State of Environment in Estonia

on the threshold of XXI century

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ESTONIAN ENVIRONMENT INFORMATION CENTRE

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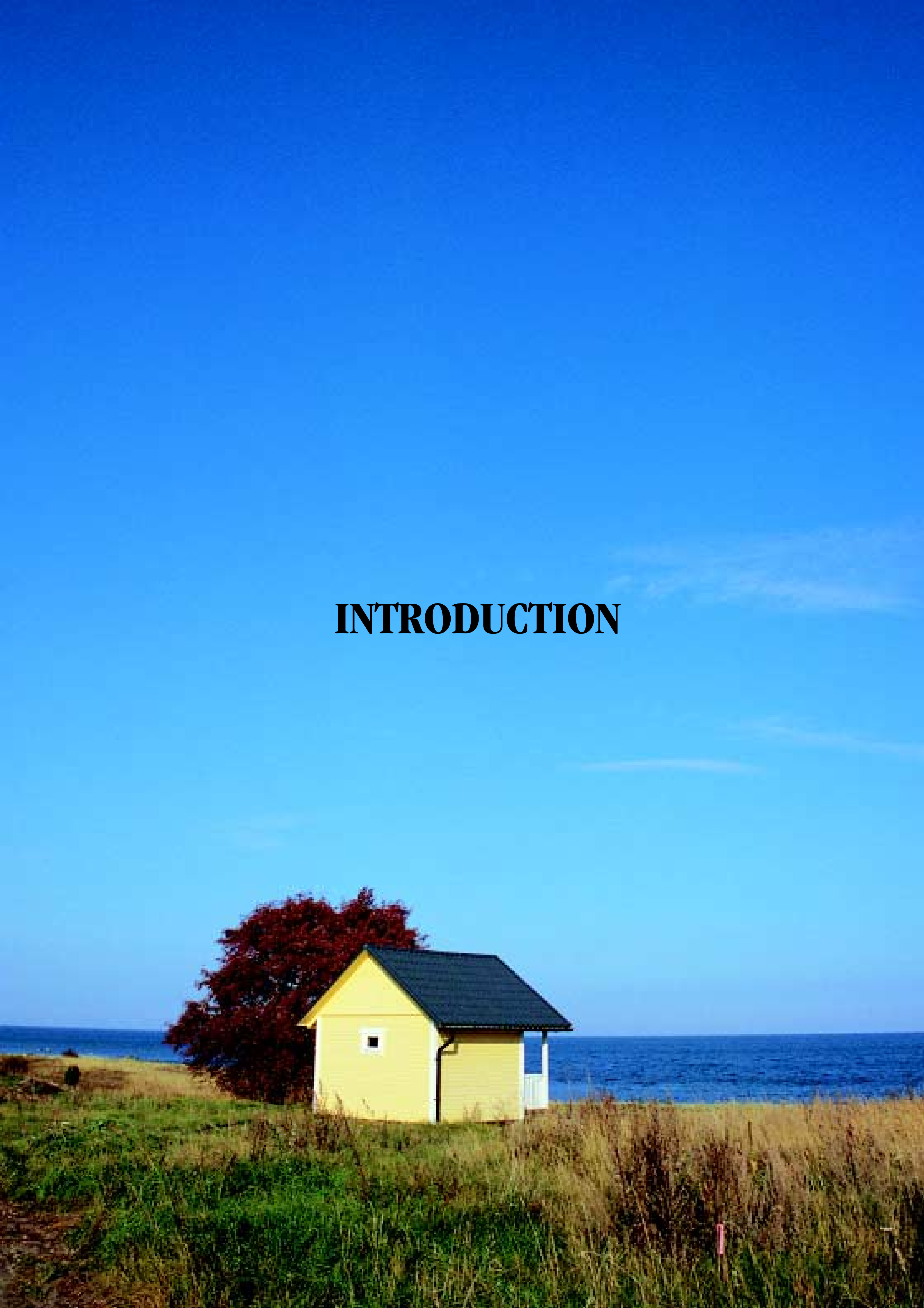
INTRODUCTION



1. Introduction

Andrus Meiner, Leo Saare

1.1 Indicators of Estonian development

Historically and naturally Estonia has always been a border area between North and South as well as East and West. Among 41 European countries, Estonia is holding 28th position by area, 35th position by population and 29th position by annual gross product per person (World Statistics…, 1998). Despite Estonian population has constantly decreased during last decade for several reasons, re-structuring of economy and return of assets as well as privatization have changed the Estonian society completely. Appearance of an owner, abandoning of inefficient technologies and general decrease of production volume have created favorable conditions for the reduction of environmental pollution. At the same time investments into environmental protection, paid by Estonia itself as well as through foreign aid, have increased. In result of these processes there are clear signs of the improvement of environmental condition. However also new negative developments have occurred: increase of the number of vehicles has brought along worsening of the quality of atmospheric air in larger cities, poor condition of rural economy is accompanied with disappearing of open landscapes and valuable preserved associations located on them, forgotten parcels of former large amelioration turn into swamped scrubs.

Table 1.1 Basic indicators of Estonia in 1999.
Source: Bank of Estonia, Statistical Office

Area, km^2		45 227
Population, th. people		1 439.2
GDP* *per capita* in USD**		3547
Changes in 1993 - 1999, %	GDP*	71.3
	Population	- 4.7
	Change of GDP compared to the previous year, average of the period***	3.4

* GDP – gross domestic production in current prices
** Average exchange rate of the Estonian kroon in 1999 EEK/USD = 14.695
*** The observed period is 1994-1999

Photo 1.1 In the turn of the century contrasts are still characterizing Estonian environment.

1.2. Basics of data capture and international responsibilities

In case of environmental data these are usually divided into three main groups: data of environmental pollution, state of environment and use of natural resources. Thereby distinctions are drawn between environmental data and environmental information, which, compared to data, is nowadays treated much more widely (EU Directive 90/313). Information in its turn is a part of environmental knowledge, which is not treated in this issue.

1.2.1. Data of environmental pollution

Collection of data of environmental pollution in the present method is as old as re-independent Republic of Estonia. Start was made with templates of data collection having preserved as heritage from the Soviet time, from which data collection forms, databases, processing programmes and data output corresponding to the conditions and needs of Estonia were developed. Three main data groups have been developed in environmental pollution accounting: use of water (water extraction and wastewater discharge, including the accounting of treatment plants), emissions from point sources of air pollution and waste treatment (including landfills). The basis for assembling of all those data is the data inquiry form filled in by the companies, which is sent quarterly to environmental services of counties and which is sent annually after primary control to the Environmental Information Center of the Ministry of Environment (EIC). In the latter institution data of all counties are assembled and is compiled after additional control of data in to public report of pollution emitted into environment, which is published in the second quarter of the year following the reporting year.

The collected data of environmental pollution are stored in data files established according to the law: data of water use in National Water Cadastre, data of air pollution in the Register of Air Pollution Sources, data of waste treatment in National Waste Register. On the basis of data of environmental pollution collected in such way also implementation of reporting responsibilities of Estonia on international level takes place, where the basis for submission of data are: HELCOM convention; Convention of Transboundary Pollution; UN Framework Convention of Climate Change and its Kyoto Protocol; Vienna Convention of Ozone Decomposing Substances and its Montreal Protocol and Basel Convention of Hazardous Waste. Data must be submitted also to the European Environmental Agency and Eurostat as well as on the basis of bilateral Estonian-Finnish and Estonian-Russian agreements. When Estonia will join the European Environmental Agency and especially the European Union, rapid increase of transmission of the data of environmental pollution can be expected, as only the directive standardizing environmental reporting (91/692EEC) specifies reporting responsibility for the control of implementation of more than 20 EU directives.

1.2.2. Data on the state of environment

Information of population about the state of environment has nowadays become a natural responsibility of the state. Although data of state of environment were collected systematically also earlier, an important milestone was the launching of the national programme of environmental monitoring in 1994 and enactment of the Law of Environmental Monitoring (RT I 1999, 10, 154) in 1999. Environmental monitoring programme financed from State Budget set the basis for systematic collection of data about the Estonian environment and its condition, which offered the possibility for establishment of national data bases and international transmission of data to the European Environmental Agency as well as implementation of international agreements. As examples we can mention data of water monitoring into the network of EUROWATERNET, data of air quality into the network of EMEP, data of forest monitoring into the network of monitoring of transboundary transmission of air pollution, data of coastal sea monitoring to HELCOM etc. Also the legal acts of the European Union, which are currently being implemented, require publication and transmission of different data on state of environment. However, the overview of environmental condition in Estonian language, meant mainly for internal consumer, should be considered extremely important. Such publication is already existing in the form of website, but it would be necessary, somewhat simplified, also in printed form. As the data of environmental monitoring are very diverse, they have been assembled into several data bases. According to the Law of Environmental Monitoring consolidation of these data has been planned in the environmental register to be established.

1.2.3 Data of the use of natural resources

Keeping an inventory of mineral resources, growing forest, water or fish resources must be as natural for a country as accounting of any other public property. Inventories of particular natural resources will still have relatively different practice. So the State Register of Mineral Resources has been established for the accounting of mineral resources and the balance of mineral resources is compiled on its basis. Data of growing forest is created during the forest stock inventory and accounting of forest use and they are entered into the State Forest Register until the establishment of common environmental register. Accounting of surface and groundwater resources in the State Water Cadastre takes place through its use and has been organized by water abstraction sites. Accounting of fish resources in its turn is taking place through fishing equipment and catch yields of fishing regions. However, at the compilation of environmental overview the data of the use of natural resources have the character of background data. Therefore in this publication less attention has been paid on data of the use of natural resources, compared with the data of environmental pollution and state of environment.

Photo 1.2. The presumption for sustainable use of natural resources is the existence of as much as possible complete database of these resources.

Table 1.2. Selection of national and international legal acts establishing the collection of environmental data.

Division of environmental data	Legal act
Organization of the right of use of a natural resource, research permit, national programme or accounting over natural resources, kept on the basis of international agreements: - Mineral resources - Forest resources - Waterbodies, groundwater resources - Fish resources - Game resources	 Earth Crust Act §7 Forest Act §39 Water Act §36 Fisheries Act §18, Gdansk Convention
Accounting of protected natural objects	Act on Protected Natural Objects §26
Accounting of areas with restrictions	Act on the Protection of Marine and Freshwater Coasts, Shores and Banks Forest Act §31 Animals Protection and Use Act, §13, §14 Planning and Construction Act §8
Accounting of individuals of species involved in internationally regulated transactions with them	Animals Protection and Use Act §6 Washington Convention (CITES)
Accounting of animal collections including protected species and hunting trophies	Animals Protection and Use Act §6 Bern Convention Bonn Convention
Accounting kept on the basis of the permits to release pollutants into environment: - Air pollution sources - Water abstraction, water use, wastewater and treatment plants	 Ambient Air Protection Act §21 Water Act §36
Data collected through the National Environmental Monitoring Programme: - Air - Sea, surface water, groundwater - Forest, soil, landscape, species and associations	Sustainable Development Act §9 Environmental Monitoring Act §6, §7 Water Act §37 Protected Natural Objects Act §25
Accounting kept on the basis of the permit to store waste in the environment	Waste Act §46
Accounting kept through the package information system	Packaging Act §15

1.3. Access to environmental information

1.3.1. Cycle of environmental data

Access to environmental data and more widely to environmental information is one of basic rights of a citizen in modern sense. In order to guarantee that and apply §44 of the Constitution, the Public Information Act has been adopted, which several articles organize also access to environmental information. The Minister of the Environment has undersigned the so-called Aarhus Convention on access to information, public participation in decision making and access to justice in environmental matters, which ratification is supported by the foreign aid project initiated in the Ministry of the Environment. Great attention should also be paid on the adoption of the European Environmental Information Directive (90/313/EEC), implementation of which particular provisions will be guaranteed in Estonia with different legal acts (in addition to the above mentioned, also the Environmental Monitoring Act, bill of the Environmental Register Act).

Environmental data are the first link of the process at making environmental decisions. Through controlling, systematization and interpretation of data the next achieved stage would be environmental information, which includes any written, visual, oral or data base form on the state of water, air, soil, fauna, vegetation, land and natural sites as well as activities (incl. those which give rise to nuisances such as noise) or measures which have negative influence or probably affect them. Also any information of activities or measures, which are aimed to protect them, including administrative measures and environmental management programmes. Environmental information, in its turn, is a part of environmental knowledge, which will be formed through the acquirement of environmental information and application into activity framework of the user, which is immediately preceding the making of decision (figure 1.1).

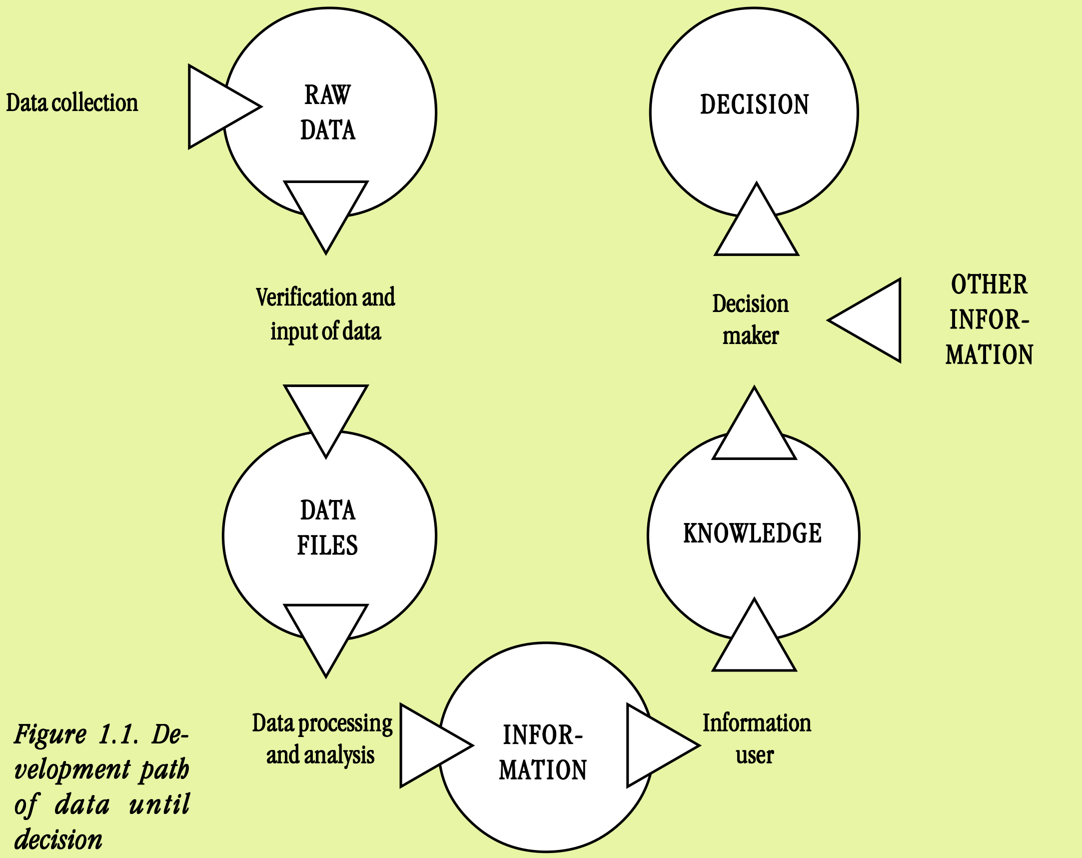


Figure 1.1. Development path of data until decision

Essential change in the management of environmental data has been planned in connection with the foundation of environmental register on the basis of corresponding legal act. The bill of environmental register specifies consolidation of national environmental registers and other data collections for better connection of data in time and space. As entry of data into register can take place only on the basis of a legal act or decision of a person fulfilling official duties, data entered into the register will acquire legal meaning, which in its turn will enable in public operations and international data exchange to demand only the use of data entered into the environmental register and thus, controlled. Upon the entry into the environmental register also spatial preciseness and extent of data will be specified, which will enable application of modern geoinformation tools in the processing of environmental data. Sub-divisions of the environmental register treat natural resources, natural objects, biological and natural environmental factors, environmental condition and waste (table 1.3).

Table 1.3. Data composition of environmental register.

Subdivision of environmental register	Group of register objects
Natural resources	Mineral resources: deposit Growing forest: forest management unit Groundwater: groundwater abstraction site Waterbodies: waterbody Surface water: surface water abstraction site Fish resources: fishing region, inland or boundary waterbody
Natural objects	Protected natural object Coast and shore Valuable habitat Partially protected area (e.g. bird areas with international importance) Area designated for reduction of hazardous anthropogenic impact Recreation area
Biological environmental factors	Genetically modified organisms Imported foreign species Animal collections Species covered with internationally regulated transactions (CITES)
Natural environmental factors	Areas endangered by natural factors
State of environment	Data on state of environment Spoiled and hazardous area
Waste	Waste data Waste treatment site Radioactive waste

Photo 1.3. Basis for functioning of environmental register is sufficiently rapid and correct data exchange between collectors, keepers, processors and users of data.

1.3.2. Dissemination of environmental data

Development of environmental data until decision can be observed also in the cause-effect context. The system of environmental indicators, used by the European Environmental Agency, is based on such methodology. According to the so-called DPSIR model (EEA, 1999), different environmental indicators are divided into five basic groups, which are shown on figure 1.2.

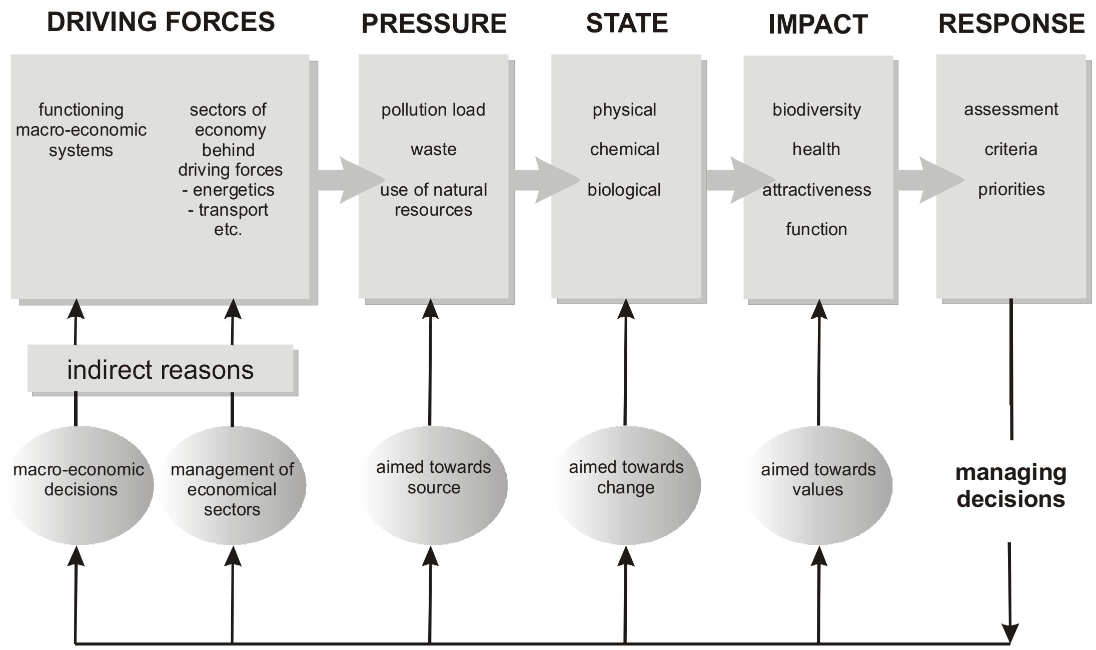


Figure 1.2. Treatment of environmental data on the basis of DPSIR model (amended UNEP/RIVM, 1999).

The state of environment report of Estonia is also using that model, however, still not treating the group of indicators of driving forces for the purposes of simplicity (http://nfp-ee.eionet.eu.int/SoE/index.html). Development of environmental indicators started already in the beginning of 1990s driven by the demand of the Organization of Economic Cooperation and Development (OECD) to create methods for determination of efficiency of measures of environmental protection. By now sets of indicators have already developed for very different purposes. Beside traditional lists of indicators, meant for the compilation of general environmental overview, the so-called sector indicators can be found in bibliography, where indicators of one branch of economy have been presented together with indicators of environmental impact of that branch of economy (e.g. transport). Maximally aggregated so-called headline indicators of environment have been developed in order to describe the most general environmental trends. More thorough binding of environmental indicators with economic and social indicators will be executed in the form of the so-called indicators of sustainable development. In conclusion it could be said that presentation of environmental data based on indicators is becoming a standard in international practice.

Beside sets of environmental indicators formed through well-considered selection of parameters, treatment of environmental data as spatial data is becoming increasingly more essential. As it is difficult, in the field of environment, to imagine anything without spatial dimension, which therefore could not be depicted on a map, the application of principles of spatial data management and geographical information systems has become inseparable part of processing, integration and especially analysis of environmental data.

Developing information technology is setting new requirements also for the process of information dissemination and information products. Publications based on indicators and the use of spatial data can nowadays exist in the form of traditional printed matter as well as internet website. Public data network enables to start also modernization process of information dissemination. Passive information output, where the request for information is satisfied after its submission, will get beside itself active information dissemination, where main principle is studying of the needs of a potential consumer and adjusting the presented information to the public interest.

AIR

2. Atmospheric Air

Natalja Kohv, Valentina Laius, Siiri Liiv, Ott Roots, Reet Talkop

2.1. Introduction

Estonian National Environmental Strategy (NES) proceeds from the main traditional goal of environmental protection which is to provide people with a healthy environment and natural resources necessary to promote economic development without causing significant damage to nature, to preserve diversity of landscapes and biodiversity while taking into account the level of economic development.

Estonian air pollution problems on regional level are connected with North-East Estonia, as the peculiarity of Estonian industry of energy production and chemistry is oil shale based production. On global level Estonian air pollution problems are connected with islands of South Estonia and West Estonia, to where air pollution is carried from Middle and West Europe through long-range transportation of air pollution.

Air pollution is causing several problems, more important of which are following:

1. Climate change (caused by greenhouse gases).
2. Acidification and eutrophication (substances causing acidification and eutrophication).
3. Problems caused by transboundary pollution of hazardous/toxic compounds (caused by heavy metals and persistent organic compounds).

Proceeding of the above mentioned, also this chapter has been compiled.

In order to get overview of the condition of air environment in Estonia, monitoring system for the whole republic should be developed simultaneously with measurement of local air pollution emissions from point sources as well as from transport, which would give constantly overview of the effect of air pollution (critical loads) on living nature (figure 2.1). At the same time condition in neighboring countries should be observed, taking account of the impact of air pollution over borders. Thereby, regional is connected with global in the evaluation process of the whole air environment.

Estonia is participating in programmes of the European Environmental Agency, UN/European Economic Committee, Helsinki Commission etc., in order to get better overview about internal environmental condition and monitor the condition of air environment in Europe as well as in global extent.

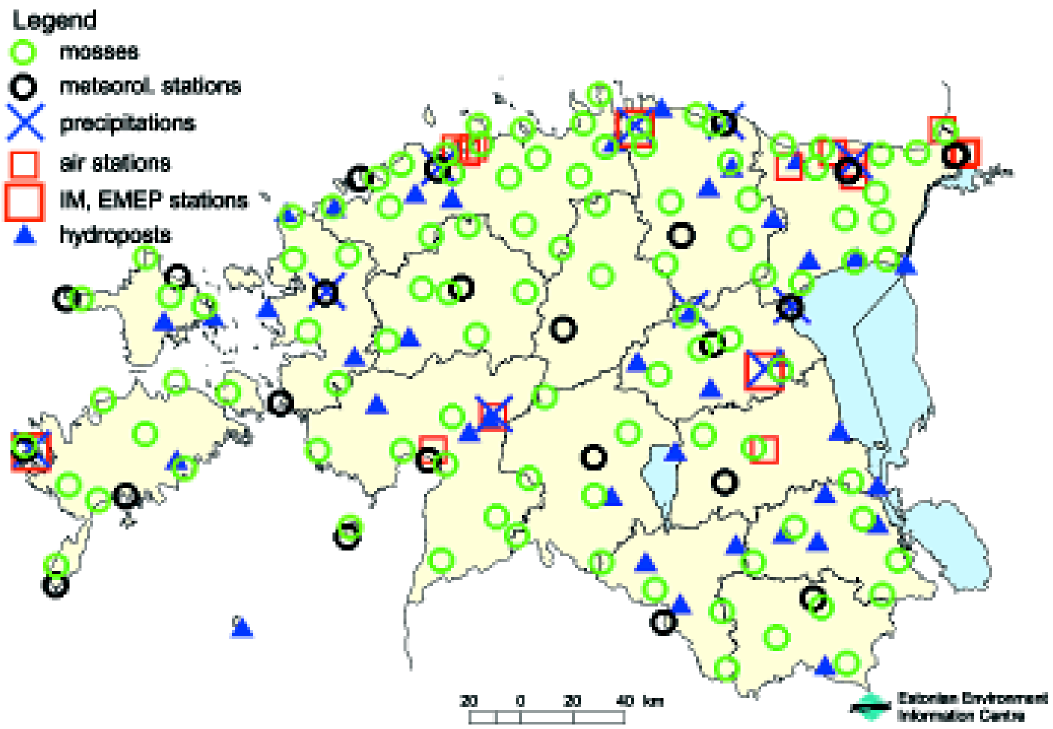


Figure 2.1. Air monitoring stations of state environmental monitoring programme in 1998.

2.2. Pollution load

2.2.1. Emissions of main pollutants in Estonia

In 1999 emissions from stationary sources in Estonia were: 94.6 thousand tons of sulphur dioxide; 14.5 thousand tons of nitrogen dioxide; 20.9 thousand tons of carbon oxide and 5 thousand tons of volatile organic compounds (table 2.1).

Table 2.1. Distribution of emissions from stationary sources in 1999 by counties (tons).

	Solid	SO_2	NO_x	CO	Volatile	Other
Estonia	70463	94603	14456	20926	5048	1610
Harju County	1503	5587	1653	1172	1899	96
Hiiu County	21	16	12	83	25	0
Ida-Viru County	38210	42528	5581	8466	823	1358
Kohtla-Järve town	1055	11009	693	517	793	105
Narva town	24765	27798	3404	320	76	5
Jõgeva County	155	146	62	214	0	0
Järva County	133	677	115	537	0	0
Lääne County	71	455	64	328	0	0
Lääne-Viru County	834	623	722	1399	54	3
Põlva County	50	139	46	312	0	2
Pärnu County	1514	610	240	790	0	1
Pärnu town	277	646	206	1129	204	1
Rapla County	93	357	88	355	0	0
Saare County	154	676	64	372	172	8
Tallinn town	463	1987	842	1420	688	26
Tartu County	365	255	180	494	81	0
Tartu town	379	71	192	883	146	6
Valga County	47	174	74	506	0	0
Viljandi County	72	482	108	717	0	0
Võru County	301	367	108	911	88	0

Photo 2.1. Biggest point-polluters of air in Estonia are large power plants.

2.2.2. Main pollution sources

Main polluters emitting SO_2 and solid particles – 87.9% and 94.5% correspondingly – were companies of energetics, heat production and oil shale chemistry in Ida-Virumaa County (tables 2.2, 2.3 and figures 2.2, 2.3). Percentage of emissions of solid particles from Kunda-Nordic Tsement Ltd in 1999 was only 0.7%, due to the renovation of dust filters in recent years. Other pollution sources are small boiler houses, companies of construction materials and wood processing. The figure 2.4 shows distribution of Estonian air polluting companies by branch of industry. Emissions of sulphur dioxide per person were, according to data of the year 1998, the highest in Ida-Virumaa County and formed average of 69.6 kg in Estonia (1996 – 79.8 kg). Other countries: Sweden – 8.8; Finland – 20.5; Germany – 18.8; Latvia – 23.7; Lithuania – 25.1; only Czech Republic had higher figure, 91.7 (data of 1996). Figures 2.5-2.9, which show distribution of emission of pollutants by regions, confirm that the highest pollution load is in Ida-Virumaa.

Table and Figure 2.2. Main companies, polluting air with solid particles (th. t).

	1996	1997	1998	1999	%
Baltic TPP*	38.9	35.7	29.5	24.7	37.01
Estonian TPP	34.4	30	29.7	35.8	53.65
Other pollution sources:					
Kunda-N. Cement Ltd	14.1	2.4	1.3	0.5	0.75
Silmet Grupp Ltd	1.2	1	0.5	0.8	1.20
Ahtme TPP	0.8	0.9	1	0.6	0.90
Viru Keemia Grupp Ltd, part of Kiviõli	0.7	0.5	0.6	0.2	0.30
Kohtla-Järve TPP	0.3	0.3	0.2	0.2	0.30
Viru Keemia Grupp Ltd	0.1	0.1	0.1	0.03	0.04
Small pollution sources	*8.4*	*7.3*	*7*	*3.9*	*5.84*

* Thermal Power Plant

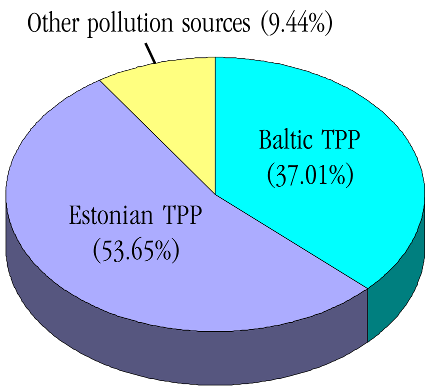
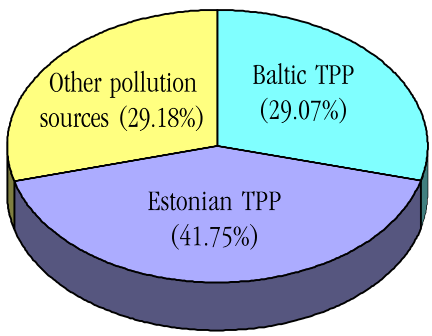


Table and Figure 2.3. Main companies, polluting air with SO_2 (th. t).

	1996	1997	1998	1999	%
Baltic TPP	40.6	36.5	31.8	27.5	29.07
Estonian TPP	37.7	38.1	35.6	39.5	41.75
Other pollution sources:					
Viru Keemia Grupp Ltd	4.6	4.5	3.1	4.6	4.86
Kohtla-Järve TPP	4.4	3.1	3.8	3.4	3.59
Ahtme TPP	3.4	4.3	4.8	3	3.17
Iru TPP	2.7	3.4	3.5	3.2	3.38
Kunda-N. Cement Ltd	2.6	2.2	0.3	0.3	0.32
Viru Keemia Grupp Ltd, part of Kiviõli	2.3	2.8	2.1	0.2	0.21
Silmet Grupp Ltd	1.7	1.6	1.6	1.4	1.48
Small pollution sources	*17.2*	*14.5*	*14.3*	*11.5*	*12.16*



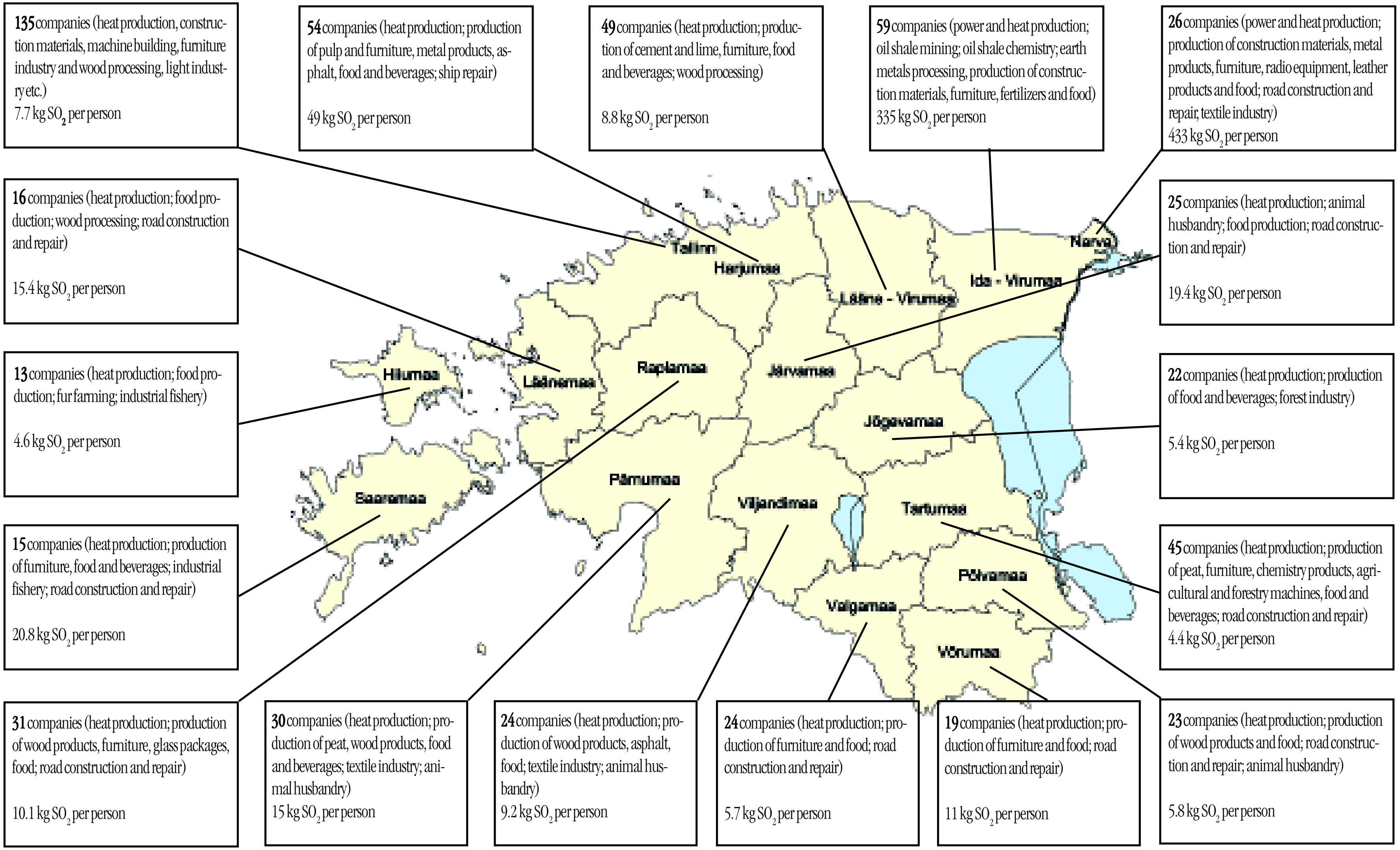
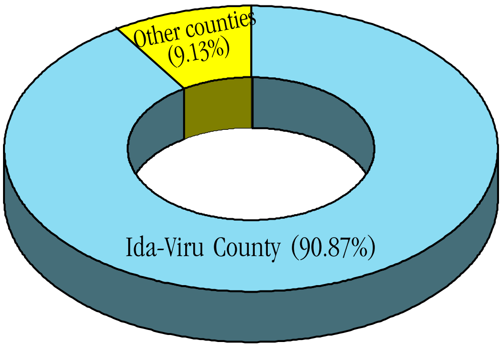
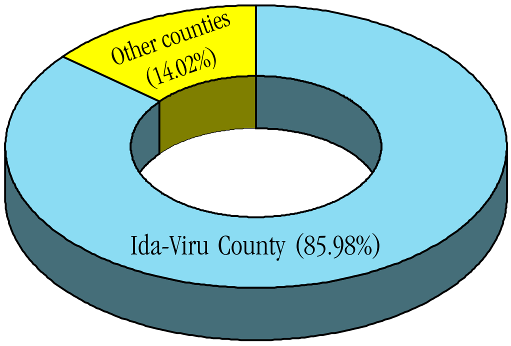


Figure 2.4. Distribution of Estonian air polluting companies by branch of industry and SO_2 emissions per person.

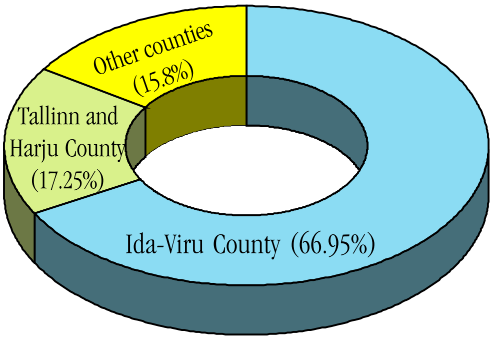
Solid particles



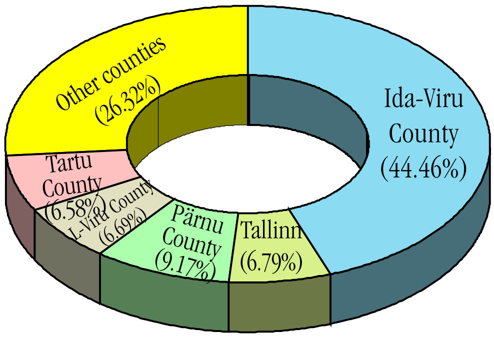
Sulphur dioxide



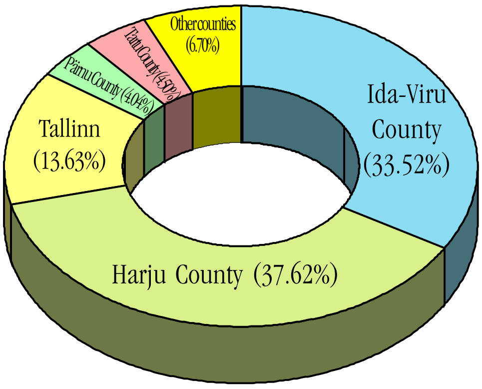
Nitrogen dioxide



Carbon oxide



Volatile organic pollutants



Figures 2.5-2.9. Distribution of emissions from stationary sources in 1999 by regions.

Main companies in Estonia, polluting air with volatile organic pollutants, are: oil shale chemistry industry, furniture and fish industry and oil terminals (table 2.4, figure 2.10). Figure 2.10 shows distribution of emissions of volatile organic pollutants by branches of economy in 1998. Emissions from fuel combustion have been accounted according to Estonian energy balance given in regulation "Procedure and Methods for Determining Emissions of pollutants from combustion plants into ambient air".

Main companies polluting air with carbon oxide are given in table 2.5 and figure 2.11. Most of CO is emitted from small boiler houses, which use mainly shale oil, coal, peat, wood and wood waste, whereby the greatest part of CO is produced from peat and wood.

Reduction of SO_2 amounts emitted into air by 6.2 tons compared to the year 1998 is connected mainly with the decrease of the amount of oil shale burnt in the Baltic Power Station by 14.8%. At the same time emissions of SO_2 and solid particles increased in Ida-Virumaa, as production of electric energy increased and calculation methodology changed in the Estonian Power Station and untreated generator gas is currently being burnt in the boiler of Viru Keemia Group Ltd.

Table 2.4. Main companies polluting air with volatile organic pollutants (th. t).

	1996	1997	1998	1999	%
Viru Keemia Grupp Ltd	2.5	2.5	1.6	0.8	16
Pak-terminal Ltd[1]	0.2	1	0.8	1.2	24
Estonian TPP (ETPP)[2]	0.3	0.3	0.2	0.6	12
Other pollution sources:					
Neste Ltd,					
Tallinn Terminal[1]	0.5	0.4	0.3	0.2	4
Viru Keemia Grupp Ltd,					
part of Kiviõli	0.4	0.3	0.3	0.2	4
Termoil Ltd[1]	0.1	0.01	0.1	0.2	4
Loksa Laevatehas Ltd	0.1	0.1	0.1	0.1	2
Masekonord Ltd[3]	0.3	0.2	0.1	0.1	2
Wermo Ltd[4]	0.01	0.1	0.1	0.1	2
Small pollution sources	*1.2*	*1.4*	*2.1*	*1.5*	*30*

[1] operation of oil terminals, all in Harjumaa
[2] oil shale processing
[3] fish and fish products processing
[4] furniture production

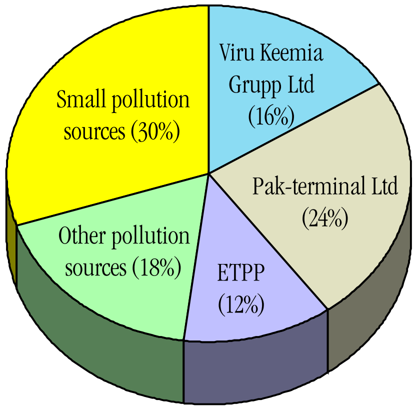


Figure 2.10. Distribution of emissions of volatile organic pollutants by branches of economy in 1998.

Table 2.5. Main companies polluting air with carbon oxide (th. t).

	1996	1997	1998	1999	%
Estonian TPP (ETPP)	8.8	7	6.5	5.6	26.79
Other pollution sources:					
Estonia mine Ltd		1.2	1	1	4.78
Võru Soojus Ltd	0.5	0.5	0.6	0.6	2.87
Kunda-N. Cement Ltd			0.7	0.6	2.87
Tootsi turvas Ltd	0.5	0.5	0.5	0.5	2.39
Silmet Grupp Ltd	0.9	0.9	0.9	0.5	2.39
Repo Industries Ltd	0.4	0.5	0.5	0.4	1.91
Kunda Elamu Ltd	0.5	0.7	0.6	0.4	1.91
Viisnurk Ltd	0.4	0.4	0.4	0.4	1.91
Small pollution sources	*17.4*	*15*	*15*	*10.9*	*52.15*

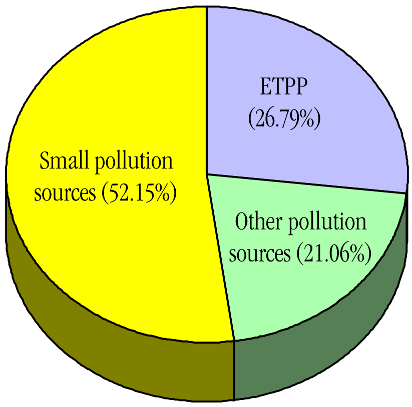


Figure 2.11. Main companies polluting air with carbon oxide

2.2.3. Emissions of pollutants in transport

Great part of Estonian environmental problems is arising from transport. Table 2.6 shows corresponding calculated emissions. Due to the increase of the number of cars, trucks and special vehicles emissions have also increased in 1992-1998 (figure 2.12). Only the emission of lead decreased in the mentioned period. Percentage of lead-containing petrol was 10% in 1998. Most of SO_2 is emitted from stationary pollution sources, at the same time, when volatile organic compounds, NO_x and CO are emitted mainly from transport (figure 2.13).

Table 2.6. Emissions from transport, th. tons per year.

	1992	1993	1994	1995	1996	1997	1998
CO	175.3	182.4	209.3	215.1	238.3	256.1	254.3
Volatile	34.4	35.9	39.9	41	44.6	47.6	48
NO_X	24.5	26	26.5	27.2	28.1	29.2	31.1
SO_2	8.2	8.7	8.1	8.3	8	8	9.2
Pb, tons	58.2	52.8	55.8	39.6	30.3	21.9	10.6
Cars	283.4	317.4	337.8	383.4	406.6	427.7	451
Trucks and special vehicles	74.6	74.1	53.7	65.6	71.3	76.6	80.6
Buses	8.4	8.7	6.3	7	6.7	6.5	6.3

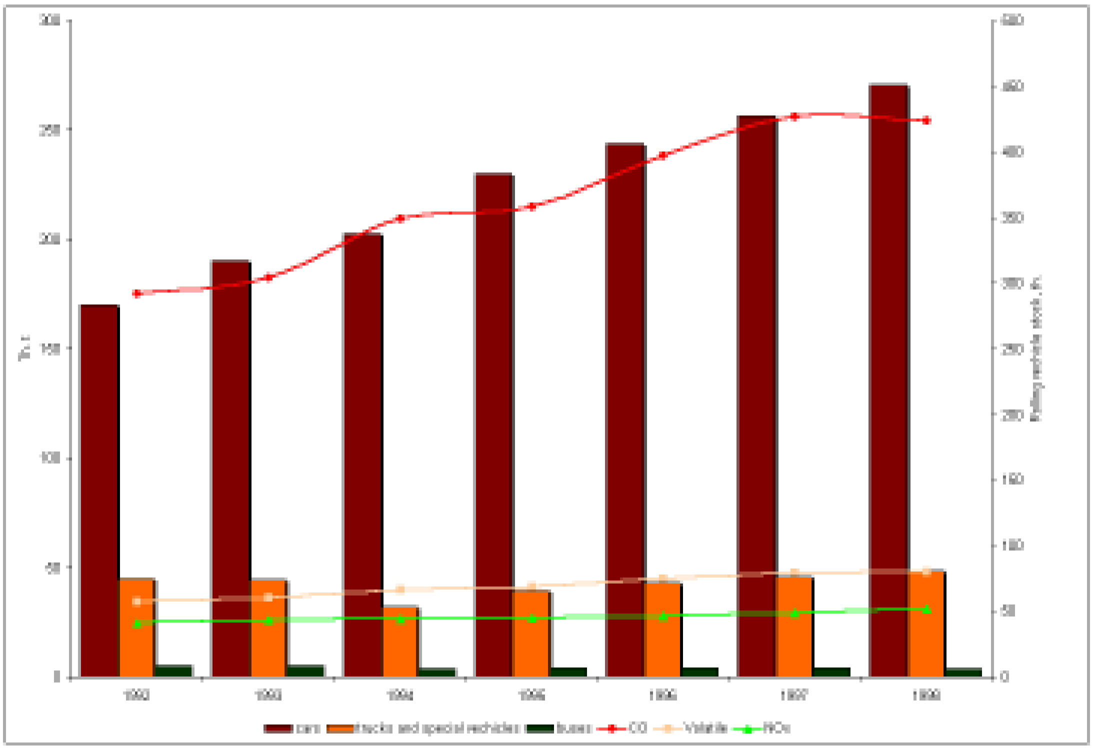


Figure 2.12. Emissions from transport and rolling vehicle stock 1992-1998.

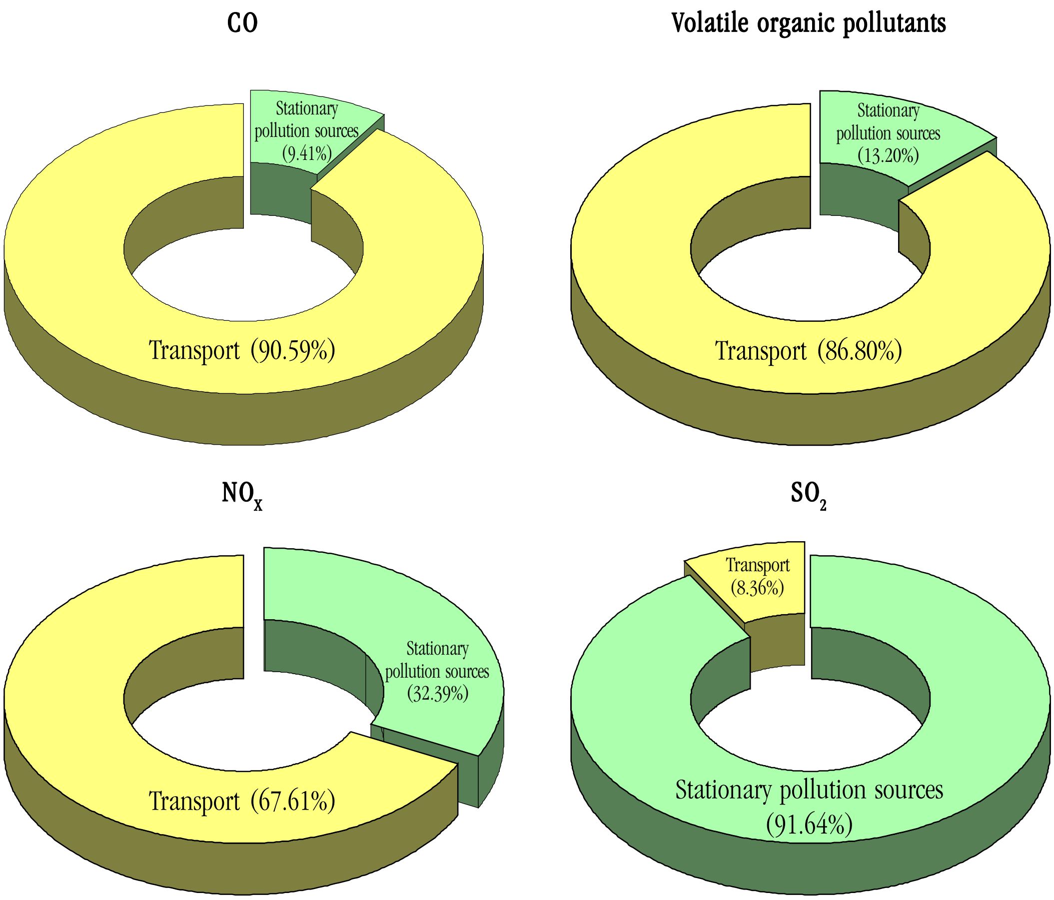


Figure 2.13. Distribution of emissions between transport and stationary pollution sources in 1998.

Photo 2.2. Cars pollute the air in Estonia much more than stationary pollution sources.

2.3. Climate change

2.3.1. Greenhouse gases (GHG) emissions in Estonia

In last century the content of greenhouse gases in atmosphere has increased in result of human activities, which increases also natural greenhouse effect, leads to warming of external surface of the Earth and its atmosphere and may damage natural ecological systems and mankind. In 1990 UN Framework Convention on Climate Change (UNFCCC) was concluded, which was ratified by Estonia in 1994. Main goal of the convention is to stabilize the emission level of greenhouse gases by the year 2000 to the same level, where it was in 1990. In 1998 Estonia joined the protocol undersigned at Kyoto conference, according to which emissions of greenhouse gases must be reduced in 2008-2012 by ca 8%, compared to the year 1990. By now 22 countries have ratified the Kyoto protocol; Estonia is planning ratification in 2001/2002.

Main social-economic factors of climate change are use of energy, agriculture, waste management and industrial activities, whereby energetics is the main factor. Estonian power supply is basing in extent of 72% on local fuel (oil shale, peat, wood), whereby the percentage of oil shale is 52% (1998). Oil shale is used in power stations (ca 98% of the whole electric energy production is basing on oil shale), for the production of shale oil and in cement industry. Production capacity has changed according to the demand of power stations and oil shale processing industry. When in 1990 the production of oil shale amounted to 22.5 million tons, it was only 12.5 million tons in 1998.

Emissions of greenhouse gases have been calculated by the Institute of Ecology according to IPCC (Intergovernmental Panel Climate Change) methodology (table 2.7 and figure 2.14).

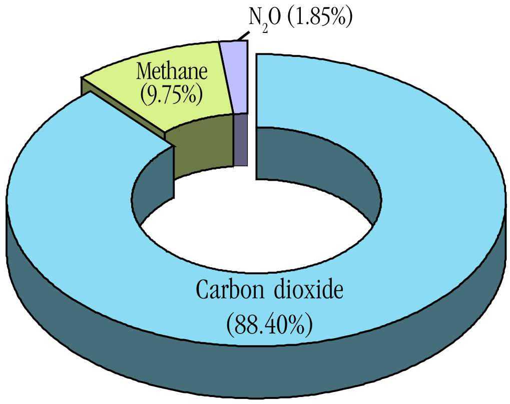


Figure 2.14. Distribution of emissions of greenhouse gases in 1998.

Table 2.7. Changes of emissions of greenhouse gases in Estonia, Gg (1990-1998).

Source and categories of greenhouse gas	1990	1991	1992	1993	1994	1995	1996	1997	1998
Carbon dioxide (CO_2)	**36251**	**35189**	**25136**	**19597**	**21527**	**17363**	**18549**	**16865**	**15875**
Energy and transformation	34528	33957	26030	20179	20882	18938	19682	19265	17653
Transport	2656	2386	1423	1607	1786	1700	1534	1097	1236
Industrial processes	613	614	313	193	215	222	206	354	342
Land use change and forestry	-1545	-1767	-2630	-2382	-1355	-3496	-2874	-3851	-3356
Methane (CH_4)	**105.2**	**102.1**	**91.3**	**79.7**	**79.5**	**67.7**	**63.2**	**103.1**	**101**
Fuel mining								12.5	10.9
Fuel distribution								19.3	18.4
Fuel combustion	2.6	2.5	1.9	1.6	1.8	1.7	1.8	2.7	5.5
Agriculture	60.2	60	54.7	47	46.4	34.3	30.2	35.1	30.4
Waste management	42.4	38.6	34.7	31.1	31.3	31.7	31.2	33.4	35.8
A Disposal of solid waste	*26.3*	*26.2*	*25.9*	*25.4*	*25.1*	*24.8*	*24.6*	24.4	24.2
B Wastewater treatment	*16.1*	*12.4*	*8.8*	*5.7*	*6.2*	*6.9*	*6.6*	9	11.6
Nitrous oxide (N_2O)	**2.3**	**2.3**	**1.7**	**1.7**	**1.3**	**1.2**	**1.2**	**1**	1.3
Fuel combustion	1.4	1.4	1	0.9	0.8	0.8	0.8	0.7	0.1
Agriculture	0.9	0.9	0.7	0.5	0.5	0.4	0.4	0.3	1.2

Emissions of GHG in CO_2 equivalent

One main sources of CO_2 is the combustion of fossil fuels. Table 2.8 and figure 2.15 show the supply of primary energy (total amount of produced and imported primary energy, minus export of primary energy), oil shale consumption and CO_2 emissions in 1990-1998. The sector of energetics produces 91.8% of total emission of CO_2, transport – 6.4% and industrial processes only 1.8% (mainly cement production) (figure 2.16).

Table 2.8. Supply of primary energy, oil shale consumption and CO_2 emissions.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Supply of primary energy, TJ	416613	387976	275338	226827	238720	225154	236886	232603	213934
Oil shale consumption, TJ	233861	212494	186568	142062	151742	140840	145331	143730	124714
CO_2 emissions, mill. tons	37.8	37	27.8	22	22.9	20.9	21.4	20.7	19.2

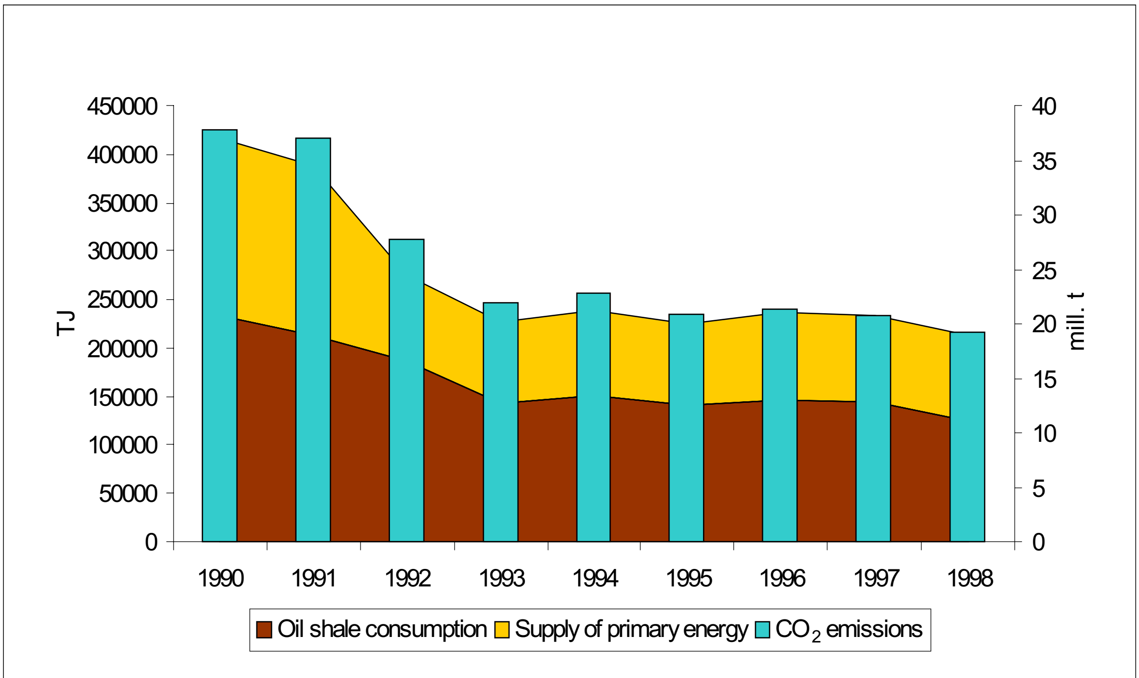


Figure 2.15. Supply of primary energy, oil shale consumption and CO_2 emissions.

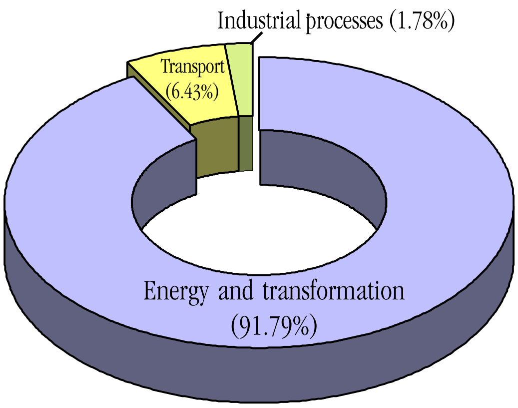


Figure 2.16. Distribution of CO_2 emissions by branches of economy.

Wood and other biological fuels are renewable sources of energy and emissions of CO_2, emitted into atmosphere with their burning, are not included in greenhouse gases, as it does not affect circulation of carbon in the nature. According to the Long-term National Development Plan for Fuel and Energy Sector, increase of the percentage of the use of renewable sources of energy and peat by 2/3 has been planned by the year 2010, compared with the year 1996, when their percentage in supply of primary energy was 9%; by the year 2010 it should increase to 13% (table 2.9).

Table 2.9. Expected change of the need for primary energy, % (Long-term National Development Plan of Fuel and Energy Sector).

	1995	2005	2010
Oil shale	62	52-54	47-50
Peat, wood, renewables	8	11	13
Fuel oils	6	5	4-5
Engine fuels	13	14	14
Natural gas	11	16-18	18-22

More important sources of methane pollution in Estonia are agriculture enteric (fermentation and manure management) and waste management (emission from landfills and wastewater treatment plants), correspondingly 30% and 35.5% in 1998. Emissions of methane from agriculture decreased by 50.3% compared to the level of 1990, which is caused by reduction of the number of cows two times. Methane is emitted also at oil shale mining and distribution of natural gas to the consumer (10.8% and 18.2%), which was first calculated in 1997. Percentage of combustion of fossil fuels in methane emission is 5.4% (figure 2.17).

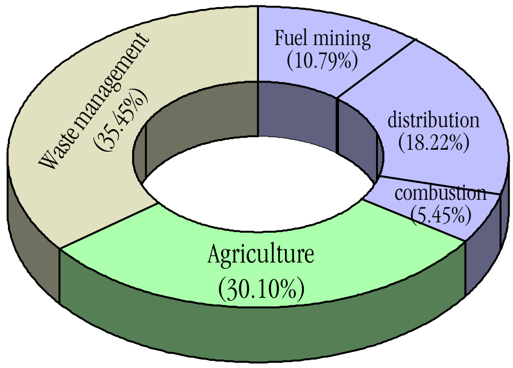


Figure 2.17. Distribution of CH_4 emissions by branches of economy.

The largest pollution source of nitrous oxide (N_2O) is fuel combustion (70%, 1997), including fuel consumption for transformation into other types of energy, in transport and other sectors. Another source of N_2O pollution is agriculture (30%), especially use of fertilizers (figure 2.18). In 1990-1997 the amount of N_2O emitted into air decreased by 56%, mainly due to the decrease of the amount of fossil fuel used for combustion and use of fertilizers in that period.

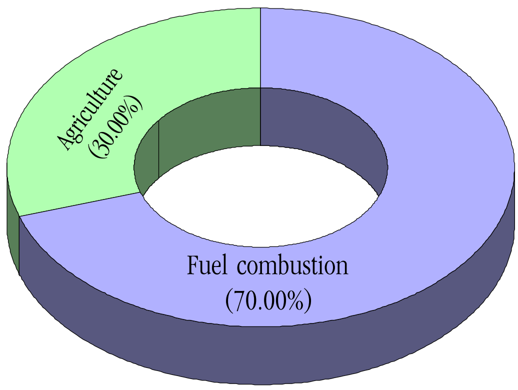


Figure 2.18. Distribution of N_2O emissions by branches of economy.

2.3.2. Implementation of the goal of UN Framework Convention on Climate Change and Kyoto Protocol

Responsibilities of 1997 Kyoto Protocol of UNFCCC have been already fulfilled in Estonia. In the period 1990-1998 the emission of greenhouse gases (CO_2, CH_4 and N_2O) in CO_2 equivalent decreased by 46.6%, which was caused by the reduction of use of fossil fuels as well as the decrease and reformation of industrial and agricultural production (figure 2.19). Figures 2.20 and 2.21 show CO_2 emissions and emissions per person in Baltic countries and member states of the European Union in 1996. When the Estonian amount of CO_2 emitted into ambient air is among the lowest in Europe, the index, calculated per person, is one of the highest – 14.6.

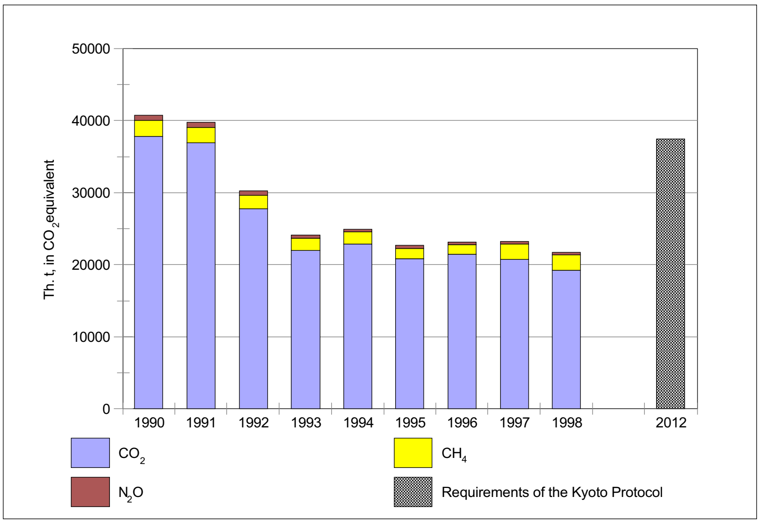


Figure 2.19. Emissions of greenhouse gases in Estonia in 1990-1998 and requirements of the Kyoto Protocol.

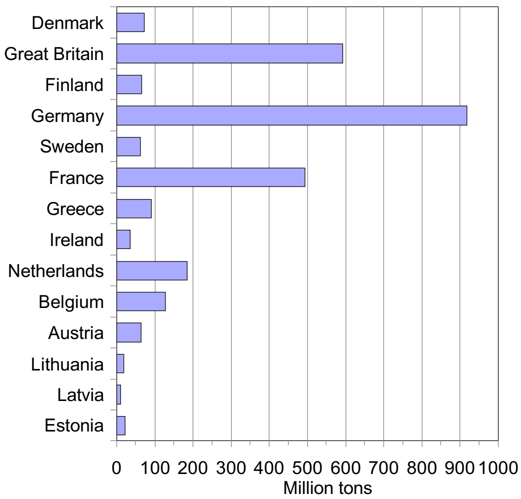


Figure 2.20. Emissions of carbon dioxide in Baltic countries and member states of the European Union in 1996.

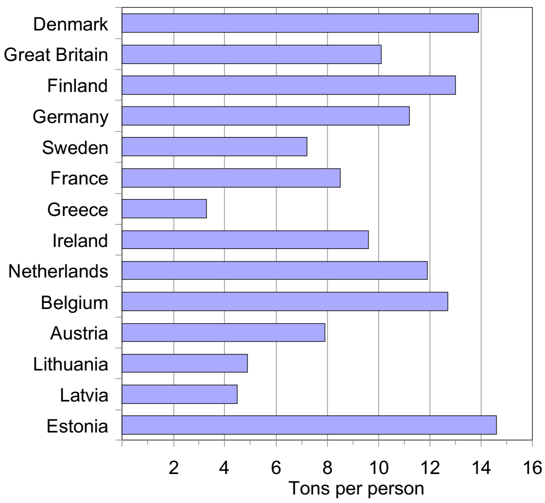


Figure 2.21. Emissions of carbon dioxide per person in Baltic countries and member states of the European Union in 1996.

Estonia has currently no programme for the reduction of emissions of greenhouse gases, but one of the main goals of long-term national development programme of fuel and energy management and goal programme of energy saving is the reduction of environmental impacts:

- to raise the efficiency of energy production and transport, use more environment-friendly fuels and reduce special consumption of energy in all branches of economy and households;
- at the establishment of new power stations, to prefer the principle of distributed electricity production and combined heat and power production;
- to provide higher efficiency in oil shale based energy production with the concurrent and significant reduction of the harmful environmental impact via the renovation of combustion technology.

2.4. Acidification

Main reason for acidification is emission of sulphur and nitrogen compounds (SO_2, NO_x and NH_3) into atmosphere. These compounds will decompose in precipitation and fall back on the earth surface in the form of acid rain. Acid rains damage forests, populations of waterbodies, cultural heritage. Largest pollution sources of sulphur and nitrogen are energy production and industry, although most of nitric oxides are emitted from transport and most of ammonium from agriculture.

In 1990-1998 emissions of SO_2 from stationary pollution sources decreased in Estonia by 61.7% and emissions of NO_x in 1987-1998 by 43% (figures 2.22 and 2.23). Decrease of emissions of sulphur dioxide took place mainly due to the decrease of load of large power stations as well as reduction of amounts of heavy fuel oil used for combustion in boiler houses.

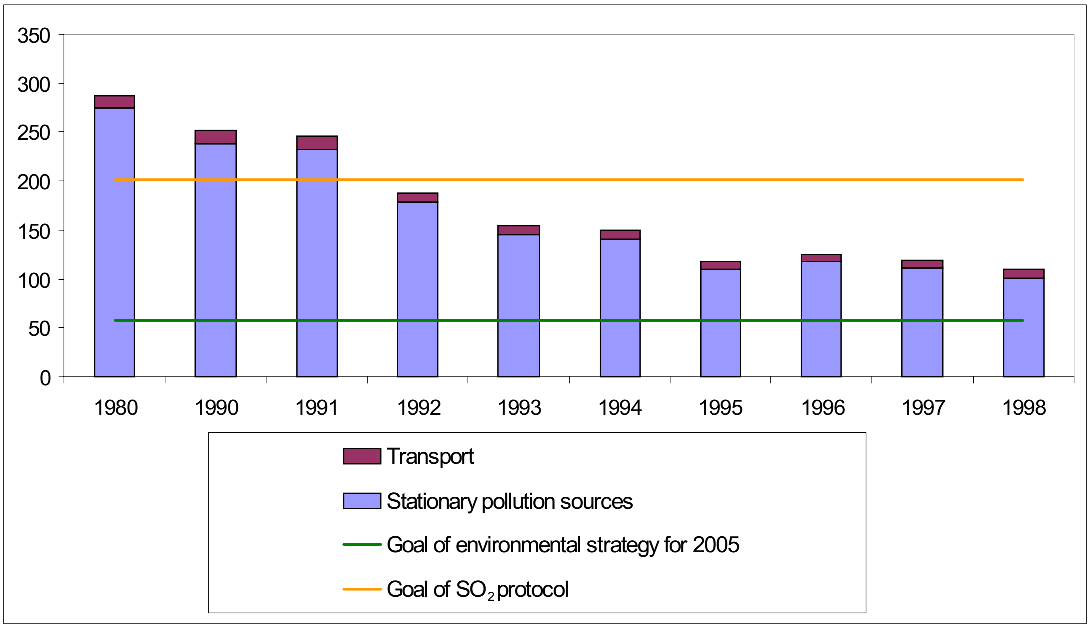


Figure 2.22. SO_2 emissions from stationary pollution sources and transport in 1980-1998, th. tons

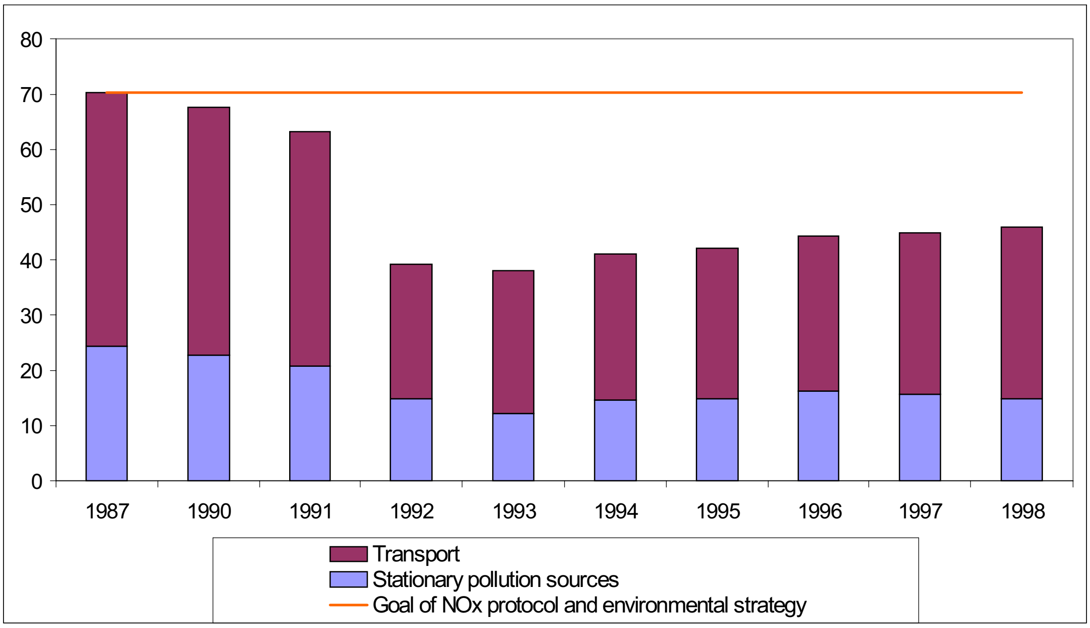


Figure 2.23. NO_x emissions from stationary pollution sources and transport in 1987-1998, th. tons

In 2000 Estonia joined the Convention on Long-Range Transboundary Air Pollution and its three protocols, which concern sulphur, nitrogen oxides and volatile organic compounds. Requirements of all those protocols have already been fulfilled in Estonia (to implement reductions of sulphur emissions or their transboundary fluxes by at least 30% at the latest by 1993 compared to the year 1980 and to stabilize emissions of nitrogen compounds on the level of 1987). Also a bill has been prepared for the joining with the protocol of the cooperative Programme for Monitoring and Evaluation of the Long-Range Transmission of air Pollutants in Europe (EMEP), belonging to the convention. In 2001-2002 it is planned to join the protocol of further reduction of sulphur emissions, belonging to the convention.

Figures 2.24 and 2.25 show territorial distribution of emissions of sulphur and nitrogen in Estonia, with density 50x50 km (requirement of EMEP). The same data have been submitted also to managing body of EMEP. The figures show that the highest pollution load is in Ida-Virumaa, where also larger energy and industrial companies of Estonia are located (Eesti Energia Ltd Narva TPP's, Kohtla-Järve and Ahtme TPP's, oil shale chemistry companies) and in Harjumaa and Tallinn (Iru TPP, Tallinna Soojus Ltd etc.). This is confirmed also by precipitation monitoring data of the year 1999 of the Environmental Research Center and Tartu University (SO_4 mg/m2) (figure 2.26).

According to the above mentioned convention and taking account of EU Directive 88/609/EEC about limit values of emissions of pollutants from large combustion equipment into ambient air, Ministry of the Environment has compiled "State Programme for Reduction of Emissions of Pollutants from Large Combustion Equipment into Ambient Air". Table 2.10 shows emissions of SO_2 and NO_x from large boiler houses with capacity 50 MW or above. Their percentage of summary emission of SO_2 and NO_x is correspondingly 92% and 79%.

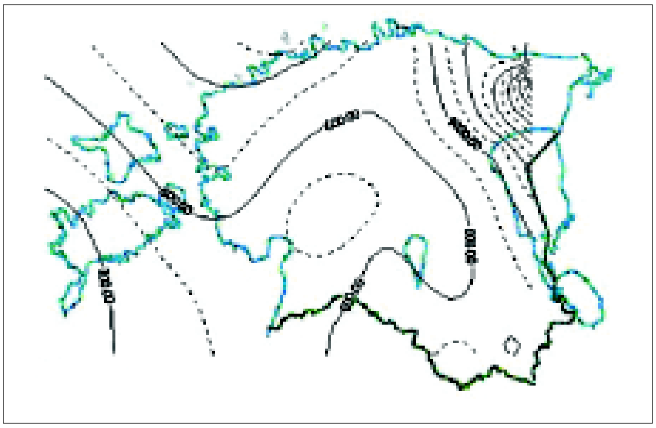


Figure 2.26. Iso-lines of precipitated sulphate (SO_4 mg/m2) according to the data of Estonian precipitation monitoring in 1999.

Measures to be taken for the reduction of emissions of pollutants are given within the frames of the programme:

- technological measures, including reconstruction of equipment, implementation of new combustion technology (implementation of new combustion technology of oil shale, basing on circulating boiling layer, in energy block no. 8 of the Estonian Power Station) etc.;
- alteration of used fuel type, e.g. use of natural gas;
- use of fuel with low sulphur content.

According to the regulation no. 15 of the Minister of Economy "Quality requirements for liquid fuels" from June 2, 2000 it is allowed in Estonia to use heavy fuel oil with sulphur content 3.0% until January 1, 2003 and with sulphur content 1.0% after that term. Limit values of the emissions of sulphur dioxide and nitric oxides are directly regulated with regulation no. 60 of the Minister of the Environment "Limit values of emissions of pollutants per volume unit of gases exiting from combustion equipment" from October 26, 1998.

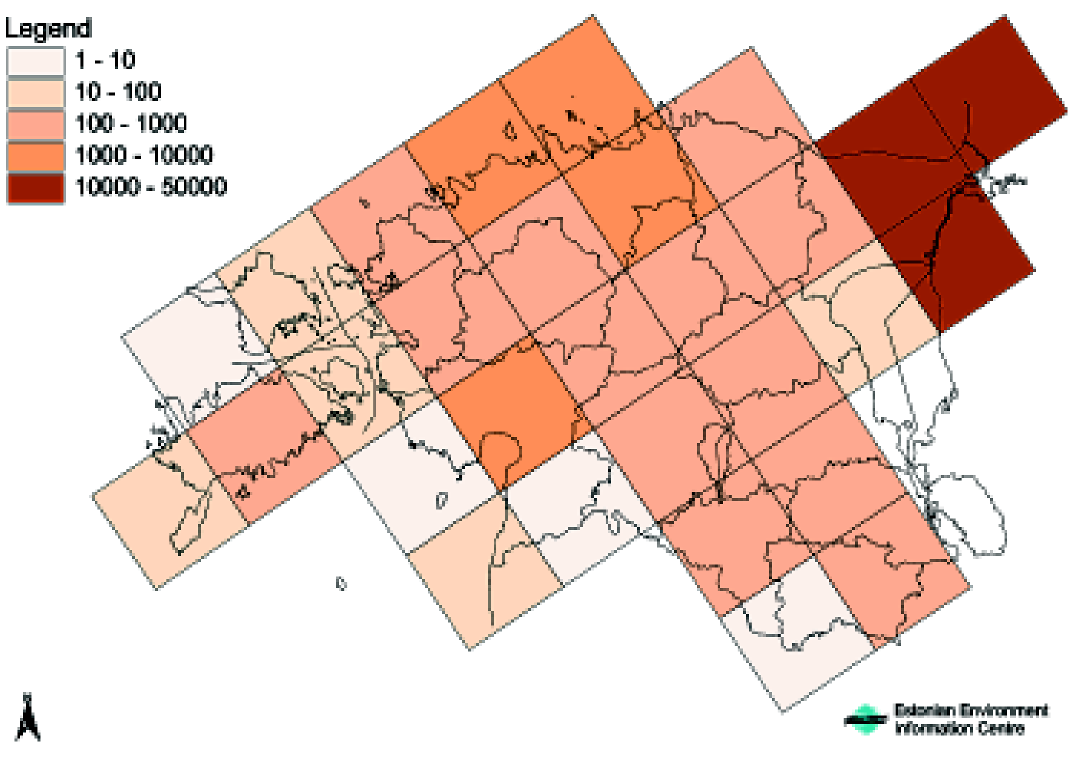


Figure 2.24. Emissions of SO_2 from stationary pollution sources in 1999 (tons per year).

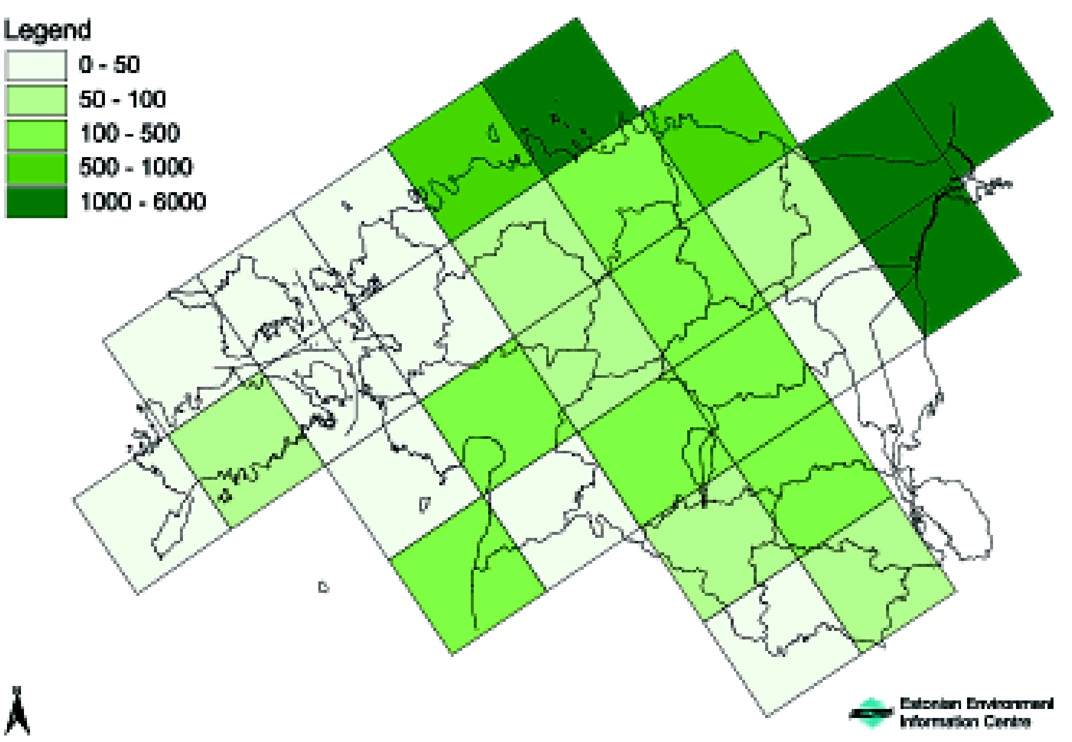


Figure 2.25. Emissions of NO_x from stationary pollution sources in 1999 (tons per year).

Table 2.10. Emissions of SO_2 and NO_x from large combustion equipment (th. t).

	1980	1993		1997		1998		1999	
	SO_2	SO_2	NO_x	SO_2	NO_x	SO_2	NO_x	SO_2	NO_x
Harju County									
Iru Power Plant	1.1	5.2	0.5	3.4	0.6	3.5	0.9	3.2	1.1
Horizon Ltd	5.8			0.1	0.01	0.8	0.06	0.8	0.1
Ida-Viru County									
Narva Power Plants Ltd									
Estonian TPP	71.1	42.2	4	37.9	5.9	35.4	5.6	39.5	5.2
Baltic TPP	120.1	53.6	3.5	36.5	3.7	31.8	3.2	27.5	3.3
Kohtla-Järve TPP	9.2	2.3	0.1	3.1	0.2	3.8	0.3	3.4	0.2
Ahtme TPP	3.2	1.9	0.05	4.3	0.2	4.8	0.3	3	0.2
Viru Keemia Grupp Ltd	13.6	4.4	0.2	4.5	0.1	3.1	0.1	4.6	0.1
Viru Keemia Grupp Ltd, part of Kiviõli	4.5	2.6	0.1	2.8	0.1	2.1	0.1	0.2	0.02
Repo Vabrikud Ltd		0.7	0.02	0.7	0.1	0.6	0.1	0.6	0.1
Sillamäe TPP Ltd	2.9	2.6	0.5	1.6	0.3	1.6	0.3	1.4	0.1
Lääne-Viru County									
Kunda Elamu Ltd	1.6	0.3	0.1	0.2	0.1	0.2	0.1	0.1	0.03
Põlva County									
Põlva Piim		0.2	0.2	0.1	0.01	0.1	0.02	0.1	0.02
Pärnu County									
Tootsi Turvas Ltd	0.2	0.4	0.1	0.5	0.1	0.5	0.1	0.5	0.1
Pärnu Soojus Ltd		0.3	0.04	0.3	0.1	0.3	0.1	0.3	0.1
Viisnurk Ltd	0.7	0.1	0.1	0.03	0.07	0.03	0.1	0.03	0.1
Tallinn									
Tallinna Soojus Ltd	5.6[1)]	7.3[1)]	0.2[1)]						
Ülemiste district heating plant				0.3	0.1	0.9	0.2	0.5	0.2
Tallinna district heating plant				0.3	0.1	0.01	0.02	0	0.01
Mustamäe district heating plant				0.5	0.2	1.3	0.2	0.9	0.2
Kadaka district heating plant				0.5	0.2	0.3	0.2	0.1	0.1
Tartu County									
Tartu Central heating plant				0.2	0.02	0.2	0.1	0.04	0.1
Anne Soojus Ltd				0.3	0.2	0.2	0.1	0.03	0.1

1) summary amount from Tallinna Soojus Ltd

2.5. Ozone layer protection

Ozone (in Greece ozün - smelling) or trioxygen is allotrophic modification O_3 of oxygen. Ozone is very contradictory and important gas for the living nature. In stratosphere ozone moleculas form layer, that protects living nature against lethal amount of ultraviolet radiation. According to recently made researches diminishing amount of ozone in stratosphere layer during 10 years in winter 5% and in summer 1-3%. Depletion of ozone layer is caused also by human activities - mainly by using freons and halons in refrigerators, fire extinguishers, electronic industry etc. Freons are very inert gases and will last in stratosphere for decades. In nineties several decisions have been taken in international basis for replacement of freons and finishing their use.

"Vienna Convention for the Protection of Ozone Layer" was concluded on March 22, 1985 and "Montreal Protocol on Substances that Deplete Ozone Layer" (further Montreal Protocol) accompanying this convention on September 16, 1987. Estonia joined these international agreements in 1996.

Montreal Protocol together with the convention of climate change is one priority of environment protection in the world as well as in Europe.

Montreal Protocol has been amended four times – in 1990 in London, in 1992 in Copenhagen, in 1997 in Montreal and in 1999 in Beijing. Estonia ratified London and Copenhagen amendments of Montreal Protocol in 1999. By now 173 have joined the Vienna Convention, 172 countries Montreal Protocol, 136 countries London amendments, 101 countries Copenhagen amendments and 26 countries Montreal amendments. Following legal acts have been adopted for the enactment of the law of joining of 1990 London amendments and 1992 Copenhagen amendments of Montreal Protocol in Estonia:

1) Regulation no. 146 of the Government of the Republic from May 6, 1999: "Establishing requirements for controlling substances depleting the ozone layer";

2) Regulation no. 43 of the Minister of the Environment from April 13, 1999: "Procedure for applying for and granting of approval for the production, export, import or transit of substances depleting the ozone layer or of the product containing such substances";

3) "State programme of gradual elimination of ozone layer decomposing substances from use" was certified with the order no. 531-k of the Government of the Republic from May 4, 1999.

Main goal of the programme is implementation of international responsibilities proceeding from the above mentioned acts and solution of tasks proceeding from other above mentioned legal acts, in order to protect health of people and the environment from damage arising from the decomposing of ozone layer.

No ozone layer deplending substances are manufactured in Estonia. Their total consumption in 1995 was 159.2 tons, which is corresponding to 131.2 ODP tons (Ozone Deplention Potential); corresponding figure in 1996 was 73.9 tons or 36.5 ODP tons. From 1986 to 1996 the consumption of ozone layer deplending substances decreased by 81%. In 1998 their consumption increased by 23.5 ODP tons compared to the year 1996, which was caused by the use of amortized cooling equipment (figure 2.27). Consumption forecast is given in table 2.11, which shows that consumption of ozone layer deplenting substances in Estonia can be ended. By 2002 Estonia would reach the level, achieved by member states of the European Union by January 1, 1996.

Table 2.11. Consumption of ozone layer deplending substances in 1986-1998 and forecast until 2002. (Numeric data have been re-calculated into ODP tons).

Sources: Health Protection Inspectorate, Customs Board, Board of Statistics

Substance	1986	1991	1994	1995	1996	1997	1998	1999	2000 forecast	2001 forecast	2002 forecast
Annex A group 1 CFC 11	12	20	23	9.7	-	0.3	-	-	-	-	-
CFC 12	177	179	95	110.5	26.9	36.5	15	10	5	2.5	-
CFC 113	0...	0...	0...	0.9	-	0...	0...	0...	0...	-	-
CFC 114	-	-	17	6.4	2.4	-	1.5	1	0.5	0.25	-
CFC 115	-	-	2	-	-	0...	-	-	-	-	-
Total A1	***189***	***199***	***135***	***127.5***	***29.3***	***36.8***	***16.5***	***11***	***5.5***	***2.75***	**-**
Annex A group 2 halon 1211	0.9	0.9	0.9	0.9	0.9	-	0.3	0.2	0.1	-	-
Halon 1302	7.7	7.7	7.7	-	-	-	-	-	-	-	-
Halon 2402	7.2	9	8.2	0.6	3.7	0.4	2	1	0.5	-	-
Total A2	***15.8***	***17.5***	***16.8***	***1.5***	***4.6***	***0.4***	***2.3***	***1.2***	***0.6***	**-**	**-**
Annex B group 1 CFC 13	-	-	-	-	-	0.3	-	-	-	-	-
Other CFC's	-	-	-	-	-	-	-	-	-	-	-
Total B1	**-**	**-**	**-**	**-**	**-**	***0.3***	**-**	**-**	**-**	**-**	**-**
Annex B group 2											
Carbon tetrachloride	*0.2*	*0.4*	*0.2*	*0.7*	*0.2*	*0.1*	*0.2*	*0.1*	*0.1*	*0.05*	-
Annex B group 3											
1.1.1.-trichloroethane	*0.1*	*0.3*	*0.1*	*0.1*	*0.2*	*0.1*	*0.1*	*0.05*	-	-	-
Annex C group 2 HBFC	-	-	-	-	-	-	-	-	-	-	-
Annex E group 1											
Methyl bromide	-	-	-	-	-	*0.1*	-	-	-	-	-
TOTAL	**210.9**	**222.7**	**153.8**	**131.2**	**36.5**	**43.6**	**25.1**	**16.35**	**8.2**	**3.8**	**-**

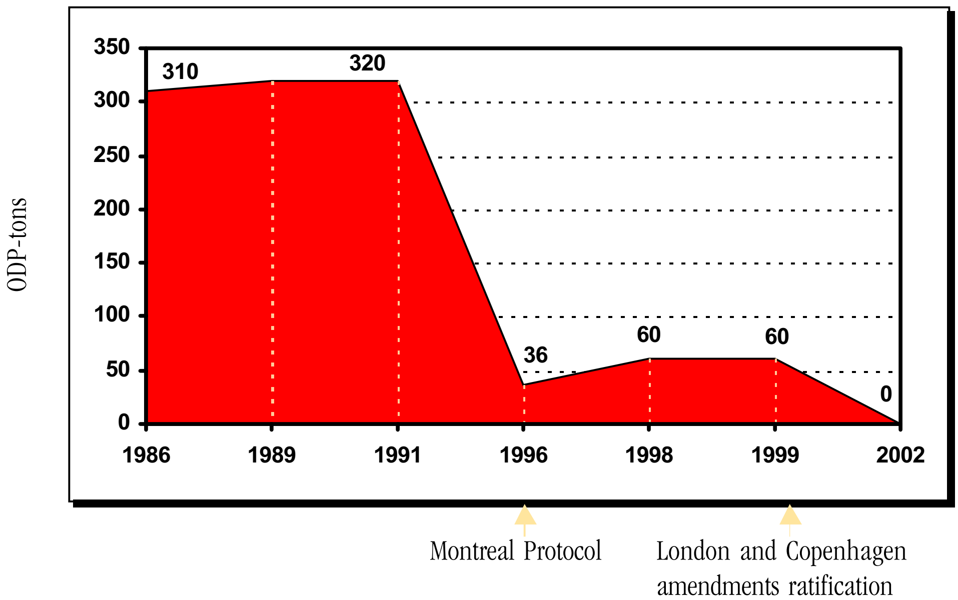


Figure 2.27. Consumption of Annex A and B substances and the GEF Project in Estonia from 1996 to 2002.

2.6. Heavy metals and persistent organic pollutants

In recent years special attention has been paid within the frames of United Nations (UN)/European Economic Committee on persistent organic pollutants and heavy metals.

Two protocols have been adopted within the frames of the convention of long-range transportation of air pollution, on which basis production and use of several persistent compounds is intended to prohibit or restrict (Executive Body decisions: 1998/2 – persistent organic compounds, 1998/1 – heavy metals). Estonia is planning to join these protocols in 2001/2002.

By the beginning of new millennium 36 countries have undersigned the protocols, including Latvia and Lithuania, but only five countries have ratified them (Canada, Norway, Sweden, Netherlands and Luxembourg).

There are 12 prohibited persistent organic compounds (Annex 1 to the protocol): aldrin, endrin, chlordane, DDT, dieldrin, heptachlorine, hexachlorine benzene, hexabromide biphenyl, chlorine decon, mirex, toxaphen and polychlorinated biphenyls. Twelve compounds were selected from 107 persistent compounds as most hazardous to people's health (Roots, 1999). Annex 2 to the protocol (list of compounds with prohibited or restricted use) includes in addition to DDT and polychlorinated biphenyls also hexachloro-cyclohexane. Belonging of DDT simultaneously into two annexes is justified with the fact that until now no substitute has been found for that compound in battle with malaria and encephalitis. In Estonia the import of chlorine organic pesticides is prohibited with Government regulation from October 21, 1967.

For heavy metals, main attention of UN/EEC is paid on three metals: cadmium, lead and quicksilver.

2.6.1. Heavy metal pollution precipitating through the air

Atmospheric heavy metal pollution has been monitored in Estonia for ten years with the method of bio-indication, using ordinary heath moss *(Pleurozium schreberi)*, which accumulates heavy metals proportionally with their content in the air.

In 1990 Estonia joined the European project of bio-indicational heavy metal monitoring, where 28 countries are participating and which is coordinated by Lund University in Sweden. According to the project, distribution of Cd, Cr, Cu, Fe, Ni, Pb, V and Zn and, if possible, also AS and Hg content in moss is mapped with interval of 5 years simultaneously in different countries (figure 2.28). In Estonia the network of monitoring of heavy metals distribution consists of 100 moss sampling points fixed with geographical coordinates, with intervals of 30 km. Heavy metal content has been measured according to that network pitch in Estonia in 1990 and 1995 (Liiv etc. 1996). For the region remaining under greater pollution load, North-East Estonia, such monitoring network is insufficient, therefore in that region heavy metal pollution has been evaluated in 1992 and 1997 on the basis of intensified monitoring programme (Monitoring sub-programme…, 1998). Collection and processing of moss samples and measuring of their content of elements is proceeding from internationally accepted methodology (Rühling, A., Steinnes, E., 1998).

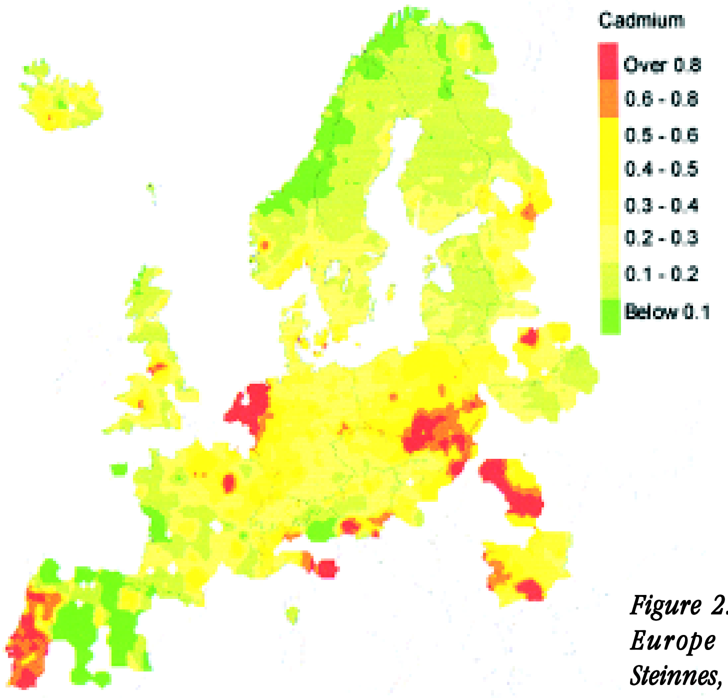


Figure 2.28. Cd content in moss in Europe in 1995 (Rühling, A., Steinnes, E., 1998).

Average **Cd** content in moss was relatively low in Estonia in 1995 – 0.189 µg/g. Cd content in moss was relatively uniformly distributed in Estonia – there are only two separated zones on the map of territorial Cd distribution. In 1990 Cd content in moss was higher than in 1995. For comparison – in Poland and Romania Cd content in moss extends to 2 µg/g.

Hg content in Estonia was relatively low in 1995 – average of Estonia was 0.0796 µg/g. Hg content in moss was the highest in Kohtla-Nõmme (North-East Estonia) and Rocca-al-Mare – over 0.1000 µg/g. In most European countries Hg content in moss remains below 0.1 µg/g. In 1990 Hg content in moss was not measured in Estonia.

Average **Pb** content in mossin Estonia in 1995 was 7.349 µg/g, the highest Pb content (20.0 µg/g) in moss samples was measured in Kunda. For comparison – in Tallinn Pb content in moss is twice as high at places, up to 41.5 µg/g in Pelgulinn (Mäkinen, Liiv, 1995). In 1995 Pb content was lower in Estonia than in 1990.

North-East Estonia 1992-1997

Cd, Cr, Cu, Fe, Ni, Pb, V and Zn content in the moss of 36 sampling points located in North-East Estonia was in most cases over average level of Estonia in 1992 as well as in 1997. On the transect of sampling points starting from the Estonian Power Station (EPS) to North-East and South-West as well as from Kunda-Nordic cement factory to East and West common rule can be observed that the content of heavy metals in moss is decreasing along the increase of distance of sampling points from the pollution source. At the same time content of elements in moss is not the highest in sampling points located closer to EPS, but only in the moss of sampling point located 3 km to North-East, where probably largest amount of solid waste is precipitating from high plant pipes. As a rule, content of elements will decrease to average level of Estonia 10 km to South-West from EPS.

2.6.2. Emissions of heavy metals

Emissions of heavy metals have been calculated proceeding from fuel combustion in 1990-1998 (table 2.12). Figure 2.29 includes the emissions of lead, cadmium and mercury by type of fuel in 1998. Greater part of heavy metals is produced at oil shale burning in large power stations. Another large pollution source is burning of wood and wood waste in small boiler houses. In 1990-1998 emissions were reduced two times, which is caused by the decrease of the amount of burnt fuel.

Table 2.12. Emissions of heavy metals from fuel combustion, kg.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Lead	83415	76352	62633	47587	50840	47933	49821	51147	44042
Cadmium	1612	1493	1188	885	937	899	940	977	829
Mercury	1292	1183	980	750	798	751	778	773	664

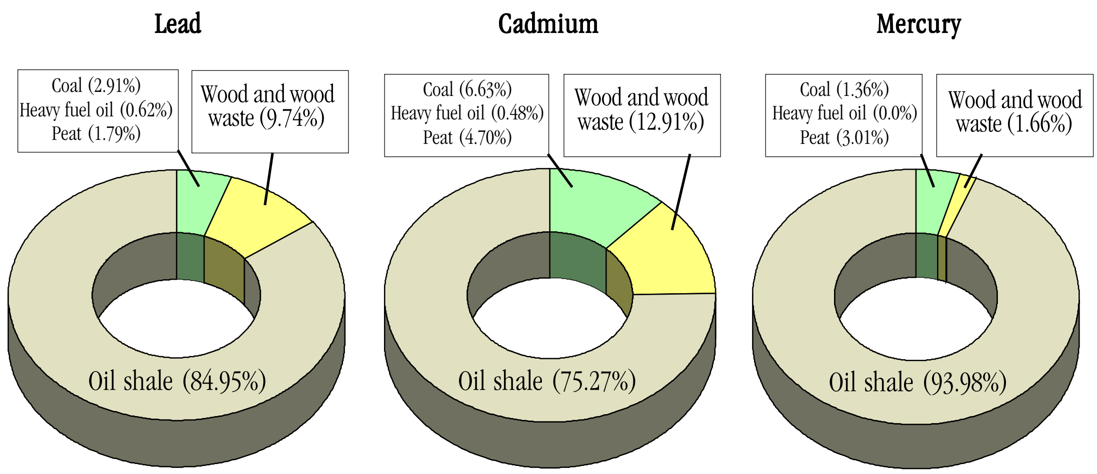


Figure 2.29. Emissions of lead, cadmium and mercury by type of fuel in 1998.

Table 2.13 shows emissions of lead from different pollution sources. Largest amounts of lead are emitted from fuel combustion and transport (figure 2.30). Figure 2.31 shows that in 1990 the emission of lead from transport was twice as large as from oil shale combustion. In 1998 this relation has changed. Lead was emitted from transport three times less, compared to oil shale combustion. This is caused by remarkable decrease of the use of petrol with lead content (only 10% in 1998).

Table 2.13. Emission of lead in tons.

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Transport	149.1	132.0	58.2	52.8	55.8	39.6	30.3	21.9	10.6
Oil shale combustion	72.6	66.0	55.5	42.6	45.5	42.3	43.6	43.1	37.4
Other fuels	10.8	10.4	7.1	5.0	5.3	5.6	6.2	8.0	6.6
Cement production	1.0	1.0	0.5	0.4	0.4	0.5	0.4	0.5	0.35
Industry			0.044	0.039	0.017	0.028	0.038	0.03	0.021

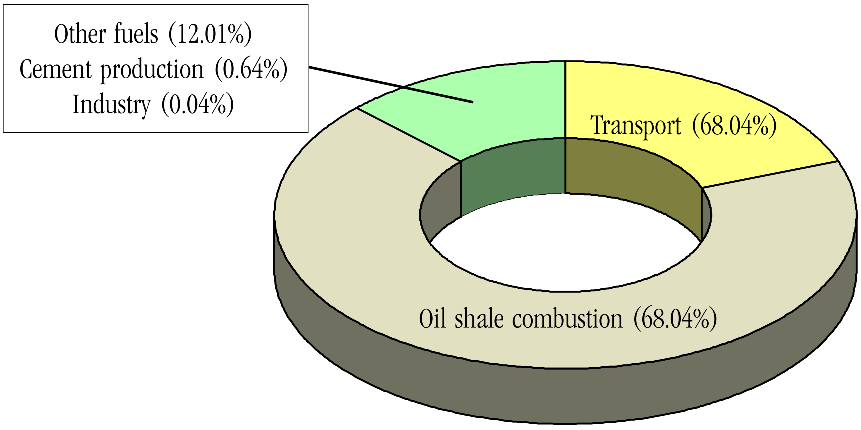


Figure 2.30. Distribution of lead emissions between main pollution sources in 1998.

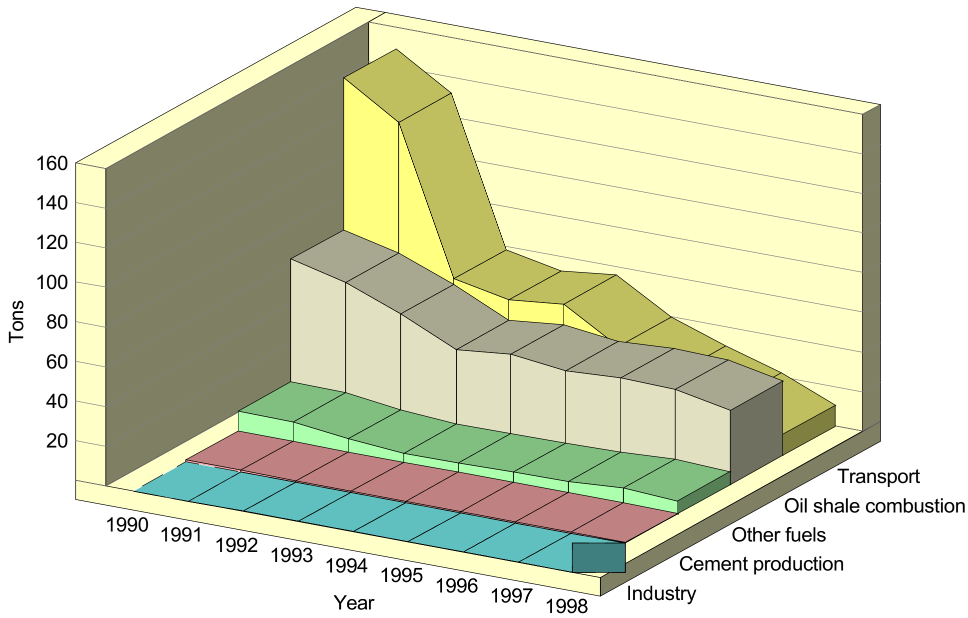


Figure 2.31. Distribution of lead emissions between pollution sources 1990-1998.

2.6.3. Persistent organic pollutants

Government Regulation from October 21, 1967 prohibited import of chlorine organic pesticides to Estonia (Müür, 1996). Estonia itself is not manufacturing chlorine organic pesticides.

By now the use (and import) of all toxic chlorine organic pesticides belonging into the protocol adopted by UNECE in 1998 is prohibited in Estonia. According to the data of the Estonian Inspectorate of Vegetation Protection 1.1 tons of DDT is currently stored under control.

Unfortunately, toxic organic compounds reach the Estonian territory through long-range transportation of air pollution. Toxic compounds reach the Baltic Sea mainly through atmosphere and rivers. For example, correspondingly 20 and 3 kg of DDT with precipitations and by rivers water brought into the Baltic Sea; also 230 and 50 kg of another toxic pesticide, hexachlorocyclohexane (HCH) and 390 and 330 kg of polychlorined biphenyls (PCB) with industrial origin (Agrell, 1999).

Due to the programme of the Nordic Council of Ministers "Environmental Research in the Baltic Sea Region" measurement of the content of toxic chlorine organic compounds was carried through for the first time in the atmospheric air of the Gulf of Liivi region (figure 2.32). In comparison, data of Hällestad station in Sweden have been given. Pärnu station was located in Tahkuse (Nordic Environmental Research Programme for 1993-1997, 1999).

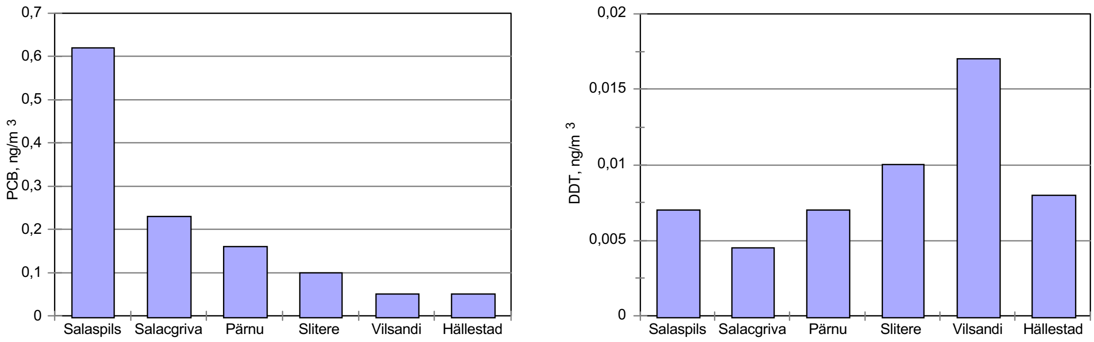


Figure 2.32. PCB and DDT content in the air of the Gulf of Liivi region according to the data of the programme of the Nordic Council of Ministers "Environmental Research in the Baltic Sea Region".

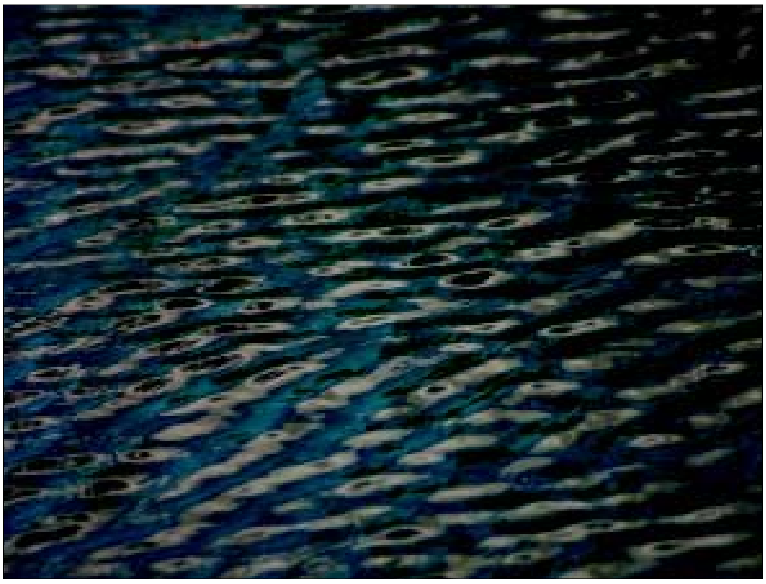
When PCB showed up decrease of compound content from local pollution source in Salaspils (Latvia) towards Saaremaa, corresponding geometric average contents of toxicants in the air were 0.6 ng/m3 and 0.05 ng/m3, distribution of summary DDT to Saaremaa region is probably caused by long-range transportation of air pollution (Nordic Environmental Research Programme for 1993-1997, 1999). In addition to toxic chlorine organic pesticides the list of extremely hazardous organic compounds includes also polychlorined biphenyls (PCB), furans and dioxins. The mentioned compounds contain correspondingly 209, 175 and 75 isomers with different toxic level, which makes analysis expensive and requires also availability of excellent equipment and analyzing staff. Currently PCB analyses are conducted in Estonia, but there is no possibility to analyze dioxins and furans.

In result of joint project of Estonia and Denmark analysis of polychlorined biphenyls (PCB) in old transformer oils was carried through. Order of the treatment of waste containing polychlorined biphenyls and polychlorined terphenyls has been developed for elimination of those compounds from use (basis: EC directive 96/59/EU).

In Estonia there are no known pollution sources of dioxins and furans, as main emission sources of toxicants are combustion of waste (69%) and black metallurgy (10%). 38% of annual emission of furans and dioxins comes from Japan, 26% from USA (Dioxin and Furan Inventories, 1999).

Researches by German scientists of dioxin and furan contents of milled oil shale taken into the furnace of the Estonian Power Station and volatile ash caught with electric filter, carried through within the frames of the European Dioxin Project, showed that contents of toxicants in the oil shale power station were insignificant, compared to amounts emitted from waste combustion plants, and were comparable with those found in brown coal dust in Germany, remaining in case of many isomers of dioxin and furan below determination level (Dioxin research in oil shale based power station, 1998).

WATER



3. Water

Karin Pachel, Maaja Narusk, Heli Ristkok, Arne Reap,
Aleksei Ljamtsev, Ott Roots, Urmas Lips, Mart Simm

3.1. Introduction

Constantly increasing mankind with its life activities is essentially influencing natural environment, so also itself. Development of towns, industry and agriculture is accompanied with large amounts of wastewater and pollution, which determines quality condition of rivers, lakes and sea water surrounding people. Estonian waterbodies are influenced by nutrients from domestic sources, food and light industry and agricultural diffuse pollution. In North and Northeast Estonia the influence of wastewater from large industry is added, which is endangering essentially coastal sea. Condition of waterbodies is directly depending on the efficiency of wastewater treatment and protective measures applied in agriculture. In last decade essential changes have taken place in Estonia: economic decline, changes in industry management and domestic water consumption have brought along decrease of pressure on water resources, which has had favorable effect on rivers, lakes and sea. Livening of economy brings along inevitable increase of pressure on water environment. Preventing pollution by the use of production technology saving water resources and water environment and promotion of suitable efficient wastewater treatment methods and organic farming, it is possible to preserve current nature-friendly condition in our waterbodies, acceptable for people.

According to the data of the Estonian Statistical Office, estimated population of Estonia by January 1, 2000 was 1.439 million. In post-war period the population of Estonia increased largely due to immigration. From 1990 population started to decrease due to emigration and decrease of birth rate. Decreased population in 1998 is mainly caused by negative natural accretion, not by the number of emigrants. In last ten years population has decreased by 8%. In connection with that, also the load of domestic wastewater discharged into water by people has decreased (figure 3.1). Domestic wastewater is polluting natural water with organic matter, nitrogen and phosphorus, disease bacteria and other contaminants. Polluting effect of organic substance discharged into water lies in oxygen destruction, wherefore its amount is measured as the amount of oxygen needed for degradation of organic matter. Biochemical oxygen demand (BOD) is equal to the amount of oxygen needed for degradation of organic matter in the water. Organic matter of domestic wastewater dissolves usually in twenty days. In Estonia evaluation is given usually with seven-day oxygen demand (BOD_7). The more wastewater contains hard-dissoluble organic compounds, the longer will be the time of dissolution and the higher the value of BOD_7. Average daily pollution produced by one person is causing oxygen demand BOD_7 = 70 grams per day.

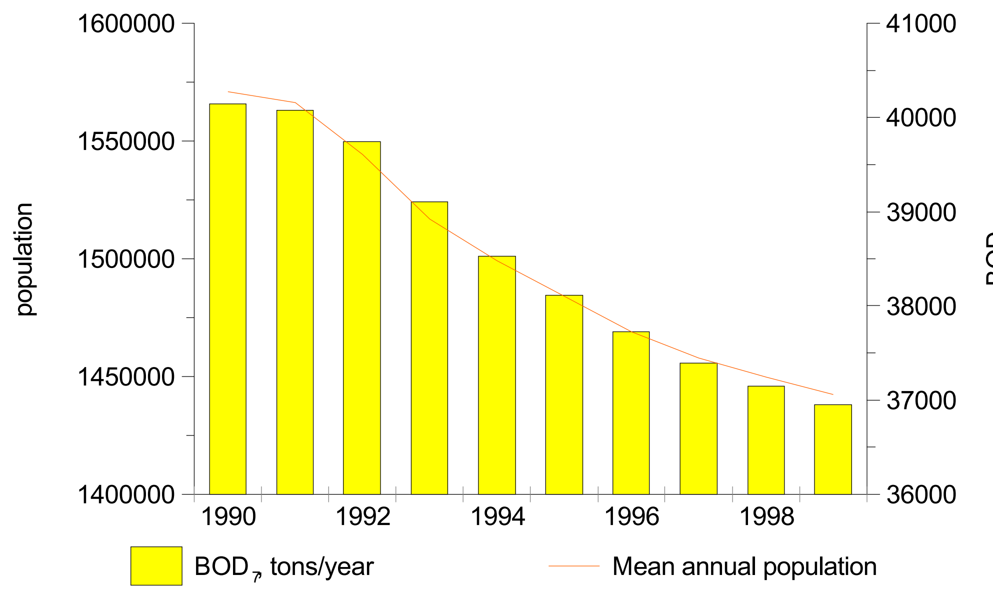


Figure 3.1. Estimated domestic pollution load. Population and pollution by organic matter.

All human wastewater contain in addition to organic matter also nitrogen and phosphorus. Increased content of organic or ammonium nitrogen in waterbodies indicates pollution. Nitrogen compounds in water act as fertilizers, their abundance spoils natural balance in waterbodies and promotes growth of algae and plants, causing eutrophication. One person is polluting water daily with average of 12 grams of nitrogen. Phosphorus is main reason for eutrophication of rivers and lakes. In natural water the content of phosphorus compounds is low, originating from minerals and soil containing phosphates. Phosphorus is led into water environment with organic matter, cleaning agents and fertilizers. In natural water excessive phosphorus is causing exuberance of phytoplankton and higher water flora. Daily average phosphorus pollution from a person into water is 1.44 grams (figure 3.2).

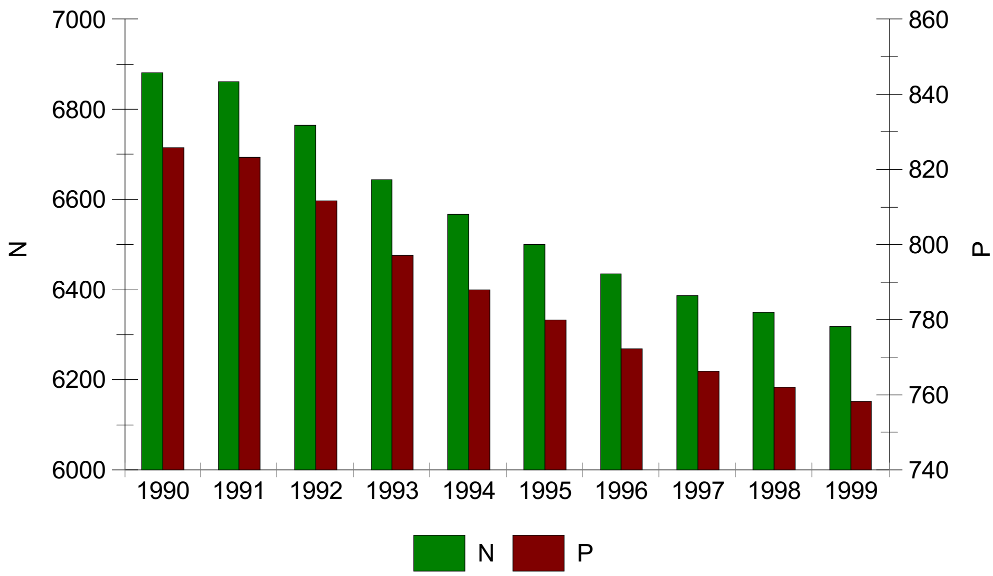


Figure 3.2. Estimated domestic pollution load in Estonia. Nitrogen and phosphorus (tons per year).

Most of wastewater is discharged into water environment by biological or biological-chemical wastewater treatment plants, where main part of pollution is decomposed. Phosphorus extraction should take place in treatment plants in order to prevent eutrophication of waterbodies.

Most of Estonian industry is basing on local natural resource. More important fields of business are production of food and beverages, wood, paper and furniture industry, metal and machinery industry, textile industry, chemical industry and energetics (figure 3.3). Food industry forms 25-38% of the whole economical activities. According to the data of the Statistical Office, Estonian economy has been on the rise since 1995. Gross domestic production in current prices was 40.7 billion EEK in 1995; 52.4 in 1996; 64.3 in 1997; 73.2 in 1998 and 75.4 in 1999. In 1995-1997 gross domestic production was most influenced by paper, wood and furniture industry; production of computers and other data processing equipment; leather industry and production of food and beverages, forming in 1997 15.1% of gross domestic production. Compared to the beginning of 1990s, the production of textile, wood, rubber and plastic products, construction material, metal products and furniture increased essentially in 1997. Decrease of the production of electric energy over two times in 1990-1998 is caused by the decrease of export possibilities.

Mainly oil shale is used for the production of electricity. Since 1996 the percentage of oil shale in electricity production has decreased from 98% to 92%. In 1999 92% of electric energy was produced from oil shale. Peat, natural gas and heavy fuel oil was used for the production of electric energy to small extent. Production of hydro-energy was minimal, but its percentage grew year by year. In 1992 the production of hydro-energy was 1 GWh, in 1995 3 GWh and in 1998 4 GWh. Production of electric energy is accompanied with environmental impact. Over 80% of mined oil shale is used for energy production, ca 90% of water consumed in Estonia is used in cooling systems. In addition, the highest amounts of air pollution and waste. Oil shale mining is covering an area of 10 000 ha in Northeast Estonia. With mining of one ton of oil shale, 20 m^3 of groundwater is pumped out, which contains lot of suspended solids, sulphates, carbonates and chlorides. Most of mining water requiring treatment is mechanically treated before discharge into rivers, but there is still no efficient technology for the treatment of such mining water. Chemical industry is discharging hazardous substances into the nature. In oil shale chemical industry in Kohtla-Järve, which has now been almost stopped, half ton of solid waste was produced per one ton of used oil shale.

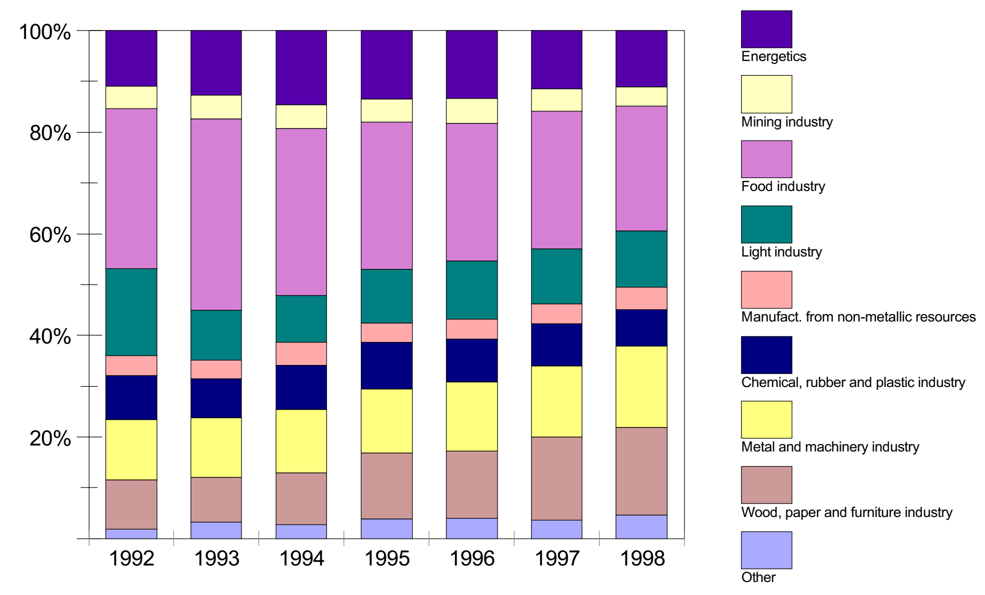


Figure 3.3. Industry. Distribution of industrial production in percents by economic activities.

Several tens meters high ash hills cover the area of 250 ha. Seepage water of ash hills, rich in phenols, is polluting Kohtla and Purtse River. Chemistry-metallurgy factory Silmet operated in 1948-1989. Presently Silmet Group Ltd is reformed and producing rare earth metals. The problem is waste deposit of Silmet, from where nitrogen compounds are leaching into the sea. Maardu phosphorite mine has been closed and production of superphosphate was also ended in 1993. This has relieved tensions in the condition of water environment in industrial regions.

According to the data of the Estonian Statistical Office, strong decrease in agricultural production was noted in the beginning of 1990s, due to collapse of collective agriculture (figure 3.4). Wasting and concentrated mismanagement of Soviet time caused poor condition of rivers, lakes and groundwater, affecting first and foremost weakly protected or unprotected groundwater regions of North and Middle Estonia. In 1994-1996 agriculture stabilized and overall decline continued in 1998. Meat and dairy production decreased compared to 1990s in connection with bankruptcy of several meat factories, reform of dairy industry and decrease of the number of cattle.

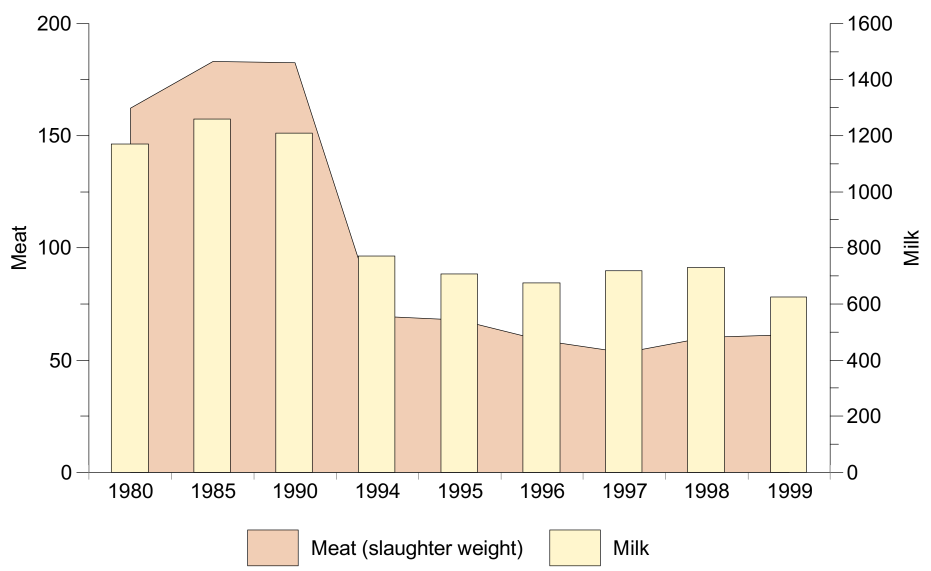


Figure 3.4. Food industry. Meat and dairy production (th. tons)

Russian economic crisis affected production in 1998. Gross agricultural production was in 1999 4.8 billion EEK in the prices of 1995, i.e. 8% lower than in 1998.

At the formation of quality of rivers, lakes and groundwater animal husbandry has an essential role. Pollution is caused by poor (wrong) handling and storage of manure and its use as a fertilizer, especially in large farms. From 1990 to 1999 the number of animals has decreased almost three times (figure 3.5). Number of cows has been decreased two times. The decrease of the number of cows has not affected significantly dairy production, as average milk production of cows has increased. In 1980 average milk production per cow was 3700 kg, in 1990 – 4210 kg and in 1999 – 4171 kg. This refers to the increase of efficiency of production and at the same time has saving effect on environment. Total milk production in 1998 was 729600 tons. Milk processing companies bought up 531800 tons of milk. Level of self-supply in case of milk and dairy products amounts to 150%, which means that remarkable percent of dairy products (25.7% of food export) is exported. In 1999 milk production was 14% less than in 1998. Decrease took place due to the fall of productivity as well as decrease of the number of cows.

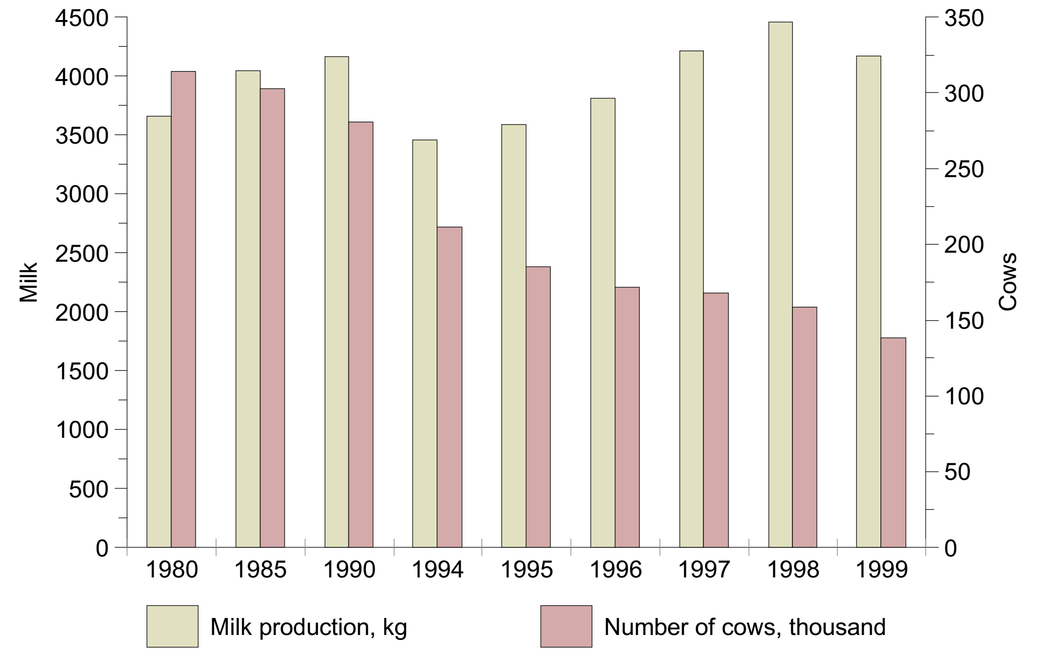


Figure 3.5. Cattle. Number of cows and average milk production per cow.

According to the data of the Statistical Office, milk production per person in 1998 was 60%, in 1999 – 53% of the level of 1988 (figure 3.6). In 1998 505 kg of milk was produced per person, actual consumption per person was 286 kg, which is much less than optimal. Optimal consumption of milk and dairy products, accounted to milk, should be ca 370 kg per person. Proceeding from that, internal need of Estonia would be ca 540 tons of milk per year, the remaining part would be exported. Average butter consumption per person is 2.1 kg, which is more than in the Netherlands, Great Britain and Australia.

Meat production per person in 1988-1998 decreased 72% (figure 3.7). Consumption per person decreased 31%. From 1994 Estonian meat production does not cover consumption, the lacking part is covered with imported meat. Compared to other European countries, Estonia is consuming much less meat. Daily need for meat of a person is 100-200 grams, i.e. annual meat consumption per person should be 64 kg. In order to cover optimal meat need of internal market, the production should be almost twice as high as it currently is. Compared to 1998, 2% more meat was produced in 1999, mainly due to the increased production of beef. In 1999 5 tons of meat was produced per 100 ha of arable land.

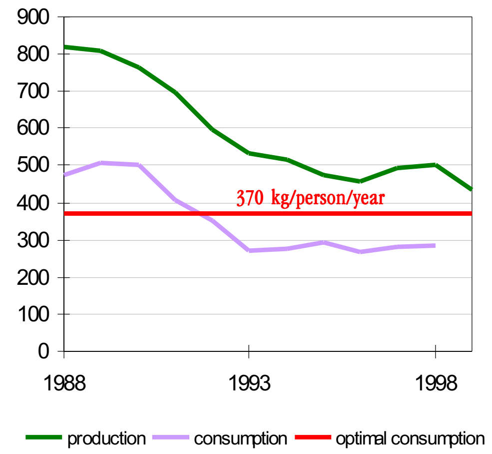


Figure 3.6. Milk production and use (kg per person per year).

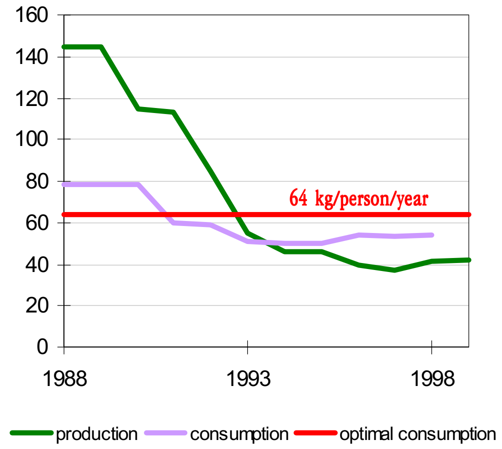


Figure 3.7. Meat production and use (kg per person per year).

Photo 3.1. Farming in large farms has been continuously decreased in Estonia.

In Estonia arable land forms 25% of total area. In 1991 arable land covered 1131947 ha, whereby 1114316 ha was under field crops. In 1998 growing area of field crops was 861087 ha, which is 23% less than in 1991. Production per person in 1991 was 600 kg of grain and legume and 378 kg of potato; in 1999 numbers were 291 and 280 kg respectively. Use of fertilizers has remarkably decreased (figure 3.8). Use of mineral fertilizers was highest in 1960-1988. Since 1990 the use of mineral fertilizers has sharply decreased, which has reduced essentially leaching of plant nutrients, nitrogen and phosphorus into waterbodies. 26.9 tons of mineral fertilizers were used for the crop of 1998, of which majority was formed by nitrogen fertilizer and 2.3 million tons by organic fertilizer.

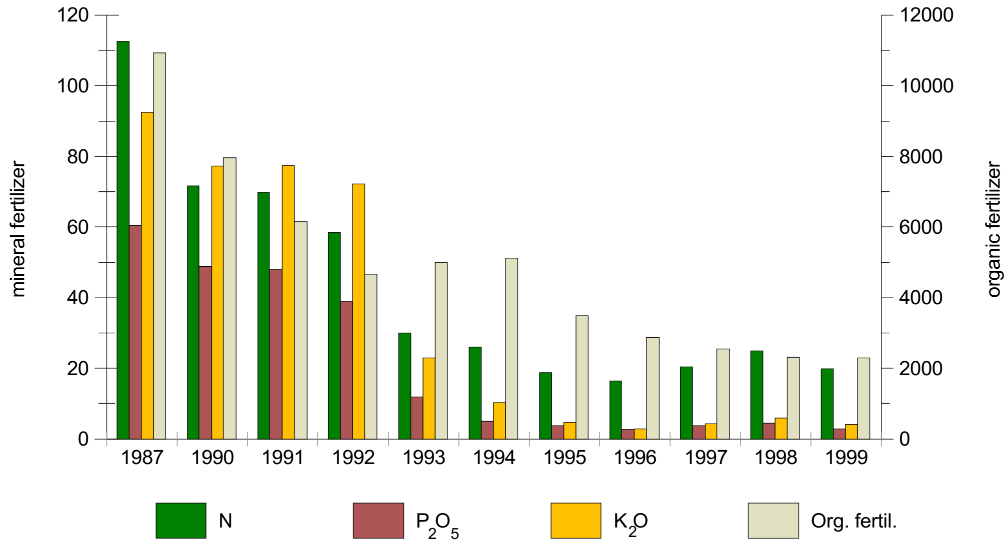


Figure 3.8. Use of fertilizers (thousand tons per year).

About 50% of gross production of plant growing products in Estonia in last 20 years have been produced with the use of mineral fertilizers. In 1999 351308 ha of arable land was fertilized with mineral fertilizers, which is 42% of total sown area (figure 3.9). One hectare received average of 77 kg of mineral fertilizer and 33 tons of organic fertilizer, which is more than two times less compared to 1992. The yield of grain and legume was 1249 kg of dry weight per ha in 1999, the yield of potatoes was 12970 kg per ha. In 1993 corresponding figures were 2160 kg/ha and 12640 kg/ha. Many agricultural producers have no resources for the purchase of fertilizers, also agricultural equipment is aged. Crops are lower, compared to other Nordic countries. As for grain, local production cover 75% of rye need and 60% of food wheat need. In order to increase productiveness without essentially endangering the environment, it is necessary to improve the technology of grain growing, standardize the use of fertilizers and pesticides and renovate agricultural equipment.

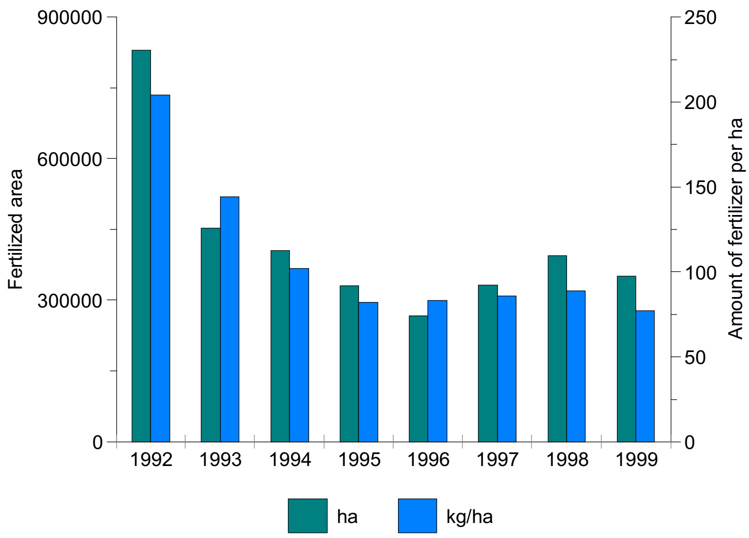


Figure 3.9. Area fertilized with mineral fertilizers.

3.2. Pressure

3.2.1. Water extraction and consumption

There are water intakes using surface, ground- and sea water (figure 3.10) (Reviews...). Surface water is extracted for water supply of Tallinn and Narva. Tallinn water supply system includes Pirita and Jägala river basins and small part of Pärnu river basin. Small extent of surface water is used also for fish rearing. The largest fish farm in Pärispea is using sea water. Its constant annual use was ca 70 million m^3. In 1999 the farm did not operate (table 3.1).

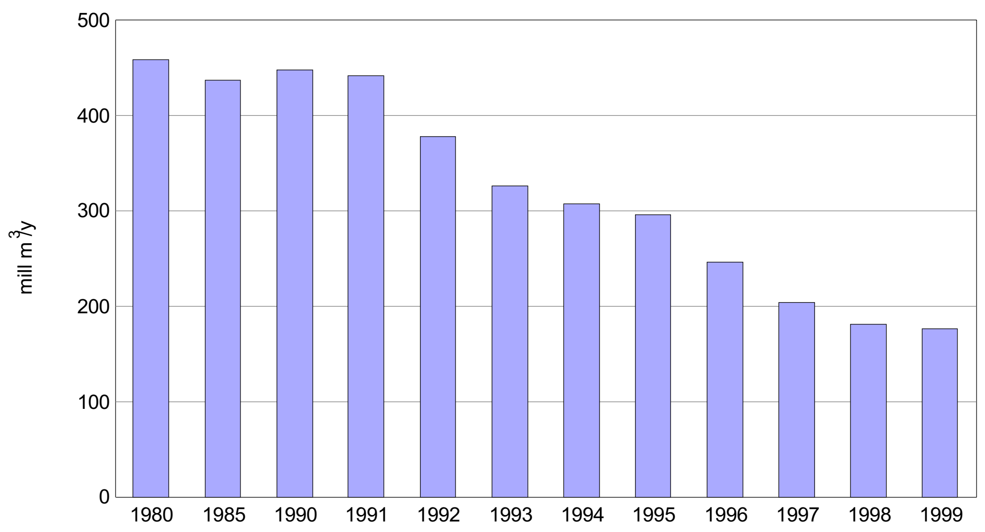


Figure 3.10. Annual water extraction in million cubic meters per year, except cooling water of power stations, mining water and sea water.

Very large amount of surface water is used as cooling water in power stations of Narva (figure 3.11). Water extraction has decreased due to the decrease of electricity production and saving of water (influence of the charge for special use of water). Narva River has relatively much water compared to consumption (figure 3.12).

Water is also used for hydro-transport of ash. As precipitation exceed evaporation, discharges of excess water from ash fields had to be done for many years, depending on water amount of the year. Alkalinity of water from the fields is extremely high. Several efforts have been made to reduce the amount of water and its alkalinity. In 1999 treatment plant was built for the changing of reaction of excess water discharged from the Baltic Power Station to Narva Reservoir.

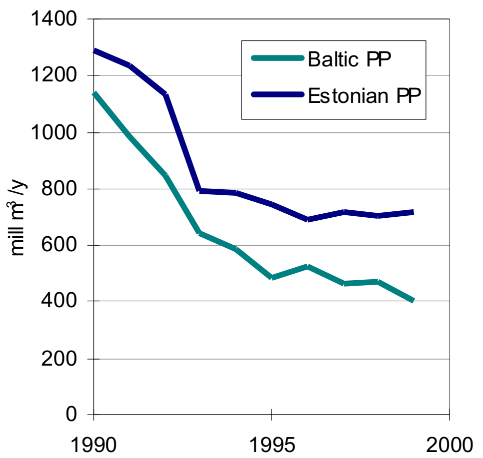


Figure 3.11. Water extraction by power plants (cooling water).

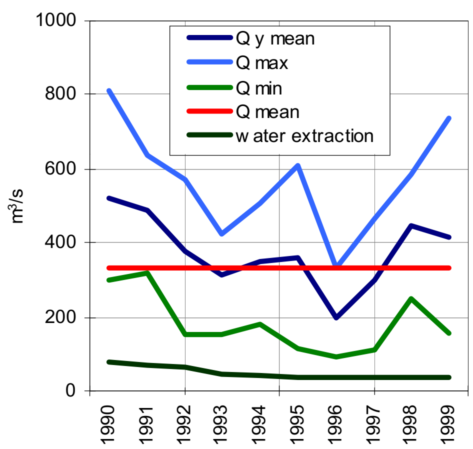


Figure 3.12. Comparison of the extracted cooling water with the runoff of Narva River.

Groundwater extraction for consumption has decreased due to saving of water and economical decline (figure 3.13, where groundwater consumption does not include water extracted from private wells. Mining water includes only the water of oil shale mines of East-Viru County). High price of water service has essentially influenced to use less water. Its result is the increase of water level of best protected and therefore most valuable Cambrian-Vendian aquifer in the regions of most intensive use – Tallinn, Kohtla-Järve, Jõhvi etc. Rise of the groundwater level has been noticed also in other aquifers (Groundwater..., 1999).

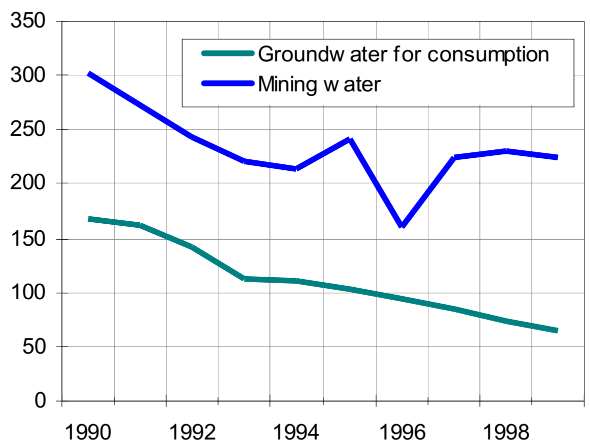


Figure 3.13. Groundwater extraction, million cubic meters per year.

Large amount of groundwater is pumped out for drainage of mines and quarries. Nearly 96% of the whole mining water is pumped in Northeast Estonia from Ordovician aquifer. In mining region the pumping of mining water has caused many inconveniences for local people. The amount of mining water depends on the precipitation and the extent of mining area. As several mines have been closed in recent years, some decrease of mining water can be expected.

Groundwater is pumped from Quaternary (Q), Devonian (D), Silurian (S), Ordovician (O), Ordovician-Cambrian (O-Cm) and Cambrian-Vendian (Cm-V) aquifers. Mining water is originating mainly from Ordovician aquifer (figure 3.14).

Only 5.9 mill. m^3 or 2.6% of mining water in East-Viru County was used in 1999.

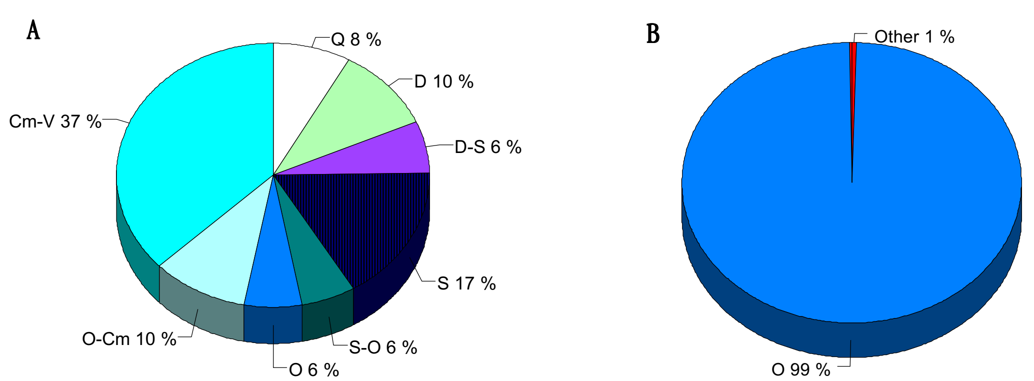


Figure 3.14. Groundwater extraction from aquifers in 1999:
A Groundwater extraction except mining water, B Mining water extraction.

Water consumption started to decrease in the beginning of 1990s, when many industries stopped in new economic conditions (table 3.1 and figure 3.15). Restrictions and orders in water protection were replaced with economic interest: companies are interested in reduction of expenses on water supply and apply saving of water, change technology towards less water consumption. People reacted to sharp increase of the water price with reduction of the use of water. In last 6-7 years many water meters have been installed in apartments, which gives sense to the saving of water at home. To save water, aged sanitary equipment and pipes inside the buildings are replaced. In agricultural regions the number of farms and inhabitants of multi-storey houses has decreased. Until the beginning of 1990s the use of water by inhabitants of rural settlements was also considered agricultural use of water. Later it was separated into domestic use.

Table 3.1. Water extraction and consumption, million m³ per year.

	1992	1993	1994	1995	1996	1997	1998	1999
Total extraction, incl:	**2 709**	**2 082**	**1 989**	**1 850**	**1 700**	**1 698**	**1 670**	**1 533**
_surface water	2 221	1 654	1 568	1 430	1 373	1 306	1 284	1228
_groundwater, incl.	409	352	343	350	257	322	316	299
from aquifers	142	113	110	103	94	85	73	65
mine drainage water	268	239	233	247	163	237	243	234
mineral water	0.005	0.016	0.007	0.007	0.007	0.009	0.011	0.008
_sea water	79	76	77	70	70	70	70	5.6
Groundwater extraction by aquifers								
_Quaternary	25.6	6.4	6.5	6.0	6.1	13.3	5.4	5.3
_Devonian	18.8	13.0	11.9	11.3	9.9	8.7	7.4	6.7
_Devonian - Silurian	14.6	8.4	8.6	7.0	6.6	5.8	5.1	4.1
_Silurian	19.6	15.5	15.1	15.2	13.7	13.2	11.1	11.0
_Silurian - Ordovician	13.7	14.2	11.4	9.5	8.4	7.5	6.6	4.6
_Ordovician	251.1	236.8	230.4	248.3	165.8	231.2	245.0	236.5
_Ordovician - Cambrian	20.0	17.1	17.2	12.5	10.9	9.8	8.5	6.9
_Cambrian - Vendian	42.6	40.5	41.6	40.2	35.8	32.3	27.1	24.0
Total water consumption, incl:	**2 440**	**1 814**	**1 725**	**1 567**	**1 504**	**1 434**	**1 403**	**1 274**
by types								
_domestic	104	99	92	88	87	76	61	53
_industry	125	75	69	62	61	63	57	52
_cooling	1 985	1 441	1 372	1 237	1 221	1 187	1 176	1 124
_agriculture	30	13	10	8	7	6	5	4.5
_fish-rearing	151	156	149	154	115	90	92	33
_other	45	30	33	18	13	12	11	7.2

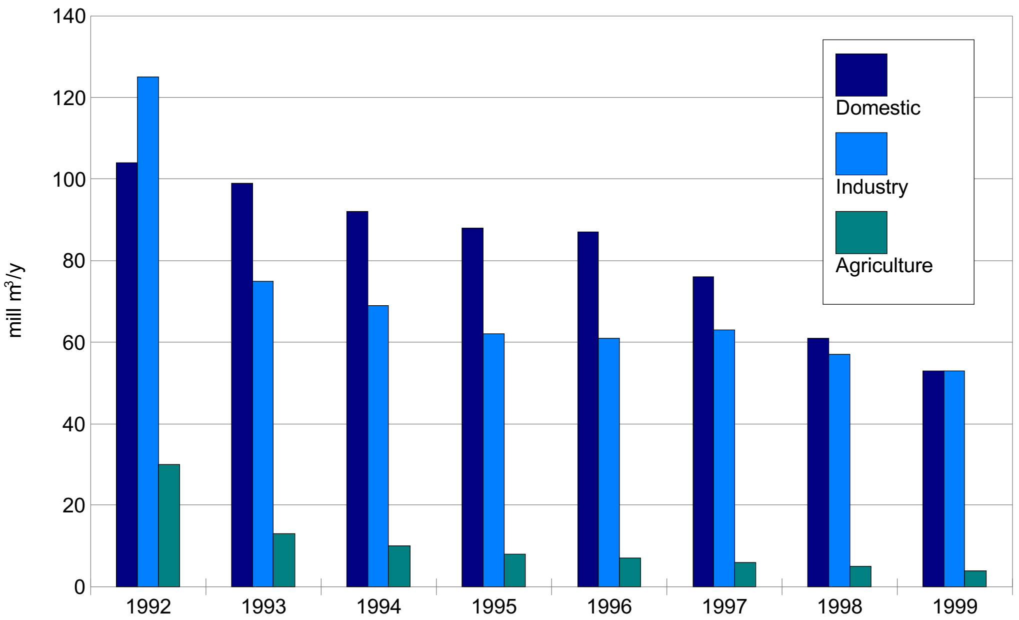


Figure 3.15. Water consumption, million m³ per year

An example of trends in water use is on figure 3.16. Water pipelines and equipments were in very bad condition, losses were high. Efforts made by a water company (Järve Vesi) to improve equipment had good results. The line which illustrates the decrease of losses is showing the extent of repair and replacement of water pipelines. The decreased amount of domestic water is showing its saving by consumers. For its activity Estonian Water Association and Oras Ltd gave special water saving award for that company.

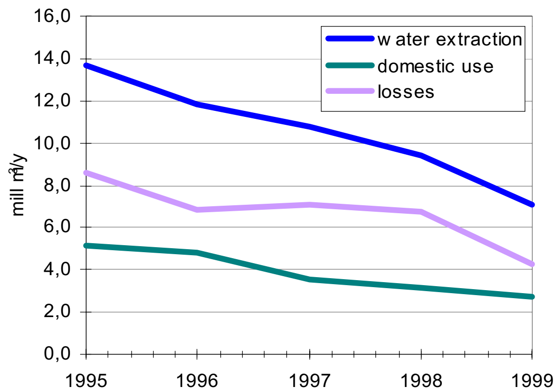


Figure 3.16. Water extraction and use in service area of AS Järve Vesi.

The relatively high price of drinking water has great influence on water saving. The price of water on figure 3.17 is an average of the prices of water sold to people and companies (Newsletter..., 2000). In some towns the difference in prices is multiple. Further aim is equalization of prices. The price is formed by expenses on water production, investments and economical-political decisions. For the consumer, wastewater sewerage price, which is usually higher than the price of drinking water is added to the price of drinking water. In medium-sized and small towns the number of population and industrial production level is lower and the costs on sewerage and wastewater treatment are higher. Average price of drinking water in the beginning of 2000 was 6.6 EEK/m^3, sewerage price 8.8 EEK/m^3.

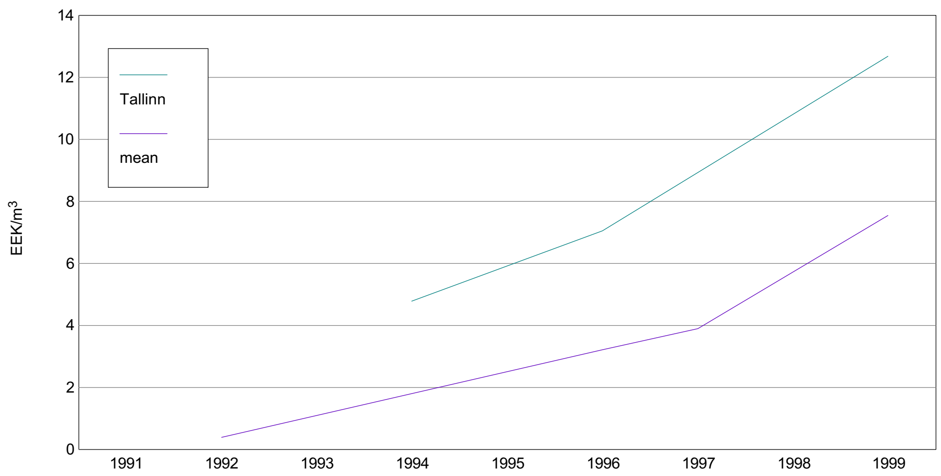


Figure 3.17. Price of drinking water.

3.2.2. Pollution load from point sources

Table 3.2. Wastewater discharge, mill. m^3/y	1992	1993	1994	1995	1996	1997	1998	1999
Total wastewater discharge, incl	2 692	2 063	1 962	1 849	1 692	1 686	1 671	1 532
--no treatment needed	2 239	1 667	1 582	1 452	1 375	1 337	1 343	1 219
--needs treatment	449	393	378	396	316	349	327	312
--untreated	21	23	19	18	15	10	8	6.8
--treated, incl	427	370	359	378	301	339	318	305
mechanically	203	188	186	203	138	184	172	171
biologically	111	86	87	89	85	82	73	64
physical- chemically	113	82	1	1	1	1	1	0.7
biological - chemically		13	84	85	77	72	73	69

Decrease of pollution load in the beginning of 1990s is caused by decrease of industrial production (figures 3.18-3.20). Production of pulp, superphosphate, nitrogen fertilizers etc. was stopped. Production of food industry decreased. Many industries have been restored in later years, but stoppages still occur.

Further decrease of pollution has been achieved with implementation and/or renovation of treatment plants. Essential role has been played by intentions of companies to reduce pollution charge by reducing the amount of water as well as implementation of cleaner technology. Overview of the pollution load of counties and towns according to BOD_7 is given on the figure 3.21.

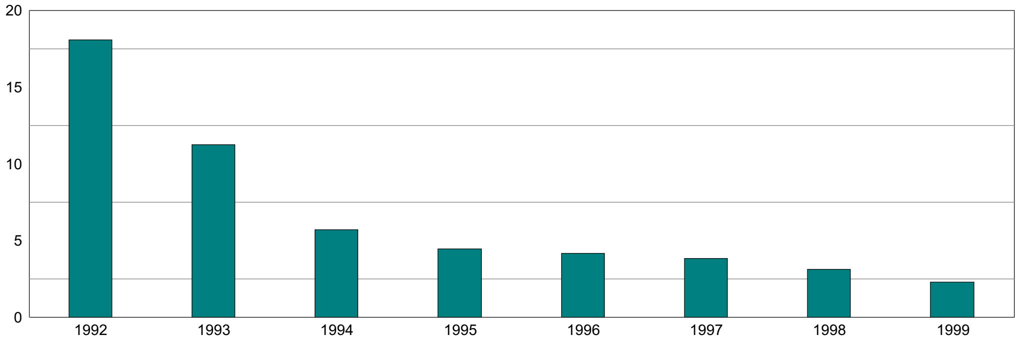


Figure 3.18. Pollution load according to BOD_7 (thousand tons/year).

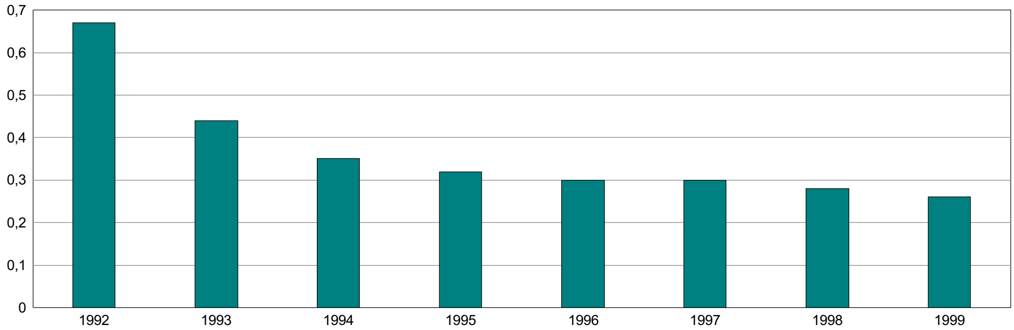


Figure 3.19. Pollution load according to P_{tot} (thousand tons/year).

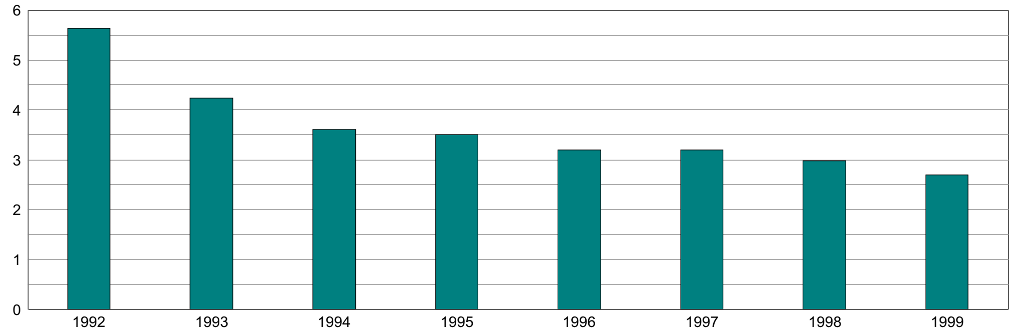


Figure 3.20. Pollution load according to N_{tot} (thousand tons/year).

Table 3.3. Pollution load, tons per year.

	1992	1993	1994	1995	1996	1997	1998	1999
BOD_7	18 080	11 250	5 710	4 480	4 174	3 838	3 122	2 308
P_{tot}	673	445	353	321	304	303	279	256
N_{tot}	5 640	4 240	3 610	3 500	3 200	3 173	2 976	2 739
sulphates	102 000	107 550	87 840	92 940	64 650	85 225	85 724	93 722
chlorides	14 600	12 830	13 880	14 000	10 550	12 011	8 432	7 082
oil products	154	127	76	93	70	83	68	52

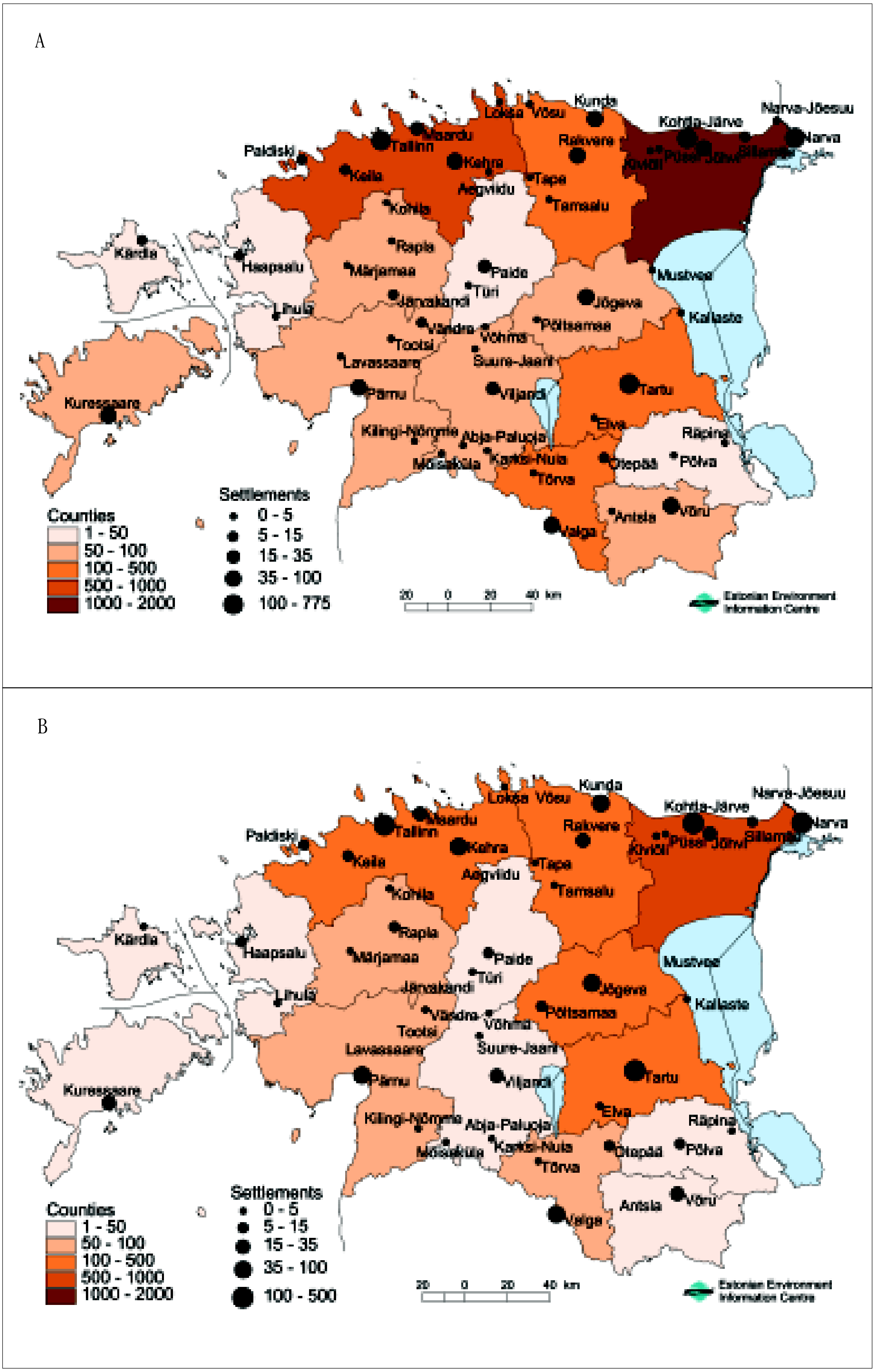


Figure 3.21. Pollution load by BOD_7 (tons O_2/year) of the year 1998 (A) and 1999 (B).

Nitrogen removal at wastewater treatment is expensive and still not widespread. New treatment plants are designed with the removal of nitrogen.

One of the biggest rare metal and rare earth metal producers in Europe - Silmet - used a lot of nitrogen in its technical processes. There were no direct outlets but a considerable amount of nitrogen leaked from the waste storage. For example, the nitrogen load of the plant calculated indirectly was in 1995 equal to the load of Tallinn. That load was not given in main table and figure of water management due to non-exact calculation. In last years some changes were made to improve the technology. Instead of ammonium bicarbonate, the sodium carbonate is used. The amount of the used reagent decreased. Since 1998 the amount of nitrogen leaked from waste deposit was added to the total sum of nitrogen load from Estonia. There was no increase of nitrogen because added amount was compensated with better removal of nitrogen in other places around the state.

Photo 3.2. View to the Sillamäe plant and its dump hill from the eastern part of the seashore.

The pollution load from point sources is biggest in the catchment area of Gulf of Finland (excl. catchment area of Lake Peipsi, which geographically also belongs to that catchment area). Load in the catchment of Lake Peipsi has essentially decreased in recent years due to the completion of Tartu wastewater treatment plant (figure 3.22).

Larger towns, which discharge their wastewater directly into the Gulf of Finland, are Kohtla-Järve and Tallinn (figure 3.23). The population of Kohtla-Järve is smaller than that of Tallinn, but its pollution has much greater impact. Renovation of treatment plant is in progress there. Wastewater treatment plant of Tallinn has achieved excellent results. Towns with lower pollution load in the catchment of the Gulf of Finland are Paldiski, Loksa and Sillamäe. The greatest pollution source of the Gulf of Riga is Pärnu, which treatment plant has been renovated during several years. Haapsalu, Kärdla, Kuressaare etc. discharge their wastewater directly into the Belt Sea.

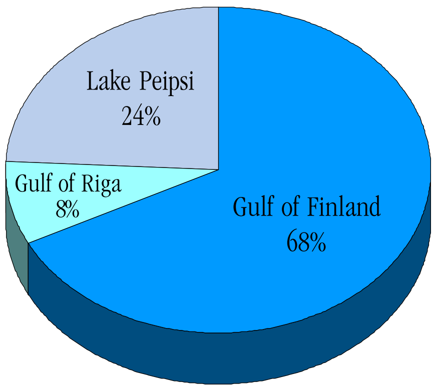


Figure 3.22. Pollution load from point sources according to BOD_7 by catchments in 1999.

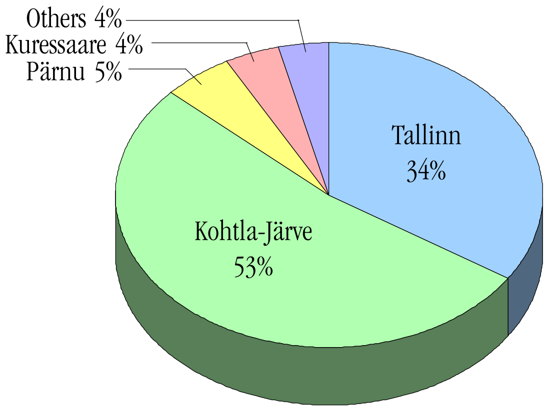


Figure 3.23. Pollution load according to BOD_7 directly into the sea in 1999.

Figure 3.24 shows the treatment level of water needing treatment. The amount of wastewater has decreased throughout the years due to the decrease of water consumption. Very high percentage of mechanical treatment is caused by mining water, which is treated in large sedimentation basins. High value of biological-chemical treatment in 1992 is formed by water treated in the wastewater treatment plant of Tallinn, where coagulant was used, but no aeration tanks. In 1993-1995 aeration tanks were constructed and later improved. Therefore the efficiency of treatment has increased. At the same time there are several biological treatment plants, which efficiency is low and which need renovation. Also the total number of biological treatment plants is constantly decreasing. When 10 years ago ca 1080 treatment plants operated, then after the splitting of large collective farms into small units the number of cattle decreased as well as number of people in central settlements and several small treatment plants in rural regions were stopped.

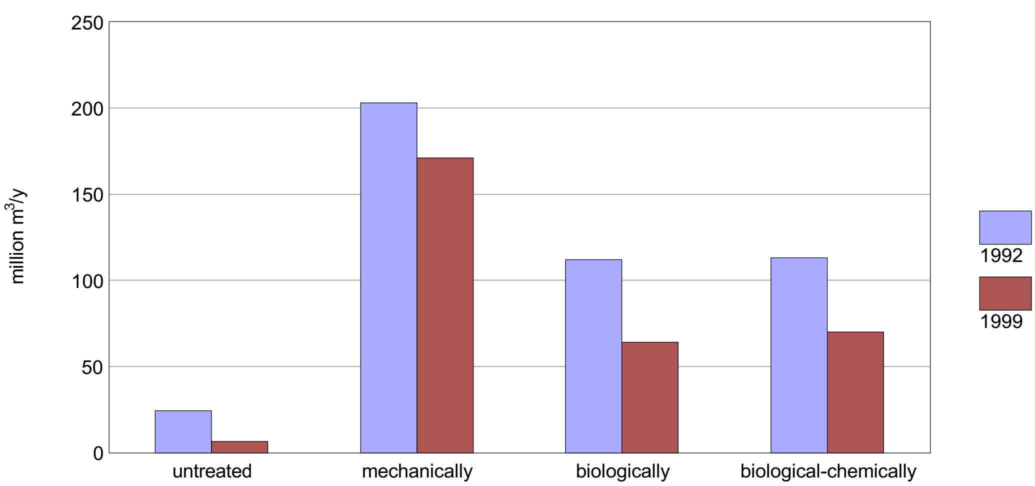


Figure 3.24. Wastewater treatment, million m³ /year.

Decrease of pollution load from larger towns is caused by their better possibilities to construct and renew their treatment plants (figure 3.25). Kohtla-Järve treatment plant was planned as regional, i.e. also wastewater of Kiviõli, Püssi and from the middle of 1999 also Jõhvi wastewater is led there. But renovation of the treatment plant is not finished. The II stage of wastewater treatment plant of Tallinn was completed in 1997. Saku, Tabasalu, Saue etc. have joined the sewerage of Tallinn. Completion of Tartu wastewater treatment plant and enlargement of sewerage in 1998 have given good results. Narva treatment plant is gradually renewed.

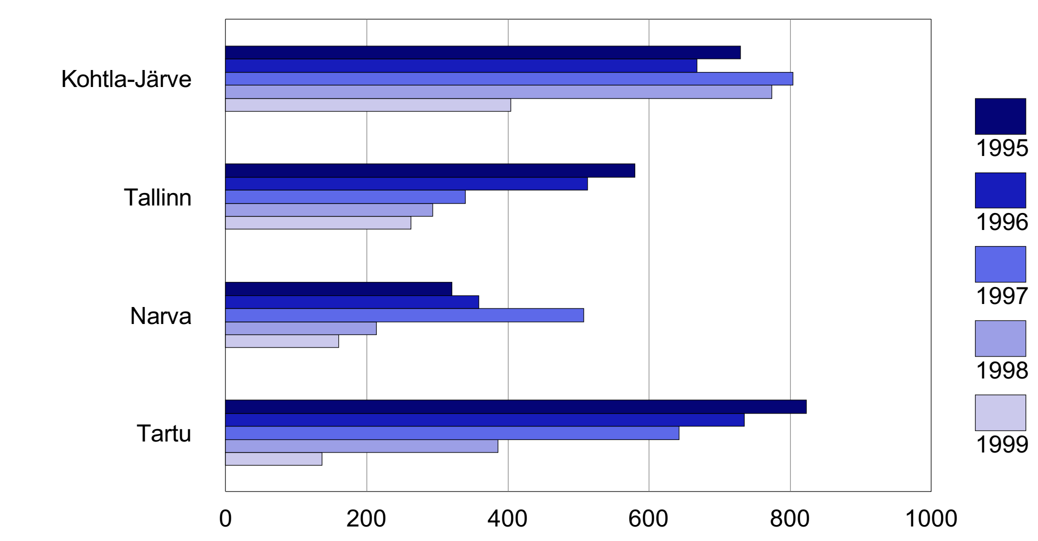


Figure 3.25. Pollution load of larger towns, BOD_7, t/y

Also several smaller towns have achieved good results on wastewater treatment (Haapsalu, Tapa, Pärnu, Paide, Põlva, Türi etc.). At the same time, in smaller settlements financing of the construction of treatment plants from their own budget is rather difficult due to small number of population (figure 3.26).

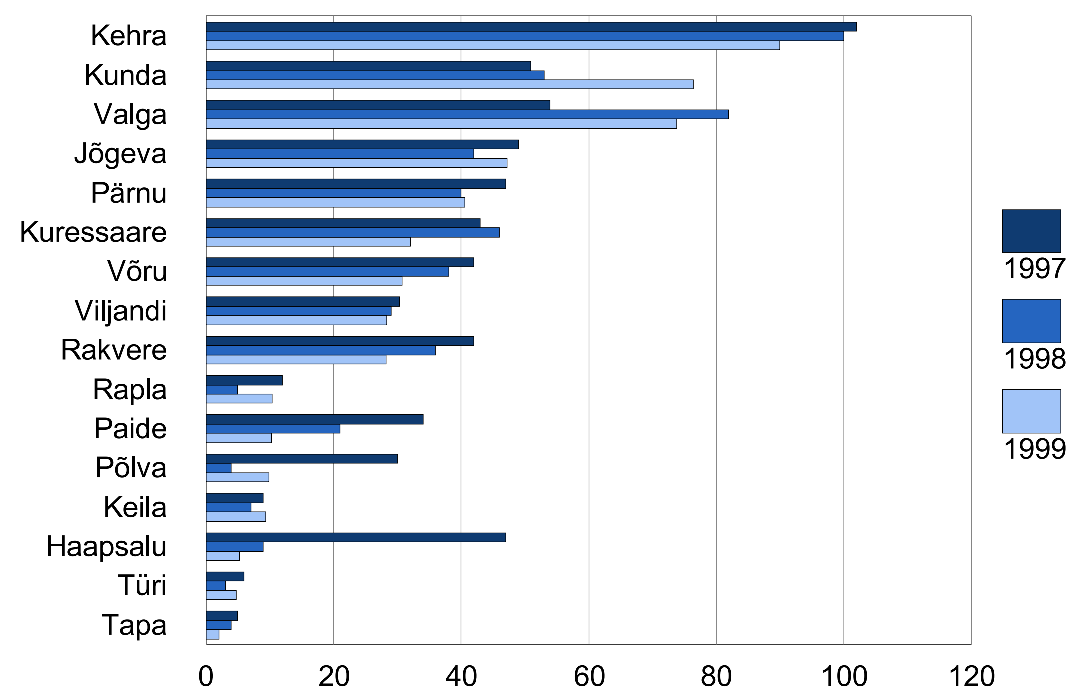


Figure 3.26. Pollution load of towns according to BOD_7, t/y

3.3. Status

3.3.1. Introduction

Status of rivers, lakes and gulfs is depending on natural conditions of the catchment and activities of people in the region. Natural chemical content of the water is determined by climate, geological conditions and soil. Pollution sources for waterbodies are wastewater of settlements and industry, agricultural leakage water from fields and manure pits, wastewater of farms, amelioration, regulation of waterbodies, recreational use of waterbody, forest cutting etc.

Management of waterbodies is basing on information of the water quality of catchment. Information of water quality enables to guide development of water management, helps to make decisions in the field of water consumption and environmental protection through water permits, site selection of construction and submission of construction conditions; to establish restrictions to production and pollution; to select production and wastewater treatment technology; to determine priorities on financing and develop legislation.

To simplify the management of waterbodies it is practical to classify waterbodies according to water quality. The basis for classification of rivers and lakes is EU water framework directive and corresponding regulation of the Minister of the Environment on the water quality classes. According to the draft of regulation the classification will be based on deviation from natural condition of rivers and lakes, first setting limits mainly to chemical parameters. According to the EU water framework directive Member States should aim to achieve the objective of at least good water status by defining and implementing the necessary measures within integrated programmes of measures, taking into account existing Community requirements. Basis for evaluation of water quality in case of rivers is occurrence probability of 90%, i.e. 90% of all samples must correspond to the limit values of the class. In case of lakes average of the whole water column will be determined. The programme of water protection measures must be worked out for those waterbodies, which water quality does not meet the requirements.

Basing on the data of the national monitoring of rivers and lakes, proceeding from limit values of the draft regulation of the Minister of the Environment, it can be said that water quality of most of Estonian rivers and lakes is sufficient at the moment.

Hydrobiological water quality of rivers is monitored on national level by the Institute of Zoology and Botany. Chemical quality of water is monitored under the coordination of the Institute of Environmental Technology of Tallinn Technical University in 42 rivers, 58 measuring stations with more than 20 chemical parameters 6-12 times in a year.

The development of water quality classes for rivers based on following indicators: pH, dissolved oxygen, content of organic substance, ammonium, total nitrogen, total phosphorus, phenols and heavy metals.

Main indicators of water quality are nutrients, nitrogen and phosphorus compounds, also organic matter. In case of their abundance waterbodies will eutrophicate. The result will be the disturbing of sanitary, chemical, hydrological and biological balance of the waterbody.

Photo 3.3. One can still find both, very polluted and almost untouched waterbodies in Estonia.

3.3.2. Rivers

Content of easily degradable organic matter according to biochemical oxygen demand BOD_7

Content of easily degradable organic matter in nationally monitored rivers is relatively low. By the content of organic matter (BOD_7) the water quality of rivers was good or complying with Class II in 99% of the national monitoring stations in 1994. In 1999 water quality of all stations was good.

Biochemical oxygen demand (BOD_7) of natural river water is as a rule less than 2 mg0_2/l. Such value was measured in the rivers Vihterpalu, Pudisoo, Reiu, Saarjõgi, Oostriku, Kunda, Õhne, Ahja (upper course) and elsewhere. Higher oxygen demand was measured in rivers, in which catchment area mires play great role, in bog water of Linnusaare and Männikjärve up to 6 mg0_2/l at places. The content of organic matter is also higher in the rivers Purtse and Pühajõgi, where large amounts of poorly treated wastewater are discharged (figure 3.27).

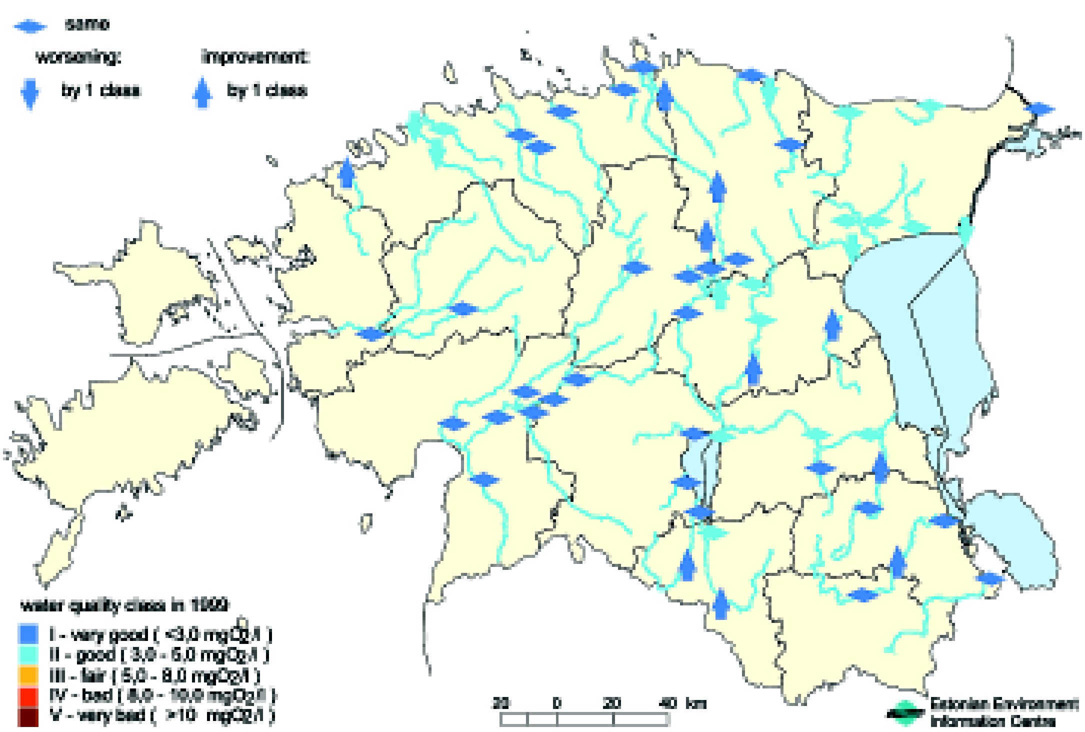


Figure 3.27. Changes in water quality in national monitoring stations of Estonian rivers according to BOD_7 in 1994-1999.

Phosphorus

According to monitoring data of 1999 general water quality of rivers by total phosphorus has improved during the last five years (figure 3.28). In 1994, 47% or less than one half of stations belonged at least into Class II, in 1999 already 63% or 14% more than in 1994. Phosphorus content corresponding to natural water is usually below 0.05 mgP/l, which was measured in 1999 in the rivers Halliste, Vodja, Reiu, Velise, Vaskjala-Ülemiste Canal, Linnusaare brook and bog water, the rivers Oostriku, Kunda, Valgejõgi, Preedijõgi etc. 84% of all samples showed total phosphorus content below critical level causing eutrophication, which is 0.1 mgP/l. Compared to earlier times, much worse results were gained in 1999 in Tagajõgi, Tõlliste station of Väike-Emajõgi and Oreküla station in Pärnu River. The condition has improved in Tänassilma and Tarvastu rivers. Phosphorus content is high in Pühajõgi and Seljajõgi rivers, which is caused by the insufficiently treated wastewater. Phosphorus content in river water is the highest in rivers falling into the Gulf of Finland, which is referring to the need to use phosphorus removal in wastewater treatment plants.

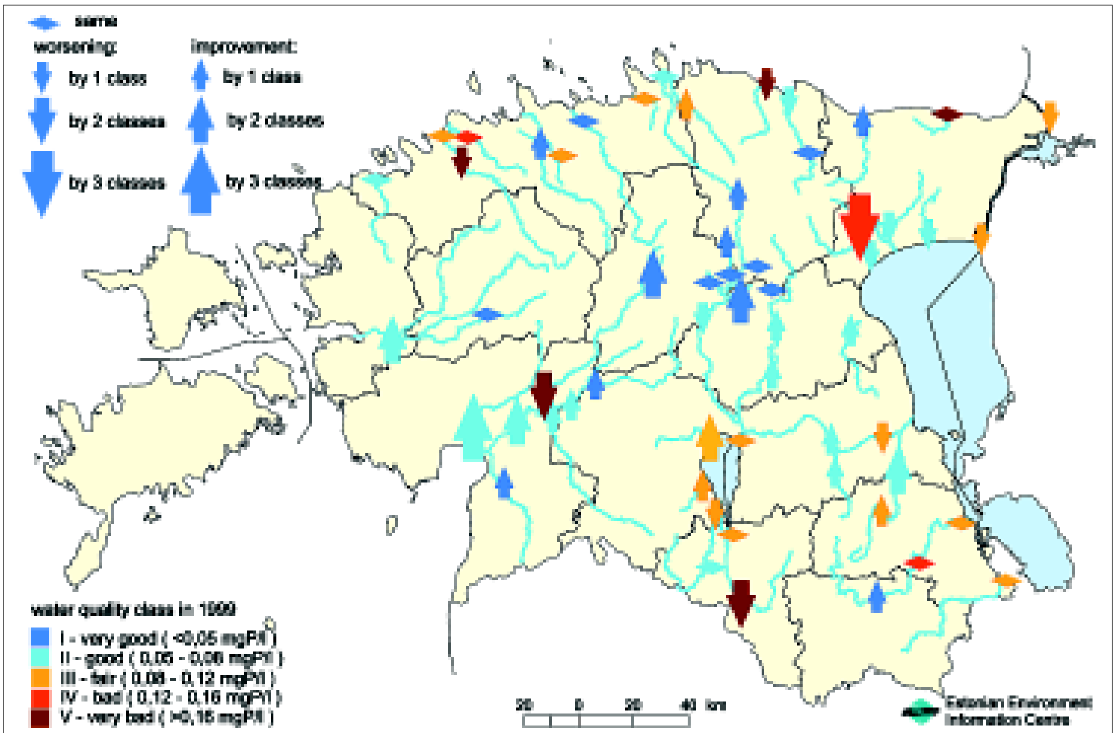


Figure 3.28. Changes in water quality in national monitoring stations of Estonian rivers according to P_{tot} in 1994-1999.

Nitrogen

General level of nitrogen content in Estonian rivers is relatively high. During the last five years the status of rivers concerning of nitrogen content has not changed much (figure 3.29). In 1999 water quality was excellent or good in 64% of monitored stations. Compared to 1994 the number of stations where the water complied with Class I (excellent quality) has increased 10%. Nitrogen content of natural water is usually below 3 mgN/l, higher values refer to the

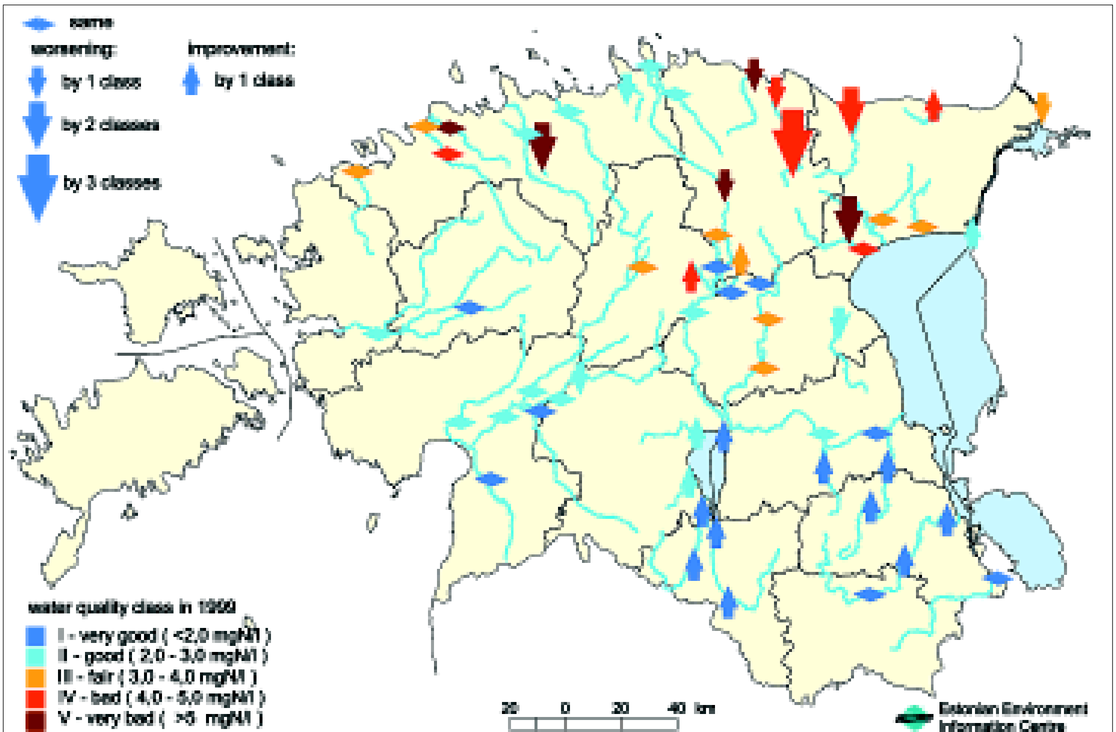


Figure 3.29. Changes in water quality in national monitoring stations of Estonian rivers according to N_{tot} in 1994-1999

impact of human activities. Regional peculiarities can be noticed in nitrogen content of rivers. Nitrogen content of rivers is relatively high in rivers falling into the Gulf of Finland, as the rivers Vääna, Seljajõgi, Purtse and Pühajõgi, exceeding 6 mgN/l. On the contrary, in Linnusaare and Männikjärve bog stations very low nitrogen content has been measured, in most cases below 1 mgN/l. Nitrogen content is highest in the rivers Oostriku, Preedi, Lavi springs of Kunda River and Porkuni monitoring station of Valgejõgi.

3.3.3. Lakes

National monitoring in 1999 was carried out on Lake Peipsi, Lake Võrtsjärv and eight small lakes, Nohipalu Mustjärv, Nohipalu Valgjärv, Pühajärv, Rõuge Suurjärv, Lake Uljaste, Viitna Pikkjärv, Ähijärv and Mullutu Suurlaht. On lakes Peipsi and Võrtsjärv hydrochemical observations were performed by Tartu Environmental Research Centre and biological observations by the Limnology Station of Lake Võrtsjärv of the Institute of Zoology and Botany. Hydrochemical as well as biological monitoring of small lakes was carried out by the Limnology Station of Lake Võrtsjärv.

Classification basis of the lakes in Estonia is their ecological type. Different limit values have been proposed for the three lake types. Limits are set for pH, total phosphorus, total nitrogen, chlorophyll-a, transparency of water, content of organic matter, sulphate content and extent of metalimnion in summer stagnation period depending on the type of lake.

The eutrophication is still common process for Lake Peipsi, Lake Võrtsjärv as well as for small lakes. Although in connection with the decrease of human impact the condition of many lakes has improved. However, changes in water quality caused by climate and water level remain.

Nitrogen

In 1970s and 1980s Estonian lakes were strongly influenced by fertilizers and wastewater of farms, which caused rapid eutrophication. After the splitting of collective farms agricultural production decreased and in the beginning of 1990s the condition of lakes, especially small lakes, started to improve (figure 3.30). Eutrophication of lakes slowed down, nitrogen content of lake water decreased. Livening of economy brings inevitably along the increase of pressure on water resources. Increase of eutrophication can be expected again in near future.

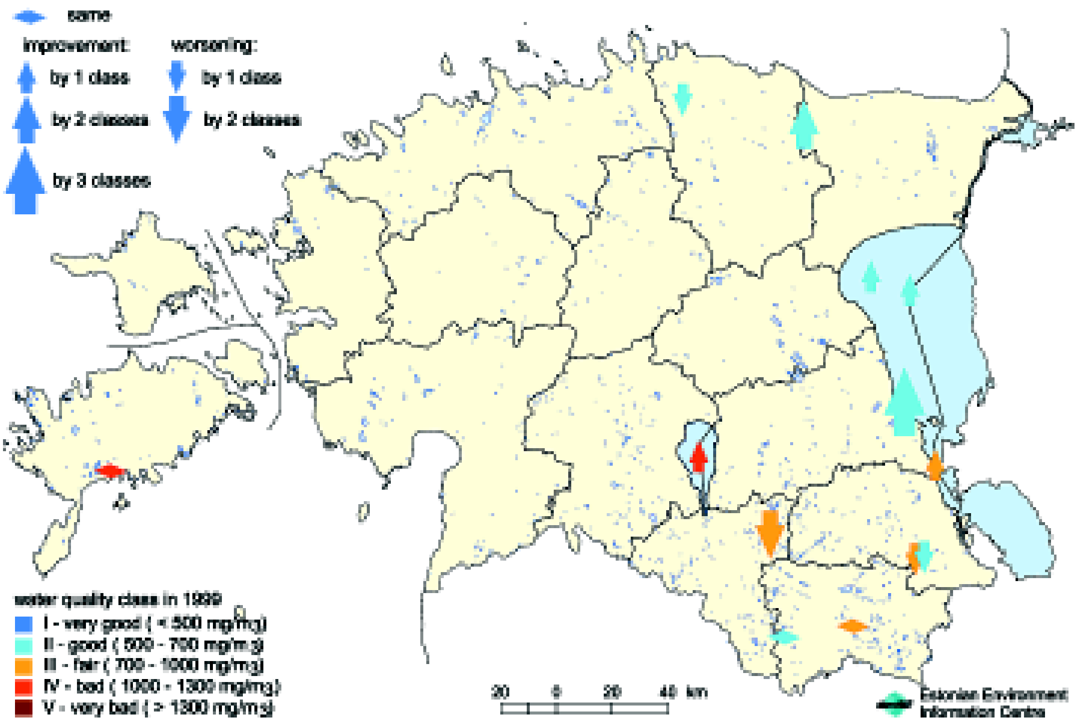


Figure 3.30. Changes in water quality in national monitoring stations of Estonian lakes according to N_{tot} in 1994-1999.

According to national monitoring of lakes in 1999 the total nitrogen content in Nohipalu Valgjärv, Lake Uljaste and most monitoring stations of Lake Peipsi corresponded to good or II Class of quality . Water of Nohipalu Mustjärv, Pühajärv, Viitna Pikkjärv and Ähijärv (first state monitoring data from 1996) did not correspond to good quality in 1999 any more, whereby monitoring data of three last lakes used for recreational purposes refer to human impact. Water quality of Lake Peipsi shows signs of improvement, especially in the estuarial waters of the river Emajõgi. Nitrogen content of Lämmijärv and Võrtsjärv is still high. Results from Mullutu Suurlaht, littoral lake, which was first switched into the state monitoring network in 1999, show correspondance to class IV, which means that the lake is extremely rich in nitrogen compounds. Nitrogen content of the bottom layer of Rõuge Suurjärv, the deepest lake in Estonia, is still very high.

Phosphorus

According to the data of the Limnology Station of Lake Võrtsjärv, content of phosphorus has decreased in Estonian lakes (figure 3.31). Nitrogen-phosphorus ratio is in most cases over 16, which indicates that phosphorus is limiting the development of phytoplankton and macrophytes. Total phosphorus content in lakes, belonging into national monitoring network, corresponded in most cases at least to good or II class of quality according to the observations of 1999. Excellent results belonging into class I of water quality were gained in lakes Nohipalu Valgjärv, Pühajärv, Uljaste and Mullutu Suurlaht. Monitoring results from lakes Viitna Pikkjärv, Nohipalu Mustjärv, Võrtsjärv and most places of Lake Peipsi corresponded to class II. Phosphate content in lake Rõuge Suurjärv has not improved. In surface layers total phosphorus content is low and is corresponding to class I, in bottom layers the phosphorus content is very high. According to average total phosphorus content of the whole water column of lake Rõuge Suurjärv belongs into class V. Compared to the data of 1994, phosphorus content of Viitna Pikkjärv has worsened by one class, still remaining within the values of class II. The condition of lake Lämmijärv is worsening. Trophic level of Lake Peipsi increases towards south, because main pollution is discharged into the lake with wastewater from that region.

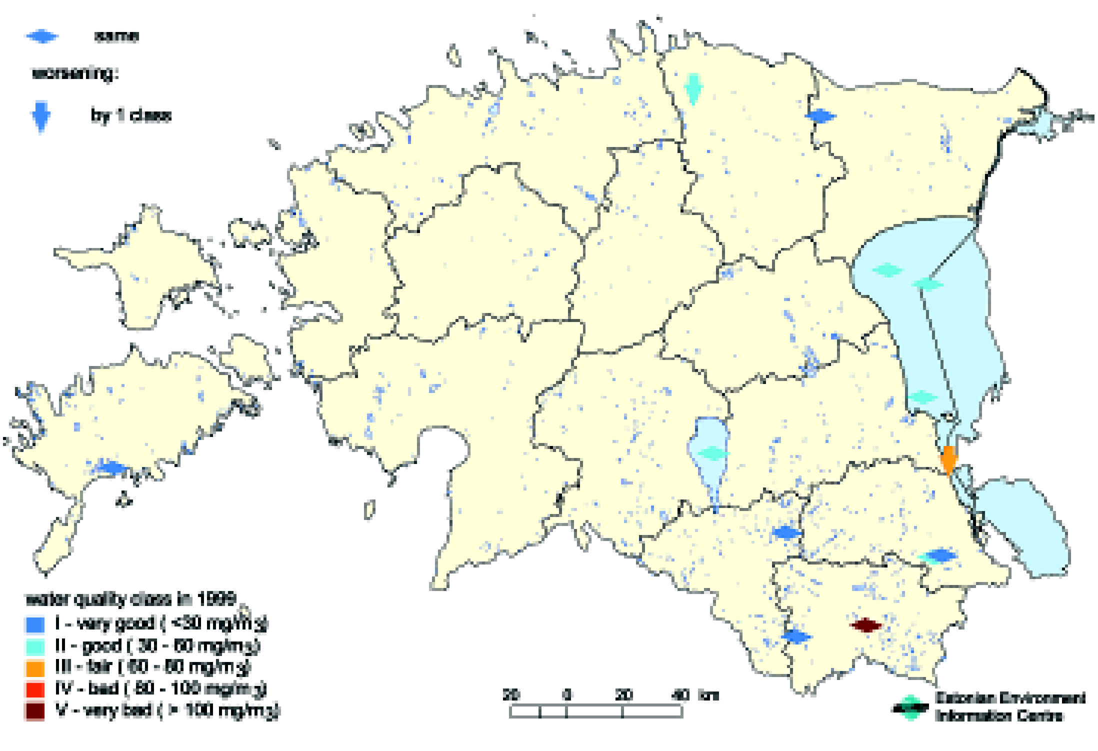


Figure 3.31. Changes in water quality in national monitoring stations of Estonian lakes according to P_{tot} in 1994-1999.

3.3.4. Groundwater

Monitoring and water quality data of observation regions of state groundwater observation network

Responsible implementor of state groundwater monitoring is the Geological Survey of Estonia, whose materials and conclusions have been used on the compilation of this article.

Changes in groundwater condition were monitored in 1999 on state monitoring network, which consists of seven observation regions (or) with different hydrogeological conditions, technogeneous factors and pollution load as follows (figure 3.32):

- natural conditions on the whole territory of Estonia (VII or), incl. the West-Estonian Archipelago (VI or) and Pandivere Upland (II or);
- conditions of intensive water extraction: coastal water intakes – Tallinn (I or), Kohtla-Järve – Sillamäe (III or) and Pärnu (V or) and inland – Tartu (IV or);
- conditions of water discharge from mines and quarries and impact of industrial pollution at East-Viru County (III or).

Observation wells (ow) of state groundwater monitoring network are divided by aquifers as follows: Quaternary aquifer – 111 ow, Middle-Devonian aquifer – 11, Middle-Lower Devonian-Silurian aquifer – 13, Silurian-Ordovician aquifer – 142, Ordovician- Cambrian aquifer – 25, Cambrian-Vendian aquifer – 60 and Lower Proterozoic aquifer – 5, altogether 367 observation wells.

Groundwater level was measured at 345 observation wells with frequency of 3 times per month in uppermost aquifers and once in a month in deep aquifers. In 13 observation wells groundwater level was measured episodically.

In order to monitor the changes in groundwater chemical composition , 44 water samples were taken for general chemical analysis from 38 observation wells and 18 water samples for limited analysis. Water samples were analyzed in the laboratory of the Estonian Geology Center and chemical laboratory of Saaremaa Health Protection Inspectorate.

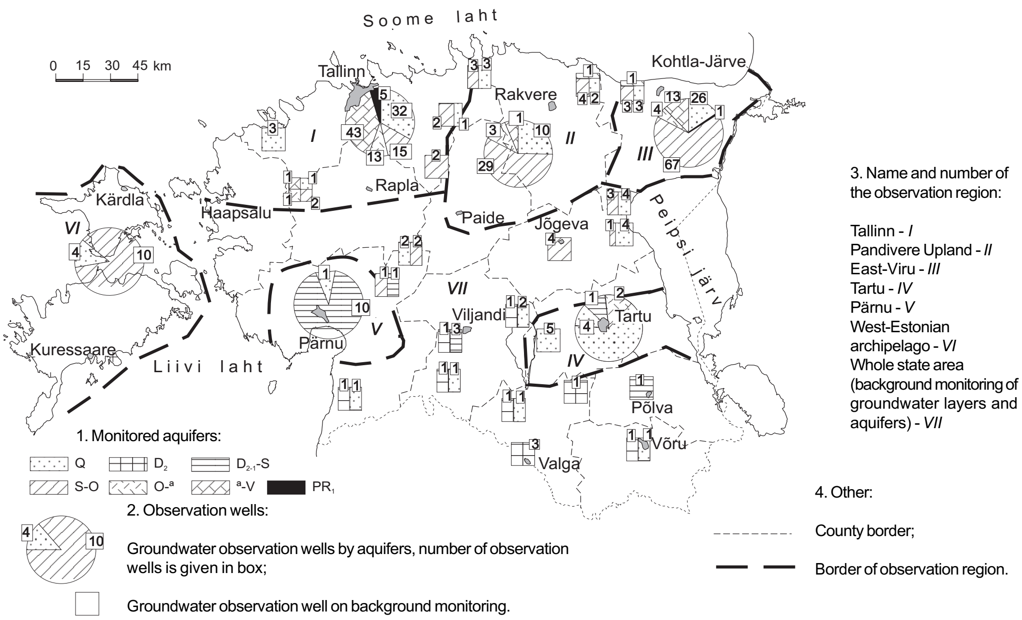


Figure 3.32. State groundwater monitoring network in 1999.

In the chemical composition of **uppermost aquifers** the increase of nitrate content was measured according to the data of single water samples taken in natural conditions in ow 1310 (Maidla, Rapla County – 1999 – 31.3 mg/l, 1996 – 14.2 mg/l); NO_3 content was essentially decreased in dug well 560-A (Reo, Saare County – 1999 – 4.1 mg/l, 1996 – 41.6 mg/l) and ow 935-A (Raigu, Western-Viru County – 1999 – 14.5 mg/l, 1998 – 22.6 mg/l).

In 1998 an average groundwater level of Quaternary aquifer was 0.1-0.4 m higher than the long-term average, also higher than the water level of 1997. There was the tendency of long-term rise of water level. In Middle Devonian aquifer water level rose by 0.1-1.1 m, in Middle-Lower Devonian-Silurian aquifer by 0.12-0.82 m, in Silurian-Ordovician aquifer by 0.1-1.45 m and in Ordovician-Cambrian aquifer at coastal region of North Estonia by 0.2-0.5 m. In natural conditions the tendency of decrease of mineralization, Cl^-, NO_3^- and SO_4^{2-} content can be noticed.

In the regions of intensive groundwater consumption like Kopli Peninsula in **Tallinn** and in the center of the city average annual groundwater level of Cambrian-Vendian aquifer rose by 0.2-0.8 m and at Nõmme by 2.3 m, which can be explained with the decrease of water extraction. Around Tallinn – at Saku – average annual groundwater level rose by 1.3 m, at Vihterpalu by 0.4 m, at Keila by 0.3 m, at Kuusalu by 0.1 m.

Groundwater chemical composition was mainly stable, except on the Kopli Peninsula in Tallinn, where the chloride content continuously increased in the groundwater of Cambrian-Vendian aquifer. Groundwater quality in Quaternary aquifer is constantly worsening in the regions of larger roads and dwelling areas of Tallinn.

Water extraction from Middle Lower Devonian-Silurian and Ordovician-Cambrian aquifers in **Tartu region** decreased and groundwater level rose by 4.7-7.7 m. Groundwater chemical composition remained mainly stable.

At Vaskrääma water intake in **Pärnu town the** average annual groundwater level of Middle Devonian-Silurian aquifer rose by 0.2 m, but at Reiu water intake the groundwater level decreased in the center of the water intake by 0.6 m. In **Ida-Viru observation region** the recharging of Cambrian-Vendian groundwater level continued. Average annual water level rose compared to the previous year in the center of Kohtla-Järve depression cone by 3.6 m, at Sillamäe – by 2.26 m, at Jõhvi – by 3.46 m, at Viivikonna – by 2.0 m.

Groundwater chemical composition remained stable in most cases, some changes are connected with climatic conditions. In the center of oil shale mines the pollution of groundwater with oil shale ash has been noticed, which indicator is the increased potassium content.

In the region of the influence of **mine dewatering** average annual groundwater level of the uppermost aquifer, the Nabala- Rakvere groundwater layer of the Ordovician aquifer, decreased by 0.9 m. Water level in Keila-Kukruse and Lasnamäe-Kunda aquifers decreased by 0.1-0.2 m, compared to the previous year.

In conclusion the average annual groundwater level of the uppermost aquifers in natural conditions was up to 0.6 m lower in 1999 than the average of 1998 in most regions of Estonia and up to 0.4 m lower than the long-term average.

Continuous decrease of water extraction at larger water intakes in Tallinn, Tartu, Pärnu (Reiu), Kohtla-Järve, Jõhvi and Sillamäe caused recharge of the groundwater level of artesian aquifers. According to the data of the groundwater cadastre the registered water resources increased by the total of 9730 m^3 per day. The total number of new bored wells bored in 1997 and 1998 was 689.

Groundwater chemical composition at water intakes remained stable in most cases, except at Kopli Peninsula in Tallinn, where the salinity of the groundwater of Cambrian-Vendian aquifer continued to increase due to the inflow of groundwater of higher mineralization from the sublaying aquifer.

Groundwater quality and trends in the Pandivere region

In 1999 the monitoring of groundwater quality was continued at Pandivere Water Reserve, which started in Järva County in 1991 and Western-Viru County in 1992. Work was performed by Maves Ltd, on the basis of what this evaluation has been compiled. In monitoring programme main attention was paid to the groundwater of uppermost aquifers, which is mostly influenced by human activity and the aim of the work was to find out the impact of the agricultural activities to the uppermost aquifer.

In monitoring programme of 1999 there were 36 observation points in Pandivere Water Reserve: 14 springs, 6 karst points and 16 wells. Totally of 379 water samples were taken from the observation points, from which NO_3^-, NH_4^+, Cl^- contents were measured; also SO_4^{2-} content was measured in 227 samples.

In 1999 the average annual nitrate ion content in all springs decreased, compared to the previous year. Nitrate ion contents in springwater were higher during spring-summer period. No over-normative contents were fixed in springwater in 1999. As chloride ion content decreased simultaneously, it could be just due to more intensive nutrition of groundwater in the spring period with pure water.

Average annual chloride ion content in the observed **spring massive** in 1999 was 10.5 mg/l (average 10.5 – 18.0 mg/l), decreasing 2.4 mg/l compared to the previous year. Average annual value of sulphate ion in 1999 was 29.3 mg/l, decreasing 3 mg/l compared to the previous year (average 29.3-39.5 mg/l). Ammonium ion content in springs has always been low (average 0.03-0.08 mg/l), also in 1999 (0.03 mg/l).

Most of the observed **bored wells for public water supply** consume the groundwater from Ordovician limestone. Average annual chloride ion content in 1999 in the water of Ordovician wells was 15.8 mg/l (average 15.8-35.4 mg/l), compared to the year 1998 it decreased by 2.8 mg/l. Average annual sulphate ion content in 1999 (32.1 mg/l) remained on the same level compared to the previous year, ranging from 32.1 to 56.8 mg/l. Ammonium ion content in bore wells for public water supply in Järva County has always been close to the laboratory detection limit, also in 1999 (0.02 mg/l).

In 1999 the average annual chloride ion content in **private wells** (13.6 mg/l) decreased by 1.6 mg/l compared to the year 1998, average annual sulphate ion content (32.4 mg/l) decreased by 0.3 mg/l. Ammonium ion contents in observation wells of Järva County have always been low (0.02-0.08 mg/l).

The average annual chloride ion content in **karst observation points** decreased in 1999 by 1.4 mg/l, average annual sulphate ion content by 7.0 mg/l. Compared to wells and springs, the lower nitrate ion content in karst water is caused by great role of rainwater and anaerobic environment, occurring at places in karst lakes. Average annual ammonium ion content in the observed massive decreased by 1.5 mg/l.

Monthly average nitrate ion contents of the uppermost groundwater in different observation sites (springs, private wells, public wells, karst) are given in the figure 3.33. Observations show obvious dependence of groundwater quality on agriculture. If the use of nitrogen fertilizers will not increase suddenly , fluctuation of average nitrate ion content will remain within the range 10-20 mg/l in the group of springs and wells.

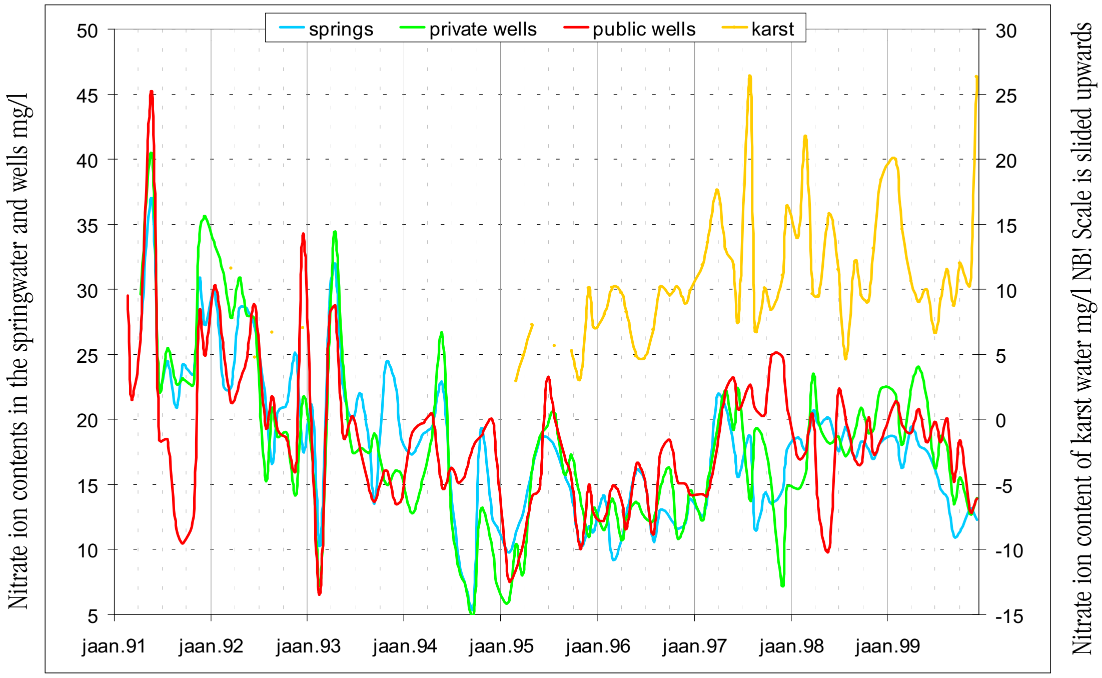


Figure 3.33. Monthly average nitrate ion contents of uppermost groundwater in different observation sites.

3.3.5 Sea

As a country having ratified the Helsinki Convention, the Republic of Estonia has taken responsibility to participate in international monitoring programme of the Baltic Sea (COMBINE).

The goal of state sea monitoring programme is: determination of human impact on the environment and biota of the Baltic Sea and determination of its extent in the context of natural changes, including qualitative and quantitative assessment of the efficiency of taken measures.

Peculiarity of the Baltic Sea, which proceeds from non-periodical renewal of the water of deep layers and hindering influence of halocline on vertical water exchange, is the occurrence of areas with oxygen deficit in the region of abysses (offshore, also in the Gulf of Finland). One sign of eutrophication, which is caused by high productivity of phytoplankton in surface layer and thereby intensified sedimentation processes, is the extension of such areas and quick re-occurrence after the inflow of water rich in oxygen.

According to the data of Helsinki Commission (HELCOM) in 1999 the water of offshore part of the Baltic Sea was influenced by hydrogen sulfide and oxygen deficit was the greatest in last 15 years. Main reason for that was weak water exchange with the North Sea in the winter 1998/1999. In 1999 the increase of hydrogen sulfide contents continued in eastern part of Gotland abyss at the depths over 150 meters. Due to weak water exchange with the North Sea occurrence of hydrogen sulfide was noticed first time after mid-80s in August 1999 also in western part of the abyss. Decrease of oxygen content from the beginning of 1990s has been noticed also in bottom water layers of the Gulf of Finland (figure 3.34). In connection with oxygen deficit zoobenthos disappeared in 1998/1999 from large sea areas in the region of abysses. In 1999 zoobenthos populated these regions in the Baltic Sea, which depth did not exceed 96-97 m.

Some hope for the improvement of oxygen conditions in the Baltic Sea (first and foremost abysses) was given by the intrusion of three more salty and oxygen-rich water masses with total volume 92 km^3 from the North Sea into the Baltic Sea from the end of September till the beginning of December 1999. However, the mentioned data require additional control.

From the standpoint of the strategy of environmental protection it is important to evaluate limiting biogenous matter in different sub-basins of the sea (figure 3.35). Optimal ratio of biogenous matter for initial production of phytoplankton is N:P = 16:1 (Redfield number). If N:P ratio is less than 16, nitrogen is limiting, otherwise – phosphorus. Since 1993 decrease of concentrations can be noticed in case of nitrogen as well as phosphorus. Maximum winter concentrations of biogenous matter have decreased in recent years (especially nitrogen compounds), but nitrogen-phosphorus ratio has changed towards favorable for the exuberance of blue-green algae, especially in summer 1999, when the temperature of surface layer of sea water was 2-3°C higher than the average of many years.

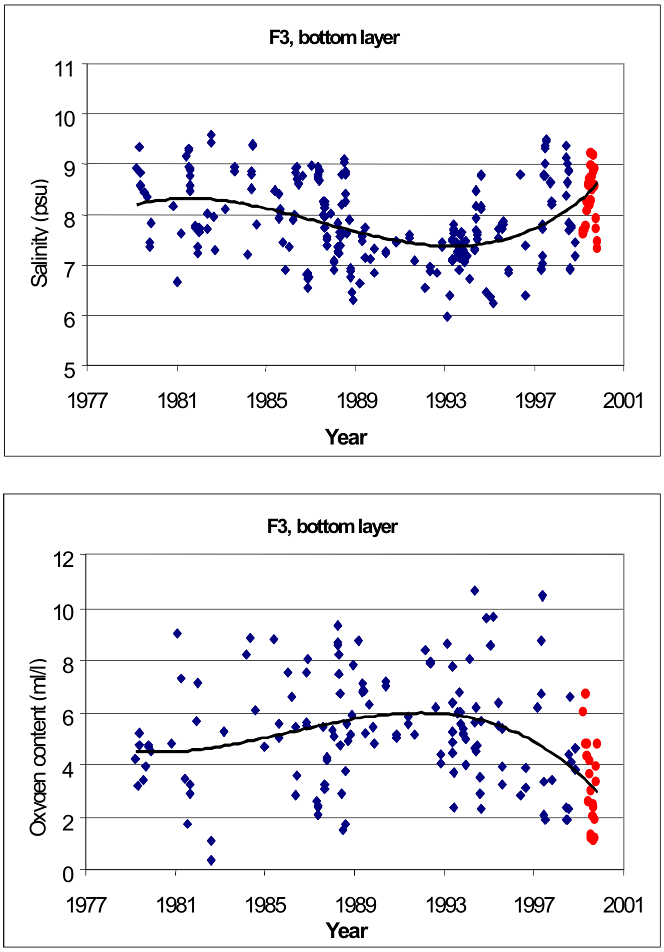


Figure 3.34. Fluctuation of salinity and oxygen content of bottom layer in middle part of the Gulf of Finland (station F3; 1979-1998 – blue rhombs, 1999 – red circles).

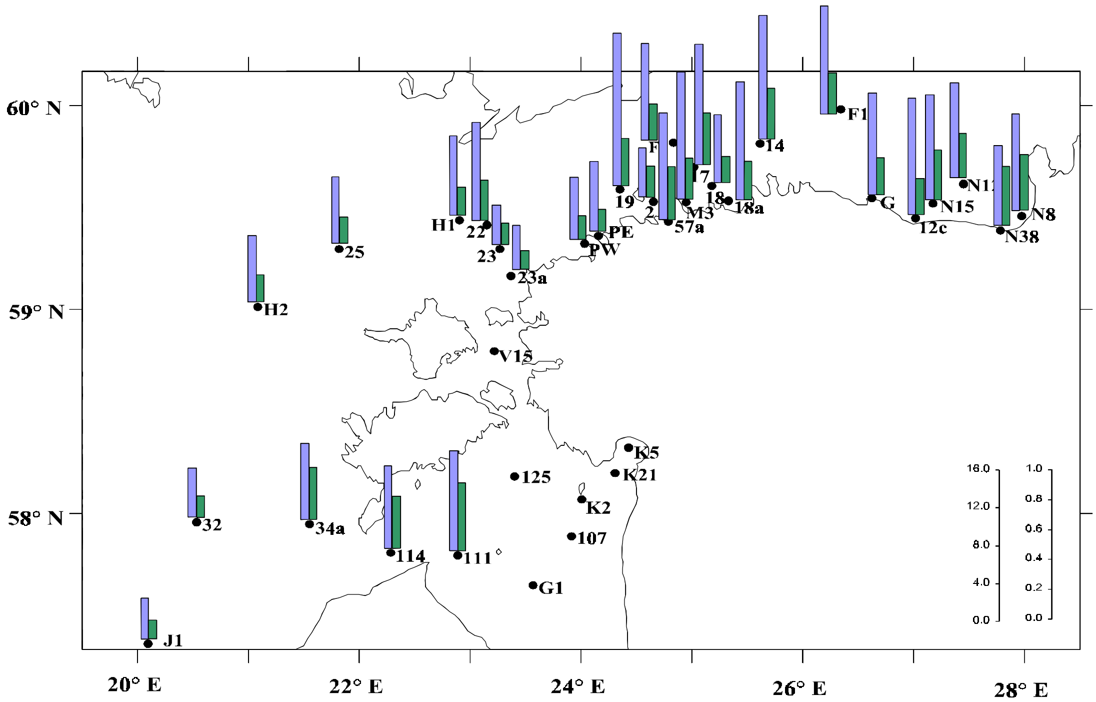


Figure 3.35. Concentrations of phosphates (blue columns) and inorganic nitrogen (green columns) in surface layer in Estonian monitoring area in March 1999. Scales (phosphates – 0.0 - 1.0 µmol/l and nitrogen 0.0 - 16.0 µmol/l) ratio corresponds to Redfield number 16:1.

Mass development of potentially toxic dinoflagellate *Prorocentrum minimum* was registered for the first time in 1999 in central and western part of the Gulf of Finland. Regional comparison of the data of recent years shows that concentration of biogenous matter in surface water layers is usually higher in the Gulf of Riga.

Contents of chlorophyll-*a*, measured in May 1999, show in most sea areas surrounding Estonia the final stage of spring inflorescence in the dynamics of phytoplankton (figure 3.36). In the Gulf of Riga, however, in mid-May the spring inflorescence was in progress, which can be also seen from much higher measured concentrations compared

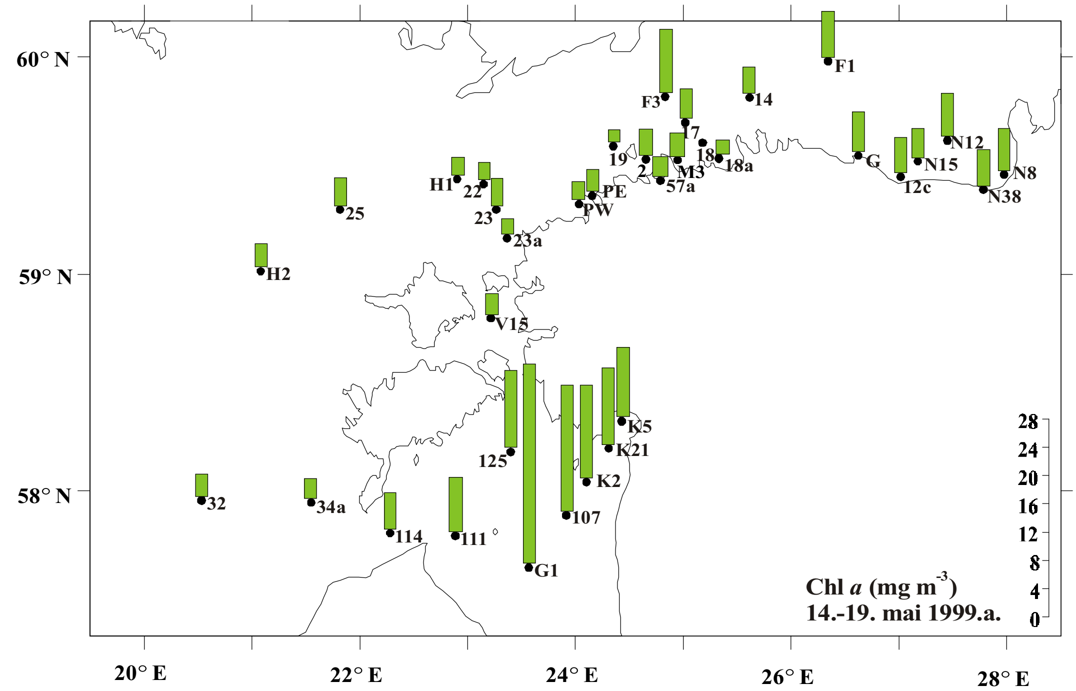


Figure 3.36. Contents of chlorophyll-a, measured in May 1999.

to other sea areas. The highest contents of chlorophyll-*a* have been measured in the offshore part of the Gulf of Riga (10.8-28.2 mg/m^3) and the Pärnu Bay (9.8-10.9 mg/m^3). On the second place at the comparison of the content of chlorophyll-*a* were the Narva Bay with Sillamäe (4.1-6.1 mg/m^3) and stations of the central part of the Gulf of Finland F1 (6.55 mg/m^3) and F3 (8.95 mg/m^3). In Tallinn, Muuga and Kolga Bay the chlorophyll contents remained within the range 2-3.6 mg/m^3. In offshore part of the Baltic Sea concentrations were within the range 2.5-4 mg/m^3. Transparency of sea water can extend in the central part of **Tallinn Bay**, similar to the western part of the Gulf of Finland and offshore part of the Baltic Sea, over 10 m in winter period (11 m was measured in March 1999). In inner part of the bay (station 57a) also the maximum of the period was registered in March 1999 – 6.5 meters. However, in near-coast station 57a (depth 8-9 m) the transparency of water is depending essentially on mixing caused by the wind, also the station lies in the maneuvering area of large passenger ferries in the mouth of the Port of Tallinn.

In summer period of 1999 (June-August) the transparency of water in monitoring stations of Tallinn region was constantly 0.5-1.5 meters below the average of several years, while in May (figure 3.39) after spring inflorescence of phytoplankton and in November at the end of vegetation period it was above average.

In **Pärnu Bay** the general tendency of the year 1999 was some increase of the transparency of water compared to the previous years. In stations K2 and K21 Secchi disc visibility measured from May to August exceeded the average by 0.3-0.5 meters (figure 3.37).

Although the concentrations of biogenous matter available for phytoplankton exceed in Pärnu region the average of the Gulf of Riga by approximately 1.5 times, at least in station K5 the development of summer phytoplankton is essentially inhibited by small transparency of water caused by vertical mixing involving bottom sediment. In 1999 it was additionally worsened by dredging activities of the channel of the Port of Pärnu, although the setting of Secchi disc showed only minimal difference from the average of 1993-1998. However, with late autumn storms transparency of water in the middle of Pärnu Bay may decrease to 30 cm (November 6, 1994).

Transparency of water measured in May 1999 in all monitoring stations of coastal sea of Estonia shows that in the Gulf of Finland (except Narva region) Secchi depth was usually greater than in previous years (1993-1996), in offshore part of the Baltic Sea and the Gulf of Riga it was similar to the average of several years, in some station also smaller (figure 3.37). In May 1999 spring inflorescence of phytoplankton had ended in the sea near northwestern coast of Estonia and western coast of islands – one reason, which could explain greater transparency of water than average.

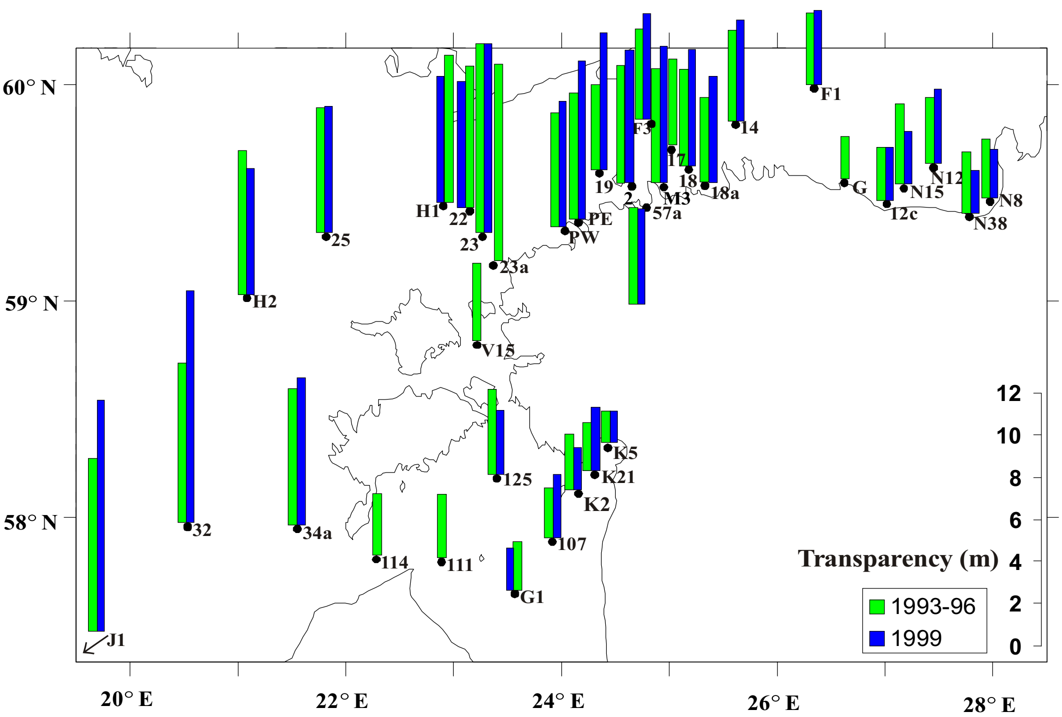


Figure 3.37. Transparency values in May 1999 compared to average values of May in 1993-1996.

Biomass and numerousness of zooplankton (figure 3.38) in Estonian monitoring area were lower in 1999 than in 1998, remaining on the average level of previous five years (1993-1997). Growth trend of zooplankton in Pärnu Bay, which started in mid-80s, continued also in 1999. In 90s a predatory adventitious daphnia *Cercopagis pengoi* has appeared in the composition of zooplankton of Estonian coastal sea. Pelagic larvae of another adventitious species, *Marenzelleria viridis,* are numerous in zooplankton in early spring and autumn. Figure 3.40 shows average biomasses of more important species of copepods in different parts of the Baltic Sea.

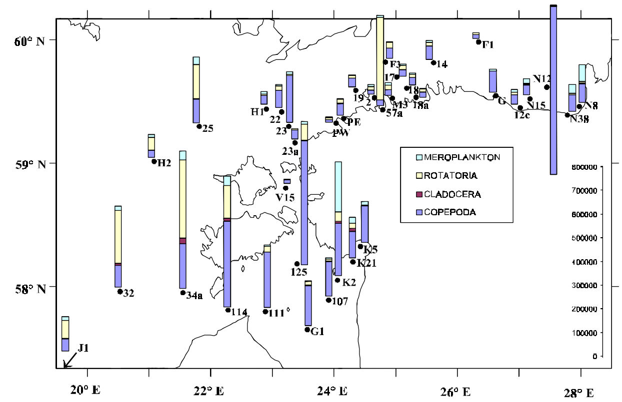


Figure 3.38. Biomass of zooplankton in Estonian monitoring area in 1999.

The gained results need further analysis together with other data collected within the frames of Estonian state environmental monitoring programme. In many cases it has not been defined, in which extent the observed changes in sea environment are connected with natural variation and in which extent with human impact. For example, possible connection between the noticed tendency of the decrease of nutrient content (especially nitrogen compounds) and decrease of general load (from rivers, point sources etc.) should be analyzed, if corresponding data are available.

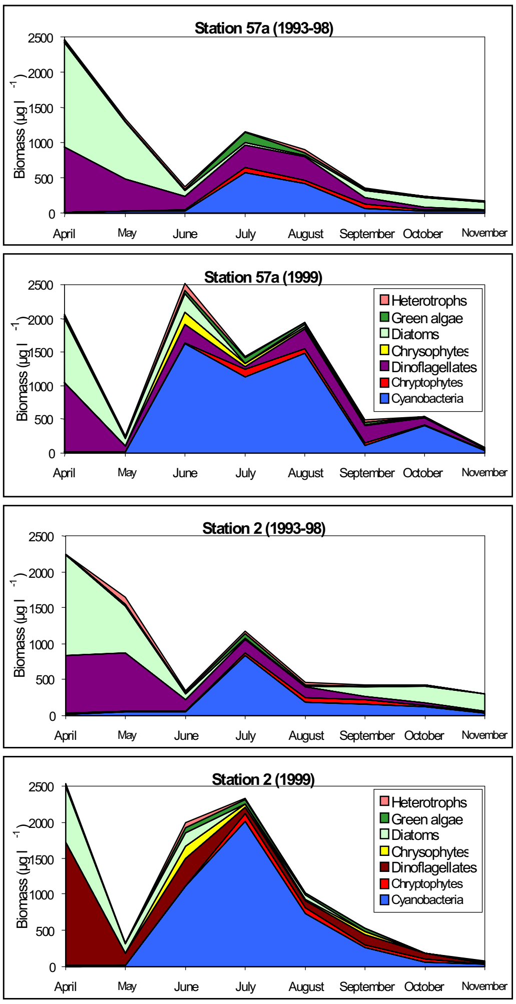


Figure 3.39. Season dynamics of phytoplankton in Tallinn region in 1999.

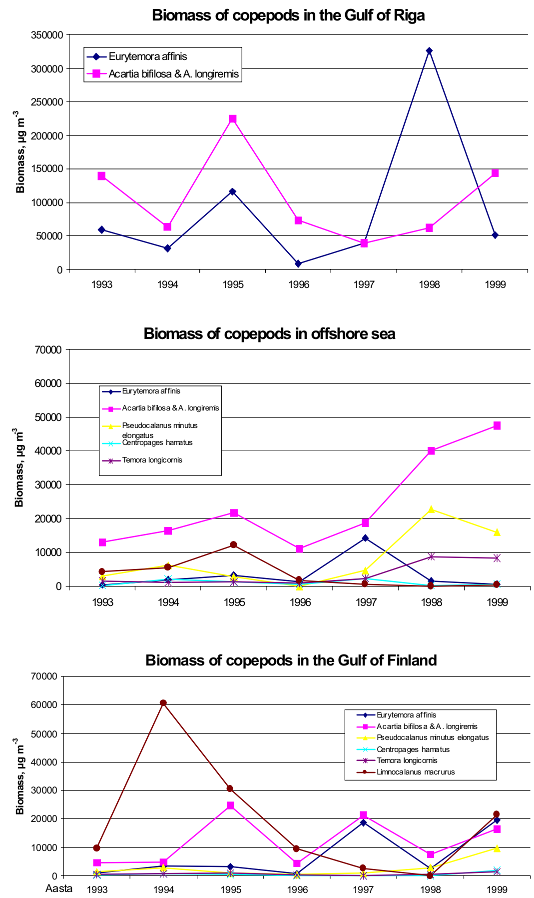


Figure 3.40. Average spring biomasses of more important species of copepods in different parts of the Baltic Sea 1993-1999.

Average amounts of biogenous matter carried into the Gulf of Riga by rivers in 1977-1995 were: 113300 t/y of nitrogen, 2050 t/y of phosphorus and 732000 t/y of suspended solids (Tema Nord 1999). In comparison: phosphorus load and nitrogen load of the Gulf of Finland are correspondingly 7000 t/y and 120000 t/y.

Contents of biogenous matter in rivers falling into the Gulf of Riga can be considered low in case of phosphorus and moderate in case of nitrogen (Tema Nord 1999) compared to the loads of biogenous matter in the rivers of other catchments of the Baltic Sea.

Organic pollutants in fish

Toxic chlororganic compounds are persistent, accumulate on ecological systems and are carried by the air far from the pollution source.

Toxic chlororganic compounds analyzed within the frames of Estonian state environmental monitoring belong on the basis of decision 1998/2 of UN/EEC Convention on Long-range Transboundary Air Pollution into the list of prohibited or restricted compounds.

In Estonia the contents of toxic chlororganic compounds in ecological system of the Baltic Sea have been researched since 1976 (Roots, 1996). From 1994 the analysis of toxic compounds in fish belongs into the Estonian state environmental monitoring programme (Estonian Environmental Monitoring, 1998). The selected bioindicator is, proceeding from recommendations of Helsinki Commission (HELCOM), female Baltic herring of two-three years of age. There are three monitoring regions in Estonian coastal sea: Pärnu, Tallinn and Kunda Bay (table 3.4).

Table 3.4. Average contents of chlororganic toxicants (μg/kg per lipids) in muscular tissue of female Baltic herring of two-three years of age.

Chlororganic compounds	Pärnu 1996	Pärnu 1997	Pärnu 1998	Tallinn 1996	Tallinn 1997	Tallinn 1998	Kunda 1996	Kunda 1997	Kunda 1998
alpha-HCH	n. a.	17	5.4	n. a.	14.5	5	n. a.	9	10.7
gamma-HCH	17.8	19.5	7.3	18.9	17.7	0.5	21.7	19.7	14.5
p,p'DDE	118	78	31.4	78.1	84	45.8	86.8	91.8	86.3
p,p'DDD	33.5	61	35.6	46.1	71.2	33.8	25.1	80	44.6
p,p'DDT	74.6	34	15.2	13.5	24.8	4.5	35.9	42.8	18.4
sDDT	249	190	90	152	198	93	163	236	164
CB 28	38.6	5.1	0.2	12.9	2.9	0.5	65.7	4.7	0.7
CB 52	140.3	4.9	0.4	13.2	3.7	0.9	211	7.2	0.5
CB 101	100.6	7.4	2.4	20.5	20.1	6	320.9	14.2	9.4
CB 118	n. a.	7.4	5.6	n. a.	25.1	13.9	n. a.	15.2	28
CB 138	140.8	17	13.4	63	20.1	3.2	87.5	12.3	45.8
CB 153	145.8	17.7	14.8	45.6	7.4	36.5	72.7	27.2	44.2
CB 156	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.
CB 180	54.4	9.9	6.7	24.6	13.3	16.4	55.7	8.2	16.8
sPCB	621	69	44	180	93	77	814	89	145

At present time the contents of toxic chlororganic compounds analyzed in the Baltic herring of Estonian coastal sea remain below standards established by FAO/WHO in food, in which case the content of toxicants in the food does not cause symptoms of illness in case of people.

Heavy metals in fish and zoobenthos

Following contents of heavy metals are analyzed in indicator organisms (zoobenthos and fish) within the frames of Estonian state environmental monitoring programme (Estonian Environmental Monitoring, 1998) and proceeding from COMBINE programme of Helsinki Commission (HELCOM): copper, lead, cadmium, zinc and mercury.

In Estonia heavy metal contents in the ecosystem of the Baltic Sea have been researched since 1974 (Jankovski, Simm, Roots 1996), whereby comparable results are from the second half of 1980s.

From fish the selected bioindicator is female Baltic herring of two-three years of age. There are three catching areas: Pärnu, Tallinn and Kunda Bay, whereby heavy metal contents in Baltic herring are higher in fish caught from the Gulf of Finland (table 3.5).

In case of zoobenthos the content of above mentioned metals is analyzed in *Macoma baltica* and *Saduria entomon* (tables 3.6 and 3.7). Monitoring samples are collected once in a year from three to five points in the southern part of the Gulf of Finland. When we compare copper and cadmium contents in zoobenthos of the Baltic Sea in 1989-1993 and 1994-1998, we can notice the decrease of contents.

According to the data from the Estonian Marine Institute, current heavy metal contents in Baltic herring expose no danger to the health of people.

Table 3.5. Concentration of heavy metals (mg/kg per wet weight) in muscletissue and liver of Baltic herring.

Organ/Region	Time	Copper	Cadmium	Zinc	Mercury
Muscle					
Kunda	1994 - 1997	0.5 ± 0.2	0.02 ± 0.01	12 ± 4	
	1998	0.6	0.01	22	0.04
Tallinn	1994 - 1997	0.4 ± 0.1	0.01 ± 0.01	11 ± 3	
	1998	0.8	0.02	13	0.02
Pärnu	1994 - 1997	0.4 ± 0.1	0.01 ± 0.01	11 ± 3	
	1998	0.5	0.01	11	0.01
Liver					
Kunda	1994 - 1997	3.0 ± 1.7	0.38 ± 0.16	33 ± 10	
	1998	3.0	0.37	30	0.03
Tallinn	1994 - 1997	4.5 ± 3.1	0.49 ± 0.33	25 ± 5	
	1998	-	-	-	
Pärnu	1994 -1997	2.5 ± 0.7	0.36 ± 0.22	31 ± 13	
	1998	1.8	0.31	23	0.01

Table 3.6. Concentration of heavy metals (mg/kg per dry weight) in *Saduria entomon* in different regions of the Gulf of Finland.

Region	Time	Copper	Cadmium	Zinc	Mercury
Klooga	1988 - 1997	94 ± 77	1.0 ± 0.7	522 ± 144	
	1998	207	1.4	1300	0.3
Kakumäe	1988 - 1997	153 ± 79	1.6 ± 0.8	494 ± 175	
	1998	74	1.0	592	0.1
Käsmu	1988 - 1997	143 ± 83	1.1 ± 0.6	433 ± 165	
	1998	133	1.2	691	0.1
Kunda	1988 - 1997	87 ± 64	1.7 ± 0.9	421 ± 126	
	1998	56	0.7	316	0.1
Sillamäe	1988 1997	111 ± 64	1.7 ± 0.9	548 ± 164	
	1998	60	1.0	541	0.2

Table 3.7. Concentration of heavy metals (mg/kg per dry weight) in *Macoma baltica* in different regions of the Gulf of Finland.

Region	Time	Copper	Cadmium	Zinc	Mercury
Klooga	1988 - 1997	94 ± 77	1.0 ± 0.7	522 ± 144	
	1998	207	1.4	1300	0.3
Kakumäe	1988 - 1997	153 ± 79	1.6 ± 0.8	494 ± 175	
	1998	74	1.0	592	0.1
Käsmu	1988 - 1997	143 ± 83	1.1 ± 0.6	433 ± 165	
	1998	133	1.2	691	0.1
Kunda	1988 - 1997	87 ± 64	1.7 ± 0.9	421 ± 126	
	1998	56	0.7	316	0.1
Sillamäe	1988 1997	111 ± 64	1.7 ± 0.9	548 ± 164	
	1998	60	1.0	541	0.2

3.4 Economical measures

The "polluter pays principle" and charges for water abstraction has been applied in the beginning of 90-ies.

Tax for water uses differ by water sources. Tax for surface water in Tallinn water catchment area is higher than in other regions. Of groundwater, Cambrian-Vendian aquifer has been evaluated higher than these which are less protected (figure 3.41). The drainage of mines is also being levied (figure 3.42). Taxes for water resource and emission of pollutants (figure 3.43) into water bodies are efficient tools for reducing pollution and pressure on water resource. Tax rates have been certified some years ahead, which will give the company chance to plan its activities.

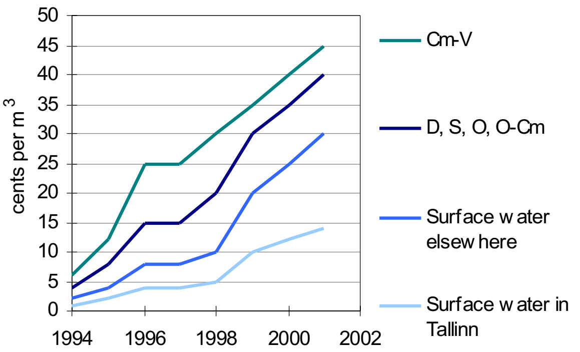


Figure 3.41. Tax on surface and groundwater, cents per m³

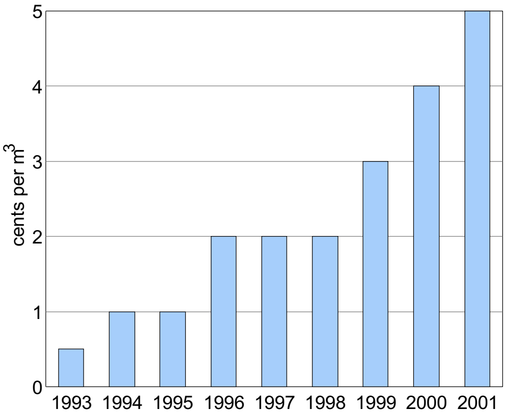


Figure 3.42. Tax on mine drainage water.

The basis for activities in water protection are Estonian National Environmental Strategy (1997) and National Environmental Action Plan (1998).

Amount of water consumption and pollution load has decreased as the output of expenses and efficient taxing system (Figures 3.15; 3.18-3.20).

Expenses made on the renewal of waterworks and sewerage, extension of pipeline networks and construction of new treatment plants are financed from several sources: State Budget, Environmental Fund (since the year 2000 the Centre of Environmental Investments), budgets of local governments, business activities of water companies, owners' equities of companies and foreign aid and loans (Figure 3.44).

Several projects were implemented to make expenses as efficient as possible. Last year's trends are to join efforts of small municipalities into bigger projects.

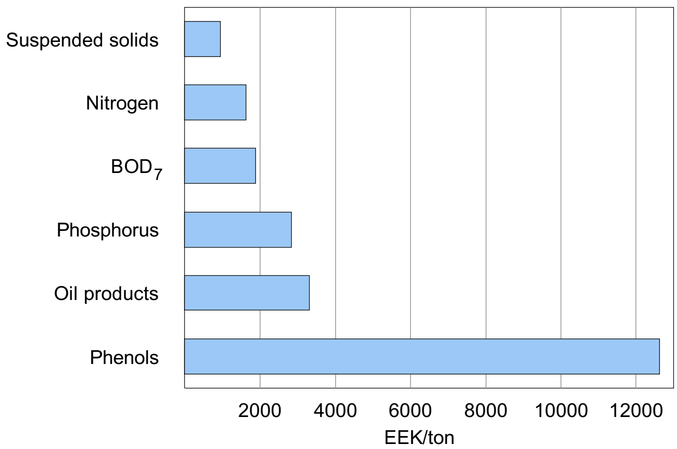


Figure 3.43. Taxes for emissions of pollutants into water.

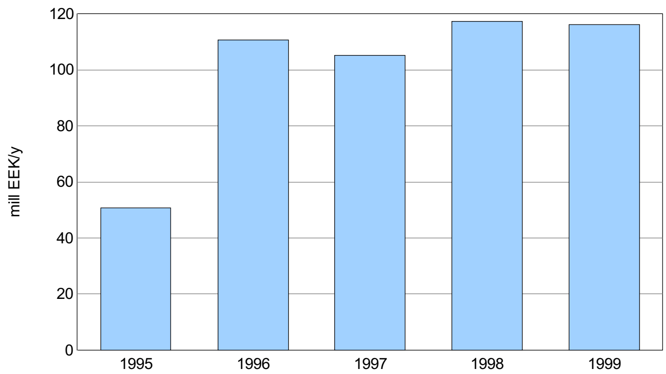
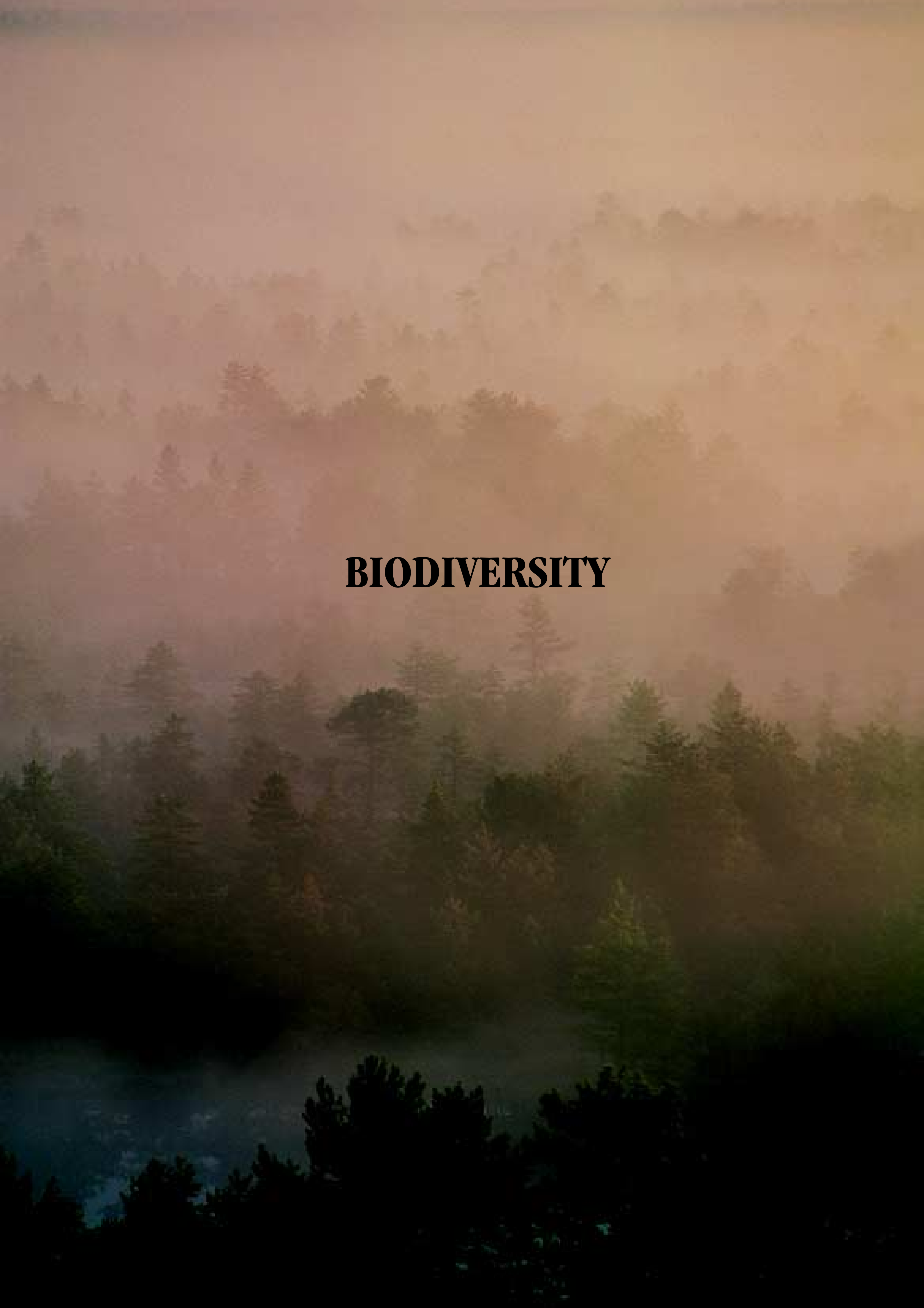


Figure 3.44. Financing of water management from State Budget and the Environmental Fund.

BIODIVERSITY



4. Biodiversity

Uudo Timm, Lauri Klein, Piret Kiristaja, Taimo Aasma

4.1. Introduction

From the moment of determination of country borders a possibility comes into being to bind phenomena and processes with human-created, fixed territory. In the context of this chapter such territory is the Republic of Estonia and the phenomenon variety of local nature.

Taking account of sufficient diffuseness and multiple meaning of variety of nature as a term, it should be mentioned that due to limited space of this chapter observation concerns only some selected indicators, which changes in the 2nd half of XX century are monitored and analyzed. Overview is given of the condition of change-sensitive species and habitats, characteristic to the organic nature of Estonia; endangering of species as well as habitats is assessed and current condition of effectiveness of protective measures is determined. Overview is also given of the fulfillment of some international obligations.

Photo 4.1. Wooded meadow in Laelatu in the autumn.

Variety of Estonian flora and fauna, compared to other territories with the same area north from the 57th northern latitude, is one of the largest in the world. Reasons for that are climatic conditions of Estonia and their variety, proceeding from geographical location, the existence of islands as well as continental part; abundance of sea and inland waters; variety of soil conditions, simultaneous occurrence of Silurian (and, to small extent, Ordovician and Devonian) limestone as well as Devonian sandstone as base rock and correspondingly existence of acid as well as neutral, lime-rich as well as lime-poor soils; extension of the area borders of large number of species onto the territory of Estonia; large percentage of natural landscapes; persistence of traditional extensive methods of land use in Estonia until the middle of this century and in several regions until the last decades; correspondingly relatively extensive preservation of semi-natural associations (original associations); small percentage of foreign tree species in forestry; small naturalization and growing wild of introduced species.

There are plant associations in Estonia, which small-scale richness of species is among the largest in the world. Such are some plant associations of West-Estonian wooded meadows, being used for a long time and remained until today, where the number of vascular plant species extends up to 74 species per square meter. Essential reason for that is the persistence of traditional methods of land use until rather recent time (Kull et al, 1999).

4.2. Status

4.2.1. Population and hunting of large game

Trends of changes of population of more important hunting game of Estonia (elk, wild boar, roe, bear and wolf) have been quite similar in last 10 years according to the data of official counting data (figures 4.1-4.3 and 4.6-4.7). Population of these game increased in the end of 1980s and in the beginning of 1990s, which was followed by quick decrease and at the end of 1990s stabilization of population or slow increase. Although official data show small increase of hunted game only until 1992, for the decrease of population of game it can be assumed that hunting bags were much greater together with poaching. In addition to hunting the decrease of the number of ungulates was without doubt influenced also by large number of large carnivores. In co-influence of several factors the number of ungulates decreased in the middle of 1990s to the lowest level of last 25 years.

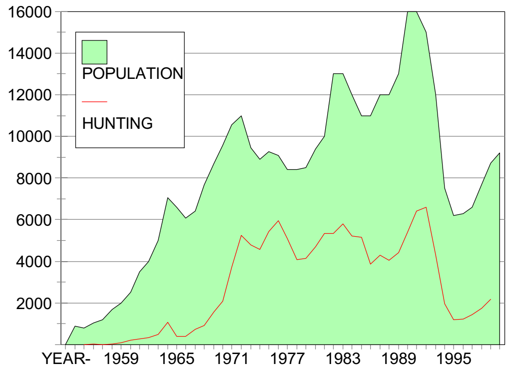


Figure 4.1. Population and hunting of elk in 1954-2000.

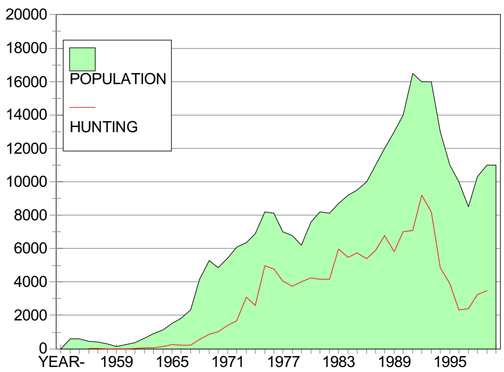


Figure 4.2. Population and hunting of wild boar in 1954-2000.

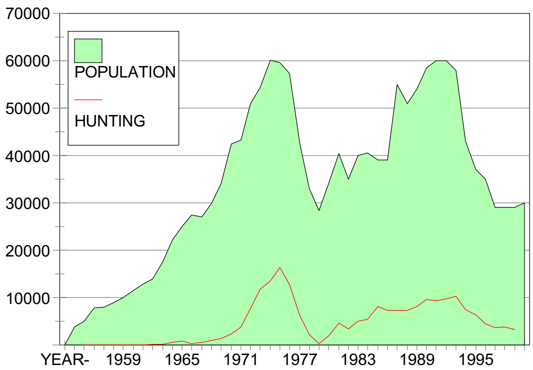


Figure 4.3. Population and hunting of roe deer in 1954-2000.

Of the ungulates, only the number of red deer has constantly increased after intermediate stabilization (figure 4.4). The number of beavers has increased constantly very rapidly in last decades in Estonia (figure 4.5). When in 1980 only 250 beavers were counted in Estonia, then in 1990 already over 2600 and in 2000 the number was 11000. Increase of the number of beavers has not stopped even due to constantly increasing hunting and the amount of beaver damages caused to agriculture and forest management as well as damaged area has increased year by year in result of the building activities of beavers.

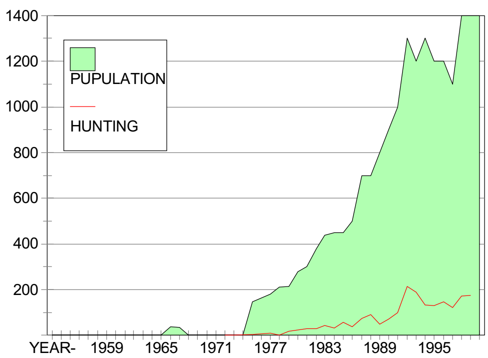


Figure 4.4. Population and hunting of deer in 1954-2000.

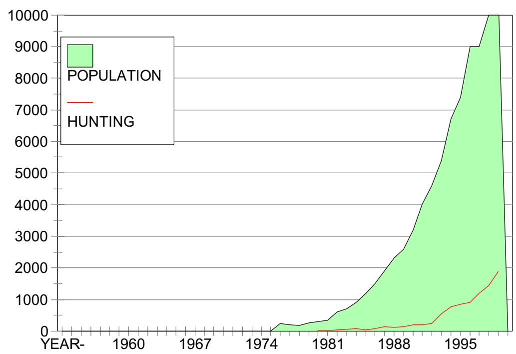


Figure 4.5. Population and hunting of beaver in 1954-2000.

Photo 4.2. Roe deers on Lake Pühajärv.

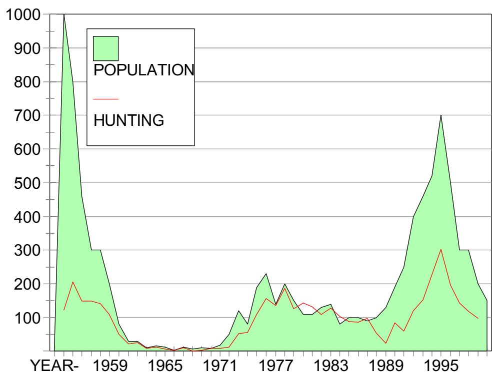


Figure 4.6. Population and hunting of wolf in 1954-2000

According to the official counting data the number of large carnivores is very high in Estonia. Maximum number of wolves, 700 in 1995, is still probably misleading (figure 4.6). As wolves migrate a lot, multiple counting of the same wolves may influence the consolidated number. At the same time 300 shot wolves per year is referring to large number of wolves in the middle of 1990s. Analogous counting error may occur also in case of the indicators of population of lynx and bear (figures 4.7 and 4.8). Decrease of the number of large carnivores in recent years has been partially influenced by hunting, but probably also more critical analysis of data at the calculation of consolidated data.

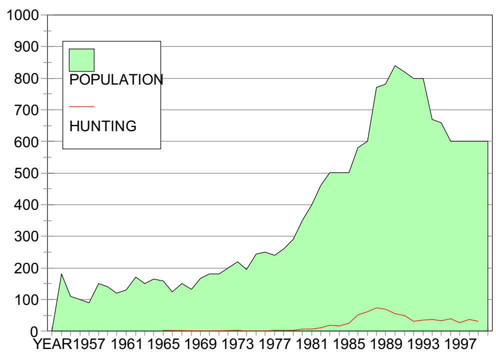


Figure 4.7. Population and hunting of bear in 1954-2000

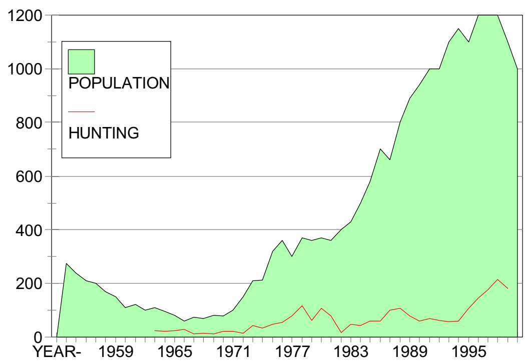


Figure 4.8. Population and hunting of lynx in 1954-2000.

When comparing the official counting data of large carnivores with their monitoring data, quite great differences appear. On the basis of monitoring results the number of large carnivores in Estonia is significantly lower. According to expert opinions the official counting data are over-estimated and monitoring results under-estimated. So the actual number should be somewhere in between. Protection and management programmes of bear, wolf and lynx are under compilation for better organization of protection and management of large carnivores.

4.2.2. Changes in the condition of selected habitat types

Essential components of the variety of nature are, beside species, also their habitats, changes of which condition influence most directly the condition of variety of species. In order to determine the distribution and condition of rare habitat types, several inventories have been carried through in Estonia. More important of those have been given in table 4.1. In result of the mentioned inventories and on the basis of earlier published data it is possible to show distribution trends of some habitat types in Estonia in last century (figures 4.9-4.11).

Table 4.1. Inventories of selected habitat types carried through in Estonia in 1990s.

Inventory project	Goal	Content	Time	Responsible institution
Inventory of wooded meadows.	To determine the condition and distribution of wooded meadows in Loe-Estonia.	Env. conditions were evaluated. Species lists were compiled. Diverity of species was determined on 10x10 m sample plots.	1995-1996	Estonian Fund for Nature
Inventory of alvars.	To detemine distribution, species composition and diversity of most known alvars in Estonia.	Env. conditions and area was estimated. Species lists were compiled.	1992-1994	Uppsala University and Tartu University
Inventory of old forests.	To determine the condition and distribution of old forests in Estonia.	Env. conditions and area was estimated. Species lists were compiled.	1993-1996	Estonian Fund for Nature
Inventory of coastal and floodplain meadows.	To determine the condition and distribution of coastal and floodplain meadows in Estonia.	Location was fixed. Conditions and protection value was estimated. Spesies lists were compiled.	1993-1996	Estonian Fund for Nature
Inventory of wetlands.	To determine the condition, distribution and protection value of Estonian uprotected wetlands.	Conditions and protection value were estimated. Species lists were compiled	1997-1998	Estonian Ministry of Environment

The reason for essential decrease of the area of meadow habitats (incl. first and foremost wooded meadows, alvars, coastal and floodplane meadows) is the perishing of traditional agricultural methods (mowing and grazing with average or low load) in rural regions of Estonia. At the same time it can be assumed that several meadow habitats have by now turned into habitats of the type of dry boreo-nemoral forests (hazel woods), which has caused also essential increase of the area of that habitat type on figure 4.11.

Main cause for the damage of swamp habitats in recent years has been drainage. It has been estimated that 70% of initial peat regions of Estonia are irrevocably drained (Paal, et al 1999).

The condition of forest habitats seems to be rather good in Estonia on the basis of figure 4.11, however the area of several habitat types has decreased throughout the time.

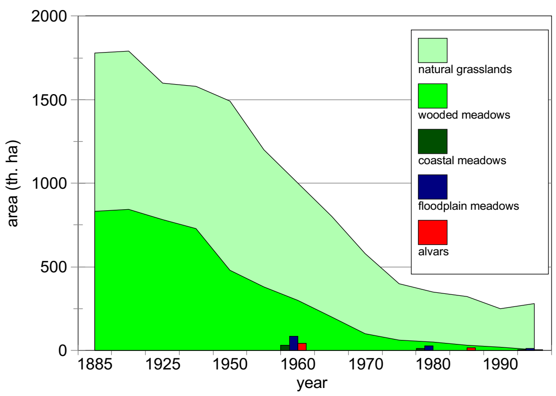


Figure 4.9. Change of the area of grasslands in Estonia (according to Kukk and Kull, 1997).

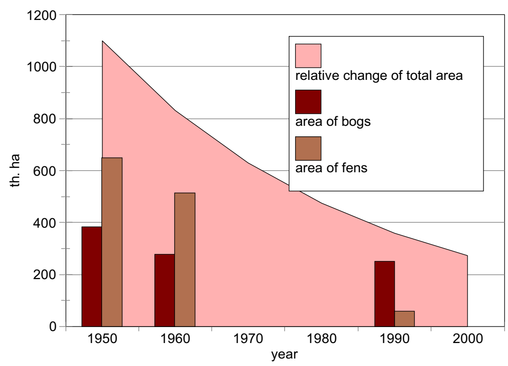


Figure 4.10. Change of the area of natural swamp habitations in Estonia (Laasimer 1965; Valk 1988; Ilomets 1993, 1994; Paal et al, 1999).

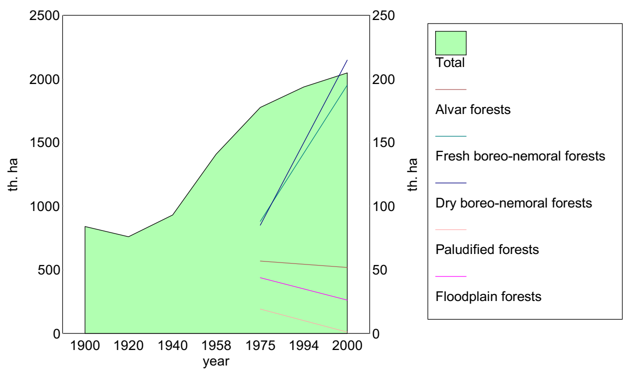


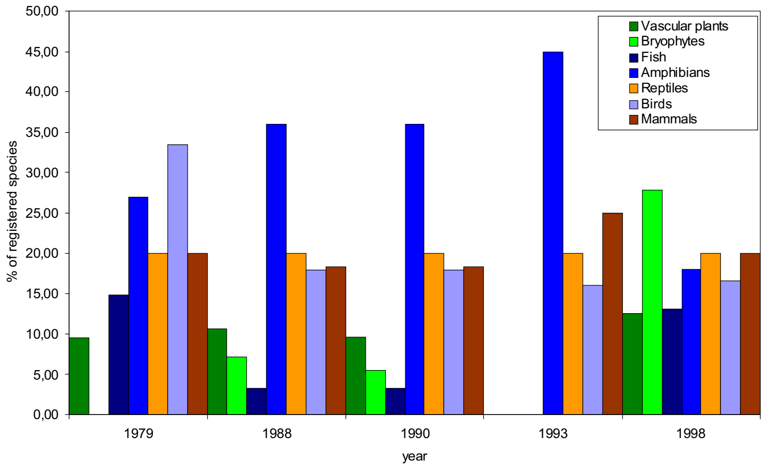
Figure 4.11. Change of the area of some forest habitations in Estonia (Laasimer 1965; Valk and Eilart, 1974; Estonian Forests, 1999).

4.3. Dangers

4.3.1. Endangered species

Three Red Data Books have been compiled in Estonia in last century (and altogether five so-called Red Data Lists). Thereby experts have re-assessed the endangering of different species. Figure 4.12 shows relative numbers of species belonged in different time into the Red Data Book in per cents in relation to the total registered number of species of the same group. However, as endangering has been assessed in different years on the basis of different methodology, on the graph only the relation between different groups in different Red Data Lists can be compared.

Figure 4.12. Relation between endangered species (categories 0, 1, 2 and 3 of the Red Data Book) and registered number of species in the second half of XX century in Estonia in percents.



4.3.2. Endangered habitats

Currently valid Red Data Book (completed in 1998) has assessed distribution of endangered species by habitats and thereby also the level of endangering of them. At the same time the endangering of habitats has been assessed also by J. Paal. On the basis of the mentioned two sources and above described habitat inventories table 4.2 has been drafted, from which conclusions can be drawn in relation to the endangering of different habitat types of Estonia.

Table 4.2. Level of endangering of different habitats of Estonia and main danger factors.

Habitat type	Number of endangered species	Main danger factors	Level and trend of dangering
Forests (total) Coniferous forests (incl old) Mixed forests (incl old) Deciduous forests (incl old) Shrubbery	401 100 (19) 75 (33) 132 (50) 17	Forest management, Change in tree species composition and clear-cuts, Drainage and removal of dead wood	Very endangered and worsening
Waterbodies (total) Sea Lakes Rivers and springs Temporary waterbodies	314 54 127 102 23	Pollution, eutrophication, overgrowing, construction	Endangered, relatively stable
Meadows (total) Wooded meadows Coastal meadows	114 19 12	Overgrowing, End of mowing, End of grazing	Very endangered and worsening
Cultural landscape	81	Construction, pollution	Endangered, relatively stable
Cliffs Alvars Dunes and sand plains Heaths	74 66 62 12	Tramping, construction, traffic, fire accidents	Endangered, relatively stable
Mires (total) Eutrophic mires Mesotrophic mires Bogs	68 22 3 16	Drainage and peat extraction	Endangered, relatively stable
Sea coasts Shores of lakes and rivers	53 37	Eutrophication, construction	Endangered and worsening
Flood plains	10	Overgrowing, eutrophication	Endangered and worsening

4.3.3. Forest management

Forest is one of the most important natural resources in Estonia, which value is hard to over-estimate. Preservation of natural variety of our forests is essential internally as well as in European context. At the same time forestry is also one of our most important branches of economy. Economic interests are, however, contradicting with the wish to retain naturality of forests and natural variety. It is still obvious that there is plenty of room for both in our forests.

One main activity in forestry, influencing natural variety of forests, is forest felling, which capacity has essentially increased in recent years (figure 4.13). When in downtime in 1992 the total felling capacity extended only to 2.146 million tm, then in 1999 it was, according to official statistics, already 6.704 million tm. In 1997 the maximum possible annual felling capacity in Estonia, determined with national forestry policy, is 7.8 million tm, until which, according to the official statistics, there should be a little room for development, although at the same time the felling capacity according to the data of the Estonian Forest Management Center amounted to 7.65 million tm in 1999, thus being very close to the maximum level. It is important to note that the increase of felling has taken place in recent years mainly due to wood volumes felled from private forests. The amount of wood felled from state forests has been stable in recent time – a little less than 3 million tm per year. Felling area has increased simultaneously with the increase of felling capacity. In 1999 the area of renovation felling extended to 22601 ha according to the data of the Board of Statistics, of which majority was formed (18 796 ha) by clear cuttings.

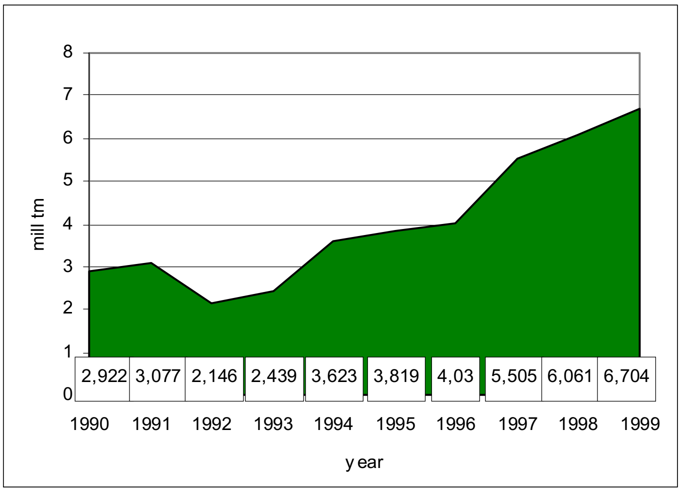


Figure 4.13. Total capacity of felling in Estonia in 1990-1999 (Statistical Office, 1995, 1999, 2000).

Estonian forest resources have multiplied after the war. When only a quarter of century ago our forest resources amounted to 200 million tm, then by now they are officially ca 352 million tm, according to some data even 400 million tm. Evaluations of forest resources carried through in 1999, which were conducted with the statistical selective method, showed that we have much more forest than assumed. Also the area of forests has increased, extending according to the official data of 1999 to 2143100 ha (of which forest stands 2059000 ha). Increase of the area has taken place mainly in result of the growing wild of the previous agricultural and natural grasslands and that process is continuing. All that has also increased the pressure to increase the felling capacity.

Essential activity influencing natural variety of forests is also forest renovation (figure 4.14). In 1999 forest renovation was carried out altogether on 8100 ha, thus exceeding again the capacity of 1991 (7700 ha) after some low level period. It should be noted that the area of these territories has started to increase, where forest renovation is carried out in the method of contribution to natural forest renewal (CNFR). When the establishment of cultures has not yet reached the level of the beginning of 1990s, then the area of CNFR is exceeding it more than twice, extending to 2000 ha in 1999. However, the area of forest renovation is much smaller than the area of renovation felling. So it can be assumed that many clearings just renew themselves or grow into bushes.

In couple of recent years several steps have been taken in forestry in order to improve the condition of natural variety of forests. Several international projects are in progress (Estonian Forest Conservation Area Network Project, Estonian Woodland Key-habitats Inventory Project), also the certification process of forests has been initiated. One goal of all the mentioned activities is to improve the condition of natural variety of our forests and contribute to its preservation and increase.

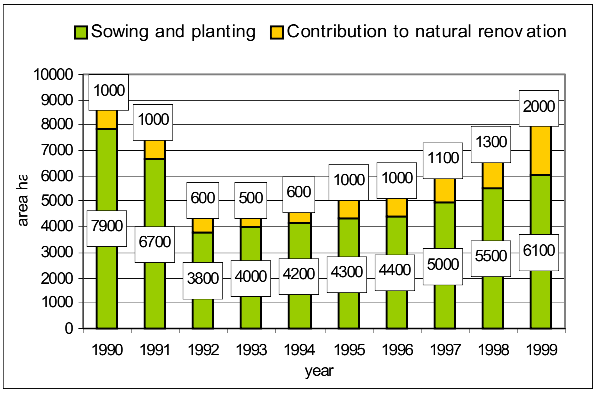


Figure 4.14. Forest renovation in Estonia in 1990-1999 (Statistical Office, 1995, 1998, 1999, 2000).

4.3.4. Fragmentation of natural areas

A direct indicator of the extent of human influence on living nature is the density of infrastructure of transport in the country. Figure 4.15 shows time trend of the density of the network of Estonian roads on the same graph with the change in the number of vehicles. Relatively rapid increase of both indicators in 1990s can be clearly observed. However, it should be noted that sharp increase of the density of the network of roads in 1995-2000 is largely caused also by the changing of calculation methodology.

At the same time it is still more important to observe fragmentation of natural landscapes by the road network (figures 4.16 and 4.17). To illustrate that, also the numbers of "mesh" of the network of Estonian roads by size classes are given:

- there are 18 areas in Estonia without roads, exceeding 100 km² (mainly bog massives);
- there are 21 areas in Estonia without roads with the size 50-100 km²;
- in size class 25-50 km² the number is already 30.

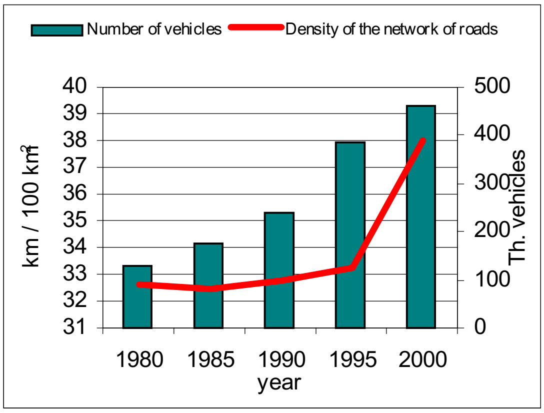


Figure 4.15. Change of the number of vehicles and density of road network in Estonia in 1980-2000.

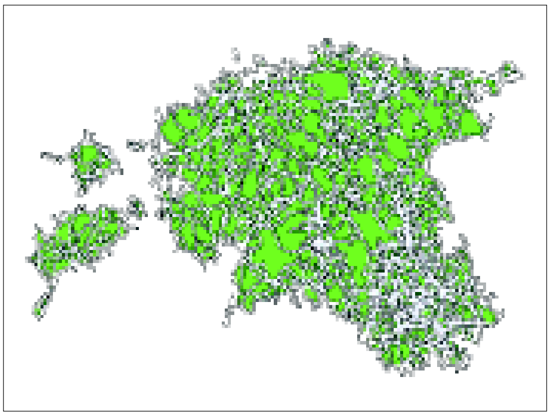


Figure 4.16. Scheme of the road network of Estonia with 2 km wide impact zone.

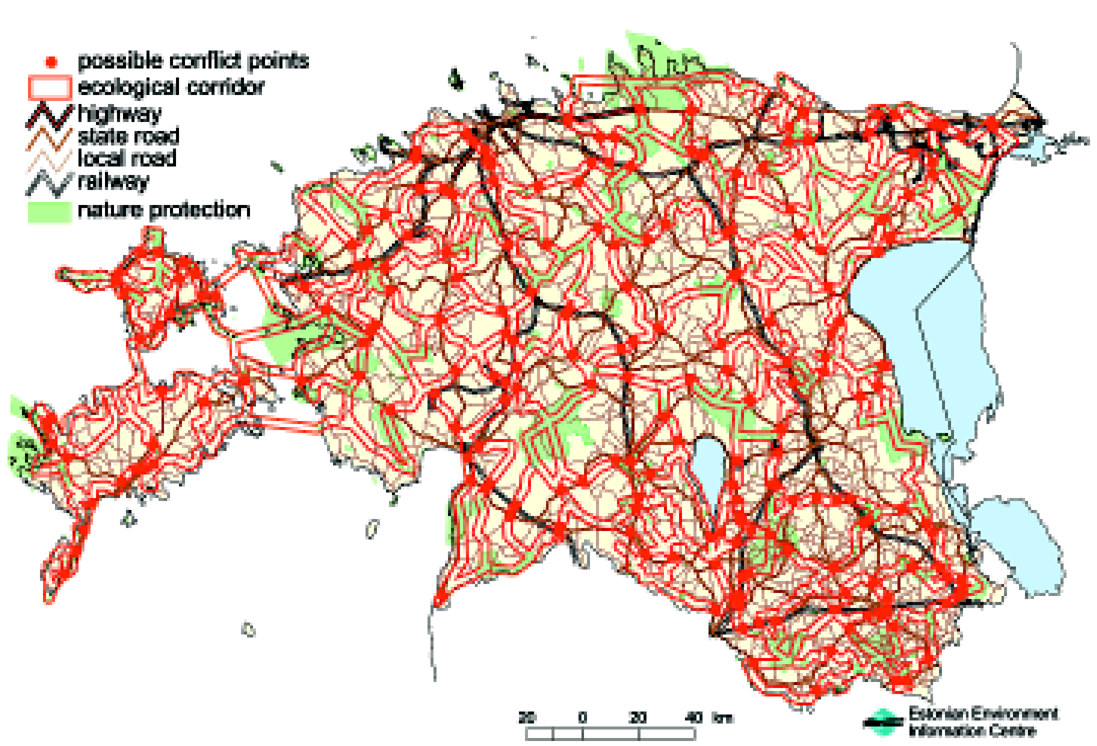


Figure 4.17. Draft scheme of crossing points of the road network of Estonia and ecological network, taking account of the migration of large game animals.

4.4. Protection

4.4.1. Protected land of I category of IUCN

Variety of Estonian nature and rapid alternation of landscape types is revealing also in zonings and variety of protection goals of our protection areas, wherefore the internationally used category system of protection areas, recommended by IUCN, is relatively difficult to apply at the division of our protection areas. More direct compliance with the categories of protective areas of IUCN can be applied in our protection areas by zones. So Ia category of IUCN complies with our nature reservation and Ib with natural part of strict protection zone, which protective goal is to guarantee development of associations only as natural process. Therefore we can carry out further analysis only for areas with renewed protection order, which zoning has been certified. By January 1, 2001 there were 121 zoned protection areas in Estonia with total area 433 532 ha. A goal has been set in Estonian environmental strategy, according to which by the year 2010 protective order should be established at least for 5% of continental territory of Estonia, where economic activities would be prohibited. Such protective order is complying with I (a+b) category of IUCN. Such protective order had been established by January 1, 2001 on 168 339 ha, which makes 3.72 % of the Estonian territory (figure 4.18). Taking account of the protective order planned for currently non-zoned protection areas and the goal to establish a network of forest protection areas, apply prohibition of economic activities on 4% of Estonian forest land, the goal set in environmental strategy can be realized in practice.

Photo 4.3. Morning in Kõnnu bog.

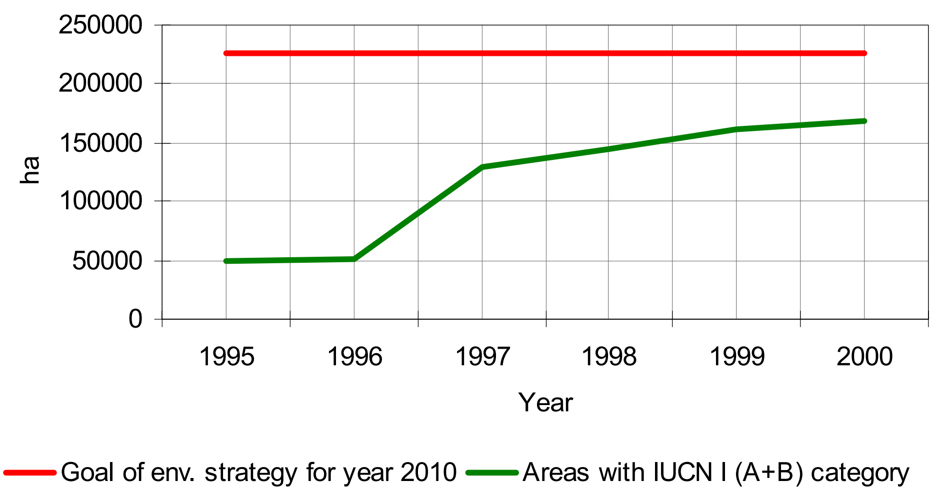


Figure 4.18. Change of the area of protected land of I category of IUCN in Estonia in 1995-2000 (ha).

4.4.2. Renewal of the order of protection

Proceeding from the Act on Protected Natural Objects the Estonian protection areas need zoning according to protection goals and, proceeding from that, correction of protection regulations and borders. Preliminary work in this field was started immediately after the enactment of the mentioned law in 1994. In 1994-1995 draft regulations for certification of protection regulations were prepared by the Department of Nature Protection of the Ministry of the Environment and in 1996-1999 by the Nature Conservation Bureau of the Estonian Environment Information Center. From 2000 corresponding draft regulations are prepared again by the Department of Nature Protection of the Ministry of the Environment. The process of renewal of the order of protection is showed on figure 4.19.

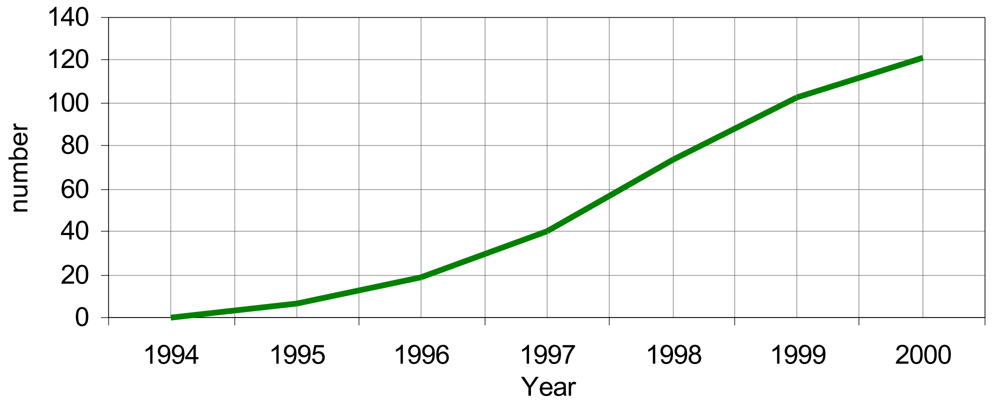


Figure 4.19. Number of protection areas with renewed protection rules in Estonia 1994-2000.

By January 1, 2001 the renewed order of protection has been certified on 121 protection areas. At the correction of borders of protection areas non-significant land from the standpoint of nature protection has been excluded from protection areas. At the same time areas deserving protection have been taken under protection in other places. In last six years 20 new protection areas have been established, which are in most cases relatively small (except Puhatu nature protection area, 12 320 ha). Total area of new protection areas is 34 380 ha.

By January 1, 2001 renewed protection rules have been certified on 121 protective areas of 308, which makes ca 40% of the total number of Estonian protection areas. Together with coastal sea areas 542 347 ha are under protection in Estonia, of which 462 157 ha form land and internal waterbodies. So the protection areas form 10.22% of the Estonian territory. Total area of the protection areas with renewed order of protection is 433 532 (together with sea area) and 353 342 ha (only land area without sea), which makes 76.45 % of the whole protected territory (figures 4.20, 4.21). Such high percent is proceeding from the fact that in the initial stage of the renewal of protection rules first the territories with large area needing more strict order of protection were started to handle.

Renewal of protection rules has been most successful in Hiiumaa, where the order of protection has been renewed in all protection areas. Also Läänemaa, Ida-Virumaa, Viljandimaa, Võrumaa, Lääne-Virumaa and Harjumaa have been successful at the renewal of protection rules.

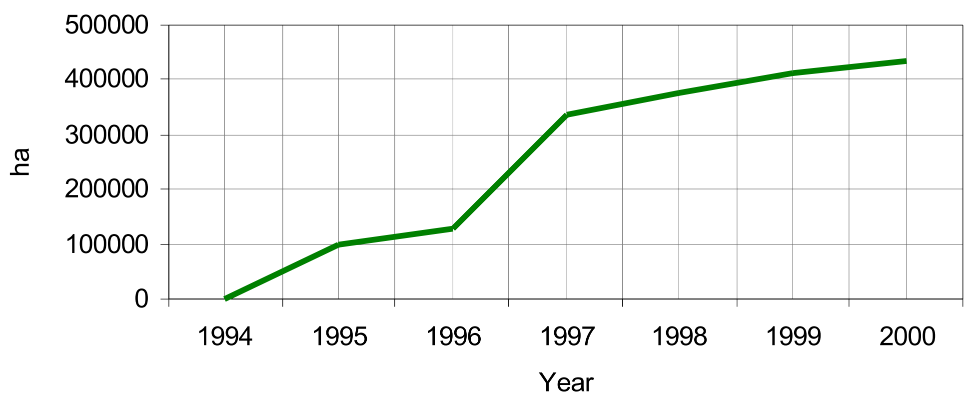


Figure 4.20. Change of total protection area with renewed protection rules in Estonia 1994-2000.

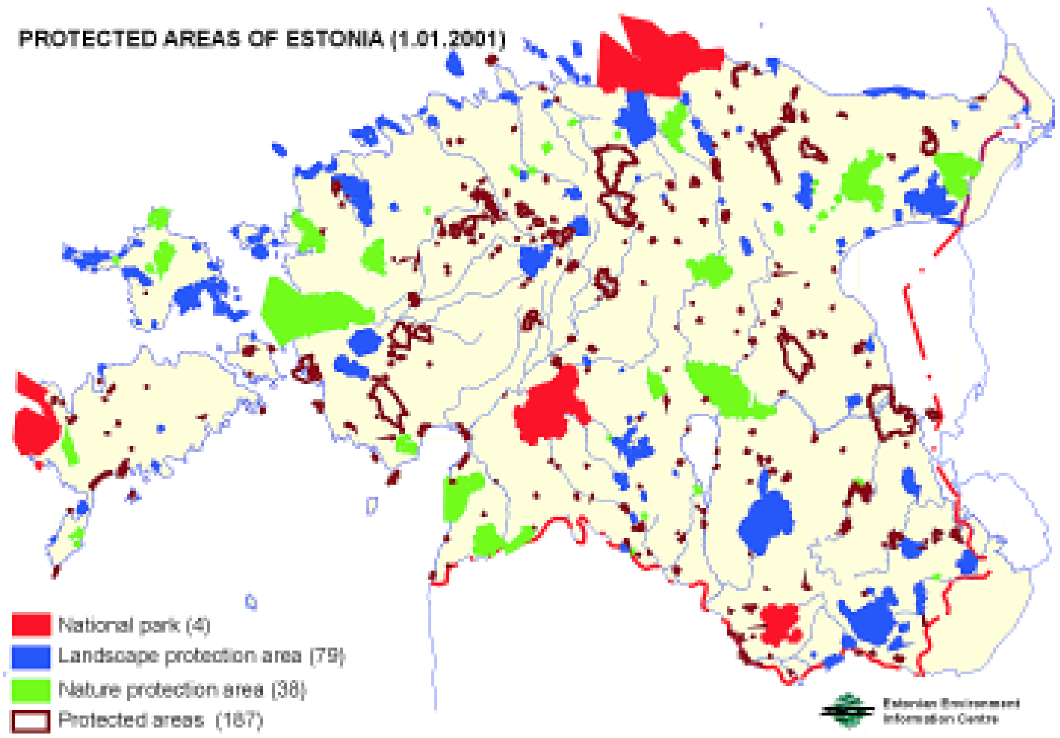


Figure 4.21. Protected areas network in Estonia at January 1. 2001.

4.4.3. Correction of land tax

Protection areas have been divided, in order to preserve diversity of species, habitats and landscapes, into parts with different order of protection – zones, where different restrictions are valid for economic activities. The mentioned restrictions for each protection area have been established in relevant protection regulation, which has been certified by the Government of the Republic according to the Act on Protected Natural Objects (RT I 1994, 46, 773; 1998, 36/37, 555; 1999, 95, 843; 54, 583).

According to the Land Tax Act (RT I 1993, 24, 428; 1996, 41, 797; 89, 1589; 1997, 82, 1398; 1999, 27, 381; 95, 840; 2000, 95, 612) land tax is not paid from the land on which economic activities are prohibited by the law or in the order specified in the law (i.e. land tax concession 100%). At the same time obligatory activities necessary for the preservation of the object, established with protection regulation, is not considered economic activity. According to the Land Tax Act land tax is paid from the land, on which economic activities are restricted by the law or in the order specified in the law, according to the decision of the Government of the Republic, 25, 50 or 75 per cent of the tax rate.

First regulation of the correction of land tax was certified in 1996. That established land tax rates in Alam-Pedja, Nigula and Viidumäe nature protection areas and in Karula National Park.

One regulation correcting land tax was certified in 1997, which established land tax rates in Soomaa and Vilsandi national parks.

In 1998-1999 preparation of drafts regulations of land tax rates took place in the Nature Conservation Bureau of the Estonian Environment Information Centre (earlier the Department of Nature Protection of the Ministry of the Environment handled that issue). 5 regulations correcting land tax were certified in 1998 and 10 in 1999. In 1998-1999 land tax was corrected in 73 protection areas (71% of protection areas with renewed regulations), which cover the total area of 160 thousand ha.

By December 31, 2000 the total number of protection areas with corrected land tax is 79 (almost 65 % of protection areas with renewed order of protection), which cover ca 263 thousand ha (i.e. 57 % of the total area of protection areas with renewed order of protection).

4.5. Implementation of international agreements

4.5.1. CITES

Estonia is the member of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since October 1992. In 1993-1999 the number of permits for transactions with individuals of species belonging into the annexes of the convention has been relatively stable (50-60 permits per year). Only in 1993 34 permits were issued for transactions and in 1999 for the first time almost 100 permits (figure 4.22).

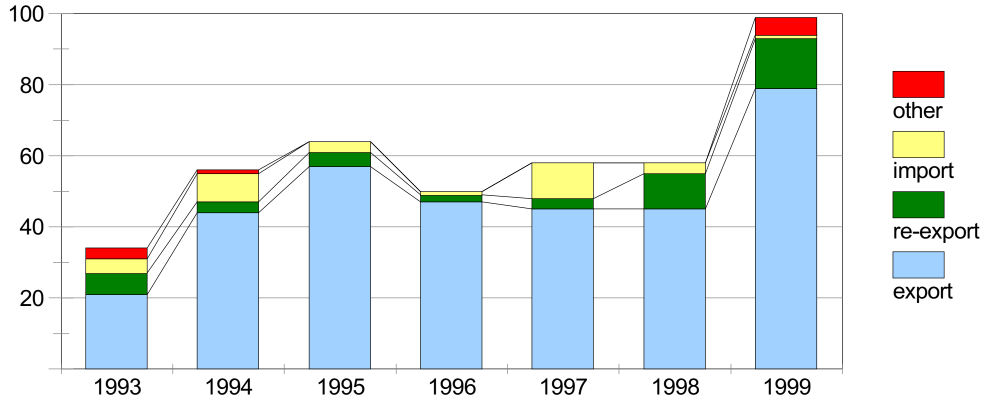


Figure 4.22. Issuing of CITES permits in Estonia in 1993-1999.

Most of the permits have been issued for the export of individuals and only some permits for re-export, import or temporary import and export to exhibitions or circuses.

Throughout the years three trade groups have dominated among the individuals of species of annexes to CITES, being the object of transactions:

1) live animals, mainly transport of animals between the Zoo of Tallinn and other zoos;
2) hunting trophies, export of skulls and skins of bear, wolf and lynx shot by hunting tourists in Estonia;
3) stuffed animals, mainly export of stuffed birds of prey and lynxes made and acquired in Estonia.

In addition to the mentioned trade groups permits have been issued for transactions with bear meat, blood and tissue samples and live plants.

Structure of individuals of the species of CITES being the object of transactions has changed essentially throughout the years (figure 4.23). When in 1993 objects of transactions were live animals exchanged between zoos and only one permit was issued for export of hunting trophy, then in recent years hunting trophies have been main trade article in case of the issued permits.

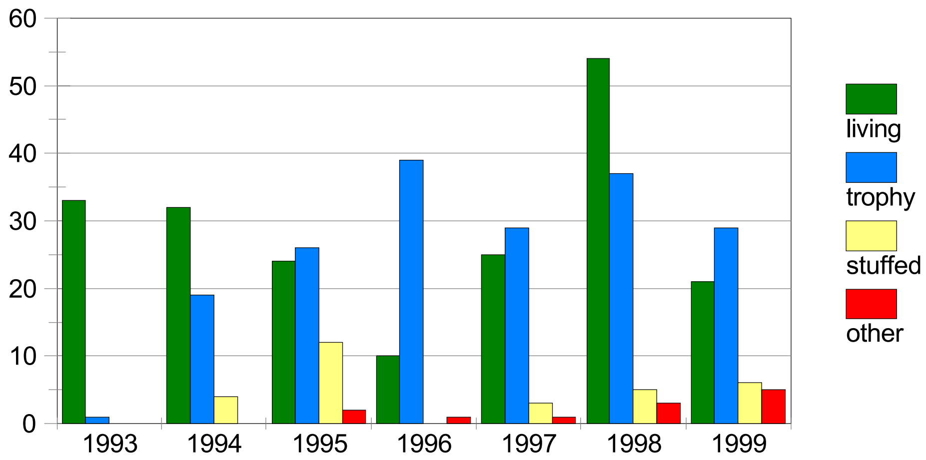


Figure 4.23. Division of the objects of CITES permits in 1993-1999.

4.5.2. Ramsar Convention

Ramsar Convention is an international agreement regulating protection and use of wetlands. It was ratified in Estonia by the Estonian Parliament on October 20, 1993.

According to Ramsar Convention wetlands are:

- mires (natural as well as artificial);
- stagnant as well as flowing, permanent as well as temporary, fresh, brackish as well as salty water areas, including sea areas, which depth is not exceeding six meters.

Initially this agreement was meant first and foremost for the protection of water birds, in order to create for them the network of 'shelters', but in the process of drafting of the text of the convention it became evident that protection of wetlands as habitats is equally important.

Wetlands with international importance in Estonia are Soomaa and Vilsandi national parks, Alam-Pedja, Endla, Matsalu, Muraka and Nigula nature conservation areas, landscape protection area of Hiiumaa islets together with Käina Bay, Emajõe Suursoo and Virtsu-Laelatu-Puhtu and Nehatu protection areas (figure 4.23). The most important presumption for implementation of the convention of wetlands with international importance is the drafting of management plans for these areas, which the Ministry of Environment must guarantee not later than by 2002 (National programme of the implementation of the convention of wetlands with international importance, especially habitats of water birds, RT I 1997, 18, 303).

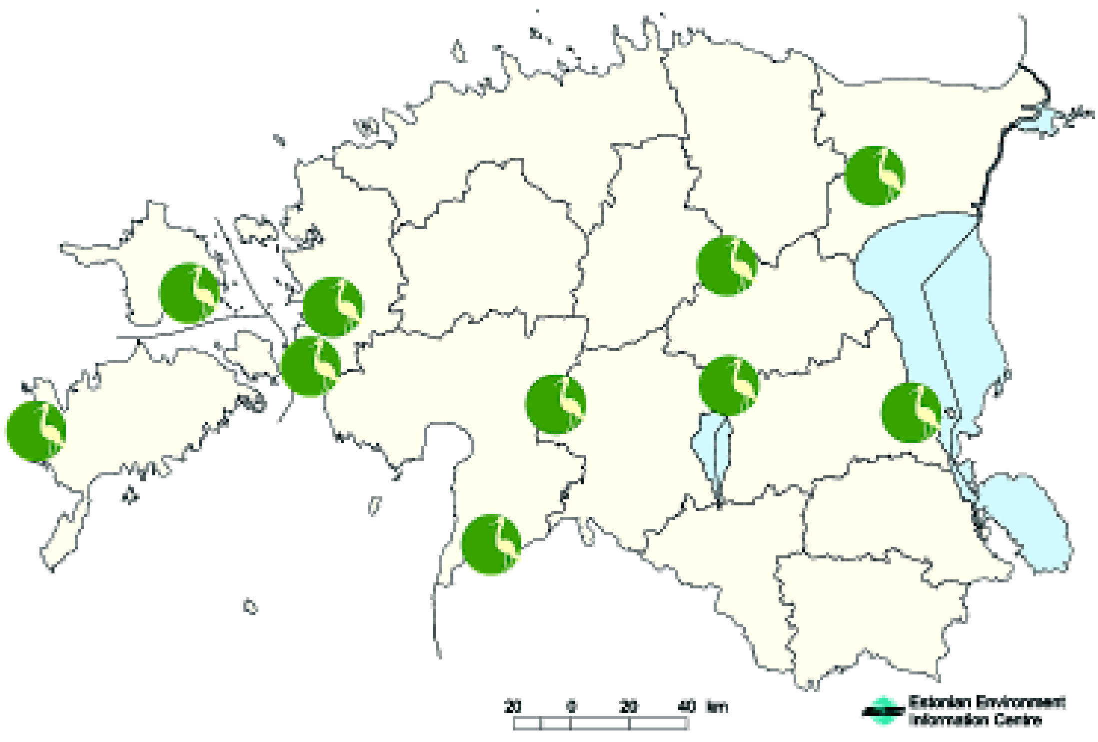


Figure 4.23. Ramsar areas in Estonia.

At the moment approved protection management plan exists for Matsalu and Alam-Pedja nature conservation areas. In Matsalu nature conservation area the plan has been implemented since 1995 and it is planned to start drafting already next working plan. Protection management plan of Soomaa national park is ready and intended to certify in 2000.

The situation is problematic with Emajõe Suursoo and Virtsu-Laelatu-Puhtu and Nehatu protection areas, as currently these have no protection rules complying with the law.

Planned Ramsar areas are Puhatu mire, Haapsalu Tagalaht with relict lakes of Noarootsi, Väike Strait with coast strip, Avaste mire, Nätsi-Võlla bog, Agusalu mire, Mullutu-Suurlaht, Siiksaare Bay, Vasknarva marsh of former river bends, Reigi Kootsaare-Mudaste coastal meadow at Hiiumaa, Rahuste coastal meadows and Lõo bay, Häädemeeste coastal meadows, Tõstamaa coastal meadows and the strait Hari kurk. These areas are planned to fix as internationally important wetlands not later than by the year 2010.

WASTE

5. Waste

Merike Liiver, Marit Leevik, Mari-Ann Mõtus

5.1. Introduction

Waste information is a subdivision of environmental information, which is necessary for the fulfillment of goals specified in Estonian environmental strategy: to support the saving use of raw material and other resources, limit the generation of waste and promote its recovery, reduce the pollution of environment caused by waste and areas contaminated by waste, develop waste management, first of all hazardous waste management

According to the Estonian Waste Act waste means any movable property which the holder has discarded or intends or is required to discard. The Waste Act specifies that every waste holder shall have adequate information concerning the types, quantities and origin of the waste in his possession, about the properties of the waste significant from the standpoint of waste handling and about the hazards they may cause to health or the environment. The task of waste statistics is to get generalized data about types and amounts of produced and handled waste in the whole country as well as counties or regions.

Data about types and amounts of waste produced and handled by Estonian companies are collected on the basis of the statistical report "Waste Handling" and processed in the Environment Information Centre (EIC) of the Ministry of the Environment in order to get generalized associated data. EIC is storing in its database – waste register – the submitted data of all inquired companies, counties and the whole country. Waste statistics involves mainly companies owning the waste permits issued by environmental authorities of counties.

For general characterization of the state of the environment the system of environmental indicators has been developed. For waste management there are following indicators:

- waste generation (mill. t/y)
- hazardous waste generation (mill. t/y)
- generation and deposition of municipal waste (th. t/y)
- industrial waste generation (mill. t/y)
- recovery of waste (%)
- import/export of waste (t/y)

The mentioned indicators are also needed for following international information issues:

- *Dobriš+3 Report* – European state of the environment report
- *Regional Environment Questionary* – Questionnaire of Eurostat
- *Baltic State of Environment Report* – Report of the Baltic Environmental Forum (BEF)
- *State of Environment Report (SoER)* – Report about state of environment in the European Information and Observation Network, EIONET).

5.2. Pressure

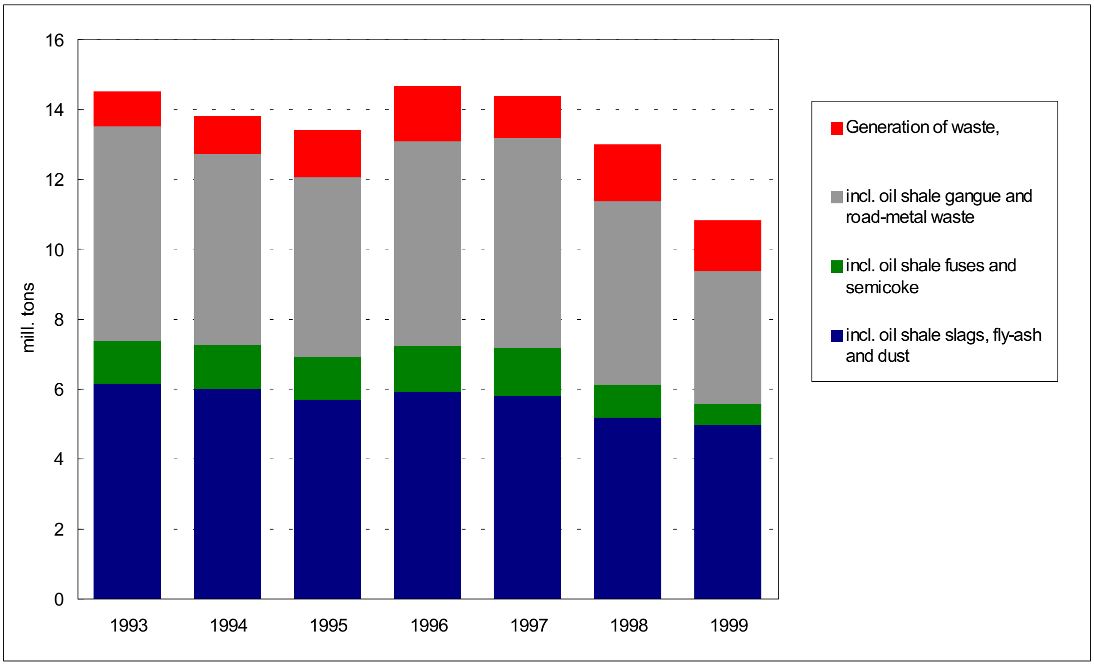
5.2.1. Generation of waste

Account is kept over the amount of waste produced in a year according to the system specified in the Estonian waste classification. Industrial and agricultural companies (production waste), waste transport companies and local governments (municipal waste) are obliged to submit to the environmental authority of a county once a year waste handling report, where the amounts of produced, treated, disposed , recovered , exported and imported waste are stated. Number of companies having participated in reporting by years is given in table 5.1.

Table 5.1. Companies having participated in reporting in 1993-1999.

Year	Number of companies having submitted the report
1993	712
1994	824 (not including Tartu town and county)
1995	2000 (on the basis of statistical selection)
1996	1076
1997	1105
1998	967
1999	805

Among the waste sources oil shale mining (underground and quarries) with oil shale based energy production and chemical industry are dominating. In Estonia oil shale ash, slag and semicoke and oil shale mining waste form average of 90% of the total amount of waste (figure 5.1). From other branches of Estonian industry construction, wood processing and food industry are more waste generating. Municipal waste form ca 4% of the total amount of waste.



	1993	1994	1995	1996	1997	1998	1999
Generation of waste (mln. tons),	14,512	13,818	13,406	14,687	14,398	12,984	10,848
incl. Oil shale slags, fly-ash and dust	6,158	5,995	5,714	5,933	5,819	5,193	4,963
incl. Oil shale fuses and semicoke	1,233	1,27	1,227	1,293	1,374	0,931	0,631
incl. Oil shale gangue and road-metal waste	6,133	5,479	5,137	5,885	5,999	5,271	3,807

Figure 5.1. Generation of waste in 1993-1999.

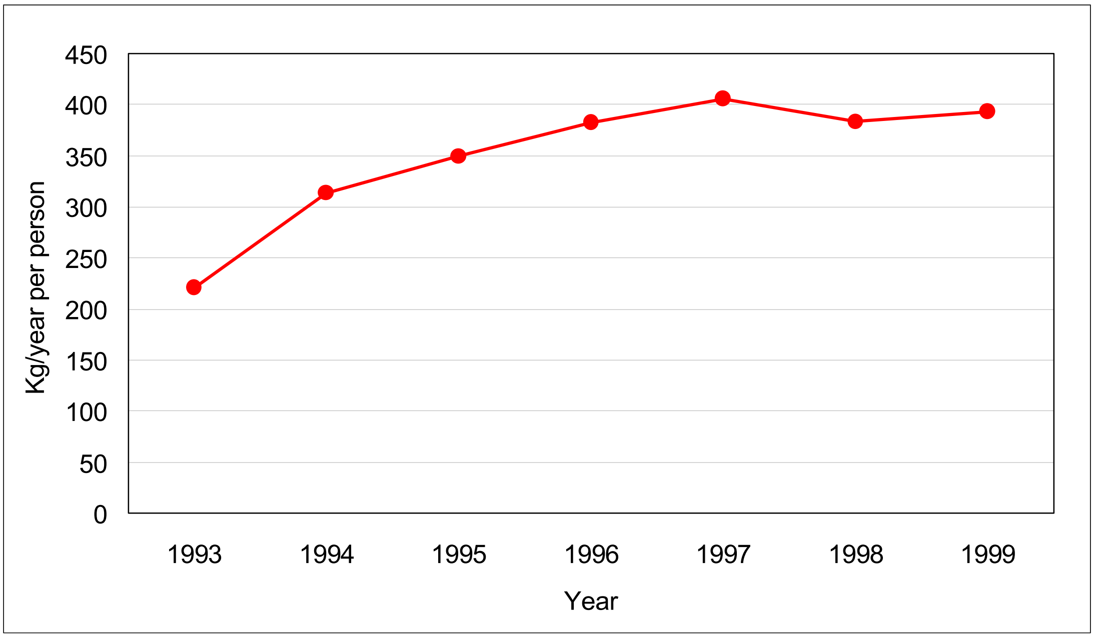
5.2.2. Generation of municipal waste

"Municipal waste" is any waste generated in households and as well as waste similar in its composition and characteristics generated in trade, provision of services or elsewhere. Municipal waste may contain components of non-hazardous waste and hazardous waste. There are relatively few data about composition of municipal waste generated in Estonia, furthermore, the composition of waste differs by regions depending on economic conditions and other aspects.

In the period 1993-1997 the amount of municipal waste has increased ca 40% (from 337 thousand tons to 593 thousand tons), which can be explained with the appearance of new consumption habits as well as coming of several new package types and materials to the Estonian market. In 1998 and 1999 average of 563 thousand tons of municipal waste were generated, which is ca 5% less than in 1997, so the growth has somewhat slowed down (figure 5.2).

Average annual production of municipal waste in Estonia is about 350 kg per person. Estonian environmental strategy specifies the stabilization of generation of municipal waste on the level 250-300 kg per person in a year. One of the main goals at the stabilization of generation of municipal waste in coming years is the reduction of generation of packaging waste, promotion of recycling and re-use of packaging and packaging materials.

Photo 5.1. Every Estonian person is probably at least once carried such municipal waste amount out of his household into closest waste container.



	1993	1994	1995	1996	1997	1998	1999
Generation of municipal waste (th. t/a)	337,134	472,639	522,097	564,704	593,258	557,157	568,694
Number of inhabitants (mill.)	1,527	1,507	1,492	1,476	1,462	1,454	1,446
Generation of municipal waste (kg/y per person)	220,850	313,644	350,029	382,513	405,749	383,000	393,288

Figure 5.2. Generation of municipal waste per person in 1993-1999.

5.2.5. Generation of hazardous waste

Hazardous waste is waste which due to its hazardous properties may cause a hazard to health or the environment. Until 1999 has waste been classified on the basis of their hazardous impact until the year 1999 according to the Estonian waste classification into four hazard classes. Consolidated data about waste generation by hazard classes in 1993-1999 are given in table 5.2.

Table 5.2. Waste generation by hazard classes in 1993-1999.

	1993	1994	1995	1996	1997	1998	1999
I hazard class – extremely hazardous waste (th. t)	0.028	0.033	0.078	0.044	0.075	0.037	0.052
II hazard class – highly hazardous waste (th. t)	9.420	10.126	11.837	9.988	22.470	14.892	6.664
III hazard class – moderately hazardous waste (th. t)	1536.180	1508.822	1452.476	1531.796	1581.429	1225.274	614.467
IV hazard class – wastes of minor hazard (th. t)	6185.670	5956.595	5808.963	6137.042	5756.856	5031.456	5238.338

As main waste generators in Estonia are oil shale mining, oil shale chemistry and energy industry, therefore also in volume of hazardous waste are dominating oil shale ashes and semi-coke. Most waste generated at the production of oil shale energy and in chemical industry is considered hazardous due to their high alkalinity, in most cases they belong into IV hazard class.

Other types of most generated hazardous waste are:

Waste of IV hazard class: sludges from wastewater treatment plants containing heavy metals, sludges from wastewater and combined sewerage, faecal matter;

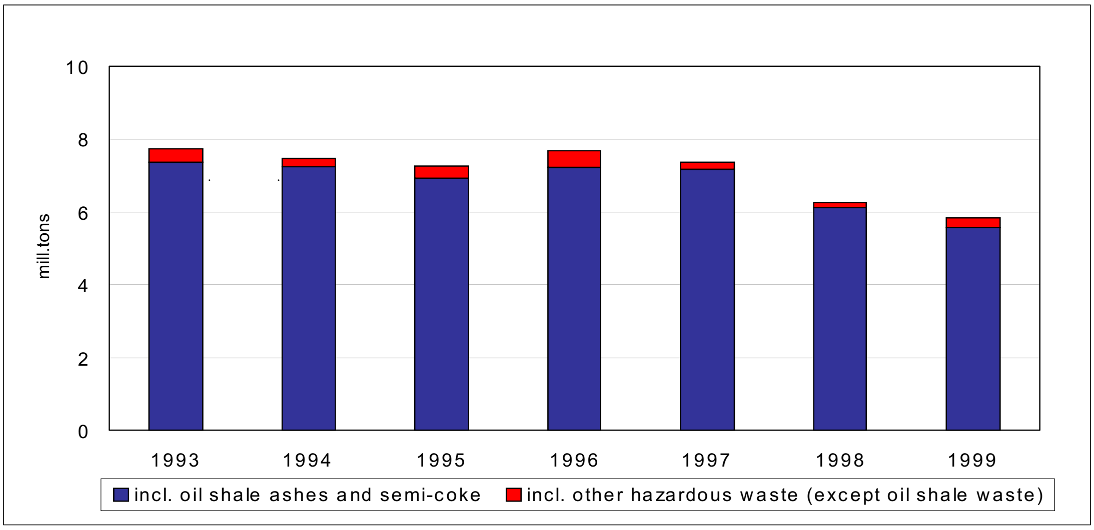
Waste of III hazard class: ballast and bilge water of ships, sawdust containing hazardous substances, mixed waste of hospitals, fuel and fuel oil waste and tank sediments;

Waste of II hazard class: lead batteries, bitumen and asphalt waste;

Waste of I hazard class: low and high pressure mercury lamps, nickel-cadmium accumulators.

In 1999 the total of 10.85 million tons of waste were generated, of which the amount of hazardous waste was 5.86 million tons, including oil shale ashes and semi-coke 5.59 million tons (95% of the amount of generated hazardous waste).

In the period 1993-1999 the amounts of hazardous waste have decreased ca 24% (from 7.73 million tons to 5.86 million tons) mainly due to the decrease of the production of oil shale energy and shale oil (figure 5.3). Reason for the decrease is also re-structuring of economy and accompanying decrease or alteration of production (including total stoppage of production in several branches of industry).

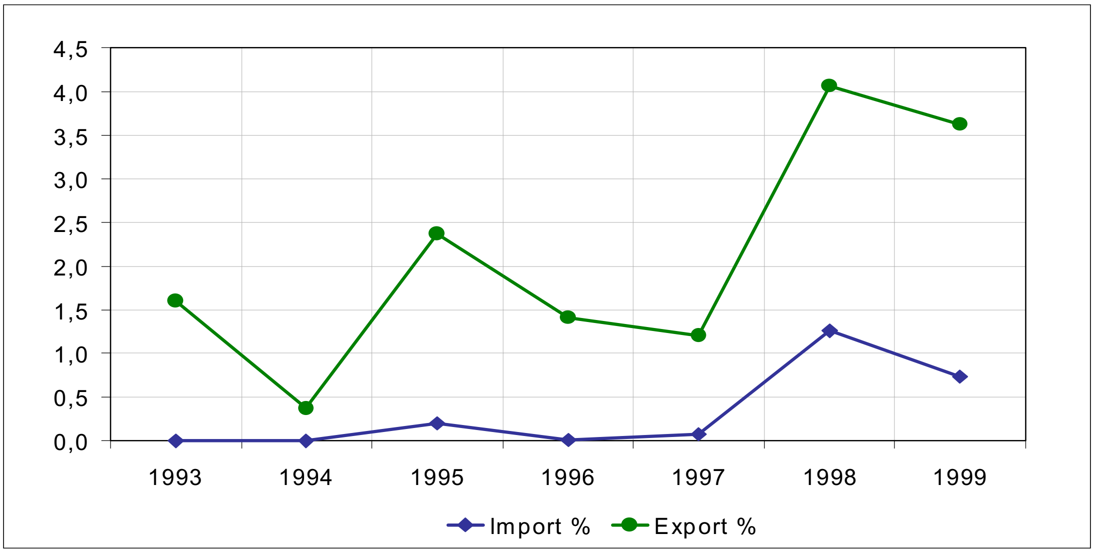


	1993	1994	1995	1996	1997	1998	1999
Total generation of hazardous waste (mill. t)	7,730	7,476	7,273	7,679	7,361	6,272	5,860
incl. oil shale ashes and semi-coke	7,382	7,257	6,933	7,216	7,170	6,110	5,588
incl. other hazardous waste (except oil shale waste)	0,348	0,218	0,341	0,463	0,190	0,162	0,271

Figure 5.3. Generation of hazardous waste in 1993-1999.

5.2.4. Export and import of waste

Import of waste in 1993-1999 has been quite low, taking average of 0.33% of waste generation (figure 5.4). Mainly scrap metal and metal waste has been brought to Estonia. In 1999 scrap iron and other ferrous and nonferrous ruptured metal formed ca 93% of imported waste. In addition to that accumulators were imported to Estonia from Baltic countries for treatment and further export (ca 6% of imported waste) as well as other waste – waste produced on ships (ballast and bilge water), board and cardboard waste, textile waste, used tyres of vehicles for recovery (ca 1% of imported waste).



	1993	1994	1995	1996	1997	1998	1999
Waste generation (mill. t/y)	14,512	13,818	13,406	14,687	14,398	12,984	10,848
Import of waste (t/y)	112,200	10,000	26260,500	1845,100	11250,600	164038,200	79903,681
Export of waste (t/y)	232111,253	50442,255	318295,694	206987,782	174809,524	527635,845	393557,812
Import (%)	0,001	0,000	0,200	0,012	0,080	1,263	0,737
Export (%)	1,600	0,370	2,370	1,410	1,210	4,064	3,628

Figure 5.4. Export and import of waste in 1993-1999 (% of waste generation).

Export of waste is forming average of 2.1% of the total amount of generated waste. Likewise the amounts of imported waste have somewhat increased in the period 1993-1999, the export of waste has also increased – increase ca 56% (from 232111 tons in 1993 to 527636 tons in 1998).

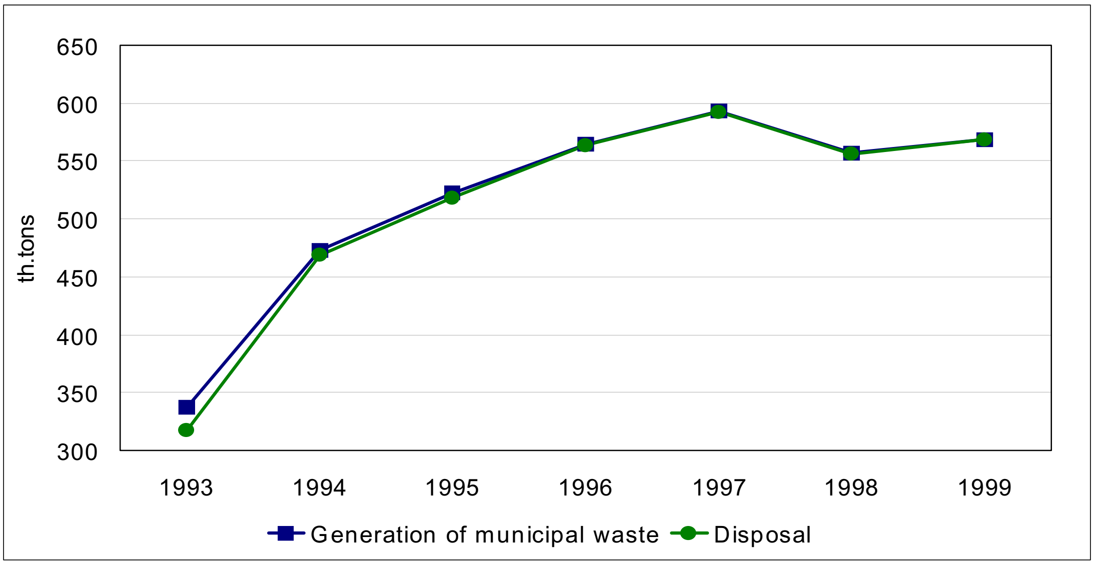
Due to the lack of facilities needed for the treatment of some types of recyclable waste the export from Estonia in 1999 included mainly scrap metal and metal waste – total of 276 002 t, wood waste – 83 928 t, oil shale slags – 14 048 t, paper and board waste 10 711 t and accumulators – 5 387 t. Exported waste includes also fibre and textile waste, plastic waste, film and celluloid waste, low pressure mercury lamps etc.

Photo 5.2. Containers of hazardous waste.

5.3. Status and effect

5.3.1. Disposal of municipal waste to landfills

Municipal waste form approximately 4% of the total amount of waste (figure 5.5). Almost all municipal waste (ca 99%) is disposed without sorting to landfills, which in most cases do not fully comply with environmental requirements. Together with municipal waste also hazardous waste is often disposed to landfills, as national hazardous waste management system is under development and not fully implemented. As disposal sites have emerged in very occasional places, such landfills are rather great environmental risk.



	1993	1994	1995	1996	1997	1998	1999
Generation of municipal waste (th. t)	337,134	472,639	522,097	564,704	593,258	557,157	568,694
Disposal (tuh. t)	317,041	468,869	518,520	563,688	591,991	556,000	568,622

Figure 5.5. Generation and disposal of municipal waste in 1993-1999.

In order to get overview of the amount of landfills in Estonia and their actual condition, work was started in 1995 for the establishment of the Register of Landfills. By March 1999 in total 565 landfills have been registered in the database of the Estonian Register of Landfills, of which 351 landfills for municipal waste. Consolidated data about the status of landfills for municipal waste (active, closed etc.) in 1996-1999 are given in table 5.3.

Table 5.3. Status of municipal waste landfills in 1996-1999.

Year	In operation	Operation finished	Closed	Closing in process	Inactive	Under establishment	Establishment cancelled	Planned	Total
1996	282	50	1	0	0	5	0	3	341
1997	252	56	33	0	0	2	5	1	349
1999	221	71	41	6	2	3	4	3	**351**

The table shows that the number of closed landfills has increased most. Landfills where operation is finished are landfills, which access road is closed and disposal of waste is prohibited; closed landfills are landfills, which territory has been levelled, covered and landscape gardened.

The largest landfill of municipal waste is Pääsküla landfill in Tallinn: waste covers ca 26 ha and the thickness of waste layer is over 20 m. In 1996 the total of 668258 t of waste were taken to Pääsküla landfill; in 1997 – 777823 t, in 1998 – 332651 t, in 1999 – 538869 t.

Coordinates of location of all landfills entered into the register have been determined, which enables to process data with methods of GIS (Geographical Information System). Figure 5.6 shows the map of Estonian working landfills in March 1999, drafted in the Environment Information Centre of the Ministry of the Environment.

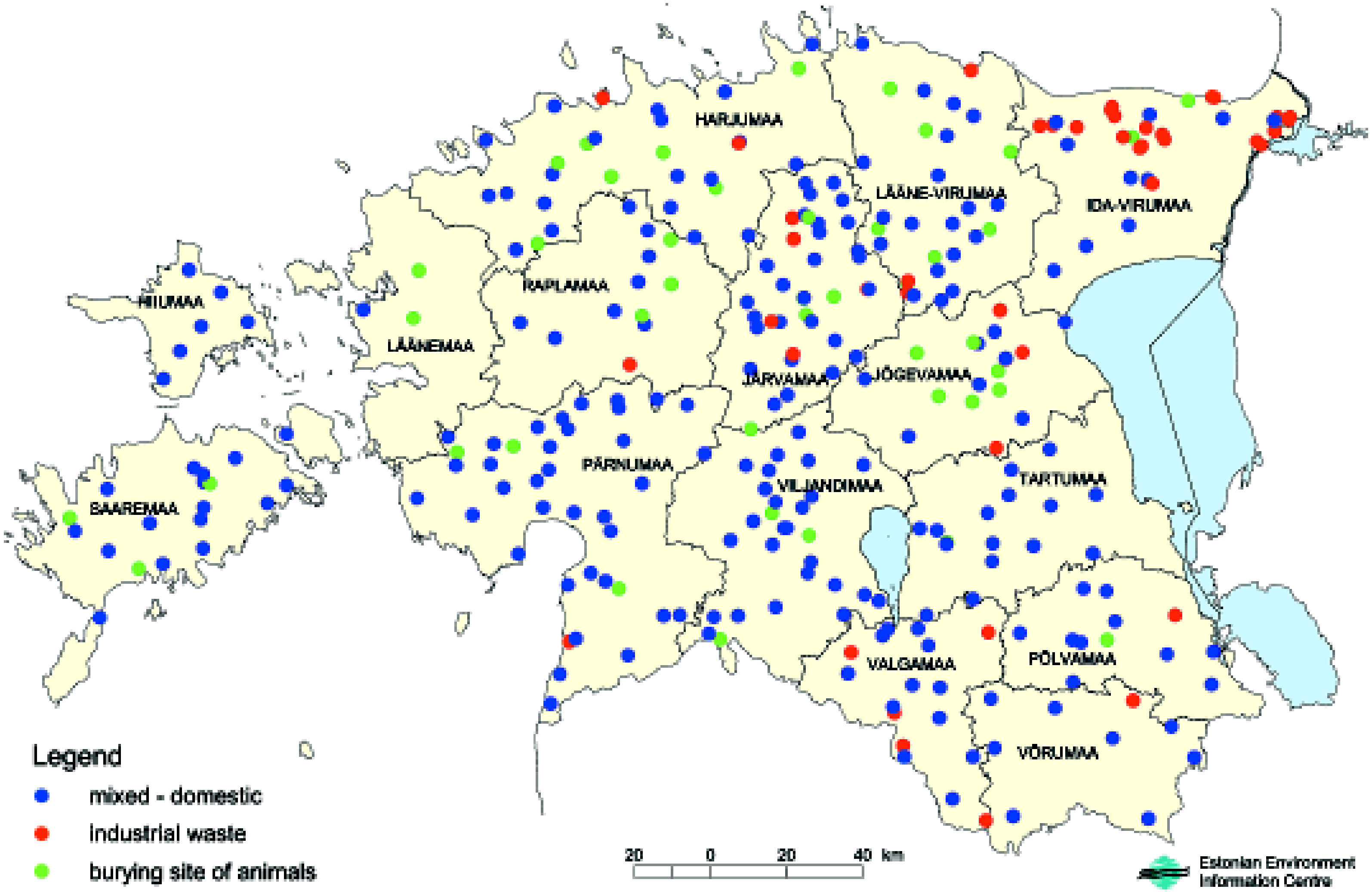


Figure 5.6. Estonian working landfills on 01.03.1999.

5.4. Measures

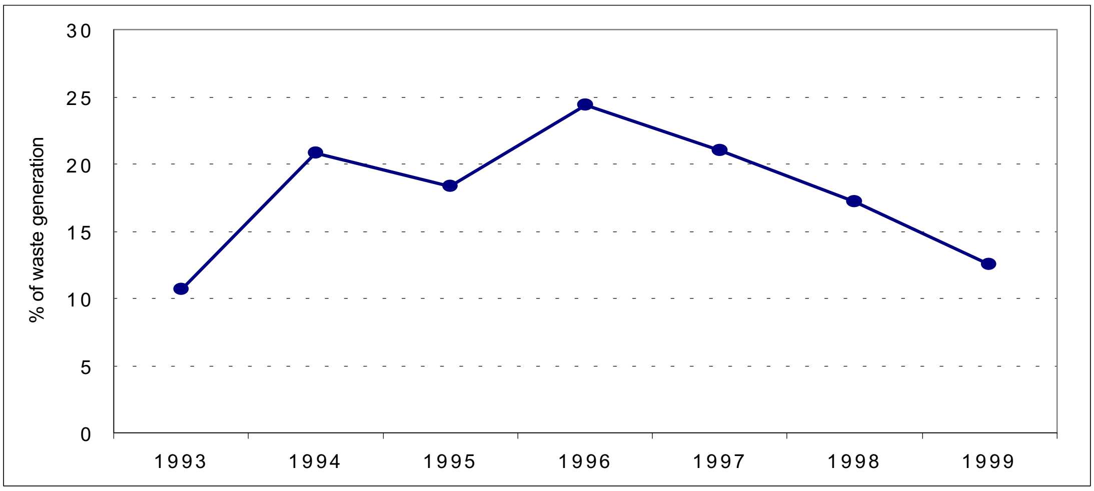
5.4.1. Waste treatment

Reduction of the production of waste and organization of waste treatment has been fixed in the Estonian environmental strategy, whereby the selection of practical measures should take place on the basis of following sequential factors:

1) prevention of waste generation;
2) reduction of generated waste volumes and decrease their hazards;
3) increase in the quantity and scale of recovered wastes, incl. re-use, material recycling, biological processes, energy recovery;
4) waste treatment complying with environmental requirements;
5) environmentally safe disposal of waste.

Estonian environmental strategy specifies that by the year 2001 recovery of waste should be increased to 50%.

Figure 5.7 shows data about production and treatment/recovery of waste.



	1993	1994	1995	1996	1997	1998	1999
Waste generation (mill. t/y)	14,512	13,818	13,406	14,687	14,398	12,984	10,848
Waste treatment (mill. t/y)	1,546	2,875	2,457	3,574	3,022	2,229	1,356
Waste treatment (%)	10,655	20,803	18,327	24,333	20,986	17,165	12,503

Figure 5.7. Waste treatment in 1993-1999 (% of waste generation).

Statistical data show that average of 18% of waste are treated in Estonia, whereby figure 5.8 shows the most used recovery operations and their percentage throughout the years.

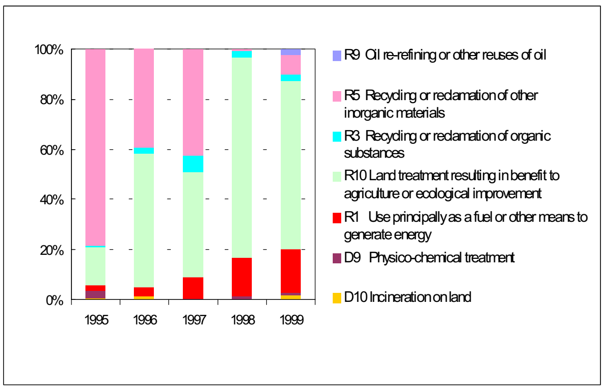


Figure 5.8. Waste treatment methods and their importance in 1993-1999.

In 1995-1999 composting and use of waste (mainly manure, sludges from wastewater and combined sewerage, waste of small treatment plants, ashes of boiler houses, vegetable waste) for soil treatment as well as use of waste for energy production (mainly combustion of wood and oil waste) has increased most. At the same time recovery of other inorganic materials (mainly oil shale slags and mineral construction waste) has decreased.

Main waste treatment method is still waste disposal in landfills.

5.4.2 National Packaging Register

The National Packaging Register was established pursuant to subsection 1 of section 15 of the Packaging Act (RT I 1995, 47, 739, § 15.1). The Statute of the National Packaging Register was passed by the Government of Republic on October 30th, 1997 (RT I 1997, 77, 1318). The Ministry of the Environment was designated as the chief processor and the Estonian Environment Information Centre as the authorised processor. The National Packaging Register was implemented step by step for alcoholic beverage packaging from 1 December 1997, for soft drinks packaging from 1 April 1998 and for other packaging from 1 April 1999. Entrepreneurs registered in the Business Register and affiliated branches of foreign business associations in Estonia who manufacture or use, import or export packaging, packaged goods or packaging waste, recover packaging and/or packaging waste, are obligated to submit data to the National Packaging Register.

The computer program of the National Packaging Register

The National Packaging Register has collected data concerning alcoholic beverage and soft drinks from 1997 and 1998 whereas the collection of other packaging just started in April of 1999. The computer program of the Packaging Register has been worked out by the Estonian Environment Information Centre for storage and arrangement of data and compilation of consolidated reports. It has been realized exactly according to the packaging register forms meant for questioning the enterprises and is working on the basis of Visual Fox Pro database program.

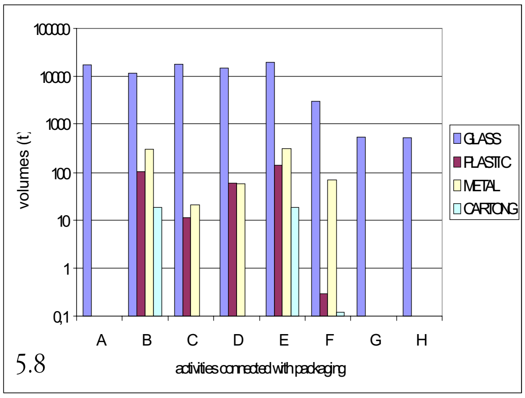
Packaging register forms

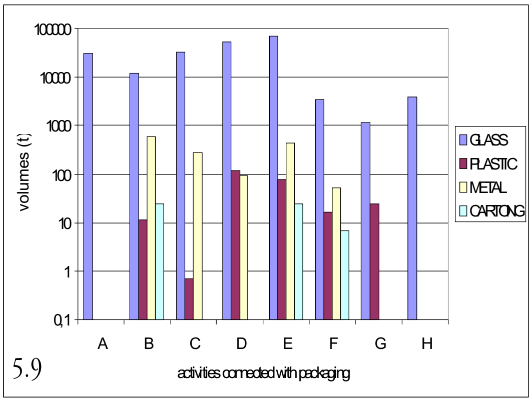
The Packaging Register forms are established with the Statute of National Packaging Register and are prepared according to those in the Commission Decision of the European Communities. The inquiry tables of forms are quite detailed and complicated to fill and need certain experience in this field. There are fourteen forms together (the first is about the information of entrepreneur and the last one is about excise rates and income of excise). The forms are separate for alcoholic beverage, soft drinks and other packaging. The information required in forms is following: imported and exported packaging quantities, packaging filled by enterprise, the methods and sites of packaging waste management and imported-exported amounts of packaging waste. Form tables contain separate columns for categories and types of packaging material (e.g. polyethylene, sales packaging). The Statute of Packaging Register obligates enterprises to submit their packaging data every year by 1 of March.

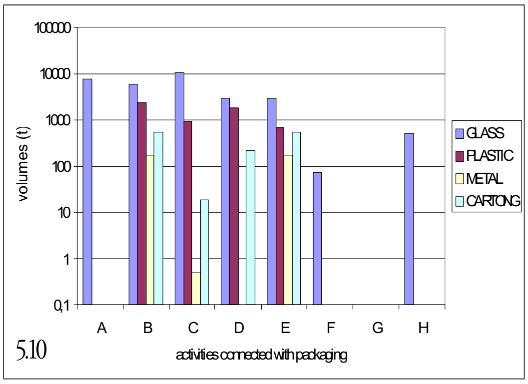
Photo 5.3. Some specimens of packages does not necessarily go into either waste basket nor recycling.

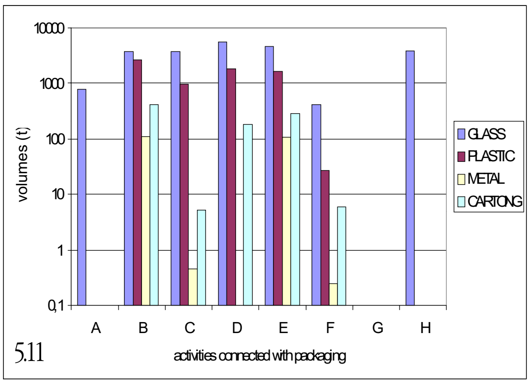
Data submission

The summary reports concerning alcoholic beverage and soft drinks packaging have been made for years 1997 and 1998. The same reports of 1999 have been completed by the end of 2000. The reminding letters were sent to enterprises dealing with other packaging, but only about 10 % of them answered to the questionnaires and summary reports have been made only in that extent. The lack of interest among entrepreneurs dealing with other packaging (exempting alcoholic beverage and soft drinks packaging) may be caused by the fact that they are not obligated to pay an excise duty tax. The maximum size of the penalty is equal to 50 days salary, what is too low for the entrepreneur to follow the requirements of the Act (Databases Act, RT I 1997, 28, 423, §183[2]). The data collection of alcohol and soft drinks packaging is supported by the Packaging Excise Duty Act, which forces companies to keep a correct documentation as otherwise it may be difficult for them to receive the certificate for exemption from excise.









Figures 5.8-5.11. 5.8. Packaging of alcoholic beverage 1997 (tons). Abbreviations of activities connected with packaging. A - production of empty packaging, B - import of packaging, C - export of packaging, D - total of filled packaging, E - total of packaging in Estonia, F - recovery of packaging (as the secondary raw material or as a fuel), G - export of packaging waste, H - import of packaging waste. 5.9. Packaging of alcoholic beverage 1998 (in tones). Abbreviations are the same as on figure 5.8. 5.10. Packaging of soft drinks 1997 (tons). Abbreviations are the same as in figure 5.8. 5.11. Packaging of soft drinks 1998 (tons). Abbreviations are the same as in figure 5.8.

Figures 5.8-5.11 show that the recovery of packaging increased in 1998 compared to 1997. Also the export of alcohol packaging waste has started. The system of recovery was launched due to packaging excise, which has been enforced for alcoholic beverage packaging from March 1, 1997 (Packaging Excise Duty Act, RT I 1997, 5/6, 31, §14). Recovery of soft drinks packaging from plastic, metal and cardboard was still lacking in 1997 (glass is reusable packaging), as the Act has been enforced for soft drink packaging only from December 1, 1998 (figures 5.10, 5.11).

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