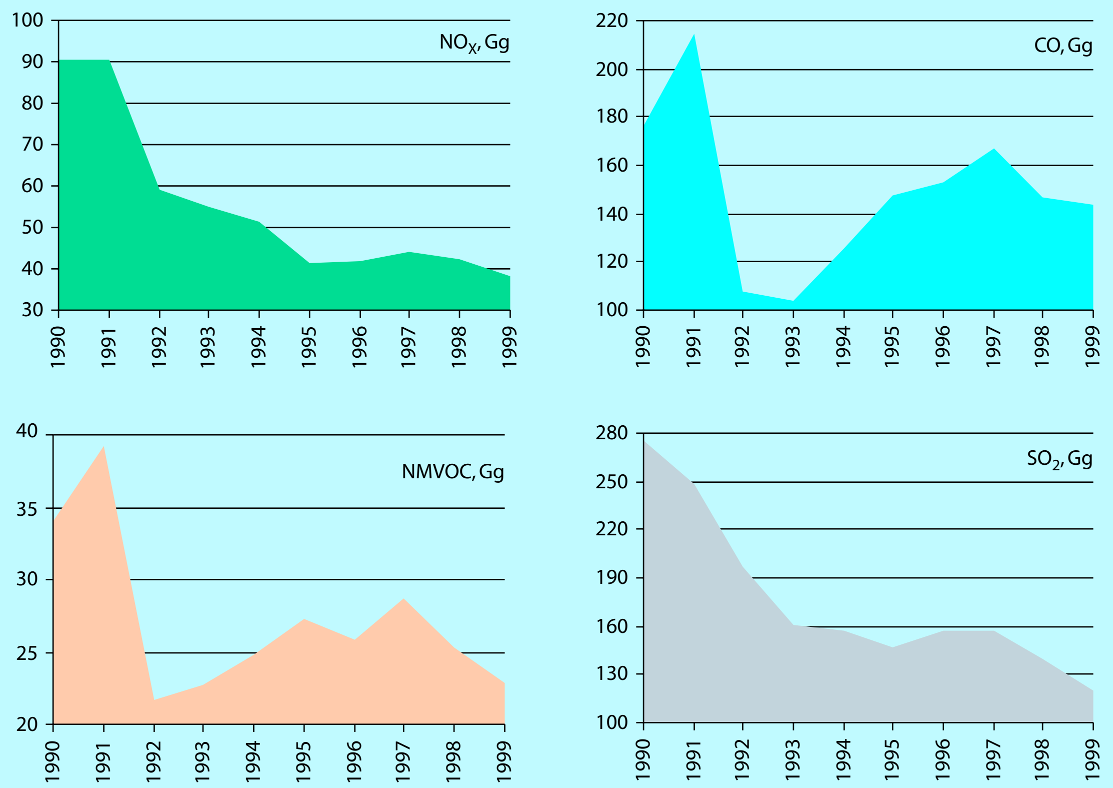
Carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2) are commonly defined as indirect GHG. These gases have an impact on global climate through their indirect radiative effect (i.e., they do not directly act as GHGs, but react with other chemical compounds in the atmosphere to form compounds that are GHGs). Unlike other criteria pollutants, SO_2 emitted into the atmosphere affects the Earth's radiative budget negatively.

CO is emitted when carbon-containing fuels are burned incompletely; oxides of nitrogen (NO and NO_2) are created from lightning, natural fires, fossil fuel combustion, and in the stratosphere from nitrous oxide; NMVOCs,

Table 3.6.1. Estonia's sources of NO_x, CO, NMVOC and SO_2, Gg

Source	NO_x		CO		NMVOC		SO_2	
	1990	1999	1990	1999	1990	1999	1990	1999
Fuel combustion	90.47	38.09	174.4	142.54	28.17	20.81	270.11	117.06
Industrial processes	0.10	0.09	0.38	1.46	5.88	2.0	4.8	3.29
Land use change and forestry	0.05	-	1.41	-	-	-	-	-
Total	**90.62**	**38.18**	**176.19**	**144.00**	**34.05**	**22.81**	**274.91**	**120.35**

Figure 3.6.1. Emission indirect GHG and SO_2.



which include such compounds as propane, butane, and ethane, are emitted primarily from transportation and industrial processes, as well as from forest wildfires. SO_2 can result from the combustion of fossil fuels, industrial processing, waste incineration and biomass burning. See Table 3.6.1 for the sources of these pollutants in Estonia.

Increase of CO emissions amounts is directly connected with the growth in the use of local fuels (wood and peat) in small boilers with a small heat capacity. Those boilers are largely used in households and in small boiler plants.

3.7. Aggregated Emissions of GHG

The Global Warming Potential Concept

Gases can contribute to the greenhouse effect both directly and indirectly. Direct effect occurs when the gas itself is as GHG, indirect radiative forcing occurs when chemical transformation of the original gas produces a gas or gases that are GHGs, or when a gas influences the atmospheric lifetimes of other gases.

The concept of global warming potential (GWP) has been developed to compare the abilities of each GHG to trap heat in the atmosphere.

Carbon dioxide was chosen as the "reference" gas to be consistent with the IPCCs GWP values. The GWP of a GHG is the ratio of global warming from one kilogram of a GHG to one kilogram of carbon dioxide over a certain period of time. This report uses the 100-year GWPs recommended by IPCC (Table 3.7.1).

Table 3.7.1. Global warming potential (GWP) values

Greenhouse gas	Chemical formula	1995 IPCC GWP
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
HFC-134a	$C_2H_3F_3(CF_3CH_3)$	3800
HFC-23	CHF_3	11700
HFC-152a	$C_2H_4F_2(CH_3CHF_2)$	140
Sulphur hexafluoride	SF_6	23900

Table 3.7.2. shows the trends in main GHG emissions as well the aggregated emission values in CO_2 equivalents. The data show that the decrease in CO_2 emissions from fossil fuel consumption has had the strongest impact on the trend of Estonia's GHG emissions. Methane and nitrous oxide represent a much smaller portion in total emissions than CO_2. It is necessary to point out that the share of emissions compensated by the sink in the land use sectors increased from 14% in 1990 to 41% in 1999.

The Estonia's total anthropogenic greenhouse gas emissions in 1999 were 11553 Gg of carbon dioxide equiva-

Table 3.7.2. Recent trends in Estonia's greenhouse gas emissions: 1990 – 1999

Gas/Source	CO$_2$ equivalent , Gg									
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	Greenhouse Gases									
Net carbon dioxide (CO_2)	**31787**	**28752**	**18325**	**10858**	**13773**	**11533**	**10656**	**11117**	**9795**	**8664**
Fossile fuel combustion	37493	35300	25828	20360	21163	19093	20056	19998	17950	16424
Industrial processes	614	615	313	193	215	222	207	226	367	347
Total	38107	35915	26141	20553	21378	19315	20263	20224	18317	16771
Land use change and forestry	-6320	-7163	-7816	-9695	-7605	-7782	-9607	-9107	-8522	-8107
Methane (CH_4, CO_2 eq)	**4362**	**3668**	**2976**	**2409**	**2632**	**2561**	**2803**	**3016**	**2754**	**2530**
Waste management	76.57	49.21	39.71	40.77	49.21	50.33	60.99	71.15	67.42	62.1
Agriculture and land use	69.89	65.41	60.41	46.89	43.88	35.68	32.35	33.2	29.29	25.54
Fugitive emission from fuels	57.13	55.2	38.21	24.16	28.72	30.04	33.29	32.32	28.99	27.5
Fuel combustion	4.13	4.83	3.37	2.89	3.5	5.92	6.85	6.94	5.46	5.33
Total	207.7	174.7	141.7	114.7	125.31	121.97	133.48	143.61	131.16	120.5
Nitrous oxide (N_2O, CO_2 eq)	**1023**	**1004**	**818**	**527**	**474**	**409**	**391**	**425**	**431**	**357**
Fuel Ccombustion	0.15	0.15	0.11	0.09	0.12	0.14	0.17	0.17	0.14	0.13
Agriculture	3.15	3.09	2.53	1.61	1.41	1.18	1.09	1.20	1.25	1.02
Total	3.3	3.24	2.64	1.7	1.53	1.32	1.26	1.37	1.39	1.15
HFCs, PFCs and SF_6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
	Indirect Gases									
Carbon monoxide (CO)	176.2	214.2	107.97	104.1	125.42	147.82	152.68	166.86	146.94	143.9
Nitrogen oxides (NOx)	90.62	90.38	59.15	54.78	51.23	41.33	41.61	44.13	42.44	38.18
NMVOC	34.05	39.27	21.75	22.78	24.75	27.33	25.83	28.98	25.36	22.81
Sulphur dioxide (SO_2)	274.91	247.87	196.89	160.52	156.85	146.61	157.61	156.98	139.44	120.35
Net Estonia's emissions	**37172**	**33421**	**22118**	**13794**	**16877**	**14505**	**13848**	**14556**	**12980**	**11553**

NE - not estimated

lents (about 69 % under the 1990 baseline level).

Figure 3.7.1. illustrates the relative contribution of primary greenhouse gases to Estonia's total emissions in 1990 (base year) and 1999. This contribution was calculated based on the global warming potentials of these gases, as presented in the figure. The emissions of indirect gases CO, NO_x and NMVOC are not included in the figure, because there is no agreed-upon method to estimate their contribution to climate change.

Due largely to oil shale and other fossil fuel consumption, carbon dioxide emissions in 1999 accounted for the largest share in Estonia's net GHG emissions - 85 per cent (the same as in 1990), while methane accounted for 12 per cent (18 %) and nitrous oxide only for 3 per cent (2.7%) (see also Table 3.7.2).

Figure 3.7.2. illustrates changes in emissions of three main greenhouse gases: carbon dioxide, methane and nitrous oxide.

Figure 3.7.1. Contribution of different greenhouse gases to Estonia's total emission

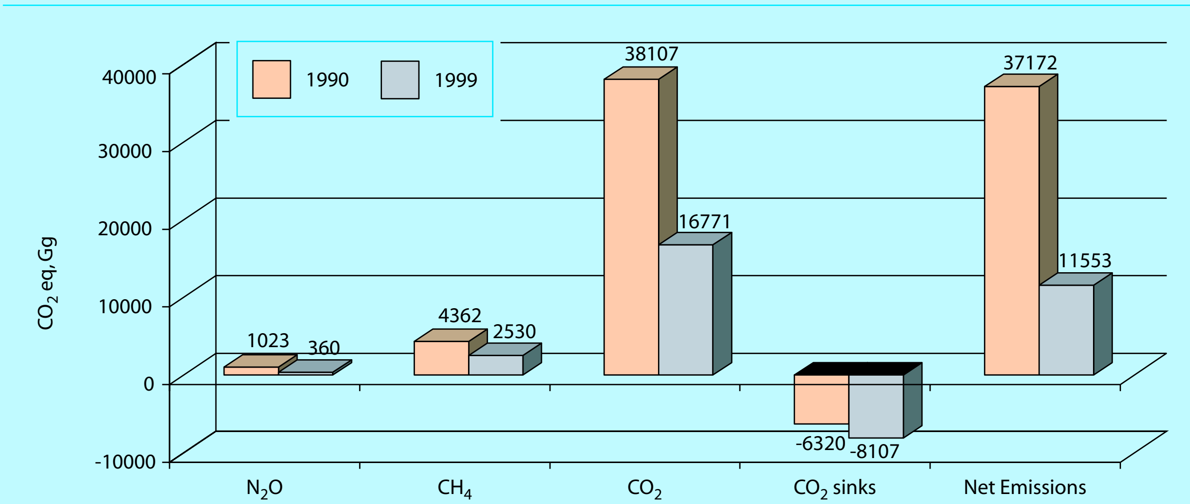
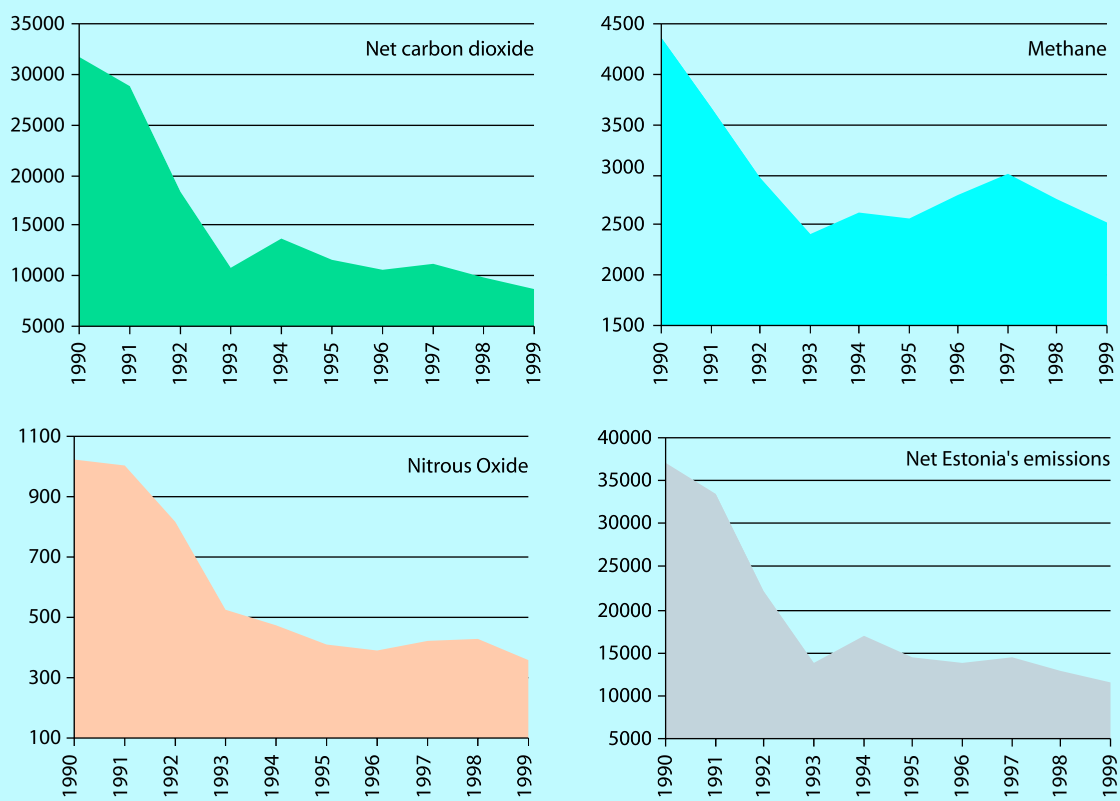


Figure 3.7.2. Dynamic of CO_2, CH_4, N_2O and net Estonia's emission, Gg CO_2 eq



POLICIES AND MEASURES

4.1. Policy-making process

During the reporting period Estonia has made relatively fast progress in the field of environmental policy and legislation. Several new legal acts, both of primary and secondary level have been enforced, as well as some strategic documents and development programmes elaborated and adopted.

Sustainable Development Act (RT[1] I 1995, 31, 384; 1997, 48, 772) sets the most general principles for sustainable development and therefore forms the basis for formulation of national and regional programmes, including action plans to reduce emissions into the air.

The legal acts related to environment are mainly initiated by the Government, especially by the Ministry of Environment and by the Ministry of Economic Affairs. According to the Constitution, committees of the Riigikogu (Parliament) have the right to initiate laws as well. The main work with the drafts (bills) of legal acts is done in the parliament committees. The Environment Committee has been a leading committee in parliament procedures for almost all acts related to environment. The committee looks through proposals for changes and amendments and is responsible for the draft law until the Riigikogu passes the final decision about it.

The *Estonian National Environmental Strategy* (RT I 1997, 26, 390), approved by the Parliament in 1997, is the major basis document for the policy-making process in the field of environment. In the *National Environmental Action Plan* (NEAP) there are defined concrete conceptual, legislation, organisational, educational, training and also investment measures for reaching the objectives set in the National Environmental Strategy. The implementation process of the new NEAP, accepted by the Government on 05.06.2001 is in progress. Overall coordination in the implementation phase lies with the Ministry of Environment. Several other ministries jointly responsible for implementation of some actions have incorporated those actions into their sectoral plans and budgets. County and local governments develop regional and local environmental action plans based on the NEAP experience. Several NGOs promote and raise the NEAP awareness among general public. They are also expected to watchdog actively the NEAP implementation process. Finally, the industry sector is expected to use the NEAP as a reference for their future plans related to environmental management.

Lately, in parallel with the NEAP process, the preparation of the *Estonian Sustainable Development Strategy* has been initiated to reach a broad discussion of, and subsequent agreement on, a long-term development policy for the country. The new strategy is planned to combine social, economic and environmental considerations.

4.1.1. International agreements and conventions

Concerning air quality, progress in introducing the necessary legislation has continued with Estonia's accession to several international conventions.

On 03.12.1998 Estonia signed the *Kyoto Protocol of the United Nations Framework Convention on Climate Change.*

On 27.01.1999 the Riigikogu passed (RT II 1999, 3, 15) the *Act on the Ratification of the two Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer – Amendment adopted at the Second Meeting of the Parties at London on 29 June 1990* and *Amendment adopted at the Fourth Meeting of the Parties at Copenhagen on 25 November 1992.*

On 19.01.2000 the Riigikogu passed (RT II 2000, 6, 34) the *Act on the Accession to the Convention on Long-Range Transboundary Air Pollution (Geneva 1979)* and the protocols thereto, including the protocol concerning the control of emission of nitrogen oxides or their transboundary fluxes (Sofia 1988).

On 15.11.2000 the Riigikogu passed (RT II 2000, 28, 169) the *Act on the Accession to the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo 1991)*.

Estonia signed *The Energy Charter Treaty* (ECT) in 1994. The ECT, together with the *Protocol of Energy Charter on the More Efficient Energy Use and the Related Environmental Aspects*, was ratified by the Parliament of Estonia in February 1998, and entered into force on 02.08.1998 (RT II 1998, 8-12, 18).

On 06.06.2001 the Riigikogu passed the *Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters* (Aarhus 1998).

Estonia signed the European Agreement and applied for first membership of the EU in 1995. In December 1997, the European Council of Ministers made the decision to invite Estonia to negotiations to join the EU. At the beginning of 1998, the elaboration of the Estonian National Programme for the Adoption of the *acquis communautaire* was completed and approved by the Government. In March 1998 the accession process was formally launched. An analytical examination ("screening") of the *acquis communautaire* was started in April 1998 and concluded in autumn 1999. An update of the screening exercise started in February 2000 in order to review the *acquis* entered into force by 1 January 2000. The Foreign Ministry has set

[1] RT – State Gazette *(Riigi Teataja)*

1 January 2003 as a possible target date for accession preparations. Therefore the approximation of EU legislation in all fields, including environmental issues related to pollution of ambient air, is in progress.

4.1.2. Development projections, strategic documents and programmes

The Long-term National Development Plan for the Fuel and Energy Sector (hereinafter the Development Plan) is a document that was approved by the Riigikogu in 1998 as a national level plan for the energy sector (RT I 1998, 19, 295). It sets targets for the development of the fuel and energy sector up to the year 2005 and gives principal development trends till 2018. As the environmental impact from the energy sector cannot be reduced to the required level without restructuring the use of energy sources, the major part of energy demand increase is projected to be met by natural gas resulting in doubling its share in primary energy supply in 10–15 years. Regarding the sustainable use of local resources, the wider use of renewable sources is planned, especially in the form of electricity and heat co-generation based on these fuels. The Development Plan sets a target to increase the share of renewables and peat in the primary energy supply by 2/3 to the year 2010 against 1996. As to the impact on environment, it is stated that the most favourable method for the combustion of oil shale is the fluidized bed combustion technology, which enables to essentially reduce the SO_2 emissions, but also the amount of CO_2, NO_x, and other hazardous pollutants. The development plan also foresees that programmes will be worked out and realised with the objective to promote regular energy audits in energy intensive industries and other fields with high energy demand in order to improve energy efficiency and restrict the CO_2 emissions.

At the beginning of the year 2000, a new *National Energy Conservation Programme* was approved by the Government. The main objective of the programme is to propose concrete measures to ensure the achieving of the relevant objectives set by the Development Plan. General targets of the programme include among others the reduction of environmental impacts of the fuel and energy sectors. One of the main goals of the programme is to ensure the CO_2 emission level to be kept lower than the limits fixed in the Kyoto Protocol (in 2008–2012 the emission level has to be 8% lower than in 1990). The *Action Plan for Energy Conservation Target Programme* for carrying out the measures planned in the programme during the period 2001–2005 was adopted by the Government in March 2001.

In 1992 Estonia acceded the Basel Convention (1989) on the *Control of Transboundary Movements of Hazardous Wastes and Their Disposal*. In October 1999 the Government approved the *Programme for the Implementation of the Basel Convention (1989) Requirements for the Years 2000–2005* (RT L 1999, 137, 1920).

In July 2000, the Government issued an order approving the *National Programme on Reduction of Pollutant Emissions from Large Combustion Plants (for 1999–2003)* (RT L 2000, 88, 1338), which is approximating the EU Directive 88/609/EEC. According to the programme emissions of pollutants from large combustion plants should be reduced substantially each year.

On the basis of *The United Nations Framework Convention on Climate Change* and the *Kyoto Protocol* it is planned to commence the elaboration of the *Greenhouse Gas Emission Reduction Programme for 2003-2012*.

With regard to the international cooperation in the integration of environmental issues into other policies, Estonia has started to implement the action plan for sustainable development adopted by all Baltic Sea countries in the framework of *Agenda 21 for the Baltic Sea Region*.

4.1.3. Enhancement of primary legislation

Ambient Air Protection Act (RT I 1998, 41, 624; 1999, 10, 155) was enforced on 01.01.1999. This new Act repealed the previous Estonian SSR *Act on the Protection of the Atmospheric Air*, which had been in force since Soviet period (1981). The new Act regulates activities, that involve the emission of pollutants into the ambient air, damage to the ozone layer, and appearance of factors causing climate change. The Act provides main principles for the control of ambient air quality, sets basis for emission standards, foresees measures for the reduction of air pollution, etc.

According to the *Planning and Building Act* (RT I 1995, 59, 1006, latest amendments RT I 2000, 54, 348) all local governments have to prepare development plans for their municipalities. Adopted county plans are the basis for comprehensive plans of rural municipalities and cities. The preparation of county plans is administered by the county governors and co-ordinated by the Ministry of Environment. The elaboration of comprehensive plans is administered by the local governments and co-ordinated by the county governments and the Ministry of Environment.

4.1.4. Fiscal measures

In February 1999 the completely new *Pollution Charge Act* (RT I 1999, 24, 361; 54, 583; 95, 843) was passed by the Parliament repealing the previous *Pollution Charge Act* (RT I 1994, 1, 2). The new Act provides rates of the charges to be paid for the release of pollutants or waste into the environment and the procedure for the calculation and payment of the charge.

For the first time in Estonia the new Act introduced (since 01.01.2000) a pollution charge on CO_2 emission.

The CO_2 charge has to be paid by all enterprises with total capacities of boilers over 50 MW, excluding those firing renewable energy sources. Up to the year 2001 (incl.) an increase of rates of pollution charges is fixed in the Act (Table 4.1.1.). It has been accepted in Estonia that the rates have to be increased later as well, but no consensus on the rate of increase has been reached yet.

Table 4.1.1. Rates of pollution charge for release of pollutants into ambient air, EEK/t

Pollutant	2000	2001
Sulphur dioxide (SO_2)	55.2	66.2
Carbon monoxide (CO)	7.9	9.5
Nitrogen oxides (as NO_2)	126.4	151.7
Carbon dioxide (CO_2)	5	7.5

The Act provides higher rates for some areas in Estonia – densely populated, resort/recreation areas and areas with heavy industrial load. It is also provided that the application of measures, which prevent or reduce environmental damage, or participation in approved programmes or projects for the preservation or improvement of the state of the environment may, under the conditions and in the amount provided for in this Act, substitute for the obligation to pay the pollution charge.

In June 1999 *The Act on the Use of Proceeds from the Exploitation of Environment* (RT I 1999, 54, 583) was amended by the Riigikogu. It enabled the state, in accordance with the laws, to establish a new foundation for organising the use of proceeds from the exploitation of the environment. On 11.05.2000 the Minister of Finance signed a regulation to establish The Centre of Environmental Investments, which started as the legal successor of the Estonian Environmental Fund to support environmental investments in different sectors (air, waste, water, etc.).

In recent years several important for Estonia projects have been financed from different foreign sources, such as EU programmes Phare and ISPA, as well as by aid programmes from neighbouring countries (e.g. Denmark, Finland, Sweden). In order to ensure high quality preparation of foreign projects an Investment Department was established in the Ministry of Environment in the autumn of 2000. The above-mentioned Centre for Environmental Investments will play an important role when it becomes an implementation unit of the ISPA environmental projects in Estonia.

Excise duty is the only specific tax that is applied directly to fuels, mainly to motor fuels. Hence, since December 1997 the excise tax is levied on light fuel as well. In the appendix of the *Fuel Excise Tax Act* (RT I 1993, 38, 563) a plan was stipulated for a gradual increase of tax rates up to the end of 2001 with the goal to reach the level required by EU directives. Due to the high prices on world oil market this plan was repealed by amendments to the *Fuel Excise Tax Act* passed by the Parliament in June 2000 (RT I 2000, 59, 380).

Since January 1997 there was enforced an element of support to the wider use of renewable energy resources in Estonia – according to the amendment to the *VAT Act* (RT I 1993, 60, 847; latest amendments 2000, 89, 581) tax exemption has been made for electricity generated by hydro and wind turbines – the rate of 0% is levied up to the end of 2006.

To support a wider use of renewable energy sources the *Energy Act* was amended in June 1998 (RT I 1998; 60, 951) with the provision that an energy trader dominating the market is required to purchase electric power from traders connected to its network and who produce such power from water, wind or solar energy, biomass, waste gases or waste material. An energy trader obligated under this provision shall purchase alternatively produced electric power at a price that constitutes 90% of the basic rate for residential customers.

4.1.5. Environmental norms and standards

The Government has issued the following regulations:

• approval of the list and requirements for checking the substances whose production, export, import or transit is restricted or forbidden, depleting the ozone layer or of the products containing such substances (RT I 1999, 45, 517);

• establishment of requirements for transport and storage of petrol (RT I 1998, 86, 1417).

The Minister of Environment has issued the following regulations:

• method for determining CO_2 emission (RT L 1998, 287/288, 1775);

• establishment of emission standards of pollutants into the ambient air by large combustion plants (RT L 1998, 327/328, 1334; enforced for new plants since 01.01.2000, for existing plants since 01.01.2003);

• establishment of maximum limits for pollution of the ambient air (RT L 1999, 21, 226);

• procedure and methods for determining emissions of pollutants from combustion plants into the ambient air (RT L 1999, 59, 779);

• establishment of the procedure for applying for and granting of approval for the production, export, import or transit of substances depleting the ozone layer or of the products containing such substances (RT L 1999, 71, 909);

• establishment of the procedure for applying for and granting of ambient air pollution emission permits (RT L 1999, 79, 984);

• establishment of target values for the pollution level of the ambient air (RT L 1999, 148, 2097).

The Minister of Economic Affairs has issued the following regulation:

• quality requirements for liquid fuels (RT L 2000, 64, 1014) repealing the previous lower requirements.

In 2001-2003, it is planned to draft ministerial regulations establishing limit values for emissions of pollutants emitted by non-road mobile machinery (in compliance with the EU directives 97/68/EC, 77/537/EEC, 74/150/EC), limit values for pollutants emitted from ship engines and limit values for emissions of volatile organic compounds emitted at the use of solvents.

4.1.6. Monitoring and supervision

The Environmental Monitoring Act (RT I 1999, 10, 154, amended RT I 1999, 54, 583). The Act provides the organisation of environmental monitoring, the procedure for processing and storing the data obtained, and the relations between persons carrying out environmental monitoring and owners or possessors of immovables. It is also established that environmental monitoring data shall be stored as a state agency database in the Ministry of Environment until compilation into the general national register of data concerning environmental protection.

The Environmental Impact Assessment and Environmental Auditing Act (RT I 2000, 54, 348, enforced since 01.01.2001) provides the legal basis and the procedure for the conduct of assessments of likely environmental impact and environmental audits, in order to prevent environmental damage.

Changes have been made in the environmental supervision system. *The Environmental Supervision Act* (RT I 1997, 86, 1460) has been amended in three cases (RT I 1999, 54, 583; 95, 843; 2000, 51, 319) establishing the rights and obligations of persons who exercise and manage state environmental supervision, the rights and obligations of persons who are subject to state supervision, and the procedure for supervisory operations. Previously, the Environmental Inspectorate, which is a coordinating, organising and supervisory body as regards the use and protection of natural resources, shared its enforcement and supervisory powers over the environmental legislation with the environmental departments of counties. Since the beginning of 2000, these departments have been converted into regional departments of the Ministry of Environment. This step was taken to improve the administrative capacity at regional and local levels. The new regional departments will play a key role in implementing environmental legislation, mainly through issuing permits and supervising pollution emissions in their territories. They are also responsible for imposing and collecting pollution charges, as well as for assessing environmental impact in their territories.

4.2. Overview by sectors

The abbreviations used in the following tables:

MoEA – Ministry of Economic Affairs;

MoE – Ministry of Environment;

EMI – Energy Market Inspectorate;

MoF – Ministry of Finance

MoT – Ministry of Transport and Communications

4.2.1. Energy sector

In the Table 4.2.1 the figures for the reduction of GHG emissions are estimations as no specific calculations of emission have been carried out, as a rule. Only in some cases calculations and measurements of environmental impact have been made.

The Swedish Programme for Environmentally Adapted Energy Systems in the Baltic Region and in Eastern Europe can be taken as an example of projects for which the assessment of the environmental impact was carried out. More than twenty projects have been realized in Estonia. As a result of boiler conversions from heavy fuel oil to biomass the annual reduction of 81.1 thousand t of CO_2 emission was achieved (by 1998).

As an example of environment related programmes with calculated impact on emission level the *National Programme on Reducing Pollutant Emissions from Large Combustion Plants*, approved by the Government Order of 25 July 2000, can be considered. The share of pollutant emissions from large combustion plants into the ambient air is 90% of the total air pollution in Estonia. According to the Programme emissions of pollutants from large combustion plants into the ambient air will decrease as follows:

• solid particles – by 39597 t, i.e. 56.4% of emission from all large combustion plants in Estonia;

• sulphur dioxide – by 23121 t (23.2 %);

• nitrogen oxide – by 1358 t (10.7 %).

The emission of CO_2 was not calculated. Here an expert opinion is given.

The Building Code has been revised for introducing higher energy efficiency requirements for new buildings and the ones to be renovated.

Some policies have been reflected in several programmes, projects and measures taken. For example, increased use of biomass, especially of wood fuel, is one of the main goals of the Long-term National Development Plan for the Fuel and Energy Sector, as well as an important target in the National Environment Strategy and in the Energy Conservation Programme. Also, boiler conversions to wood fuel have been carried out in the framework of several projects and aid programmes (e.g. Boiler conversion programme, Swedish assistance, etc.).

4.2.2. Transport

In September 1998 there was issued a new regulation of the Government stipulating the requirements for facilities of transport and storage of petrol (RT I 1998, 86/87, 1417). The goal of the regulation was to reduce the emission volumes of volatile organic compounds from petrol during its transport and storage. The new requirements will be enforced gradually, starting 01.01.2001 (for smaller facilities in use) and reaching the full compliance by 01.01.2007.

Table 4.2.1. Policies and measures in the energy sector

Name of policy / measure	Objective and/ or activity affected	GHG affected	Type of instruments	Status	Implementing entity/entities	Mitigation impact, Gg in CO_2 equivalent		
						1995	2000	2005
Long-term National Development Plan for the Fuel and Energy Sector	Reduction of emissions; energy efficiency	CO_2	Regulatory	Planned, ongoing	MoEA	-	110	800
National Energy Conservation Programme	Reduction of emissions	CO_2	Regulatory	Planned, ongoing	MoEA	-	90	950
Estonian National Environmental Strategy	Reduction of emissions	CO_2	Regulatory	Planned, ongoing	All ministries	-	70	190
National Programme for Reduction of Pollutant Emissions from Large Combustion Plants (for 1999 2003)	Reduction of emissions;	CO_2	Regulatory	Planned, ongoing (up to 2003)	MoEA	-	70	200
Quality requirements for liquid fuels	Reduction of emissions	CO_2	Regulatory	Implemented	MoEA; EMI	-	5	20
Emission standards of pollutants into ambient air by large combustion plants	Reduction of emissions	CO_2	Regulatory	Planned, partially implemented	MoE, MoEA	-	n.a.	n.a.
Fuel switch from coal	Reduction of emissions	CO_2	Voluntary	Implemented	Utilities	350	350	350
Boiler conversion programme		CO_2	Voluntary	Implemented		5	42	42
Swedish assistance (NUTEK)		CO_2	Foreign aid	Implemented	MoEA	40	94	131
Renovation of DH systems		CO_2	Voluntary	Ongoing		2	30	50
Local energy planning		CO_2	Regulatory	Ongoing		15	28	35
Revised Building Code		CO_2	Regulatory	Implemented		4	10	18
Implementation of EU SAVE Directive	Energy auditing and certification	CO_2	Regulatory/ voluntary, educational	Planned	MoEA	-	-	15
Renovation of apartment houses		CO_2	Voluntary	Ongoing		-	-	8
Renovation of Narva Power Plants		CO_2	Voluntary	Planned	Eesti Energia, MoEA	-	-	500
Labelling of household appliances		CO_2	Regulatory	Planned, ongoing	MoEA	-	-	10
Regulation establishing target values for pollution level of the ambient air	Reduction of emissions		Regulatory	Planned		-	n.a.	n.a.
Pollution Charge Act	Reduction of emissions		Regulatory	Implemented	MoF	-	n.a.	n.a.

The Act on Amendments to the *Motor Vehicles Excise Act* (RT I 1995, 17, 236; latest amendments 1999, 56, 588), initiated by the Government of the Republic of Estonia, was passed in 1999. Excise rates for motor vehicles are determined according to the displacement and the age of the motor vehicle. The amendments were enforced on July 1, 1999. On 01.01.2003 a new act – *Heavy Goods Vehicle Tax Act* (RT I 2000, 81, 515) – will be enforced repealing (since the same date) the *Motor Vehicles Excise Act.* According to the new act the heavy goods vehicle tax shall be paid for the following classes of vehicles, which are intended for the carriage of goods:

• lorries with a maximum authorised weight or gross laden weight of not less than 12 tonnes which are registered in the national motor vehicle register of Estonia;

• road trains composed of trucks and trailers with a maximum authorised weight or gross laden weight of not less than 12 tonnes whereas the trucks of the road trains must be registered in the motor vehicle register.

In March 1999 the Government approved the *Development Plan of the Transport Sector for 1999–2006.* As to the environment, it is stated that the general aim is retarding the growth of absolute amounts of all damaging emissions from transport. The next step should be to stop the growth at a certain level (e.g. starting from 2003), followed by later emission reduction. The use of leaded petrol and diesel with sulphur content higher than 0.05% must end starting from 2000-2001.

The Ministry of Transport and Communications has prepared a *Development Plan of Civil Aviation for 2000–2006.* As a measure foreseen in this plan the Government issued regulation No. 225 of 7 July 2000 *Environmental Eligibility Requirements for Powered Aircraft* (RT I 2000, 59, 384). This Regulation provides the environmental eligibility requirements for powered aircraft used in civil aviation and the requirements for issue of certificates of environmental quality. Certificates of environmental quality declare powered aircraft to be environmentally eligible and permit their operation in civil aviation.

Table 4.2.2. Policies and measures in the transport sector

Name of policy / measure	Objective and/ or activity affected	GHG affected	Type of instruments	Status	Implementing entity/entities	Mitigation impact, Gg in CO_2 equivalent		
						1995	2000	2005
Quality requirements for liquid fuels	Reduction of emissions	CO_2	Regulatory	Implemented	MoEA; EMI	-	5	20
Requirements for transport and storage of petrol	Reduction of emission	NMVOC	Regulatory	Implemented	MoE	-	n.a.	n.a.
Motor Vehicles Excise Act	Reduction of emissions	CO_2 NMVOC	Regulatory	Implemented	MoF	-	n.a.	n.a.
Heavy Goods Vehicle Tax Act	Reduction of emissions	CO_2 NMVOC	Regulatory	Implemented	MoF	-	n.a.	n.a.
Development Plan of the Transport Sector for 1999-2006	Reduction of emissions	CO_2	Regulatory	Implemented	MoT	-	5	100

Table 4.2.3. Policies and measures in the industrial sector

Name of policy / measure	Objective and/ or activity affected	GHG affected	Type of instruments	Status	Implementing entity/entities	Mitigation impact, Gg in CO_2 equivalent		
						1995	2000	2005
Estonian National Environmental Strategy	Reduction of emissions	CO_2	Regulatory	Planned, ongoing	All ministries	-	0,5	12
National Energy Conservation Programme	Reduction of emission	CO_2	Regulatory	Planned, ongoing	MoEA	-	0,8	35
Quality requirements for liquid fuels	Reduction of emissions	CO_2, SO_2	Regulatory	Implemented	MoEA;	-	n.a.	n.a.
Regulation establishing target values for pollution level of the ambient air	Reduction of emissions	All GHG	Regulatory	Implemented	MoF	-	n.a.	n.a.
Pollution Charge Act	Reduction of emissions	All GHG	Regulatory	Implemented	MoF	-	n.a.	n.a.

4.2.3. Industry

The enterprises covered by the *Industrial Pollution Prevention Control* (IPPC) directive have been identified. As to control of industrial accidents all enterprises concerned have provided information sheets on dangerous substances. Regulations regarding VOC control, pollutant emission target levels, stricter requirements for liquid fuels and several other legal documents have been issued (Table 4.2.3).

The first voluntary agreements were concluded between the Ministry of Environment and some industrial enterprises to reduce the impact of industrial processes on the environment and to improve the exchange of information between the Ministry and large enterprises.

4.2.4. Agriculture

Agricultural GHG emission covers about 6-7% of the total GHG emission in Estonia. Although traditionally agriculture has been one of the most important sectors in the Estonian economy, the proportion of agriculture in the overall economy has declined since Estonia regained independence. CH_4 and N_2O emissions from the agricultural sector have decreased during the last decade about 60-70%. In mid-term scenarios there cannot be any further decrease in the total emissions from this sector, if Estonian agriculture develops through different support programs and measures. Investments into technology and equipment will cause a decrease in GHG emissions per production unit, but not in total values. To support and encourage this kind of investments, Estonia has several programmes (e.g. SAPARD) and regulations. Now one of the priorities is to support agriculture and increase the share of Estonian food in the total consumption. Naturally it is connected with the intensity of GHG emissions, but not proportionally with output. All policies and measures have an aim to increase productivity by using new technologies. Despite increasing values in GHG emissions, the emission level will be strongly below the baseline.

The Republic of Estonia is applying for full membership of the European Union. The *Rural Development Plan* (RDP) has been drafted in accordance with the programming requirements of Article 4 of Council regulation (EC) No 1268/1999. The Regulation lays down the framework for pre-accession assistance to agriculture and rural development (*SAPARD*) in the Central and Eastern European Countries for the period 2000-2006. This Programme has been prepared by the Ministry of Agriculture in co-operation with other state agencies and co-ordinated with various non-government institutions (http://www.agri.ee/SAPARD/En/index_RDP.htm).

Preparation for the implementation of EU *Nitrate Directive* (91/676/EEC) is a high priority in Estonia. Support for this process was also provided for the Ministry of Environment in early 2000 from the PHARE project entitled "Support to the EU accession process in Estonia" (ES No 9620.01.01). Estonia is also planning to Rural Development Regulation implement the national agri-environment programme (AEP) in accordance with the Regulation 1257/99.

The organic farming movement started in Estonia in 1989 with the establishment of the Estonian Biodynamic Association. During the first year advice, training and control were organised with the help of foreign experts. In 1997 the *Organic Agriculture Act* (RT I 1997, 51, 823, amendments RT I 1999, 30, 415; 2000, 40, 252) came into force. The purpose of the Act is to organise a system, that assures a high quality of organic, that is, ecologically or biodynamically grown and handled, foodstuffs and the development of environmentally sustainable agriculture. This Act, among other issues, promotes the sustainability of the environment by restricting the use of fertilisers and pesticides in growing organic foodstuffs. A year later standards and the certification label "MAHEMÄRK" (Green production) were introduced. In the year 2000 there were more than 238 farmers (including converting) with around 10 000 ha of land who had applied for the state label "MAHEMÄRK". From the year 2001 the present system where the state label is granted by two non-governmental private bodies will be changed since these private bodies are not accredited according to EN45011 standards.

The *Estonian National Environmental Strategy* (NEAP), approved by the Riigikogu (Estonian Parlament) in 2001, focuses on the improvement of air quality and sets goals for the reduction of emissions of substances causing climate change and ozone depletion. NEAP task by the year 2010 is to ensure that the emission of polluting substances would not exceed European Union standards.

The *Ambient Air Protection Act* (RT I 1998, 41, 624; 1999, 10, 155) was enforced on 01.01.1999. It regulates activities that produce emissions causing climate change.

4.2.5. Forestry

In June 1997, the Riigikogu approved the *Estonian Forestry Policy (Development Programme for Estonian Forestry Sector)* (RT I 1997, 47, 768), which sets the general targets for the development of forestry-related issues:

- definition of the general objectives for the development of the forest sector;

- determination of the actions to be taken by the public sector in order to reach these objectives.

According to this act, annual felling of forests (deforestation) must be less than or equal to annual forest increment. The main felling types are regeneration cutting, The traditional bond between the Estonian people and forests is still strong. Forestry is an essential element of the environment in which people lead their daily lives and spend leisure time. References to forests are frequently found in Estonian art, folklore and language indicating that forests are an integral part of Estonian cultural heritage. The forest sector makes also a significant contribution to Estonian economy by creating employment and providing forest-based products and services for local consumption and export.

The Estonian forest policy recognizes that the Estonian forests have high environmental and ecological values including species biodiversity and landscape, natural stand structure etc., whose existence contributes to alleviating environmental problems both at local and global levels. These values will be protected in conformity with the Estonian Environmental Strategy and the international agreements the Estonian Government is committed to. On the other hand, the Forest Policy is underpinned by the notion that the Estonian forest sector has high capacity to provide material and social benefits, and that the utilization of this potential will be encouraged to the extent that other values and benefits are not lost or reduced. Third, it is considered imperative that any action taken today does not reduce the amount and range of benefits available to future generations.

Based on these considerations two principal, closely interrelated objectives for the Estonian forestry sector have been set:

1) **sustainability of forestry,** which is considered to require the management and utilization of forests and forest land in a manner and at a rate which maintains their biological diversity, productivity, capacity for regeneration, and vitality as well as their potential to fulfill at present and in the future ecological, economic and social functions at local, national and global levels without damaging other ecosystems

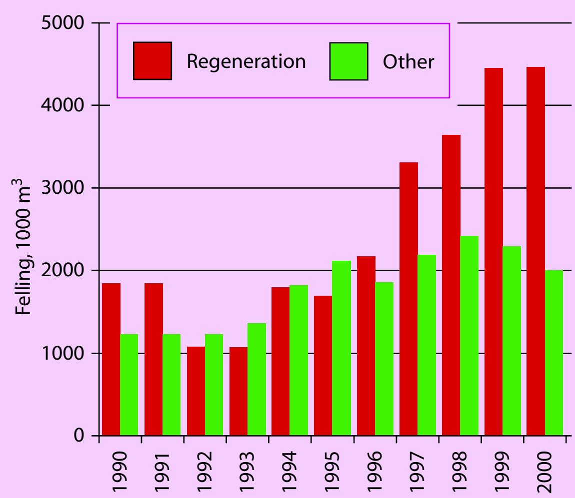
2) **efficiency in forest management,** which entails securing an efficient production and effective utilization of valuable forest-based products and services for present and future generations

In order to reach these objectives public administration will be reorganized and private forest owners will be supported by providing them with public services. Regulations regarding forest management will be relaxed. Financial incentives will be introduced as the administrative capacity improves.

improvement cutting, selective cutting and other cutting (felling of single trees, etc.). Regeneration cutting is done in mature forests and in premature forests if their condition does not respond to their function.

The purpose of improvement cutting is to form stand properties toward enlargement of stand productivity. Selective cutting is performed for improving forest conditions on preserved areas where regeneration cutting is restricted. Regeneration cutting is the main source of commercial wood (Fig. 4.2.1.). However, the official data presented by the Statistical Office of Estonia do not show the actual amount of wood felled annually. The inventory of forests conducted from May 1999 to April 2000 by the Estonian Forest Survey Centre revealed that about 11 million m^3 solid volume of wood was felled during that period. The official figure was only about 6.4 million m^3 for the same period. This difference indicates that the felling data for previous years must be treated with caution. Instead the data on the import of pulp wood should be used to estimate actual felling.

Figure 4.2.1. Share of regeneration cutting in total felling



The *Forest Act* (RT I 1998, 113/114, 1872) states the need for *Estonian Forest Strategy* – a development plan, in which the forestry activities are planned for a period of ten years. The *Strategy* shows what measures should be taken to achieve the following objectives:

- preservation of Estonian forest resources;
- protection of biodiversity of Estonian forests;
- social goals (employment, preservation of recreative value of forests);
- forest felling;
- improvement of the co-operation among private forest owners;

- afforestation of abandoned agricultural lands;
- improvement of premature forests;
- amelioration of forest soils, road building.

While the reforestation in state-owned forestland is a well-regulated process (by *Forest Act* and *Directive on Renewal of State Forests*), that of private forests is still rather chaotic. Forest owners have frequently left the clearings to natural renewal as they are not stimulated to improve forest condition. On the basis of the *Strategy* it is planned to support private forest owners in tree planting, in contribution to natural renewal and in doing improvement cuttings. It is estimated that within the next ten years the area of private forests where improvement cuttings have to be done is about 320000 ha and the area of reforestation has to increase four times.

As stated in the *Forest Act*, the forest felling has three goals: renewal of forests, production of wood by logging, and direction of the growth of a new forest generation. At present, these goals are unbalanced towards extensive forest logging. In the *Strategy* it is planned to stimulate sustainable use of forests by stronger control and taxes. It is estimated that annual felling should be approximately 9000000 m^3 from 2001 to 2010.

The area of Estonian forests has increased significantly during the last fifty years due to abandonment of agricultural lands. In the near future, about 100000 ha of abandoned lands are planned to be afforested according to the *Strategy*. Additionally, about 300 ha of closed opencast oil shale mines will be afforested every year (regulated by the directive of MoE *Restoration of Mining Areas*, RT I 1996, 11/12, 89) (Table 4.2.4).

The *Estonian Forest Strategy* states that the need for planting material will increase and recommends measures to stimulate establishment of plantations. Growing and importing of planting material is regulated by the *Seed and Plant Reproduction Act* (RT I 1998, 52/53, 771) and by the relevant directives of MoE (RT L 1999, 114, 1489-1490).

There are no forestry related objectives or activities planned in the Estonian National Environmental Strategy that would enable to estimate the effect on CO_2 emissions/removals.

4.2.6. Waste management

The *Waste Act* (RT I 1998, 57, 861; 1999, 23, 353) provides general requirements for the prevention of waste generation, for the prevention of health and environmental hazards arising from waste generation and for the organisation of waste management with the objective to reduce the harmfulness and quantity of waste and liability in the case of violation of the established requirements.

Several regulations for waste management have been recent during last years (see also Table 4.2.5).

The Government has issued the following regulations:

- the list specifying the fields of activity requiring a permit for generation of waste and the related limit values for production volumes and waste volumes (RT I 1998, 96, 1517);
- the procedure for issuing, amending, suspension, cancellation and publishing of hazardous waste handling licences (RT I 1999, 8, 127);
- the list of products which cause damage to the environment as waste and whose production, import, export, sale and use are prohibited (RT I 1999, 30, 422).

The Minister of Environment has issued the following regulations:

- procedure for marking hazardous waste (RT I 1999, 68, 890);
- form of, and procedure for completion, handling and registration of, consignment notes of hazardous waste (RT I 1999, 122, 1662).

Table 4.2.4. Policies and measures in forestry sector

Name of policy / measure	Objective and/ or activity affected	GHG affected	Type of instruments	Status	Implementing entity/entities	Mitigation impact, Gg in CO_2 equivalent		
						1995	2000	2005
Estonian National Environmental Strategy	Improving forest growth	CO_2	Regulatory	Implemented	MoE	-	-	-
Estonian Forestry Strategy	Improving forest growth	CO_2	Regulatory	Planned, ongoing	MoE	-	-	1095,5
Forest Act	Improving forest growth	CO_2	Regulatory	Implemented	MoE	1460	11951	1739
Restoration of Mining Areas	Improving forest growth	CO_2	Regulatory	Implemented	MoE	-	8	15

Table 4.2.5. Policies and measures in waste management

Name of policy / measure	Objective and/ or activity affected	GHG affected	Type of instruments	Status	Implementing entity/entities	Mitigation impact, Gg in CO_2 equivalent		
						1995	2000	2005
Estonian National Environmental Strategy	Reduction of emissions	CH_4	Regulatory	Planned, ongoing	All ministries	-	n.a.	n.a.
Environmental Impact Assessment and Environ-mental Auditing Act	Reduction of emissions	CH_4	Regulatory	Planned, ongoing	MoE	-	n.a.	n.a.
Requirements to Establishing, Using and Closing of Landfills	Reduction of emissions	CH_4	Regulatory	Planned, ongoing	MoE	-	5	15

PROJECTIONS AND THE TOTAL EFFECT OF POLICIES AND MEASURES

The projections of the GHG emissions presented in the communication are calculated on the basis of general trends of the development of national economy, energy demand and supply in Estonia. The results of the inventory of GHG show that an approximate total of 76% of all GHG emissions consist of CO_2, with combustion processes being the largest source of CO_2 (approx. 98% of all CO_2 emissions). For this reason, the main attention is directed to the projection for CO_2 emissions from combustion processes. The remaining 24% of all GHG emissions consist of methane (21%) and nitrous oxide (3%). Here the uncertainties are greater. Another very complicated task is to compile scenarios for the GHG sink, the more so as we have not scientifically supported calculations for biogeochemical cycles of CO_2 in terrestrial ecosystems for Estonia.

5.1. General background for making projections

The task to forecast the GHG emissions in Estonia for the next twenty years is a difficult and a complicated one due to several uncertainties. The first and major problem is the lack of long-term projections for the national economy as a whole. For compiling Estonia's Second National Communication (ENC2) report serious efforts were made and results of a comprehensive modelling process were used. This was possible thanks to the studies in the energy sector, carried out by Estonian (Tallinn Technical University, Estonian Energy Research Institute -EERI) and international (Stockholm Environment Institute, Netherlands Energy Research Foundation) teams in the elaboration process of elaborating the *Long-Term Development Plan for the Estonian Fuel and Energy Sector* (LT Plan). As the main tool the MARKAL[1] model, linked with a macroeconomic model called MACRO, was used in these studies. The combination of these two models enabled to get results on the optimal allocation of technologies and energy on the supply side.

During the last 3-5 years significant changes have taken place in Estonian economy including the energy sector. According to analysts Estonia has almost completed the transition to market economy and several uncertainties associated with the transitional period have started to disappear gradually. Nevertheless, there are several factors that have hindered carrying out the new long-term modelling cycle of the development of the energy sector. In the electric power industry, the major element of Estonian energy system, the restructuring and institutional changes have not yet been completed. The feasibility assessment of the construction of a sub-marine cable connecting Estonia to the Finnish (Nordic) electricity system is in progress. The future of chemical processing of oil shale (i.e. the production of shale oil) is extremely uncertain due to unpredictable developments on crude oil world market. The decision on the pace of increase of pollution charge rates has not been made, and therefore the level of pollution charges is not known even for 2002.

The lack of up-to-date comprehensive modelling results of energy supply projections for the Estonian economy forced us to base the current forecasts of GHG emissions mainly on the results of previous modelling studies and to use expert estimations to take into account the changes which have taken place during the last years. EERI completed a study on development options of the Estonian energy sector.

5.1.1. Population

Due to the low birth rate and negative migration balance, the number of permanent inhabitants of Estonia has decreased during last years. The growth rate of population is estimated to continue as a negative one. The latest detailed population projections made some years ago were based on the number of population in 1995 (1.48 million) and foresaw the reduction down to 1.35 million. As a fact, the population census carried out in 2000, indicated the real number of population as 1.37 million. Therefore the mentioned above projection was up-dated and a new figure of 1.29 million for population in 2020 was taken as the basis for our projections (see Table 5.1.1).

Table 5.1.1. Key variables used in projections

Parameter	Unit	Historical			Projected			
		1990	1995	2000	2005	2010	2015	2020
Population	Million	1.57	1.49	1.37	1.35	1.33	1.31	1.29
GDP (in 1995 constant prices)	Billion EEK	59.0	40.9	52.4	64.3	71.3	79.6	90.0
Annual CPI growth	%	49.0	28.8	5.0	4.0	3.0	2.5	2.5
TPES (excl. motor fuels)	PJ	366.6	200.2	170.4	165.7	166.9	166.7	170.0
Share of renewables*	%	1.8	6.0	11.7	12.7	13.1	13.6	13.9
Pollution charge on CO_2	EEK/t	-	-	5	11.3	17	25	38
Pollution charge on NO_x	EEK/t	-	48	126	314	782	1947	4848
World oil price**	USD/bbl	23.81	17.18	28.98	20.83	21.37	21.89	22.41

* Share of renewable energy sources in TPES (excl. motor fuels)

** Source of projected figures: Annual Energy Outlook 2001. EIA, US DoE. (1999 USD)

[1] MARKAL – a top-down dynamic optimisation model

5.1.2. Gross Domestic Product

There exist several short-term projections of Gross Domestic Product (GDP) (up to the years 2003 or 2005), but no forecasts for longer terms have been made. The estimation of GDP up to the year 2020 was received as a result of interviews with officials from the Ministry of Economic Affairs. The consumer price index (CPI) projections were used as the measure of inflation. Using these figures the projections of GDP values at constant (1995) prices were made (Table 5.1.1).

The structure of the economy, reflected in the structure of the GDP, determines to a great extent the national energy consumption. The proportion of industry, as a main energy intensive sector of national economy, is projected to diminish gradually during the next twenty years.

5.1.3. Energy prices

In Estonia the direct subsidies to fuels and energy were phased out at the beginning of the 1990s. Still, there exist some cross-subsidies in the tariff system of electricity: household consumers are subsidised by industrial and commercial consumers. In some locations similar subsidies are practised in the case of district heating. The political decision to stop cross-subsidies in the energy sector will be gradually carried out in the near future.

Energy prices in Estonia have had a general trend towards increasing, especially those of oil fuels. In addition to the corresponding tendency on world market there are some local factors, that influence in the same direction: the quality requirements will be higher, the share of taxes in the end-user prices will rise, etc. As to the price on electricity, which is generated in Estonian power plants firing oil shale, during the next 5 years there is a need to raise the average price by 30% to cover long-term marginal costs. According to the proportion of electricity in the consumer basket it will mean a 0.8% increase of the general price level. The price increase in turn will reduce the consumption of electricity to some extent.

5.1.4. Energy taxation

The end-user prices of fuels and energy depend also on the development of energy taxation. In Estonia the target has been set to reach the EU level of excise tax rates on oil fuels in the process of harmonisation of legislation during accession. For Estonia this will mean the increase of tax rates on motor fuels approximately by one fourth and the introduction of excise tax on heavy fuel oil, which is not taxed with excise duty currently.

As to energy-related taxation another important factor is the level of pollution taxes. The Ministry of Environment has informed about plans to raise the rates for pollution charges (except on CO_2) by 20% per year during the next 15 years (Table 5.1.1). As Estonia has no difficulties with meeting Kyoto requirements on CO_2 emissions, no decision has been made on the future rates of the pollution charge on CO_2 introduced in 2001. Therefore, the projection of changes on CO_2 taxation given in Table 5.1.1 is based only on expert opinions.

5.1.5. Energy policy and institutional issues

The key elements of Estonian energy policy are:

- improvement of energy supply efficiency;
- implementation of energy conservation measures on demand side;
- wider use of renewable energy sources;
- switch (conversion) to natural gas from other fossil fuels.

Technological improvements should become an important driving force for energy efficiency in both the energy sector and industry, but also for demand side developments. The greatest effect on the reduction of CO_2 emission in Estonia is expected from the introduction of an up-to-date combustion technology - the fluidised bed combustion of oil shale - in the Narva Power Plants.

The developments in the electricity sector are of key importance for reducing GHG emissions. The electricity consumption is expected to increase with the growth rate of consumption by households being faster than the average one. The reflections of consumption on electricity generation are complicated to assess as the restructuring of the Estonian electricity sector, together with the oil shale mining, has been in progress for several years already. The main power plants are old, losses in networks, especially in low voltage ones, are high. Large investments are needed to improve the situation. On the other hand, the installed capacity of power plants in Estonia is still considerably higher than needed for meeting the domestic demand. Therefore, the policy of electricity export is one of the key issues in the CO_2 emission projections. At the same time, the potential introduction of or partial switch to biomass and/or natural gas in the electricity generation is very sensitive to the market situation and highly uncertain due to the ongoing electricity market liberalisation.

District heating (DH) is a widely used heat supply option in Estonia. DH can be considered as a major basis for the introduction of co-generation of heat and electricity (CHP), which enables to substantially increase the energy efficiency compared to separate production of electricity in condensing power plants. But because of the poor condition of several DH systems customers have started to switch over to gas based local heating and in some cases to electrical heating. The gradual adoption of energy efficiency normatives for new and renovated buildings as well as standards for electrical appliances and equipment will improve the specific energy consumption, which in turn will lead to reduction of energy demand and declining emissions.

Increasing the share of natural gas in primary energy consumption has been set as major target in the LT Plan. As natural gas is the least carbon-intensive fossil fuel this trend will be an important factor affecting CO_2 emission.

An important option for reducing of CO_2 emission is a wider use of renewable energy sources. In Estonia biomass energy is the most important renewable option, wind energy has smaller and small-scale hydropower minor importance. Here an improved access to modern technologies is needed as well as some support schemes for wider introduction of biomass with the perspective for later gradual commercialisation of biomass use in the energy sector.

In addition to internal for Estonia factors the accession to the EU was considered as well. According to analysts' estimations the effect of accession will have a relatively small effect on Estonia's average economic growth in the first decade of the 21st century. Only in the very end of the decade the effect will be more essential – mainly in the form of faster economic growth, lower unemployment, more foreign investments, resulting in higher living standards.

5.2. GHG emission projections

In addition to the above described general policies and tendencies, the main quantitative indicators for the energy sector and national economy as a whole during the years 1993–1999 were analysed to elaborate the GHG emission projections for years 2005–2020. The development of some key indicators during this period is presented in Table 5.1.1. This set of factors was taken into account when drafting GHG emission scenarios for Estonia.

As a result of analysis of previous studies together with expert assessments considering the latest developments in the energy sector and in economy as a whole, three projections for GHG emission up to the year 2020 have been made in the framework of the current communication.

The two projections elaborated were:

• WM-projection ("with measures" projection), which reflects the impact of planned measures and the policies and measures implemented in period 1995-2000;

• WAM-projection ("with additional measures" projection), which encompasses additional policies and measures, that may be taken in future.

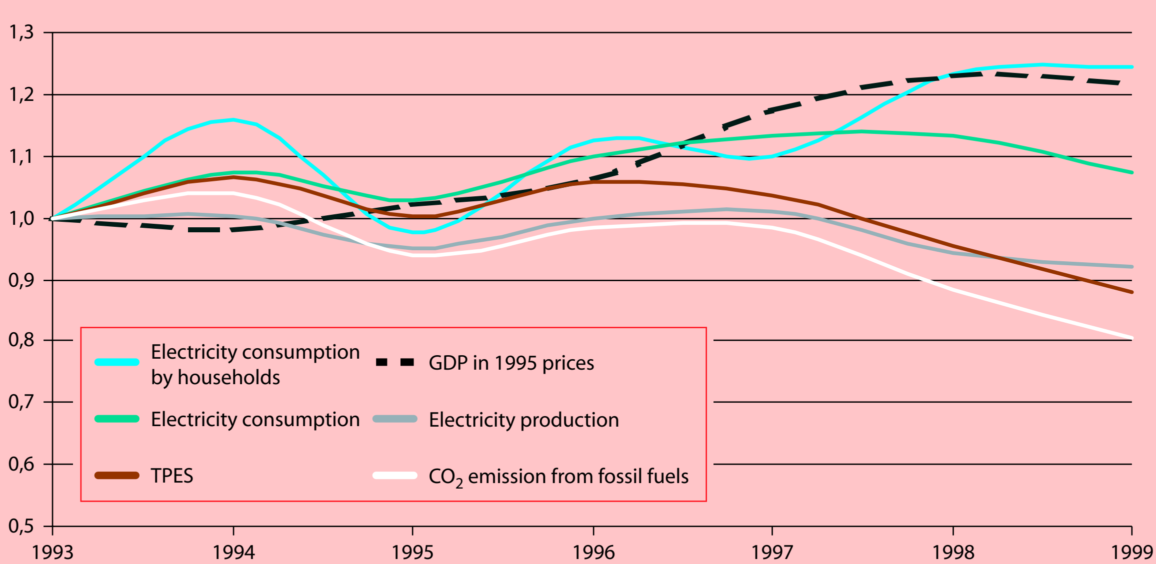
To compile the projections mainly the "top-down" methodology was used. However, a combination with the "bottom-up" methodology was needed for several aspects, e.g. for analysis of technology options of emission reduction, etc.

5.2.1. Projections of CO_2 emissions

Energy sector

As can be seen in Figure 5.2.1, the elasticity between

Figure 5.2.1. Annual dynamics of some key indicators in comparison with 1993



TPES and GDP has been below 1.0 during 1993-1999 and the trend towards further decrease can be easily identified. The elasticity between TPES and CO_2 emission was below 1.0 at the very beginning of the period but stabilised later with the value near 1.0. The assessment of these two elasticities together results in an indicator of CO_2/GDP elasticity, value of which is substantially below unity. When applying these development tendencies it was taken into account that since 1995 these indicators already include the impact of measures taken for increasing efficiency and reducing emissions.

The WM-projection encompasses the impact of measures implemented since 1995. As to quantitative evaluation of the impact of the measures taken on the reduction of CO_2 emission it was possible to use only a couple of studies on the topic. One of these was the project *Top-down CO_2 Emission Baselines for the Estonian District Heating Sector*, completed in 2000, commissioned by the Swedish National Energy Administration (STEM, the former NUTEK) and compiled by T. Kallaste (Stockholm Environment Institute Tallinn Centre) and I. Roos (EERI). The study dealt only with the district heat supplied by boiler plants, i.e. DH from power plants was excluded. To assess the impact of other measures expert opinions were mainly used.

To extend the EERI scenario up to the year 2020, extrapolation together with expert estimates was used. The structure of primary energy supply according to an extended version of this scenario is presented in Table 5.2.1.

Table 5.2.1. The supply of primary energy (basic scenario in EERI study), PJ

Fuels	2000	2005	2010	2015	2020
Oil shale	113.9	105.6	101.5	94.2	87.4
Coal	2.3	1.8	1.4	1.0	0.8
Peat	1.5	2.1	2.6	3.1	3.6
HFO	8.1	5.3	3.1	1.4	0.6
LFO	2.6	2.3	2.1	2.1	2.2
Natural gas	22.0	27.5	34.3	42.2	51.8
Renewables	20.0	21.1	21.9	22.7	23.6
Total	**170.4**	**165.7**	**166.9**	**166.7**	**170.0**

The main positive changes would be the increase in the shares of natural gas and renewable sources as well as the decrease in percentage of oil shale in TPES. The share of natural gas would grow to 25% in 2015 and to 30% in 2020. The share of renewable energy sources would rise to almost 14% by the year 2020 from 11.7% in 2000. The main component of renewable energy would still be biomass, the wind and hydro energy make up only 6–7% of the total of renewables (i.e. up to 1% of TPES). As motor fuels were excluded from TPES in the EERI scenarios the relevant correction was made for the current communication.

To elaborate the WAM-projection some potential additional measures, described in Chapter 4, were considered and applied to the WM-projection. One of the most important ones is the replacement of pulverised shale oil combustion by fluidised bed combustion tehnology. Pressurised fluidised bed combustion (PFBC) tehnology would improve the situation even more (0.83 kg CO_2/kWh_{el}), but there is still no feasible technology of PFBC available for firing Estonian oil shale. An other option for substantial reduction of CO_2 emissions from power plants could be reconstruction of some power units to work as combined cycle blocks on natural gas. It would enable to reduce the specific CO_2 emission to 0.39 kg CO_2/kWh_{el}, which would mean the reduction by 0.89 kg of CO_2 per every kWh_{el}.

The losses in electricity transmission and distribution networks are at present 15-18%, according to the *Energy Conservation Target Programme* (ECTP) the reduction of these losses to 10% should be an acceptable target.

The ECTP estimates the potential of savings in heat production to be 5-10% and in distribution of heat up to 50%. This requires introduction of up-to-date combustion technologies and equipment and renovation of district heating pipelines.

Regarding the demand side, the ECTP points out that the specific heat consumption in Estonia is substantially higher than in developed countries with similar climate. Several studies have indicated that the average heat consumption in the Estonian household sector is 250–400 kWh/m^2 per year, as the same figure for developed countries with a similar climate is 150–230 kWh/m^2 pear year. In Scandinavian countries the average heat demand is still lower: 120–150 kWh/m^2 as a result of intensive energy conservation policy. Therefore the ECTP refers to possibilities of saving in the residential sector 15–25% of energy with modest investments and even up to 50% in the case of large investments. As the building codes were changed during the 1990s, the energy losses in new buildings are substantially lower than in older ones. According to the *Development Plan for the Housing Sector (up to 2010)* the minimal rehabilitation measures taken in apartment houses would save at least 20–30% of energy for heating.

An important factor in carrying out the measures foreseen in WAM-projection is the financing capacity. Therefore, in several cases the joint implementation mechanism can be applied. Hence, in these cases the reduced emission quantities would be (partially) registered in financing countries.

A substantial increase in pollution charges, especially in CO_2 ones, may have a significant impact on the structure of fuels used in Estonia. The introduction of a common energy/carbon tax in the EU would accelerate this development considerably, forcing to limit the use of fossil fuels (especially oil shale) and to replace them with renewable energy sources.

Transport

The combustion of fossil fuels in transport gave over 7% of Estonia's CO_2 emissions in 1999.

In March 1999 the Estonian Government approved the new Development Plan of the Transport Sector for 1999-2006. The following priorities are outlined in the new national transport policy:

- accessibility (opportunity to get high quality transport service in all regions over the territory of Estonia);
- increased integration (higher integration of the transport sector and other spheres of national economy, also higher international competitiveness);
- spatial balance (reduction of development dissimilarities in different regions of the country);
- environmental friendliness.

The general goal is deceleration of the growth of absolute amounts of hazardous emissions from transport with the later goal of reduction of the emissions. For this purpose several measures are foreseen, including the following most essential:

1. *Alternatives for passenger cars.* We can expect further growth of the number of passenger cars based on the experience of recent years. According to expert evaluations, the absolute maximum number of passenger cars could be one car per two persons. Thus for the maximum scenario the number of cars could increase by about 220 thousand vehicles. Alternatives for passenger cars should be looked for more actively. These include increasing role of public transport, providing facilities for bicycle riding, improvement of the infrastructure of railroads and waterways, etc.

2. A very significant measure for making traffic environmentally friendlier is *control of moving or mobility.* Constant growth of the total number of vehicles results in traffic jams, in particular in places with high traffic intensity. Smooth traffic flows can be ensured, but high capital investments are necessary for this purpose.

3. *Improvement of the implementation mechanisms of transport policy.* The bases and implementation mechanisms of transport policy are traditionally weak and need to be improved. This includes legislative norms and standards, supervision, subsidies from taxation and price policies, business licences, information and communication, statistics, research work, etc.

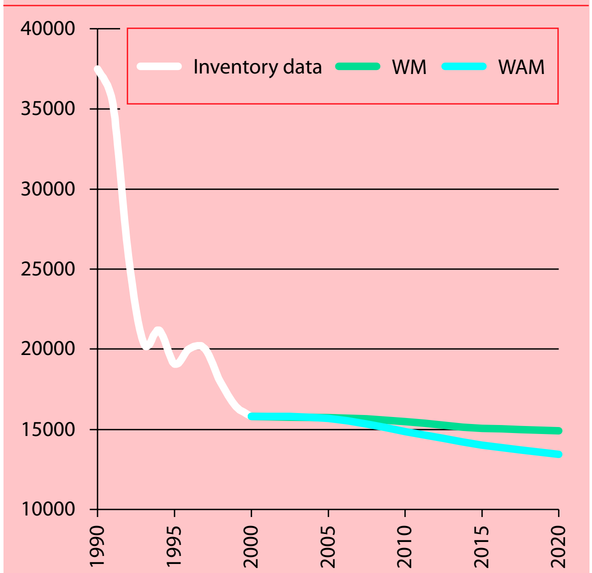
No specific scenarios have been made for projecting GHG in the transport sector since transport has been considered as a part of energy sector according to the IPCC Guidelines for GHG inventory. However, the objectives of the transport policy and measures for reaching them, have been considered in preparing energy scenarios.

The dynamics of CO_2 emission (actual and projected) from the energy sector of Estonia during the period from 1990 to 2020 is presented in Table 5.2.2 and Figure 5.2.2.

Table 5.2.2. Emission of CO_2 from the energy sector in 1990–2020, Gg

Scenario	1990	1995	2000	2005	2010	2015	2020
WM	37494	19093	15800	15740	15500	15050	14910
WAM	37494	19093	15800	15650	14870	13950	13440

Figure 5.2.2. CO_2 emission from the energy sector, Gg



In the both projections the level of CO_2 emission from the energy sector would be substantially lower than the level in 1990.

Industrial processes

In the Estonian industry CO_2 emissions are released mainly by cement and lime production. By thermal processing of calcium carbonate ($CaCO_3$) from limestone, chalk or other calcium-rich materials, calcium oxide (CaO) and carbon dioxide (CO_2) are formed.

Cement and lime are both produced in Estonia only by one enterprise - *Kunda Nordic Tsement AS* and *Partek Nordic Calk AS*, respectively. In the case of the WM scenario it is presumed that production quantities will not increase significantly compared to the year 2000, as both of the enterprises worked already at the maximum load. In the case of WAM scenario, production quantities will be the same, but in addition, supplementary technological measures will be implemented for the reduction of CO_2

emissions.

Land-use change and forestry

Forests have an important role as a sink of CO_2. At the same time, mainly due to forestry activities, forests are sources of GHG. Estonian forestry policy bases on the Forest Act and on the Forestry Strategy, in which the objectives and activities are planned for the next ten years (2001-2010).

In the case of the WM scenario, it is presumed that the annual harvest will continue to increase and this is the main reason for the decline in the removal of CO_2 by forests. The WM projections for years 2005–2020 were made from the actual inventory data.

The WAM scenario grounds mainly on the forestry activities planned in the Forest Strategy and on the predictions of the Ministry of Environment (Table 5.3.3). The following measures are planned by the Strategy:

- Area of reforestation has to increase 4 times in private forests. By 2005, about 3000 ha should additionally be reforested.

- Annual harvest should remain below annual increment. Maximum harvest should be 9000000 m^3 a year.

- From 2001 to 2010, about 100000 ha of abandoned lands is to be afforested (10000 ha a year). By 2005, about 50000 ha should be afforested.

Additionally, as it has been stated in the directive of MoE on Restoration of Mining Areas (RT I 1996, 11/12, 89), about 300 ha of closed opencast oil shale mines will be restored every year.

Table 5.2.3. Forestry activities projected according to the *Forest Strategy*

	2005	2010	2015	2020
Forestland area, thousands ha	2287.5	2325.0	2362.5	2400.0
Growing stock increment, t dm^3 ha^{-1}	4.11	4.09	4.08	4.06
Total harvest, thousand t dm^3	4623	4618	4612	4597
Area of afforestation, thousands ha	11.5	15.0	15.0	15.0

5.2.2. Net CO_2 emission

The dynamics of net CO_2 emission (actual and projected) is presented in Figure 5.2.4 and emission/removal values from different sectors are given in Tables 5.2.4 and 5.2.5.

Figure 5.2.3. CO_2 removal from forestry and land use change, Gg

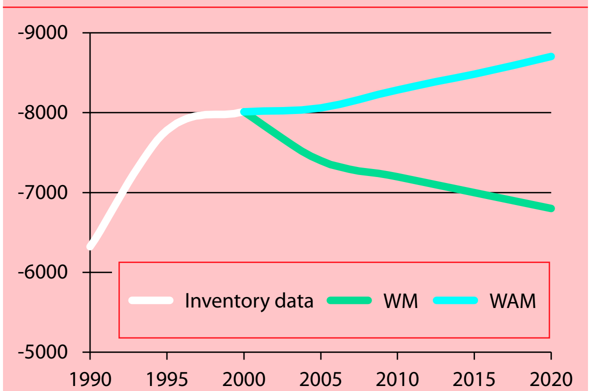


Figure 5.2.4. Net CO_2 emission, Gg

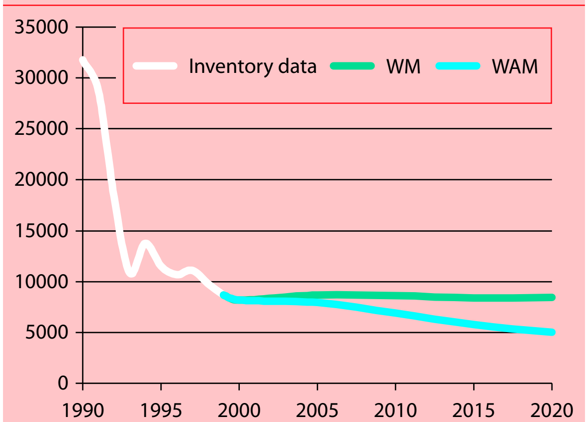


Table 5.2.4. WM scenario: CO_2 emissions and removals, Gg

Sector	1990	1995	2000	2005	2010	2015	2020
Energy	37493	19093	15800	15740	15500	15050	14910
Industrial processes	614	222	364	350	340	330	320
Land use change and forestry	-6320	-7782	-8010	-7400	-7200	-7000	-6800
Net emissions	**31787**	**11533**	**8154**	**8690**	**8640**	**8380**	**8430**

Table 5.2.5. WAM scenario: CO_2 emissions and removals, Gg

Sector	1990	1995	2000	2005	2010	2015	2020
Energy	37493	19093	15800	15650	14870	13950	13440
Industrial processes	614	222	364	350	330	310	300
Land use change and forestry	-6320	-7782	-8010	-8060	-8290	-8490	-8700
Net emissions	**31787**	**11533**	**8154**	**7940**	**6910**	**5770**	**5040**

5.2.3. Projections of CH_4 emissions

Methane comprises about 21% of the net Estonia's GHG in CO_2 eq units. According to Figure 3.7.2 and Table 3.7.2 in Chapter 3, in 1999 the amount of methane emitted (in CO_2 eq) was 2530 Gg. The primary sources of methane emissions are waste management, particularly landfills, agriculture and energy production (including fugitive emissions from oil shale mining and fuel combustion).

Energy production

The share of CH_4 emissions from fuel combustion is very small in overall Estonia's methane balance. In 1999, 5.3 Gg of CH_4 was emitted, which corresponds to about 4% of the total Estonia's methane emissions.

Methane is also produced from fugitive emissions of oil shale mining. About 23% of total CH_4 emissions is emitted from this source. According to Table 5.1.1, the share of oil shale in TPES will decrease from 67% in 1999 to 50% by the year 2020. In the WM scenario the amount of fugitive emissions from oil shale mining is expected to be proportional to the mined volume of oil shale. For the WAM scenario some additional measures (installing recovery systems, etc.) are planned.

Waste management

A new regulation of the Estonian Ministry of Environment *Requirements to Establishing, Using and Closing of Landfills* (KKMm RTL 2001, 87, 1219) specifies measures for reducing various impacts of the total waste treatment system from generating waste to the final treatment via establishing, using and closing landfills. According to the regulation, from 1 January 2003 only treated waste can be disposed in the landfill and treatment service for the household waste must be provided. The proposed measures should reduce the amount and hazard from organic waste disposed in landfills. From the produced waste only 20% of biodegradable substances can be deposited in the landfill by the year 2020. In the WM scenario CH_4 emissions will decrease 50% and in the WAM scenario 80%.

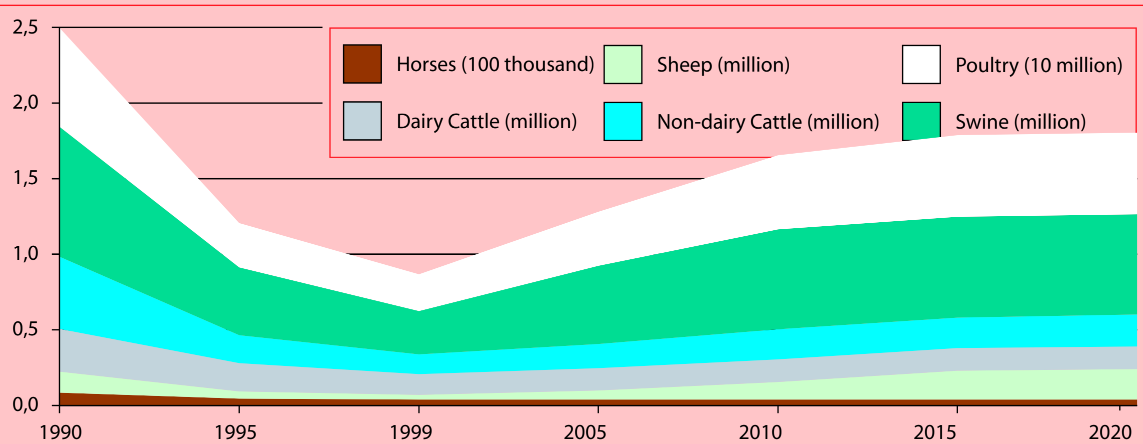
Agriculture

The most important source of CH_4 emission in agriculture is domestically raised animals, who produce methane through enteric fermentation. Manure management is also an important source of CH_4, but methane emission from enteric fermentation forms 75% of total CH_4 emission in Estonian agriculture. Different scenario calculations are based on changes in number of animals and efficiency of agricultural production (e.g. milk production per cow).

Emission of CH_4 from agriculture for the years 1990-2020 was calculated using the numbers of animals according to the statistical data (up to 2000) and expert projections (2005-2020) from the Ministry of Agriculture (Figure 5.2.5) and the IPCC methodology, which applis different emission factors to different kinds of animals. Coefficients given for Eastern Europe and/or developing countries were used in GHG emission calculations for 1990-1999 (according to IPCC Guidelines for National Greenhouse Gas Inventories).

The WM scenario assumes that Estonian agriculture will reach the level and all parameters of EU countries (Table 5.2.6). Calculations are based on input data from the Ministry of Agriculture and on emission factors, which are given for Western Europe countries. The WAM scenario assumes, that production of milk will rise slightly and then will stabilising (at about 700000 tons per year) (Table 5.2.7). At the same time the production per cow will rise through investments for improvement of the dairy cattle (production of milk was 4171 kg per cow in 1999 and it will be 7800 kg per cow in 2020). For example, in 2000 the number of cows decreased from 138400 to 131000 (by 5%), but the production of milk was 0.6% higher than in 1999. In 2000 the average milk yield per cow was 4660 kilograms.

Figure 5.2.5. Number of livestock



The dynamics of CH_4 emission (actual and projected) is presented in Figure 5.2.6

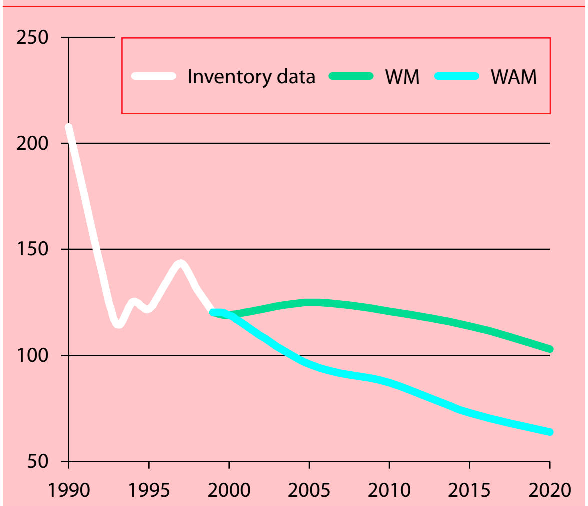
Table 5.2.6. WM scenario: CH_4 emissions, Gg

Sector	1990	1995	2000	2005	2010	2015	2020
Energy	61	36	33	30	28	27	26
Agriculture	70	36	24	39	44	45	46
Waste	77	50	62	56	49	42	31
Total	**208**	**122**	**119**	**125**	**121**	**114**	**103**

Table 5.2.7. WAM scenario: CH_4 emissions, Gg

Sector	1990	1995	2000	2005	2010	2015	2020
Energy	61	36	33	26	24	22	20
Agriculture	70	36	24	29	31	32	32
Waste	77	50	62	41	32	19	12
Total	**208**	**122**	**119**	**96**	**87**	**73**	**64**

Figure 5.2.6. CH_4 emission, Gg



5.2.4. Projections of N_2O emission

Nitrous oxide emissions in CO_2 equivalent accounted for about 3% of total GHG emissions in Estonia in 1999. The energy sector contributed about 5% of the total Estonia's N_2O emissions in 1999. Both mobile and stationary sources emit nitrous oxide and the amount of nitrous oxide depends on the fuel and technology use. As the number of catalytic converter-equipped vehicles has been increasing in Estonia from year to year, the amount of N_2O emissions from this source will also increase but their proportion in total GHG emissions is insignificant.

The main source of N_2O is agriculture and especially the use of fertilizers. As compared with developed agricultural countries, the application of fertilisers in Estonia is very low nowadays and it will presumably rise in time. A very small amount of N_2O is emitted by manure management (about 1-3% of the total N_2O emission in agriculture).

Emission was calculated using the IPPC methodology. Input data (e.g. use of mineral fertilizers) are based on expert estimates obtained from the Ministry of Agriculture. Predictions of the use of mineral fertilisers (t N/yr) are based on agricultural optimum, which means that 110 kg N/ha (organic and mineral fertilizers together) gives plants the best warranted rate of growth. The WM scenario assumes that the actual fertilization rate will be much lower (at least 50%) because of the high price of fertilizers and some other reasons (legislation and standards, e.g. Organic Agriculture Act) (Table 5.2.8). The WAM scenario presumes that the use of mineral fertilizers will not rise much in time and will stay on the average level of the recent years (Table 5.2.9).

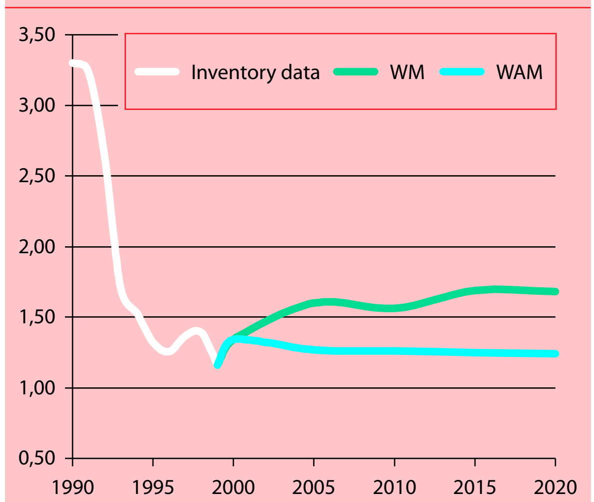
Table 5.2.8. WM scenario: N_2O emissions, Gg

Sector	1990	1995	2000	2005	2010	2015	2020
Energy	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture	3.1	1.2	1.2	1.5	1.5	1.6	1.6
Total	3.3	1.3	1.3	1.6	1.6	1.7	1.7

Table 5.2.9. WAM scenario: N_2O emissions, Gg

Sector	1990	1995	2000	2005	2010	2015	2020
Energy	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture	3.1	1.2	1.2	1.2	1.2	1.2	1.2
Total	3.3	1.3	1.3	1.3	1.3	1.3	1.3

Figure 5.2.7. N_2O emission, Gg



5.2.5. Aggregated effects of policies and measures on the GHG emissions in CO_2 equivalent

The projections of the total GHG are based on the concept of Global Warming Potential (GWP) within a 100 year time horizon. The GWP values used for emission projections are shown in Table 3.7.1. The WOM scenario (baseline, "without measures") are calculated assuming that the net emission of GHG (on CO_2 equivalent) per every unit of GDP should be constant over time i.e. that the total increase of GDP is closely connected with the increase of GHG. This assumption is the based on close correlation between the decrease of GHG emission and GDP from 1990 to 1994 (Figure 5.2.8). Net Estonia's GHG emissions values are presented in Tables 5.2.10 - 5.2.11 and in Figure 5.2.9.

Figure 5.2.8. Dynamic of GDP and GWP from 1990 to 1999

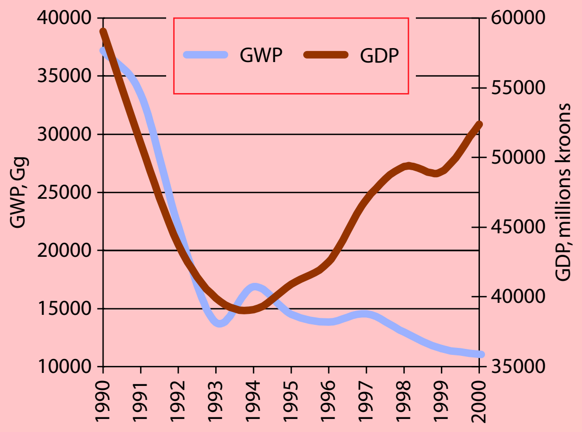


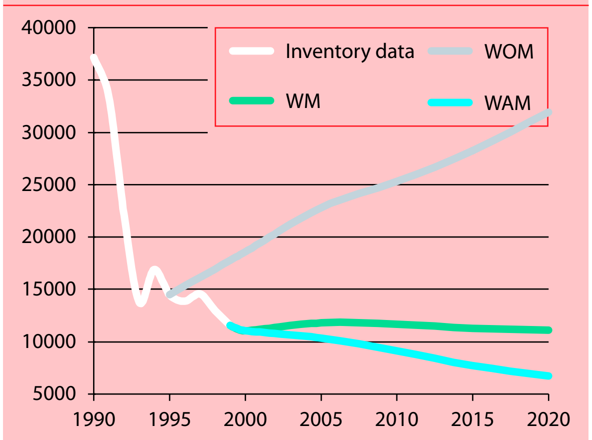
Table 5.2.10. WM scenario: GHG emissions, Gg CO_2 equivalent

Gas	1990	1995	2000	2005	2010	2015	2020
CO_2	31787	11533	8154	8690	8640	8380	8430
CH_4	4362	2561	2499	2630	2540	2390	2160
N_2O	1023	410	415	500	480	520	520
Total	**37172**	**14504**	**11068**	**11820**	**11660**	**11290**	**11110**

Table 5.2.11. WAM scenario: GHG emissions, Gg CO_2 equivalent

Gas	1990	1995	2000	2005	2010	2015	2020
CO_2	31787	11533	8154	7940	6910	5770	5040
CH_4	4362	2561	2499	2020	1830	1530	1340
N_2O	1023	410	415	390	390	390	380
Total	**37172**	**14504**	**11068**	**10350**	**9130**	**7690**	**6760**

Figure 5.2.9. Net Estonia's emission, Gg CO_2 equivalent



EXPECTED IMPACTS OF CLIMATE CHANGE AND VULNERABILITY ASSESSEMENT

6.1. Climate Scenarios

Climate change scenarios for the 21st century, were constructed following the methodology recommended for regional climate change impact studies. Air temperature and precipitation projections were compiled using a climate model – Model for the Assessment of Greenhouse-Gas Induced Climate Change (MAGICC) and a regional climate change database – (SCEN)ario (GEN)erator (SCENGEN). The baseline climate was defined as that prevailing between 1961 and 1990. Climate change scenarios were created for the years 2050 and 2100.

Three GHG emission scenarios elaborated by IPCC - IS92a (central), IS92c (low) and IS92e (high) – were used in the MAGICC model.

Data from two 5D5 degree grid boxes with medium co-ordinates 57.5°N/22.5°E and 57.5°N/27.5°E cover the territory of Estonia (Figure 6.1.1).

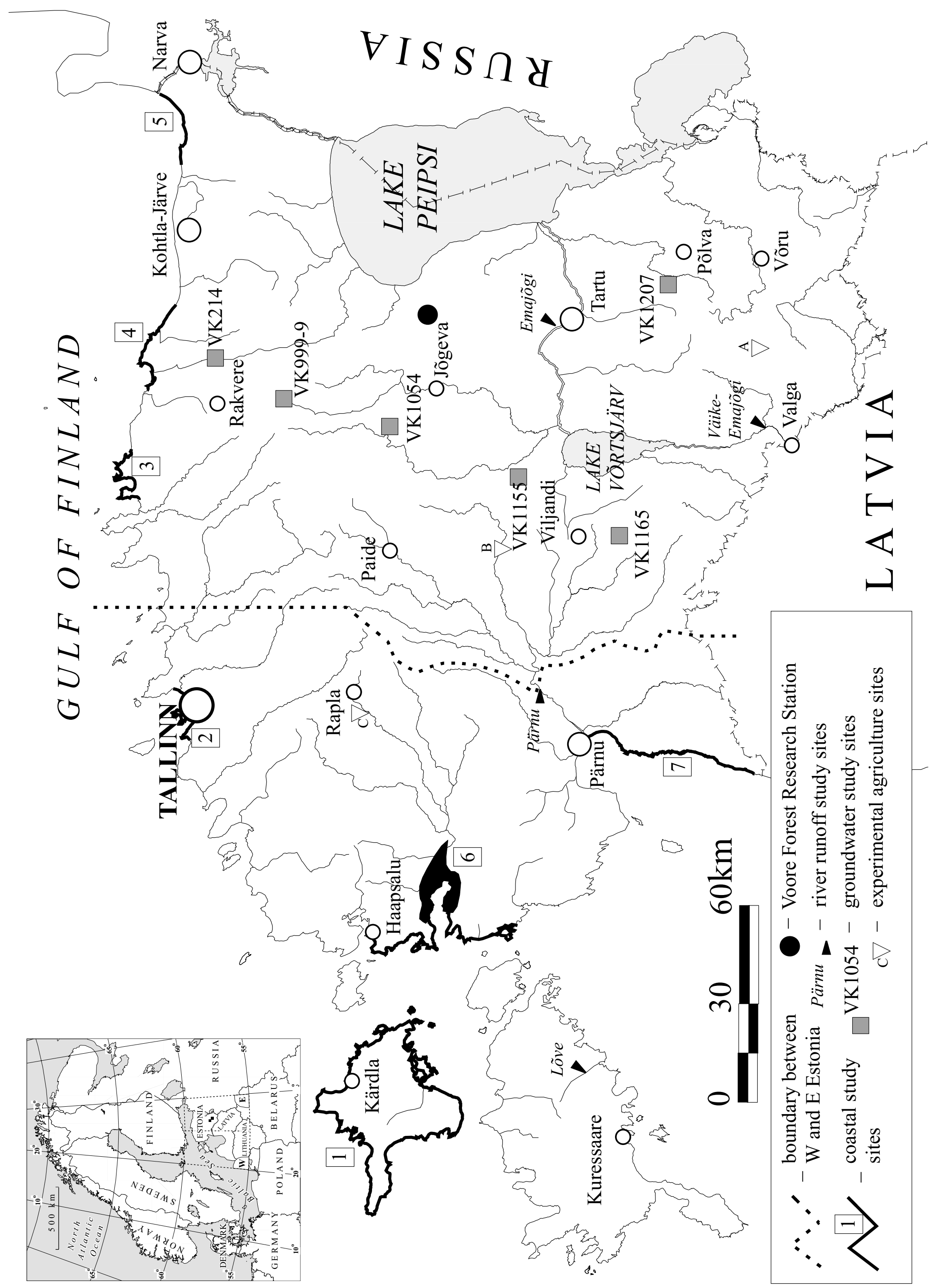


Figure 6.1.1. Location of Estonia in Northern Europe and in relation to the SCENGEN data grid boxes. Location of study areas. Agricultural Experimental Stations: A – Antsla; B – Olustvere; C – Kuusiku. Voore Forest Research Station. River runoff study sites. Groundwater study sites. Coastal study sites: 1 = Hiiumaa; 2 = Tallinn; 3 = Käsmu - Vergi; 4 = Toolse - Aseri; 5 = Sillamäe - Narva-Jõesuu; 6 = Matsalu Bay; 7 = Pärnu – Ikla.

The results of the 14 GCM experiments provided a wide variety of possible climate change scenarios in Estonia. Middle emission scenarios projected an increase in annual mean temperature by 1.3-2.6°C for the year 2050 with greater increases occurring in central and eastern Estonia. In addition, warming in winter and spring was expected to exceed that in summer and autumn, indicating a continuation, if not intensification, of the trend observed in Estonia during the 20th century. Climate change scenarios yielding the greatest changes were compiled for the year 2100 using the high emission scenario. All GCMs expressed a exceptional warming throughout the year (Figure 6.1.2), yet the highest temperature increases seem unrealistic for a country at such a high latitude.

The modelled increase in annual precipitation for the year 2050 was generally < 10%, an insignificant change compared to the large inter-annual variability of precipitation. Only two GCMs predicted higher increases of approximately 15%. The greatest seasonal change in precipitation was modelled for winter. Some GCMs demonstrated a decrease in summer (July) rainfall. Increases in precipitation during the cold half-year were modelled by every GCM, but results for the summer season were contradictory.

6.2. Vulnerability analysis

Because of its geography, wide coastal areas, water resources, forests and wetlands, the environment of Estonia is sensitive to climate change. Therefore Estonian scientists have made serious work to make vulnerability and adaption assessments focused on these sectors. This chapter gives some results of these studies.

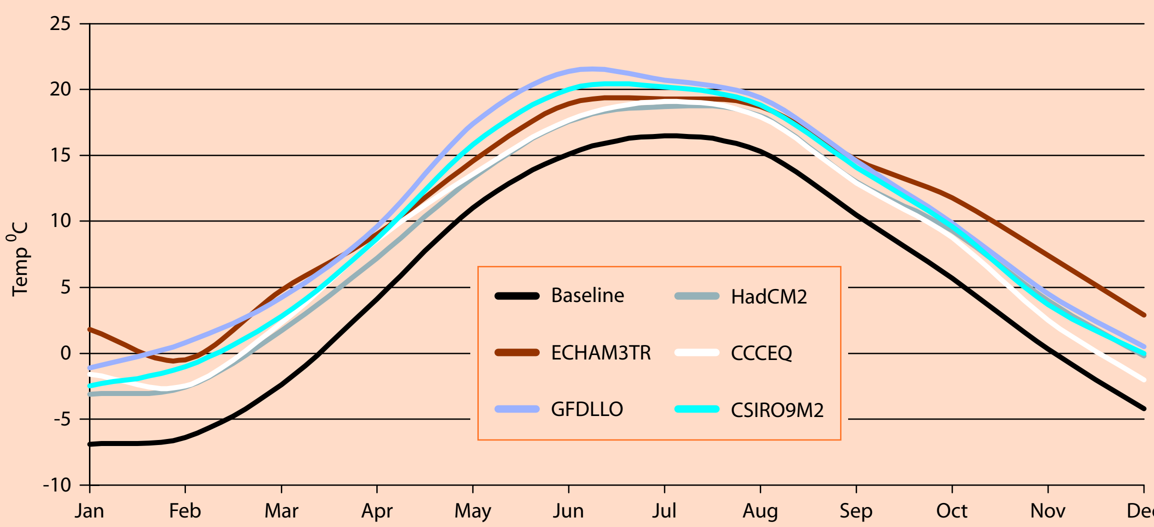
6.2.1. Agriculture

Estonian agriculture is specialized in animal husbandry, which depends on the yields of crops. Since meteorological conditions during the growth period of plants vary substantially from year to year, the yields of crops and grasslands are unstable. Despite a small territory, the soil and climate conditions for growth of plants are extremely variable. For example, in central Estonia the pedoclimatic conditions for the cultivation of cereals are 20-30% more favourable than in northern and south-eastern parts of the country.

The vulnerability and adaptation assessment for Estonia in the sector of agriculture supported by the U.S. Country Studies Program was carried out in 1995. At that time 38% of the total arable land of Estonia was covered by grain fields, and the main cereal was barley (60% of the sown area). The impact of climate change on potato and clover-timothy mixture yields was also considered.

The CERES-Barley model was used for crop productivity assessment. For analysis of the sensitivity of barley yields to temperature, precipitation and carbon dioxide level, incremental scenarios were created, combining certain changes in the climatic variables (-2°, -1°, 0°, +1°, +2°, +4°, and +6°C in temperature; 0%, ±10%, and ±20% in

Figure 6.1.2. Annual curve of modelled air temperature in grid box 57.5oN/27.5oE for the year 2100 using the high emission scenario (IS92e) and different GCMs



HadCM2 - Hadley Centre Unified Model 2 Transient (UK);
ECHAM3TR - European Centre/Hamburg Model 3 Transient (Germany);
CCCEQ - Canadian Climate Centre Equilibrium Model (Canada);
GFDLLO - Geophysical Fluid Dynamics Laboratory Transient Model (USA);
CSIRO9M2 - Commonwealth Scientific and Industrial Research Organisation, Mark 2 (Australia).

precipitation; and 330 ppm, 355 ppm, 440 ppm, and 580 ppm in CO_2 level). Using the model, it was possible to simulate the plant development and the yield capacity, integrating the climatic, soil, genotype, and management factors. Unfortunately, the CERES-Barley model is more appropriate to dry and rubbly soils. On Gleysols and on soils with heavy texture, great variation of groundwater level at the beginning of the vegetation period is strongly disturbing the modelling results. In addition to barley, possible changes in potato (main food crop in Estonia) yields were also examined using the results of earlier experiments.

Three case study areas (Antsla, Olustvere and Kuusiku) were selected in different parts of Estonia (Figure 6.1.1). All three areas have experimental stations where special trials (1966-1987) were carried out on four different soil types characteristic of Estonia. These are the following: (1) Haplic Podzol at Antsla, (2) Podzoluvisol at Olustvere, (3) Cambi-Rendzic Leptosol and (4) Base-saturated Gleysol at Kuusiku. The trials consisted of 6-field crop rotation: potato -> barley -> barley -> timothy-clover mixture -> timothy-clover mixture -> rye.

The data on barley are based on 16 variants of fertilizing experiments. The simulations done with a barley cultivar Julia indicate a considerable decrease in productivity in the case of climate warming (Figure 6.2.1). At the present CO_2 concentration level, the increase in temperature without changes in precipitation would decrease the barley yield by 45-48% on unfertilized soils. On arid fertilized sandy soils, a temperature rise of 6°C would cause a drop of barley productivity by even 56-61%. On gleyic and gleyed soils with heavy texture and much better water supply, the effect of higher temperatures is less notable. On dry sandy soils, the barley yields depend mainly on the rate of nitrogen fertilization and the plant water supply. On the other soils, the relative effect of fertilization is less important.

The productivity of pastures in Estonia depends on solar radiation, temperature and water supply. The soil and climate conditions for herbage are the most favourable in central and western parts of the country. A temperature rise would increase the timothy-clover mixture yield by 10% in average.

It is necessary to irrigate the sown pastures (100-120 mm on average, in some droughty years even up to 200 mm) to get a maximum yield (7-12 t/ha of dry matter). Such irrigation rates may increase the pasture yield by 1.3-1.9 t/ha. In general, the productivity of sown pastures depends on the type of grass sward and the rates of fertilization and irrigation (Table 6.2.1).

Table 6.2.1. The influence of nitrogen fertilization and irrigation on the yield of sown pastures (Viiralt, 1986)

Grass sward	N (kg/ha)	Dry matter yield (t/ha)	
		Unirrigated	Irrigated
Grasses	0	1.83	2.56
	100	4.96	6.52
	200	7.63	9.27
	300	8.38	10.58
White clover	0	3.03	6.48
	100	5.44	7.09
	200	6.25	9.03

Potato is very sensitive to climatic conditions. In general, high temperatures during the planting and sprouting period give a positive effect on potato yield. The temperatures after sprouting and during harvesting are less significant. On moist gley soils, heavy rainfalls in spring cause a

Figure 6.2.1. Sensitivity of barley yield to climate change on Cambi-Rendzic Leptosols.

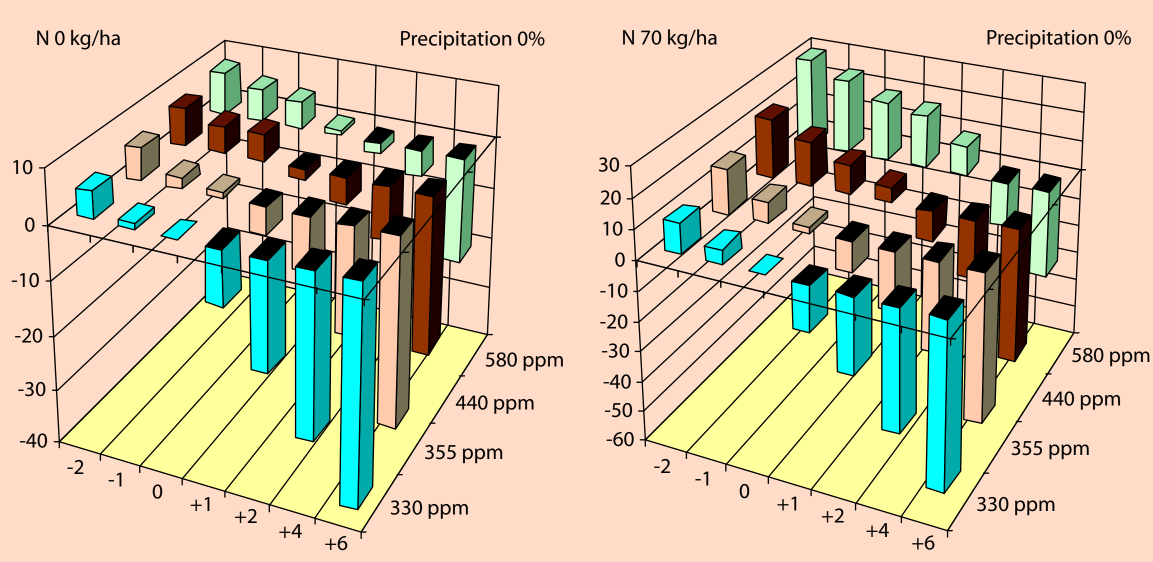
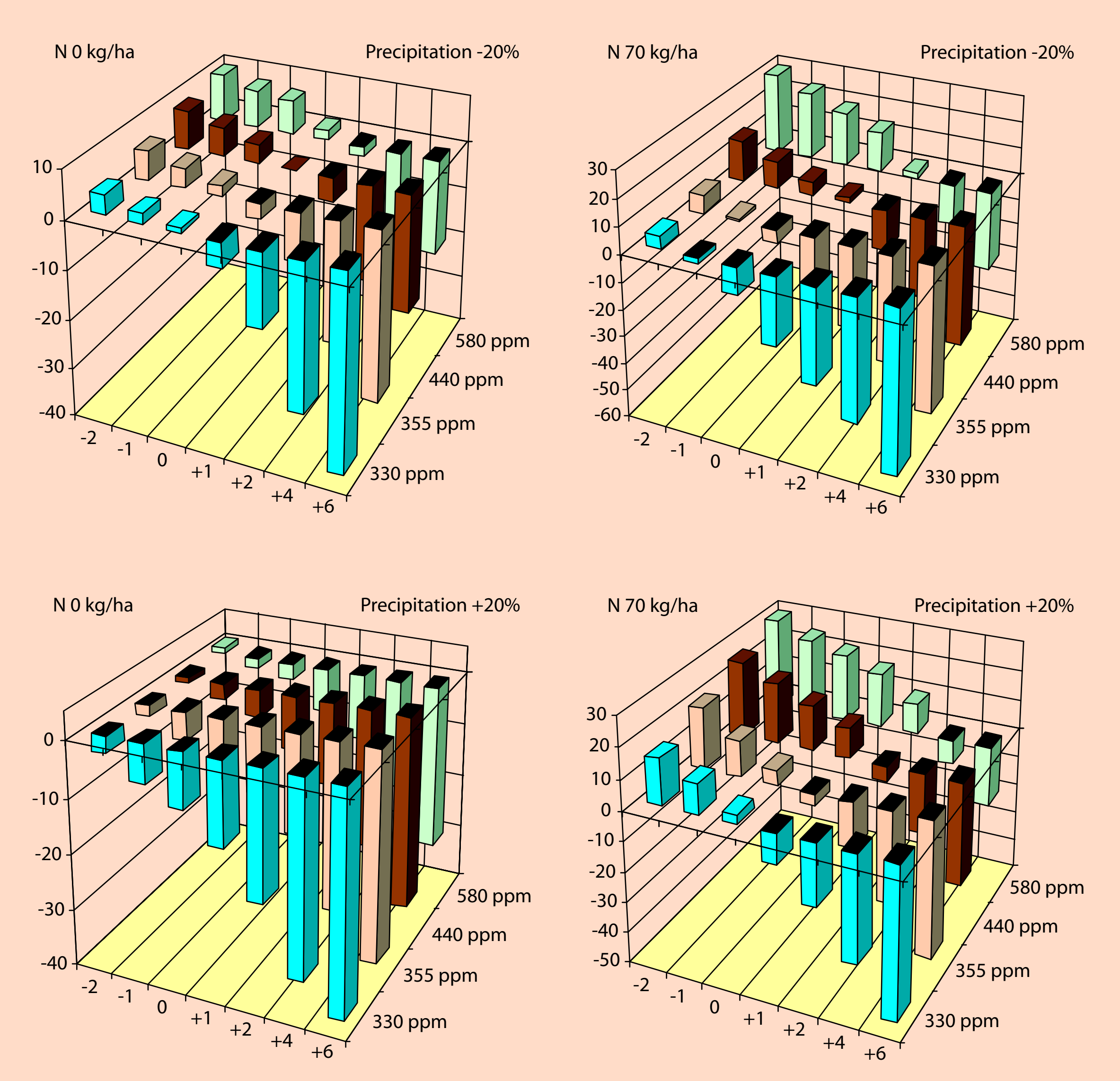


Figure 6.2.1. Sensitivity of barley yield to climate change on Cambi-Rendzic Leptosols



very strong decrease in potato yield. For instance, every millimetre of precipitation in spring reduces the potato yield by 0.3-0.6 t/ha. However, precipitation during and after flowering give a positive result.

For the analysis of the effect of various climate change scenarios on the national grain yield, changes in barley productivity were estimated by aggregating the results on the tested soils and presenting as weighted mean values over the whole cultivated area of Estonia. As the tested soils of various properties are typical cultivated soils in the country, the aggregation makes it possible to evaluate reli-

Table 6.2.2. Aggregation of the CCCM results for barley

Soil	Main occurrence	Sown area of barley (thous. ha)	N (kg/ha)	Percent of total production	Percent of change in yield	Weighted average
Cambi-Rendzic Leptosols, Calcareous Cambisols and Luvisols	North and Central Estonia	84	0	48.9	-18.4	-0.44
			70	49.6	-18.7	-1.25
Haplic Podzols, Podzoluvisols, Stagnic Luvisols and Planosols	South Estonia	68	0	39.2	-18.9	-0.45
			70	39.1	-19.2	-1.26
Gleysols	West Estonia	36	0	11.9	+4.4	+0.04
			70	11.3	-9.0	-0.34
National		188	0	100	-18.8	-0.41
			70		-17.8	-1.07

ably the potential effect of climate change on the national grain yield (Table 6.2.2).

It may be concluded that despite the small territory of Estonia, the soil and climate conditions are extremely variable, affecting strongly plant growth. As the modelling results show, temperature rise would decrease the crop yields everywhere in Estonia. Most vulnerable would be the cultivated areas on dry sandy soils. The fields on gleyic and gley soils would be less affected. However, the yields on these soils are so low (1.42-3.20 t/ha) and unstable that cultivation of barley is not profitable at all.

Earlier experiments using biophysical models for the productivity of various crops have shown that the effect of climate warming is more favourable on herbage cultivation than on cereals. Climate warming would make the potato yield very unstable. It may fall on unfertile and overmoist soils. It is worth mentioning that various potato cultivars have different disease-resistance, which, in our conditions, is of great importance to the formation of potato yield. Unlike herbage, the soil and climatic preconditions are relatively unfavourable for potato cultivation in western Estonia.

6.2.2. Forestry

The RipFor forest-soil-atmosphere model was used to analyse the potential influence of climate change on forest biomass production and nutrient cycling in Estonian forests. The objective of this exercise was to estimate the changes in nutrient availability and nutrient fluxes in the soil-vegetation system. Changes in forest productivity were estimated according to the HadCM2 and ECHAM3TR climate change scenarios.

The main processes addressed by the RipFor model are net primary production (proportional to foliage biomass affected by nutrient availability), biomass respiration, litterfall (including throughfall), litter decay (including translocation of nutrients and of photosynthate before foliage fall), nutrient uptake from available nutrient pools within the soil, ion exchange, and replenishment of soil base cations (Ca, Mg, K, Na) via soil weathering, and atmospheric deposition. The model includes balanced cycles (mass, ion charge) for Ca, Mg, K, N, P and S, and addresses biomass growth for forest stands and forest gaps. The climatic factors included in the model are radiation, CO_2 concentrations in the atmosphere and soil, atmospheric deposition of nutrients, air temperature and precipitation. In the model, air temperature, precipitation and leaf area affect the rate of evapotranspiration. In turn, rates of evapotranspiration and nutrient availabilities affect productivity and water use efficiency. Rates of evapotranspiration and soil moisture availability were calculated separately with the ForHyM model.

The climate change scenarios with respect to forest resources reflected obvious trends: a decrease in the snow pack duration and earlier snowmelt with increasing climate warming. The reduced influence of snowmelt on stream discharge would increase the synchronization between precipitation and stream discharge. Soils would become slightly drier during the growing season and, coupled with decreased spring and summer precipitation, increase drought stress. This could increase the forest fire potential, which could, in turn, accelerate species migration. A major species shift, anticipated or not, would make the RipFor calculations unreliable and require increased quantification. However, calculations made with different species compositions demonstrated stability of the model, indicating that minor changes in species composition yield insignificant changes in model output.

This study assumed linear climatic changes over 100 years. Calculations presented in the figures below were carried out for the period 1990 - 2100 for a spruce stand at Vooremaa (Figure 6.1.1). Results from other sites showed similar behaviour and the general trends presented here are characteristic of all spruce stands in Estonia.

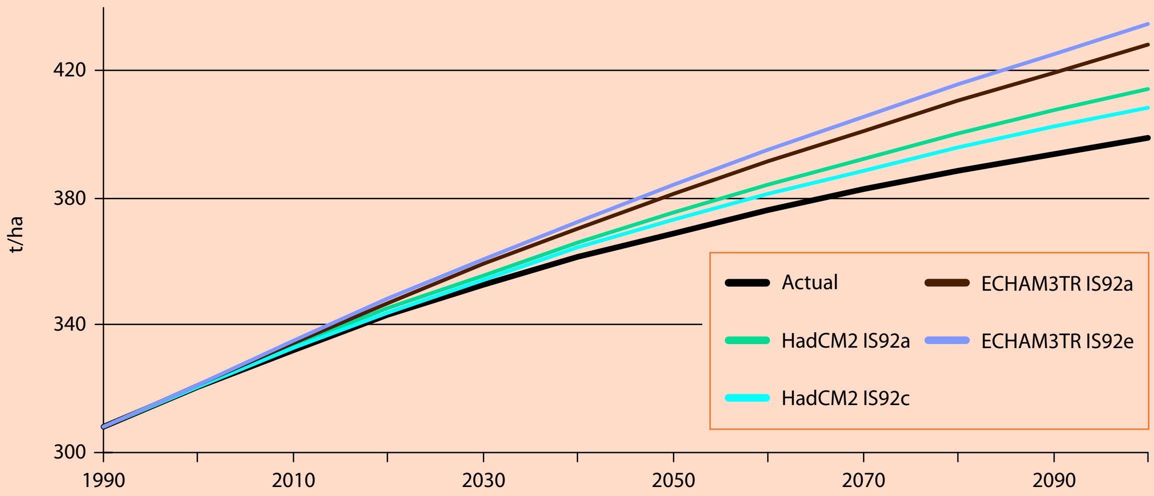
The simulations based on the climate change scenarios imply increased productivity due to (1) increased atmospheric CO_2, (2) increased evapotranspiration, (3) increased allocation of photosynthate to foliage, and (4) increased rates of nutrient cycling (increased net primary production implies increased nutrient uptake, litterfall, litter decomposition and mineralization).

These calculations were based on reasonable assumptions of net primary production, allocation pattern of nutrients and photosynthates within the vegetation, nutrient cycling rates, but ignored the effects of soil temperature and moisture on organic matter decomposition, soil weathering, and nutrient mineralization and nutrient transformations within the soil (e.g., nitrification). The calculations also neglected the possibility of changing atmospheric ion loads, changing rates of N fixation and denitrification, as well as P-dependent vegetation-soil dynamics. Most of these omissions reflected a lack of site-specific data that could quantify the related effects.

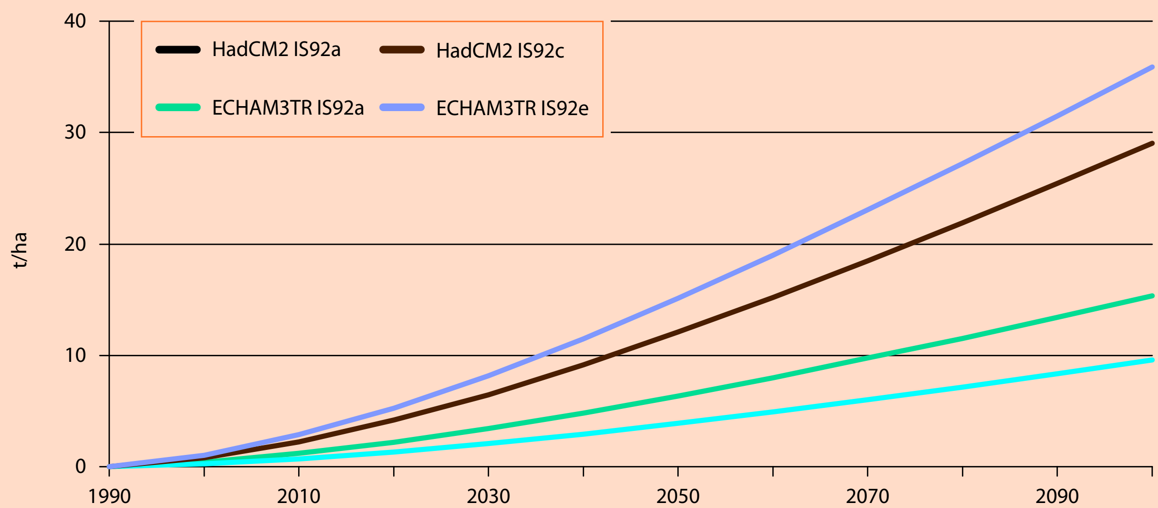
Increased nutrient availability, in particular that of nitrogen, clearly favours increased forest biomass. Growth rates of wood biomass under four different scenarios and current conditions for a Norway spruce stand at Vooremaa (eastern Estonia) are presented in Figure 6.2.2. Stable growth without harvesting and natural disasters (e.g. diseases or storm events) was assumed for all calculations. Wood biomass in these calculations included branches, stump and larger roots. The additional wood biomass growth during the 100 year period was predicted to range from 2.5 to almost 9%. We assume a proportional increase in harvestable timber.

Figure 6.2.2. Wood biomass growth scenarios

a) Wood biomass growth in Norway spruce forest at Vooremaa (eastern Estonia) under four different climate change scenarios.



b) Additional woody biomass growth (tons per hectare) in a Norway spruce stand in Vooremaa under four climate change scenarios compared to growth under current climatic conditions during the next century.



6.2.3. Water resources

To investigate the influence of climate change on river runoff after a hundred years (RR1), a point model (Wat)er (Bal)ance – WatBal – was chosen.

The WatBal model requires a large amount of meteorological and hydrological data, which were obtained from the Estonian Institute of Meteorology and Hydrology. Runoff data from 36 river basins were used to model climate change impact. A number of model parameters were determined for each river basin, including the monthly mean precipitation, air temperature and runoff. The data on precipitation were obtained from four meteorological observation stations located near the study areas (Figure 6.1.1). An algorithm was written to calculate the spatial mean values. The monthly mean temperature, as well as the long-term mean values of sunshine duration, relative humidity, and wind speed were collected from the central meteorological observation stations of the studied catchment areas. The runoff data of the lowest discharge stations of the observed rivers were used to calibrate and validate the model. The baseline period for vulnerability assessment of water resources was the same (1961-1990) as for the climate scenarios.

The same climate change scenarios were used to model the impact of climate change on river runoff. Three alternative GHG emission scenarios developed by IPCC (IS92a, IS92c, IS92e) were combined with two general circulation models (HadCM2, ECHAM3TR).

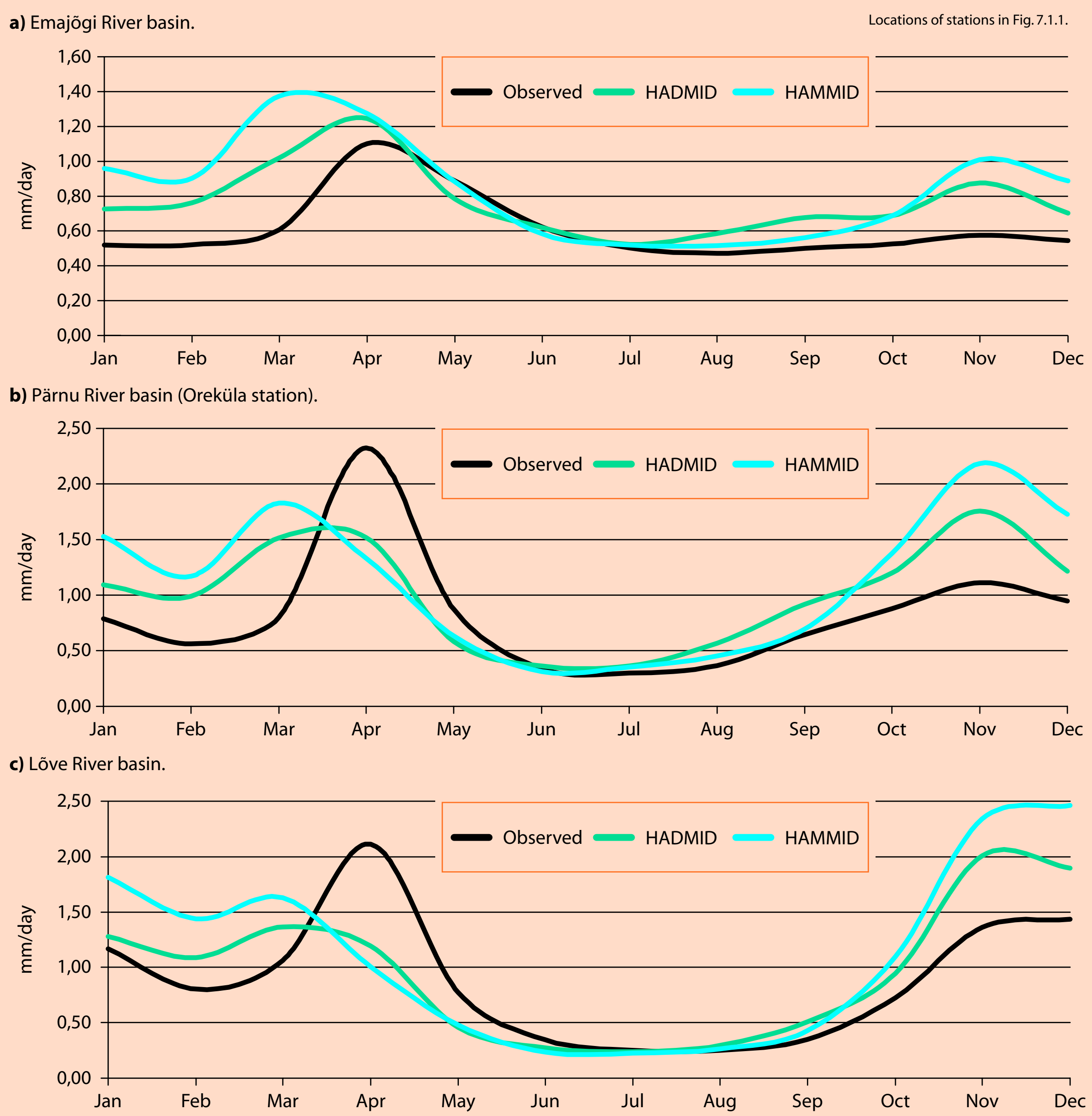
Data for groundwater regime analysis were collected by the Estonian Geological Survey. The modelling results of river runoff were used to determine possible changes in groundwater levels due to changes in climatic conditions. The time series of groundwater levels reflect the changes in aquifer storage as well as aquifer recharge or discharge. The seasonal patterns of precipitation and runoff in the analysed regions are similar, but the correlation between runoff and groundwater level is higher than between precipitation and groundwater level.

The modelled changes in annual mean runoff for the four climate change scenarios in the 36 studied river basins ranged from -1% to +74%. Modelling results demonstrate the possibility of significant changes in the annual course of monthly runoff caused by climate warming. A significant re-distribution of the seasonal runoff was projected. The most important changes would take place during the cold half-year. Frequent melting periods would decrease snow and ice accumulation during winter. Consequently, the start of snowmelt in spring would be earlier with a reduced runoff maximum.

All climate scenarios predicted a significant increase in river runoff during autumn caused by increased precipitation. In the western part of Estonia, the runoff maximum in autumn (November) was expected to exceed the spring maximum. In eastern Estonia, typical snow cover conditions would remain but the duration of winter and its stability would decrease.

These predicted changes were not equal throughout Estonia. Figure 6.2.3 illustrates the modelling results for three river basins located in different parts of the country. Runoff changes in the Emajõgi River basin represent the region with the most continental climate in Estonia. The modelling results show that runoff changes in western Estonia are greatly different than in the rest of continental Estonia

Figure 6.2.3. Changes in the monthly runoff in the river basins of different regions



On Saaremaa Island, West-Estonian archipelago, the region with the most maritime climate in Estonia, the hydrological cycle would change completely. With no runoff maximum in spring, the annual cycle would consist of a single maximum (cold half-year) and one minimum (warm half-year).

As a consequence of the earlier spring runoff maximum, the minimum runoff in summer would also start earlier, in May rather than June. Therefore, its duration would increase by an average of one month. A certain pattern is influenced by local conditions, first of all by the character of the spring runoff peak of the rivers. The results of the water resources vulnerability assessment showed a strong dependence on regional changes in runoff and local topography and landscape features.

Examples of modelled groundwater level changes in different geohydrological conditions are presented in Figure 6.2.4. A rising groundwater table would enhance the water supply. The head of the uppermost confined aquifers would rise by 0.5-1.5 m due to the climate change in areas >50 m a.s.l. Wells in these areas with a depth from 60 to 100 m tap the upper confined aquifers and are commonly used for urban water supply. The discharge of these wells usually ranges from 200 to 800 m^3/d per a drawdown of 3-8 m. As a result of general increment of groundwater recharge, the safe yield of bored wells would augment by at least 20%. Thus, the required groundwater can be obtained with fewer wells or reduced pumping. Consequently, climate change would reduce the cost of groundwater extraction from upper confined aquifers.

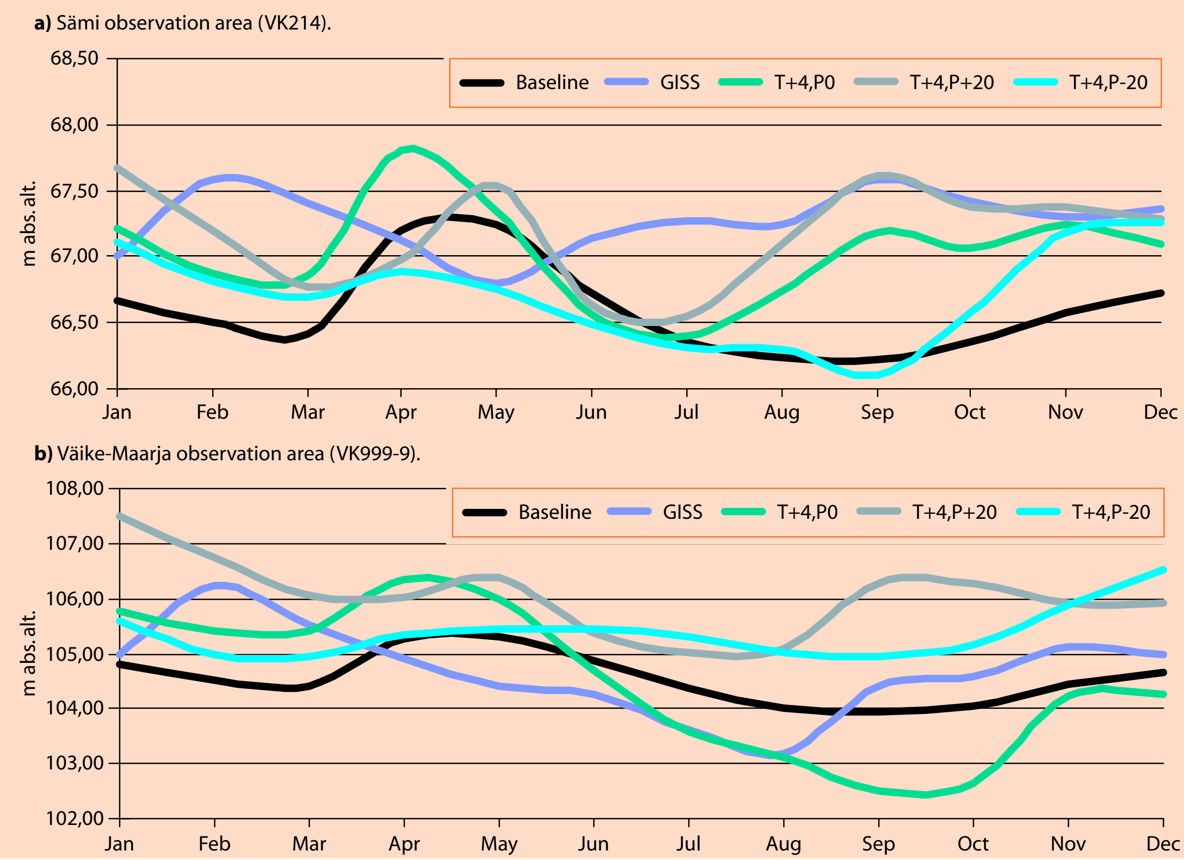
The results of analysis of water supply and demand indicated no effect of climate change on water use in Estonia. The groundwater resources can guarantee a sufficient supply of good quality domestic water in all regions of the country. Water consumption in towns and other settlements would be independent of the quantity and quality fluctuations of rivers. Climate warming would also have a positive influence on the ecological state of water-bodies in Estonia.

6.2.4. Coastal resources

Estonia is rich in different geomorphic types of shores: cliff shore, scarp shore, rocky shore, till shore, gravel shore, sandy shore, silty shore, and artificial shore have been distinguished. Seven study areas containing all these shore types were selected for detailed analysis and assessment (Figure 6.1.1). The study sites serve different human functions and represent a variety of coastal settlements. Thus, detailed analysis of the study areas provides the means of extrapolating the results for the whole country.

Detailed measurements were made along the coastline at 200 m intervals using 1:25000 topographic and geo-

Figure 6.2.4. Modelled groundwater level changes in different geohydrological conditions



morphic maps and calculations according to the Bruun Rule. There were some problems in using the Bruun Rule: (1) shoals off the Estonian coasts reduce wave energy and thus defend the shore against erosion; (2) the Bruun Rule was created to calculate erosion only on sandy beaches. Because the US Country Studies Program provides no alternative methods for non-sandy shores, the Bruun Rule was also used to calculate erosion on other depositional shore types (gravel, pebble and till). Therefore, the overfill ratio of 1.0 for sandy shores was modified for the other shore types: gravel and pebble – 0.7; till (shingle-rich loam) – 0.4; and limestone – 0.1.

The results of the Estonian vulnerability assessment were obtained from a hypothetical 1.0 m sea-level rise with respect to the Kronstadt benchmark from 1990 to 2100. The data from isostatic uplift measurements were taken into account in land loss estimates at each site. Calculations of relative sea-level rise by the year 2100 took into account the rate of land uplift.

All potential loss from inundation and storm surge zones was calculated at current average prices in Estonia. The monetary values of three different types of losses was calculated: cost of submerged and temporarily damaged land; cost of actually existing features in these two zones today; and profit theoretically missed from the damaged meadows and forests. The overall potential loss for the whole coastal zone of Estonia was calculated by multiplying the losses of the study areas by four (the coastline length of the study areas provides 25% of the total coastline length of Estonia), and adding the losses in the coastal settlements.

Despite a slow uplift of the earth's crust, extensive erosion and retreat of depositional coasts, e.g., sandy beaches, has been observed in Estonia in recent years. Increased activity of coastal processes, including erosion, is presumed to be associated with climate change. In autumn and winter, westerly and south-westerly storm winds raise the sea level up to 2.0 m above its summer level. Because there is little evidence of a rising sea over this period, beach erosion appears to be largely due to the recent increased storminess in the eastern Baltic Sea.

A 1.0 m sea rise would change substantially the coastline contour and the number of small islands. The most significant changes would occur on the western coast, including the Matsalu Bay test area (Table 6.2.3). Coastal meadows and reed beds, characteristic ecosystems of the western coast of mainland Estonia, would migrate inland, but would not perish. Nevertheless, sea-level rise would reduce species richness, because the new sites for developing seashore grasslands are currently arable lands or young species-poor forests, and many of the rare species may not survive the migration into initially unfavourable conditions.

The main hazard of the rising sea would manifest with modern land use. Today, natural and semi-natural communities are located more often near the shoreline, while cultivated communities and overgrown lands tend to penetrate inland. A sea-level rise would restore the coastline close to its position in the 1700s. Consequently, all plant communities would migrate inland. Unlike in the 1700s, current arable lands, secondary species-poor forests, and cultivated grasslands impede migration of natural and semi-natural communities. The lack of suitable species pools at

Table 6.2.3. Economical vulnerability of study areas to 1.0 m sea-level rise. All prices are counted as Estonia's average in thous. U.S. Dollars

	Inundation zone							
	Hiiumaa		Käsmu - Narva-Jõesuu *		Matsalu Bay		Pärnu-Ikla	
		Price		Price		Price		Price
Coastline length (km)	326		190		230		150	
Coastal meadows (km^2)	7.8	116	0.9	22	31	714	19.7	411
Wetlands (km^2)	13.7	204	3.3	85	38	875	0.8	17
Forests (km^2)	8.3	123	1.5	40	7.5	173	0.3	6
Beaches (km^2)	5.6	83	2.9	75	0.15	3	1.4	29
Settlements (km^2)	2.6	39	0.11	118	0	0	0	0
Total area (km^2)	38	565	9.8	340	76.6	1765	22.2	463
Timber (m^3)	126990	4535	23 562	842	114750	4098	4590	164
Hay (in 100 kg/century)	561600	3009	133920	717		11957		7600
Dwellings	20	83	120	471	27	108	30	122
Harbors **	7		5		2		0	
Beacons **	8		5		1		0	
Roads (km)	9.7	414	8.5	364	12	514	0	0
Overhead lines (km)	15.5	78	11.8	59	7.3	37	0	0
TOTAL		**8684**		**2793**		**18479**		**8349**

* integrated results of three smaller study areas (Figure. 6.1.1)

** possible damages are not expressed in monetary values because they can be avoided by regular care

Table 6.2.3. Economical vulnerability of study areas to 1.0 m sea-level rise. All prices are counted as Estonia's average in thous. U.S. Dollars

	Storm surge zone							
	Hiiumaa		Käsmu - Narva-Jõesuu *		Matsalu Bay		Pärnu-Ikla	
		Price		Price		Price		Price
Coastal meadows (km^2)	30	446	0.7	17	23	530	20.2	422
Wetlands (km^2)	0	0	3.7	92	15	345	0	0
Forests (km^2)	44.2	6570	2.5	62	25.5	587	2.5	51
Arable lands (km^2)	0	0	0.03	1	4.5	104	0	0
Settlements (km^2)	1.1	943	0.2	300	0	0	0	0
Total area (km^2)	75.3	7959	7.15	472	68	1566	22.7	473
Timber (m^3)	676260	24152	382500	13661	390150	13934	37485	1339
Hay (in 100 kg/century)		11571	161280	864		8871		7791
Dwellings	330	1296	415	1630	267	1049	304	1194
Roads (km)	44	1886	31.5	1346	40	1714	0.7	30
Overhead lines (km)	60	300	22.5	112	36	180	0	0
TOTAL		47164		18085		27314		10827

* integrated results of three smaller study areas (Figure 6.1.1)

** possible damages are not expressed in monetary values because they can be avoided by regular care

new sites and unfavourable conditions for migrating grassland species would probably result in a considerable decrease in species richness.

A site at risk in north-eastern Estonia is Sillamäe, an important industrial centre. The dumping site of the former uranium enrichment plant is still the greatest threat to the environment of the coastal plain and the Gulf of Finland. Separated from the sea by a narrow dam, thousands of tons of radioactive substances containing ^{238}U, ^{232}Th, and ^{226}Ra leak into the soil and sea every year. Sea level rise and stronger storms would increase the risk of dam rupture, causing catastrophic pollution of the sea.

Estimates of losses on Hiiumaa Island indicate that 100% of reed beds and 80% of coastal meadows (salt marshes), including rare saline plant communities (*Salicornia europaea*, *Carex glareosa*, and *Glaux maritima-Juncus gerardi* site types, that occur in all successional transitions, are in direct danger. The rare ecosystems of numerous lagoons and calcareous orchid-rich meadows on the north-western coast of Hiiumaa would completely disappear, along with the spawning grounds for trout and lavarets.

Although 1/3 of Tallinn's coastline is protected by dikes, the damage potential is greater than in the other study areas. The most vulnerable area is the Paljassaare Peninsula, a low-lying industrial district, which contains over half the potentially submerged area of Tallinn.

The territories most vulnerable to sea level rise in the Pärnu-Ikla study area lie in the north, where silt shores are predominant, and on the densely populated Kihnu Island. Waves during the most recent strong storms approached dwellings 300 m inland. Almost 2.5 km^2 of the territory of Pärnu, the largest town in this region, is located in the zone of inundation. Although no rare or valuable natural ecosystems in this area require special protection, the socio-economic impact, particularly, concerning recreational areas, would be critical.

The estimates of potential losses over the entire coastal territory of Estonia are presented in Table 6.2.4.

Table 6.2.4. Aggregate economic vulnerability (in million USD) of Estonia to 1.0 m sea-level rise

Study area	Inundation zone	Storm surge zone	Both zones together
Hiiumaa	8.7	47.1	55.8
Käsmu - Narva-Jõesuu	2.8	18.0	20.8
Matsalu Bay	18.5	27.3	45.8
Pärnu - Ikla	8.3	10.8	19.1
Tallinn	22.6	53.0	75.6
Study areas in total	60.9	156.2	217.1
Estonia in total	**243.6**	**624.8**	**868.4**

The greatest destruction of the coastal zone in Estonia today is associated with stormy periods. Research carried out in Estonia over the last decade shows that the absence of sea ice cover in winter fosters coastal damage. The most exceptional changes in shoreline position and contour in many coastal areas of Estonia are attributable to a combination of strong storms, high sea level and mild (ice-free) weather. Depositional coasts, particularly beaches, are most vulnerable to this combination. As a result, the balance between erosion and deposition is fragile and an initial coastal shape cannot be restored during the intermediate period between storms.

FINANCIAL RESOURCES, RESEARCH, EDUCATION AND PUBLIC AWARENESS

7.1. Introduction

Global warming is one of the most serious environmental concerns in the history of mankind. Estonian society is gradually starting to get aware of the consequences of the global climate change. Better environmental education and public awareness are primary objectives of the corresponding responsible institution. Public interest and support can be crucial in the application of the long-term governmental strategy and climate change policy. The measures to be implemented require co-ordinated joint efforts by the governmental organisations and NGOs.

The activity in this field is in Estonia co-ordinated mainly by the Commission on the Implementation of the UN Framework Convention of Climate Change established on 17 October 1995. The main task of the Commission is to prepare national plans based on the UNFCCC directives and support the government in achieving the main goals on the field of climate programmes.

To join the European Union is one of the main goals of our government today. According to preliminary prognoses Estonia should be ready to become a member of the EU by the year 2003, yet there is still much work to be done. Many new laws and directives need to be adopted and also numerous old laws need to be revised. This includes also new laws and decisions in climate change policy and other sectors in the environmental field. Co-operation between the European Union, non-European Union countries and Estonia is getting better and better in every field.

The environmental education programme is concentrated on giving different target groups as advanced environmental training as possible. Great emphasis is laid on mass media as well as on the training of schoolteachers, schoolchildren and university students.

The Estonian Ministry of Education has to develop the relevant research and education programme. This includes also environmental education. Some results can be seen already. Pupils and students have more opportunities to choose than three years ago. At the level of primary and secondary education more environmental issues are included in the programmes and at higher education level more courses are offered.

A detailed plan of policy objectives for the improvement of environmental education has been worked out and it has an important part of the Estonian National Environmental Plan. The estimated funding for the whole projects was planned as 907160 million Estonian kroons, including 12 million kroons as targeted international aid.

For the year 2001 the budget of the Ministry of Education envisages ca 14 million kroons for the support of environmental education and public awareness.

7.2. Research

Estonian scientists have long traditions of environmental studies, among them also climate forming and development-related studies. During the reporting period many scientific groups from the Institute of Ecology at Tallinn Pedagogical University, Institute of Geography and Institute of Marine Research at the University of Tartu, State Institute of Hydrology and Meteorology, Estonian Energy Research Institute, Estonian Agricultural University and Tartu Observatory continued their basic research on global climate change impacts and adaptation in agriculture, water resources, forestry, the Baltic Sea and the Estonian coast. The development of regional climate conditions on the background of global climate warming, climate change impacts on seasonal cycles of nature, the aquatic ecosystems of the Baltic Sea, the ground water regime, evapotranspiration and agriculture have been analysed.

The research was financed mainly by the grants of the Estonian Science Foundation. Every year about 8-10 grants are financed on the topic of global warming amounting in total to ca 1-1.5 million EEK. In addition, there are many target financed projects funded by the Estonian Ministry of Education (Institute of Ecology at Tallinn Pedagogical University, Institute of Geography at the University of Tartu, Estonian Agricultural University).

Many Estonian scientists take part in the R&D projects of the 5th Framework and there are many international cooperational research projects on climate change topics. As an example of projects that are also of importance in the field of education the Baltic Environmental Education Network project "Climate protection and energy saving" could be mentioned. Excellent results have been obtained by scientists from the Institute of Ecology at Tallinn Pedagogical University and Max Planck Institute for Terrestrial Microbiology carrying out the joint project "Methane emission from a raised bog and its control by production, transport and oxidation".

The Stockholm Environment Institute Tallinn Centre is active in various joint practical and training projects, especially in the field of GHG mitigation options in the energy sector. As a result of long-term studies some comprehensive overviews have been published (eg Possible Energy Sector Trends in Estonia. Context of Climate Change, Tallinn, 1999). During the reporting period also results of the very successful project "Country Case Study on Climate Change Impacts and Adaptation Assessments", initiated by the UNEP were published. Estonian Green Cross has initiated many projects on the field of sustainable development and global warming

7.3. Education

The main subjects that cover environmental issues also include the anthropogenic contribution to the environmental disasters and climate change. But the issue of climate change is not a subject to a specific approach in basic and secondary education. Now the Ministry of Education has prepared special curricula Environmental Sciences for the ordinary secondary schools and gymnasiums. During the last years a large amount of translated and original materials and workbooks have been issued for schools. As an example 4-volume textbook for gymnasiums Environmental Studies. These volumes contain materials prepared by Estonian researcher jointly with experienced teachers about the most important environmental problems such as climate change, desertification, ozone depletion etc. The aim of the textbook is to describe, in the context of key words, the content of the elements of environmental studies, based on the programme of natural sciences for secondary schools. The book has also special pages for teachers together with rich illustrations and the latest data about these problems. Environment is a compulsory theme in the national curricula. To ensure uninterrupted and systematic environmental education, the teaching staff and administration should, apart from other subjects, discuss the principles of environmental education in the school curriculum development.

Pupils from grades 6 to 12 are acquainted with:

• Atmosphere and the ozone layer;

• Energy and energy economy. Sustainable energy consumption;

• Air. Air quality. Air movement. Dangerous additions in the air. Combustion and nature protection;

• Fossil fuels: peat, oil, gas, coal, and oil shale;

• Climate, human activity and its influence on the nature. Factors that change the Earth's climate, peculiarities of climate zones and sectors. Greenhouse gases, ozone depletion;

• Chemistry and the environment. Sources of environmental pollution;

• Ecosystems and natural cycles;

• Air, water and soil pollutants (H,C, N, P, Cl compounds).

7.3.1. Non-obligatory study programme, voluntary activities and projects

In addition to the obligatory study programme every school can add lessons to their curriculum. For instance, an environmental programme is obligatory but schools can add lessons about consumption, environmental management, ecology, global environmental problems or something else.

Students have opportunities for different kinds of environmental activities inside and outside the class or school area. There are NGOs, nature clubs and environmental projects that pupils can join voluntarily, for instance the GLOBE project, Young Reporters for the Environment, etc.

The GLOBE project

GLOBE is a world-wide project, under which students measure and monitor the quality of the environment under the supervision of specialized teachers. The US ex-President candidate Al Gore initiated this project in 1994 and invited other countries to take part in it. Observation results are sent regularly to the co-ordinator centre in Washington. There, the results are fed through a special computer program and sent back to the researchers. Scientists all over the world will use the data measured by students to help them with their global research of the planet Earth. Every participating school will have the opportunity to communicate and co-operate with any other project participant. The data collected can be used locally for projects aimed at helping the environment. Altogether 96 countries are participating in the GLOBE project.

Estonia joined the GLOBE countries on 13 June 1996. A total of 33 schools, ca 50 teachers and 800 pupils are taking part in it. By the end of the year 2000, 160000 measurement results had been sent to the co-ordinator centre in Washington, which put Estonia on the seventh place among 96 GLOBE countries. During the GLOBE project, the environmental awareness and IT-skills have risen among the teachers and pupils. Also international communication has become more intensive. Estonian GLOBE schools are co-operating with Norwegian and Latvian GLOBE schools.

Young Reporters for the Environment

Initiated by the Foundation for Environmental Education in Europe (FEEE) in 1990 with the support of the European Commission, this campaign is Europe's oldest and most advanced co-operation programme between secondary school pupils. The Young Reporters for the Environment (YRE) are the teams of secondary school pupils who become journalists and carry out investigations about environmental issues in their area. They investigate on six broad topics: energy, water, waste, agriculture, cities and coastline, with an aim of sharing their conclusions with the public through any media used in a journalistic way (local press, radio, TV, conference, exhibition, etc). Pupils co-operate also with young reporters from other countries also. They form a team using the Internet to produce one or more articles in common on the chosen theme. The best articles are selected and published online. Every year, a European award is given to the team that produced the best European article. This year the award was won by

Estonia who took part in the competition for the first time. There are 15 countries with over 10 000 pupils participating in this project.

7.3.2. Higher education

Universities have been adding new courses on the environment into their programmes. Within the past few years several opportunities have opened for those interested in environmental science as a career. Today many Estonian higher schools are offering programmes leading to a Bachelor's as well as Master's degree in environmental science. In addition, students can select various optional courses on the environment and nature conservation. The University of Tartu, Tallinn Pedagogical University, Estonian Agricultural University and Tallinn Technical University have faculties and chairs responsible for environment-related curricula, including climate. All these universities offer programmes at Bachelor's Master's and PhD level. Also international students exchange as well inter-university exchange to extend students' changes to select environment-related courses are getting increasingly more popular. Today Estonian students have such opportunities that nobody could even dream a few years ago.

7.3.3. Environmental training for adults

Adults have various opportunities to study on environmental issues. Several training centres offer a good choice of environmental courses that adults can take. Trainings is usually not free of charge. Adults who want to take some course must pay for it. Here are some examples of the training opportunities for adults. Regular courses for adults are organised by the Centre for Development Programs EMI-ECO. EMI-ECO provides professional development training and management consulting services for Estonian industries and governmental institutions.

EMI-ECO is determined to give its contribution to the training of well-qualified decision-makers – local government officers, school and business managers – capable of planning the sustainable development of their region based on the overall development trends in the economy and society. It also provides consultation services and has often found potential funding sources for the proposed solutions. Environmental courses that it gives are listed below:

- Basic Course for Environmental Managers in Companies
- Environmental Impact Assessment (EIA)
- Environmental Management Systems
- Chemical Safety

At Tallinn Technical University is working a Centre of Continuing Education. Centre also organises various training for adults, including training on environmental issues. Only recently a training course called "Contemporary Environment" ended. The course was meant for teachers, nature and ecotourism organisers, environment officers and other people whose work involves environmental problems. The course was arranged via Internet. The aim was to educate people using contemporary study technology. They studied the following subjects:

- Environmental Ecology,
- Global Environment Problems (intelligent use of energy),
- Environment and Health (influence of environmental change on humans),
- Environment and Technology (protection of water and atmosphere)
- Influencing Environment (environmental policy, possibilities of influencing the environment, environment management systems).

7.4. NGOs

New environmental organisations are created every year and becoming a member of an NGO is coming ever more popular. Large number of public campaigns, training courses, leaflets, etc. have been made by NGOs or with their help. Environmental NGOs take very actively part also in climate actions. For instance Estonian NGOs organised a bus trip of climate activists from all three Baltic States to the Hague, Netherland to a Climate conference.

NGOs are also co-operating with each other. Eight biggest environmental NGOs came together and created an umbrella organisation for environmental NGOs. The umbrella organisation was named Green Alliance and the number of its organisations is growing. The Green Alliance is working with various environmental projects and lobbying.

One of the founders was the Estonian Fund for Nature. The aims of this NGO are saving Estonian diverse nature and co-operation with different interest groups, organisations and government institutions. One of their co-operate partner is also WWF.

Environmental NGOs have currently several projects running that are related to climate change and global warming. For example:

Estonian Students Society for Environment Protection "Sorex" has organised an inquiry in Estonian schools. The main aim of this project is to get feedback from pupils about their knowledge on sustainable development and environmental problems. The preliminary results indicate the lack of knowledge about environmental issues and the need for more intensive work to raise their awareness. This project is funded by the Estonian Ministry of Environment.

Estonian Youth Society for Nature Protection (EYSNP) has a joint project with the environmental club Scarabeus. The project is part of the European project "The Bet". The name is such because 8 countries over Europe have made a bet with the European Commission that within 8 months they are able to decrease CO_2 emission at least 8% in 8 countries in at least in 88 schools. In Estonia the project has the name "Youth and sustainable development". The idea was to raise interest in sustainable development and find solutions to environmental problems. Within 8 months, pupils were practising an environmentally friendly lifestyle and hopefully at the end of the project this would become their lifestyle. To take part in the campaign the pupils had to live as environmentally friendly as they could. They had special workbooks where they wrote how much electricity, gasoline and water they had saved. They also had a special formula for calculating how much CO_2 emission they had avoided. It was hoped that at the end of the project the pupils would have decreased CO_2 emission by 8% and that they would have learned that by living in a environmentally friendly lifestyle, they are able to decrease the speed of climate change and that the future is in their hands. Project started in the end of year 2000.

It is not only societies and voluntary organizations who are worried about our future. Tallinn city council is working on an environment class project also. Tallinn city council is co-operating with various organizations and NGOs to make this project work. Their plan is to establish environmental classes all over Tallinn. The classes would be about forestry, energy, etc. The city is concerned about environmental education in Tallinn and the city council would like to see more nature clubs and environmental classes to increase the number of pupils who have interest in nature protection and such movement. City council has made a special work plan to develop environmental education. They are also planning to build an environmental information centre into Tallinn's Zoo so that the visitors could find any kind of information about our nature, nature problems and environmental organizations.

There are many environmental projects but for most getting funding is not easy. Our government, ministries and city councils do allocate money to NGOs and their projects but it is not enough. The rest of the money comes from sponsors inside and outside of Estonia. One possible organisation to get funding is Regional Environmental Center for Central and Eastern Europe-Estonian department - REC Estonia. Twice a year environmental projects to be funded with small grants are selected. Four times a year REC Estonia publishes its own magazine Bulletän, which is free of charge. The magazine gives information about environmental issues including articles about climate change and global warming, the funding & co-operation possibilities, REC news, etc. The department has a database with most of the information about environmental organisations in Estonia at its web page.

7.5. National Environmental Action Plan

Everything about Estonian environment policy, laws etc. can be found from the homepage of the Estonian Ministry of Environment. Once every three years they arrange an Environment Forum. It is opened for organisations and peoples who are interested in MoE work and the future of Estonian environment. During the forum there are lectures, discussions, workshops etc. The main reason of this meeting is to make a new National Environmental Action Plan for the next three years, revise the last NEAP, specify priorities and give new ideas. In 1997, The Parliament of Estonia approved the National Environmental Strategy (NES). Based on 10 priority goals of Estonian environmental policy, the first NEAP was developed including both short-term activities (1998-2000) and long-term activities (2001-2006). The last meeting was on 22 November 2000 with 250 participants as working group members or advisors. Estonian Government ratified new NEAP (2001-2003) on 05.06.2001.

The NEAP idea is building a bridge between the sustainable development and the EU approximation processes. Many actions included in the NEAP are oriented at legal and substantive approximation with the EU environmental *acquis*. Much effort has been put to make sure that the NEAP is co-ordinated with the EU Accession Strategy as well as with other environmental programs, particularly the Agenda 21, the National Environmental Health Action Plan, and stimulates development of the local and regional environmental action plans.

This NEAP consists of 657 actions classified by Policy Goal and within each policy goal by objective and subsequently by time scale (short-term actions and medium-long-term actions).

The NEAP contains a large variety of different types of actions such as education, environmental awareness campaigns etc. The top priority actions according to the prioritisation methodology applied are typically legal reforms, drawing of management plans or capital investment into pollution abatement.

Large number of actions within the NEAP (nearly 1/4 of all actions) is oriented directly or indirectly at the EU approximation (both legal and substantive). Within this number, more than 50 actions are directly targeted at a specific EU Directive. PG4 (Air quality), PG 7 and 8 (Groundwater and Surface water) and PG 3 (Energy) are particularly oriented at the EU approximation.

Among the EU Environmental Directives the most frequently addressed by the NEAP are:

• Air Quality Framework Directive (96/62/EC).

• Emissions from Motor Vehicles (70/220/EEC with amendments)

• Environmental Information Directive (90/313/EEC).

Within particular policy goals, the highest weights were given to the following types of actions:

• legal reforms: public access to information and public right of appeal, as well as launching of public awareness campaigns,

• capital investment into pollution abatement technology,

• legal reforms, traffic management plans.

A few examples of the NEAP:

• Advanced environmental education for teachers (incl. pre-school)

• Nature conservation and environmental protection courses at universities (basics for all faculties, specific courses, adult education and open university courses, obligatory for obtaining teachers qualification).

• To amend the Civil Code to introduce citizens' rights to appeal against violation of environmental rights.

• Revision and amendments to the existing environmental legislation to ensure effective and transparent procedures for public access to environmental information and public participation.

• To organize regular forums and dialogues between the NGOs and the Government.

• To organize environmentally sound consumption campaigns targeted at specific product groups.

7.6. Public awareness

The public is primarily made aware of global climate change through mass media (television, radio, newspapers, etc.). A number of articles have been published in daily newspapers and professional periodicals. Numerous leaflets, booklets, funding projects, etc have been published. Also special conferences, workshops, etc have been held for the public to increase their awareness. Of course the co-operation with the Ministry of Environment & NGOs, work with communities, journalists, etc. help to give better results. This is how the Ministry of Environment is rising people's awareness also in global warming issues. The results can be read from newspapers, e-mail lists, Ministry of Environment homepage, etc.

The Internet plays a very important role, because much information can be obtained there. New books, conferences, environmental NGOs, nature clubs, EME, universities, etc. - everything can be found there. Estonians have good access in the Internet. For example 80% of the inhabitants of Suure-Jaani, small town in southern Estonia, have access to the Internet from schools, libraries, Internet cafes, etc. Because of good Internet access environmental campaigns, training, etc. can be made also via the Internet. There are several e-mail lists on the environmental subject. For instance *Loodus ja Aeg* (Nature and Time) gives a good information about resent articles, MoE work, environmental policy laws, conferences, new books, etc. To become a member of this kind of list is free of charge and usually available for anyone who is interested.

Estonian Academy of Sciences, Estonian universities, research institutes and scientific societies organise regularly workshops and seminars to discuss different aspects of global warming and possibilities to mitigate negative consequences.

THE ESTONIA'S THIRD NATIONAL COMMUNICATION UNDER THE UNITED NATION'S FRAMEWORK CONVENTION ON CLIMATE CHANGE HAS BEEN PREPARED BY THE TEAM OF THE ESTONIAN INTERMINISTERIAL COMMISSION OF THE UNFCCC AND OF EXPERTS:

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