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Preface

Co-operation among the Baltic Sea countries on environmental issues has developed over the last 27 years, and considerably so in the last decade. The HELCOM Ministerial Meeting in 1988 was, in a certain sense, a turning point in the history of the Commission, laying down the cornerstone for notable changes in the political motivation for controlling marine pollution. The overall 50 percent reduction target concerning discharges from point and non-point sources engendered environmental activities at all levels, and served as a starting point for advanced environmental policy.

The aim of this report is to summarise progress toward implementing the strategic goals of the 1988 Ministerial Declaration, in particular with regard to the 50 percent reduction goal for nutrients by 1995. The report also provides an overview of more specific targets developed in the Baltic Sea countries.

This report on implementation of the 1988 Ministerial Declaration provides an overview of the pollution load of nutrients from various sources entering directly into the Baltic Sea, as well as to the water bodies in the catchment area of the Baltic Sea. Data are provided for the late 1980s and 1995 on the bases of the **source-orientated** approach adopted by the Extraordinary Meeting of the Helsinki Commission in 1999. The most difficult task was to assess and compare the agricultural loads from the late 1980s and 1995 and the reductions achieved by 1995, due to the missing information for some of the countries, different methodologies and climatic conditions. Therefore the load data and the reductions achieved in agriculture are tentative, and should be refined in conjunction with the preparation of the next Pollution Load Compilation Report (PLC-4) in 2003.

Taking into account the reductions achieved by 1995, the project group has compiled final or preliminary national water protection targets. Referring to the 1998 Ministerial Communiqué, the preliminary reduction targets should be reviewed in 2003 on the basis of information for the year 2000 (PLC-4), which provides the Contracting Parties the possibility to define more realistic targets for the year 2005.

The institute responsible for the work has been the Finnish Environment Institute with Mr. Heikki Pitkänen as the project manager and Mr. Ain Lääne as the project co-ordinator. The national institutes and experts participating in the project have been:

- Denmark, National Environmental Research Institute, Mr. Lars M. Svendsen;
- Estonia, Estonian Environment Information Centre, Ms. Karin Pachel;
- Finland, Finnish Environment Institute, Mr. Antti Räike;
- Germany, Institute of Freshwater Ecology and Inland Fisheries, Mr. Horst Behrendt;
- Latvia, Latvian Environment Agency, Ms. Sarmite Lucane;
- Lithuania, Centre for Environmental Policy, Mr. Simonas Valatka;
- Poland, Institute of Meteorology and Water Management, Mr. Waldemar Jarosinski;
- Russia, State Centre for Environmental Programmes, Mr. Alexander Shekhovtsov;
- Sweden, Swedish Meteorological and Hydrological Institute, Ms. Berit Arheimer.

We wish to extend sincere thanks to the representatives of the Contracting Parties who have contributed to the success of the work in collecting and presenting national data, as well as in finalising the report. We also wish to thank Mr. Robert Downing for checking the English of the Report.

We also wish to express our appreciation to the Directorate General Environment, Nuclear Safety and Civil Protection of the Commission of the European Communities (EU/DG XI), the Helsinki Commission, and the Finnish Ministry of the Environment for their financial support.

Contents

Summary

In September 1988 the Ministers of Environment of the Baltic Sea States decided that anthropogenic loading to the Baltic Sea should be reduced by 50 % from 1987 levels by the year 1995 (The 1988 Ministerial Declaration). Due to partly unreliable and/or missing loading data, real progress in achieving this target could not be assessed regarding the entire Baltic Sea catchment area. The Extraordinary Meeting of the Helsinki Commission decided in 1999 that the Land-based Pollution Group (HELCOM LAND) shall monitor and assess the implementation of the strategic goals set in the Declaration, as well as to report on the implementation of the Declaration.

The present report assesses the development of nitrogen (N) and phosphorus (P) discharges, based on the so called source-orientated approach, i.e. loading figures for point (municipalities, industry, fish farming) and diffuse (agriculture) sources. In addition, some countries have also presented information on nutrient retention in river catchments and the net loads to the Baltic Sea (load-orientated approach). It should be highlighted that it is difficult to reliably estimate losses from agriculture into surface water, and that the models and methodologies used do not necessarily provide comparable and/or accurate estimates of these loads between different countries and time periods.

The report summarises the national nitrogen and phosphorus loading figures for 1987 (or any other year or period in the late 1980s) and 1995, as well as the reduction achieved between these years. The national loading figures have been collected in long-term monitoring programmes, which, however, differ among countries, especially regarding diffuse loading. Additionally, some of the loading figures for the late 1980s have been calculated based on background statistics and/or model calculations, without the possibility of verification by monitored data. The loading figures for 1995 are, for the most part, calculated from the data obtained in monitoring programmes.

The country-specific reduction figures were produced by the national experts of the project group, and the overall results and their comparison are based on these estimates. Regarding point sources, the 50 % reduction target was achieved for phosphorus by almost all the Baltic Sea countries, while most countries did not reach the target for nitrogen. In general, the reductions were biggest both for point and non-point sources in the transition countries, due to fundamental changes in their political and economical systems in the early 1990s. In EU member countries, the observed decrease was usually smaller and was based on water protection measures implemented during the period. This development strengthened also in the countries in transition during the 1990s. Denmark, Finland, Germany (Western part) and Sweden had already achieved reductions in point source loading in the 1970s and 1980s. This partly explains lower reductions from point sources in these countries between the late 1980s and 1995.

Agricultural loading levels usually showed smaller decreases than the point source loading. In general, decreases could be found in nitrogen, while decreases in phosphorus remained smaller. In Finland, Germany and Sweden, no decrease could be found in agricultural phosphorus loading, despite strong reductions in the use of P-fertilisers. The main reason is the net surplus of phosphorus in the soil

due to the high use of phosphorus fertilisers in these countries. The reduction in fertilisation has balanced the surplus to zero or close to it. This has, however, not been sufficient to reduce soil phosphorus concentrations. There will be a long lag before any changes can be seen in losses. With nitrogen also, some time lag is expected between the implementation of reduction measures and decreases in nitrogen discharges to surface water. According to national estimates, the 50 % reduction in agricultural nutrient loading has been reached by transition countries except Poland. The conclusion concerning the reductions achieved is, however, uncertain due to the lack of monitoring systems for diffuse loading in the late 1980s. However, both the drastic reduction in the use of fertilisers (80–90 %) and decrease in agricultural production (30–40 %), as well as the increase of the green set-aside area, supported the estimated reductions.

The comparison of national point source loading figures with available background information (statistics, reports, projects) indicate most results are reliable enough for developing conclusions. The largest inconsistencies can be found in the agricultural loading figures. It seems probable that estimates of agricultural loading for countries in transition during the late 1980s can be regarded only as tentative, as direct monitoring of agricultural loading during period is lacking. Further, the used models and methodologies are not necessarily comparable. Thus, regarding total national loads and reductions, figures for point and diffuse sources were assessed separately. However, at the request of the extraordinary meeting of the Helsinki Commission (HELCOM EXTRA 99) and the decisions of HELCOM LAND 3, this report also summarises these loads and reductions achieved.

A description of the Finnish National Programme on Water Protection for the year 2005 is included in the present report as an example for the action plan to further reduce nutrient loads in order to reach the 50 % (or more) target, including EU requirements. The chapter includes descriptions of technical measures, the economic impacts and environmental effects related to the implementation of the programmes.

In addition to the Finnish programme, the corresponding programmes of Denmark, Estonia, Latvia, Lithuania, Poland, Russia and Sweden are also presented and discussed.

PART I
The assessment of the load reductions achieved

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Introduction

The Convention on the Protection of the Marine Environment of the Baltic Sea Area was the first international agreement to cover all sources of marine pollution: from land and ships as well as airborne sources. It was signed in March 1974 by the coastal states, and entered into force in May 1980. From 1992 to 1994, the Convention was acceded to by the Baltic States (Estonia, Latvia, and Lithuania) as well as the Commission of the European Community. Within the work of the Helsinki Commission, the main marine pollution problems had, by 1988, certainly been identified [1, 2, 3, 4]. It was generally agreed that improving the state of the Baltic Sea requires extensive reductions in pollution loads.

The Declaration, adopted at the Ministerial meeting of the Helsinki Commission in 1988 [5], recognised that the challenges in the Baltic Sea region were both economic and institutional.

The Ministers declared their firm determination to:

> *"Make further provisions for reducing discharges from point sources, such as industrial installations and urban wastewater treatment plants, of toxic or persistent substances, nutrients, heavy metals, and hydrocarbons by construction and operation of installations and equipment in conformity with the best available technology. In this context it is noted that actions concerning non-point sources will also be needed. In order to fulfil these objectives current and new efforts on reduction of the load of pollutants should aim at a substantive reduction of the substances most harmful to the ecosystem of the Baltic Sea, especially of*
> - *heavy metals and toxic or persistent organic substances, and*
> - *nutrients*
>
> *for example in the order of 50 percent of the total discharges of each of them, as soon as possible, but not later than 1995."*

At its tenth meeting in 1989, the Commission decided that the Contracting Parties should report on the national implementation of the 1988 Ministerial Declaration every three years, and that implementation status reports should be submitted to the Commission in 1991, 1994 and 1997.

The Interim Implementation Report [6], submitted to the 15th Meeting of HELCOM in 1994, revealed some promising developments in implementing the 50 percent reduction goal. Some progress was noted in the reduction of pollution from the industrial sector (mostly in wastewater treatment) and from municipalities and transport, but improvements were least apparent in agriculture.

At its 16th meeting in 1995 the Commission decided to establish a project to prepare a Final Report on Implementation of the 1988 Ministerial Declaration. The following objectives of this report were defined:

- to assess to what extent the overall 50 % reduction goal was met;
- to describe where and why shortcomings occurred; and
- to list the imperative actions which should follow as a consequence of any failure to reach the goals set in 1988.

In the Final Report [7], submitted to the 19th Meeting of HELCOM in 1998, the Commission considered e.g.: "the overall 50 percent reduction target has not been achieved for all polluting inputs despite the efforts of the Contracting Parties to reduce them; major problems of continuing eutrophication arising from agriculture and sewage in-flows are still present".

The report also noted that to implement the goals of the Convention, the Helsinki Commission must have reliable data in order to both assist the effectiveness of measures implemented and to assist in the subsequent decision making process.

The Commission reaffirmed the commitment of the Contracting Parties to the strategic goals set up in the 1988 Ministerial Declaration and decided to further progress by defining more specific targets, aimed at the most cost-effective solutions.

Following the Communiqué of the Ministerial Session in 1998 [8] and the decision of the 19th Meeting of the Helsinki Commission, the Technological Committee developed the document "Implementation of the Strategic Goals of the 1988 Ministerial Declaration, in Particular with Regard to the 50 % Reduction Goal" [9] adopted by the Extraordinary Meeting of the Helsinki Commission in September 1999.

According to the document, more specific targets will be elaborated after the gathering of pollution load data for the year 1987 or any year in the end of 1980s, as well as for the year 1995 concerning the whole Baltic Sea catchment area.

Based on these data, every Contracting Party should consider elaborating more specific targets for the implementation of the 50 % goal of the 1988 Ministerial Declaration for its own territory. In elaborating more specific targets, the Contracting Parties may use the source-orientated or the load-orientated approach. The Contracting Parties will report on the data according to the source-orientated approach. It is up to the Contracting Parties whether they want to use the load-orientated approach in combination with the source-orientated approach.

Each Contracting Party can set up sector-specific reduction targets to fulfil the 50 % reduction goal. However, it should be noted that the adoption of a source-orientated approach must not mean that the determination of the percentage reduction needed within each sector is a task for HELCOM to decide upon, but is to the exclusive discretion of each Contracting Party.

Based on the above-mentioned documents, a Grant Agreement between the European Community/European Atomic Energy Community/European Coal and Steel Community (the Community) and the Baltic Marine Environment Protection Commission (HELCOM) concerning the project "The follow up of implementation of the strategic goals of the Ministerial Declaration, in particular with regard to the 50 % reduction goal concerning nutrients" was signed on 8 June 2000.

The overall objective of the project is to assess the anthropogenic nutrient (nitrogen and phosphorus) discharges from various sources (including agriculture) to surface waters in the Baltic Sea catchment area and directly to the Baltic Sea for late 1980s and to make the load figures comparable with the pollution load data from years 1990 and 1995. Therefore each Helsinki Commission member state should supply updated data on discharges for 1987 (or any year in the late 1980s) as well as for 1995 to the project consultant, the Finnish Environment Institute (FEI).

This report contains information on the reduction of anthropogenic nitrogen and phosphorus loads achieved, by country and source type (e.g., municipal wastewater, industrial wastewater and agriculture). The report also provides an overview of the most important nitrogen and phosphorus sources, and the effects of programmes and proposals to reduce the nutrient discharges to the environment (more specific targets).

2 National loading estimates for the late 1980s and 1995 and reductions achieved by countries

This chapter contains a review of national loading figures for the late 1980s and 1995, and reductions achieved based on the source-orientated approach. The chapter is based on national reports contained in Chapters 6 through 14. Only the most important elements from these national reports are highlighted, and general trends are assessed. All numerical values in Chapters 2 to 5 are rounded: total nitrogen values to hundreds of tonnes, and total phosphorus to tens of tonnes. Countries with roughly similar development in their economies and in the implementation of water protection measures and monitoring systems are presented together.

The first group is the Nordic countries (Denmark, Finland, Sweden), which have had quite similar development in their environment protection, legislation and monitoring systems. In Germany, the greatest changes took place in the early 1990s when the two different economic and political systems (FRG and GDR) were united. Developments in Poland differ from those in Estonia, Latvia, Lithuania and Russia, especially regarding the changes in agriculture. Estonia, Latvia, Lithuania and Russia had the same legislative and economic base until the early 1990s, and have had certain similarities in the development of water protection measures since the collapse of the Soviet Union during the first half of the 1990s.

There are large differences among the Baltic Sea countries in the monitoring systems of **agricultural loading**. National loading estimates are based on small experimental catchments, different types of statistics together with mechanistic models, or on different combinations of the above methods. Thus, fully reliable comparisons between the countries cannot be made. As climate (hydrological) conditions have a large influence on the agricultural load, comparisons between the two time periods include relatively large possibilities for inconsistencies. All countries except Denmark have submitted flow-normalised load values. Latvia, Lithuania and Russia have used statistics and mechanistic models based on long-term monitoring in Estonia. National loading figures for point and non-point sources are expressed separately, to avoid the possibility that unreliability of the agricultural values also makes the total national values unreliable.

2.1 Denmark, Finland and Sweden (Chapters 6, 8 and 14)

Point sources (municipalities, industries and fish farms)

The point source load assessments submitted by the national experts (Table 2.1) are based on monitoring data and loading figures from national authorities for both the late 1980s and 1995. However, for the late 1980s Denmark, Finland and Sweden had some difficulties in separating municipal and industrial load according to size classes and industrial branches. The information concerning treatment methods and efficiency is comprehensive.

The schedule of load reductions from municipal and industrial sources differ among the three countries and depends largely on when the countries started to implement water protection measures for phosphorus and nitrogen. Nutrient load from fish farms in Denmark and Finland as a rule were calculated from feed consumption and production of fish. For Sweden the loads from both freshwater and marine fish farms were calculated by multiplying production levels by emission factors.

Table 2.1 Point source nitrogen (N) and phosphorus (P) load reductions achieved by Denmark, Finland and Sweden between the late 1980s and 1995.

Country	N				P			
Source	(tonnes/year)		Reduction		(tonnes/year)		Reduction	
	late 1980s	1995	(tonnes)	(%)	late 1980s	1995	(tonnes)	(%)
Denmark								
Municipal	15 500	7 100	8 400	54	3 910	1 030	2 880	74
Industrial	4 200	1 700	2 500	60	1 010	120	890	88
Fish farms	2 600	1 700	900	35	290	140	150	52
TOTAL	22 300	10 500	11 800	53	5 210	1 290	3 920	75
Finland								
Municipal	14 500	14 900	–400	–3	450	260	190	42
Industrial	5 800	4 300	1 500	26	830	360	470	57
Fish farms	1 550	1 250	300	20	210	160	50	31
TOTAL	21 850	20 450	1 400	6	1 490	780	710	48
Sweden								
Municipal	25 600	25 000	600	2	1 040	420	620	60
Industrial	7 400	5 200	2 200	30	770	480	290	38
Fish farms	295	300	–5	–2	36	52	–16	–44
TOTAL	33 295	30 500	2 795	8	1 846	952	894	48

Denmark has reduced point source loads with more than 50 % for nitrogen and with 75 % for phosphorus, while the corresponding reductions in Finland and Sweden were considerably lower. With regard to phosphorus, the smaller decrease compared with Denmark is largely due to the fact that in these countries chemical phosphorus precipitation techniques had already been introduced in the 1970s or the early 1980s. One of the reasons in the reduction of phosphorus discharges from municipalities was also the introduction of phosphorus-free detergents. Loads from fish farms were quite small compared to other point source categories; however, the reduction achieved in Denmark is largest, exceeding 50 % for phosphorus.

The primary difficulties in Finland and Sweden to achieve the 50 % reduction were connected to nitrogen loads. Practically no changes occurred in municipal loads between the late 1980s and 1995, with reductions of only 25 to 30 % in industrial loads. The introduction of the nitrification-denitrification method was not started in these countries until the 1990s.

Agriculture

Estimates of agricultural nitrogen and phosphorus loads are based on small catchments and model calculations. The Danish National Environmental Research Institute (NERI), the Finnish Environment Institute (FEI) and the Swedish Meteorological and Hydrological Institute (SMHI) have also conducted several special studies to assess the anthropogenic nutrient load from agriculture (Chapters 6, 8 and 14). While models have been developed and verified both on the national and joint level, there is no harmonised model approach to assess the nutrient load from agriculture between the three countries. In Sweden, the models SOIL-N and HBV-N were used to assess the agricultural loads (Chapter 14), while for Denmark and Finland, agricultural loads are based more directly on the monitoring data (Chapters 6 and 8).

The results for agricultural loading presented in Table 2.2 indicate to loads to the nearest surface water body (calculated on the basis of methods described in Chapters 6, 8 and 14). Natural background losses have been subtracted from the agricultural loads. The figures for Finland and Sweden are flow-normalised, while the Danish values represent the actual hydrological conditions.

Table 2.2 Discharges of nutrients into surface waters from agriculture in Denmark, Finland and Sweden and the reduction achieved between the late 1980s and 1995.

Country	N (tonnes/year)		Reduction		P (tonnes/year)		Reduction	
	late 1980s	1995	(tonnes)	(%)	late 1980s	1995	(tonnes)	(%)
Denmark[1]	79 000	53 800	25 200	32	670	580	90	13
Finland[2]	45 500	37 000	8 500	19	2 650	2 600	50	2
Sweden[3]	65 100	48 200	16 900	26	390	360	30	8

1) The discharge from agriculture was calculated from nutrient discharges to rivers as a residual by subtracting loads from all other sources. The Danish load figures are not flow-normalised. (See Section 3.1.1 and Chapter 6).

2) The discharge was estimated on the basis of intensive monitoring in four small agricultural drainage basins and in four agriculturally loaded river basins in southern and southwestern Finland. (See Section 3.1.1and Chapter 8).

3) The discharge from agriculture was estimated using two different models (see Section 3.1.1 and Chapter 14).

Although many agricultural measures were implemented in Denmark between the late 1980s and 1995, no corresponding improvements were found in the quality of runoff water due to the considerable time lags between the implementation of control measures and their ecological effects. The reduction in nitrogen discharges from agriculture can be explained by weather and run-off conditions in 1994 and 1995, as explained in Chapter 6.

The implementation of different protection measures, such as the reduction in the use of nitrogen fertilisers and the increase in the area of set-aside fields, have probably somewhat decreased the agricultural nitrogen load in Finland. However, the Finnish data also show a considerable time delay between the implementation of measures and their effects.

In Sweden, the calculated reduction in the nitrogen load from agriculture is mainly a consequence of set-asides and changed crop composition, which includes more grass ley and less cereals. In addition, leakage concentrations from individual crops were decreased due to the increased nitrogen use efficiency (i.e. higher yields). National reductions in phosphorus loads are significantly smaller than that of nitrogen in all three countries.

Despite the reduced use of phosphorus fertilisers, no corresponding change can be found in the agricultural loads to water bodies. This is mainly due to the efficient sorption and slow release of phosphorus in agricultural land. The fact has been verified in national reports using both monitored and modelled information.

2.2 Germany (Chapter 9)

Point sources (municipalities, industries and fish farms)

Germany has carried out several projects in the 1990s to establish a database of direct and indirect discharges from municipal and industrial sources using both measurements and models (MONERIS). The database includes information from 126 municipal wastewater treatment plants for the late 1980s, and from 160 treatment plants with a capacity more than 2000 PE for 1995. Detailed information on treatment method efficiencies is also available for assessing point source nutrient loads. The load from fish farms was calculated according to HARP (OSPAR) and PLC-3 (HELCOM) Guidelines (Chapter 9). Statistical data on fish production in freshwater systems was available only for the area of the former GDR (Table 2.3).

The nitrogen discharge from municipal treatment plants and industries declined 47 % and 42 % respectively, while the reduction of phosphorus discharges was significantly higher (79 % and 89 % respectively). The main reason for the decreases is the construction of wastewater treatment plants in the eastern part of Germany (former GDR), as well as the closing or modernisation of industrial plants. The nitrogen and phosphorus load reduction from fish farming was about 33 %, mostly due to a reduction in fish production.

Table 2.3 Nitrogen and phosphorus load from point sources in Germany and the reduction achieved between the late 1980s and 1995.

Source	N (tonnes/year) late 1980s	N (tonnes/year) 1995	Reduction (tonnes)	Reduction (%)	P (tonnes/year) late 1980s	P (tonnes/year) 1995	Reduction (tonnes)	Reduction (%)
Municipal	16 100[1]	8 600[1]	7 500	47	2 750[1]	590[1]	2 160	79
Industrial	1 900[1]	1 100[1]	800	42	440[1]	50[1]	390	89
Fish farms	160[2]	110[2]	50	31	30[2]	20[2]	10	33
TOTAL	18 160	9 810	8 350	46	3 220	660	2 560	80

1) Estimated on the bases of measurements and model calculations

2) The statistical data concerning fresh water fish farming were available only for the former GDR. Data on loading from marine fish farms in the late 1980s for the whole German Baltic Sea catchment area is unavailable.

Agriculture

The anthropogenic nutrient load from agriculture was calculated by the MONERIS model (Table 2.4). Statistical information on agricultural area, number of livestock and mineral fertiliser use for the Federal Republic of Germany and the former German Democratic Republic were used. The data of the former GDR were recalculated into terms needed for the report. To reduce the influence of climate on the losses from agricultural areas into freshwater systems, the loads were calculated for two longer periods (1983–1987 and 1993–1997). The background load was then subtracted from the calculated load figures.

Table 2.4 Discharges of nutrients into surface waters from agriculture in Germany and the reduction achieved between the late 1980s and 1995.

N (tonnes/year) late 1980s	N (tonnes/year) 1995	Reduction (tonnes)	Reduction (%)	P (tonnes/year) late 1980s	P (tonnes/year) 1995	Reduction (tonnes)	Reduction (%)
35 200[1]	26 100[1]	9 100	26	600[1]	640[1]	–40	–7

[1)] Model calculations (MONERIS) in which loads from all diffused pathways are determined separately. The model is based on data on river flow and water quality as well as a geographical information system (GIS). The agricultural submodel is based on soil types and a classification of soil water conditions, and is validated by overlaying digitised maps of area drained with soil maps (Chapter 9).

The changes in the nutrient loading from agricultural areas seemed to be close to the corresponding changes in the Nordic countries: a decrease of ca. 25 % for nitrogen, but no significant change for phosphorus. An analysis of nutrient surplus in agricultural areas shows a reduction of over 50 % for nitrogen and over 70 %

for phosphorus (Chapter 9). However, the release of agricultural inputs to surface waters cannot be controlled by technical measures at the source alone. The inputs to river systems will remain at the original higher level for a certain period of time depending on the magnitude of the changes in agricultural practices, local geology, geomorphology, soil geochemistry etc. (cf. Chapter 9). This time lag is much longer for phosphorus (mostly particulate) than for nitrogen (mostly soluble).

2.3 Poland (Chapter 12)

Point sources (municipalities, industries and fish farms)

The Polish estimates of wastewater loads from industrial point sources for 1989 and 1995 and the changes between these years were estimated on the basis of the Statistical Yearbooks of the Central Statistical Office "Environmental Protection" (Table 2.5). Because of the lack of specific data, calculations of nitrogen and phosphorus loads were based on BOD_5 discharges by using the assumption that the proportion of BOD:N:P in untreated wastewater is 60:11:2.4. Load figures for municipal discharges are based on the data presented in the Second and Third Pollution Load Compilations [10, 11]. The load from fish farms was calculated on the basis of the method presented in the Guidelines for PLC-4 [12].

Table 2.5 Point source loads of nitrogen and phosphorus from Poland and the reduction achieved between the late 1980s and 1995.

Source	N (tonnes/year)		Reduction		P (tonnes/year)		Reduction	
	late 1980s	1995	(tonnes)	(%)	late 1980s	1995	(tonnes)	(%)
Municipal	157 700[1]	119 800[1]	37 900	24	26 310[1]	20 400[1]	5 910	23
Industrial	5 900[1]	4 900[1]	1 000	17	2 300[1]	1 580[1]	720	31
Fish farms	400	400	0	0	50	50	0	0
TOTAL	164 000	125 100	38 900	24	28 660	22 030	6 630	23

1) Estimates are based on measured BOD_5 values and on the BOD:N:P ratio

The estimated reductions in nutrient loads varied between 0 % and 31 %, depending on the sector and substance. The main reasons for these trends was a decrease in water consumption, an increase in the number of towns served by wastewater treatment plants, a decrease in the number of industrial plants discharging wastewater to water bodies, and a decrease in total industrial wastewater discharge.

Agriculture

Estimates of Polish agricultural nutrient loads for 1989 and 1995 (Table 2.6) are based on data from more than forty small catchment areas. The calculations take into account information on land use, consumption of mineral and organic fertilisers, and number of livestock as well as the hydrological conditions in the catchments, according to the methodology described in PLC-3 [11]. Sources of background information were the Statistical Yearbooks of the Central Statistical Office "Environmental Protection" (1989, 1991 and 1996 editions), and the Statistical Yearbook of Agriculture, 1998 (Chapter 12). The background load was subtracted from the agricultural load. The agricultural load data have been flow-normalised.The estimated reduction in agricultural loads especially for nitrogen resulted from decreases in the use of fertilisers and in the number of animals.

Nutrient loads from agriculture were verified using information from a joint project of the Polish Academy of Science (PAN) and Deutscher Verband fur Wasserwirtschaft und Kulturbau e. V. (DVWK), titled "Investigation on the quantity of diffuse entries in rivers of the catchment area of the Odra and the Pomeranian Bay to develop decision facilities for an integrated approach to water protection".

Table 2.6 Discharges of nutrients into surface waters from agriculture in Poland and the reduction achieved between the late 1980s and 1995.

N (tonnes/year)		Reduction		P (tonnes/year)		Reduction	
late 1980s	1995	(tonnes)	(%)	late 1980s	1995	(tonnes)	(%)
135 100[1]	94 600[1]	40 500	30	7 390[1]	6 650[1]	740	10

[1]) *The discharge were calculated using data from more than forty small catchment areas and statistical information on agricultural activities (Chapter 12).*

2.4 Estonia, Latvia, Lithuania and Russia (Chapters 7, 10, 11 and 13)

Point sources (municipalities, industries and fish farms)

The information available from the late 1980s differs significantly among the four countries, since legislation in the former Soviet Union concerning loads monitoring was implemented by the Soviet Republics by different ways. The quality of the sampling, analysing, storing and assessment of the monitoring results was dependent on local authorities. According to the national reports, the systematic monitoring and establishment of electronic databases was started in Latvia and Lithuania in the early 1990s. For the late 1980s there are statistical ("2-water") reports containing information on water consumption and discharge rates, and on some parameters such as BOD, COD and suspended solids. As a rule, data on total nitrogen and total phosphorus were not presented in the statistical reports before 1990. In Estonia and the Russian Federation, only the inorganic fractions of nutrients were monitored.

The construction of small biological wastewater treatment plants in Estonia, Latvia, Lithuania and to some extent also in the Russian Federation began in the early 1970s, while the reconstruction of sewage systems and treatment plants for the municipalities bigger than 20 000 PE was not started until the end of the 1980s. Systematic monitoring of thousands of separate outlets was impossible; therefore only rough estimates of loading are available. Detailed descriptions of the municipal and industrial pollution sources are missing, as is a description of the treatment methods used.

In Lithuania for example, in 1985 only 21 % of the total wastewater amount was treated according to the Maximum Permissible Pollution Standards [13]. In the former Soviet Union this did not necessarily require biological or chemical treatment. Prior to the early 1990s the required treatment efficiency was calculated according to the Sanitary Water Quality Standards, and depended on the dilution system and the self-purification capacity of the water body. According to this system, in most cases it was enough to have only mechanical treatment. For large cities (St. Petersburg, Tallinn, Riga, Vilnius and Kaunas), more detailed load assessments and monitoring results are also available.

The point source load figures from 1995 are more detailed, and are mostly based on monitoring data. Thus the comparison of the results among the Baltic Sea countries for 1995 is much more reliable than is the comparison of results for the late 1980s. Discharges from fish farms for both the late 1980s and 1995 were calculated on the basis of the Guidelines for PLC-4. The load from fish farms is significantly smaller than from the other point sources.

The estimated point source reductions (Table 2.7) are remarkable, mostly between 40 % and 80 % depending on the country and nutrient. The load reductions can be seen also in the riverine inputs entering to the Gulf of Finland (e.g. Neva, Narva) and in water quality in the eastern part of Gulf of Finland as decreases in nutrient concentrations and discharges [14, 15]. The large uncertainty of the late 1980s loading figures, however, should be noted. The substantial reductions in nitrogen and phosphorus loads from point sources in the four countries is due primarily to the economic collapse connected with the disintegration of the Soviet Union in the early 1990s. The decreases were also due in part to the construction or reconstruction of wastewater treatment plants. Considerable investments in water management, including wastewater treatment capacity, have also been made especially in the Baltic States since 1995 [16].

Agriculture

In the former Soviet Union the first attempts to assess agricultural nutrient loads to the Baltic Sea were begun in Estonia in the late 1980s. A few years later, joint projects with the Nordic countries were launched in Estonia, Latvia and Lithuania. In the "Gulf of Finland Year 1996" project, agricultural loads and the load apportionment of river loads were jointly assessed by Estonian, Finnish and Russian experts [14].

Due to a lack of comprehensive monitoring programs, agricultural load estimates for the late 1980s are approximately and can only be considered as tentative values (Table 2.8). However, national riverine concentration and discharge measurements, together with results of international joint projects, provide sup-

Table 2.7 The point source loading and reduction achieved by Estonia, Latvia, Lithuania and Russia between the late 1980s and 1995.

Country	Source	N (tonnes/year) Late 1980s	N 1995	Reduction (tonnes)	Reduction (%)	P (tonnes/year) Late 1980s	P 1995	Reduction (tonnes)	Reduction (%)
Estonia	Municipal	6 500[1]	2 700	3 800	59	570[1]	240	330	58
	Industrial	12 500[1]	2 100	10 400	83	130[1]	50	80	62
	Fish farms	160	40	120	75	30	10	20	67
	TOTAL	19 160	4 840	14 320	75	730	300	430	59
Latvia	Municipal	11 000[2]	3 600	7 400	67	1 220[2]	730	490	40
	Industrial	1 400[2]	700	700	50	240[2]	120	120	50
	Fish farms	100	10	90	90	3	0.1	2.9	97
	TOTAL	12 500	4 310	8 190	66	1 463	850	613	42
Lithuania	Municipal	9 700[2]	6 900	2 800	29	2 210[2]	920	1 290	58
	Industrial	2 000[2]	700	1 300	65	300[2]	170	130	43
	Fish farms	1 300	300	1 000	77	200	40	160	80
	TOTAL	13 000	7 900	5 100	39	2 710	1 130	1 580	58
Russia	Municipal	46 400[1,3]	30 300[3]	16 100	35	7 250[1,3]	4 180[3]	3 070	42
	Industrial	–	4 600[4]	–	–	–	560[4]	–	–
	Fish farms	–	–	–	–	–	–	–	–
	TOTAL	46 400	30 300	16 100	35	7 250	4 180	3 070	42

1) Sum of the inorganic nitrogen and phosphorus, which is in some extent underestimated compared to the total nitrogen and phosphorus loads (cf. Chapters 7 and 13).
2) Estimates based on measured BOD values(cf. Chapters 10 and 11).
3) Industrial load included in the municipal load (cf. Chapter 13).
4) Included in municipal load.

port for the observed strong decreases in agricultural loading from Russia and Estonia [14, 17, 18].

The reported strong decrease in agricultural loading from Latvia has not been reflected in the nutrient concentrations of the Daugava and Lielupe rivers (cf. Chapter 10). Verification of agricultural loads from Latvia and Lithuania on the basis of riverine load data is not possible, as the main Latvian and Lithuanian rivers (Daugava, Lielupe, Nemunas) are trans-boundary rivers transporting loads from neighbouring countries, and results of source apportionment for Belorussia, Russia and the Kaliningrad region are not available.

With regards to agricultural loads in Lithuania, recent results from a bilateral Danish-Lithuanian project, "Long-term Assistance in Transposition and Implementation of the Nitrates Directive in Lithuania" show that the 1995 load estimates are in good correspondence with data submitted by the national expert. The 1995 nitrogen load was 35 500 tonnes/year and 29 400 tonnes/year in 1998. Corresponding phosphorus loads were 887 tonnes/year and 880 tonnes/year for these years respectively (Chapter 11).

The Estonian load figures are flow-normalised and natural background has been subtracted. The Latvian, Lithuanian and Russian load figures from the late 1980s are estimated on the basis of statistics and mechanistic models based on long-term monitoring in Estonia.

The agricultural loads for Estonia, Latvia and Lithuania in 1995 were estimated on the basis of joint international projects (cf. Chapters 7, 10 and 11), while the Russian estimates are based on background statistics (changes in the livestock, use of fertilisers, etc.) and on observed changes in river water quality (cf. Chapter 13).

Table 2.8 The anthropogenic loading from agricultural areas in Estonia, Latvia, Lithuania and Russia and the reduction achieved between 1980s and 1995.

Country	N (tonnes/year)		Reduction		P (tonnes/year)		Reduction	
	Late 1980s	1995	(tonnes)	(%)	Late 1980s	1995	(tonnes)	(%)
Estonia	30 200	12 600	17 600	58	360	250	110	31
Latvia	33 800[1]	17 100	16 700	49	1 010[1]	510	500	50
Lithuania	59 500[1]	35 500	24 900	42	1 810[1]	890	920	51
Russia	82 700[1]	24 000[1]	58 700	71	2 450[1]	1 010[1)]	1 440	59

1) The load estimates for Latvia, Lithuania and Russia for the late 1980s and those of Russia for 1995 are based on statistical information concerning agricultural activities and Estonian research results on agricultural loading (cf. Chapters 10, 11 and 13).

The estimated nutrient load reductions reached in the four countries are remarkable compared to those of other Baltic Sea countries. The main reason for the reductions is the sharp decrease in agricultural production based on collective farms during the Soviet era, together with a very large decrease in the use of fertilisers. In addition, land privatisation and the restoration of small farms with rough production systems in the early 1990s influenced the reduction in nutrient discharges. A large amount of arable land has been out of production as set-aside. For instance, in Estonia the area of unused arable land increased from 1991 to 1995 about 20-fold (from 14 000 ha to 254 000 ha) and the area of fallow land more than tripled (from 6 600 ha to 21 400 ha) [19]. During the same period, agricultural production in these states decreased by about 30 to 50 % (Chapters 7, 10, 11 and 13).

Despite the ultimate changes in the structure and production of agriculture, the estimated decreases may overestimate the actual changes in loading, especially regarding phosphorus, which is effectively bound in soil particles. Finnish, Swedish and German monitoring and modelling studies suggest that even a strong decrease (up to 40 to 50 % in Germany and Finland) in the total use of fertilisers has not been reflected in the rates of leaching to water bodies, due to the high surplus and effective binding of P in the agricultural soil. For N, the dependence between inputs to and losses from the fields should be more immediate. However storages (surpluses) caused by earlier high fertilisation levels probably make this process also less immediate (cf. Chapters 8, 9 and 14). Further, as mentioned for Denmark (cf. Chapter 6), if a substantial part of a nutrient load arrives from groundwater aquifers with long residence times (30 to more than 100 years) it will take several years before the full effect of implemented measures can be observed in rivers and lakes.

2.5 Possibilities to further decrease nutrient loads in the Baltic Sea catchment area

For political and historical reasons the Baltic Sea countries can be divided into two main groups. The first group is the Nordic countries and Germany, and the second group is Estonia, Latvia, Lithuania, Poland and Russia. Chapters 4, 6, 7, 10, 11, 12, 13 and 14 present examples of water protection targets by Baltic Sea countries.

Nordic countries and Germany

The Nordic countries and (western) Germany started to implement water protection measures in the late 1960s, and larger municipalities and industries had wastewater treatment plants by the early 1980s. In addition, various industries began to implement internal measures to reduce the nutrient load discharged to municipal sewage systems or directly into water bodies. Denmark and Germany have reached the 50 % reduction goal concerning phosphorus. Denmark has a 80 % reduction goal for the point sources load compared with the late 1980s.

The phosphorus load reductions achieved by Finland and Sweden between the late 1980s and 1995 are less than 50 %. Taking into account reductions achieved before the late 1980s, however, by 1995 the phosphorus removal efficiency of municipal discharges was close to 90 % in both countries. Further reductions are technically possible, but are very expensive and require much attention from plant staff.

In Denmark and Germany, nitrogen load reductions from municipal discharges compared to the late 1980s was about 50 %. Implementation of EU legislation and the HELCOM Recommendations have supported further reductions of nitrogen loads. The results of the effects of the measures will be available after the Fourth Pollution Load Compilation is completed in 2003.

In Finland and Sweden, nitrogen load from the municipal treatment plants changed very little between 1987 and 1995. The implementation of EU's Waste Water Directive and HELCOM's Recommendation 16/9 have reduced the loads significantly during the late 1990s, and will further reduce them in the future. However, these reduction targets are not necessarily met at present, depending on the definition of water areas sensitive to this nutrient.

In Denmark and Germany, level of phosphorus discharges from industry were reduced approximately 85 % from the late 1980s and 1995; thus a further reduction of phosphorus load is becoming increasingly difficult to achieve in these countries. Despite that, a further reduction in phosphorus load was achieved in Denmark from 1996 to 1998. In Finland and Sweden the reduction of phosphorus load in 1995 compared to the late 1980s was 50 % and 40 % respectively. According to Finnish national water protection targets, further load reductions of the order of 50 % are possible.

Reducing nutrient loads from agriculture is much more complicated than for point loads. The implementation of load reduction measures (e.g., the HELCOM Recommendations concerning agriculture, Annex III of the Helsinki Convention and EU's Nitrate Directive) will support the further reduction of nutrient loads from agriculture. According to present knowledge, there is a considerable time lag between implementation of agricultural water protection measures and their effects in water bodies. Thus, the full effect on loads to surface freshwater bodies will not necessarily be observable by 2005, even if all planned measures regarding agricultural catchments are implemented.

Former socialist countries

In the former socialist countries, implementation of water protection measures began in the early 1970s. Within existing financial constraints, the main goal was the construction of biological wastewater treatment plants in small communities. Planning and construction of municipal wastewater treatment plants for larger communities (greater than 50 000 PE) was not started until in the mid-1980s, or in some cases not until the early 1990s. The purification principles of the plants were mostly either mechanical or mechanical/biological, i.e. the purification efficiencies were low when compared to tertiary treatment, particular in regard to phosphorus.

In addition to the measures implemented for water protection, a drastic reduction in the use of water in households and industries took place in the early 1990s. Since the general efficiency of municipal and industrial wastewater purification systems was low in the late 1980s, the implementation of the 1988 Ministerial Declaration was easier. In 1995, the removal efficiency for phosphorus in the Nordic countries and Germany was still greater than in the transition countries. Regarding nitrogen loads, only Denmark, Estonia and Germany already achieved clearly advanced purification efficiencies by 1995.

There are official plans to still reduce nutrient loads to water bodies in Estonia, Latvia, Lithuania and Poland. In addition, EU legislation requires new control measures for candidate countries. Deadlines for implementing HELCOM Recommendation 16/9 as well as EU Directives should guarantee that sewage treatment efficiency will be at the same level as (e.g.) that in the Nordic countries by 2010.

In Russia, a further reduction of municipal nutrient load is anticipated from the completion of wastewater treatment facilities in St. Petersburg (about 30 % is still discharged to the sea without any treatment; the rest is mechanically-biologically treated), and further implementation of nitrogen and phosphorus removal technologies. The construction of wastewater treatment plants in the Kaliningrad region will reduce significantly the nutrient load to the Baltic proper. These ventures are largely dependent on funding arrangements e.g. between Russia and the European Union.

Due to economic reasons, agricultural nutrient loads from the transition countries (except Poland) declined between the late 1980s and 1995. It is probable that the further load reductions will be small. According to the targets submitted by the Baltic states, the main goal of environment protection authorities is to maintain future loading rates at 1995 levels.

Possibilities to reduce unit load

The comparison of changes in unit load figures (kg per inhabitant/year) from point sources (Figures 2.1 and 2.2) for the late 1980s and 1995 indicates that further reductions in point load nutrients are still feasible.

The highest nitrogen unit load in the late 1980s came from Estonia, due to the chemical plant Silmet at Sillamäe (Figure 2.1). Unit loads in other countries were from 4 to 7 kg/y (11–19 g/d). By 1995, unit loads were reduced in Denmark, Latvia and Lithuania to a level of 2–3 kg/y (6–8 g/d); in Estonia, Germany and Sweden to

3–4 kg/y (8–11 g/d) and in Finland, Poland and Russia to about 5 kg/y (14 g/d). Following the Danish example (using advanced municipal nitrogen removal techniques) there are possibilities also for further reductions in other countries. During the late 1990s and early 2000s progress has been continuing, at least in EU member countries.

The phosphorus unit load in the late 1980s (Figure 2.2) was highest in Denmark, Germany, Lithuania, Poland and Russia (about 1 kg/y, with no chemical

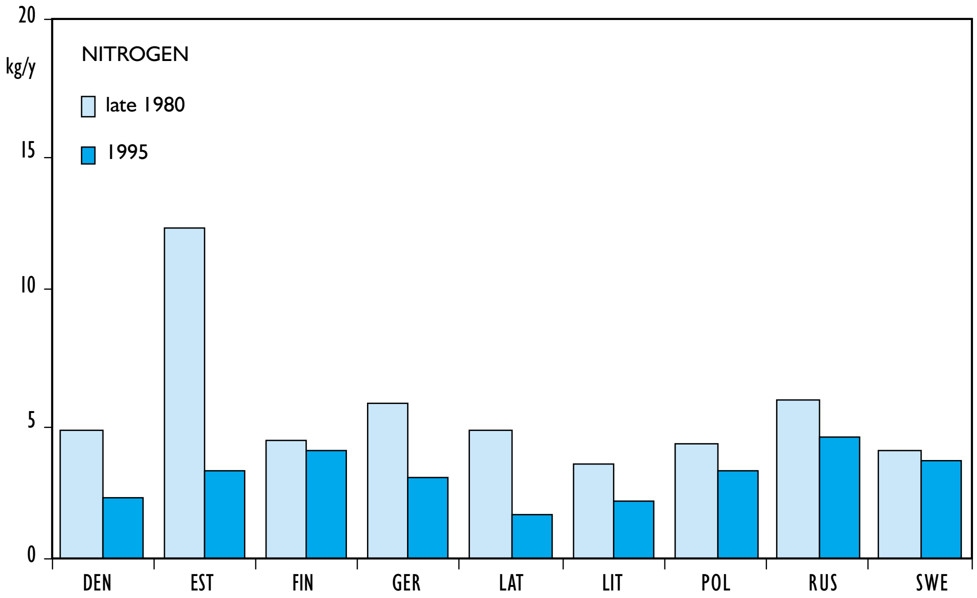

Figure 2.1. Estimated nitrogen unit load per inhabitant (kg/y) from point sources in the late 1980s and 1995 in the Baltic Sea countries. See Sections 2.1–2.4 and 3.1.1–3.1.2 for details on the origin and reliability of the data.

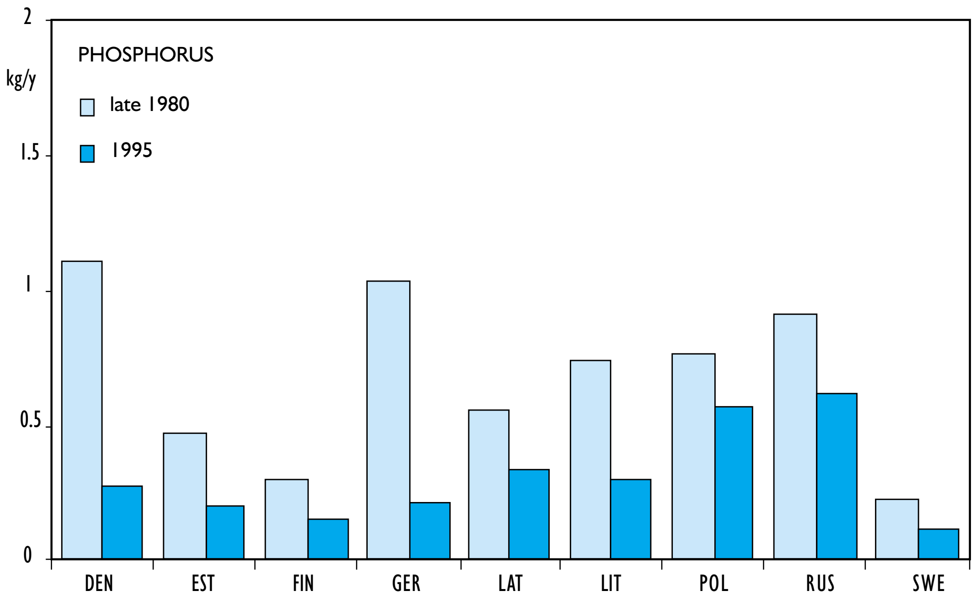

Figure 2.2. Estimated phosphorus unit load per inhabitant (kg/y) from point sources in the late 1980s and 1995 in the Baltic Sea countries. See Sections 2.1–2.4 and 3.1.1–3.1.2 for details on the origin and reliability of the data.

phosphorus precipitation) and lowest in Finland and Sweden, at 0.4–0.5 kg/y (where phosphorus precipitation was introduced the early 1970s). Between the late 1980s and 1995, noticeable reductions of unit loads occurred in all countries. The lowest unit loads still occurred in Finland and Sweden (less than 0.2 kg/y), while Denmark, Estonia, Germany, Latvia and Lithuania had reached levels of 0.2–0.3 kg/y. The highest unit loads, in Poland and Russia (0.7 to 0.8 kg/y), are most likely due to the lack of chemical phosphorus removal and the presence of considerable amounts of industrial wastewater in municipal systems.

3 Reductions achieved by sectors

Until now, the Helsinki Commission has published three pollution load compilations (PLCs): for 1987 (PLC-1) [20], for 1990 (PLC-2) [10] and for 1995 (PLC-3) [11]. These reports indicate that rivers contribute the main part of the waterborne pollution load to the Baltic Sea. Due to the lack of primary information (i.e. load data from point and diffuse sources in the catchment area), it was impossible to apportion sources for riverine load, and therefore to evaluate whether the 50 % reduction target between 1987 and 1995 in the catchment area of the Baltic Sea was fulfilled.

In 1999 the fourth Meeting of the Working Group on Inputs to the Environment (HELCOM TC INPUT) [21] elaborated a questionnaire on nutrients to collect **anthropogenic** load data for the late 1980s and 1995, covering both the direct discharges to the Baltic Sea as well as discharges to surface fresh waters in the catchment area of the Baltic Sea. In response to the questionnaire, the Contracting Parties of the Helsinki Commission submitted source-orientated load data concerning anthropogenic discharges.

The analysis concerning the load reductions achieved by different sectors indicates the level of the reductions achieved by countries by 1995. While the reductions of the different sectors have been compared with the 50% reduction target, the determination of the future percentage reductions needed in each sector is the exclusive discretion of each country.

3.1 Origin of the data

3.1.1 Evaluation methods used by the countries

Municipal and industrial discharges

The methods used by countries to calculate municipal and industrial loads depend very much on flow measurements and sampling frequencies. The detailed description of calculation methods recommended for Baltic Sea countries is presented in the Guidelines for PLC-2 and PLC-3 [12]. Chapters 6 through 14 contain short overviews on monitoring systems and calculation methods.

Denmark, **Finland** and **Sweden** (countries with more developed water protection systems) have developed municipal and industrial discharge monitoring system. The load calculations for municipalities and industries bigger than 10 000 PE were based, as a rule, on continuous flow measurements and 24-hour flow-weighted composite samples [11]. Loads from overflows and bypasses have been included in the load figures. Loads from smaller municipalities and industries were calculated on the basis of periodic flow and concentration results (cf. Chapters 6, 8 and 14).

German nitrogen and phosphorus discharges are estimated by monitoring data and various calculation methods depending on the available data (cf. Chapter 9). Municipal discharges were estimated on the basis of per-capita load figures and on the treatment efficiency for different types of wastewater treatment plants. The per-capita nitrogen load figures used were 11 gN/d for both 1985 and 1995, and 1.8 gP/d for 1995 for all German Federal States. For the year 1985 the per-capita phosphorus load figure used for the former GDR was 4.0 gP/d and for the FRG 3.3 gP/d. For nitrogen it was further assumed that the emission of the industrial discharges was 6.5 gN/d per capita (cf. Chapter 9).

In **Estonia**, monitoring results were used to calculate loads (Chapter 7). In the late 1980s the frequency of periodic flow measurements and sampling varied between 1 and 12 times per year. Only inorganic nitrogen and phosphorus forms were analysed. Load figures for 1995 are more precise, since continuous flow measurement systems were in place at the largest wastewater treatment plants, and total nitrogen and phosphorus analyses were introduced. The analytical methods used correspond to the PLC-3 Guidelines [12].

Latvian nutrient discharges in the late 1980s were assessed using State Statistical Reports on water consumption and wastewater discharges (Chapter 10). These reports contained, in addition to flow values, some information on BOD and suspended solids. No information on nitrogen and phosphorus was available, thus per-capita load values (2,7 gP/d and 12 gN/d) were used. As industrial wastewater was also discharged into the municipal sewerage system, it was not possible to calculate the industrial loads separately.

The obligatory monitoring of discharges and a corresponding electronic data storage system was implemented in the early 1990s. The 1995 load figures are more precise, but still include some estimated values. According to the PLC-3 Report, continuous flow measurements were used by two municipalities and one industrial plant. In other cases, wastewater volume was assessed on the basis of water consumption. The sampling frequency for point sources bigger than 10 000 PE was between 12 and 104 times per year, and 12 times per year for smaller sources. Composite samples were taken using analytical methods corresponding to the PLC-3 Guidelines [12].

In **Lithuania** the situation was quite similar to that in Latvia. Electronic data bases for loads data were not in place until 1991. Statistical reports available from the Soviet era provide only data on discharges of inorganic nutrients for the years 1987 and 1988. Therefore, the late 1980s loading data were assessed using several assumptions described in Chapter 11. Two different methods were used to estimate loads, and the results match very well, with a difference of approximately 6 %.

The 1995 load calculations are based on monitoring results. According to the PLC-3 Report, in some cases (the largest municipalities and industries), continuous flow measurement was used, but normally wastewater volume was calculated based on water consumption. Composite sampling was conducted 12 times per year for all point sources. The analytical methods corresponded to the PLC-3 Guidelines [12].

According to the **Polish** Water Law of 24 October 1974, all enterprises and treatment plants are required to measure abstracted water and discharged wastewater (Chapter 12, Section 12.2). Based on the PLC-3 Report [11] continuous flow measurement, assessment of wastewater volumes based on water consumption rates, or other methods were used for point sources discharging directly to the Baltic Sea. Sampling frequency depends on the size of the pollution source. Sources larger than 10 000 PE use composite 24-hour flow-proportional samples, smaller ones sample 1 or 2 times per week (with a minimum frequency of twice per year). The analytical methods used correspond to the PLC-3 Guidelines [12].

Polish municipal and industrial nutrients loads for the late 1980s were estimated using data from the Statistical Yearbooks of the Central Statistical Office. Because of the lack of specific information, the calculations of nitrogen and phosphorus loads were based on BOD_5:N:P ratio (60:11:2.4) in untreated wastewater (cf. Chapter 12). Industrial wastewater constituted 40 % of total wastewater volume. Since there are no direct measurements of industrial nutrient discharges, estimates of nitrogen and phosphorus loads from industries in 1995 were based on the project report, “Strategy of the Protection of Water Resources from Pollution: the perspective of human health and nature protection and economic needs”.

In **Russia** nutrient loads calculations for both 1987 and 1995 were based on monitoring data compiled in the statistical report “2-water” (Chapter 13). Loads from sewage systems and industrial plants were calculated using various methods depending on measurement and sampling frequency. In the former Soviet Union industrial wastewater was normally treated together with municipal sources, thus there is no information available to assess industrial loads alone. Nitrogen and phosphorus loads figures were taken from the regional reports to the Parliament of the Russian Federation. The data included into the regional reports of the year 1995 were more specified and therefore the direct discharges and discharges into the Baltic Sea catchment area could be separated.

According to the PLC-3 report [11], in some cases (the largest municipalities and industries) continuous flow measurement was used, but as a rule wastewater volume was assessed based on water consumption. Composite and grab sampling (with frequency 2–12 times per year) for all point sources were used. Analytical methods used correspond to the PLC-3 Guidelines [12].

Fish farming

All the countries have used mass balance approaches, using data on feed used (amount and nutrient content), amount of fish produced and the type of fish farm (Chapters 6–14). Production figures and feed consumption data were taken from the state statistics. The comparability of the load data depends greatly on the availability and reliability of the statistical information.

Agriculture

Methods for calculating agricultural loads differ significantly between countries, and depend greatly on available data. Nitrogen and phosphorus loads from agriculture are closely dependent on geomorphological and climatic conditions, the use of mineral and organic fertilisers, and also as agricultural practices of the area. Thus a short overview is presented to clarify the differences and reliability of the loading data on the basis of the reports submitted by the national experts (Chapters 6–14).

In **Denmark**, the discharge from agriculture was calculated from nutrient discharges in rivers as a residual by subtracting the load from point sources, the background load, the deposition on surface fresh waters and estimated retention in surface waters (cf. Chapter 6). Nutrient loads were determined using data from about 130 downstream monitoring stations. Annual sampling frequency varied generally between 12 and 26, and water flow on an average 12 times per year.

The Danish monitoring program also includes approximately 150 stations situated in small agricultural catchments (5 to 60 km^2) with only minor inputs from point sources. In monitored catchments with point sources, the diffuse nutrient losses are calculated by subtracting the load from point sources from the monitored riverine load (cf. Chapter 6, equation 5). Diffuse nutrient losses from unmonitored catchments are estimated by the use of flow-weighted concentrations or area-specific runoff coefficients from these agricultural catchments. The specific flow-weighted concentrations are chosen from catchments where soil type, climate, runoff and land use correspond to those of the non-monitored areas. The flow-weighted concentrations are then multiplied by measured or estimated runoff values. The natural background losses are determined by monitoring some small catchments without agriculture and point sources

In **Estonia** the agricultural load was estimated using results from investigations of small catchments (Chapter 7). Nutrient leaching from the surface unit on kg per hectare per year (kg / ha y) was calculated on the basis of results of continuous flow measurements and flow-weighted water quality samples for these catchments. Unit load value was multiplied by the entire area in agricultural use.

Nitrogen load estimates for 1995 were based on measurements by automatic monitoring stations and results from the River Kasari catchment area. The same method was used to calculate phosphorus load. There was a significant difference in phosphorus leaching estimated between the late 1980s and 1995.

Estimation of phosphorus and nitrogen losses from agricultural land to surface waters in **Finland** is based on monitoring in four small agricultural drainage basins and in four agriculturally loaded river basins in southern and southwestern Finland. The size of the small basins range from 12 ha to 15 km^2, and the river basins from 870 km^2 to 1 300 km^2. The agricultural land use in the catchments varies from 23 to 100 %. The monitoring schemes are based on continuous water flow measurements in the small catchments and flow-weighted water quality sampling in the rivers. Using this data, annual N and P flux estimates are calculated, from which possible point source loads and estimated losses from forested areas and natural leaching subtracted. The losses are scaled up by multiplying the estimated agricultural losses by the total agricultural area in Finland, taking into account different specific losses from acid sulphate soils and peaty soils.

Since the annual loads vary greatly due to annual climatic variations, mean annual loads were calculated for consecutive five-year periods: 1981–1985, 1986–1990 and 1991–1995.

In **Germany** the anthropogenic nutrient load from agriculture was calculated using the model MONERIS (Modelling Nutrient Emissions in River Systems, Chapter 9). The model was designed to estimate nutrient inputs into river basins in Germany from point sources and various diffuse pathways. A submodel was used to estimate agricultural loads. Data on agricultural area, number of livestock and the use of mineral fertiliser, available from statistics of the Federal States for both investigations periods, were used to estimate the surplus in the topsoil. The calculations were based on CORINE land cover data. To avoid additional sources of errors, the high-resolution CORINE data for 1995 were used in calculations for both periods.

To estimate the anthropogenic portion of nutrient discharges by agriculture, the natural background was estimated separately, and subtracted from the total agricultural load.

Up to 1993 there was no monitoring programme in **Latvia** specially designed to assess pollution from agricultural sources (Chapter 10). The nutrient load calculations for the late 1980s were based on statistical information, simple models and on the assumption that geo-morphological and climate conditions were similar to Estonia (Chapter 10).

The monitoring of agricultural loads was started in 1993 by joint project between the Agricultural University of Latvia, the Swedish Agricultural University in Uppsala and the Norwegian Jordforsk Institute of Agricultural University (Chapter 10). Three catchments with different field cultivation intensities (low, moderate and high) were investigated. Nutrient leaching from the surface in kg per hectare per year (kg / ha y) was calculated using continuous flow measurements and flow-weighted water quality samples. These unit load values were multiplied by a factor for the corresponding cultivation intensity level.

The nutrient load calculations in **Lithuania** were based on statistical information, simple models and on the assumption that geomorphological and climate conditions were similar to neighbouring countries (Chapter 11).

The amounts of mineral fertilisers used in agriculture in 1987 and 1995 were obtained from the reports of the Statistical Department of Lithuania. The amounts of nitrogen and phosphorus in livestock manure were calculated using statistical data on the number of animals in 1987 and 1995, converting these into livestock units according to the PLC-3 Guidelines [12].

It was not possible to obtain any reliable studies on nitrogen and phosphorus loads from agricultural sources in 1987. Taking into account experiences from other HELCOM countries, it was assumed that in the late 1980s approximately 12 % of nitrogen and 1 % of phosphorus applied in agriculture was lost to the environment. The estimated figures do not take into account e.g. hydrological conditions and retention in freshwater ecosystems. In 1995, the Lithuanian Water Management Institute conducted a study in five agriculture-dominated watersheds and three nature-dominated watersheds. The load calculations were based on nutrient concentration and flow measurements.

The1995 figures on the discharge of phosphorus per hectare is unrealistically low compared to other HELCOM countries. Therefore it was decided to use the value of 0.3 kg P/ha comparable to other HELCOM countries with similar agricultural conditions (Estonia, Poland, Germany).

Anthropogenic nutrient discharges from **Polish** agricultural areas (excluding emissions from atmosphere and background loads) in1995 were based on calculations performed under the PLC-3 project (Chapter 12). These calculations used data from more than forty small catchment areas, taking into account the available information on land use, consumption of fertilisers and hydrological conditions in the catchments.

Average unit loads for the four physical-geographical regions with different soil types were calculated using discharge-weighted concentrations of nitrogen and phosphorus and runoff data, taking into account the mean nutrient input of mineral and organic fertilisers during the study period. Differences in discharges of nitrogen and phosphorus loads between 1989 and 1995 were dependent on the area of arable land, number of livestock, the consumption of mineral and organic fertilisers, and hydrological conditions.

There was no specific data available in **Russia** on the loads of nitrogen and phosphorus compounds from agricultural land (Chapter 13). Data on the use of the fertilisers and manure on the catchment area of the Baltic Sea were taken from regional reports to the Parliament concerning the ecological status of the regions. As a result of the economic collapse, significant reductions in the use of fertilisers and manure took place in the early 1990s.

The Leningrad, Novgorod, Pskov and Kaliningrad regions are geologically and geographically quite similar to the three Baltic States, with roughly the same amount of fertiliser and manure use. The Russian agricultural loads were calculated using the same leaching coefficients as Estonia. The load figures from agriculture do not include the natural background load.

To calculate anthropogenic nutrient discharges from agriculture in **Sweden**, export coefficients from about 500 types of fields have been multiplied with the Swedish area of arable land in the Baltic Sea drainage basin, based on information of crop cultivation in 1988 and 1995, respectively (Chapter 14). The export coefficients represents root zone leaching from different crops, soils and hydroclimatological regimes, and are based on the SOIL-N and HBV-N models, which have also been validated against monitoring programmes. Leaching from grassland has been validated as the natural backround load, and has been withdrawn from the export coefficients. The method of calculation result in flow-normalised leakage coefficients of anthropogenic arable load. Export coefficients including retention has also been estimated to describe the actual agricultural impact on the sea, i.e., net load (Chapter 14).

No large-scale mapping of phosphorus leaching from arable land has been done for all of Sweden, although various field studies are available for 1995. These studies shows that average export coefficients for arable land vary considerably between different regions, fields and soil types.

3.1.2 Reliability of data

Load data from the late 1980s

On the basis of the questionnaire the quality of the **point source load** data submitted by the Contracting Parties differs significantly between countries. In **Denmark**, **Estonia**, **Finland**, and **Sweden**, loads were calculated using existing monitoring data. In **Germany**, **Latvia** and **Russia** various models and estimation methods were used in addition to monitoring data. Point source loads in **Lithuania** and **Poland** were estimated on the basis of statistical information, such as number of inhabitants connected to sewage systems, per-capita load figures, fixed relationships between BOD, N and P and treatment efficiencies for various types of wastewater treatment plants. It should be mentioned that the monitoring programs differed between countries.

Another problem is the assessment of **anthropogenic loads from agriculture**. In Denmark, Estonia, Finland, Germany and Sweden, several studies have been initiated since the early 1980s to assess the agricultural nitrogen and phosphorus load [22, 23, 24, 25 and 26]. Based on these investigations, as well as on model calculations, estimates of agricultural loads can be regarded as reliable within relatively rough limits of error (cf. Chapters 6,7,8 and 14). In Germany and Poland, model calculations based on statistical information (consumption of manure and fertilisers, area of arable land), as well as geographic and geologic information have been applied. Latvia, Lithuania and Russia have used simple models based on statistical information and on the assumption that measured area-specific leaching coefficients from neighbouring countries are applicable.

Load data from 1995

Point source data covering both direct coastal discharges as well as the discharges to surface fresh waters in the catchment area of the Baltic Sea for 1995 are more comparable among countries than are the load figures from the late 1980s. The Baltic Sea countries have harmonised monitoring methodologies as far as possible according to the Guidelines for the third Pollution Load Compilation [12].

The load figures presented concerning direct discharges are practically the same as those included in PLC-3 [11]. As a rule, loads to surface fresh waters from point sources in the catchment area of the Baltic Sea were calculated on the basis of monitored data.

Beginning in the early 1990s investigations of **anthropogenic discharges from agriculture** were carried out by all countries except Russia. Several joint studies in Estonia, Latvia, Lithuania and Poland together with the Nordic countries have been performed [27, 28]. However, there are still some questions concerning agricultural loads due to (e.g.) small nitrogen leaching coefficients in some countries, which can also be explained by different runoff values between countries (cf. Section 3.4.3). On the other hand significant riverine nitrogen and phosphorus load reductions (about 30 %) during the 1990s from the Neva and Narva rivers support the reliability of the agricultural loading estimates from Russia and Estonia.

To assess the reliability of the information submitted by the national experts, the Finnish Environment Institute (FEI) compared the information with the HELCOM data submitted earlier under different projects (PLC, JCP, Reports on implementation of the HELCOM Recommendations). OECD environmental data reports [29, 30 and 31] were used. Unfortunately OECD reports from 1989 to 1999 contain only very general information concerning the number of inhabitants connected to sewerage systems and to public wastewater treatment plants. Some information on surface water quality (oxygen concentration) was also available. Very limited data is available from the transition countries. There was no information about nutrient concentrations and loads in wastewater or rivers.

The following assessment and comparison of nitrogen and phosphorus loads and the reductions achieved by the different loading sectors were conducted using load figures (Chapters 6–14) submitted by the national experts of the present project. All numerical values in Chapters 2 to 5 are rounded: total nitrogen to hundreds of tonnes and total phosphorus to tens of tonnes.

3.2 Reduction of municipal discharges

3.2.1 Municipal load reduction achieved by the countries

Reductions in municipal nitrogen and phosphorus loads between the late 1980s and 1995 are largely a result of the construction or reconstruction of advanced biological wastewater treatment plants and the introduction of chemical phosphorus removal (Table 3.1). The substitution of older detergents with phosphorus-free types also influenced phosphorus load reductions. In addition, the economic collapse and the closing of unprofitable industries that discharged wastewater into municipal sewage systems in the transition countries, and the introduction of economically relevant prices to water use have had a large contribution to load reductions.

For Finland and Sweden the relatively low load reduction rates between the late 1980s and 1995 are due to the fact that these countries started to implement chemical phosphorus removal as early as the late 1960s, and the process was almost complete by the late 1980s. In the transition countries the active construction of wastewater treatment plants began in the late 1980s, and many plants for large cities were not in operation until the early 1990s.

The comparison of the nitrogen and phosphorus reductions at the source indicate that the 50 % reduction was achieved by Denmark, Estonia and Germany for both of the nutrients, while in Lithuania and Sweden the reduction level was achieved only for phosphorus and in Latvia only for nitrogen. Finland was close to reaching the 50 % reduction for phosphorus, but due to the high removal efficiency in 1987 (nearly 90 %), the reduction achieved between the late 1980s and 1995 was only about 40 %. Reasons for this vary from country to country. Poland and Russia should implement additional measures regarding both nitrogen and phosphorus in order to achieve a 50 % reduction. In most countries, special attention should be paid to more efficient nitrogen removal in the future.

Denmark achieved a considerable reduction in phosphorus load (74 %) and a reduction of 54 % for nitrogen discharges, due to the construction of new and reconstruction of old wastewater treatment plants, which was started in the early 1980s. There are no differences in the reduction efficiency achieved between the coastal and inland wastewater treatment plants.

Estonia achieved the 50 % reduction for both nitrogen and phosphorus discharges due to the construction of wastewater treatment plants for the largest coastal municipalities. The largest reduction was achieved in Tallinn, which comprises about one-third of the total Estonian population. The economic collapse and significant reduction of industrial discharges into municipal wastewater systems also influenced the overall reduction of nitrogen and phosphorus discharges.

Finland achieved significant reductions in phosphorus load (more than 40 %) as implementation of chemical wastewater treatment continued in the late 1980s. At the same time there was a slight increase in nitrogen load resulting from the connection of new customers to wastewater treatment networks. If the reduction achieved between 1980 and 1988 (470 t) is taken into account, Finland has reduced the phosphorus load from municipalities by about 70% between 1980 and 1995. The overall reduction of nitrogen discharges between the late 1980s and 1995 was

Table 3.1 Reductions of municipal nutrient loads in the Baltic Sea countries between the late 1980s and 1995.[1]

Country	Type of Discharge	N (tonnes/year) Late 1980s	N (tonnes/year) 1995	Reduction (tonnes)	Reduction (%)	P (tonnes/year) Late 1980s	P (tonnes/year) 1995	Reduction (tonnes)	Reduction (%)
Denmark	Direct	10 800	5 000	5 800	54	2 630	790	1 840	70
	Indirect	4 700	2 100	2 600	55	1 280	240	1 040	81
	Total	15 500	7 100	8 400	54	3 910	1 030	2 880	74
Estonia	Direct	4 700	1 800	2 900	62	290	110	180	62
	Indirect	1 800	900	900	50	280	130	150	54
	Total	6 500	2 700	3 800	58	570	240	330	58
Finland	Direct	6 600	7 100	–500	–8	200	110	90	45
	Indirect	7 900	7 800	100	1	250	150	100	40
	Total	14 500	14 900	–400	–3	450	260	190	42
Germany	Direct	9 100	4 700	4 400	48	1 570	230	1 340	85
	Indirect	7 000	4 000	3 000	43	1 180	360	820	69
	Total	16 100	8 700	7 400	46	2 750	590	2 160	79
Latvia	Direct	5 300	1 100	4 200	79	660	330	330	50
	Indirect	5 700	2 500	3 200	56	560	400	160	29
	Total	11 000	3 600	7 400	67	1 220	730	490	40
Lithuania	Direct	1 100	900	200	18	250	140	110	44
	Indirect	8 600	6 000	2 600	30	1 960	800	1 160	59
	Total	9 700	6 900	2 800	29	2 210	940	1 270	57
Poland	Direct	7 600	5 900	1 700	22	1 470	770	700	48
	Indirect	150 100	113 900	36 200	24	24 840	19 630	5 210	21
	Total	157 600	119 800	37 900	24	26 310	20 400	5 910	22
Russia	Direct	37 300	24 300	13 000	35	5 350	3 400	1 950	37
	Indirect	9 100	6 000	3 100	34	1 900	780	1 120	59
	Total	46 400	30 300	16 100	35	7 250	4 180	3 070	42
Sweden	Direct	14 100	12 900	1 200	9	660	240	420	64
	Indirect	11 500	12 100	–600	–5	380	180	200	53
	Total	25 600	25 000	600	2	1 040	420	620	60
TOTAL	Direct	96 600	63 700	32 900	34	13 080	6 120	6 960	53
	Indirect	206 400	155 300	51 100	25	32 630	22 670	9 960	31
	Total	303 000	219 000	84 000	28	45 710	28 790	16 920	37

1) See Sections 2.1-2.4 and 3.1.1-3.1.2 for details on the origin and reliability of the data.

practically zero. In 1998 advanced nitrogen reduction was implemented in the wastewater treatment plants of the capital region of Helsinki, serving about 900 000 inhabitants.

Germany achieved high nitrogen and phosphorus load reductions rates by constructing wastewater treatment plants mainly in the territory of the former GDR. A particularly high reduction in phosphorus load, about 80 %, was achieved. According to investigations in the late 1980s, the per-capita load of phosphorus in the former GDR was 4.0 gP/d and 3.3 gP/d in West Germany. For several reasons, including ending the use of phosphorus-containing detergents, per-capita phosphorus loads were reduced by 1.8 gP/d by 1995 (Chapter 9). The 46 % reduction of nitrogen load was mainly a result of the construction of advanced wastewater treatment systems. In 1995 advanced nitrogen removal processes treated 28 % of all waste water.

Latvia achieved more than 60 % reduction of the nitrogen load from all municipal discharges, and a phosphorus load reduction of 40 %. The exceptionally large reduction for nitrogen was probably due to the decreases in the input of industrial wastewater to municipal sewage networks in the late 1980s, and the high treatment efficiency (about 50 % removal for nitrogen and phosphorus) in the new Riga wastewater treatment plant serving approximately one-third of Latvian population. The construction of Riga's wastewater treatment plant increased the amount of biologically treated wastewater from 5.3 million m^3/year in 1991, to 74.7 million m^3/year in 1995.

The overall reductions in nitrogen and phosphorus loads were mainly a result of the construction of new and reconstruction of old wastewater treatment plants starting in the late 1980s, reduction of water use in households due to rising water prices, and the significant reduction of industrial discharges to municipal wastewater networks.

Lithuania achieved a high phosphorus load reduction (more than 50 %) due to the construction/reconstruction of municipal wastewater treatment plants and the reduction of industrial discharges to municipal wastewater treatment plants. Reduction of the nitrogen load in the catchment area was 30 %, while it was 18 % in the coastal area.

Poland was still far from the 50 % reduction level for municipal discharges. In the case of phosphorus, most activity focused on direct coastal discharges, where the load reduction was 48 %. The municipal phosphorus load in the catchment area was more than twenty times the direct coastal load, and the total load reduction was 21 %. Nitrogen load reductions from coastal and inland municipal sources were 22 % and 24 %, respectively.

Russia achieved overall reductions of 35 % for nitrogen and 42 % for phosphorus. The load reductions were mainly caused by the enlargement of the wastewater treatment plants in St. Petersburg, as well as by the reduction of industrial discharges to the municipal wastewater systems. Russia will have a good chance to meet the goals of the 1988 Ministerial Declaration through the construction of new wastewater treatment plants in the Kaliningrad region, St. Petersburg, and the Leningrad, Novgorod and Pskov regions. This, however, presumes that present funding problems can be solved.

Sweden achieved a 60 % reduction of phosphorus load from municipal discharges between the late 1980s and 1995. Improved phosphorus treatment in municipal plants took place largely during the 1970s. The overall reduction from the late 1960s to 1995 was as high as 93 %. Further reduction of the phosphorus load is extremely expensive and difficult in practice. The overall reduction of the nitrogen load was negligible, at about 2 %. For direct coastal discharges, a somewhat higher reduction (9 %) was achieved. Further reductions after 1995 are expected, since the EU Waste Water Directive has been implemented.

3.2.2 Comparison of loads and reductions between countries

The load data concerning municipal discharges are in most cases based on monitored results. In some cases (Lithuania, Poland) loads for the late 1980s were estimated from statistical background information.

Municipal loads are dependent on the number of inhabitants connected to sewage systems. Additionally the amount of industrial wastewater, as well as wastewater pretreatment efficiency, affect national loading figures. The nitrogen and phosphorus loads for the late 1980s and 1995 are presented in Table 3.1 and in Figures 3.1 and 3.2.

In Table 3.2 the comparison of the municipal nitrogen and phosphorus load reduction measures are presented.

Table 3.2 Comparison of the municipal nitrogen and phosphorus load reduction measures in the Baltic Sea countries in the late 1980s and 1995. The table has been prepared from information submitted by the national experts, with missing information using literature data added by the consultant. Abbreviations: UNTR – untreated wastewater; M – mechanically treated; B – biologically treated; C – chemically treated and N – nitrogen removal, were used.

Country	Treatment methods in the late 1980s (%)					Treatment methods in 1995 (%)				
	UNTR/M	MC	MB	MBC	MBCN	UNTR/M	MC	MB	MBC	MBCN
DEN	–/21	–	64	6	9	–/2	–	14	5	79
EST	66[1]	–	34	–	–	7[2]/8[2]	–	45[2]	–	40[2]
FIN	–/–	13	–	87	–	–/–	9	–	91	–
GER	– /35	–	57	8	–	–/10	–	10	51	29
LAT	46[1]	–	54	–	–	14[2]/13[2]	–	73[2]	–	–
LIT	45[3]/23[3]	–	32[3]	–	–	19[2]/29[2]	–	52[2]	–	–
POL	46[4]/22[5] (41[6])	–	32[5] (59[6])	–	–	–/21[6]	–	70[6]	3	6
RUS	68[7] /–	–	32[7]	–	–	37[7]/–	–	63[7]	–	–
SWE	–	4	4	83	9	–	5	–	85	10

1) Untreated and mechanically treated together.
2) 2nd Baltic State of the Environment report. [32]
3) A. Cetkauskaite and A. Jakstaite. [13]
4) Taken from the Polish National Plan for Reduction of the Load of Pollution on the Baltic Sea. [33]
5) Recalculated by the consultant, taking into account the amount of untreated wastewater.
6) Percentages of mechanically and biologically treated wastewater were calculated from the amount of water passing through the treatment process. Untreated wastewater was not taken into account.
7) Only St. Petersburg.

Table 3.2 shows significant changes in technical measures applied between the late 1980s and 1995. First of all, the proportions of untreated or only mechanically treated wastewater were reduced significantly. The construction of biological and biological-chemical wastewater treatment plants significantly reduced discharges of phosphorus and nitrogen to surface waters and, at the same, created good conditions for implementing more advanced phosphorus and nitrogen removal systems. Only Denmark, Estonia and Germany built treatment plants with nitrogen removal (MBCN) to a relatively high percentage by 1995.

In **Denmark**, the amount of untreated wastewater was reduced from 21 % to 2 %. The majority of biological wastewater treatment plants were reconstructed and advanced phosphorus and nitrogen removal processes implemented during this period. 79 % of all municipal wastewater was treated using advanced treatment technology (chemical precipitation, denitrification). The high nitrogen and phosphorus removal reductions that have been achieved (74 % and 54 % respectively) reflect the measures implemented.

In the late 1980s, most (66 %) municipal wastewater in **Estonia** was discharged without any treatment or only mechanically treated into water bodies. By the end of 1995 the proportions of untreated or only mechanically treated wastewater were reduced to 7 % and 8 %, respectively. A total of 45 % of the wastewater was treated biologically, and 40 % biological-chemically. In addition, many industrial polluters were closed or supplied with local pretreatment facilities. The reduction in the hydraulic load to treatment plants, resulting from decreased water consumption, created good conditions to improve the treatment efficiency. The same is valid also for the other transition countries.

In **Finland** the implementation of advanced wastewater treatment systems was underway by the early 1970s. There were no measurable changes in wastewater treatment between the late 1980s and 1995. Improvements were achieved primarily by implementing biological-chemical treatment, from 87 % to 91 % of total wastewater volume. Advanced nitrogen removal was not undertaken until the late 1990s.

In **Germany** the proportion of mechanically treated wastewater reduced declined from 35 % in the late 1980s to 10 % in 1995. The amount of biologically treated wastewater was reduced by 10 % and replaced by combined biological-chemical treatment (51 %). Advanced treatment methods (MBCN) were used to treat 29 % of municipal wastewater. In addition, the phosphorus load to treatment plants was reduced by replacement of phosphorus-containing detergents with phosphorus-free ones.

In the late 1980s in **Latvia**, according to the answers to the questionnaire, 46 % of all municipal wastewater was discharged without any treatment or only mechanically treated, and 54 % was treated biologically. Since wastewater from Riga (approximately one-third of total Latvian wastewater) was discharged into the River Daugava mainly without any treatment in the late 1980s, the statistics on the amounts of untreated and mechanically treated wastewater concerning this period seems to be very approximate. By the end of 1995 the amounts of untreated and mechanically treated wastewater were reduced to 14 % and 13 %, respectively. The rest (73 %) was treated biologically.

In **Lithuania** in the late 1980s about two-thirds of municipal wastewater was discharged without any treatment (45 %) or only mechanically treated (23 %) to water bodies, and one-third was treated biologically (32 %). By the end of 1995 the situation was improved, and untreated and mechanically treated wastewater volumes were reduced by 19 % and 29 % respectively. The rest (52 %) was treated biologically.

Poland submitted data about mechanically and biologically treated wastewater only; the volume of untreated wastewater was not indicated separately. In the late 1980s, 41 % of all treated wastewater was discharged after mechanical treatment, and 59 % after biological treatment. According to a report submitted by Poland to HELCOM in the early 1990s [33], the amount of untreated wastewater in 1987 was 46 %. According to this figure, the recalculated amounts of mechanically and biologically treated wastewater were 22 % and 32 %, respectively. In 1995 the proportion of biologically treated wastewater was increased to 70 %, but 21 % of wastewater was still treated only by mechanical means. The advanced treatment methods were implemented mainly in coastal areas. Biological-chemical phosphorus removal were implemented for 3 %, and in combination with nitrogen removal for 6 % of the total wastewater amounts.

Detailed information concerning treatment methods in **Russia** is unavailable. It is, however, possible to draw some conclusions on the basis of developments in St. Petersburg between the late 1980s and 1995. The amount of untreated wastewater decreased from 68 % to 37 %, while the biologically treated amount increased from 32 % by 63 %. In addition, the overall amount of wastewater declined by 18 % as result of decreases in household and industrial water use. Similar developments can be expected to have occurred in other regions of Russia within the Baltic Sea catchment area.

In **Sweden** the implementation of wastewater treatment systems was started significantly earlier than in most other Baltic Sea countries. Discharges of untreated or only mechanically treated wastewater were stopped in the mid-1980s.

By the end of the decade, the majority (83 %) of municipal wastewater was treated using biological-chemical treatment. Nitrogen removal techniques were implemented for 9 % of the total wastewater amount. The nitrogen load reduction (2 %) achieved between the late 1980s and 1995 corresponds to the measures implemented.

Despite some differences between the implementation of methods to reduce loads to water bodies and the achieved reductions submitted by the countries, information on purification measures can be used as the background material to assess progress toward the implementation of the 1988 Ministerial Declaration.

3.2.3 Overall reduction of municipal loads

The overall reduction of municipal loads for the entire catchment area of the Baltic Sea between the late 1980s and 1995 is estimated at 28 % (84 000 t) for nitrogen and 37 % for phosphorus (16 920 tonnes) (Table 3.1). Total reductions in direct coastal discharges were slightly higher, 34 % for nitrogen and 53 % for phosphorus, than the corresponding figures for indirect discharges (25 % for nitrogen and 31 % for phosphorus). However, there are some exceptions such as Denmark and Lithuania, where more efficient reductions were achieved for indirect discharges than for direct discharges.

Further possibilities to reduce nitrogen loads are mainly connected to the implementation of national and EU legislation as well as the HELCOM Recommendation 16/9 "Nitrogen removal at municipal sewage water treatment plants". The target year for Recommendation 16/9 was 1998 for Denmark, Finland, Germany and Sweden, and 2010 or 2020 for the transition countries depending on the size of treatment plants. According to the Summary Report on Implementation of HELCOM Recommendations [34], the Recommendation concerning nitrogen was implemented only by Denmark.

Improvements in phosphorus reduction are mainly connected – in addition to national and EU legislation – to implementing HELCOM Recommendation 9/2 concerning measures aimed at the reduction of discharges from urban areas. According to the Summary Report on Implementation of HELCOM Recommendations [34] at least five countries – Estonia, Latvia, Lithuania, Poland and Russia – did not fully comply with the phosphorus recommendation.

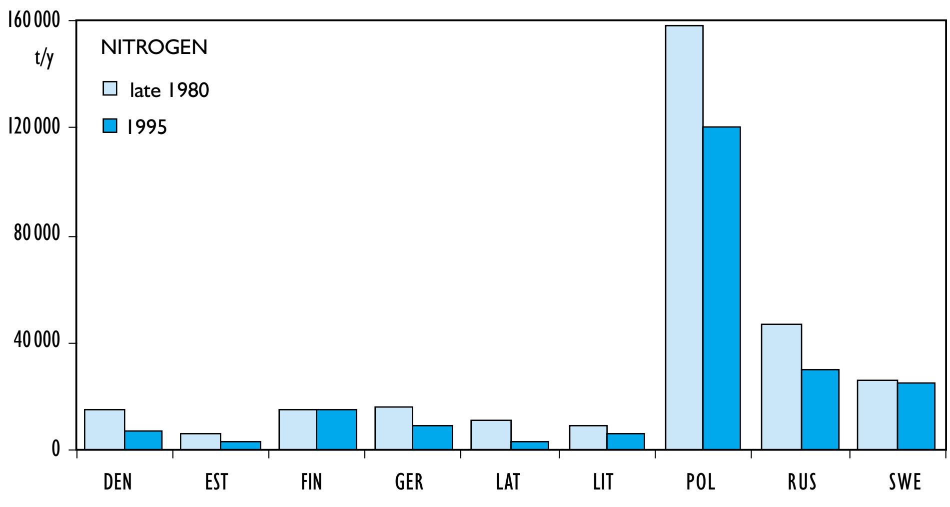

Figure 3.1. Nitrogen load to water bodies from municipalities in the late 1980s and 1995. See Sections 2.1–2.4 and 3.1.1–3.1.2 for details on the origin and reliability of the data.

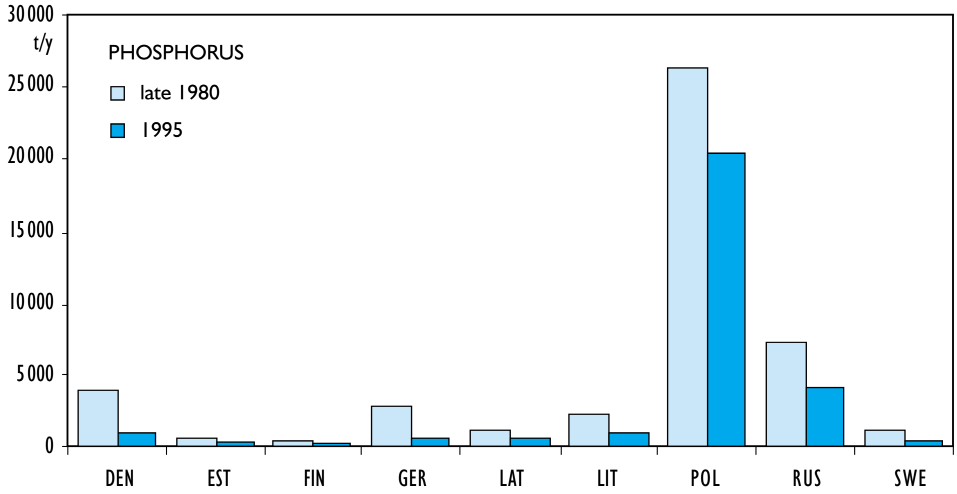

Figure 3.2. Phosphorus load to water bodies from municipalities in the late 1980s and 1995. See Sections 2.1–2.4 and 3.1.1–3.1.2 for details on the origin and reliability of the data.

3.3 Comparison of industrial discharges

The total industrial nitrogen and phosphorus load to the environment from the Baltic Sea countries (Table 3.3) in this report as well as in all the PLC reports [10, 11, 20] is underestimated due to the fact that **most industries,** also partly in EU countries, **have been connected to municipal sewage systems** and separate monitoring of these industrial discharges is missing.

A comparison of the loads and reductions achieved in various industries was impossible due to the lack of information for the late 1980s. This lack of data is not only a problem for countries in transition, but also for Denmark, Finland and Sweden, which could not provide complete information on industrial branches. The main reason is the structure of databases where older data are often available only in a summarised form.

According to available figures, the overall annual industrial load to the environment in the late 1980s was about 41 000 tonnes N and about 6 000 tonnes P (Table 3.3). The estimated reduction of nitrogen and phosphorus loads between the late 1980s and 1995 totalled 20 200 tonnes N and 3 100 tonnes P. The main reason for the reductions in the countries in transition was the economic collapse after the political changes of the late 1980s and early 1990s. Several industrial plants were closed down, or production was reduced significantly. In the 1990s new environmentally friendly technologies using best available technology (BAT) were implemented and new wastewater treatment plants began operation.

In Denmark, Finland, Germany and Sweden the load reductions were caused by the further implementation of environmental protection measures, the introduction of BAT and the construction/reconstruction of wastewater treatment plants.

Denmark achieved the biggest nitrogen and phosphorus load reductions among Baltic Sea countries: 60 % (2 500 t) for nitrogen and 88 % (890 t) for phosphorus. The reason is that many industries have their oven wastewater treatment facilities.

Estonia reduced nitrogen loads by 83 % (10 400 tonnes) and by 62 % (70 tonnes) for phosphorus. The significant reductions were caused by cutting most discharges from a large waste deposit of the chemical-metallurgic industrial site

Table 3.3 Reductions of industrial nutrient loads in the Baltic Sea countries between the late 1980s and 1995.[1]

Country	Type of DisCharge	N (tonnes/year) Late 1980s	N 1995	Reduction (tonnes)	Reduction (%)	P (tonnes/year) Late 1980s	P 1995	Reduction (tonnes)	Reduction (%)
Denmark	Direct	4 000	1 600	2 400	60	1 000	120	880	88
	Indirect	200	100	100	50	12	2	10	83
	Total	4 200	1 700	2 500	60	1 012	122	890	88
Estonia	Direct	11 800	1 600	10 200	86	40	20	20	50
	Indirect	700	500	200	29	80	30	50	63
	Total	12 500	2 100	10 400	83	120	50	70	62
Finland	Direct	2 100	1 900	200	10	300	170	130	43
	Indirect	3 700	2 400	1 300	35	540	190	350	65
	Total	5 800	4 300	1 500	26	840	360	480	57
Germany	Direct	150	50	100	67	14	4	10	71
	Indirect	1 800	1 100	700	39	430	40	390	91
	Total	1 950	1 150	800	41	444	44	400	90
Latvia	Direct	400	300	100	25	60	50	10	17
	Indirect	1 000	500	500	50	180	80	100	56
	Total	1 400	800	600	43	240	130	110	46
Lithuania	Direct	400	300	100	25	40	20	20	50
	Indirect	1 600	400	1 200	75	270	150	120	44
	Total	2 000	700	1 300	65	310	170	140	43
Poland	Direct	700	700	0	0	520	180	340	63
	Indirect	5 100	4 200	900	18	1 780	1 400	380	21
	Total	5 800	4 900	900	16	2 300	1 580	720	31
Sweden	Direct	4 500	3 000	1 500	33	570	330	240	42
	Indirect	2 900	2 200	700	24	200	150	50	25
	Total	7 400	5 200	2 200	30	770	480	290	38
TOTAL	Direct	24 050	9 450	14 600	61	2 544	894	1650	65
	Indirect	17 000	11 400	5 600	33	3 492	2 042	1450	42
	Total	41 050	20 850	20 200	49	6 036	2 936	3 100	51

1) See Section s 2.1-2.4 and 3.1.1-3.1.2 for details on the origin and reliability of the data.

at Sillamäe. The closing of several industrial plants and the reconstruction of old plants were the reasons for the phosphorus reduction.

Finland achieved more than a 50 % (480 t) reduction for phosphorus mainly due to implementation of the activated sludge method in pulp and paper industry. The nitrogen reduction of about 25 % (1 500 t) did not correspond to the target. In 1995 most pulp and paper plants did not have nitrogen removal obligations. The management of the nitrogen balance in the wastewater treatment of pulp and paper industry is difficult due to the addition of inorganic nitrogen to the wastewater treatment process.

Germany achieved a reduction of 90 % (400 t) for phosphorus by closing and restructuring industries in the former GDR, as well as by implementing BAT in former West Germany. The overall reduction for nitrogen was 41 % (800 t), attributable mostly to the same reasons.

Latvian load reductions of the nitrogen and phosphorus discharges by 43 % (600 t) and 46 % (110 t), respectively, were very close to the overall 50 % reduction goal. The reductions were achieved mainly by closing or restructuring old industrial plants.

Lithuania achieved the 50 % reduction target for industrial nitrogen discharges, while the reduction of phosphorus load of 43 % (140 t) was close to the 50 % reduction target. The load reduction was achieved mainly by closing or restructuring old industrial plants.

Poland reported relatively low industrial loads of nutrients, which reflects the fact that a substantial part of industrial wastewater was discharged to municipal sewage systems, thus increasing loads reported from municipal sources. The reason for the relatively low reduction in discharged loads was the significantly smaller economic collapse and decreases in production compared to other transition countries. This process began already in the mid-1980s, i.e. earlier than in other transition countries. Reduction in loads of nitrogen and phosphorus were 16 % (900 tonnes) and 31 % (720 tonnes), respectively.

The **Russian** industrial load data for the late 1980s and 1995 are missing from Table 3.3 because these loads during the late 1980s, and also partly in 1995, were included in municipal loads. To enhance comparability of data from the late 1980s and 1995, the 1995 industrial loads were also presented under municipal loads.

Sweden achieved a reduction of 30 % (2 200 tonnes) for nitrogen and 38 % (290 tonnes) of phosphorus by 1995. The largest source of industrial nutrient discharges is the pulp and paper industry. The reduced nutrient load was achieved through improved wastewater treatment methods and to a lesser degree changes in production methods.

The overall reduction for the estimated industrial inputs are 49 % (20 200 tonnes) for nitrogen and 51 % (3 100 tonnes) for phosphorus, meaning that in practice the 50 % reduction for the entire Baltic Sea catchment area was reached between the late 1980s and 1995. However, it should be noted that a large part of the industrial discharges is included in municipal load estimates. Roughly one-half of the estimated total reduction of nitrogen was caused by the significant reduction of discharges to the waste deposit of the chemical-metallurgic industrial plant in Sillamäe, Estonia.

3.4 Comparison of discharges from agriculture

3.4.1 Introduction

In the present report, agricultural nutrient loading figures of the countries are assessed considering the entire Baltic Sea catchment area. Nitrogen loads from agriculture constitute about 60 %, and phosphorus more than 25 %, of the total anthropogenic load to the catchment area of the Baltic (Tables 3.1, 3.2 and 3.3).

The basic information concerning agricultural loading was collected by the national experts of the Project Team, in response to a questionnaire adopted by the Working Group on Inputs to the Environment (HELCOM TC INPUT) [21]. The fourth meeting of TC INPUT was of the opinion that data on arable land (ha), number of livestock (animal units), total number of cattle, total number of pigs, consumption of mineral and organic fertilisers (tonnes/year) and estimated discharges from agriculture that reaches surface freshwater is sufficient to clarify the changes that occurred between the late 1980s and 1995.

The basic information collected by the Project Team and the description of the calculation methods to assess agricultural loads revealed substantial differences between countries. First of all, the information requested by TC INPUT was not complete enough to quantify reduction of agricultural discharges, especially with respect to the transition countries. Secondly, a full comparison of nutrient load figures between the countries is difficult for several reasons, including differences in:

- the consumption of mineral fertilisers and manure,
- the density of livestock,
- the geological, topographical and climatic conditions,
- the production technologies and agricultural practices, and
- the calculation methods to assess the agricultural loads.

The calculation methods to assess the anthropogenic load from agriculture and the basic data used in these calculations differ significantly between countries. In **Denmark**, **Estonia** and **Finland** estimates of anthropogenic losses of nitrogen and phosphorus from agricultural land to surface waters are based on monitoring of fluxes from small agricultural drainage basins (Chapters 6, 7 and 8). These estimates of anthropogenic losses from agriculture do not contain natural background. The Estonian and Finnish load figures are flow-normalised, while the Danish figures are not.

In **Latvia**, **Lithuania** and **Russia** there were no monitoring systems for anthropogenic load from agriculture at the end of the 1980s (Chapters 10, 11 and 13). Thus loads to surface waters have been estimated on the basis of results from Estonia, by assuming that the consumption of fertilisers and manure have been on the same level. In addition, it was assumed that the geological conditions are similar enough to justify this approach.

Monitoring systems for anthropogenic loads from agriculture in Latvia and Lithuania were introduced in the early 1990s. Load reductions for the 1995 were calculated on the basis of agricultural monitoring data (discharges per ha) and the percentage of agricultural land. The natural background losses are subtracted from the agricultural load. The loading figures are assessed by using integrated leaching coefficients for longer periods (several years) to avoid the effects of climate changes between years.

In **Germany** statistical information and the CORINE land cover maps were used as input data for calculations of agricultural nutrient losses with the MONERIS model (Chapter 9). The natural background calculated by the model was subtracted from the calculated load values. To reduce the influence of climatic changes between the years the losses from agricultural areas were calculated for two longer periods (1983–1987 and 1993–1997).

The **Polish** calculation method is based on the analysis of measured data from more than forty small river catchment areas for the both periods under study (Chapter 12). The calculation system takes into account available land use information, the consumption of fertilisers and hydrological conditions. The natural background is subtracted from the agricultural load.

In **Sweden** the calculations of anthropogenic nitrogen load from arable land were made by using the models SOIL-N and HBV-N, and the results have been compared to monitored load from small catchments (Chapter 14). The phosphorus leaching calculations were based on long-term average export coefficients by the Swedish University of Agriculture (Chapter 14). The natural background losses are subtracted from the agricultural load. The loading figures are flow-normalised.

Direct comparison of the agricultural load figures submitted by the countries is a complicated task. For example, results obtained using the MONERIS model have been compared with calculation results based on monitored catchments and flows [35]. The overall conclusion was that the relative differences in results produced by different methods vary between rivers. This indicates that at least some methods do not address ambient conditions in river catchments and the variability in conditions within catchments. Due to these differences, it was not possible to judge what methods may be most appropriate for source apportionment of nutrient loads. Nevertheless, this study verified that methodologies should be developed and agreed upon by which the apportionment of nutrients between different sources could be reliably estimated.

To understand and assess the agricultural load reductions in the Nordic countries, some additional information would be relevant. As a rule, the changes in the area of arable land in countries do not describe the changes important from the viewpoint of discharges. According to available data, changes in arable land varied between + 2 to –10 % from 1987 to 1995. On the other hand agricultural production (milk, meat, cereal and potatoes) in the transition countries, except Poland, decreased by 30 to 40 % (Chapters 7, 11, 13) during the same period. This discrepancy indicates that possibly up to one-third of the arable land has actually been out of production, which is not reflected in the statistics.

Another important factor that significantly affects estimates of discharges from agriculture is the nutrient surplus resulting from agricultural activities which constitute one of the links in the chain of enrichment of nutrients in inland waters. The surplus is defined as the difference between the total quantity of nutrients that enters the agricultural production process, and the outgoing quantity that results from this production. There are several models available to calculate this surplus. A comparison of the different models shows that it is possible to carry out relevant and comparable assessment on a large area, despite the high heterogeneity of the statistics available according to the territories, but improvements in the modelling and calculation of surplus remain desirable [36].

The total nutrient loss from agriculture measurable by monitoring the composition of waters, can be correlated with the surplus [36]. The results of measurements in small agricultural catchments concerning nutrient losses from agriculture in the Nordic and Baltic countries confirm that the correlation between nutrient losses and nutrient surplus is weak. This may be explained by the fact that the surpluses are for the soil surface, while measurements of losses are conducted in the primary surface water recipient [37]. The time lag between implemented protection measures and monitored effects also weakens the correlation. Because of this weak correlation between surplus and the nutrient losses in the Nordic and Baltic countries, model calculations to assess the surplus were not conducted.

3.4.2 Reductions achieved by countries

Based on the national values the total agricultural load decreased by 217 200 tonnes/year (38 %) of nitrogen and 3 840 tonnes/year (22 %) of phosphorus (Table 3.4).

Denmark achieved a decrease of 32 % (25 200 tonnes) for nitrogen and 13 % (90 t) for phosphorus, but this is mostly due to hydro-meteorological conditions (Chapter 6). The consumption of nitrogen and phosphorus fertilisers were reduced by 14 % and 46 %, respectively, while the consumption of manure increased by 4 %.

The growth of the area of arable land and the increase of the number of livestock (animal units) was below 5 %.

Estonia achieved the 50 % reduction for agricultural nitrogen, which is attributable to drastic changes in agriculture. The number of livestock and the use of manure declined by more than 50 %, and the overall consumption of fertilisers by

Table 3.4 Agricultural load from the countries and the reductions achieved between the late 1980s and 1995.[1]

Country	N (tonnes/year)		Reduction		P (tonnes/year)		Reduction	
	Late 1980s	1995	(tonnes)	(%)	Late 1980s	1995	(tonnes)	(%)
Denmark	79 000	53 800	25 200	32	670	580	90	13
Estonia	30 200	12 600	17 600	58	360	250	110	31
Finland	45 500	37 000	8 500	19	2 650	2 600	50	2
Germany	35 200[2]	26 100[2]	9 100	26	600[2]	640[2]	–40	–7
Latvia	33 800[3]	17 100	16 700	49	1 010[3]	510	500	50
Lithuania	59 500[3]	35 500	24 000	40	1 810[3]	890	920	51
Poland	135 100	94 600	40 500	30	7 390	6 650	740	10
Russia	82 700[3]	24 000[3]	58 700	71	2 450[3]	1 010[3]	1 440	59
Sweden	65 100	48 200	16 900	26	390	360	30	8
TOTAL	566 100	348 900	217 200	38	17 330	13 490	3 840	22

1) See Sections 2.1-2.4 and 3.1.1-3.1.2 for details on the origin and reliability of the data.
2) Calculated on the basis of MONERIS model. In the calculations the changes of agricultural area between the late 1980s and 1995 have not be taken into account.
3) Estimated on the basis of simplified models (cf. Chapter 10, 11 and 13).

more than 80 %. The use of phosphorus fertilisers decreased by more than 90 %. Much arable land was out of production or treated as green set-asides, while at the same time agricultural production decreased by 30–50 % (Chapter 7).

The nitrogen load from **Finnish** agriculture decreased by 20 %, which is comparable to the reduction in the use of nitrogen fertilisers from 1987–1995. In addition, the green set-aside field area increased by about 25 % during this period. The reduction in the use of phosphorus fertilisers (41 %) was not reflected in the reduction in phosphorus load from agriculture. This is caused by the high phosphorus retention capacity of the arable land, as well as the surplus caused by over-fertilisation in the 1970s and 1980s.

In **Germany** the reduction of agricultural nitrogen discharges into surface waters was 23 %. Reductions of about 40 % occurred the number of livestock as well as the consumption of fertilisers and manure. Reductions in usage of phosphorus fertilisers and manure of about 50 % could not be seen in the levels of agricultural phosphorus discharges into surface waters.

Latvia is one of the countries that achieved the 50 % reduction for both nutrients according to estimated figures. The most evident reason for the estimated decreases was the collapse of agriculture in the early 1990s. The reorganisation of collective farms to ordinary farms reduced the use of fertilisers and manure by 60 %. At the same time a significant reduction (62 %) in the number of livestock took place. From 1991 to 1995, the area sown was reduced by almost 50 % from 1.6 million ha to 0.9 million ha.

The **Lithuanian** estimates for nitrogen and phosphorus load reductions from 1987 to 1995 are about 40 % and 50 %, respectively. The most obvious reasons are the reorganisation of agriculture and significant reductions in the use of fertilisers and manure, as well as in the area sown.

In **Poland** the nitrogen and phosphorus load reductions from agriculture were approximately 30 % and 10 %, respectively. Collective farms were not the dominant form of agricultural production during the socialist era, and therefore the influence of political changes to agricultural production was significantly smaller than in countries that were part of the former Soviet Union. Compared to the other former socialist countries, the reductions achieved in nitrogen and phosphorus loads were smaller and, the general level in the nitrogen load in kg/ha y (Fig.3.3) is much smaller than in the other countries, and may be caused by the low runoff. There is a possibility that the detailed monitoring of discharges and riverine load to be conducted under the Fourth Pollution Load Compilation will also specify loads from Polish agriculture.

Russia achieved clear reductions in both nitrogen and phosphorus loads because of the economic collapse connected with the political changes. The reliability of the figures is, however, rather low due to the missing measurements of agricultural loads. Decreases in the use of fertilisers (more than 95 %) and manure (more than 65 %), as well as the number of livestock (30 %) were significant in the early 1990s. There are also some problems concerning the agricultural load data of the Kaliningrad region. An investigation organised by the Nordic Investment Bank [38] showed higher loads for the late 1980s than the calculations made using statistics from the former Soviet Union. Some further details may be available after the publication of the Fourth Pollution Load Compilation.

Sweden achieved nitrogen and phosphorus load reductions of 24 % and 8 %, respectively. The nitrogen load reduction was mainly caused by increased set-asides and changed crop composition, which included more grass ley and less cereals. In addition, leakage concentrations for individual crops were decreased due to increased nitrogen use efficiency (i.e. higher yields). The reduction of phosphorus discharges are not in balance with the significant reduction in the consumption of phosphorus fertilisers (31 %), most probably due to the effective adsorption of phosphorus in agricultural land.

3.4.3 Comparison of results

To assess and compare anthropogenic nitrogen and phosphorus discharges from agriculture to water bodies, the average use of fertilisers per hectare and the average losses of fertilisers used were calculated by using the data submitted by the countries (Appendix 1).

These background indicators are general, and do not take in account different climatic and geological/morphological conditions between countries, as well as differences in agricultural practices. Further, the time lag between a reduced fertiliser application and effects in rivers must be taken into account. Despite of these facts the background indicators help to draw attention to different controlling factors and to the possibility of unreliable results and uncertainties.

Nitrogen

In the late 1980s, in Denmark, Germany and Russia, on average more than 200 kg/ha of nitrogen fertilisers (including manure) was used annually (Fig. 3.3). In Estonia, Finland, Latvia, Lithuania and Poland the corresponding value was between 140 to 170 kg/ha and in Sweden only 105 kg/ha. The situation changed drastically during the early 1990s.

The average losses from nitrogen fertilisers (discharges to water body/amount of fertilisers used x 100) varied between 12 and 19 % in Denmark, Estonia, Finland, Latvia, Lithuania and Russia. From the viewpoint of losses, the use of nitrogen fertilisers was most effective in Germany and Poland, where the losses were below 10 %. Another explanation for the small losses is likely the significantly smaller runoff from the territories of Poland and Germany than those from the other countries. The average runoff to the Bothnian Bay varies between 10 to 20 l/s km^2, and runoff to the Gulf of Finland ranges from 7 to 9 l/s km^2, but from the territory of Poland and Germany to the southern part of the Baltic Proper is only about 5 l/s km^2 [39]. In Sweden nitrogen fertilisers use was low in the late 1980s (105 kg/ha), but as much as 24 % was washed out from the fields (Fig 3.4, Appendix 1).The percentage losses in 1995 were higher, especially for the transition countries due to significant reductions in the use of fertilisers.

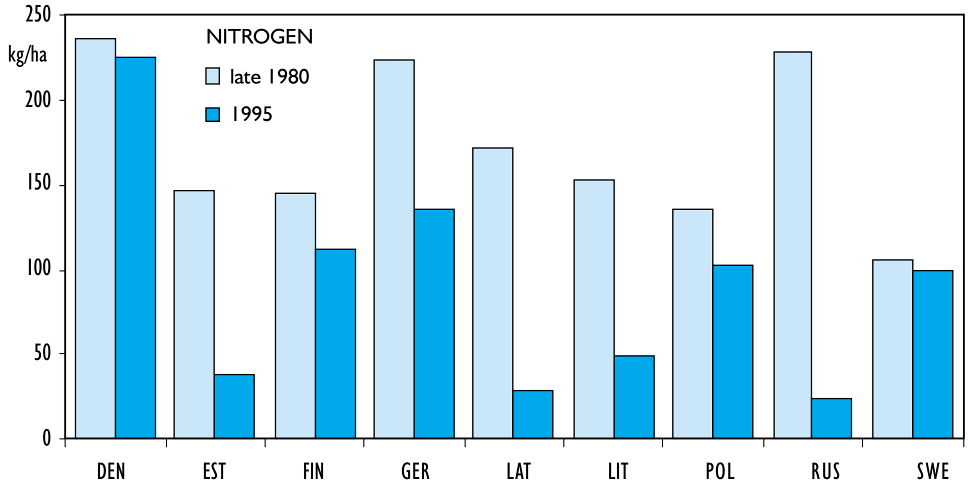

Figure 3.3. The use of nitrogen fertilisers in the late 1980s and 1995.

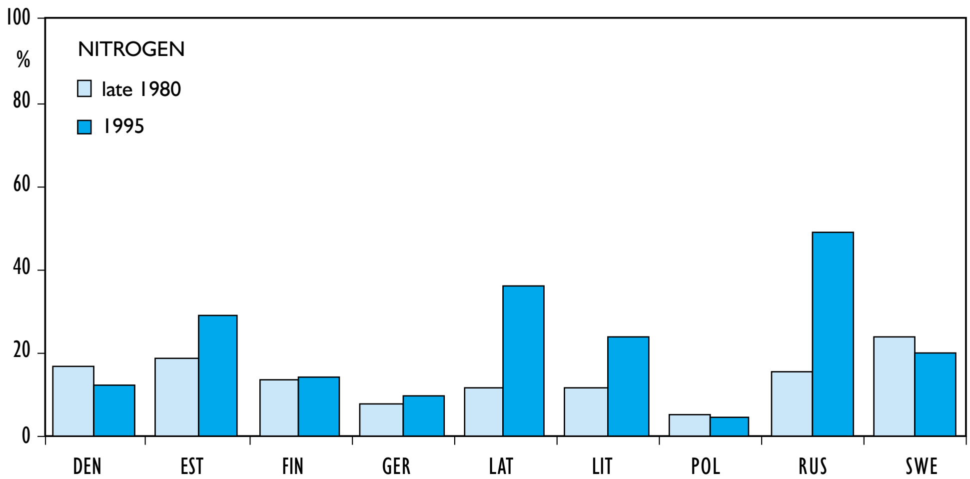

Figure 3.4. Average loss (in percent) of fertilisers used in the late 1980s and 1995.

In the late 1980s in Estonia, Finland, Germany, Latvia, Lithuania and Russia nitrogen discharges ranged from 20 to 35 kg/ha (Fig. 3.5). In 1995 the average annual washout of nitrogen was stabilised to values between 10 to 16 kg/ha. In Denmark and Sweden, discharges were higher (28 and 24 kg/ha respectively) which may be explained by the accumulation of nitrogen in the soil. Extremely low agricultural discharges of nitrogen were estimated for Poland (5 kg/ha), which may be a result of underestimation either in the monitoring or in the calculation procedures (Fig. 3.5). However, it is also probable that the lower values are due to low runoff rates, the special structure of the Polish agriculture, and the relatively high proportion of animal manure in fertiliser.

Phosphorus

In the late 1980s, the use of phosphorus fertilisers per hectare between Baltic Sea countries varied by nearly one order of magnitude. The heaviest users were Russia and Latvia with 96 and 82 kg/ha, respectively. In 1995 the use of phosphorus fertilisers was reduced to levels of 10 to 25 kg/ha. The largest reductions took place

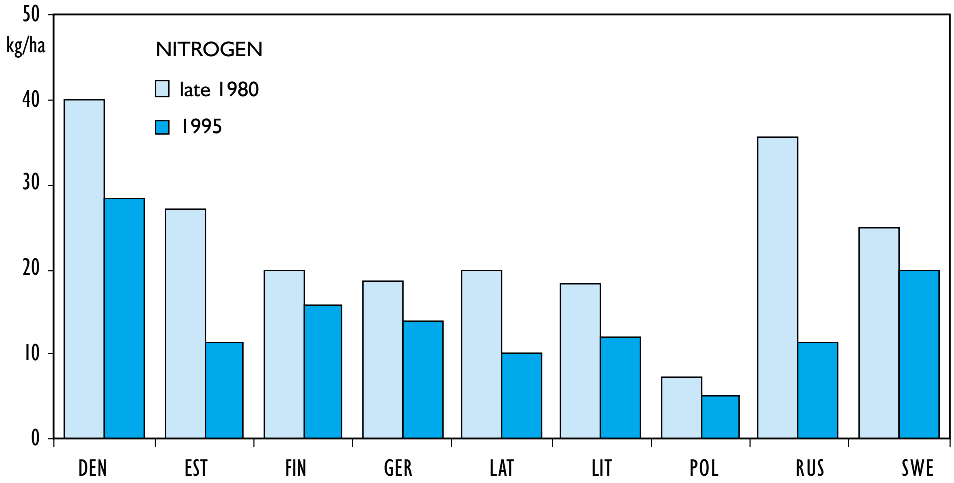

Figure 3.5. Nitrogen discharges from arable land in the late 1980s and 1995.

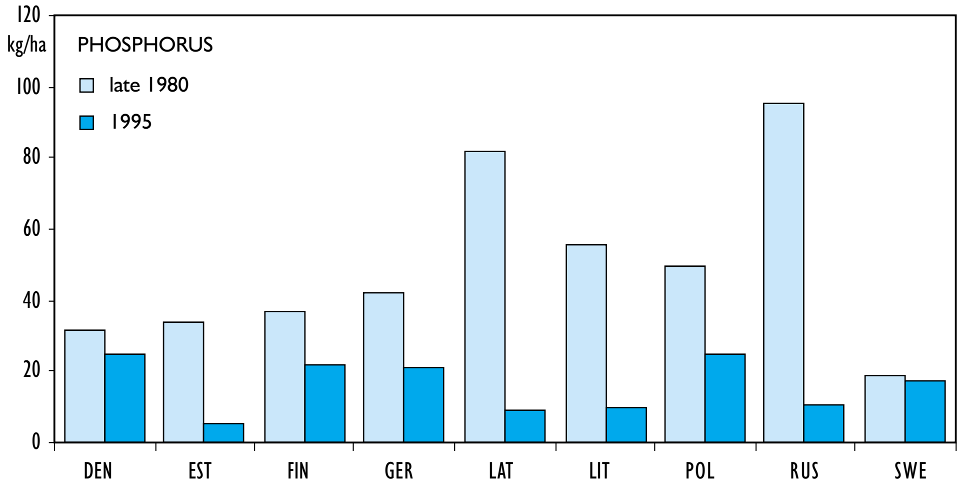

Figure 3.6. The use of phosphorus fertilisers in the late 1980s and 1995.

in Estonia, Latvia, Lithuania and Russia (Fig 3.6 and Appendix 1). Disregarding these countries the measured values indicate that there were no significant changes in the leaching of agricultural phosphorus fertilisers between the late 1980s and 1995 (Fig. 3.7). The highest leaching values were calculated for Finland, which can be explained by chemical characteristics of soil, erosion risk of the soil and local topography [37].

The average losses of the phosphorus fertilisers used varied from 1 to 5 %. In the late 1980s the losses from phosphorus fertilisers were below 2 %, except in Finland. In 1995 losses increased in all countries; in Estonia, Latvia, Lithuania and Russia the losses increased up to 4 %. This indicates that the leaching of phosphorus has not decreased at the same rate as the use of phosphorus fertilisers (Fig 3.8).

The comparison suggests that despite a lack of monitoring information and methodological variations, national load figures are to some extent comparable. It seems probable that there are no strongly overestimated results either for the late 1980s or 1995. However, based on the comparisons presented in figures 3.6 and 3.7 it seems possible that the agricultural phosphorus loads for 1995 may be in some extent underestimated in some of the transition countries. In general, the leaching coefficients and the calculated losses are comparable between countries.

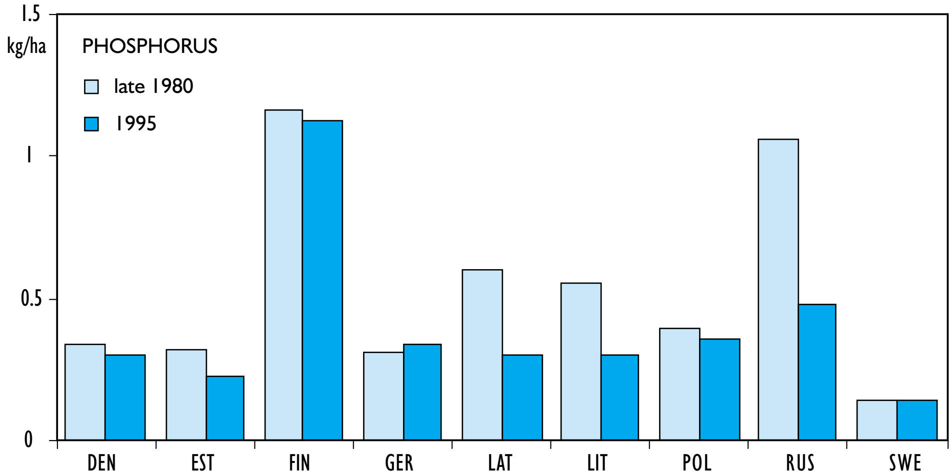

Figure 3.7. Discharges of phosphorus from arable land in the late 1980s and 1995.

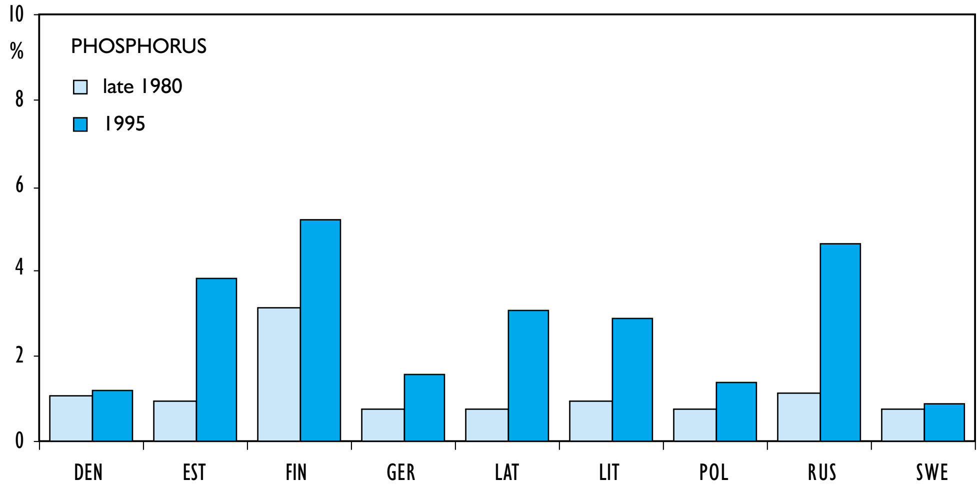

Figure 3.8. Phosphorus loss (in percent) from fertilisers used in the late 1980s and 1995.

The PLC-4 report will include material which will allow verification of the present results. However, additional research will also be needed to identify causes of the large variability in leaching values between the countries.

3.5 Reductions of summarised point and non-point loads

The assessment of the overall nitrogen and phosphorus load reductions is based on the national information submitted by national experts and analysed by the Project Team. The main difficulties in comparing the loads are methodological. Especially the fact that there were no special monitoring programmes for agricultural loading in the transition countries complicates the assessment.

Denmark, **Estonia**, **Finland, Russia** and **Sweden** estimated point source loads and reductions achieved on the basis of monitoring results. In **Germany**, point source loads were assessed using both statistical information and monitoring results. The **Latvian, Lithuanian** and **Polish** point source load figures for the late 1980s were estimated on the basis of statistical information (amounts of discharged wastewater and a standard BOD:N:P ratio) on water consumption and wastewater treatment. Load figures for 1995 were calculated using monitoring results.

The agricultural loads in **Denmark**, **Estonia**, **Finland** and **Sweden** were estimated from monitoring and investigation results. In **Germany** agricultural load figures were calculated using the MONERIS model. **Latvia** and **Lithuania** estimated agricultural loads for the late 1980s using statistical information and simplified models, while **Poland** used results from various investigations. The agricultural loads in **Latvia, Lithuania** and **Poland** for 1995 were calculated using results from joint investigations and monitoring. The agricultural loads for **Russia** were estimated from statistical data (use of manure and fertilisers, area of arable land) and an assumption that climatic and hydrological conditions are similar to those of Estonia.

The overall nitrogen and phosphorus load reductions achieved by the countries between the late 1980s and 1995 are summarised (Chapters 6–14) and presented in Table 3.5. According to the data, overall the countries achieved load reductions of 35 % for both N and P in this period. The load reductions for each country, however, differ significantly. As a rule, most countries achieved the 50 % reduction target for phosphorus. The nitrogen reduction efficiency was, in general, smaller and only some of the transition countries were able to reach the 50 % goal.

Denmark achieved the overall 50 % reduction of phosphorus load due to large decreases in municipal, industrial and fish farm loads, which compensated for the small agricultural load reduction (13 %). Municipal and industrial nitrogen load reductions (54 % and 60 % respectively) were not enough to compensate for the smaller agricultural nitrogen load reduction (32 %). The reduction in agricultural nutrient loads is mainly explain by different climatic conditions in 1995 (dry) compared with the late 1980s. To achieve the 50 % reduction goal set by the 1988 Ministerial Declaration, attention should be focused on implementing new measures in agriculture.

Estonia achieved the 50 % reduction goal for both nitrogen and phosphorus due to fundamental changes in the economy and reconstruction/construction of wastewater treatment plants. The calculated point source loads for 1995 are slightly higher than those published in the Second Baltic State of the Environmental Report [32]. According to government targets (Chapter 7), further attention will be paid to implementing EU Directives to further reduce point source discharges. The target for agricultural loads is to keep the future loads no higher than 1995 levels.

The measures implemented in **Finland** to achieve the 50 % reduction goal reduced nitrogen and phosphorus loads between 1987 and 1995 by 15 % and 19 % respectively. To achieve the 50 % reduction goal by the year 2005, Finland has elaborated targets described in Chapter 4. According to these targets all loading sectors should reduce nitrogen and phosphorus discharges by about 40 to 50 percent.

Germany achieved the overall 50 % reduction goal for phosphorus due to the construction of municipal wastewater treatment plants, reduction of the use of phosphorus-containing detergents and restructuring of industries.

Latvia achieved overall reductions of nitrogen and phosphorus loads by 54 % and 45 % respectively due to fundamental changes in the economy and the reconstruction/construction of wastewater treatment plants. Further reductions in nitrogen and phosphorus loads will depend on results of negotiations with the European Union.

Lithuania achieved 40 % and 55 % load reductions for nitrogen and phosphorus, respectively, due to radical changes in the economy and reconstruction/construction of wastewater treatment plants. According to Section 11.2, the 50 % nitrogen load reduction will have been achieved by the year 2000. Further load reductions will follow the timetable and targets adopted during the negotiations with the European Union.

Poland has achieved reductions of 27 % and 20 % for nitrogen and phosphorus, respectively. The implementation of further measures to reduce the loads are presented in Secton 12.2 and based on international agreements and negotiations with the European Union.

The estimated load reductions in **Russia** were 58 % and 47 % for nitrogen and phosphorus, respectively. Further reductions depends on government decisions and on nationally and internationally available financial resources to implement water protection measures (Section 13.2).

Sweden achieved 20 % and 42 % reductions in nitrogen and phosphorus loading, respectively. Further reductions of the nitrogen load is dependent on the efficiency in implementing advanced nitrogen removal technology in municipal wastewater treatment systems, and on the implementation of measures for agriculture. The phosphorus load reduction target will be achievable via reduction of agricultural loads. According to the targets (Section 14.2) there are some difficulties in achieving the 50 % reduction of the nitrogen load by the year 2005.

The preliminary Swedish judgement is that it will be very difficult to reach the HELCOM goal of nitrogen reduction to the sea by 2005, mainly due to the difficulties involved in reducing the leaching from arable land. According to the Swedish targets proposed so far, 26 % of the load to the sea will be reduced by the year 2005, while 39 % will be reduced by the year 2020. This is in line with the HELCOM goal, but not within the HELCOM timetable. However, no Parliamentary decision have yet been taken either for the targets or the timetable.

Table 3.5 Overall nitrogen and phosphorus load reductions achieved by countries between the late 1980s and 1995.[1]

Country	N (tonnes/year)		Reduction		P (tonnes/year)		Reduction	
	Late 1980s	1995	(t)	(%)	Late 1980s	1995	(t)	(%)
Denmark	101 400	64 300	37 100	37	5 890	1 870	4 020	68
Estonia	49 360	17 440	31 920	65	1 080	545	535	50
Finland	67400	57 400	10 000	15	4 150	3 380	770	19
Germany	53 260	36 000	17 260	32	3 820	1 300	2 520	67
Latvia	46 310	21 510	24 800	54	2 473	1 371	1 102	45
Lithuania	72 500	43 400	29 100	40	4 530	2 040	2 490	55
Poland	298 900	219 700	79 200	27	36 050	28 680	7 370	20
Russia	129 100	54 300	74 800	58	9 700	5 190	4 510	47
Sweden	98 400	78 700	19 700	20	2 240	1 310	930	42
Grand Total	916 780	592 800	323 980	35	69 935	45 688	24 247	35

1) See Sections 2.1–2.4 and 3.1.1–3.1.2 for details on the origin and reliability of the data.

4 Conceptual approach to develop more specific targets to achieve the 50 % reduction goal

4.1 Introduction

Referring to Article 4 (2) of the 1992 Convention [40] each Contracting Party, without prejudice to its sovereignty, shall implement the provisions of the Convention within its territorial sea and its internal waters **through its national authorities**. It means, that the implementation of the provisions of the Convention as well as the 1988 Ministerial Declaration [5] will take place according to individual national legislation. Specific water protection targets are closely connected to national environmental protection activity plans, which in principle also cover international obligations (EU Directives, HELCOM- and OSPAR-recommendations).

Water pollution control measures should be taken **at source** based on existing knowledge concerning the vulnerability of the Baltic Sea and inland waters to eutrophication. In planning and implementing these measures consideration should also be given to the technological and economical prerequisites of pollution control. Any measures that decrease the release of nutrients into the Baltic Sea, a major cause of eutrophication, should be targeted at coastal areas and rivers flowing into the sea [41].

The differences among the Baltic Sea countries (e.g. living standard, financial resources to implement environmental protection measures, surface and coastal water quality, wastewater treatment efficiency) were significant. Denmark, Finland and Sweden have achieved reductions of nitrogen and phosphorus from municipal and industrial discharges to a level that will be achievable only after some decades for transition countries. Therefore the concepts to elaborate more specific targets will also differ significantly.

The more specific targets in the transition countries, to reach the level of western countries, should be based primarily on implementing basic principles such as best available technology, best environmental practices, and the precautionary principle and "polluter-pays" principle which are currently implemented in western countries.

At the same time the task of the western countries are more complicated. To achieve a 50 percent load reduction from the level of high treatment efficiency is both more complicated and more expensive. The strategy to elaborate more specific load reduction targets differ significantly from strategies applied by the transition countries.

The Baltic Sea coast is highly variable, from deep embayments and fjords to extensive archipelagos along some stretches of coast. Still other areas have completely open coasts. The turnover time for water therefore varies widely between different coastal sections, from a day or so along the open coasts to nearly hundred days in the more enclosed archipelagos. This in turn is of importance for how nitrogen loads affect the local aquatic environment and which response measures are appropriate [42]. To guarantee ecological balance and high coastal water quality, different load reductions for different coastal areas will be needed.

A strategy to elaborate water protection targets based on indicators or "Ecological Quality Criteria" taking into account regional and local conditions was proposed by Sweden [42]. Discharge targets and remedial measures must be adopted to the different needs and conditions that exist in different parts of the coast. The strategy is in accordance with the EU Water Framework Directive, which is based on the principle of organising water management practices according to river basins, taking into account different needs and conditions in the river basins.

A prerequisite for being able to adapt measures and discharge targets to regional and local conditions is knowledge of the specific conditions that prevail along coasts. The environmental status of different coastal waters can be assessed by using a number of different parameters and indicators. Pollution abatement measures can then be prioritised to the areas where they can have the best effect on the marine environment [42].

Section 4.2 presents the Finnish national approach to develop national water protection targets for the year 2005, as well as its economic impacts and environmental effects. This program is presented as an example of a source-orientated approach. However, the program also contains an impacts-orientated part, in which the probable effects of the targets are assessed as potential changes in the water area belonging to different quality categories.

The report "Water Protection Targets for the Year 2005" [41], the base for elaborating more specific Finnish targets, has been prepared by a working group appointed by the Ministry of the Environment jointly with those responsible for discharges. The target program for water protection is based on a proposal developed by the Finnish Environment Institute. Following deliberations by the Finnish Cabinet's Finance and Economic Policy Committees, the Council of State has, at the request of the Ministry of the Environment, decided to prepare and implement the following measures aimed to guide the planning, decision-making and monitoring of water protection.

The Finnish Ministry of Environment elaborated the target program for water protection following national water protection legislation which includes the following basic principles: the precautionary principle, the "polluter-pays" principle, use of best available technology and best environmental practices. The Finnish target program is based on the source-orientated approach.

Reviews of plans to reduce the pollution load to the environment elaborated by the Danish, Estonian, Latvian, Lithuanian, Polish, Russian and Swedish experts are included in this report as Sections 6.2, 7.2, 10.2, 11.2, 12.2, 13.2 and 14.2. A summary of the Finnish plans describing possibilities to further decrease nutrient loads in the Baltic Sea catchment area is presented in Section 4.2.

4.2 The Finnish water protection targets for the year 2005

On 19 March 1998, the Finnish Council of State issued a Decision-in-Principle on Water Protection Targets [41] to 2005. The main goals of the Decision-in-Principle are the reduction and prevention of eutrophication. The general objectives of water protection are to (1) prevent further deterioration in the state of the Baltic Sea and inland waters caused by human activities and (2) improve the conditions of those watercourses that have already been contaminated. The quality and quantity of groundwater must, in general, be maintained at least at present levels and improved in locations where its quality has been degraded by human activities.

Water pollution is prevented primarily by actions that reduce waste loads at the source. The anthropogenic load of phosphorus shall be decreased by about 45 % and nitrogen by about 40 % of the levels in the period 1991–1995. Targets are also set for biological oxygen demand and for substances causing harmful effects in water.

Achieving the Water Protection Targets established by the Finnish Council of State will be part of the implementation of the 1988 Ministerial Declaration to reduce the load of pollutants most harmful to the ecosystem of the Baltic Sea by 50 percent of total discharges. The targets also support the 1998 Ministerial Communiqué, in which the Ministers reaffirmed their commitment to achieve the strategic goals of the 1988 Ministerial Declaration, and to define a series of more specific targets to be achieved before 2005 and reviewed in 2003.

4.2.1 Loading from different sectors

Urban areas

Wastewater discharges into inland waters and the Baltic Sea concerning phosphorus input should be cut by at least 35 percent, and nitrogen inputs 14 percent, compared to 1991–1995 average levels.

In urban areas, phosphorus and nitrogen discharges should be cut and wastewater should be treated with biological-chemical or similar processes. The requirements concerning biological-chemical or similar processes and more effective nitrogen removal are based on the Finnish Council of State Decision on "the Treatment of Wastewater entering Water Areas through the Public Sewerage System and from Certain Industrial Sectors and Industrial Wastewater Entering the Public Sewerage System", by which the urban wastewater directive was incorporated in Finnish legislation. The requirement concerning more efficient phosphorus removal is based on the need to combat eutrophication. The modernisation and careful maintenance of sewerage networks are important for groundwater protection, but also reduce fluctuation in the amounts and quality of wastewater caused by infiltration water, which complicates the treatment process.

By 2005, wastewater treatment plants should be able to handle around 94 percent of the oxygen demand and remove 96 % of phosphorus. To reach targets for nitrogen loads, the wastewater of about 1.6 million residents should be treated with an average nitrogen removal rate of 60 percent. The target program is estimated to reduce municipal discharges into water as follows:

Nutrient	Load in 1995 (t/y)	Load in 2005 (t/y)
Phosphorus	244	170
Nitrogen	14 334	12 500

Scattered dwellings

The need to improve wastewater treatment in scattered dwellings was taken into account in the new environmental protection act. Earth closets and water-saving applications should be given priority when waste management alternatives are considered. At present, there are no nitrogen removal technologies suitable for treating wastewater in rural areas and thus it is essential to develop and test such technologies. Water protection should be promoted with education, dissemination of information, increasing use of professional water and waste management, land use planning, and incentives for housing repairs and renovation. These measures should reduce water pollution by rural areas and holiday homes as follows:

Nutrient	Load in 1992 (t)	Load in 2005 (t/y)
Phosphorus	415	300

Industry

Nitrogen and phosphorus discharges flowing into the Baltic Sea and inland waters should both be reduced by at least 50 % compared with 1995 levels. Industrial water protection practices should focus on the largest polluters and introduce environmentally-friendly operating and production methods, as well as efficient methods for treating waste and wastewater. To meet targets set for industry, both new plants and plants undergoing modernisation should incorporate the best available technology to reduce discharges and environmental impact as comprehensively and effectively as possible.

To reduce nutrient loads from the pulp and paper industry, the process-related use of chemicals containing nitrogen and phosphorus should be optimised and the maintenance, control and use of industrial wastewater treatment plants should be made more effective, for example when adding nutrients to biological treatment plants. Targets set for other industries are based on their readiness to adopt process and treatment technologies that reduce discharges.

In the following table, discharges from industrial plants subjected to statutory monitoring in 1995 are compared with the targets for the year 2005:

Nutrient	Load in 1995 (t/y)	Load in 2005 (t/y)
Phosphorus	358	170
Nitrogen	4 334	2 500

Agriculture and rural business

Crop cultivation and animal husbandry

Phosphorus and nitrogen discharges into inland waters and the Baltic Sea should both be reduced by at least 50 % from 1990–1993 average levels.

Nutrient discharges should be cut, in particular by introducing cultivation techniques that decrease field erosion and provide for the more efficient use of nutrients. For more efficient water protection, the use of fertilisers should be in keeping with the conditions at the site and nutrient requirements of the crops. Nutrient utilisation requirements can be assessed using farm-specific nutrient balances.

Leaching of nutrients from animal husbandry into water areas should be reduced by introducing environmentally efficient methods of manure treatment, storage and spreading. Liquid manure, other liquid organic fertilisers or uncomposted dry manure should not be spread in important or potentially important groundwater areas, if the spreading may affect groundwater quality.

Nitrogen discharges should be reduced in accordance with the Council of State Decision on Restriction Discharges of Nitrates from Agricultural Sources into waters. Under the Environmental Program for Agriculture to be launched in the year 2000, partly funded by EU, support is made conditional on the implementation of water protection measures.

The target program is estimated to reduce agricultural discharges into water as follows:

Nutrient	Load in 1995 (t/y)	Load in 2005 (t/y)
Phosphorus	2 600	1 545
Nitrogen	37 000	15 435

Forestry

Targets for the forestry sector are based on the Environmental Program for Forestry approved by the Ministry of the Environment and the Ministry of Agriculture and Forestry in 1994, which defines targets for the year 2005. Phosphorus and nitrogen discharges into inland waters and the Baltic Sea should both be reduced by at least 50 percent from estimated 1993 average levels.

The measures are specifically aimed at reducing phosphorus and nitrogen losses in forest soils, which should be achieved by reducing erosion of nutrients and surface deposits. Fertilisers should be used to compensate for nutrient losses in forest, but should not be applied to low-yield peatland which is unable to absorb phosphorus and is unsuitable for tree planting. The Environmental Program is estimated to reduce forestry discharges into water as follows:

Nutrient	Load in 1993 (t/y)	Load in 2005 (t/y)
Phosphorus	340	170
Nitrogen	3 330	1 670

Fur farming

Phosphorus and nitrogen discharges into inland waters and the Baltic Sea should both be reduced by at least 55 % from estimated 1993 average levels. To achieve the targets set for fur farming, wastewater and drainage systems at existing farms should be modernised, and new farms should be equipped with watertight waste treatment systems and efficient systems for treating runoff. Watertight waste treatment systems for the cage structures include waste collection bins or waste troughs, watertight ground or floor structures or other arrangements preventing excrement or feed waste from entering surface water and groundwater. Co-operation between fur farms and agriculture should be encouraged, with a goal of more efficient utilisation of fur animal manure as fertiliser. The Environmental Programme is estimated to reduce discharges into water as follows:

Nutrient	Load in 1993 (t/y)	Load in 2005 (t/y)
Phosphorus	45	20
Nitrogen	430	190

Fish farming

Phosphorus and nitrogen discharges into inland waters and the Baltic Sea should both be reduced by at least 30 % from estimated 1993 average levels. To met these targets, better-quality feed and improved feeding methods should be introduced, and farms should reduce their discharges. This can be achieved by modernising existing plants that rely on net closures and tanks during their useful life or at their closure. The farms to be modernised should be equipped with sophisticated feeding systems and, to bring about significant cuts in discharges, their closures equipped with more efficient sludge removal systems.

With these measures and careful maintenance, the nationwide specific load produced by fish farms can be reduced to an average of 7 g phosphorus and 44 g nitrogen for each kilogram of live fish produced. If there are no significant changes in the number of fish farms, discharges into water are expected to decline as follows:

Nutrient	Load in 1995 (t/y)	Load in 2005 (t/y)
Phosphorus	290	200
Nitrogen	1 260	1 100

4.2.2 Summary of targets to achieve the 50 % reduction regarding nutrients

Finland established sector-specific reduction targets for nutrients (Tables 4.1 and 4.2), taking into account pollution loads in 1987, using the source-orientated approach to fulfil the 50 % reduction goal adopted by the ninth meeting of the Helsinki Commission.

Table 4.1 Draft Specific Targets for Finland to Achieve 50 % Reduction of Nitrogen by 2005.

Pollution Source	Load in late 1980s (t/y)	Load in 1995 (t/y)	Reduction Achieved by 1995 (%)	Specific Target Reductions (t)	Reduction to be Achieved to 2005 (%)	Load to be Achieved in 2005 (t/y)
Urban Areas	14 505	14 334	1	1 834	13	12 500
Industries	5 824	4 334	26	1 834	42	2 500
Fish Farms	1 740	1 260	28	160	13	1 100
Agriculture	45 500	37 000	19	19 895	54	17 105
Forestry	5 000	3 330	33	1 660	50	1 670
Fur Farming	500	430	14	240	56	190
Total	73 069	60 688	15	25 623	42	35 065

Table 4.2 Draft Specific Targets for Finland to Achieve 50 % Reduction of Phosphorus by 2005.

Pollution Source	Load in late 1980s (t/y)	Load in 1995 (t/y)	Reduction Achieved by 1995 (%)	Specific Target Reductions (t)	Reduction to be Achieved to 2005 (%)	Load to be Achieved in 2005 (t/y)
Urban Areas	452	244	46	74	30	170
Industries	834	358	57	188	53	170
Fish Farms	210	290	–38	90	31	200
Agriculture	2 650	2 600	2	1 055	41	1 545
Forestry	500	340	32	170	50	170
Fur Farming	50	45	10	25	56	20
Scattered Dwellings	415	415	0	115	28	300
Total	5 111	4 292	16	1 717	40	2 575

4.2.3 Economic impacts and environmental effects of Water Protection Targets in 2005

Economic impact

General

Water protection costs arise from project-specific measures, which are usually developed in conjunction with the processing of water and environmental permits. This Resolution does not entail any direct costs, because the target program is not binding on Water Rights Courts, the judicial authority granting project-specific permits. The public administration is expected to take the program targets into account in its decision-making processes, however, and thus the Resolution is essentially designed to function as a mechanism to guide and promote protection measures.

The proposed target program gives industry and business sufficient time to harmonise their environmental protection operations in accordance with the program's objectives. With long-term and well-focused water protection efforts, human and economic resources can be put to more efficient use and misdirected investments be avoided. As a result, significant savings can be achieved compared to a short-sighted approach to water protection. As the water protection targets are of a general nature and comprise a broad range of activities, it is difficult to estimate the overall costs of the Resolution. In internal production-related measures, it is difficult to distinguish between water protection investments and investments aimed at making the production process more efficient, and thus it is difficult to give an accurate assessment of the precise economic impact of the program.

In keeping with the "polluter-pays" principle, the polluter is responsible for covering the cost of upgrading water protection. This means that the cost of improved water protection is ultimately transferred to the price of water-pollution services and commodities. An exception to this rule in the EU member states is agriculture, for which environmental subsidies are granted under the EU agri-environmental program and agricultural investment subsidies provided to finance water protection projects.

In calculating polluter-specific costs, total investments have been converted into annual costs using an annuity method with an amortisation period of between 10 and 20 years (depending on the type of investment) and an annual interest rate of 6 %. When examining economic effects, annual water protection costs are usually compared with the total annual production value of the polluting activity. The purpose of this approach is to examine water protection costs as part of the overall operations and facilitate the comparison of the economic costs of water protection borne by different sectors.

Rural business

Since 1995, most water protection measures undertaken in agriculture have been implemented under the voluntary Environmental Program for Agriculture approved and partly funded by the EU, and through agricultural investment subsidies.

In 1997, agricultural environmental subsidies amounted to around FIM 1.7 billion. This total comprises farmers' portion of costs arising from protection measures, income losses, and incentives to join the program. Water protection targets for agriculture are based on the assumption that the subsidy program, set to end in 1999, will continue after that date.

Costs for water protection measures in animal husbandry and crop cultivation, and income losses caused by the measures are estimated at FIM 1.2 billion annually for the period 1995–1999. The measures are included in the conditions of the basic portion of the environmental subsidy and other special subsidies. Most of the cost is covered by environmental subsidies, which totalled about FIM 1.7 billion annually in the period 1995–1999.

The reduction targets for agricultural discharges set out in this program will be achieved with voluntary subsidies, investment subsidies, counselling and training. Renovation of manure and silage stores in order to meet water protection standards would require a sum of about FIM 1 billion during the entire program period. The FIM 90 million extra investment cost that farmers are expected to pay is 1 % of the FIM 7.9 billion income from animal husbandry received in 1995.

Water protection costs to be paid by the forestry sector are largely dependent on the size of the protective zones and forest management methods. Protective zones of 5–10 meters width would reduce forest owners' annual cutting revenue by around FIM 85 million. The additional costs resulting from more stringent effluent water protection measures, implemented in conjunction with improved drainage methods, would total about FIM 12 million annually in the next few years. The annual extra cost of around FIM 97 million is 1 % of the annual cutting revenue from Finnish forests, which averaged FIM 8.1 billion in the period 1994–

1996. The development and introduction of forest management methods that give greater consideration to water protection would reduce overall environmental discharges from the Finnish forest sector and make its products more competitive. Crucial factors contributing to this competitive edge would be a production process with minimal environmental impact and sustainable use of renewable resources.

More attention should be paid to water protection in greenhouse cultivation taking place in groundwater areas which are important or potentially important for water supply and near protected water areas. Investments required for equipping greenhouses with closed-loop water systems are estimated at FIM 350 million. The resulting annual cost (approximately FIM 47 million) equals 4 % of the total FIM 1.1 billion income from greenhouse production in 1996. It should be noted, however, that a large percentage of greenhouse farmers already comply with water protection regulations, and only a small proportion of enterprises are faced with the need to overhaul their systems.

Fish farming

Fish farming should apply best available technology to more than half of its estimated 2005 capacity of 24 500 tonnes. The required total investment is estimated at FIM 100 million. The annual investment cost of around FIM 13.5 million would be 3 % of the estimated 2005 production of FIM 400 million. However, an allowance should be made for the fluctuating costs of sludge removal systems and the development of water protection technology. The estimated additional costs will increase fish prices by around FIM 0.6/kg. For 1991–1993, the average producer price for fish was around FIM 21/kg and in the period 1994–1996, FIM 17/ kg.

Fur farming

If the targets set for fur farming are to be achieved, an estimated FIM 400 million should be invested in the period 1996–2005. This sum includes the renovation of existing farms, farm relocations, and the introduction of new technology. The industry is prone to fluctuations in fur prices and demand. Fur production peaked in 1985 (around 8 million furs) and dropped to its lowest level in 1991 (around 2.5 million). During the last few years, annual production has varied between 4 and 4.5 million furs with a total value of FIM 1.7 billion. Thus, the annual water protection cost of around FIM 50 million is 3 % of the annual fur production.

A reduction in discharges of solid matter and humus in peat production would require investments of around FIM 150 million in the period 1995–2005. The figure is based on the assumption that the production area will reach 70 000 hectares in the year 2005. The annual cost of around FIM 30 million arising from these investments would be 2 % of the estimated FIM 1.3 billion production generated by an area of 70 000 hectares. In 1996, the production area was about 55 000 hectares and the value of peat produced was FIM 1.1 billion.

Industry

Environmental protection is central to day-to-day industrial operations and consequently, total discharges and environmental effects are given high priority when investments in production technology are made. Environmental investments are increasingly being targeted at the development and modernisation of production processes, since environmentally conscious markets are subjecting products and production processes to ever closer scrutiny. It is very difficult to distinguish between requirements for environmental investments made by authorities, market demands, and the routine maintenance and modernisation of production processes. It is even more difficult to make a clear distinction between operating and maintenance costs. Only the investment and operating costs of wastewater treatment outside the production process can indisputably be classified as water protection costs.

In 1995, the pulp and paper industry accounted for about 80 % of all industrial investment in water protection and the sector will maintain its dominant position in this respect. Almost all wastewater from pulp, paper and board miss in Finland is treated with modern and efficient biological processes. During the period covered by the target program, a large number of existing treatment plants will be expanded and made more efficient.

Environmental investment in the pulp and paper industry, as well as in other branches of industry, is primarily targeted at process technology, in particular at white water systems. Most investment is incorporated in planned expansions or modernisation, or in projects already underway. Significant improvements in wastewater treatment are also planned in the metals and chemical industries.

In the 1990s, water protection accounted for between 2.5 % and 4 % of all industrial investment. In 1995, water protection investment totalled around FIM 920 million and annual operating and maintenance costs around FIM 650 million. The latter sum includes FIM 250 million of annual sewage fees paid to public sewerage works.

It is estimated that industry will spend between FIM 1 and 1.1 billion on water protection annually. By the year 2005, the annual operating and maintenance costs of water protection are estimated at between FIM 750 and 800 million. The proportion of the overall economic impact of water protection on industrial production will probably remain unchanged, if the annual growth in industrial production stays at 2 %. The total FIM 1.6 billion expenditure on water protection is about 0.4 % of the annual industrial production of FIM 382 billion and about 1.2 % of its added value.

Settlements

Chemical treatment of wastewater from urban areas should be converted to a biochemical process during the period 1995–2005. Phosphorus and nutrient removal rates should also be improved. These measures are estimated to generate additional annual costs of FIM 150 million by the year 2005. From 1991 to 1995, annual investment in wastewater treatment averaged about FIM 320 million; in 1996 the figure was about FIM 220 million. Modernisation costs for existing facilities that will remain operational is expected to total between FIM 100 and 150 million annually. Water protection targets can thus be achieved by maintaining the present level of investment in wastewater treatment plants between now and the year 2005. The annual operating costs of treatment plants is estimated to rise by FIM 150 million.

The annual amount of wastewater for which urban areas will be charged is estimated to reach 400 million m^3 by the year 2005. Thus, improvements in wastewater treatment and increased operating costs would cause the sewage fee to rise by FIM 0.7/m^3, which is roughly 10 % of the FIM 7.28/m^3 average at the end of 1995.

The number of permanent dwellings in rural areas is estimated to be 320 000 by the year 2005. Of this total, 32 000 would have been built after 1997. If the targets are to be met, wastewater of all dwellings constructed after 1997 should be treated using the best available technology. In addition, the sewerage and wastewater treatment systems of at least 60 000 dwellings built in 1997 or earlier should be modernised.

The estimated costs of water protection improvements in rural areas are based on the assumption that wastewater treatment will be improved by treating soil after sludge separation or by introducing earth closets and waste composting. Soil treatment is estimated to require investment of around FIM 1.1 billion and earth closets of FIM 120 million, bringing the annual costs of these measures to around FIM 110 million. The annual operating costs generated by improved wastewater treatment in 320 000 rural dwellings would amount to about FIM 160 million. Compared to 1997, the additional costs of these improvements are estimated to average FIM 310 for each rural resident annually.

The number of holiday homes is estimated to rise from 416 000 to 510 000 in the period 1995–2005. If their water protection targets are to be met, the estimated 60 000 holiday homes to be constructed after 1997 should treat their waste and wastewater by making use of compost toilets and soil infiltration treatment of wastewater. In addition, waste and wastewater treatment systems should be improved in 50 000 existing holiday homes. Investment and more efficient utilisation are estimated to increase the average annual costs of holiday homes by FIM 150 between now and the year 2005.

Groundwater protection

It is impossible to estimate the total costs of groundwater protection between now and the year 2005. The need for protection measures should be assessed on a case-by-case basis at all sites where activities pose (or threaten to pose) a risk to groundwater resources. Developing groundwater protection plans is one way of establishing the need for protection in areas where potential risk activities already exist. However, the impact of any new activities begun between now and the year 2005 remains outside the scope of these plans. Thus, reliable cost estimates of groundwater protection can only be given at the end of this period.

Typical groundwater protection measures that entail costs include: the construction of protection basins and drains, modernisation of existing tanks and pipes or the use of high-quality, more expensive alternatives, ground surfacing or sealing, the introduction of monitoring and alarm systems, the use of risk-free but more expensive chemicals, improved treatment of wastewater or drainage water, more efficient waste treatment and recycling, treatment of contaminated soil, and dealing with polluted groundwater. Restrictions in gravel extraction will also generate costs, as income from sales will inevitably decline. Some protection measures, however, such as the prevention of oil and chemical pollution, will also benefit the operators.

Protection measures involve considerable cost fluctuations. In some locations, additional groundwater protection may not be necessary, as the problems have already been addressed. On the other hand, the protection of roadside ditches where necessary will entail costs of about FIM 1 million per road kilometre. The cost of dealing with groundwater pollution can also vary considerably. In serious cases, research costs alone can amount to hundreds of thousands of Finnish marks, not to mention the repair costs, which can run into millions.

Environmental effects

The program is expected to increase the area of waters classified as being in very good condition by 600 km^2, from the present 10 200 km^2. The total area of lakes classified in the “good” category should decline by almost 300 km^2, from 11 400 km^2. This is because more water areas will move up to the “very good” category than are likely to drop down to the “satisfactory” category. The area of lakes of satisfactory water quality should decrease by about 300 km^2, from 5 150 km^2, and the area of lakes with adequate water quality by 30 km^2, from 1 040 km^2. The total area of lakes with poor water quality, 140 km^2, should remain unchanged.

The program should halt the decline in water quality in rivers. The total length of rivers with adequate water quality should increase by 20 km, from 3 800 km and the total length of good quality rivers should also increase by 20 km, from 4 300 km.

It is estimated that a reduction in phosphorus discharges into sea areas will markedly improve water quality in the inner parts of archipelagos. The high content of inorganic nutrients and an effective nutrient cycle in coastal waters and open water areas would prevent any wider impact.

Decreases in nutrient discharges could reduce eutrophication in some parts of the Archipelago Sea and the Gulf of Finland. A rapid 25 % reduction in the discharges flowing to the Bothnian Bay would bring the phosphorus content of this sea area down to the 1980s level in 30 years. Nitrate content, however, would come down much faster and could actually drop below levels of the 1960s.

Conclusions

5

General

1. The nitrogen and phosphorus loads presented in the present report were calculated and assessed for the late 1980s and 1995 on the basis of monitoring programmes, calculation methods and data submitted by the countries according to the questionnaire adopted by the meeting of HELCOM TC INPUT 4/99. The initial information submitted by the national experts was accepted by the national authorities.
2. For different reasons, the experts could not submit all data requested in the questionnaire. With regards to data for late 1980s, some experts submitted only summarised figures on municipal and industrial loads, due to difficulties in separating the older load data by the classes or industrial branches requested in the questionnaire. In addition, the treatment methods used and corresponding percentages could not be always determined.
3. In the transition countries (Latvia, Lithuania, Poland and Russian Federation) the monitoring of agricultural loads was missing at the end of 1980s. Therefore only estimates based on background information were available, which makes the comparison of loads between the countries, as well as between the different time periods, unreliable.
4. Methodological differences between countries prohibit the use of complicated models for comparison and assessment of the results obtained. Therefore background indicators (person equivalents, amount of fertilisers used, etc.) were used to verify the estimated values.

Point source nutrient load

5. Point-source nutrient loads of the countries can be regarded to be reliable, and comparisons can be made both between the two time periods examined and among different countries.
   The total point source loads of nitrogen and phosphorus decreased by 30 % and 39 %, respectively. The 50 % target was in practice achieved by most of the Baltic Sea countries for phosphorus, while most countries did not reach the target for nitrogen. The most prominent reductions occurred in countries in transition (except Poland and Russia) and Denmark.
6. The nutrient load reductions achieved in Denmark, Finland, Sweden and Germany (western part) are attributable to the implementation of protection measures. In Estonia, Germany (former GDR), Latvia, Lithuania, Poland and Russia, the decreases were caused by economic reasons and the active construction or reconstruction of wastewater treatment plants.
7. Further reduction of nutrient loads from point sources is likely. The further introduction of chemical phosphorus precipitation and the nitrification-denitrification process will decrease municipal loads, while the further introduction of best available technologies, along with investments in process technology and wastewater treatment, will decrease industrial loads.

Diffuse loads from agriculture

8. There are inconsistencies between the 1987 and 1995 data, which cannot be fully explained by the available background information or observed changes in the river water quality. The most important reason for this is the lack of the monitoring of agricultural nutrient losses in most of the countries in transition in the late 1980s. For Russia this lack continued still in 1995.
9. Decreases could be found in nitrogen loads, while decreases in phosphorus remained smaller or negligible. In Denmark, Finland, Germany and Sweden, no decreases could be found in agricultural phosphorus, despite reductions in the use of phosphorus-containing fertilisers due to the surplus of phosphorus in agricultural land. The estimates suggest that the 50 % reduction target would have been reached by some countries in transition for both N and P. The final implementation of the 50 % target is much more uncertain for diffuse sources than for point sources, despite various measures designed to reduce agricultural loading. It seems possible that at least in Estonia, Latvia and Lithuania, the amounts of used fertilisers per hectare will increase in the future. In all countries future trends will depend largely on the total area of fields under active cultivation and on the future agricultural policies of the European Union.
10. There is a need to further develop methodologies by which to measure diffuse agricultural loading, as well as generally accepted methodologies for determining discharges/losses from diffuse sources into surface waters.
11. As pollution load data for the year 2000 will be available in 2003 (PLC-4), the Baltic Sea countries will again have the opportunity to assess and revise their preliminary targets.

Adoption and implementation of water protection targets

12. The **Finnish** national water protection targets, their economic impacts and environmental effects for 2005 were presented as an example how to elaborate and adopt national water protection targets based on the source-orientated approach. By implementing sector-specific national targets, Finland will also achieve the reduction goals of the 1988 Ministerial Declaration by 2005.
13. Additionally, national qualitative/quantitative targets/principles have been presented for Denmark, Estonia, Latvia, Lithuania, Poland, Russia and Sweden. For the countries in transition (except Russia) the targets are connected to the accession process to the EU.
    - The **Danish** national water protection targets (Section 6.2) are in accordance with the 1988 Ministerial Declaration. Some concern have been expressed by national experts concerning agricultural targets, taking into account the time lag between the implementation of measures and the obtained reduction of loads to water bodies.
    - The EU accession countries (**Estonia**, **Latvia**, **Lithuania** and **Poland**) will continue to implement water protection measures in accordance with the EU accession protocol which defines the timetable for implementation of the Urban Waste Water Directive, Nitrate Directive and the Integrated Pollution Prevention Control (IPPC) Directive.
    - Due to the restructuring of the agricultural production system and the drastic decrease in nutrient loads in the transition countries, the target for them is to keep the loads during the following decade at 1995 levels. In light of the predicted increases in agricultural production, these levels will be achieved via implementation of best environmental practices and the Code of Good Agricultural Practice.

- The implementation of the 1988 Ministerial Declaration by the **Russian Federation** is closely connected with adoption, by the end of 2001, of two programmes: "Ecology and Natural Resources of the Russian Federation" (for the years 2002–2010) and "Social and Economic Development of the North-Western Administrative Region of Russia" (up to 2010).
- **Sweden** has well-developed plans with specific reduction targets on reducing nutrient discharge to the Baltic Sea. These national proposals focus on the most eutrophied areas, and on sources for which the efforts will give the most effective results, and thus be most cost-effective (i.e., they are problem- and source-orientated). However, no Parliamentary decisions for individual targets have yet been taken.

14. In order to implement the 1988 Ministerial Declaration by the year 2005, eight Baltic Sea countries have elaborated national qualitative and/or quantitative targets. Some countries have expressed concern about the 2005 deadline with regards to agricultural loading, since there is a substantial time lag between the implementation of water protection measures in agriculture and load reductions to water bodies in the Baltic Sea catchment area.
15. In parallel to the implementation of the 1988 Ministerial Declaration, all the Baltic Sea countries except Russia have obligations to implement the EU Directives and Regulations as well as the HELCOM Recommendations concerning agricultural, municipal and industrial nutrient load reductions, also including post-2005 deadlines.
16. With regard to the above-mentioned developments, possibilities to harmonise the implementation timetables of water protection measures between the EU and HELCOM should be discussed. In addition, the possibility to implement the 1988 Ministerial Declaration by the year 2010, as well as to elaborate the more specific targets by the year 2005, should be considered. However, the revision of the targets should not occur before 2003, when the Fourth Pollution Load Compilation will be available.

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PART II
The national reports

Danish national report on nutrient loads

6

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6.1 Nutrient loads and reductions achieved

6.1.1 Description of calculation/assessment methods used

Denmark uses the load-orientated approach to quantify riverine and direct discharges to coastal areas, and to quantify the various source types. The methodology is based on an extensive monitoring programme in rivers and streams (about 110) covering approximately 60 % of the Danish catchment draining to the Baltic Sea. In addition, loads from all point sources larger than 30 PE are monitored or measured including the part of the drainage area in which riverine load is not monitored. The Danish methodology also includes the estimation of retention in surface freshwaters (rivers and lakes), as well as background or natural losses from open land and the atmospheric deposition on surface freshwaters. The extensive monitoring programme began in 1989 and has been conducted each year since. [1, 2]

6.1.1.1 Direct and indirect municipal discharges

In the late 1980s, 93 % of the Danish population was connected to sewage systems. Thus most sewage was treated in municipal wastewater treatment plants before being discharged to surface freshwaters or directly to the sea. Information about the proportion of the population and amount of industries connected to municipal sewage systems during the 1980s is known, as well as the type wastewater treatment during this period. The estimates of discharges from the mid- to late 1980s result from a combination of monitoring results from 1989 and data on population and industries connected to systems, and the treatment of wastewater (Table 6.1).

Table 6.1 Treatment methods used in Danish municipal wastewater treatment plants.

Size class	status in the late 1980s (%)				status in 1995 (%)			
	M	MB	MBC	MBCN	M	MB	MBC	MBCN
2 000–10 000 PE	11	68	9	12	4	18	34	45
10 000–50 000 PE	23	62	6	9	7	1	10	82
> 50 000 PE	20	67	4	9	0	17	0	83
% of total load	21	64	6	9	2	14	5	79

Discharges from municipal wastewater treatment plants are monitored for each individual unit larger than 30 PE. Sampling frequency for different size classes is shown in Table 6.2. Losses from small municipal wastewater treatment plants are calculated from empirical equations or by using standard units (1 PE =4.4 kg N/year and 1.0 kg P/year in 1995, but in the mid- to late 1980s, 1 PE = 1.5 kg P/year). Losses from fish farms are calculated from feed consumption and production of fish. Losses from rainwater construction are calculated based on empirical equations relating rainfall amount/intensity to the extension of fortified area, and the construction and capacity of the rainwater construction system.

Table 6.2 Annual sampling frequency at municipal sewage treatment plants included in the Danish Aquatic Environment Nationwide Monitoring Programme [3]. Municipal sewage treatment plants larger than 5 000 PE treat 92 % of the total wastewater load to the plants shown in the table.

Treatment plant capacity (PE)	Number of municipal treatment plants	Sampling frequency (samples per year)
30–199	494	2
200–999	415	4
1 000–4 999	375	12
5 000–9 999	107	12
> 10 000	189	12

6.1.1.2 Direct and indirect discharges from Danish industries not connected to treatment plants

In 1984 discharges for each Danish industry not connected to treatment plants was estimated [4,5]. Monitoring has been performed since 1989, and the 1984 estimates were evaluated based on the monitoring results from 1989 [1].

Discharges from individual Danish industries not connected to treatment plants are monitored for each individual unit greater than 30 PE. Sampling frequencies for different size classes are shown in Table 6.3. Discharges from small Danish industries not connected to treatment plants are calculated from empirical equations or by using standard units (1 PE = 4.4 kg N/year and 1.0 kg P/year, but in the 1980s 1 PE= 1.5 kg P/year). In Denmark approximately 150 individual Danish industries are not connected to treatment plants, of which approximately 115 are situated in the Baltic Sea catchment area.

Table 6.3 Sampling frequency for Danish industries not connected to treatment plants.

Effluent class	Total nitrogen (tonnes/year)	Total P (tonnes/year)	Sampling frequency (samples per year)
I	0.13–0.89	0.05–0.29	2
II	0.9–4.39	0.3–1.49	4
III	4.4–21	1.5–7.4	12
IV	> 22	> 7.5	12

6.1.1.3 Direct and indirect discharge from fish farms

Losses from fish farms are calculated from feed consumption and the production of fish. The feed consumption is multiplied by an emission factor. Fish farmers are obligated to report their annual feed consumption and fish production. Losses of nitrogen and phosphorus from fish farms are calculated as [6]:

Losses of nitrogen:

$$TN = (\text{feed consumption} \times \text{N content in feed}) - (\text{production of fish} \times \text{N content in fish}) \quad (1)$$

Losses of phosphorus:

$$TP = (\text{feed consumption} \times \text{P content in feed}) - (\text{production of fish} \times \text{P content in fish}) \quad (2)$$

The content of nitrogen and phosphorus is specified from the type of feed used, and the content of nitrogen and phosphorus in the fish from some analyses. The N and P content in fish are approximately 30 kg N/ton and 5 kg P/ton, respectively.

In 1995 Denmark had 475 freshwater fish farms, approximately 40 % of which were situated in the Danish part of the Baltic catchment. The number of freshwater fish farms has been reduced since the late 1980s. In 1995 there were 44 marine fish farms in Denmark, of which 36 were situated in marine waters belonging to the Baltic Sea. The number of marine fish farms has declined since the mid-1980s.

6.1.1.4 Discharge from agriculture

The discharge from agriculture is calculated by Equation (3) below by quantifying point sources, the nutrient discharge in rivers, the background load, the deposition on surface freshwaters and by further quantifying the retention in surface waters. Nutrient loads to coastal areas consist of riverine input and direct inputs from point sources. It is not possible to monitor the total catchment area of Denmark, as monitoring stations are located a certain distance from the coast to avoid impacts from tides. Further, many streams are very small, and it is economically infeasible to measure several thousand small streams and brooks to cover the entire Danish territory of 43 000 km^2. Therefore the Danish territory is divided in a monitored and an unmonitored part in relation to riverine loads.

Nutrient loads are determined by means of approximately 130 river monitoring stations situated downstream in rivers, but far enough from the coastline that tidal influence are avoided. Approximately 105 of these monitored streams discharge to the Baltic Sea. Sampling frequency generally ranges between 12 and 26 times per year, with an average of approximately 19 samples per year. Each monitoring site includes a stage recorder, and the discharge is measured on average 12 times per year.

Besides the monitoring stations located as far downstream as possible, the Danish monitoring program includes many river monitoring stations in small catchments. Approximately 150 of these are situated in small agricultural catchments (5 to 60 km^2) with only minor input from point sources. Diffuse nutrient losses from unmonitored catchments are estimated by use of flow-weighted concentrations or area-specific runoff coefficients from these agricultural catchments. The specific flow-weighted concentration is chosen from catchments where soil type, climate, run off and land use correspond to that of non-monitored areas. The flow-weighted concentrations are then multiplied with measured or estimated runoff values. To the calculated diffuse discharges are added (1) the monitored and estimated discharges from point sources (without the load from scattered dwelling, which is included in the diffuse losses) and (2) the direct point source load, as these loads are also measured in non-monitored areas.

Since 1993, flow-weighted concentrations have been recommended for estimating the contribution from unmeasured areas. If there are no measured catchments without point sources within a county or a region, point source loads are deducted from the nutrient transport measured, before calculating the flow weighted concentrations. An average of flow-weighted concentrations from several measured catchments can often be used.

Source apportionment:
The total discharge to coastal areas (L_T) is determined as:

$$L_T = L_m + L_u + P_D \qquad (3)$$

where:

L_m = the total monitored discharge of either nitrogen or phosphorus
L_u = the total unmonitored discharge of either nitrogen or phosphorus
P_D = the discharge from point sources discharging directly to coastal areas (direct inputs).

The total discharge from unmonitored areas is determined as:

$$L_u = L_{Du} + P_u \qquad (4)$$

where:

L_{Du} = the calculated diffuse discharge from unmonitored areas
P_u = the total discharge from point sources in unmonitored areas.

To evaluate the importance of nutrient sources for the total discharge to coastal areas, source apportionment is performed on L_T. Nutrient losses from diffuse sources such as agricultural land, forests and pristine areas are estimated as the difference between the gross discharge (defined as the sum of L_T and retention in surface freshwater), and the total discharge from point sources. In general the discharge from scattered dwellings is included in the diffuse sources; therefore nutrient losses from cultivated areas includes potential discharge from scattered dwellings entering the surface freshwater system. The model accumulates the uncertainty factors with respect to total nutrient discharge from diffuse sources.

To calculate nutrient discharge from agriculture (A) to coastal waters, the following variables must be determined:

a) Total discharge of a particular nutrient to coastal waters consisting of the discharge from monitored catchments (L_m) and from unmonitored catchments (L_u).
b) Point source nutrient discharge to freshwater from sewage treatment plants, industrial plants, fish farms and urban storm water runoff consisting of the discharge from monitored (P_m) and unmonitored catchments (P_u) and point sources discharging directly to coastal areas (P_D).
c) Discharge from scattered dwellings ($S_m + S_u$).
d) Discharge from background/natural areas (B).
e) Retention in lakes (R_l) and rivers (R_r).
f) Atmospheric deposition on freshwater (D).

The nutrient discharge to freshwater from agricultural areas (A) in a specific catchment are then calculated as:

$$A = (L_m + L_u) - (P_m + P_u + P_D) - (S_m + S_u) - B + (R_l + R_r) - D \qquad (5)$$

It is often not possible to separate discharges from scattered dwellings (S) from the discharge from cultivated areas, thus therefore A+S usually is given as the sum of discharges from diffuse sources (L_D):

$$L_D = A + S_m + S_u \qquad (6)$$

Calculation of background losses (B):
Natural background losses of nitrogen and phosphorus constitute a part of the total estimated nitrogen and phosphorus inputs to primary surface water recipients, and include losses from unmanaged land and that part of the losses of nitrogen and phosphorus from managed land that would occur irrespective of anthropogenic activities.

The natural background losses are determined from measurements of the nutrient losses in 9 small non-agricultural catchments. These are subdivided into sandy and loamy catchments. Each year the flow-weighted concentrations of N and P for sandy and loamy soils are calculated and used to calculate the background losses from unmanaged and managed land, according to the dominant soil type. The mean median figure for 9 natural watersheds from 1989 to 1999 is:

1.50 ± 0.15 mg N/l (2.20 ± 0.76 kg N/ha)
50 ± 6 mg P/l (0.078 ± 0.04 kg P/ha)
5.8 ± 1.3 l/s km^2

Natural losses are calculated by multiplying the flow-weighted concentration with a relevant specific discharge.

Calculation of atmospheric deposition (D):
The atmospheric deposition in Denmark is calculated based on monitoring results. In the late 1990s typical values were:

15–20 kg N/ha year, with highest deposition during wet years.
1–2 kg P/ha year, with highest deposition during wet years.

Calculation of catchment retention (R):
Nutrient losses to freshwater are often greater than the measured nutrient transport due to the retention and cycling of the nutrients in lakes and rivers. Retention plays a key role in the amount and composition of fluxes, especially of phosphorus, through river systems. Retention takes place for nitrogen and phosphorus from all sources. We can assume that an equal proportion is retained from each source, if the sources are evenly distributed in the catchment, and if the proportion of dissolved and inorganic fractions from each source is equal. This is, however, seldom the case.

Retention in the catchment must be added to the measured load to estimate the amount of diffuse sources (natural background + agriculture + scattered dwellings) losses to freshwater.

Examples of Danish monitoring results from 27 monitored Danish lakes are given in Tables 6.4 and 6.5.

Table 6.4 Retention of total phosphorus and total nitrogen in Danish lakes (1994–98). Q1 = 25 % quartile, Q3 = 75 % quartile.

Parameter	Units	Mean	Q1 (25 %)	Median	Q3 (75 %)
P retention (absolute)	mg P/m^2 day	0.80	0.00	0.32	1.75
P retention (relative)	% of loading	5.4	–5.0	3.3	18.6
N retention (absolute)	mg N/m^2 day	116	53	110	152
N retention (relative)	% of loading	39.5	20.5	40.5	58.3

Table 6.5 Median retention of total phosphorus and total nitrogen and related 95 % confidence limits.

Parameter	Units	Median	Lower CL* (95 %)	Upper CL* (95 %)
P retention (absolute)	mg P/m^2 day	0.32	0.05	1.55
P retention (relative)	% of loading	3.3	–3.7	15.4
N retention (absolute)	mg N/m^2 day	110	56	147
N retention (relative)	% of loading	40.5	23.7	57.7

** CL = confidence level.*

Alternatively, retention can be estimated from data on residence time, lake depth, lake surface area and concentration of nitrogen and phosphorus in the inlets. In-stream retention in Danish streams can also be significant (primarily during the summer), but over a number of years, this retention is negligible and therefore not included in the calculations. In stream systems where flooding occurs, on the other hand, retention of phosphorus is especially important. In major rivers, nitrogen retention (as denitrification) can have significant influence on the total load from the river system. Net retention of nitrogen and phosphorus in rivers and streams is less than 1 to 2 % of the total load from Denmark to coastal areas.

Total riverine discharges before 1989 are estimated based on relations that have been monitored in the 1980s and 1990s, as well as relations between the diffuse discharges of nitrogen and phosphorus from 1989–1997 and the runoff in the corresponding period.

6.1.1.5 Discharges from scattered dwellings and from storm water overflows

In Denmark the load from scattered dwellings and from storm water overflows are also quantified.

Scattered dwellings:
There were approximately 350 000 scattered dwellings in Denmark in 1995, of which approximately 285 000 are situated in the Danish part of the catchment to the Baltic Sea.

Nutrient losses from scattered dwellings is estimated by:

- Multiplying the actual number of dwellings not connected to sewage plants > 30 PE by 2.7 (i. e. assuming 2.7 individuals per dwelling) or by using the empirical value for the percentage of the population not connected to sewage plants of > 30 PE.
- Assuming a wastewater production of 4.4 kg N/year and 1.0 kg P per person per year (in the mid- and late 1980s 1 PE was 1.5 kg P/year).
- Assuming that in average 50 % of the wastewater produced from scattered dwellings is lost to rivers and lakes (this figure differs depending on the type of treatment or discharge system the individual scattered dwelling has).

Since the mid-1980s, improved information has been collected from scattered dwellings concerning the types of treatment and discharge systems.

Stormwater overflows:
In 1995 there were about 12 000 stormwater overflows in Denmark. About 25 % had a rainwater basin, thereby reducing the discharge to surface waters. Approximately 85 % of the stormwater overflows are situated in the Danish part of the catchment to the Baltic Sea. Approximately 5 000 are combined sewer overflows.

Denmark uses two different models for measuring/calculating the nutrient loss from storm water overflows: (1) combined sewer overflow, and (2) separate sewer overflow. The calculations of nutrient discharges are used only as a estimation of the yearly outlet from storm water overflows; monthly calculations of discharges are not made. Each county in Denmark calculates the nutrient loss from storm water overflows.

Combined sewer overflow:
Nutrient discharges from combined sewer overflow are estimated from the MOUSE-SAMBA models and measurements of rainfall. The unit figures used in these models are refined from measurements in three counties, in which measurements are performed and used to extend and verify the calculations. The results from these measurements are used in all other counties, and the unit figures are used in the MOUSE-SAMBA models. Calculations are made for each drainage area. This programme has been used in Denmark since 1989 [1]. Currently the values in Table 6.6 are used.

Table 6.6 Recommended Danish unit figures for combined sewer overflow.

Substance	Annual discharges*	Off-line in sewage with basins above 3–5 mm
Suspended solids (mg/l)	150–200	100–150
Total phosphorous (mg/l)	2–3	1.5–2.0
Total nitrogen (mg/l)	10	3–7
COD (mg/l)	160	

** Flow-weighted average value*

Separate sewer overflow
Nutrient discharges are basically calculated from measurements of rainfall, paved area, and a hydraulic reduction factor. Calculations are made for each drainage area using the recommended unit values shown in Table 6.7.

Table 6.7 Recommended Danish unit figures for separate sewage overflows.

Substance	Annual loads*
Suspended solids (mg/l)	30–100
Total phosphorous (mg/l)	0.5
Total nitrogen (mg/l)	2
COD (mg/l)	40–60

** Flow weighted average value*

A hydraulic reduction factor (0.8) is used most frequently.

6.1.2 Nitrogen and phosphorus discharge to the environment

6.1.2.1 Discharge from municipalities (direct/indirect)

Based on the database and monitoring and calculation methods described in Section 6.1.1.1, direct and indirect discharges of nutrients from municipal wastewater treatment plants are presented in Tables 6.8 and 6.9, respectively.

Table 6.8 Total discharges of nitrogen and phosphorus from Danish municipalities entering directly to the Baltic Sea.

Size class (PE)	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
2 000–10 000	480	296	38.3	146	39	73.3
10 001–50 000	1 800	771	57.2	478	117	75.5
> 50 000	8 561	4 139	51.7	2 007	634	68.4
Total	10 841	5 026	52.0	2 631	790	70.0

Table 6.9 Total discharges of nitrogen and phosphorus from Danish municipalities entering into surface freshwater in the Baltic Sea catchment area.

Size class (PE)	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
2 000–10 000	1 005	709	29.5	346	81	76.6
10 001–50 000	1 516	540	64.4	419	50	88.1
> 50 000	2 131	849	60.2	511	104	79.6
Total	4 652	2 098	54.9	1 276	235	81.6

6.1.2.2 Direct and indirect discharges from individual Danish industries not connected to treatment plants

Based on the data and monitoring and calculation methods described in Section 6.1.1.2, direct and indirect discharges of nutrients from individual Danish industries not connected to treatment plants are presented in Tables 6.10 and 6.11 respectively.

Table 6.10 Total discharges of nitrogen and phosphorus from Danish industries not connected to treatment plants entering directly into the Baltic Sea.

Industry	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Chemical		53			3	
Food processing		577			62	
Pulp and paper		458			44	
Other industries		545			11	
Total	4 000	1 633	59.2	1 000	120	88.0

Table 6.11 Total discharges of nitrogen and phosphorus from individual Danish industries not connected to treatment plants entering into surface freshwater in the Baltic Sea catchment area.

Industry	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Food processing		21				
Pulp and paper		4				
Other industries		67				
Total	200	92	54.0	12	2	83.3

6.1.2.3 Discharge from fish farms

Based on data submitted by the Ministry of the Environment and Energy and the methodology described in section 6.1.1.3, total discharge of nutrients from freshwater and marine fish farms were calculated. Results are presented in Table 6.12.

Table 6.12 Estimated discharges of nitrogen and phosphorus from Danish freshwater and marine fish farms.

Nutrient	Discharge in late 1980s (tonnes)	Discharge in 1995 (tonnes)	Reduction (tonnes)	Reduction (%)
N-TOT	2 650	1 735	915	34.5
P-TOT	295	144	151	51.2

6.1.2.4 Agricultural discharges

Based on the methodology described in Section 6.1.1.4, nutrient loads from agriculture to the environment were estimated. The results are presented in Table 6.13. It should be stressed that the agricultural loads include background losses, which are quantified in Table 6.14.

Table 6.13 Estimated discharges of nitrogen and phosphorus from Danish agriculture to surface fresh waters draining to the Baltic Sea.

Nutrient/ Runoff	Discharge in late 1980s (tonnes)	Discharge in 1995 (tonnes)	Reduction (tonnes)	Reduction (%)
N-TOT	79 000	53 750	25 250	32.0
P-TOT	670	580	90	13.4
Runoff (million m^3)	10 136	9 906	230	2.3

Natural background losses are calculated in Table 6.14 based on the methodology described in Section 6.1.1.4.

Table 6.14 Estimated natural background losses from Denmark to surface fresh waters draining to the Baltic Sea.

Nutrient	Discharge in late 1980s (tonnes)	Discharge in 1995 (tonnes)	Reduction (tonnes)	Reduction (%)
N-TOT	10 900	9 650	1 240	11.4
P-TOT	342	313	29	8.5

Although runoff levels in the mid- and late 1980s were slightly higher than in 1995, this does not explain the reduction in agricultural discharges. Later measurements clearly indicate that no statistically significant reductions in nitrogen losses to surface waters from Danish agriculture have been obtained before the late 1990s [7]. The figures in Table 6.13 can be explained by record high precipitation in 1994, during which most of the easily assessable soil nitrogen pool was lost to surface and groundwaters. Precipitation in 1995 was approximately 10 % lower than normal (1961–1990), but runoff was approximately 10 % above normal, since much of the extensive precipitation in 1994 discharged in 1995. This also explains the quite high agricultural losses of phosphorus in 1995.

6.1.2.5 Discharges from scattered dwellings and from storm water overflows

Losses from scattered dwellings and storm water overflows are based on the description in Section 6.1.1.5 and information compiled in Table 6.15.

Table 6.15 Estimated direct and indirect discharges from Danish scattered dwellings and storm water overflows.

Nutrient	Discharge in late 1980s (tonnes)	Discharge in 1995 (tonnes)	Reduction (tonnes)	Reduction (%)
N-TOT	2 000	1 650	350	17.5
P-TOT	600	400	100	33.3

6.1.3 Overall reductions of nutrient load into the environment

At its ninth meeting (HELCOM 9/88), the Helsinki Commission adopted the Ministerial Declaration concerning reduction of the load of nutrients to the Baltic Sea on the order of 50 % of total discharges, as soon as possible, but not later than 1995.

During the period between the late 1980s and 1995, significant decreases can be observed in the pollution load (Tables 6.16 and 6.17). The large decreases in point sources are attributable to large investments in wastewater treatment, as well as substitution of high-phosphorus detergents. The reduction in nitrogen discharges from agriculture can be explained by unusual weather and runoff conditions in 1994 and 1995 discussed in Section 6.1.2.4. Overall the objective to reduce pollution load by 50 % has been achieved for phosphorus, but not for nitrogen.

Table 6.16 Total discharge of nitrogen into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load, late 1980s (tonnes)	Load, 1995 (tonnes)	Reduction (tonnes)	Reduction (%)
Direct municipal discharge	10 841	5 026	5 815	52.0
Indirect municipal discharge	4 652	2 098	2 554	54.9
Direct industrial discharge	4 000	1 633	2 367	59.2
Indirect industrial discharge	200	92	108	54.0
Discharge from fish farms	2 650	1 735	915	34.5
Discharge from agriculture	79 000	53 750	25 250	32.0
Natural background discharge	10 900	9 650	1 240	11.4
Discharge from scattered dwellings and stormwater overflows	2 000	1 650	350	17.5
Total discharge via rivers and direct discharge	106 000	69 000	37 000	34.9

Table 6.17 Total discharge of phosphorus into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load, late 1980s (tonnes)	Load, 1995 (tonnes)	Reduction (tonnes)	Reduction (%)
Direct municipal discharge	2 631	790	1 841	70.0
Indirect municipal discharge	1 276	235	1 041	81.6
Direct industrial discharge	1 000	120	880	88.0
Indirect industrial discharge	12	2	10	83.3
Discharge from fish farms	294	144	151	51.2
Discharge from agriculture	670	580	90	13.4
Natural background discharge	342	313	29	8.5
Discharge from scattered dwellings and stormwater overflows	600	400	200	33.3
Total discharge via rivers and direct discharge	7 500	2 600	4 900	65.3

Denmark has also achieved the 50 % reduction target for phosphorus loading if the data are normalised to take into account variations in climate and runoff.

6.1.4 Clarification of differences between discharge figures published earlier

There have not been any significant changes in the reported figures, but only minor corrections. The present report clarifies that discharges from scattered dwellings and from stormwater overflows are included in the total discharges. Further, information concerning the natural background losses has been provided.

6.2 Water protection targets

6.2.1 Introduction

The Danish water protection targets wer compiled on the basis of draft targets for the Danish Environmental Agency.

Protection of the aquatic environment, especially marine areas, requires a coordinated effort both nationally and internationally. Denmark participates actively in international co-operative efforts to protect groundwater and drinking water resources as well as inland and marine waters. Denmark has ratified a large number of binding agreements on protection of the aquatic environment at the regional, European and global levels: international agreements that form the foundation for Danish legislation and regulation of pollution and hence for protection of the Danish groundwater and surface waters.

This chapter presents the Government's overall political objectives and policy measures for the Danish aquatic environment. The Danish reduction targets for nutrients are outlined, and the central planning of Danish water body quality is described. Only laws that has passed the Danish Parliament are described. New political measures discussed at present (2001) in the Danish Parliament are summarised in a separate chapter.

6.2.2 Pure water

The quality and protection of the groundwater and the aquatic environment – both nationally and internationally – continues to be accorded high priority in the Government's work, as is apparent from the Government's Policy Statement of March 1998.

The Government's overall goal is to ensure that the water in Denmark is clean. The Government's endeavours in this respect are described in the Environmental Policy White Paper [8]. This states that the Government will work to ensure that:

- Danish watercourses, lakes and marine waters are clean and of a satisfactory quality as regards health and hygiene,
- exploitation of water bodies and associated resources takes place in a sustainable manner,
- the groundwater resource remains unpolluted, and
- groundwater abstraction and groundwater recharge balance.

In addition, the Government will fulfil the objectives of relevant international agreements, i.e. objectives that aim to prevent and remove pollution of the aquatic environment in the long term, especially objectives aimed at a progressive reduction of discharges and losses of pollutants to the aquatic environment.

The Government's objectives entail that only insignificant or minor anthropogenic changes in the state of the aquatic environment can be accepted. Unfortunately, though, some water bodies currently have an environmental state that does not live up to these objectives. In special situations and in particularly vulnerable areas, a poor or very low environmental state sometimes has to be accepted.

With regard to groundwater in Denmark, the Government's objectives include:

- that groundwater has to comprise a safe and permanent source for the drinking water supply,
- that drinking water quality and the drinking water resource must not be deteriorated by pollution and water abstraction, and
- that the quality of groundwater swell has to be of such a quality as to ensure a good environmental state in watercourses and lakes.

Commercial and other types of groundwater exploitation thus have to be conducted in a manner that respects environmental and natural wealth and is sustainable. Further detail can be found in "Denmark's groundwater and drinking water" [9] and in the Environmental Policy White Paper [8].

With regard to Danish watercourses, the Government's overall objectives as stated among other places in the Watercourse Act [10] and the Environmental Policy White Paper [8] entail:

- that water flow has to be adequate,
- that obstructions must not be present that hinder the dispersal of fish and macroinvertebrates,
- that the watercourses have to exhibit physical variation and have good oxygen conditions, and
- that the watercourses have to contain a varied and natural fauna and flora.

Commercial exploitation, i.e. fishery, navigation, drainage, etc. and recreational activities such as pleasure boat sailing, angling and bathing and other uses of watercourses have to be conducted in a manner that respects environmental and natural wealth and is sustainable, both in the watercourses themselves and on the adjacent land.

With regard to Danish lakes, the Government's overall objectives as stated among other places in the Environmental Policy White Paper [8] entail:

- that animal and plant communities have to be natural and in equilibrium, and
- that the water has to be clear and submerged macrophytes have to be present in the shallow parts of the lakes.

Commercial exploitation, recreational activities and other uses of the lakes also must be conducted in a manner that respects environmental and natural wealth and is sustainable.

The Government's overall objectives for the environmental state of Danish marine waters are based on (among others) the 1992 Convention on Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention), the 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) and the 1995 Declaration of the 4th International Conference on the Protection of the North Sea (Esbjerg Declaration) [11]. This means:

- that fauna and flora may only be insignificantly or slightly affected by anthropogenic pollution and human activities,
- that nutrient levels must be at a natural level, the clarity of the water has to be normal, unnatural blooms of toxic planktonic algae or pollution-dependent macroalgae must not occur, and oxygen deficiency may only occur in areas where this is natural, and
- that the levels of hazardous substances have to be at background levels in the case of naturally occurring substances and close to zero in the case of hazardous substances.

Commercial exploitation such as fishery, navigation, offshore industry, minerals extraction, marine dumping of seabed material, etc., and recreational activities such as pleasure boat sailing, angling and bathing, and other uses of the sea have to be conducted in a manner that respects environmental and natural wealth.

6.2.3 Nutrient reduction targets and measures

The primary means of achieving these objectives for both groundwater and surface waters is a reduction in nutrient discharges and emissions. This section briefly examines the strategic targets for preventing and combating nutrient pollution.

It is important to note that the reduction targets have been set for the whole of Denmark, and not separately for the part of Danish land area (catchment) draining to the Baltic Sea (i.e., the Helsinki Convention area). Therefore it is not possible to quantify the reduction targets to specific values for the Danish part of the Baltic Sea catchment area.

Strategic reduction targets for nutrients

In the January 1987 Action Plan on the Aquatic Environment and the April 1987 Report on the Action Plan on the Aquatic Environment, reduction targets for nitrogen and phosphorus were 50 % and 80 %, respectively. This corresponds to a reduction in annual discharges and losses to the aquatic environment from a level of around 283 000 tonnes nitrogen and 9 120 tonnes phosphorus at the time the plan was adopted to a level of approximately 141 600 tonnes nitrogen and 1 820 tonnes phosphorus. As agriculture, municipal wastewater treatment plants, and separate industrial discharges are the main sources of nutrient pollution of the aquatic environment, only these three source types are included in the calculations of whether the reduction targets stipulated in the Action Plan on the Aquatic Environment have been met, (cf. Table 6.18), although reductions from fish farms and storm water effluents also have been obtained.

Table 6.18 Sector-specific reduction targets for annual discharges etc. (in tonnes) of nitrogen and phosphorus to the aquatic environment for Denmark [1, 12]. The reductions and target levels are described in detail below in the section on agriculture, municipal wastewater treatment plants and separate industrial discharges.

Source	Nitrogen					Phosphorus				
	1987	–	Reduction	=	Target	1987	–	Reduction	=	Target
Agriculture	260 000	–	127 000	=	133 000	4 400[1]	–	4 000	=	400
Municipal wastewater treatment plants	18 000	–	11 400	=	6 600	4 470	–	3 250	=	1 220
Separate industrial discharges	5 000	–	3 000	=	2 000	1 250[2]	–	1 050[2]	=	200[2]
Total	283 000	–	141 400	=	141 600	9 120	–	8 050	=	1 820

1) Encompasses the farmyard load, i.e. does not include loss of phosphorus from fields.
2) See Section 6.2.3 (separate industrial discharges) for explanation.

Pollution of the sea is transboundary in nature; thus the countries in the North Sea and Baltic Sea regions have adopted similar reduction targets:

- At the North Sea Conference in London in November 1987, the countries of the North Sea region excluding the United Kingdom adopted the goal of reducing nitrogen and phosphorus inputs to the sea by 50 % over the period 1985-1995 in areas where these could cause pollution. At conferences in the Hague (1990) and Esbjerg (1995), these reduction targets were reiterated and the need to take action against wastewater discharges and losses from agriculture was specified.
- In June 1988, the Paris Commission adopted a 50 % reduction target for nutrient inputs to marine waters that are susceptible to eutrophication, and also adopted a programme to achieve the reductions. In 1992, it was decided to integrate the Oslo and Paris Conventions, both of which aimed to prevent marine pollution from dumping and land-based sources of pollution. The objective of the successor – the OSPAR Convention – is to protect the marine environment of the Northeast Atlantic region. In 1989, the reduction target was specified in relation to specific sectors. As a follow-up on the 1988 decision, the 1998 OSPAR Ministerial Meeting adopted a strategy to combat eutrophication.
- At a ministerial meeting in February 1988, HELCOM adopted a declaration specifying a 50 % reduction target for discharges of nutrients etc. by the year 1995. In the Communiqué from the ministerial meeting in 1998, the ministers confirmed that they are committed to attaining the strategic goal from 1988 and to defining specific objectives that have to be achieved before the year 2005.

The sections that follow examine the measures that Denmark has decided to employ to achieve the reduction targets – both for the three sectors encompassed by the Action Plan on the Aquatic Environment I (i.e. agriculture, industry and wastewater treatment plants) and for a number of other sectors for which specific reduction targets were not specified in the Action Plan on the Aquatic Environment.

It should be stressed that the Danish reduction targets are not reductions in inputs to the sea, but rather reductions of nitrogen and phosphorus input to the aquatic environment. The reduction targets from point sources are set at the outlet from the point sources, and the reduction targets for agriculture is defined primarily as a reduction in root zone losses of nitrogen. There is not any phosphorus reduction target for agriculture.

Sector-specific reduction targets

Since agriculture is one of the main sources of pollution of the aquatic environment, the Danish Parliament has adopted goals for reducing nitrogen pollution from agricultural sources. Since the mid-1980s, a number of action plans and strategies have been adopted to regulate development of the agricultural sector and its impact on the aquatic environment:

- The NPO (Nitrogen, phosphorus and organic matter) Action Plan (1985),
- The Action Plan against Pollution of the Danish Aquatic Environment with Nutrients (Action Plan on the Aquatic Environment) (1987) [12],
- The Action Plan for Sustainable Agriculture (1991) [13],
- Parts of the Government's 10-Point Programme for Protection of the Groundwater and Drinking Water (1994),
- Follow-up on the Action Plan for Sustainable Agriculture (1996), and
- The Action Plan on the Aquatic Environment II (1998).

Further measures are under consideration in the Danish Parliament.

The reduction targets for nitrogen and phosphorus stipulated in the Action Plan on the Aquatic Environment I are an approximate halving (49 %) of nitrogen losses and the elimination of the phosphorus farmyard load. Nitrogen losses are to be reduced from around 260 000 tonnes to a level of approximately 133 000 tonnes per year, corresponding to a reduction in losses of 127 000 tonnes N per year (cf. Tables 6.18 and 6.19). The 127 000 tonnes consist of a reduction of 27 000 tonnes N from manure heaps, stables, dairies (the losses was estimated at 30 000 tonnes in the mid-1980s) and a reduction of 100 000 tonnes N of root zone losses. The Action Plan on the Aquatic Environment I further stipulates the magnitude of the nitrogen and phosphorus reduction necessary to avoid unintended pollution of the aquatic environment. The reduction targets were to be attained by 1993 through the following measures:

- The agricultural sector has to establish sufficient capacity to store nine months of manure production (six months on certain farms) so that the manure can be stored until the crop growth season starts.
- The agricultural sector must establish crop rotation and fertilisation plans to ensure that the nitrogen content of the fertiliser is optimally exploited.
- Fields must have green cover during the winter period so that nitrogen can also be taken up during the autumn.
- Manure has to be ploughed in or in some other way deployed into the soil within 12 hours.
- Limits on how much livestock manure may be applied to fields.
- Stop of farmyard losses (manure heap, stables, dairies etc.) to the aquatic environment.

It soon became clear that it would not be possible to attain the reduction targets by 1993 [13]. The measures stipulated in the Action Plan on the Aquatic Environment I were therefore tightened in 1991 in the Action Plan for Sustainable Agriculture. The reduction target was maintained, but the time frame was extended to the year 2000. The measures included:

- Fertilisation accounts so that fertiliser application can be documented.
- More stringent and fixed requirements on utilisation of the N content of livestock manure.
- All farms must establish sufficient capacity to store nine months of manure production (six months for certain farms).
- Ban on the application of liquid manure between harvest time and February except on fields cultivated with winter rape or grass.

Since the Action Plan for Sustainable Agriculture, there have been a number of follow-up plans to reduce the impact of the agricultural sector on the aquatic environment, including the Government's 1994 10-Point Programme for Protection of the Groundwater and Drinking Water in Denmark. Among other things this entails selection of areas of the country on which the water supply is to be chiefly based.

The need to further tighten the regulation of agricultural nitrogen losses has become even more necessary, since Denmark must comply with the EU Nitrates Directive by the year 2003. The directive restricts the application of livestock manure to 170 kg N per hectare per year. For some types of farm this level is less than the levels currently permitted. Denmark has sought permission to deviate from the 170 kg N per hectare rule on cattle holdings so as to enable the application of up to 230 kg N per hectare per year on a small number of these holdings.

In February 1998, Parliament adopted several new instruments aimed at achieving the reduction targets stipulated in the Action Plan on the Aquatic Environment I. As a supplement to the Action Plan on the Aquatic Environment I, the Action Plan on the Aquatic Environment II will reduce nitrogen leaching by a further approximately 37 000 tonnes N per year. Measures to reach the reduction target of 100 000 tonnes N per year of root zone losses should be applied and fully implemented no later than the end of the year 2003. Not all the measures in the Action Plan on the Aquatic Environment II will have taken full effect by 2003, however. It will take further some years before the full effect is seen in surface waters, as much groundwater reaching lakes and streams is from ten to over fifty years old. The following measures have been implemented under the Action Plan on the Aquatic Environment II:

1. Re-establishment of wetlands. This will help reduce nitrogen leaching to the aquatic environment due to their ability to convert nitrate to free nitrogen. Assuming that one hectare of wet meadow can remove an average of approximately 350 kg nitrate per year, the re-establishment of 16 000 hectares of wet meadow will reduce nitrogen leaching to inland and marine waters by about 5 600 tonnes N per year.
2. Afforestation in Denmark. Among other things this is founded on the idea that in general, little nitrate is washed out of forest soils. Planting 20 000 hectares forest before 2002 is expected to reduce nitrogen leaching by around 1 100 tonnes N per year.
3. Agri-environmental measures. Financial support to farmers willing to cultivate sensitive agricultural areas in a more environmentally sound manner, among other things by using less fertiliser or by completely refraining from cultivating the land. Until now, there has been very little interest in this scheme. Conversion of 90 000 hectares to the scheme is expected to reduce nitrogen leaching by 1 900 tonnes N per year.
4. Improved fodder utilisation. The agreement on which the Action Plan on the Aquatic Environment II is based assumes that fodder utilisation will be improved. Changes in feeding practice are expected to reduce nitrogen leaching by 2 400 tonnes N per year.
5. Stricter harmony criteria. Implementation of stricter harmony criteria governing livestock density is expected to reduce nitrogen leaching by a further 300 tonnes N per year.
6. Stricter requirements on utilisation of the N content of livestock manure. It should be possible to get crops to use even more of the nitrogen in livestock manure than is presently the case. This is expected to reduce nitrogen leaching by 10 600 tonnes N per year.

7. Organic farming. Organic farming can help reduce total nitrogen leaching from the agricultural sector. If 170 000 hectares are converted to organic farming, nitrogen leaching will be reduced by 1 700 tonnes N per year.
8. Catch crops on a further 6 % of a farmer's land. Catch crops can take up nitrogen in the autumn. The additional acreage with catch crops is expected to reduce nitrogen leaching by 3 000 tonnes N per year.
9. Nitrogen norm reduced by 10 %. A new element in the regulation of the agricultural sector is that farmers may now only apply nitrogen in amounts corresponding to 90 % of the economically optimal level. The reduced nitrogen norm is expected to reduce nitrogen leaching by 10 500 tonnes N per year.

The requirement for the 10 % reduction in the nitrogen norm entered into force on 1 August 1998. The requirement for catch crops on a further 6 % of each farmer's land entered into force in autumn 1998. The requirement for improved utilisation of livestock manure is being implemented in two steps: 5 % from 1 August 1999 and a further 5 % from 1 August 2001.

The harmony criteria (number of LU/ha) have been tightened for cattle holdings as of 18 August 1998. The criteria for all livestock holdings will be further tightened in the year 2002 (1.4 LU/ha for pig holdings and 1.7 LU/ha for cattle holdings).

If the measures in the Action Plan on the Aquatic Environment II are implemented as changes in agricultural practice, 20 years of nitrate policy (1985–2003) will result in a 100 000 tonnes N per year reduction in leaching from agricultural land. Moreover, nitrogen consumption in the form of commercial fertiliser will decrease from approximately 400 000 tonnes N per year in 1985 to about 200 000 tonnes N per year in 2003 [14].

The measures and targets for reducing nitrogen pollution from agricultural sources are summarised in Table 6.19. In connection with the Action Plan on the Aquatic Environment I it was estimated that nitrogen losses could be reduced by a total of 127 000 tonnes N per year by 1993. The reduction targets were approximately 100 000 tonnes N per year for the nitrogen load from fields and approximately 27 000 tonnes N per year for the farmyard load. In the Action Plan for Sustainable Agriculture it was estimated that by the year 2000, the measures stipulated in the Action Plan on the Aquatic Environment I would only have reduced nitrogen losses by 50 000 tonnes N per year and that further measures were therefore needed to achieve the total reduction of 127 000 tonnes N per year. The existing measures and targets under the Action Plan on the Aquatic Environment I and the Action Plan for Sustainable Agriculture were re-evaluated in 1998 and again in 2000 in connection with the preparation of the Action Plan on the Aquatic Environment II and it concluded that by the year 2003, the existing measures will reduce nitrogen losses by 93 300 tonnes N per year. Further in a mid term evaluation from December 2000 the effect of the different measures of it was re-evaluated the Action Plan on the Aquatic Environment II and it was concluded, the existing measures will reduce nitrogen losses by 119 600 tonnes. The reasons are:

- that only 6 000 ha wed meadows will be established by the end of 2003 against the planned 16 000 ha
- less afforestation will be achieved by the end of 2003
- the expected effects or the implementation of stricter harmony criteria, stricter requirements on utilisation of N content of manure, catch crop on a further 6 % of the land and the 10 % reduction in N norm results in less root zones losses that assumed in 1998.

Table 6.19 Summary of measures and estimated reductions (in tonnes N per year) in nitrogen loading from agricultural sources, cf. Action Plan on the Aquatic Environment I, Action Plan for Sustainable Agricultural Development, follow-ups hereto, and Action Plan on the Aquatic Environment II. The table is also an example of strategic environmental planning, i.e. the process whereby a target is set, measures are implemented, the effects are monitored and evaluated and supplementary measures are implemented if – as in the present case – the original target is not attained as expected.

Actions	1993	2000	2003
1. ACTION PLAN ON THE AQUATIC ENVIRONMENT I (1987):			
I. Optimal utilisation of livestock manure			
A. NPO Subsidy Act	55 000		
B. NPO Subsidy Act	5 000		
C. Further initiatives	10 000		
II. Programme for improved utilisation of fertiliser			
A. Systematic fertilisation plans	15 000		
B. Improved application methods	5 000		
C. Winter green fields – catch crops and ploughing down of straw	20 000		
D. Winter green fields – further initiatives	8 000		
III. Structural measures	9 000		
Total	127 000	50 000	
2. ACTION PLAN FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT (1991):			
Improved utilisation of livestock manure		20 000–40 000	
Reduction in commercial fertiliser consumption		8 000–15 000	
Protection of groundwater in particularly vulnerable areas		1 000–2 000	
Reduction in agricultural acreage		17 000–20 000	
Structural development, other measures		15 000	
Total		77 000	93 200
3. ACTION PLAN ON THE AQUATIC ENVIRONMENT II (1998):		Expected in 1998	Evaluation Dec. 2000
Wetlands		5 600	2 100
Sensitive agricultural areas		1 900	900
Afforestation		1 100	900
Organic farming		3 000	1 600
Improved fodder utilisation		2 400	3 100
Stricter harmony criteria		300	15.800
Stricter requirements on utilisation of N content of manure		10 600	
Catch crops on a further 6 % of the land		3 000	
10 % reduction in N norm		10 500	
General development in agriculture		0	2 000
Total		37 100	26 400
Total:	127 000	127 000	119 600

Therefore the mid-term evaluation in late 2000 concluded that further measures should be taken to reduce nitrogen losses with 7 400 ton N to the aquatic environment to fulfil the nitrogen reduction targets of 127 000 tonnes. The Danish Parliament is now (spring 2001) negotiating which further measures can be taken.

Conversion to organic farming has hitherto been taking place faster than presumed in the Action Plan on the Aquatic Environment II. Thus in 1998 and 1999, the area under organic farming increased by a net 90 000 hectares corresponding to just over 50 % of the target of 170 000 hectares. With respect to the

Action Plan on the Aquatic Environment II's target for conversion of farmland to agri-environmental measures, more acreage needs to be converted. It is estimated that new agreements have been signed covering 21 000 hectares, while agreements on 23 000 hectares are soon to run out. The total area of farmland encompassed by the agri-environmental measures scheme has thus decreased.

The Action Plan on the Aquatic Environment II also encompasses so-called regional measures. These represent implementation of the recommendations of the Drinking Water Committee concerning the protection of groundwater resources considered particularly vulnerable to nitrate pollution.

Municipalities

In general, discharges from municipal wastewater treatment plants are regulated by the Environmental Protection Act, the Urban Wastewater Directive and derivative statutory orders and official guidelines.

Council Directive 91/271/EEC of 21 May 1991 concerning Urban Wastewater Treatment as amended by Commission Directive 98/15/EU of 27 February 1998 – commonly referred to as the Urban Wastewater Directive – is one of the most important legal documents in EU legislation on the aquatic environment. The purpose of the directive is to protect the environment against the negative effects associated with the discharge of inadequately treated urban wastewater and discharges of biologically degradable industrial wastewater from enterprises within the food processing industry. The directive therefore requires that Denmark implement regulations on the collection and treatment of these forms of wastewater. According to the directive, wastewater discharges have to be subjected to a level of treatment appropriate to the environment at the place in question and the use to which the recipient water bodies in question are put. Denmark implemented the provisions of the directive in Danish legislation in 1994

The Action Plan on the Aquatic Environment's reduction targets for municipal wastewater treatment plants were adjusted in 1990 on the basis of the results of the Nationwide Monitoring Programme [1]. In the case of nitrogen, annual discharges in treated wastewater are to be reduced from approx. 18 000 tonnes N to about 6 600 tonnes N. Phosphorus discharges are to be reduced from approximately. 4 470 tonnes P to approximately 1 220 tonnes P. The reduction in nitrogen discharges from municipal wastewater treatment plants corresponds to all new or upgraded plants exceeding 5 000 PE and all existing plants exceeding 1 000 PE having to implement biological treatment with nitrogen removal down to an annual average of 8 mg N per litre. In 1987 this was considered as low as practicable to reach via biological nitrogen removal. As regards phosphorus, municipal wastewater treatment plants exceeding 5 000 PE must remove phosphorus down to an annual average of 1.5 mg phosphorus per litre.

The Action Plan on the Aquatic Environment's reduction targets for discharges from municipal wastewater treatment plants should originally have been met within three years, i.e. by 1 February 1990 at the latest. A number of plants, however, were granted a deadline extension for technical reasons. The reduction target for nitrogen of 6 600 tonnes N per year was achieved in 1996, as was the reduction target for phosphorus of 1 200 tonnes P per year.

In general, separate industrial discharges are regulated by (e.g.) the Environmental Protection Act and the EU Directive on Pollution Prevention and Control (IPPC Directive) and derivative statutory orders and official guidelines.

From 1997/1998 the nitrogen and phosphorus reduction targets for municipalities have been met.

Separate industrial discharges

The IPPC Directive aims at the integrated prevention and control of pollution by major industrial companies. The directive specifically regulates the energy industry (power stations and refineries, etc.), production and processing of metals, the mineral industry, the chemical industry, waste management plus a number of other activities such as paper manufacturers, textiles pre-treatment and dyeing, slaughterhouses and dairies, as well as installations for intensive rearing of poultry and pigs exceeding a certain capacity. The IPPC Directive contains measures designed to prevent or, where that is not practicable, to reduce emissions to the air, water and land from the above-mentioned activities.

As with the reduction targets for municipal wastewater treatment plants, the Action Plan on the Aquatic Environment's reduction targets for separate industrial discharges were revised on the basis of the results of the Nationwide Monitoring Programme (the forerunner of NOVA-2003 [3]). In 1986–1987, industrial discharges of phosphorus were largely attributable to a few individual enterprises that had already planned treatment measures to reduce discharges to a total of 350 tonnes P per year. It was therefore considered that implementing best available techniques (BAT) could reduce industrial discharges of phosphorus to a level below the original target of 600 tonnes P per year. The original starting point was 3 400 tonnes P per year, but this has now been adjusted to 1 125 tonnes P per year. As the percentage reduction has remained unchanged, the new target is a total annual discharge of approximately 200 tonnes P per year.

Because of the large differences between the individual enterprises and their discharges of wastewater, the Action Plan on the Aquatic Environment I did not stipulate general discharge requirements for industry as it did for wastewater treatment plants. Industry was to reduce its discharges through the application of BAT, understood as the level of treatment that is technically attainable and economically viable for the industry in question.

Discharges of nutrients via separate industrial discharges should originally have been reduced within three years as stipulated in the Action Plan on the Aquatic Environment, i.e. by 1 February 1990 at the latest. The reduction targets for nitrogen (2 000 tonnes) and phosphorus (200 tonnes) were attained at the end of 1995.

From 1997/1998 the nitrogen and phosphorus reduction targets for separate industrial discharges were fulfilled.

Other sources

The Action Plans on the Aquatic Environment focus on the major sources of nutrient pollution. A number of other sectors and source types also contribute to pollution in the aquatic environment, including freshwater fish farms, mariculture, transport, combustion plants (heat and power production), sparsely built-up areas and stormwater outfalls. The plans did not specify specific reduction targets for these sectors and types of source but instead describe a number of other measures.

Freshwater fish farms

With regard to freshwater fish farms, the Action Plan on the Aquatic Environment presumed that a statutory order would be issued stipulating detailed guidelines for the design and operation of the farms. The statutory order was to ensure satisfactory water quality in the associated watercourses and to considerably reduce nutrient loading. On 5 April 1989 the Ministry of Environment thus issued the Statutory Order on Freshwater Fish Farms. The statutory order provided for general regulation of the industry with guidelines for the county authorities to stipulate the maximal permitted feed consumption at the individual fish farms, minimum requirements as to treatment measures on the fish farms as well as minimum requirements as to utilisation and quality of the fish feed.

Mariculture

As regards mariculture (seawater-based fish farming), a one-year moratorium was placed on the establishment of new farms and the expansion of existing farms. The moratorium was raised in connection with issuance of Statutory Order No. 640 in 1990 on mariculture. This stipulated general regulations on feed quality and consumption as well as consumption of feed relative to production. In addition, upper limits were placed on nutrient discharges to the surrounding aquatic environment from each individual farm. However, in early 1996, the Danish EPA requested counties not to issue any permits for new sea-based or land-based mariculture farms or for extensions of existing farms. The counties were simultaneously urged to assess whether environmental or operational benefits could be obtained by moving or merge the existing farms.

Emissions to the air

When the Action Plan on the Aquatic Environment was adopted in 1987, the Danish EPA was instructed to prepare a report containing a specific reduction programme for power station NO_x emissions. This was done in continuation of earlier reports on limitation of NO_x emissions from power stations. In connection with the Action Plan on the Aquatic Environment I in 1987 it was also decided to investigate the possibilities for promoting the use of catalytic converters through changes to the car taxation system.

Regulation of NO_x emissions in Denmark has concentrated on improved combustion technology and flue gas abatement at power stations (cf. Statutory Order No. 885 of 18 December 1991 on Limitation of Emissions of Sulphur Dioxide and Nitrogen Oxides from Power Stations), enhanced use of natural gas and renewable energy (cf., the Government's 1990 Energy Action Plan) as well as implementation of the requirement for catalytic converters on cars (cf. Ministry of Justice Statutory Order on Detailed Regulations for the Motor Vehicle Design and Equipment from 1990).

Under the United Nations ECE Convention on Transboundary Air Pollution, Denmark has entered into an international agreement to reduce emissions of NO_x by 30 % over the period 1986–1998. However, the measures needed to meet this goal are inadequate in Europe as regards acidification and eutrophication. In June 1999, the EU Commission therefore issued proposals for two directives on acidification and ozone formation at ground level (Proposal for a Directive on National Emission Limits for Certain Polluting Substances, and Proposal for a Directive on the Ozone Content of the Air). These two directives stipulate national limits for emissions of NH_3 and NO_x, etc. In the case of Denmark, the proposed directives will limit ammonia (NH_3) emissions to 71 000 tonnes per year and nitrogen oxide (NO_x) emissions to 127 000 tonnes per year from 2010.

Sparsely built-up areas (scattered dwellings)

In line with the reduction in discharges from wastewater treatment plants and industry over the past 10 years, the relative impact of sparsely built-up areas and stormwater outfalls on watercourses and lakes has increased. It can be assumed that the expected future improvements in treating wastewater from sparsely built-up areas resulting from the initiatives in connection with the amendment of the Environmental Protection Act concerning wastewater treatment in rural areas (Ministry of Environment and Energy, 1997) will have a positive effect.

According to state instructions to counties concerning revision of the Regional Plans in 2001 [8], a county will have to specify in its Regional Plan or an annex to it the areas in which the treatment of wastewater from properties in rural areas is to be improved. In consultation with the municipal authorities, the County Council has to stipulate quality objectives for the individual recipient waters in its Regional Plan. The County Council has to identify watercourses and lakes that are vulnerable to pollution and, based on its knowledge of the environmental state and pollution load on the individual recipient waters, has to assign each individual recipient a maximal environmentally permissible level of pollution.

The Danish EPA estimates that there are approximately 67 000 properties in rural areas nationwide that currently have individual discharges and which will have to improve wastewater disposal in the near future. The remaining properties can maintain the existing means of wastewater disposal without further improvement.

Stormwater outfalls

As mentioned above, stormwater outfalls are one of the contributory reasons for the failure of many watercourses and lakes to meet their quality objectives as stipulated in the Regional Plan. Knowledge of how best to regulate stormwater overflows is lacking, however. The Wastewater Committee of the Danish Engineering Association has established a working group to investigate how to develop appropriate discharge requirements for stormwater overflows. The Danish EPA is participating in the Working Group's work, which is intended to result in proposals for guidelines that can be incorporated in official Danish EPA Guidelines. The Working Group is expected to complete its task by the end of 2001.

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7 Estonian national report on nutrient loads

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7.1 Nutrient loads and reductions achieved

7.1.1 Description of calculation/assessment methods used

Municipal discharges

Environmental reporting systems have been in operation in Estonia since the Soviet era, and there are about 40 environment databases existing in Estonia at present. The basis for calculating pollution loads from municipalities and industries to the environment is the statistical annual report "Review of Estonian Water Management" [1,2]. The data base includes information on water extraction and consumption, as well as wastewater discharges into the environment and wastewater treatment plants.

In the late 1980s flow measurement systems, sampling methods and frequency corresponded to guidelines adopted by the Ministry of Land Reclamation and Water Management of the Soviet Union. Continuous flow measurement was used only for municipal wastewater treatment plants larger than 50 000 PE. Wastewater volume was normally assessed on the basis of water consumption. For industrial point sources both methods were used. Composite or grab samples from treated or untreated wastewater were taken 1 to 4 times per week for municipalities larger than 50 000 PE, while grab samples were used in other instances. Standard methods adopted by the Ministry of Land Reclamation and Water Management of the Soviet Union were used for chemical analyses. The load from sewage systems and industrial plants were calculated using various methods, depending on the measurement and sampling frequency.

Beginning in 1994, Estonian water protection authorities implemented "Guidelines for the Third Pollution Load Compilation" (PLC-3) [3] and later, "Guidelines for the Fourth Pollution load Compilation" (PLC-4) [4]. To assess the 50 % reduction according to the 1988 Ministerial Declaration, the municipalities listed below in Tables 7.1 and 7.2 were considered.

Table 7.1 Estonian settlements discharging wastewater directly to the Baltic Sea.

Size categories (PE)	Settlements
2 000–10 000	Haapsalu, Loksa
10 001–50 000	Kuressaare, Pärnu, Sillamäe, Maardu
More than 50 000	Tallinn, Kohtla-Järve

Table 7.2 Estonian settlements discharging into surface freshwaters in the Baltic Sea catchment area.

Size categories (PE)	Settlements
2 000–10 000	Jõgeva, Kehra, Keila, Kunda, Narva-Jõesuu, Paide, Põltsamaa, Põlva, Rapla, Tapa, Türi, Võhma
10 001–50 000	Jõhvi, Rakvere, Valga, Viljandi, Võru
More than 50 000	Tartu, Narva

Taking into account methodological difficulties in measuring total nitrogen and total phosphorus in the late 1980s, only NO_3, NO_2, NH_4 and PO_4 were measured. Therefore only the sum of inorganic nitrogen and phosphorus compounds are included in the tables for 1988.

Industrial discharges

Methodological aspects concerning flow measurements, sampling frequency, analytical and calculation methods were described above.

Discharges from fish farms

There is no data about the pollution load of fish farms in the statistical report. Estimated discharges from the freshwater and marine fish farms are based on data on fish production and feed consumption presented by the Fishery Department of the Ministry of the Environment.

As shown in Table 7.3, fish production has decreased more than fourfold, and feed consumption about eightfold. At the late 1980s, 50 % of the feed used was moist feed, and the remainder was primarily semi-moist feed. At the moment mainly dry feed is used.

Table 7.3 Fish production and feed consumption in the late 1980s and in 1995.

Source	Late 1980s			1995		
	Feed consumption (t/y)	Production (t/y)	Number of fish farms	Feed consumption (t/y)	Production (t/y)	Number of fish farms
Freshwater fish farms		1 200	30		130	20
Marine fish farms		500	6		270	2
Total	5 400	1 700	36	684	400	22

Discharge of nitrogen and phosphorus from fish farms is calculated by a mass balance equation, including feed use, amount of fish produced and the type of fish farm according to the HELCOM Guidelines for the Third Pollution Load Compilation [3]:

$$L = 0.01\ (IC_i - GC_f)$$

where:

- L = phosphorus (P) or nitrogen (N) load to water body, kg/y
- I = amount of feed used for feeding fish, kg/y
- C_i = P or N content in feed, %
- G = growth of fish, kg/y
- C_f = P or N content in fish, %

Discharge from agriculture

Pollution loads from agriculture were estimated by Environment Protection Institute of Tallinn Technical University, based on studies of small catchments [5]. According to research results, nutrient leaching from the surface unit in kg per hectare per year (kg/ha y) was calculated. This unit load value is multiplied by the entire area of the agricultural land to derive a potential anthropogenic nutrient load of all agriculture, although not all of the nutrient load reaches the sea (e.g., self-purification, retention, etc.). The same methodology is also used by Finland, Sweden and Norway.

Research conducted in the 1980s on small river catchments showed that nitrogen leaching varied between 20 and 32 kg/ha y, which form up to 32 % from the total amount of fertilisers used [5]. Maximum leaching was 76 kg/ha y. An average value of 27 kg/ha y was used in the 1980s. Total agricultural land area was 1 120 000 ha. Total nitrogen load in the 1980s was calculated at 30 240 tonnes/y.

Nitrogen load estimates in 1995 were based on values measured in automatic monitoring stations and the results of an assessment of the Kasari river catchment area [6]. Nitrogen load was between 4.4 and 11 kg/ha y. The lower value is from the Räpu river and is rather low, and therefore does not reflect the situation for all of Estonia. For the calculation was used 11 kg/ha y.

The same method was used to calculate the phosphorus load. In general phosphorus is quite stable in the soil and does not forward essentially to the water bodies. Problems may occur only in areas sensitive to erosion when phosphorus may leach with humid particulars into the water. Phosphorus fertiliser used during the previous years (average 30–35 kg/ha y) is accumulated in the soil. There are no major difference in phosphorus leaching between the 1980s and 1995. Phosphorus surface load was 0.32 kg/ha y in the 1980s and 0.22 kg/ha y in 1995.

The outcome and variation of nutrients load in the year patterns is quite realistic and describing real situation in Estonia.

7.1.2 Nitrogen and phosphorus discharge to water bodies

Municipal discharges

Based on the data base and calculation methods described in section 7.1.1, direct and indirect discharges of nutrients from municipal wastewater treatment plants were calculated. The results are presented in Tables 7.4 and 7.5 respectively.

Table 7.4 Total discharges of nitrogen and phosphorus from municipalities entering directly to the Baltic Sea.

Size class (PE)	Inorganic nitrogen late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	PO_4 late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
2 000–10 000	74	28	62.1	13	5	61.5
10 000–50 000	303	176	41.9	71	40	43.7
> 50 000	4 342	1 584	63.5	207	61	70.5
Total	4 719	1 788	62.1	291	106	63.6

Table 7.5 Total discharges of nitrogen and phosphorus from municipalities entering into surface freshwater in the Baltic Sea catchment area.

Size class (PE)	Inorganic nitrogen late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	PO_4 late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
2 000–10 000	301	166	44.9	63	25	60.3
10 000–50 000	446	181	59.4	75	33	56.0
> 50 000	1 045	534	49.3	144	76	47.3
Total	1 792	881	54.7	282	134	52.5

Industrial discharges

Based on the data base and calculation methods described in Section 7.1.1 the direct and indirect discharges of nutrients from industries were calculated. The results are presented in Tables 7.6 and 7.7 respectively.

Table 7.6 Total discharges of nitrogen and phosphorus from industries entering directly into the Baltic Sea.

Industry	Inorganic nitrogen late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	PO_4 late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Chemical	11 790	1 554	86.8	31	19	38.7
Non-ferrous metal	2	2	0.0	1	1	0.0
Pulp and paper	–	–	–	12	–	100.0
Total	11 792	1 556	86.8	44	20	54.5

Table 7.7 Total discharges of nitrogen and phosphorus from industries entering into surface freshwater in the Baltic Sea catchment area.

Industry	Inorganic nitrogen late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	PO_4 late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Mining and metal	637	490	23.1	65	19	70.8
Food processing	74	49	33.8	18	11	38.9
Pulp and paper	20	8	60.0	1	1	0.0
Total	731	547	25.2	84	31	63.1

Discharge from fish farms

Based on the data submitted by the Fishery Department of the Ministry of the Environment the total discharge of nutrients from freshwater and marine fish farms was estimated. The results are presented in Table 7.8.

Table 7.8 Estimated discharges of nitrogen and phosphorus from freshwater and marine fish farms.

Nutrient	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	160	38	122	76.3
P-TOT	27	5	22	81.5

Agricultural discharges

Based on the methodology described in Section 7.1.1 nutrient loads from agriculture to the environment was estimated. The results are presented in Table 7.9.

Table 7.9 Estimated discharges of nitrogen and phosphorus from agriculture.

Nutrient	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	30 240	12 600	17 640	58.3
P-TOT	360	250	110	30.6

According to data from the Estonian Board of Statistics, a strong decline in the volume of agricultural production was noted in the beginning of the 1990s, which is connected with disintegration of collective agriculture. Wasting and much concentrated management of Soviet era lead to the poor condition of rivers, lakes and groundwater, influencing primarily weakly protected or unprotected groundwater regions in northern and central Estonia. Pollution is caused by poor (incorrect) treatment, storage and use of manure, especially in large farms. From 1990 to 1999 the number of animals decreased almost three times, and the number of cows has decreased two times. In 1994–1996, agriculture stabilised and the overall decline continued in 1998. Meat, dairy and field crops production decreased significantly compared to 1985 (Table 7.10) in connection with bankruptcy of several meat factories, reformation of dairy industry and decrease in the number of cattle.

Table 7.10 Production of field crops, meat and milk in Estonia (thousand tonnes) [7].

Crop	1985	1990	1995	1999
Cereals and legumes (dry weight)	725.6	957.5	519.8	404.7
Potatoes	832.9	618.1	537.4	403.7
Meat (slaughter weight)	182.5	182.5	67.7	61.1
Milk	1 260.1	1 208	706.9	

Arable land comprises 25 % of the total area of Estonia. In 1991 arable land covered 1 131 947 ha, of which 1 114 316 ha was field crops. In 1998, the area of field crops was 861 087 ha, 23 % less than in 1991. Per-capita production in 1991 was 600 kg of grain and legumes and 378 kg of potato; by 1999 the corresponding values were 291 and 280 kg per capita.

The use of fertilisers during this period has decreased markedly. Use of mineral fertilisers was highest from 1960–1988. Since 1990, the use of mineral fertilisers has sharply decreased, which has reduced the leaching of plant nutrients (nitrogen and phosphorus) into water bodies. In 1998, 26 900 tonnes of mineral fertilisers were used for crops, of which the majority was formed by nitrogen fertiliser, and 2.3 million tonnes by organic fertiliser. 315 308 hectares of arable land were fertilised with mineral and 69 759 hectares with organic fertilisers (manure), which accounted for 42 % and 8 % of the area sown. In 1999, one hectare received average of 77 kg of mineral fertiliser and 33 tonnes of organic fertiliser, which is more than two times less than in 1992. Table 7.11 provides an overview of some primary indicators of Estonian agriculture.

Table 7.11 Overall indicators of Estonian agriculture.

	Indicators	Late 1980	1995	Decrease	Decrease (%)
	Arable land (ha)	1 120 000	1 128 000	– 8 000	–7.0
	Number of livestock (animal units)	711 000	336 700	374 300	52.6
	Tot. numb. of cattle	840 200	370 400	469 800	55.9
	Tot. numb. of pigs	1 073 600	448 800	624 800	58.2
	Consumption of fertiliser (t/y)	112 500	18 900	93 600	83.2
	Consumption of manure (t/y)	51 400	24 100	27 300	53.1
N	Use of fertiliser and manure (kg/ha)	1 829	477	1 352	73.9
	Annual discharge (t/y)	30 240	12 600	17 640	58.3
	Discharge kg per ha/y	27.0	11.2	15.8	58.5
	Losses (%)	18.5	29.3		
	Consumption of fertiliser (t/y)	27 280	1 760	25 520	93.6
	Consumption of manure (t/y)	10 500	4 800	5 700	54.3
P	Use of fertiliser and manure (kg/ha)	42.2	7.3	34.9	82.7
	Annual discharge (t/y)	360	250	110	30.6
	Discharge (kg/ha y)	0.3	0.2	0.1	33.3
	Losses (%)	1.0	3.8		

7.1.3 Overall reduction of nutrient load to the environment achieved

During the period between the late 1980s and 1995 significant decreases can be observed in the pollution load. The overall objective to reduce pollution load by 50 % has generally been realised.

Table 7.12 Total discharge of nitrogen into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load in late 1980s (tonnes/year)	Load 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
Direct municipal discharge	4 719	1 788	2 931	62.1
Indirect municipal discharge	1 792	881	911	54.7
Direct industrial discharge	11 792	1 556	10 236	86.8
Indirect industrial discharge	731	547	184	25.2
Discharge from fish farms	160	38	122	76.3
TOTAL from point sources	19 194	4 810	14 384	74.9
Discharge from agriculture	30 240	12 600	17 640	58.3

Table 7.13 Total discharge of phosphorus into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load late 1980s (tonnes/year)	Load 1995 (tonnes/year)	Reduction (t)	Reduction (%)
Direct municipal discharge	291	106	185	63.6
Indirect municipal discharge	282	134	148	52.5
Direct industrial discharge	44	20	24	54.5
Indirect industrial discharge	84	31	53	63.1
Discharge from fish farms	27	5	22	81.5
TOTAL from point sources	728	296	432	59.3
Discharge from agriculture	360	250	110	30.5

The decrease in industrial production has also caused a decrease in water usage. Higher water prices and more accurate measurement of water usage influenced industry and the populace to save water. Water was saved due to increased water resource taxes and pollution charges. Loads were also decreased due to wastewater treatment plants constructed in recent years.

In recent years several settlements have been provided with operating wastewater treatment plants. In Tallinn, where one-third of the Estonian population lives, biological-chemical wastewater treatment plant was constructed. The construction of wastewater treatment plants in Pärnu, Rakvere, Kuressaare, Viljandi, Türi, Kilingi-Nõmme, Kõrgessaare and other settlements was completed.

Due to economic changes in Estonia, enterprises with old and unsustainable technology have been closed or reorganised. Pulp industry facilities in Tallinn and Kehra closed because of bankruptcy in 1993, although the facility in Kehra was reopened in 1995. In 1993 the chemical facility in Maardu was also closed. The chemical-metallurgic industry Silmet was reorganised to produce rare metals, and the food industry also underwent great modernisation. The Maardu phosphorite mine near Tallinn was closed because of critical ecological concerns.

By the 1990s agricultural production declined considerably mainly due to land reform, privatisation and the dismantling of collective farms. The decrease in mineral fertiliser usage started in 1989 and continued in 1995, and there was also a significant decrease in the number of livestock number during the same period. Fish farms production declined more than fourfold, feed consumption decreased about eightfold, and the number of farms declined 36 to 22.

7.1.4 Clarification of differences with load figures published earlier

Municipal discharges

Differences between load figures for municipal discharges published earlier and those presented in this report are due to different years of reference. While the PLC-2 report uses 1990 as the base year, the current report uses 1988. There are also differences in the settlements included in each report.

The PLC-2 report includes all direct discharges to the sea from Haapsalu, Kuressaare, Pärnu, Sillamäe, Kohtla-Järve, Aseri, Kunda, Loksa, Maardu and Tallinn. The MINDEC 88 report included settlements according to the person equivalents larger than 2 000 PE. Kunda discharges wastewater to the Kunda River, but not directly to the sea. Aseri is too small and is not included in the report.

For the reporting year 1988 only NO_3, NO_2, NH_4 and PO_4 load was available. Total nitrogen and phosphorus values were used for 1995.

There are different values for nitrogen load from industries in the PLC-2 and MINDEC 88 reports. The reason is new data (loads were estimated by Tallinn Technical University) for the Silmet chemical facility, which is now included also for 1988. In the end of 1980s information about nitrogen load from Silmet, which used nitrogen acid in their processes, was not available because the industry belonged to the Soviet Ministry of Defence.

Agricultural discharges

During the Soviet era large-scale collective and state farms were established. Production became more intensive and concentrated in smaller areas. Use of mineral fertilisers and pesticides increased greatly. Concentrated animal breeding became a major source of pollution.

By the 1990s agricultural production declined, which in its turn led to mitigation of the environmental impact of agriculture. The decline was mainly due to land reform, privatisation and the dismantling of collective farms.

Currently, livestock is distributed more evenly over a large territory than previously. Use of arable land liven up since middle of the 90s. Continuous leaching of past pollution due to the intensive use of fertilisers and poor management of farmyard manure still causes eutrophication. Problems resulting from agricultural pollution include the lack and amortisation of manure storages, as well as the shortage of equipment for spreading manure and fertilisers.

7.2 Estonian water protection targets

7.2.1 Introduction

During the last ten years in Estonia, discharges of nitrogen and phosphorus from point sources were significantly reduced. Decrease of pollution loads in the early 1990s is largely due to decreases in production. Production of pulp, super phosphate, nitrogen fertiliser, etc. was stopped, and production of the food industry decreased. Many industries were restored in later years, but stoppages still occur. Further decreases in pollution have been achieved through the construction and/or renovation of treatment plants. An essential role has been played by companies who wish to reduce pollution charges by reducing water usage, as well as through the implementation of cleaner technology.

During this time, several other had been occurring. New wastewater treatment plants were constructed in Haapsalu, Tartu, Tapa, Mustvee, Rapla, Lihula, Võsu and in other smaller settlements. Wastewater from the Narva-Jõesuu was discharged to the Narva wastewater treatment plant, and wastewater from Jõhvi was discharged to the Kohtla-Järve wastewater treatment plant. Also, wastewater from the Kehra pulp industry's ash field was discharged to the biological wastewater treatment plant in Kehra. Many industries have been closed: the Räpina and Kohila paper factory, Võhma meat factory, and fish industry facilities in Purtse, Toila, Narva-Jõesuu, Voka and Läätsa. Several treatment plants were renovated, including Kärdla, Antsla, Adavere, Paide, Märjamaa and Roosna-Alliku.

7.2.2 Reduction achieved from the late 1980s to 1999

As described in Section 7.1.2, the 50 % reduction target set by Ministers in 1988 concerning nitrogen was achieved by Estonia by 1995. To achieve the 50 % reduction target for phosphorus Estonia should reduce phosphorus loads by 2 tonnes (0.2 %) by the year 2005.

Based on monitoring results Estonia has significantly reduced nitrogen and phosphorus loads between 1995 and 1999. The load figures for nitrogen and phosphorus, calculated using monitoring results, are presented in table 7.14.

As indicated in Table 7.14, the goal to reduce nitrogen and phosphorus load to the environment by 50 %, has been implemented by Estonia by 1999. There is therefore no need to set more specific quantified targets to implement the 1988 Ministerial Declaration.

In addition to the implementation of the 1988 Ministerial Declaration, the Estonian Parliament and Government are very much concerned about the sustainable development of the country, and thus implementation of environmental protection measures receives continuous attention.

Table 7.14 Nitrogen and phosphorus load reduction achieved by Estonia between the late 1980s and 1999.

Source	Nitrogen load		Reduction		Phosphorus load		Reduction	
	1980s	1999			1980s	1999		
	(t/y)	(t/y)	(t)	(%)	(t/y)	(t/y)	(t)	(%)
Direct municipal	4 719	1 163	3 556	75	291	112	179	62
Direct industrial	11 792	337	11 455	95	320	0	320	100
Indirect municipal	1 792	605	1 187	66	282	77	205	73
Indirect industrial	7 304	373	6 931	95	833	4	829	99
Fish farms	160	19	141	88	27	2	25	93
Agriculture	30 240	12 600	17 640	58	360	250	110	31
TOTAL	56 007	15 097	41 910	73	2 113	445	1 668	79

7.2.3 Environmental targets to implement EU Directives and other international agreements

Estonian National Environment Strategy (NES)

To help guarantee sustainable development in Estonia, a National Environmental Strategy was adopted by the Estonian Parliament in 1997. This document defines objectives of environmental protection measures, but defines no quantifiable targets for pollution reduction. The NES specifies the trends and priority goals of environmental management and protection in the new political and economic situation, and establishes the main short-term and long-term tasks to be achieved by 2000 and 2010 respectively.

The Strategy follows major international environmental initiatives: the World Nature Protection Strategy, Agenda 21, the Declaration of the Earth Summit (Rio de Janeiro, 1992), the Environmental Action Programme for Central and Eastern Europe (adopted at the Ministerial Conference in Lucerne in 1993 and revised at the Sofia Conference in 1995), international agreements which have become valid for Estonia, and the White Paper drafting the principal requirements of integration of Central and Eastern European countries with the European Union.

The NES focuses on achieving ten principal policy goals. Since promotion of public awareness and the introduction of environmentally sound technologies are preconditions for solving most existing environmental problems, these are considered to be priority goals of the NES. Another of the priority goals is to reduce negative environmental effects of energy production, which is a cause of major global and local environmental problems. Improvement of air quality, waste management and water protection as well as reduction of past pollution will help to ensure a healthy environment. One of the goals is the protection of surface water bodies and coastal seas.

Protection of Surface Water Bodies and Coastal Seas

Goal: To ensure the ecological balance of surface water bodies and coastal seas, natural regeneration of fish stock and aquatic flora and fauna through the rational use of water bodies.

To achieve this goal, it is necessary to: introduce a countrywide scheme of rational use of water bodies; introduce rational use of water in industry and in households; ensure biological and, if necessary, chemical treatment of wastewater contaminating the environment.

Tasks by the year 2000: To bring the main municipal and industrial wastewater treatment indicators (BOD, phosphorus etc.) in line with the recommendations of the Helsinki Commission (HELCOM).

Tasks by the year 2010: To remove nitrogen compounds from the wastewater of municipalities of more than 5 000 inhabitants in accordance with the HELCOM recommendations, in order to maintain ecological balance of water bodies sensitive to nitrogen content.

National Environment Action Plan (NEAP)

With a view to implement the Strategy, a detailed National Environmental Action Plan (NEAP) was developed between April 1997 and April 1998, and approved by the Estonian Government. The Ministry of Environment is responsible for implementation of the Action Plan.

The objective of NEAP is to enable further progress towards sustainable development through the effective implementation of policy goals stipulated in the Estonian National Environmental Strategy. More than 150 actions within the NEAP (nearly one-quarter of all actions) are orientated (directly or indirectly) to approximate both legal and substantive requirement of EU policies. Of this number, more than 50 actions are directly targeted to specific EU Directives. Among EU environmental directives, the most frequently addressed by the NEAP are the: Drinking Water Directive (80/778/EEC), IPPC Directive (96/61/EC), Urban Waste Water Directive (91/271/EEC) and others.

Implementation of EU Directives

Estonia has stated its willingness to become a member of the European Union and has expressed its readiness to harmonise its legislation with European Union environmental legislation by the day of accession. The EU Urban Waste Water Treatment Directive 91/271/EEC (UWWTD) is regarded as one of the most expensive directives in the environmental sector.

Targets for reducing nitrogen and phosphorus discharges from municipal sources

Estonia has not declared national targets for reduction of nitrogen and phosphorus discharges from municipal sources. At present, major investments in this area are channelled for implementation of EU Urban Waste Water Treatment Directive 91/271/EEC.

The Urban Wastewater Directive will be fully transposed into Estonian national laws during 2001. The main legal act regulating wastewater treatment, including requirements for collection, is the Water Act. Under the Water Act, the Government establishes limits for wastewater discharges into water bodies and soil. In 2001 the Water Act will be amended to include definitions and monitoring requirements. Requirements on wastewater discharges are in line with the requirements of the EU Waste Water Directive or even stricter, because Estonia has signed the Estonian-Finnish Agreement on water protection and ratified the Helsinki Convention.

Table 7.15 Comparison between Estonian and EU wastewater treatment requirements for agglomerations of 2 000–100 000 PE or more.

Parameters	Estonia		European Union	
	Concentration (mg/l)	Minimum reduction (%)	Concentration (mg/l)	Minimum reduction (%)
BOD_5 (in Estonia BOD_7)	15	90	25	70–90
COD	125	75	125	75
Total suspended solids	15	90	35	70–90
Total phosphorous	1.5/1.0*	80	2	80
Total nitrogen	15/10*	70–80	15	70–80

* *The requirements for total nitrogen concentration (10 mg/l) and phosphorus concentration (1 mg/l) have been established for Estonian agglomerations where the pollution load exceeds 100 000 PE.*

Sensitive water bodies in Estonia are identified according to the 1998 Ministerial Regulation (RT (State Gazette) I 1998, 346/347, 1432). This Regulation has since been amended to include more sensitive areas. According to the Regulation, most Estonian water bodies and coastal sea are sensitive. These water bodies' catchment areas cover almost all Estonian territory; only a few rivers, mainly in south and southeastern Estonia (Emajõgi, Õhne, Neitsi etc.) are not identified as sensitive.

All Estonian agglomerations of 2 000 PE or more must remove phosphorus at least to a concentration of 1.5 mg/l. All agglomerations with a pollution load of 10 000 PE or more are committed to remove nitrogen except Tartu, because the Emajõgi River is not a nitrogen-sensitive water body. Tartu is located more than 150 km away from the Baltic Sea, and only 20–30 % of nitrogen discharged reaches the Baltic. The investigation concerning the need to remove nitrogen in Tartu is ongoing, and relevant information will be sent to the Commission.

In Estonia, 61 agglomerations with a pollution load of 2 000 PE or more have been identified. There are 45 agglomerations with a pollution load of 2 000 to 10 000 PE, and three agglomerations with pollution load of 10 000–15 000 PE. There are 12 agglomerations with a pollution load from 15 000 to 150 000 PE, and 1 agglomeration with a pollution load of more than 150 000 PE.

There is more than 3 000 km of sewerage. In addition, about 590 km of sewerage should be constructed and 412 km renovated. There is a need to build 16 wastewater treatment plants and renovate 23 additional plants.

Table 7.16 Compliance in implementing Estonian and EU Directive requirements on the basis of three parameters.

Parameters	Agglomerations which are in compliance with Estonian and EU directive requirements	
	Number of agglomerations	%
BOD_7 (15 mg/l)	38	62
Total phosphorus (1.5 mg/l)	27	44
Total nitrogen (15 mg/l)	9	56

There is no need for significant investments for phosphorus removal, but nitrogen removal requires large-scale investments, as there is a need to construct denitrification zones in wastewater treatment plants.

According to estimates, investments of more than 224.8 million euro are needed to renovate and construct wastewater treatment systems in agglomerations with a pollution load of 2 000 PE or more. According to Article 7 of the Directive, it is also necessary to renovate and construct wastewater treatment systems in smaller agglomerations with collection systems, and this would cost more than 100.2 million euro. An implementation plan for the Directive has been drafted, taking into consideration the following factors: pollution load from agglomerations, discharges into highly sensitive water bodies (surface water bodies, which are used as drinking water resources) or to the soil, and agglomerations located in areas where groundwater is vulnerable (karst areas, alvars). Some agglomerations with a small pollution load are also included in the priority list because of a high risk of environmental pollution.

Implementation of Articles 4 and 5 will be carried out from 2000–2005. The implementation of Article 3 is planned to be accomplished by 2000–2010.

Construction of new and reconstruction of existing wastewater treatment plants according to the existing plans will guarantee the continuous reduction of nitrogen and phosphorus loads to the environment.

Targets for reduction of industrial discharges, agricultural discharges and discharge from fish farms

In last decade essential changes have taken place in Estonia. Economic restructuring, changes in industry management, and domestic water consumption have brought about decreases in pressures on the aquatic environment, which has had favourable effects on rivers, lakes and seas. The revitalisation of the economy will inevitably be accompanied by increases in these pressures.

Preventing pollution through the use of production technology, thus saving water resources and the promotion of suitable wastewater treatment methods and sustainable ("mild") agriculture, it is possible to preserve the present situation in water bodies.

In Estonia, as a rule industrial and domestic wastewater is treated in a common wastewater treatment plant. Only a small part is discharged directly into surface waters. Estonia has not set any specific targets for reduction of nitrogen and phosphorus discharges from industrial sources. The main focus of environmental measures will be to prevent an increase of nitrogen and phosphorus discharges when industry recovers.

Significant reductions in agricultural and fisheries production occurred in the early 1990s due to land reform and changing market circumstances. Outputs from agriculture and fisheries is expected to increase in the near future. Estonia has not set any specific targets for reduction of nitrogen and phosphorus discharges from agriculture and fisheries for the period 1999–2005, but aims to prevent pollution of aquatic environment in the future.

Estonia intends to implement EU Nitrate Directive and the Code of Good Agricultural Practice. Implementation of the Code will reduce nutrient leaching to surface waters. Introduction of modern fertilisers and manure handling techniques and other measures required by the Nitrate Directive and Code will decrease impacts on the environment.

The HELCOM Recommendations concerning reduction of nutrient discharges from agriculture and reduction of discharges from marine fish farming and fresh water fish farming is also followed.

During the period 1990–2000 more modern fish farming practices were introduced. The efficiency of food production has been improved, and resulted in reductions of environmental impacts. It is realistic that the number and productivity of fish farms will increase in the future. Environmental measures will focus on prevention of further pollution.

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Finnish national report on nutrient loads

8

Antti Räike, Finnish Environment Institute

8.1 Nutrient loads and reductions achieved

8.1.1 Methods used for calculations

Municipal discharges

Estimates are based on continuous wastewater flow measurements. The sampling frequency of concentration measurements varies according to the plant size (Table 8.1). The samples are 24 hours flow-proportional, taken by composite samplers. Overflows and bypasses are included in the load figures.

Table 8.1 Sampling frequency of Finnish municipal wastewater treatment plants.

Treatment plant capacity (PE)	Sampling frequency (samples per year)
< 10 000	2-8
10 001–20 000	12–24
> 20 000	52

Industrial discharges

Estimates are based on continuous wastewater flow measurements. Sampling frequency for concentration measurements varies between the plants depending on plant size and type of production. The pulp and paper industry reports weekly mean concentration values, which are based on daily values. The samples are 24-hour flow-proportional samples taken by composite samplers. Other branches measure concentrations according to individual permits.

Discharges from fish farms

The load calculations are based on the amount of nutrients in fish and on the nutrient content of the feed, using the equations described in PLC-4 Guidelines [1].

Discharges from agriculture

Estimates of phosphorus and nitrogen losses from agricultural land to surface waters in Finland is based on monitoring of N and P fluxes from four small agricultural drainage basins and from four agriculturally loaded river basins in south and southwestern Finland [2, 3]. The size of the small basins vary from 12 ha to 15 km^2, and the river basins from 870 km^2 to 1300 km^2. The agricultural land use varies from 23 to 100 %. The monitoring schemes are based on continuous water flow measurement and flow-weighted water quality sampling. Using this data, annual N and P flux estimates are calculated, from which possible point source loads and estimated losses from forested areas are subtracted. The scaling up of the losses is conducted by multiplying the estimated agricultural losses by the total agricultural area in Finland, taking into account different specific losses from acid sulphate soils and peaty soils.

Since annual loads vary greatly due to climatic variations, we have calculated the mean annual loads for consecutive five years periods: 1981–1985, 1986–1990 and 1991–1995 [3]. The variations for each of the periods represent the variability between the different monitoring areas, not the annual variation within the period. Additional information can be drawn from studies of the impact of agri-environmental support schemes in Finland [4].

8.1.2 Nitrogen and phosphorus discharge to water bodies

Discharges from municipalities

Based on the data base and calculation methods described in Section 8.1.1, direct and indirect discharges of nutrients from municipal wastewater treatment plants were calculated. The results are presented in Tables 8.2 and 8.3 respectively.

Table 8.2 Total discharges of nitrogen and phosphorus from municipalities entering directly to the Baltic Sea.

	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Total	6 587	7 096	–7.7	202	112	44.6

Table 8.3 Total discharges of nitrogen and phosphorus from municipalities entering into surface freshwater in the Baltic Sea catchment area.

	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Total	7 918	7 818	1.3	253	145	42.7

There was an increase in municipal nitrogen load between the late 1980s and 1995 resulting from the connection of new polluters to municipal wastewater treatment plants. Nitrogen removal from municipal wastewater from the larger plants discharging directly to the Baltic Sea was first started in the late 1990s, and reduction of nitrogen load will be assessed starting from 1995. Before that time, about 30 % of the nitrogen was removed during the treatment process.

Chemical phosphorus removal from municipal wastewater was started in Finland in the 1970s and the removal efficiency has been good (over 90 %) since the late 1980s. Improved treatment methods has lead to further decreases since the late 1980s. Taking into account that in the end of 1980s many inhabitants were connected to wastewater treatment plants causing an increase of input load, the reduction achieved from the late 1980s to 1995 is significantly smaller than in the early 1980s, as indicated in Table 8.4.

Table 8.4 Total phosphorus load to both coastal and inland recipients from municipal treatment plants in 1980, 1988 and 1995.

	1980	1988	1995	Reduction (t / %)
Total load (t/y)	846	372	257	589 / 69.6

Taking into account reduction achieved between 1980 and 1988 (474 t), Finland has reduced the phosphorus discharges from the municipal wastewater treatment plants 589 t (69.6 %) by the year 1995.

Discharges from industry

Based on the data base and calculation methods described in Section 8.1.1 the direct and indirect discharges of nutrients from industries were calculated. The results are presented in Tables 8.5 and 8.6 respectively.

Table 8.5 Total discharges of nitrogen and phosphorus from industries entering directly into the Baltic Sea.

Industry	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Chemical	299	241	19.4	22	15	31.8
Petrochemical	86	30	65.5	3	2	33.3
Mining, metal	1	1	0.0	–	–	–
Iron and steel	457	457	0.0	3	3	0.0
Food processing	38	27	29.7	5	3	40.0
Pulp and paper	1 162	1 137	2.0	254	141	44.5
Other	59	32	46.3	9	2	77.8
Total	2 102	1 925	8.4	296	166	43.9

Table 8.6 Total discharges of nitrogen and phosphorus from industries entering into surface freshwater in the Baltic Sea catchment area.

Industry	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Chemical	272	171	37.1	8.4	2.3	72.6
Mining, metal	36	6	84.2	0.3	0.2	33.3
Iron and steel	19	9	54.2	1.4	0.7	50.0
Food processing	148	126	14.9	19.1	4.5	76.4
Leather and textile	52	28	46.9	0.6	0.4	33.3
Pulp and paper	3 072	2 009	34.6	498	178	64.3
Other	123	60	51.6	9.9	6.8	31.3
Total	3 722	2 409	35.3	537.7	192.9	64.1

Phosphorus removal from industrial wastewater was started in Finland in the 1970s and the removal efficiency was good in the late 1980s. Improvements in the treatment methods, e.g. the activated sludge method, has lead to further decreases since the late 1980s.

Treatment plants in the pulp and paper industry add usually nitrogen to wastewater in order to achieve efficient reduction of organic matter. This is one of the reasons that earlier there were no obligations for nitrogen removal. From 1998 onwards emission limits for the pulp and paper and chemical industries have been implemented [5]. There has not been any significant reduction of direct nitrogen discharges, but indirect discharges have decreased remarkably since then.

Loads from fish farms

Based on feed consumption and production data, the total discharge of nutrients from freshwater and marine fish farms was estimated. The results are presented in Table 8.7.

Table 8.7 Estimated discharges of nitrogen and phosphorus from freshwater and marine fish farms.

Nutrient	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	1 150	1 248	302	19.5
P-TOT	210	164	46	21.9

Both phosphorus and nitrogen loading from fish farms decreased slightly between late 1980s and 1995 due to decreased consumption of fish feed.

Discharges from agriculture

Based on the methodology described in Section 8.1.1, the nutrient load from agriculture into the environment was estimated. The results are presented in Table 8.8.

Table 8.8 Estimated discharges of nitrogen and phosphorus from agriculture.

Nutrient	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	45 500	37 000	8 500	18.7
P-TOT	2 650	2 600	50	1.9

Nitrogen loading from agriculture decreased between the late 1980s and 1995, but has increased slightly since 1995. No significant change has been observed in phosphorus loading. Explanations for the decrease in nitrogen losses are reduction in fertilisation since 1990 and the extensive set-aside (with green cover), which comprised 25 % of total arable land in the early 1990s. After Finland joined the European Union in 1995, the set-aside has decreased dramatically, while cereal crop production has increased. This is probably the reason for an observed increase in nitrogen loads in the late 1990s [3, 4]. There are no clear trends for phosphorus since changes in soil phosphorus levels are much slower compared to those for nitrogen.

Table 8.9 provides an overview of some primary indicators of Finnish agriculture explaining the changes between the late 1980s and 1995.

Table 8.9 Supplementary indicators for agriculture.

	Indicators	Late 1980s	1995	Decrease	Decrease (%)
	Arable land (ha)	2 271 000	2 302 000	–31 000	–1.4
	Number of livestock (animal units)	1 176 763	1 028 374	148 389	12.6
	Total number of cattle	932 520	735 764	196 756	21.1
	Total number of pigs	125 979	140 512	–14 533	–11.5
	Consumption of fertiliser (t/y)	231 768	168 918	62 850	27.1
	Consumption of manure (t/y)	97 735	89 402	8 333	8.5
N	Use of fertilisers and manure (kg/ha)	145.1	112.2	32.9	22.7
	Annual discharge (t/y)	45 500	37 000	8 500	18.7
	Discharge kg per ha/y	20.0	16.1	3.9	19.5
	Losses %	13.8	14.3		
	Consumption of fertiliser (t/y)	64 728	34 143	30 585	47.3
	Consumption of manure (t/y)	19 325	16 128	3 197	16.5
P	Use of fertilisers and manure (kg/ha)	37.0	21.8	15.2	41.1
	Annual discharge (t/y)	2 650	2 600	50	1.9
	Discharge kg per ha/y	1.2	1.1	0.1	8.3
	Losses (%)	3.2	5.2		

8.1.3 Overall reduction of nutrient load into the environment achieved

During the period between the late 1980s and 1995, some decreases can be observed in pollution load, but the overall objective to reducing pollution loads by 50 % has not been realised.

Table 8.10 Total discharge of nitrogen into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load in 1988 (t/y)	Load in 1995 (t/y)	Reduction (t)	Reduction (%)
Direct municipal discharge	6 587	7 096	–509	–7.7
Indirect municipal discharge	7 918	7 818	100	1.3
Direct industrial discharge	2 102	1 925	177	8.5
Indirect industrial discharge	3 722	2 409	1 313	35.3
Discharge from fish farms	1550	1 248	302	19.5
TOTAL from point sources	21 879	20 496	1 383	6.3
Discharge from agriculture	45 500	37 000	8 500	18.7

Table 8.11 Total discharge of phosphorus into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load in 1988 (t/y)	Load in 1995 (t/y)	Reduction (t)	Reduction (%)
Direct municipal discharge	202	112	90	44.6
Indirect municipal discharge	253	145	108	42.7
Direct industrial discharge	296	165	131	44.3
Indirect industrial discharge	538	193	345	64.1
Discharge from fish farms	210	164	46	21.9
TOTAL from point sources	1 499	779	720	48.0
Discharge from agriculture	2 650	2 600	50	1.9

8.1.4 Clarification of difference between load figures and previous estimates

Discharges from municipal wastewater treatment plants

Both nitrogen and phosphorus load figures are in good agreement with the previous estimates.

Discharges from industry

The load figures in PLC-2 and in PLC-3 include also fish farming. If the load from fish farms is subtracted from the total industrial load, the PLC-2 and PLC-3 load figures are in good agreement with the present load figures.

Load from fish farms

The nitrogen load figures are in good agreement with PLC-3 figures, but the phosphorus figures are higher. This discrepancy might be due to missing data in PLC-3 report.

Agriculture

No comparison has been made with previous estimates.

8.2 Water protection targets

Detailed description of the Finnish water protection targets for the year 2005 is presented in Chapter 4.

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9 German national report on nutrient loads

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9.1 Nutrient loads and reductions achieved

9.1.1 Calculation methods used

9.1.1.1 Discharges from municipalities (direct/indirect)

The data base for calculating direct and indirect discharges from municipal wastewater treatment plants (MWWTP) into the German part of the Baltic Sea catchment area was established within the framework of the project "Nutrient balances in German river basins" founded by the German Federal Environmental Agency [1,2]. This data base includes 126 MWWTPs for the late 1980s and 160 MWWTPs for the year 1995 with a capacity of more than 2 000 population equivalents (see Table 9.1).

Table 9.1 Number of MWWTPs in the German part of the Baltic Sea catchment area in the different size classes used for the analysis of direct and indirect nitrogen and phosphorus discharges into the Baltic Sea.

Size class (PE)	Late 1980s MWWTPs discharging into surface freshwaters	Late 1980s MWWTPs discharging directly into the Baltic Sea	1995 MWWTPs discharging into surface freshwaters	1995 MWWTPs discharging directly into the Baltic Sea
2 000–10 000	36	32	27	45
10 000–50 000	17	17	21	37
> 50 000	14	10	14	16
Total	67	59	62	98

Table 9.2 provides an overview of different treatment methods within each MWWTP size class in the late 1980s and 1995. The reference year for the analysis representing the late 1980s is 1985. Based on available data on the number of MWWTPs and treatment methods used for the years 1986–1989, it can be concluded that possible changes are minimal, especially in the former GDR.

Table 9.2 Percentage of different treatment methods within the size classes of MWWTPs in the late 1980s and 1995.

	Status in the late 1980s (%)				Status in 1995 (%)				
Size class (PE)	M	MB	MBC	MBCN	M	MB	MBC	MBN	MBCN
2 000–10 000	18	80	2	0	3	50	10	9	28
10 000–50 000	34	47	19	0	6	19	16	1	58
> 50 000	37	57	6	0	12	4	65	0	19

M = mechanical; B = biological; C = chemical; N = nitrogen removal

Discharges of nitrogen (N) and phosphorus (P) from MWWTPs can be estimated by different methods depending on the data available. The discharges were estimated primarily on the basis of per-capita load figures and the treatment efficiency for different types of MWWTPs (see Tables 9.3 and 9.4). The per-capita nitrogen load figure used was 11 gN/d for both 1985 and 1995 for all German federal states. According to Schmoll [3], it is assumed that the per-capita phosphorus loads are 1.8 gP/d for 1995. For 1985 the author took different values into account and derived different per-capita load figures for the former GDR (4.0 gP/d) and West Germany (3.3 gP/d). For nitrogen, it was further assumed that industrial discharges were 6.5 gN/(d PE).

Table 9.3 N-removal performance for various types of treatment plants located in the former GDR and West Germany separately for 1985, as well as for the all of Germany in 1995 [2].

Plant type	N removal (%)		
	1985 Former GDR	1985 West Germany	1995 Germany
Wastewater pond (unaerated)	50	50	50
Wastewater pond (aerated)	30	30	30
Activated sludge plant	30	30	30
Mechanical treatment	10	10	10
Submerged trickling filter/Percolating filter plant	25	25	25
Reed bed treatment or root zone treatment	45	45	45
Treatment of farms wastewater	80	–	–
Nitrification	–	45	45
Denitrification	–	75	75

The MWWTP inventory comprises the following information: treatment efficiency, treated wastewater in population equivalents (PE), population connected and treated industrial wastewater (PE) (i.e., the part of indirect industrial discharges that is connected to the MWWTPs). In addition, this database includes the mean annual quantity of wastewater treated, partitioned into domestic and industrial wastewater, external water and storm water.

Table 9.4 Phosphorus removal performance for various types of treatment plants [2].

Plant type	P removal (%)		
	1985 Former GDR	1985 West Germany	1995 Germany
Wastewater pond (unaerated)	25	25	45
Wastewater pond (aerated)	25	25	45
Activated sludge plant	20	35	50
Mechanical treatment	10	15	20
Submerged trickling filter/Percolating filter plant	15	30	45
Reed bed treatment or root zone treatment	75	75	75
Treatment of farms wastewater	90	–	–
Chemical/biological phosphate elimination	90	90	90
Microfiltration	–	–	95

The population connected to MWWTPs were estimated depending on the plant size according to sewage statistics. Additionally, nutrient discharges were estimated for a part of the MWWTPs by using the annual mean of nutrient concentrations at the outlet of MWWTPs and the amount of treated wastewater. In addition to nutrient discharges by the plants, the discharges caused by sewer systems (combined sewer overflows and separate rain sewers) and scattered dwellings must be considered in order to estimate total discharges from municipalities. The method used for these estimations is described in Behrendt et al. [2] as well as in HARP Guideline 4.

9.1.1.2 Discharges from industry (direct/indirect)

The results of the studies of Rosenwinkel and Hippen [4] were used regarding the direct and indirect industrial discharges for the year 1995. For the period before 1990, published results by Werner and Wodsak [5] were used.

9.1.1.3 Fish farming

Statistical data on fish production in freshwater systems are only available for the former GDR. Based on this data, the total production of freshwater fish was between 25 000 and 27 500 tonnes per year in the late 1980s. For the districts located in the Baltic Sea catchment area, fish production totalled 4 800 tonnes per year (see Statistical Yearbooks of the GDR for Agriculture, Forestry and Food Production, 1985–1987).

From total annual fish production in the freshwater systems of the GDR districts within the Baltic Sea catchment area, 2 200 tonnes were carp and salmon, which are mainly produced in fish farms. If this fish production is transferred to the total area of the German Baltic Sea catchment the production of fish farms in the Baltic Sea catchment area seems to be within an order of magnitude of 2 700 tonnes per year in the late 1980s. With regards to freshwater fish production in the new federal states, one can assume a dramatic reduction (comparable to the decreases of livestock numbers).

The calculation of nutrient inputs by fish farming followed the procedure according to HARP Guideline 2, using the following formulas:

$$L = 0.01 \text{ x } (FCR \text{ x } P \text{ x } Ci - P \text{ x } Cf) \qquad (1)$$

where:

- L = Phosphorus (P) or nitrogen (N) discharge to water body (tonnes/year)
- I = Feed used (tonnes/year)
- FCR = Feed conversion ratio (= I/P)
- Ci = P or N content in feed (%)
- P = Production (tonnes/year)
- Cf = P or N content in organisms (%)

Table 9.5 Content of nitrogen and phosphorus in dry feed and in produced fish.

	Total phosphorus content (%)	Total nitrogen content (%)
Dry feed	1.2	7.5
Fish	0.45	3.0

For the FCR, a value of 1.2 was used.

Marine fish farming

With reference to HELCOM Recommendation 18/3 (former 15/3) concerning measures aimed to reduce discharges from marine fish farming we are able to present the information for 1995 (see 9.1.2.3). Due to the fact that this HELCOM

Recommendation entered into force in 1992 there is no information available for the late 1980s.

9.1.1.4 Anthropogenic discharges from agricultural areas

From the 16 German federal states, only four comprise the Baltic Sea catchment area. Table 9.6 gives an overview on the total area and the area located in the Baltic Sea catchment area of these four federal states.

Data on agricultural area, the number of livestock, and the use of mineral fertiliser are only available from statistics of the federal states for both investigation periods. The needed data for the former GDR which are available based on former administrative levels of "Bezirke" had to be summarised to the level of the new federal states, which were re-implemented in 1990. A data base with a higher spatial resolution exists for 1995, but not for the late 1980s. Because the use of data bases with different spatial resolution may introduce additional errors, it is decided that only data sets with a higher spatial resolution would be applied.

Table 9.6 Area of the federal states located in the Baltic Sea catchment area.

	Total area of the German federal states (km^2)	Area of the German federal states located in the Baltic Sea catchment area (km^2)
Schleswig-Holstein	15 730	5 250
Mecklenburg-Vorpommern	23 835	16 720
Brandenburg	29 060	5 940
Saxonia	18 338	880
Total area	86 963	28 790

The emission factors given in Table 9.7 were used for the calculation of the livestock units and the amount of manure as nitrogen and phosphorus.

Table 9.7 Emission factors of livestock used for the calculation of livestock units

	Recalculation factor for livestock units	Emission factor per animal (kgN/y)	Emission factor per animal (kgP/y)
Cattle	1	65	10.2
Pigs	0.33	10.9	2.3
Sheep	0.1	9	2.5
Poultry	0.02	0.62	0.125

The data related to agricultural area, livestock number and application of mineral fertiliser within the German part of the Baltic Sea catchment area were calculated using area-weighted sums of the four federal states located in the Baltic Sea catchment area. Statistical Yearbooks of Germany and the former GDR for the years 1987, 1988, 1989 and 1995 were used as data sources. The data from these Statistical Yearbooks had to be recalculated into the terms needed for the report. These transformations are published by Behrendt *et al.* [6]. The mean of the years 1987, 1988 and 1989 was used for the estimation of the agricultural data which represents the situation in the late 1980s.

To estimate the anthropogenic part of the nutrient discharges by agriculture the natural background have to be estimated separately and subtracted from the total load of agricultural areas. The assumptions for the calculation of natural background for nitrogen and phosphorus are:

- Nitrogen surplus for all areas which has a amount of 10 kgN/ha y,
- Concentration of phosphorus in groundwater of 0.050 µgP/l for sandy soils and 0.010 µgP/l for loamy soils [1],
- Direct atmospheric deposition into the surface freshwaters of 10 kgN/ha y,
- No tile drained areas,
- No erosion and non surface runoff because the area is covered by forest,
- No discharges by point sources and from urban areas, and
- The same hydrology as used for the model calculations for the period 1993–1997.

Based on these assumption the natural background was calculated by means of the model MONERIS.

9.1.2 Results for nitrogen and phosphorus discharges to the environment from different sources in the late 1980s and 1995

9.1.2.1 Discharges from municipalities (direct/indirect)

Table 9.8 gives an overview on the total population living in the German part of the Baltic Sea catchment area and the statistics related to the connection of this population to different sewers and municipal wastewater treatment plants in both time periods.

Table 9.8 Total population living in the German part of the Baltic Sea catchment area and the statistics of the connection to sewers and MWWTP's in 1985 and 1995.

	Total population (in thousands)	Population (in thousands) connected to sewer systems	Population (in thousands) connected to MWWTPs	Population (in thousands) with sewer connection without MWWTP	Population (in thousands) without connection to sewer systems
1995					
Area with direct discharges	1 320	1 120	1 080	40	200
Within the river systems	1 820	1 450	1 410	40	370
Total German part of Baltic Sea catchment	3 140	2 570	2 490	80	570
1985					
Area with direct discharges	1 310	650	640	10	660
Within the river systems	1 800	1 130	1 090	40	670
Total German part of Baltic Sea catchment	3 110	1 780	1 730	50	1 330

Based on the data base and methods described in Section 9.1.1 the direct and indirect discharges of nutrients from MWWTPs were calculated. The results are presented in Tables 9.9 and 9.10.

Table 9.9 Discharges of nitrogen and phosphorus from MWWTPs entering directly to the Baltic Sea.

Size class (PE)	Discharge (1000 m³/year) Late 1980s	1995	Nitrogen (tonnes/year) Late 1980s	1995	Reduction (%)	Phosphorus (tonnes/year) Late 1980s	1995	Reduction (%)
2 000–10 000	9 509	3 791	303	125	59	88	14	84
10 000–50 000	17 977	14 893	766	45	40	159	30	81
> 50 000	121 004	96 710	7 124	3 557	50	1 171	112	90
Total	148 490	115 394	8 194	4 138	49	1 418	157	89

Table 9.10 Discharges of nitrogen and phosphorus from MWWTPs into surface freshwaters in the German part of the Baltic Sea catchment area.

Size class (PE)	Discharge (10^3 m³/year) Late 1980s	1995	Nitrogen (tonnes/year) Late 1980s	1995	Reduction (%)	Phosphorus (tonnes/year) Late 1980s	1995	Reduction (%)
10 000–50 000 PE	16 267	24 357	823	821	0.2	181	71	61
> 50 000 PE	64 248	44 077	4 290	2 024	52.8	682	161	76
Total	97 509	73 985	5 450	3 043	44	971	253	74

Table 9.11 shows the results of the estimated direct and indirect nutrient inputs from urban areas. These data includes the discharges from combined sewer overflows, from separate storm water sewers and from scattered dwellings.

Table 9.11 Total direct and indirect discharges of nitrogen and phosphorus from urban areas in the German part of the Baltic Sea catchment area.

Municipal discharge	1983–1987 (tonnes N/year)	1995 (tonnes N/year)	Reduction (%)	1983–1987 (tonnes P/year)	1995 (tonnes P/year)	Reduction (%)
Direct discharges from urban areas	770	490	36.4	99	70	29.3
Indirect discharges from urban areas	1 400	880	37.1	171	103	39.8

9.1.2.2 Discharges from industries (direct/indirect)

The results of direct and indirect industrial discharges are given in Table 9.12.

Table 9.12 Direct and indirect industrial discharges of nitrogen and phosphorus in the German part of the Baltic Sea catchment area.

Industrial discharge	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Direct	150	50	66.7	14	4	71.4
Indirect	1 770	1 090	38.4	426	44	89.7

9.1.2.3 Discharges from fish farms

Based on data on fish production in the late 1980s in the former GDR, additional data on the regional differences in fish production in the districts of the GDR (Statistical Yearbook for Agriculture, Forestry and Food Production, 1986), FAO data on fish production in Germany in the late 1980s and 1995, and formulas including specific coefficients given in Table 9.3, the following discharges of nitrogen and phosphorus from aquaculture into the German part of the Baltic Sea catchment area can be estimated (Tables 9.13 and 9.14).

Marine fish farming is negligible compared to freshwater fish farming in the German Baltic Sea catchment area.

Table 9.13 Estimated discharges from freshwater fish farming into the German part of the Baltic Sea catchment area for the late 1980s and 1995.

	Fish production (tonnes/year)	N discharges (tonnes/year)	P discharges (tonnes/year)
1985	2 700	162	27
1995	1 800	108	18
Reduction	33 %	33 %	33 %

Table 9.14 Estimated discharges from marine fish farming into the German part of the Baltic Sea catchment area for the late 1980s and 1995.

	Fish production (tonnes/year)	N discharges (tonnes/year)	P discharges (tonnes/year)
1985	N/A	N/A	N/A
1995	110	1.7	0.2
Reduction	–	–	–

N/A: No information available

All information is from the German implementation report of HELCOM Recommendation 15/3 for 1995.

9.1.2.4 Anthropogenic losses from agricultural areas

Table 9.15 shows the changes in agricultural area, livestock number and application of mineral fertilisers within the German part of the Baltic Sea catchment area. According to these data, the reduction of the total agricultural area is 13.3 %. The livestock numbers show different reductions, between 36 and 72 %. Based on livestock units, a reduction of 48 % was estimated. The decrease of the use of mineral fertiliser amounts to 41 % for nitrogen and 52 % for phosphorus. Table 9.15 provides data on nutrient inputs to agricultural area from applied mineral and organic fertilisers, as well as the inputs caused by legumes and atmospheric deposition, which can be an important part of the nitrogen balance.

Table 9.15 Changes of agricultural area, livestock numbers and mineral fertiliser application in the German part of the Baltic Sea catchment area between the late 1980s (mean 1987–1989) and 1995 [6].

	Unit	Mean 1987–89	1995	Reduction (%)
Agricultural area*	ha	1 857 500	1 610 800	13.3
Agricultural area (CORINE data)**	ha	1 896 400	1 896 400	0.0
Cattle	number	5 338 300	3 395 200	36.4
Pigs	number	9 463 300	3 060 800	67.7
Sheep	number	1 542 800	555 800	64.0
Poultry	number	35 090 100	20 154 800	42.6
Livestock units	LU	9 317 300	4 864 000	47.8
Nitrogen in manure	tN/y	105 300	59 100	43.9
Mineral nitrogen fertiliser	tN/y	244 900	150 200	38.7
N-input by legumes	tN/y	18 500	14 900	19.5
Atmospheric deposition	tN/y	53 600	33 900	36.8
Total nitrogen inputs	tN/y	422 300	258 100	38.9
Nitrogen output by crops	tN/y	172 900	161 700	6.5
Nitrogen surplus in agricultural areas	tN/y	249 400	96 400	61.3
Phosphorus in manure	tP/y	27 400	14 700	46.4
Mineral phosphorus fertiliser	tP/y	52 000	25 500	51.0
Total phosphorus inputs	tP/y	79 400	40 200	49.4
Phosphorus output by crops	tP/y	34 100	32 300	5.3
Phosphorus surplus in agricultural areas	tP/y	45 300	7 900	82.6

** Data on the agricultural area in late 1980s and 1995 cannot be used for calculations because there are changes in the statistical base, especially for the part of the former GDR.*

*** This agricultural area was estimated by overlaying the CORINE land cover map with the boundaries of the German part of the Baltic Sea catchment area (for the period 1989-1992).*

Table 9.16 Changes in agricultural area, livestock numbers and mineral fertiliser application in the Baltic Sea part of the federal state Schleswig-Holstein between the late 1980s (mean 1987–1989) and 1995 [6].

	Unit	Mean 1987–89	1995	Reduction (%)
Agricultural area*	ha	360 143	351 550	2.4
Cattle	number	1 489 580	1 398 080	6.1
Pigs	number	1 540 700	1 268 740	17.7
Sheep	number	208 590	237 010	–13.6
Poultry	number	3 138 940	2 709 110	13.7
Livestock units	LU	2 081 640	1 894 650	9.0
Nitrogen in manure	tN/y	25 222	23 554	6.6
Mineral nitrogen fertiliser	tN/y	46 855	37 932	19.0
N-input by legumes	tN/y	3 721	3 902	–4.9
Atmospheric deposition	tN/y	12 365	11 531	6.7
Total nitrogen inputs	tN/y	88 799	76 919	13.4
Nitrogen output by crops	tN/y	41 476	40 604	2.1
Nitrogen surplus in agricultural areas	tN/y	47 323	36 315	23.3
Phosphorus in manure	tP/y	6 483	5 871	9.4
Mineral phosphorus fertiliser	tP/y	9 280	4 535	51.1
Total phosphorus inputs	tP/y	16 014	10 406	35.0
Phosphorus output by crops	tP/y	8 055	7 804	3.1
Phosphorus surplus in agricultural areas	tP/y	7 947	2 601	67.3

** The data on the agricultural area in late 1980s and 1995 cannot be used for calculations due to changes in the statistical base, especially for the former GDR.*

Table 9.17 Changes of agricultural area, livestock numbers and mineral fertiliser application in the German part of the new federal states within the Baltic Sea catchment area between the late 1980s (mean 1987–1989) and 1995 [6].

	Unit	Mean 1987–89	1995	Reduction (%)
Agricultural area*	ha	1 497 400	1 259 200	15.9
Cattle	number	3 848 800	1 997 100	48.1
Pigs	number	7 922 600	1 792 100	77.4
Sheep	number	1 334 200	318 800	76.1
Poultry	number	31 951 200	17 445 700	45.4
Livestock units	LU	7 235 700	2 969 300	59.0
Nitrogen in manure	tN/y	80 100	35 600	55.6
Mineral nitrogen fertiliser	tN/y	198 000	112 300	43.3
N-input by legumes	tN/y	14 700	11 000	25.2
Atmospheric deposition	tN/y	41300	22 300	46.0
Total nitrogen inputs	tN/y	334 100	181 100	45.8
Nitrogen output by crops	tN/y	131 400	121 100	7.8
Nitrogen surplus on agricultural areas	tN/y	202 700	60 100	70.4
Phosphorus in manure	tP/y	20 900	8 800	57.9
Mineral phosphorus fertiliser	tP/y	42 700	21 000	50.8
Total phosphorus inputs	tP/y	63 600	29 800	53.1
Phosphorus output by crops	tP/y	26 100	24 500	6.1
Phosphorus surplus on agricultural areas	tP/y	37 500	5 300	85.9

* *The data on the agricultural area in late 1980s and 1995 can not be used for calculations because there are changes in the statistical base especially for the part of the former GDR.*

Further, the table shows the results for the estimated nutrient outputs from agricultural areas by crops and as the result of the total inputs and outputs the estimated nutrient surpluses on the agricultural areas. All of these data are taken for the individual federal states from the report of Behrendt *et al.* [6] and calculated for the agricultural areas within the Baltic Sea catchment area. The reduction figures presented in Table 9.15 are mean values for the whole German Baltic Sea catchment area. Within this area the reductions are not homogeneously distributed. The highest reductions occur in the area of the new federal states (Mecklenburg-Vorpommern, Brandenburg and Saxonia; see Table 9.17). This is caused by the socio-economic changes in the former GDR. Especially the reductions of livestock numbers is higher for the new federal states than for the old states located in the Baltic Sea catchment area.

The data presented in Table 9.15 can be used to separate the agricultural changes within different parts of the Baltic Sea catchment area. Table 9.18 presents the estimated background discharges from agricultural areas within the German catchment of the Baltic Sea. Because the background calculations were based on the CORINE land cover data base, changes in these background data within the time periods considered was not estimated.

Table 9.18 Nutrient background discharges from agricultural areas into the freshwater systems.

	1983–1987	1993–1997
Phosphorus background from agricultural areas (tP/y)	130	130
Total background of phosphorus (tP/y)	200	200
Nitrogen background from agricultural areas (tN/y)	4 200	4 200
Total background of nitrogen (tN/y)	5 400	5 400

If the nutrient background is taken into account, nutrient discharges from agricultural areas to surface waters can be estimated for the late 1980s and the mid-1990s with the MONERIS model [6]. These results are given in Table 9.19.

Table 9.19 Losses from agricultural areas into the freshwater systems of the German part of the Baltic Sea catchment area for the time period 1983–1987 and 1993–1997.

	1983–1987	1993–1997	Reduction (%)
Nitrogen (tN/y)	35 190	26 120	25.8
N loss (kgN/ha y)	18.6	13.8	25.8
Phosphorus (tP/y)	598	640	–7.0
P loss (kgP/ha y)	0.32	0.34	–7.0

The estimated anthropogenic losses from agricultural areas to freshwater systems within the German part of the Baltic Sea catchment do not include changes in agricultural area, since the calculations were also conducted using CORINE land use data. These losses include inputs from pathways such as groundwater (only the agricultural area), tile drainage, erosion and surface runoff.

A comparison of losses from each pathway for both time periods shows that the reduction of nitrogen losses is mainly due to decreased losses from tile drainage, whereas losses from groundwater show only very small changes within this time period. The smaller estimated increase in phosphorus losses is due to estimated water flow from surface runoff in the period 1983–1987 compared to 1993–1997.

In addition to nutrient discharges from agricultural areas (i.e., both the background and anthropogenic part), the background and anthropogenic parts of other diffuse sources (i.e., direct atmospheric deposition to the surface waters and groundwater discharges from non-agricultural areas) must be considered in estimating the total diffuse inputs to freshwater systems of the catchment area. These results were presented in Table 9.20.

Table 9.20 Discharges from non-agricultural areas to freshwater systems of the German part of the Baltic Sea catchment area.

	1983–1987	1993–1997	Reduction (%)
Nitrogen (tN/y)	1 670	890	46.0
Phosphorus (tP/y)	111	69	37.8

9.1.3 Total discharges within the German part of the Baltic Sea Catchment area

Tables 9.21 and 9.22 present an overview on nutrient discharges from various sources and the reductions achieved. The tables also include data on measured load from eight river basins within the German Baltic Sea catchment area. The reductions in the loads are comparable to the reductions of discharges. Differences can be explained as follows:

- Differences in retention of nitrogen and phosphorus in surface water systems in both time periods. Especially for phosphorus, the retention is partly influenced by desorption of phosphorus from the sediments of eutrophic lakes in the summer.
- Differences within the reduction of discharges in the various regions, which are characterised by a different specific runoff and hydraulic load, are the main driving forces for nutrient retention within river systems, according to Behrendt and Opitz [1].

- The reduction of direct municipal and industrial discharges is larger than the reduction of total discharges caused within the river systems of the German part of the Baltic Sea catchment area. If the sources located only in these areas are considered, the estimated reduction within the area of the river systems is only 26 % for nitrogen and 48 % for phosphorus.

Further, it should be noted that changes in loads could not be calculated for total nitrogen and total phosphorus, as these parameters have only been measured in most rivers since 1989. The loads for the years 1989 and 1990, however, are not representative for the situation in late 1980s, because both years were very dry.

Table 9.21 Total nitrogen emissions from point sources and agriculture at source in the German Baltic Sea catchment area and reductions achieved between the late 1980s and 1995.

Source	Discharges, late 1980s (t/y)	Discharges, 1995 (t/y)	Reductions achieved (%/t)
Municipal discharges	16 050	8 610	46 / 7 440
Industrial discharges	1 920	1 140	41 / 780
Discharges from fish farms	162	108	33 / 54
TOTAL point sources	18 132	9 858	46 / 8 274
Surplus on agricultural areas	249 400	96 400	61 / 153 000
TOTAL	267 532	106 258	60 / 161 274

The 50 % reduction target concerning nitrogen emissions at source has been achieved in Germany.

Table 9.22 Total discharge of nitrogen of the German Baltic Sea catchment area and reductions achieved between the late 1980s and 1995.

Source	Discharges, 1985 (t/y)	Discharges, 1995 (t/y)	Reductions achieved (%/t)
Direct municipal discharge to the Baltic Sea*	9 100 (8 330)	4 670 (4 180)	48.7 / 4 430 (49.8 / 4 150)
Municipal discharge into surface freshwaters*	6 950 (5 550)	3 940 (3 060)	43.3 / 3 010 (44.9 / 2 490)
Direct industrial discharge to the Baltic Sea	150	50	66.7 / 100
Industrial discharge into surface freshwaters	1 770	1 090	38.4 / 680
Discharges from fish farms	162	108	33 / 54
Estimated anthropogenic discharges from agricultural areas into surface waters+	35 190	26 120	25.8 / 9 070
Other anthropogenic diffuse sources+	1 670	890	46.0 / 780
Natural Background	5 400	5 400	0
GRAND TOTAL	60 390	42 270	30.0 / 18 120
Calculated load, excluding direct discharges	29 020	21 630	25.5
River load (8 rivers: 12 840 km² = 46 %) only N-TOT**+	9 310	7 630 N-TOT: 9 370	18.1

The numbers in brackets give the discharges by MWWTPs without discharges from urban areas.
*** N-TOT was not measured before 1989.*
+ These discharges are averages for the period 1983–1987 and 1993–1997.

To reach the 50 % reduction regarding total discharges to freshwater systems, the load would have to be reduced by 9 400 t N/y nitrogen (34 % of the total reduction of 28 050 tN/y), but this would require hydrological measures which are beyond currently practical measures.

Table 9.23 Total discharge of phosphorus and reductions achieved between the late 1980s and 1995.

Source	Discharges, 1983–1987 (t/y)	Discharges, 1993–1997 (t/y)	Reductions achieved (%/t)
Direct municipal discharge to the Baltic Sea*	1 566 (1 467)	231 (161)	85.2 / 1 335 (89.0 / 1 306)
Municipal discharge into surface freshwaters*	1 183 (1 012)	361 (258)	69.5 / 822 (74.5 / 754)
Direct industrial discharge to the Baltic Sea	14	4	71.4 / 10
Industrial discharge into surface freshwaters	426	44	89.7 / 382
Discharges from fish farms	27	18	33.3 / 9
Estimated anthropogenic discharges from agricultural areas+	598	640	-7.0 / -42
Other diffuse anthropogenic discharges+	111	69	37.8 / 42
Natural Background	200	200	0.0 / 0
GRAND TOTAL	4 125	1 567	62.0 / 2 558
Calculated load with exception of direct discharges	780	454	41.8
River load (8 rivers: 12 840 km^2 = 46%) only P-TOT**+	235	106 P-TOT: 273	54.9

** The numbers in brackets give the discharges by MWWTP's without discharges from urban areas*
*** P-TOT is not measured before 1989*
+ These discharges are averages for the period 1983–1987 and 1993–1997

The 50 % reduction target concerning phosphorus load has been achieved in Germany.

9.1.4 Clarification of differences between load figures reported earlier

9.1.4.1 Discharges from municipal wastewater treatment plants (direct/indirect)

The discharge data of nitrogen and phosphorus from MWWTPs into the German part of the Baltic Sea catchment area are in complete agreement with data already used by HELCOM. Differences exist in the differentiation between direct and indirect discharges compared to PLC-2 and PLC-3. In the PLC-2 and PLC-3 reports, the MWWTPs of all non-monitored and partly monitored areas were considered as direct discharges, but in this report direct discharges are only related to MWWTPs discharging directly to the Baltic Sea.

9.1.4.2 Discharges from industry (direct/indirect)

Compared with HELCOM data sets, differences exist only for the late 1980s. This can be explained by misinterpretation of the published data of Werner and Wodsak [6] and the fact that industrial discharges were not considered for this time period for the Schleswig-Holstein part of the German Baltic Sea catchment area. The data of Werner and Wodsak [5] of 900 tN/year and 220 tP/year do not correspond to direct industrial discharges to the Baltic Sea. These numbers represents the discharges from industry into the whole part of the former GDR Baltic Sea catchment area, with the exception of areas located in the Oder catchment area. Consequently, the data used by HELCOM for indirect discharges are only the indirect discharges into the German part of the Oder catchment area.

In addition to the area of the former GDR, the new estimates consider also industrial discharges from Schleswig-Holstein, and split the data set correctly into a part which is discharged directly into the coastal zone and a part which is discharged into the river systems of the German Baltic Sea catchment area. The official direct discharges from industry given in PLC-2 and PLC-3 were used for this apportionment.

9.1.4.3 Fish farming

The very rough estimates of discharges from fish farming into the German part of the Baltic Sea catchment area for the late 1980s should be used only as a guide. It can be assumed that these discharges were much lower in 1995, since most fish farms in the former GDR were closed after unification.

9.1.4.4 Agriculture

The existing HELCOM data set on agricultural uses and losses in the German Baltic Sea catchment area differs slightly from that given in Tables 9.15 through 9.18. The small differences regarding estimated annual losses can be explained by the fact that the HELCOM data set was derived from a draft version of the MONERIS model.

9.1.5 Conclusions

9.1.5.1 Phosphorus

Regarding phosphorus, the overall target for a 50 % reduction in 1995 compared to the late 1980s has been reached.

9.1.5.2 Nitrogen

1. Nitrogen emissions from point sources and agriculture at source in the German Baltic Sea catchment area

The data show clearly that:

- Discharges from point sources (emissions at source) show reductions by about 46 % for MWWTPs and 41 % for industrial plants.
- Anthropogenic losses from agricultural areas show reductions of emissions at source (nitrogen surplus on agricultural areas) by about 61 % for nitrogen, which is mainly due to the dramatic change in livestock units (reduction of ca. 48 %), a proportional reduction in manure application (–44 %) and a reduction of the use of mineral nitrogen fertiliser (–39 %), particularly in the new federal states, which represent the largest contributors within the German catchment area.

Thus no further reduction measures are necessary to be taken at the source of agricultural emissions, but increasing the nitrogen surplus on agricultural areas should be avoided by practising Good Agricultural Practices. Taking into account diffuse sources weighted by their proportion within the catchment area (Schleswig-Holstein and Mecklenburg-Vorpommern) and point sources, the overall reduction of nitrogen at sources are more than 50% between the late 1980s and 1995.

2. Releases (discharges/losses) of nitrogen to surface freshwater in the German Baltic Sea catchment area

The analysis shows a reduction greater than the needed 50 % has already been reached through losses of the agricultural sector at source (nitrogen surplus in agricultural areas). The release from the agricultural areas and soils into the river systems is still higher than the discharges from agricultural sources. This is due to the fact that any further release of nutrients from fully loaded agricultural soils is due to leaching, groundwater transport and release to surface waters (both freshwater and marine water). This release cannot be controlled by practical technical measures at source, so inputs to river systems will remain at higher levels for a certain time period until the 50 % reductions at source become effective in the river systems. At present, the 61 % reduction of nitrogen surplus in agricultural areas has led to only a 26 % reduction of nitrogen reaching the freshwater systems in the German Baltic Sea catchment area.

The differences between the levels of reductions (i.e., nitrogen surplus in agricultural areas and nitrogen inputs into river systems) must be explained by the very long residence times of water within the unsaturated zone and in groundwater, which is on average is an order of magnitude of 20 to 30 years (increasing west to east). Further decreases in diffuse anthropogenic losses requires time and can no longer be influenced by anthropogenic technical and practical measures. If the average nitrogen surplus in agriculture in the German part of the Baltic Sea basin is maintained at the 1995 level, one can expect that the 50 % reduction at source will be reflected in aquatic systems between 2020 and 2030.

The small reductions needed to achieve specific nitrogen targets for direct and indirect discharges from municipalities and industry will be reached in combination with the EC Wastewater Directive. If the targets for the different size classes of MWWTPs according to the Directive are compared to the present situation, one can expect a substantial further reduction of nitrogen and phosphorus discharges from municipalities.

3. Further development

But at least in the new German federal states, nitrogen surpluses are once again increasing in recent years (after 1995) [6]. Therefore additional measures are necessary to maintain the target reduction level of 50 % which has already been achieved. These measures include a stabilisation of nitrogen surplus levels in agriculture at a certain unified level for all German federal states (i.e., Good Agricultural Practice), and (depending on this level) a reduction in discharges from tile drains (e.g. decreasing tile drains or other hydrology-related measures). Further, retention during transport in the freshwater system has to be considered.

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Latvian national report on nutrient loads

10

Sarmite Lucane, Latvian Environment Agency

10.1 Nutrient loads and reduction achieved

10.1.1 Methods used for calculation

Municipal discharges

There is no measured pollution load data by sector for the late 1980s as is needed to assess the implementation of the 1988 Ministerial Declaration. From statistical reports there is some information about trends in sewage treatment in the late 1980s, especially for the city of Riga [1,2,3]. The current computerised information system on water protection data has only been in place since 1991. Therefore detailed data on water consumption and discharges from industry and municipal treatment plants are available only beginning in 1991.

Information on discharges entering directly to the Baltic Sea (volume as well as nitrogen and phosphorus load figures) from municipal sewage effluents for the years 1990 and 1995 was obtained from PLC-2 and PLC-3 reports.

Discharges from municipal sewage effluents into surface freshwaters in the Baltic Sea catchment area were estimated using State Statistical Reports on water consumption and wastewater discharges "2-water" in 1991 and 1995 [4, 5].

In the former Soviet Republics, industrial wastewater was generally treated together with municipal wastewater in municipal wastewater treatment plants, and thus there is no information to separately estimate industrial loads. Therefore the discharges from MWWTPs are taken as municipal loads.

Even taking into account information included in the Statistical Reports, it was not possible to apportion load data from MWWTPs according to size categories as was requested in the questionnaire adopted by the Technological Committee of the Helsinki Commission. According to new reporting procedure, information on population equivalents (PE) will be an obligatory parameter in Latvia for water users beginning in 2000 (PLC-4 guidelines).

Industrial discharges

Information about direct industrial discharges into the Baltic Sea (nitrogen and phosphorus load) was taken from PLC-2 and PLC-3 Reports [6]. Nitrogen and phosphorus discharges from industries into surface freshwaters in the Baltic Sea catchment area were estimated on the basis of the State Statistical Reports on water consumption and wastewater discharges "2-water" in 1991 and 1995 [4].

Latvia is a relatively small country, so reductions of nitrogen and phosphorus in some industries have been achieved by decreasing industrial production or closing certain enterprises. After regaining independence in 1991, industrial activity has declined, especially in the chemical and pulp and paper industries. On the other hand, increasing nitrogen and phosphorus loads from the food processing industry have been observed.

Discharges from fish farms

Discharges from fish farms were taken from the State Statistical Report on water consumption and wastewater discharges "2-water" [4]. This sector has drastically declined from 1991 to 1995, and reduction of nitrogen and phosphorus load is close to 100%. In the mid-1990s the fish farming industry began to grow, so future increases in nitrogen and phosphorus loads could be observed in this sector.

Discharges from agriculture

There are many difficulties in estimating discharges from agriculture, especially for the late 1980s. There were no monitoring programmes in Latvia specially designed to assess pollution from agricultural sources until 1993.

In Latvia, monitoring of agricultural runoff was started in 1993 through a joint project of the Agricultural University of Latvia, the Swedish Agricultural University in Uppsala and the Norwegian Jordforsk Institute of the Agricultural University [7]. There were three monitored catchments with different agricultural intensities (low, moderate and intensive).

The results of the project in 1994 and 1995 show that nitrogen and phosphorus losses vary widely. The lowest losses measured were 1.8 kg/ha y for N and 0.07 kg/ha y for P, while the largest losses were 19.6 and 0.69 kg/ha y respectively. The range in losses depends on agricultural land management, farming practices and meteorological conditions [8].

On the basis of the statistical data concerning the consumption of mineral fertiliser and additional information submitted by the Latvian Agricultural University [8], which were needed to calculate discharges, Latvian experts have estimate discharges from agricultural lands in 1990 and 1995. The nitrogen and phosphorus content of manure was taken from "Manure norms in Latvia" [9].

10.1.2 Nitrogen and phosphorus discharge to the water bodies

Municipal discharges

Based on the calculation methods described in Section 10.1.1 the direct and indirect discharges of nutrients from municipal wastewater treatment plants were calculated. The results are presented in Tables 10.1 and 10.2 respectively.

Table 10.1 Discharges of nitrogen and phosphorus from municipalities entering directly to the Baltic Sea.

N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
5 322	1 143	79	658	334	49

Table 10.2 Discharges of nitrogen and phosphorus from municipalities entering into surface freshwater in the Baltic Sea catchment area.

N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
5 671	2 455	57	561	403	28

Discharges from industry

Based on the calculation methods described in Section 10.1.1 the direct and indirect discharges of nutrients from industries were calculated. The results are presented in Tables 10.3 and 10.4 respectively.

Table 10.3 Discharges of nitrogen and phosphorus from industries entering directly into the Baltic Sea.

Industry	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Chemical	4.43	0.05	99	0.39	0.25	36
Food processing	23	37	–62	10	7	30
Pulp and paper	247	95	62	29	16	45
Other industry	146	133	9	20	23	–15
TOTAL	420	265	37	60	46	23

Table 10.4 Discharges of nitrogen and phosphorus from industries entering into surface freshwater in the Baltic Sea catchment area.

Industry	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Chemical industry	142	116	18	21	21	0
Food processing	164	88	46	52	21	60
Pulp and paper	131	60	54	13	9	31
Other industry	524	217	59	95	26	73
TOTAL	960	480	50	180	77	57

Loads from fish farms

Discharges from fish farms were taken from the State Statistical Report on water consumption and wastewater discharges "2-water" [4]. Results are presented in Table 10.5.

Table 10.5 Estimated discharges of nitrogen and phosphorus from freshwater and marine fish farms.

Nutrient	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	111	0.7	110.3	99
P-TOT	3	0.1	2.9	97

Loads from agriculture

Based on the methodology described in Section 10.1.1 the nutrient load from agriculture into the environment was estimated. The results are presented in Table 10.6

Table 10.6 Estimated discharges of nitrogen and phosphorus from agriculture.

Nutrient	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	33 760	17 130	16 630	49
P-TOT	1 013	514	499	49

Table 10.7 Supplementary indicators concerning the anthropogenic load from agriculture [10].

Indicators		Late 1980s	1995	Decrease (t/y)	Decrease (%)
Arable land (ha)		1 688 000	1 713 000	–25 000	–2
Number of livestock (animal units)		1 671 000	627 000	1 044 000	63
Total number of cattle		1 469 000	537 000	932 000	64
Total number of pigs		1 619 000	553 000	1 066 000	66
	Consumption of fertiliser (t/y)	212 688	20 566	192 132	90
	Consumption of manure (t/y)	78 052	26 758	51 294	66
N	Use of fertilisers and manure (kg/ha)	172	28	144	84
	Annual discharge (t/y)	33 760	17 130	16 630	49
	Discharge (kg/ha y)	20	10	10	50
	Losses %	12	36		
	Consumption of fertiliser (t/y)	114 784	8 565	106 219	93
	Consumption of manure (t/y)	23 565	8 078	15 487	66
P	Use of fertilisers and manure (kg/ha)	82	10	72	12
	Annual discharge (t/y)	1013	514	499	49
	Discharge (kg/ha y)	0,6	0,3	0,3	50
	Losses %	1	3		
Riverine runoff 10^6 m^3/y		48 807	31 346	17 461	36
N-tot load from rivers		88 557	80 811	7746	9
P-tot load from rivers		2 531	1 555	976	39

10.1.3 Overall reduction of nutrient load to the environment achieved

During the period between the 1980s and 1995 significant decrease can be observed in the pollution load, as shown in Table 10.8.

Table 10.8 Total discharge of nitrogen to the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
Direct municipal discharge	5 322	1 143	4 179	79
Indirect municipal discharge	5 671	2 455	3 216	57
Direct industrial discharge	420	265	155	37
Indirect industrial discharge	960	480	480	50
Discharge from fish farms	111	1	110	99
TOTAL from point sources	12 496	4 344	8 152	65
Discharge from agriculture	33 760	17 130	16 630	49

Significant reductions in nitrogen load from all pollution sources (except direct industrial discharges) were observed in Latvia. The reduction of municipal load is connected to the construction of new and reconstruction of old wastewater treatment plants as well as to reductions in water consumption. The reduction of industrial and agricultural loads is manly connected to the economic changes.

Table 10.9 Total discharge of phosphorus into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

	Load late 1980s (tonnes/year)	Load 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
Direct municipal discharge	658	334	324	49
Indirect municipal discharge	561	403	158	28
Direct industrial discharge	60	46	14	23
Indirect industrial discharge	180	77	103	57
Discharge from fish farms	3	0.1	2.9	97
TOTAL from point sources	1 462	860	602	41
Discharge from agriculture	1 013	514	499	49

Significant reductions in phosphorus load from all pollution sources except direct industrial discharges has taken place from the late 1980s to 1995. The overall 50 % reduction target has not yet been fulfilled.

10.1.4 Clarification of differences between load figures published earlier

There are no differences with the load figures published earlier by HELCOM. The main reason for lacking more precise information on pollution load data for the late 1980s is that, during the Soviet era, Latvian environmental protection authorities were not organised to monitor of municipal, industrial and agricultural pollution sources. In addition, different measurement, calculation and chemical analysis methods, as well as different geographic areas, for calculating loads, were used.

10.2 Water protection targets

10.2.1 Legal framework

Protection of water bodies against pollution in Latvia is provided in particular through the following legislation:

- The Law on Environmental Protection (1991) includes both protection against pollution as well as other forms of water resource use.
- The Law on Natural Resources Tax (1995) determines fees and requires a permit for the use and pollution of waters.
- The Regulation on Water Use Permits (CM 155, April 22, 1997; Amendments- CM 17, January 20, 1998, Amendments- CM 437, November 17, 1998) applies to both polluting activities and to water management. Both issues are considered simultaneously and included in the same permit. The Regulation is directly subordinated to the Natural Resources Tax Law and the Law on Subsoil (1995).
- The Regulation for the use of effluent sludge in the fertilisation of soil and in organising territorial public services (CM 316, September 9, 1997) prescribes

the procedure of using effluent sludge in soil fertilisation and the organisation of territorial public services and methods of determination and inspection in order to prevent a direct or indirect adverse cumulative effect on the environment including water.

The most important legislation is the Water Use Permit Regulation (1997), which applies to both the pollution and extraction of water and the use of inland and sea water within Latvia.

Since Latvia is moving towards EU membership, the transposition and implementation of European Union environmental legislation into national laws is the priority at the moment. In addition the 1992 Helsinki Convention was ratified by the Latvian Parliament in 1994, and Latvia has acknowledged its obligations to fulfil all requirements concerning the protection of the Baltic Sea.

10.2.2 The National Environmental Policy Plan

The Cabinet of Ministers of the Republic of Latvia accepted the National Environmental Policy Plan (NEPP) on April 25, 1995. Water quality and the degradation of inland aquatic ecosystems and the Baltic Sea were some of the prior environmental problems mentioned in the NEPP.

The main goal for water protection is to reduce pollution load from different types of activities (households, industry, agriculture, forestry, etc.). The NEPP sets targets regarding point sources designed to minimise pollution loads, in order to reduce total nitrogen emissions from point sources to 50 % of 1995 levels by the year 2010.

This group of measures includes:

- *Improvement of household wastewater treatment/management technologies and the technical condition and operation of sewerage networks*. The main instruments for solving these problems are policies supporting investments and loans; setting prices for water supply and wastewater services in accordance with the real costs of these services; and improving the administration of water supply and wastewater services, which may also include change in ownership status.
- *Construction of new wastewater treatment facilities and expansion of sewerage systems*. The above-mentioned instruments should be applied along with construction and expansion of facilities. An integrated approach would be of greatest benefit, which can be ensured by correct territorial planning (e.g., the law "On territorial planning") and a comprehensive environmental impact assessment (EIA) for choosing discharge sites and the most appropriate wastewater treatment technologies.
- *Water resource saving and reduction of consumption in the production, services and domestic sectors.* This can be implemented by using instruments such as the natural resources tax, pricing policies connected with water use, as well as the education of the population (consumers), i.e. formation of public opinion.
- Introduction of environmentally-friendly technologies and household products into the services and domestic sectors. Particular attention should be paid to custom duty policy, the certification of domestic chemical products, the use of the State Environmental Expertise, as well as the influencing of public opinion.

Concerning the reduction of diffuse pollution a group of measures has been elaborated, the implementation of which would reduce diffuse emissions of biogenic substances (e.g., nitrogen, phosphorous, organic substances) into watercourses from agricultural lands and fertiliser storage, diffuse pollution from transport that enters watercourses as rainwater runoff from highways and roads, as well as local and transboundary air pollution.

This group of measures includes:

- reduction of agricultural pollution;
- reduction of transport pollution;
- reduction of air pollution;
- introduction of coastal protective belts and associated requirements;
- reorganisation, improvement and environmentally friendly operation of melioration systems.

Reduction of industrial pollution is addressed separately. A group of measures to reduce toxic emissions from industrial sources includes:

- introduction of environmentally-friendly technologies on the basis of the 'best available technology' and substitution principles. This can be achieved by the application of appropriate investments, loan and tax policies, customs duties on environmentally unfriendly raw materials and production certification;
- treatment and pre-treatment of industrial wastewater, as well as the practical utilisation or environmentally safe storage of toxic sludge; and practical utilisation or environmentally safe storage of industrial wastes.

Reduction of the hydro-technical burden

These are measures to mitigate the negative impacts of hydro-technical constructions on water quality and aquatic ecosystems, including the redrafting of regulations and standards for the design, construction and operation of hydro-technical installations, strengthening the EIA requirements, guaranteeing fish migration paths, and the implementation of environmentally-friendly operational regimes.

Sustainable use of biological water resources, ensuring the interests of resource users, and avoiding the destabilisation of ecosystems and degradation of biotopes.

Effect-oriented measures

A group of measures for the rehabilitation of natural watercourses and increasing the self-purification ability of aquatic ecosystems:

- restoring the natural course of straightened rivers;
- removal of heavily polluted sludge and sediment from the beds of watercourses;
- rehabilitation of overgrown lakes;
- maintenance of watercourses and their riparian zones (removal of sludge, harvesting of aquatic plants, regulation of overgrowth, restoration of benthic and littoral zone biodiversity, restoration of fish spawning and feeding grounds).

Environmental impact of agriculture

Agricultural production constitutes a significant proportion of the national economy. Therefore it substantially influences the environment and causes a large number of environmental problems:

- soil pollution and erosion;
- water pollution, both inland and the Baltic Sea; organic pollution leading to eutrophication and pollution with pesticide residues and heavy metals.
- reduction of biodiversity and degradation of rural landscapes.

During the present stage of national economic development, it is important to balance environmental requirements with the development of modern agricultural practices. Therefore environmental policy in the agricultural sector should be co-ordinated with national agricultural policies and national programmes for rural development.

Since the collapse of the socialist mass-production system of agriculture which took place in 1990, total production has fallen by 50 %. Its effect on the environment has also decreased correspondingly.

Potential agricultural pollution vectors in 1994 compared to 1986 (in percent):

- Use of mineral fertilisers: 40
- Use of organic fertilisers: 30
- Use of pesticides: 13
- Number of cattle: 42

10.2.3 Agriculture development programmes

Agricultural production has declined since 1990. Fertiliser usage has decreased about 90 % and pesticide usage about 88 %. Threefold decreases in the number of cattle and pig farms of have been observed, as well as production and usage of organic manure. Total pollution levels are low but some substantial point sources (e.g., farms and some pesticide and fertiliser storage sites) still exist.

Latvia has not set any specific targets in figures for phosphorus and nitrogen load reduction from agriculture. In general, agriculture development programs contain several measures for reducing pollution from agriculture. The following measures and research are planned:

- Investments under the SAPARD Rural Development Plan programme "Environmentally friendly methods in agriculture"
- Using of environmental criteria for supporting activities in agriculture.
- Publishing of study materials about environmentally friendly agriculture.

An important step in the prevention from the nitrogen pollution from agriculture is the implementation of the EU Nitrate Directive (91/676/EEC) and Code of Good Agricultural Practice in Latvian legislation. Currently draft regulations for protecting water bodies and water courses from nitrogen pollution from agricultural sources have been elaborated.

10.2.4 State program 800: Water Supply and Sewerage in Small and Medium-Sized Latvian Towns and Large Cities

The strategy for improving the water supply and sewerage in small and medium-sized towns aims to improve the water quality in the Baltic Sea, the Gulf of Riga and other receiving waters by reducing pollution loads arising from the discharge of untreated sewage.

The strategy incorporates objectives set in the National Strategy as defined by National Environmental Policy Plan (NEPP), which identifies following priorities:

- Serious threats to human health, e.g. low-quality drinking water;
- Irreversible changes in ecosystems, with particular respect to decreasing biodiversity and landscape deterioration, e.g. caused by eutrophication and deterioration of water ecosystems and transboundary pollution; and
- Latvia's international agreements and commitments to improve environmental quality e.g. HELCOM and EU;

As well as principal points of the Public Investment Programme, e.g.:

- preservation of the present system of water supply, wastewater treatment and infrastructure, and improvement of its functionality;
- construction of new water supply and wastewater treatment installations in areas where poor environmental quality has significant impacts on public health; and
- development of a monitoring and information system on water quality and management.

The strategy envisages application of HELCOM and EU Wastewater Treatment Directive requirements on effluent standards. In signing the EU Association Agreement, Latvia has undertaken measures to harmonise its national legislation with EU guidelines and directives and to provide for their implementation.

Strategic priorities include:

- Water management improvement in large cities (Riga, Daugavpils, Liepaja) by the year 2010;
- Water management improvement in towns with more than 2 000 inhabitants by the year 2015.

The total investments required for implementation of the programme is 580 million lats (LVL), of which 310 million LVL are intended for sewage treatment and the rest for improvement of preparation of drinking water [11].

Table 10.10 Sewage treatment parameters. [12]

Size of town (population equivalent*)	Maximum permissible concentration in sewage [mg/l] **				
	BOD_5	COD	Suspended solids	P-TOT	N-TOT
>100 000 (to be enforced by 2001)	25	125	35	1	10
10 000–100 000 (to be enforced by 2006)	25	125	35	2	15
2 000–10 000 (to be enforced by 2006)	25	125	60		
< 2 000 (to be enforced by 2006)	If sewage is discharged to a river with a high selfpurification capacity, mechanical purification may be sufficient.				

** Calculation based on biological oxygen demand in 5 days, which is 60 g/day per inhabitant equivalent.*
***According to EU Directives.*

Table 10.11 Status of the implementation of water projects in 1999. [11]

Project status	Number of projects	Number of towns involved	Number of inhabitants involved
Completed	6	6	12 622
Implementation phase	22	22	1 226 547
Feasibility study	35	35	418 376

10.2.5 Urban Waste Water Treatment Directive

Directive 91/271/EEC (UWWTD) aims to protect surface inland water and coastal waters by regulating collection and treatment of urban wastewater and discharge of certain biodegradable industrial wastewater (basically from the agro-food industry). As a rule, it requires establishment of sewerage systems and secondary (i.e. biological) treatment for all agglomerations larger than 2 000 PE. More advanced treatment is required for so-called sensitive areas (i.e. water bodies subject to eutrophication or in danger to become so). For certain marine waters, mechanical treatment might be sufficient, if it can be proven that water quality is not adversely affected.

List of agglomerations affected by the UWWTD

Based on statistical data from 1999, agglomerations affected by the UWWTD were identified, and a list comprising 61 cities and towns whose population is above 2 000 was developed, as shown in Table 10.12.

Table 10.12 Agglomerations in Latvia that must have wastewater collecting systems according to the UWWTD. [13]

No.	City/town	Population	No.	City/town	Population
1.	Riga	796 732	32.	Aizpute	6 050
2.	Daugavpils	115 450	33.	Smiltene	5 847
3.	Liepaja	95 427	34.	Lielvarde	5 014
4.	Jelgava	70 931	35.	Grobina	4 665
5.	Jurmala	58 865	36.	Vilani	4 341
6.	Ventspils	46 501	37.	Balozi	4 351
7.	Rezekne	40 557	38.	Vangazi	4 137
8.	Valmiera	28 593	39.	Plavinas	3 937
9.	Jekabpils	28 384	40.	Kandava	3 955
10.	Ogre	27 783	41.	Ikskile	3 858
11.	Tukums	19 402	42.	Rujiena	3 773
12.	Cesis	19 270	43.	Saulkrasti	3 688
13.	Salaspils	18 549	44.	Salacgriva	3 633
14.	Kuldiga	13 184	45.	Auce	3 545
15.	Olaine	12 968	46.	Dagda	3 242
16.	Talsi	12 958	47.	Ilukste	3 194
17.	Saldus	12 598	48.	Broceni	3 157
18.	Dobele	12 502	49.	Priekule	3 021
19.	Kraslava	12 028	50.	Skrunda	2 827
20.	Ludza	11 221	51.	Karsava	2 831
21.	Lvani	10 672	52.	Varaklani	2 527
22.	Sigulda	10 727	53.	Viesite	2 507
23.	Bauska	10 492	54.	Kegums	2 507
24.	Aluksne	9 814	55.	Kalnciems	2 242
25.	Gulbene	9 750	56.	Zilupe	2 219
26.	Aizkraukle	9 685	57.	Baldone	2 141
27.	Madona	9 608	58.	Lubana	2 131
28.	Limbazi	9 414	59.	Strenci	2 116
29.	Balvi	9 145	60.	Stende	2 034
30.	Preili	9 061	61.	Vilaka	2 009
31.	Valka	6 721			

Food Industries affected by the UWWTD

The UWWTD regulates the treatment and discharge of wastewater from the following industrial sectors:
- Milk processing
- Manufacture of fruit and vegetable products
- Manufacturing and bottling of soft drinks
- Potato processing

- Meat industry
- Breweries
- Production of alcohol and alcoholic beverages
- Manufacturing of animal feed from plant products
- Manufacturing of gelatine and of glue from hides, skin and bones
- Malt houses
- Fish processing industry

Approximately 58 wastewater treatment plants in the relevant industrial sectors were identified [13].

Identification of sensitive and less sensitive inland and coastal areas
Under Article 5 of the Urban Waste Water Directive, identification of sensitive areas based on the criteria set out in Annex II is required. There are three criteria [14]:
- fresh water bodies, estuaries and coastal waters which are eutrophic or which could become eutrophic if protective action is not taken;
- surface fresh waters intended for the abstraction of drinking water where the nitrate content is, or could become, more than 50 mg/l;
- areas where further treatment is necessary to meet the requirements of Council Directives such as quality of surface waters, fishing waters, bathing waters, shellfish waters.

Member States must review the identification of conservation of wild birds and natural habitats, etc. Meeting one of the above criteria is sufficient to designate a body of water as sensitive area every four years.

The identification of a water body as a sensitive area requires, for all agglomerations with more than 10 000 PE whose discharges are made into this area and into the relevant catchment areas contributing to the pollution of that area, collection and treatment systems more stringent than secondary treatment. These conditions concerning treatment do not apply for a sensitive area where it can be proved that the minimum reduction in the total nitrogen and phosphorus load is at least 75 % for each of the two parameters.

10.2.6 Industrial discharges reduction

There is no set separate specific target in figures for load from industrial point sources. The National Environmental Policy Plan for Latvia (1995) defines objectives and measures that have to be introduced in industry to prevent from water pollution.

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Lithuanian national report on nutrient loads

11

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11.1 Nutrient loads and reduction achieved

11.1.1 Description of calculation / assessment methods

Municipal and industrial discharges

One of the major problems when compiling this report was to obtain data for the late 1980s. A computerised database of discharges was introduced only in 1991. Therefore only since 1991 is raw data (statistical forms on use of water and discharge of pollutants) available for individual polluters in each of four categories:

- Discharge of municipal sewage effluents directly to the Baltic Sea
- Discharge of municipal sewage effluents to the catchment area of the Baltic Sea
- Discharge of industrial sewage effluents directly to the Baltic Sea
- Discharge of industrial sewage effluents to the catchment area of the Baltic Sea

Before 1991, annual reports presented only summary data on discharges to different river basins, regardless of pollution source (industry or urban agglomerations). The statistical reports provide no data on discharges of nitrogen and phosphorus for the years 1987 and 1988; therefore only 1989 data can be used [1]. In order to estimate discharges of nitrogen and phosphorus from municipal and (direct and indirect) industrial sources, the following assumptions were made:

Nitrogen

Assumption #1: *The proportion (in %) of nitrogen discharges in 1989 from each categories (direct/indirect municipal, and direct/indirect industrial discharges) is similar to those in 1992 and 1995.*

The basis for the assumption is provided in Table 11.1 below.

Table 11.1 Assumptions regarding discharge of nitrogen in 1989.

Type of discharge	N discharge, 1992 (%)	N discharge, 1995 (%)	Assumed N discharge in 1989 (%)
Municipal sewage effluents directly to the Baltic Sea	10.6	11.8	10
Municipal sewage effluents to the catchment area of the Baltic Sea	73.9	79.4	72
Industrial discharges directly to the Baltic Sea	3.7	3.9	3.5
Industrial discharges into surface freshwater in the Baltic Sea catchment area	11.8	4.9	14.5

Another methodological problem is caused by differences in the parameters monitored in 1989 and 1995. Before 1992, only inorganic nitrogen was monitored in sewage discharge. Therefore another assumption was adopted:

Assumption #2. *Inorganic nitrogen in sewage effluents comprises 70 % of total nitrogen ($N_{tot} = 1.43\ N_{inorg}$).*

The assumption was made after consultation with specialists in the laboratories of the regional Departments of Environmental Protection. In Lithuania, the majority of industrial sewage effluents are discharged to the municipal sewerage network, and Assumption #2 is based on analysis of sewage effluents.

The amount of total nitrogen discharged to surface waters from municipal (direct and indirect) and industrial (direct and indirect) sources in 1989 was calculated applying these two assumptions. The results of these calculation is presented in Table 11.2.

Table 11.2 Estimated discharge of total nitrogen from point sources in 1989 (Calculated using Assumptions #1 and #2).

Type of discharge	Assumed N discharge (%)	Calculated discharge of inorganic N (t)	Assumed discharge of total N (t)
Municipal sewage effluents directly to the Baltic Sea	10	777.4	1 112
Municipal sewage effluents to the catchment area of the Baltic Sea	72	5 597.4	8 004
Industrial discharges directly to the Baltic Sea	3.5	272.1	389
Industrial discharges into surface fresh waters in the Baltic Sea catchment area	14.5	1 127.3	1 612
Total point sources	100	7 774.2 [1]	11 117

In order to check the calculations presented above, an alternative method was applied using population data as a basis for calculation. The calculation was made applying the following formula:

$$N_{tot} = I \times 0.6 \times N_d / 1\,000\,000 \times 365$$

where:

N_{tot} = Amount of total nitrogen discharged per year in the late 1980s.
I = Number of inhabitants in Lithuania in late 1980s: (approximately 3.7 million).
0.6 = Proportion of population in late 1980s living in urban agglomerations > 2 000 PE.
N_d = Amount of total nitrogen discharged per inhabitant per day (12 g N/day).

Calculations by this method indicate that in late 1980s approximately 9 724 t of N_{tot} per year was discharged into the environment from urban agglomerations. This figure matches very well with the 9 116 t N_{tot} calculated using assumptions described in Section 6.1, with a difference of approximately 6 %.

Data on the capacity of urban wastewater treatment plants and the amounts of industrial effluents discharged to municipal sewerage network in the late 1980s is very limited. However, wastewater from the three largest agglomerations (Vilnius, Kaunas and Klaipeda) was discharged without biological treatment during this period. The amount of nutrients discharged with industrial effluents to municipal sewerage network in late 1980s was of the same magnitude as the capacity of municipal wastewater treatment plants.

Summing up the results obtained by two different methods, discharges of N-TOT from municipal sources in the late 1980s were 9 724 tonnes per year. Most stormwater in Lithuania is collected in separate collection systems. The figure provided does not include pollution by stormwater discharged into surface waters.

Phosphorus

Similar methodological problems occurred when trying to assess discharges of phosphorus in the late 1980s. Assessed phosphorus discharges calculated applying Assumptions #1 and #2 were very low compared to nitrogen discharges and it was decided to calculate phosphorus discharges according to HELCOM guidelines (Assumption #3):

Assumption #3: *The phosphorus to nitrogen ratio in municipal discharges in late 1980s was 1g P-TOT = 4.4 g N-TOT [2]*

The P:N ratio of 4.4 (for municipal discharges) could not be used for industrial effluents due to different nature of the effluents. Therefore Assumption #4 was adopted:

Assumption #4: *The phosphorus to nitrogen ratio in industrial discharges in late 1980s was the same as in 1992 (1:6). This ratio was calculated from the data on discharges of N and P with industrial effluents to the catchment area of the Baltic Sea.*

Fish farming

Discharges of nitrogen and phosphorus from fish farms was calculated by a mass balance equation on the basis of feed use, amount of fish produced and the type of fish farm according to the HELCOM PLC-3 Guidelines [2]:

$$L = 0.01 \times (IC_i - GC_f)$$

where:

L = Phosphorus (P) or nitrogen (N) load to water body, kg/y
I = Amount of feed used for feeding fish, kg/y
C_i = P or N content in feed, %
G = Growth of fish, kg/y
C_f = P or N content in fish, %

Fish farming specialists from the Lithuanian Ministry of Agriculture indicated that there were no major changes in fish feed volumes between 1987 and 1995.

Agriculture

The amount of phosphorus and nitrogen used in agriculture in 1987 and 1995 in the form of mineral fertilisers was obtained from reports of Statistical Department of Lithuania. Data on the amount of nitrogen and phosphorus in livestock manure was calculated using statistical data on the number of animals in 1987 and 1995, and converting these into livestock units according to HELCOM guidelines (1 LU= 100 kg N, 1 LU = 16 kg P).

It was not possible to obtain any reliable studies on nitrogen and phosphorus loads from agricultural sources in 1987. Taking into account the experience of other HELCOM countries, it was assumed that in the late 1980s approximately 12 % of nitrogen and 1 % of phosphorus applied in agriculture was lost to the environment. Estimated annual discharges of nitrogen and phosphorus in the late 1980s thus are estimated at 59 455 t N and 1 809 t P (discharge per ha arable land was 18.3 kg N/y and 0.4 kg P/y). It should be noted that the figures provided above are very rough estimates estimate in comparison with data from other countries at that time. The figures do not take into account hydrological conditions, retention time in freshwater ecosystem, etc.

In 1995 the Lithuanian Water Management Institute conducted a study [3] in five agriculturally dominated watersheds and three nature-dominated watersheds. Arable land load calculations were based on nutrient concentration and flow measurements. Results from the study indicate that the annual agricultural load in 1995 was 12 kg N/ha y and 0.08 kg P/ha y.

1995 figures on discharge of phosphorus per hectare is unrealistically low compared to other HELCOM countries. Therefore it was decided to use a values of 0.3 kg P/ha y, which is comparable to other HELCOM countries with similar agricultural situations (i.e., Estonia, Poland and Germany). The estimated annual discharge of nitrogen and phosphorus in 1995 corresponds to 35 500 t N and 887 t P. The calculations do not take into account nutrient retention in freshwater ecosystems.

11.1.2 Nitrogen and phosphorus discharges to the environment from various sources in the late 1980s and 1995

Municipal discharges

There are only three towns in Lithuania (Palanga, 22 000 PE; Klaipeda, 204 600 PE; and Neringa, 2 700 PE) that discharge municipal sewage directly into the Baltic Sea. Another municipality (Mazeikiai) used to have a common discharge pipe with Mazeikiai oil refinery, but since mid-1995 effluents from the town are discharged into inland surface waters (separate from the oil refinery's discharges). Available data on discharges do not allow one to separate Mazeikiai's municipal discharges (47 000 PE) from those of the oil refinery. Historically discharges from the town and oil refinery are presented under the category industrial discharges.

Any apportionment of total nitrogen and phosphorus load figures for the late 1980s into size classes of urban agglomerations would be very artificial, considering the calculation methods used.

Data on municipal discharges of phosphorus and nitrogen in 1995 was obtained from the database of the Ministry of Environment of Lithuania. The list of agglomerations > 2 000 PE (totalling 84 agglomerations) was obtained from the Ministry of Environment. When calculating the person equivalent industrial pollution (pollution load by industrial effluents discharged to the municipal sewerage network), the Council Directive 91/271/EEC concerning urban wastewater treatment (1 PE = 60 g BOD_5 per day) was also taken into account. The 1995 data also includes discharges of stormwater.

Based on the calculation methods described in Section 6.1, direct and indirect discharges of nutrients from municipal wastewater treatment plants were calculated. The results are presented in Tables 11.3 and 11.4 respectively.

Table 11.3 Discharges of nitrogen and phosphorus from municipalities entering directly to the Baltic Sea.

Size class (PE)	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
2 000–10 000		15			2	
10 001–50 000		91			27	
> 50 000		799			90	
Total	1 112	905	18.6	253	119	53.0

Table 11.4 Discharges of nitrogen and phosphorus from municipalities entering into surface freshwater in the Baltic Sea catchment area.

Size class (PE)	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
2 000–10 000		297			48	
10 001–50 000		1 115			192	
> 50 000		4 552			559	
Total	8 612	5 964	31	1 957	799	59

Industrial discharges

There is only one industrial plant, (the Mazeikiai oil refinery) that discharges sewage effluents directly into the Baltic Sea. Mazeikiai municipal sewage effluents are discharged together with the effluents from the oil refinery.

Nitrogen discharges in the late 1980s were calculated using the assumptions described in Section 11.1.1 and Tables 11.1 and 11.2. The structure of the database does not include a detailed description of nitrogen and phosphorus discharges according to industry type for the late 1980s.

No reliable data was available on industrial discharges of phosphorus in the late 1980s. There is only one industrial plant discharging directly to the Baltic Sea, and phosphorus discharges were estimated to be approximately 35 t (based on analysis of discharges in recent years).

Industrial discharges of phosphorus to the catchment area of the Baltic Sea were estimated based on a nitrogen to phosphorus ratio. It was assumed that in the late 1980s, the phosphorus to nitrogen ratio in industrial effluents was approximately the same as that in 1992 (1:6).

Data on discharges of phosphorus and nitrogen in 1995 were obtained from a Ministry of Environment database on discharges. The database contains data on all discharges > 5 m^3 wastewater per day.

The direct and indirect discharges of nutrients from industries were calculated using data from the database of discharges and calculation methods described in Section 11.1.1. The results are presented in Tables 11.5 and 11.6 respectively.

Table 11.5 Discharges of nitrogen and phosphorus from industries entering directly into the Baltic Sea.

Industry	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Petrochemicals		293			16	
Total	389	293	25	35	16	54

Table 11.6 Discharges of nitrogen and phosphorus from industries entering into surface freshwater in the Baltic Sea catchment area.

Industry	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Chemicals		26			41	
Food processing		94			16	
Leather and textile		6			2	
Pulp & paper		23			20	
Other		220			73	
Total	1 612	369	77	269	152	44

Unfortunately the structure of the database does not allow a more detailed analysis of specific data on discharges from individual industrial sectors in the late 1980s.

Discharges from fish farms

Fish farming specialists from the Lithuanian Ministry of Agriculture indicated that there were no major changes in fish feed between 1987 and 1995. The estimated discharges of nitrogen and phosphorus from fish farms is presented in Table 11.7. There are no marine fish farms in Lithuania.

Table 11.7 Estimated discharges of nitrogen and phosphorus from freshwater fish farms.

Nutrient	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	1 275	262	1 013	80
P-TOT	204	42	162	79

Discharges from agriculture

Based on the methodology described in Section 11.1.1 the nutrient load from agriculture into the environment was estimated. The results are presented in Table 11.8.

Table 11.8 Estimated discharges of nitrogen and phosphorus from agriculture.

Nutrient	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	59 455	35 500	23 955	40
P-TOT	1 809	887	922	51

Note: figure on discharge of nutrients from agriculture in late 1980s and 1995 very uncertain and level of error might be high.

More detail description of the reasons for reduction of nitrogen and phosphorus discharges from agriculture is presented in section Reduction achieved (description of reasons) below.

11.1.3 Total discharge of nitrogen and phosphorus in the Baltic Sea catchment area and reductions achieved between late 1980s and 1995

Table 11.9 Total discharge of nitrogen into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load late 1980s (tonnes/year)	Load 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
Direct municipal discharge	1 112	905	207	19
Indirect municipal discharge	8 612	5 964	2 648	31
Direct industrial discharge	389	293	96	25
Indirect industrial discharge	1 612	369	1 243	77
Discharge from fish farms	1 275	262	1 013	80
TOTAL from point sources	13 000	7 793	5 207	40
Discharge from agriculture	59 455	35 500	23 955	40

Table 11.10 Total discharge of phosphorus into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load late 1980s (tonnes/year)	Load 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
Direct municipal discharge	253	143	110	44
Indirect municipal discharge	1 957	799	1 158	59
Direct industrial discharge	35	16	19	54
Indirect industrial ischarge	269	152	117	44
Discharge from fish farms	204	42	162	79
TOTAL from point sources	2 718	1 152	1 566	58
Discharge from agriculture	1 809	887	922	51

11.1.4 Reduction achieved (description of reasons)

Municipal discharges

Several reasons for the reduction in municipal discharges of phosphorus and nitrogen should be mentioned: (1) the large-scale decline in industrial pollution (a majority of industries in Lithuania discharge their effluents into municipal sewerage systems), (2) the building or renovation of new wastewater treatment plants (e.g. Palanga, Kedainiai, Kupiskis, Silute, Pabrade, Birstonas, Jieznas, Gelgaudiskis, Rusne, Sakiai, Salininkai), and (3) the increased efficiency of wastewater treatment plants. New water metering and pricing systems were introduced in the early 1990s, which led to significant reductions in water consumption by households and industry. Smaller volumes of wastewater lead to longer retention times in wastewater treatment plants, thus improving treatment characteristics.

A substantial part of phosphorus load decreased due to reduction in the amount of phosphorus in detergents and other substances used to decrease water hardness.

Industrial discharges

A large-scale decline in industrial output took place between the late 1980s and 1995, resulting in a significant decrease in discharges of total nitrogen and phosphorus to the catchment area of the Baltic Sea. A significant reduction in industrial discharges of nitrogen and phosphorus took place in the early 1990s.

Fish farming

Loads of nitrogen and phosphorus from fish farming decreased due to a general reduction in fish production (more than 3 times) and improvements in feeding practices (fish feed consumption decreased by 4.7 times), as illustrated in Table 11.11.

Table 11.11 Reduction in fish production and use of fish feed between 1989 and 1995.

	1989	1995
Use of fish feed (t)	28 000	6 000
Fish production (t)	5 000	1 537

Agriculture

The reduction of nitrogen and phosphorus discharges from agriculture during the 1987–1995 period was caused by significant reductions in the consumption of fertiliser, number of livestock and agricultural production. These changes were caused by land reform and changing markets for agricultural products (Table 11.12).

Table 11.12 Changes in livestock density, area of arable land, consumption of fertiliser and agricultural production in Lithuania between the late 1980s and 1995.

Indicators		Late 1980s	1995	Decrease	Decrease (%)
Arable land (ha)		3 255 200	2 958 300	296 900	9
Number of livestock (animal units)		2 214 560	1 181 560	1 033 000	47
Total number of cattle		2 488 200	1 152 400	1 335 800	54
Total number of pigs		2 772 100	1 259 800	1 512 300	55
Production of grain		2945	1954	991	34
Production of sugar beet (thousand t)		1008	692	316	313
Production of potatoes (thousand t)		1872	1594	278	15
N	Consumption of fertiliser (t/y)	274 000	28 800	245 200	9.5
	Consumption of manure (t/y)	221 456	118 156	103 300	47
P	Consumption of fertiliser (t/y)	144 000	10 900	133 100	92
	Consumption of manure (t/y)	36 909	19 693	17 216	47

However, data on discharges of nitrogen and phosphorus from agriculture during the late 1980s is very uncertain, as the estimates are based on simple theoretical models in comparison with other HELCOM countries, and not on actual measurements.

The table above indicates that even higher reductions in discharges from agriculture might be achieved in future years, as pressure indicators such as consumption of fertilisers and consumption of manure have dropped by 90 and 47 % respectively. The reduction in fertiliser use (including animal manure) and use of agricultural land, as well as changing market circumstances, have lead to a reduction in plant production: (e.g. a 34 % decrease in grains, 31 % decrease in sugar beet, and a 15 % decrease in potatoes).

11.1.5 Clarification of differences with load figures published earlier

Municipal discharges

The differences with load figures on municipal discharges published earlier and those presented in this report are due to different references years. The system of collecting statistical information on water usage and discharges was changed in the early 1990s and a computerised database on discharges introduced in 1991. Questionnaires supplied earlier presented load figures for 1992.

This report, the first attempt to estimate load figures for the late 1980s, was produced using indirect methods of calculation and assessment. Figures obtained by these methods are higher compared to those provided earlier due to:

- different calculation methods applied;
- a three-year difference between data (estimated discharges in 1989 as compared to load figures for 1992 from the database).

Industrial discharges

Reasons for difference between the data on industrial discharges published earlier and those presented in this report are the same as for municipal discharges:

- different calculation methods applied
- a three-year difference between data (estimated discharges in 1989 as compared to load figures for 1992 from the database).

Fish farming

Figures on load of total N and P from fish farms published earlier are unrealistically low. It is probable that the load figures presented earlier were not calculated using HELCOM Guidelines.

Agriculture

The data on livestock density, use of fertiliser and arable land presented in this report were obtained from reports of Statistical Department of Lithuania. The difference between these figures and those presented earlier are most probably due to different sources of information.

11.2 Water protection targets

11.2.1 Methodology for setting targets for water protection

Lithuania has not quantified national targets for water protection. General targets for water protection are established in national strategic documents. The most important strategic document defining national goals and priorities for environmental protection is the National Environmental Protection Strategy.

Environmental Protection Strategy

The Lithuanian Environmental Protection Strategy was adopted in 1996 by the Parliament of Lithuania. The Strategy defines environmental protection goals, sets environmental protection priorities, describes environmental policies, principles and strategy implementation instruments. However, pollution reduction goals and targets are not quantified.

The reduction of water pollution is one of the most important environmental protection goals extensively addressed in the Strategy, which defines following actions in the field of water protection:

- reduction of pollution by industrial and agro-industrial wastewater,
- reduction of ground water pollution,
- reduction of non-point source pollution to water bodies,
- reduction of pollution load into the sea,
- reduction of soil pollution with organic and mineral fertilisers and other agricultural chemicals, and
- prevention of further degradation of river valleys and lakes as well as marine biocenoeses.

The Environmental Protection Strategy sets the highest priority for protection of water quality. It states that along with treatment of municipal wastewater, measures should be implemented to reduce non-point source pollution of ground and surface waters, to restructure financial mechanisms for the wastewater sector by introducing the "polluter/consumer pays" principle. Promotion of ecologically sustainable farming is mentioned among the priorities in the landscape protection area.

Legal framework

The legal system of water resources management in Lithuania consists of laws and regulations. Laws establish general management principles, while regulations delineate the detailed requirements for implementing the requirements established by law. The main laws related to protection of aquatic environment are:

- Law on Environmental Protection (1996) defines the main principles of environmental protection in Lithuania. This framework law defines the rights and responsibilities of private and legal persons with respect to the environment, the use of natural resources, regulation of economic activities, and introduces general principles for use of economic instruments for protection of environment;
- Law on Water (1997) is the primary law which regulates the management of water resources. The water law defines the main principles of management, use, protection and ownership of water resources (except for marine waters).
- Law on Protection of Marine Environment (1997) defines the main principles of the protection of marine environment: protection from pollution from vessels, liquidation of incidents, regulation of economic activities in the sea, etc.
- The Underground Law (1995) establishes requirements for protection, control and exploitation of underground resources (including water).

In addition to these main laws there are a number of other laws regulating water management in Lithuania, such as:

- Law on Monitoring of the Environment (1997) establishes and sets requirements for implementation structure of the environmental monitoring in Lithuania;
- Law on Protected Areas (1993),
- Law on Environmental Impact Assessment (1996), and
- Law on Land (1994).

Abstraction of water and discharge of effluents in Lithuania is regulated via permit system established by the Order of the Ministry of Environment on Issuing of Operational Permits (LAND 32–99). All abstractions of water greater than 10 m^3/day and discharge of effluents greater than 5 m^3/day are subject to regulation via the permit system. In addition, these water users are required to supply statistical data about use of water and discharge of effluent to the Ministry of Environment.

The quality of receiving waters in Lithuania is regulated by controlling the concentration of pollutants in effluents. The Order of the Ministry of Environment on Waste Water Pollution Standards (1995) sets requirements for the treatment of effluents (concentrations of nutrients and dangerous substances). The Waste Water Pollution Standards are currently under revision.

Diffuse pollution of surface waters is controlled via the Regulation on Special Conditions for Use of Land and Forest (1992) and the Order of the Ministry of Environment and Ministry of Agriculture on Requirements for the Management of Manure and Waste Water at Farms (LAND 33–99).

The State Environmental Monitoring Programme (1998) defines sampling points, frequencies, and parameters for monitoring of surface, ground and coastal waters.

EU accession

In recent years the process of EU accession has become an important factor for the establishment of targets for water protection. Implementation of EU environmental requirements will be an important driving force for water protection in Lithuania.

In June 1995, Lithuania signed an Association Agreement with the European Union and aims to implement requirements of the EU Directives. Under the Association Agreement, Lithuania has made a commitment to approximate its legal framework with the laws of the European Union. The Ministry of Environment has elaborated a National Environmental Approximation Strategy (1998). In the field of water protection, top priority was assigned to the implementation of the EU Urban Waste Water Treatment Directive and Nitrates Directive.

EU Urban Waste Water Treatment Directive 91/271/EEC

The EU Urban Waste Water Treatment Directive 91/271/EEC (UWWTD) is regarded as one of the most expensive directives in the environmental sector. Lithuania has recently developed a national plan for implementation of the Directive. The objective of the plan is to achieve compliance with the standards of the Directive by the end of 2009. Estimated costs for implementation of the plan total nearly 290 million euro.

The plan covers 84 agglomerations larger than 2 000 person equivalents (PE) in which requirements for wastewater treatment will be achieved:

- 7 agglomerations larger than 100 000 PE
- 31 agglomeration between 10 000 and 100 000 PE
- 46 agglomerations between 2 000 and 10 000 PE

After implementation of the plan the load reductions in Table 11.13 will be achieved.

Table 11.13 Expected reductions of municipal discharges of nitrogen and phosphorus due to implementation of the UWWTD.

Nutrient	1987 (t/y)	1995 (t/y)	2010 (t/y)
Nitrogen	9 724	6 869	3 070
Phosphorus	2 210	942	261

The expected reductions of nitrogen and phosphorus load presented in the table above were calculated by multiplying the volume of effluents discharged (using 1999 data) and the concentration of nitrogen and phosphorus to be achieved according to the requirements of the UWWTD.

EU Nitrates Directive 91/676/EEC

Reduction of diffused pollution from agricultural sources is another area targeted by the activities related to EU accession. The Ministry of Environment has recently developed a Strategy for Implementation of the Nitrates Directive that aims to improve the environmental performance of agricultural activities. The main focus of the measures is to prevent increases in pollution of the environment as Lithuanian agriculture develops.

The priority actions defined in the Strategy for Implementation of the Nitrates Directive in Lithuania (2001) aim to introduce Good Agricultural Practices and modern management techniques for livestock manure. The first four-year action programme for implementation of the Nitrates Directive will be developed in 2002–2003. Measures will be implemented to improve the uptake of nutrients by crops and to reduce leakage of nitrogen and phosphorus to the environment. It is estimated that costs for the installation of manure storage facilities and the purchase of manure spreading equipment may be as high as 400 million euro.

Lithuania has not set official targets for reducing nitrogen and phosphorus discharges from agriculture. Since the late 1980s the input of nutrients in Lithuanian agriculture in terms of mineral fertiliser and livestock manure has decreased by more than 50 % compared to the late 1980s, and significant improvements in fertiliser management have been observed. The present agricultural output in Lithuania should be regarded as low compared to output levels in the late 1980s and agricultural output in Western European countries.

The agricultural sector of Lithuania is still undergoing large-scale reforms. It is expected that agricultural output and livestock density will not increase significantly by the year 2005. The main objective of environmental protection measures in the agricultural sector is to maintain discharges at the level of the late 1990s, and to prevent increases in pollution as agriculture in Lithuania recovers.

EU Water Framework Directive

In the near future additional requirements and targets for water protection will be established for the implementation of river basin management, with the objective to achieve good surface water and very good groundwater status. A number of pilot projects were started in international river basins aiming to improve co-operation with neighbouring countries in the field of protecting the water environment.

11.2.2 Recent trends in reduction of nitrogen and phosphorus discharges

Discharges from municipal and industrial sources

During the last decade discharges of nitrogen and phosphorus from point sources (municipal sources and industry) were significantly reduced (Figures 11.1 and 11.2). Several reasons for the decline should be mentioned: the decline in industrial pollution, substantial investments in wastewater treatment facilities in large cities and smaller towns, increased efficiency of wastewater treatment, and increased taxes for use of water and discharge of pollutants.

The majority of industrial wastewater in Lithuania is discharged into municipal sewers, and only a small part is discharged directly into surface waters. Large-

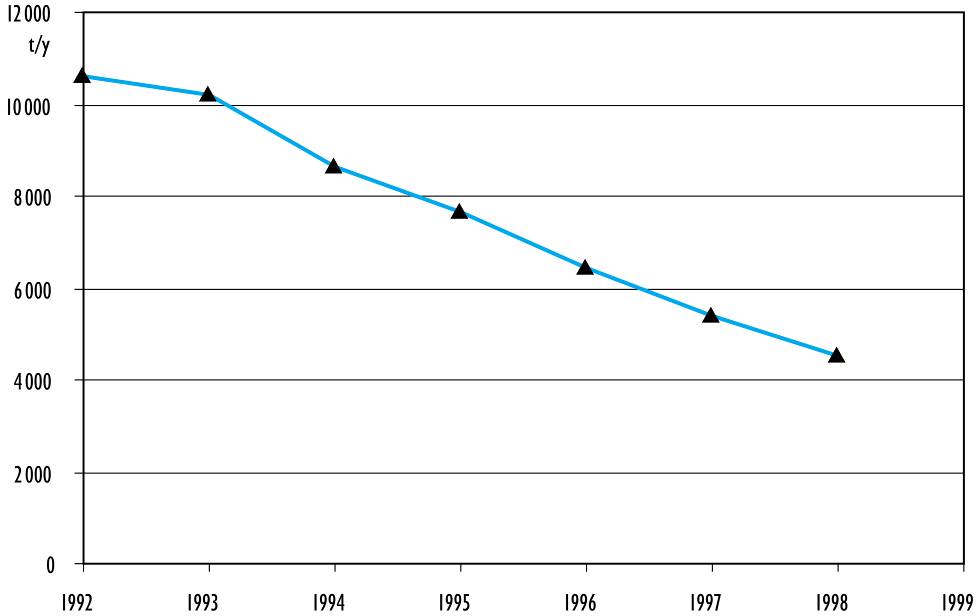

Figure 11.1. N-TOT emissions from point sources (tonnes per year).

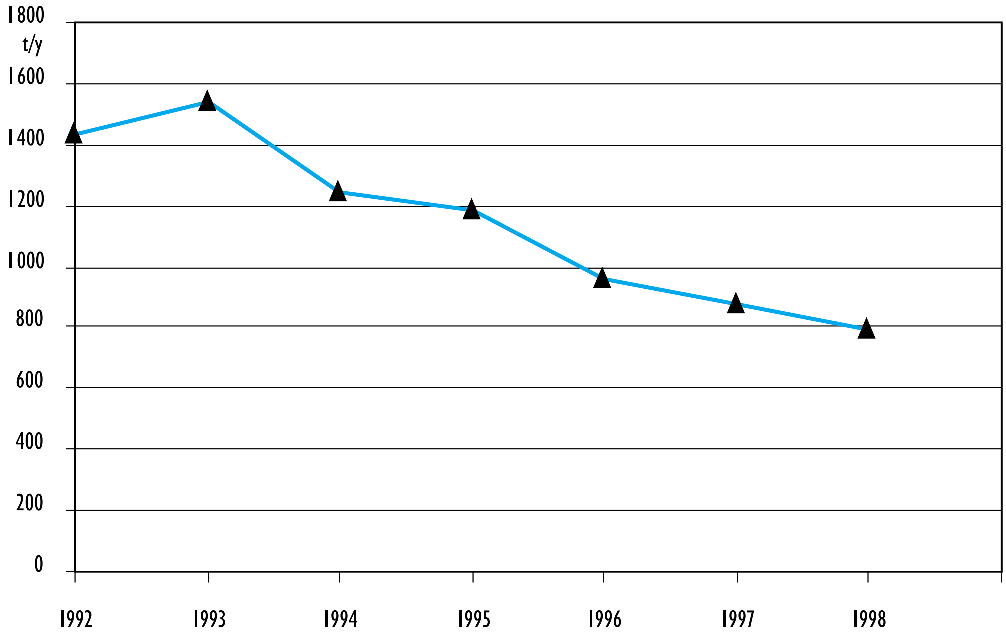

Figure 11.2. P-TOT emissions from point sources (tonnes per year).

scale restructuring of industry and changes in technological processes occurred after the collapse of the Soviet Union in early 1990s. The decline of industry and the introduction of water meters in households has resulted in decreased usage of water and discharge of effluents. Since the late 1980s, the treatment of municipal wastewater has improved significantly .

During the last decade volume of effluents discharged from urban agglomerations was constantly decreasing. It is assumed that water consumption has stabilised and it is expected that it shall stay at the level of 1999.

Tables 11.14 and 11.15 below show the decline in total nitrogen and total phosphorus discharges from municipal and industrial sources.

Table 11.14 Discharges of total nitrogen and total phosphorus from municipal sources in Lithuania.

	1987 (tonnes/year)	1995 (tonnes/year)	1999 (tonnes/year)	Reduction (%)
N-TOT	9 724	6 869	3 395	65
P-TOT	2 210	917.5	617	72

The table above shows that during the period between 1987 and 1999 Lithuania has reduced municipal discharges of total nitrogen and total phosphorus by 65 % and 72 % respectively. The 50 % reduction target for phosphorus discharges was achieved already in 1995.

Table 11.15 Discharges of total nitrogen and total phosphorus from industrial sources in Lithuania.

	1987 (tonnes/year)	1995 (tonnes/year)	1999 (tonnes/year)	Reduction (%)
N-TOT	2 001	662	528	74
P-TOT	304	167.8	133	56

The table above shows that during the period between 1987 and 1999 Lithuania has reduced industrial discharges of total nitrogen and total phosphorus by 74 % and 56 % respectively. The 50% reduction target for nitrogen discharges was already achieved in 1995.

Discharges from agriculture

Land reform, privatisation and changing markets have led to significant decrease in livestock density in Lithuania. During the period between 1989 and 1999, the number of livestock has decreased by more than 50 % (Figure 11.3). The use of fertilisers has also decreased more than four times (Figure 11.4).

As overall density of livestock per hectare of arable land is relatively low, environmental measures will focus on reducing point source pollution from agricultural sources. It is expected that introduction of modern manure handling tech-

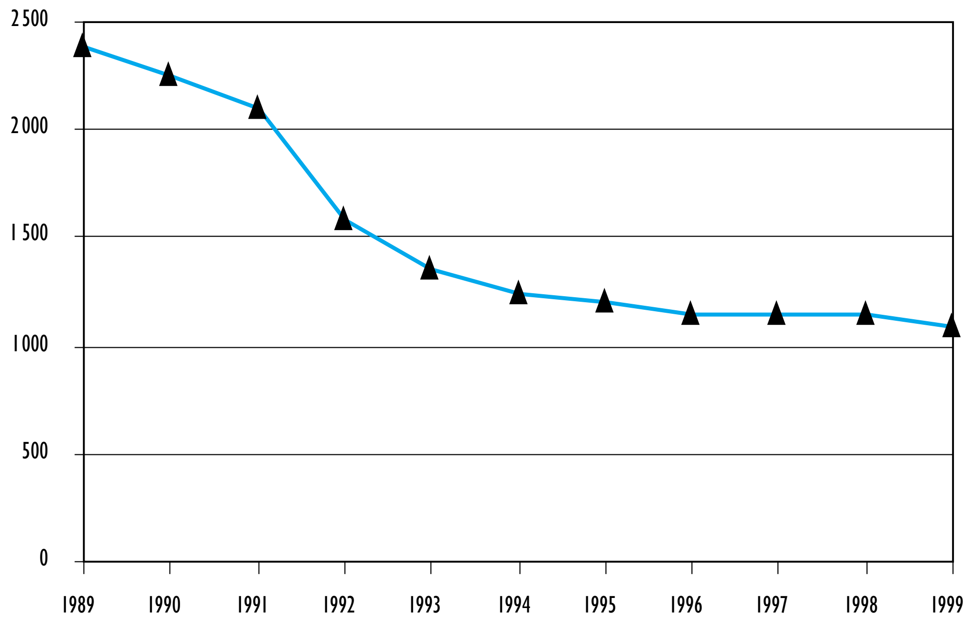

Figure 11.3. Number of livestock in Lithuania (thousands animal units).

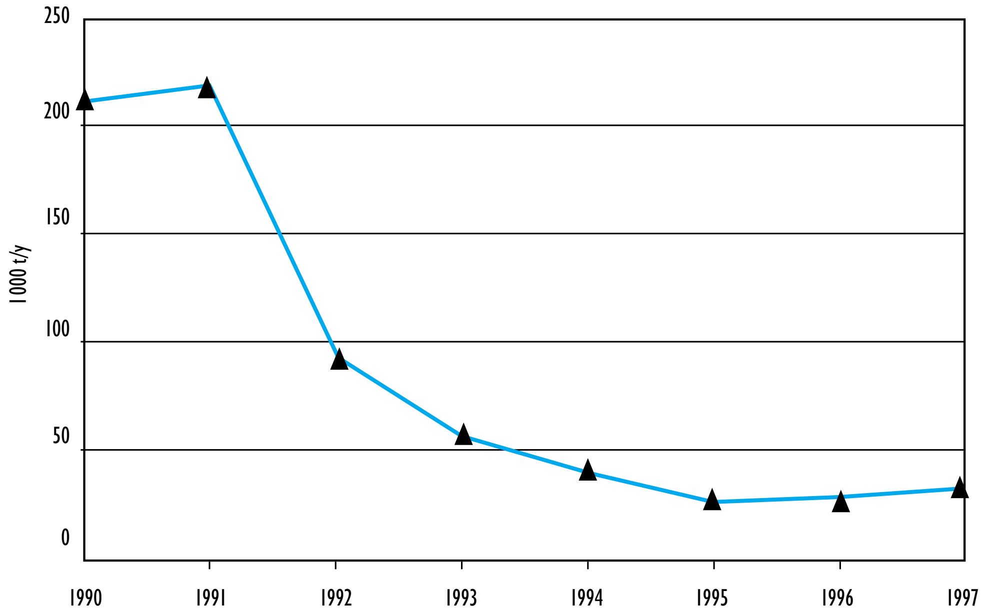

Figure 11.4. Consumption of nitrogen fertiliser in Lithuania.

niques will increase the efficiency of plant uptake of nutrients and decrease local environmental impacts.

Lithuania aims to implement EU Nitrate Directive and has adopted the Code of Good Agricultural Practice (2000). Phased implementation of the Code will improve management of nutrients on the farm level and reduce nutrient leaching to surface waters.

As shown in Figures 11.3 and 11.4, the input of nutrients in agriculture has decreased by more than 50 %. However, monitoring data does not indicate a rapid decrease of nutrients in receiving waters. In fact washout of nutrients calculated per hectare of land varies from year to year even though the input of nutrients is steadily decreasing. This can be due to following reasons:

- There is a time lag between reduction of pressure on the environment and response due to internal recycling of nutrients within the ecosystem. In other words, the effects of environmental measures taken in early 1990s are still expected to come in the future.
- Leaching of nutrients from areas covered by natural vegetation is higher than estimated in previous studies (share of nutrients due to nitrogen fixation, atmospheric deposition, decomposition of vegetation).

An assessment of nitrogen discharges from agricultural sources in the late 1990s was carried out by the consultants in a Danish bilateral assistance project "Long-term Assistance in Transposition and Implementation of the Nitrates Directive in Lithuania". During the study, discharge of nitrogen was calculated for selected nature-dominated and agriculture-dominated watersheds. Washout of nitrogen from agricultural land was calculated using data on daily flow and concentration of nitrogen in the streams and data on land use of the watersheds. The results of the study indicate that average nitrogen load from agricultural areas during the years 1997 and 1998 was 10 kg/ha y. Phosphorus load from agricultural areas was similar to the load from nature-dominated areas.

The results of the study indicate that discharges of total nitrogen from agricultural sources in Lithuania in 1997–1998 were 29 400 t/ N y.

Table 11.16 Discharges of total nitrogen and total phosphorus from agriculture

	1987 (tonnes/year)	1995 (tonnes/year)	1999 (tonnes/year)	Reduction (%)
N-TOT	59 455	35 500	29 400	51
P-TOT	1 809	887	880	51

The table above shows that Lithuania has implemented the Ministerial Declaration and reduced nitrogen discharges by 51 %, and phosphorus discharges by 51 % during the period 1987–1995.

References

1. Statistical Report of the Water Department on Use of Water and Discharges of Pollutants, 1989.
2. Guidelines for the Third Pollution Load Compilation (PLC-3), Baltic Sea Environment Proceedings, No. 57, Pakett Ltd., Tallinn, 1994.
3. Sileika, A.S., 1996. Nitrogen and Phosphorus Load Calculation for Lithuanian Rivers, Lithuanian Water Management Institute.

Polish national report on nutrient loads

12

Waldemar Jarosinski, Institute of Meteorology and Water Management

12.1 Nutrient loads and reductions achieved

12.1.1 Description of calculation/assessment methods used

Municipal discharges

Load data from the Second and Third Pollution Load Compilations [1,2] concerning direct nitrogen and phosphorus discharges from municipal outlets to the Baltic Sea were used.

Data on the amount of wastewater discharged by municipal sewerage systems to the Baltic Sea catchment area in 1995 were taken from two sources:

- the project report "Strategy of the Protection of Water Resources from Pollution; the perspective of human health and nature protection, and economic needs" (PZB-28-02), presented at the Conference in Ustron, March 1998.
- the report from a joint project of the Polish Academy of Science (PAN) and Deutscher Verband fur Wasserwirtschaft und Kulturbau e. V. (DVWK), "Investigation on the quantity of diffuse entries in rivers of the catchment area of the Odra and the Pomeranian Bay to develop decision facilities for an integrated approach on water protection".

Nutrient loads in 1989 and 1995 and the changes between these years were estimated using the Statistical Yearbooks of the Central Statistical Office [3,4]. Due to a lack of specific information, calculations of nitrogen and phosphorus loads were based on BOD_5 discharge figures, using the assumption that the proportion of BOD:N:P in untreated wastewater was 60:11:2.4.

Loads from municipal sources include industrial wastewater discharged to municipal sewage network. Quantitatively, municipal sources comprise 40 % of total wastewater volume.

Industrial discharges

Load data from the Second and Third Pollution Load Compilations [1,2] concerning direct nitrogen and phosphorus discharges from industrial outlets to the Baltic Sea were used. In addition, data from statistical yearbooks of the Main Statistical Office "Environmental Protection" editions 1989 and 1996 were incorporated.

Due to a lack of direct measurements of nutrient discharges to the Baltic Sea catchment area, estimates of nitrogen and phosphorus load from industry in 1995 were based on the project report "Strategy of the Protection of Water Resources from Pollution; the perspective of human health and nature protection, and economic needs". Reductions achieved between 1989 and 1995 were calculated using data on the quantities of treated and untreated industrial wastewater in 1989 and 1995.

Fish farming discharges

According to PLC-4 guidelines [5], loads of nitrogen and phosphorus can be calculated bases on the equation:

$$L = 0.01 \times (ICi - GCf)$$

where:

L = Phosphorus or nitrogen load discharged to water body in t/y.
I = Amount of feed used for feeding of fish in t/y.
Ci = P or N content in feed in % (equals 1.0 % for P and 7.5 % for N).
G = Growth of fish in t/y.
Cf = P or N content in fish in % (equals 0.4 % for P and 2.5 % for N).

Agricultural discharges

The estimation of anthropogenic discharges of nutrients from Polish agricultural areas (excluding emission from the atmosphere and background loads) for 1995 was based on calculations conducted under the PLC-3 project. This calculation was based on an analysis of data from more than forty small catchment areas, taking into account land use information, consumption of fertilisers, and hydrological conditions in the catchments according to the methodologies described in the PLC-3 Guidelines [2].

The unit loads for nitrogen and phosphorus from agriculture (cultivation of soil) was calculated as:

$$L_r = (0.31536 \times Cw_r \times Q \times Z_{1995}) / Z_{exp}$$

where:

L_r = Nitrogen or phosphorus unit outflow from agriculture in kg/ha y.
Cw_r = Discharge B weighted nitrogen (phosphorus) concentration from agriculture in the runoff in mg/l.
Q = Mean runoff during the study period in the area concerned in l/ s km^2.
Z_{1995} = Fertiliser consumption (divided in to mineral and natural) for a given area in 1995 in kg/ha y.
Z_{exp} = Mean fertiliser consumption (mineral and natural) in the catchment areas in kg/ha y.

These corrected unit loads, averaged by physical-geographical regions for four soil types as discharge-weighted concentrations of nitrogen and phosphorus, were calculated for each soil type in relation to runoff from fields and mean nutrient input from mineral and natural fertilisation.

Differences in discharges of nitrogen and phosphorus loads between 1989 and 1995 were calculated based on statistical data regarding arable land area, number of livestock, and the consumption of mineral and organic fertilisers in 1989 and 1995. Data sources included the Statistical Yearbooks of the Central Statistical Office "Environmental Protection" (1989, 1991 and 1996 editions) and the 1998 Statistical Yearbook of Agriculture.

Nutrient loads from agriculture were verified based on information from a joint project of the Polish Academy of Science (PAN) and Deutscher Verband fur Wasserwirtschaft und Kulturbau e. V. (DVWK), "Investigation on the quantity of diffuse entries in rivers of the catchment area of the Odra and the Pomeranian Bay to develop decision facilities for an integrated approach on water protection".

12.1.2 Nitrogen and phosphorus discharge to the environment

Discharge from municipalities

Based on the data and calculation methods described in Section 12.1.1, the direct and indirect discharges of nutrients from municipal wastewater treatment plants were calculated. The results are presented in Tables 12.1 and 12.2 respectively.

Table 12.1 Discharges of nitrogen and phosphorus from municipalities entering directly to the Baltic Sea.

Discharge (10^3 m^3/y)		Nitrogen (t/y)			Phosphorus (t/y)		
Late 1980s	1995	Late 1980s	1995	Red. (%)	Late 1980s	1995	Red. (%)
177 900	147 600	7 630	5 852	23	1 466	767	47

Table 12.2 Discharges of nitrogen and phosphorus from municipalities entering into surface freshwater in the Baltic Sea catchment area.

Discharge (10^3 m^3/y)		Nitrogen (t/y)			Phosphorus (t/y)		
Late 1980s	1995	Late 1980s	1995	Red. (%)	Late 1980s	1995	Red. (%)
2 478 100	1 852 400	150 100	113 900	24.1	24 843	19 626	21

Discharge from industries

Based on the data base and calculation methods described in Section 12.1.1 the direct and indirect discharges of nutrients from industries were calculated. The results are presented in Tables 12.3 and 12.4 respectively.

Table 12.3 Discharges of nitrogen and phosphorus from industries entering directly into the Baltic Sea.

Industry	Discharge (10^3 m^3/y)		Nitrogen (t/y)			Phosphorus (t/y)		
	Late 1980s	1995	Late 1980s	1995	Red. (%)	Late 1980s	1995	Red. (%)
Chemical	171 116	133 294	266	666	–150.4	400	120	70.0
Petro-chemical	4 606	3 217						
Food processing	1 933	1 393	375	44	88.3	110	49	55.5
Pulp and paper	5 995	4 657	21	4	81.0	3	2	33.3
Other	10 248	7 976	55	26	52.7	10	4	60.0
Total load	193 352	150 537	717	740	–3.2	523	175	66.5

Table 12.4 Discharges of nitrogen and phosphorus from industries entering into surface freshwater in the Baltic Sea catchment area.

Industry	Discharge (10^3 m^3/y)		Nitrogen (t/y)			Phosphorus (t/y)		
	Late 1980s	1995	Late 1980s	1995	Red. (%)	Late 1980s	1995	Red. (%)
Chemical	359 600	164 600						
Petro-chemical	37 900	29 700						
Mining and metals	594 400	402 600						
Iron and steel	134 300	48 600						
Non-ferrous metals	158 800	31 900						
Food processing	96 800	47 000						
Leather and textiles	27 100	12 500						
Pulp and paper	226 400	122 400						
Other	353 200	207 900						
Total load	1 988 500	1 167 200	5 148	4 185	18.7	1 178	1 400	21.2

Discharges from fish farms

Fish farm production in Poland is based primarily on two fish species: common carp and rainbow trout. Carp production is rather constant at approximately 19 000–20 000 tonnes per year.

According to data provided by the Institute of Inland Fishery, carp farming has no adverse effects on the environment, and discharges from the ponds do not increase nutrient concentrations in receiver waters. Data on fish farms in Poland for 1988 and 1995 is presented in Tables 12.5 and 12.6.

Table 12.5 Fish farm production in Poland (in thousand tonnes).

Year	Common carp	Rainbow trout	Others	Total
1988	n.d	n.d	n.d	25.6
1995	19.6	4.8	0.7	25.1

Table 12.6 Estimation of fodder consumption in fish farms (in thousand tonnes).

Year	For carp production	For trout production and others	Total
1988	n.d	n.d	n.d
1995	63.9	7	70.9

Nutrient loads from fish farms in 1995 and 1988 was calculated according to the Guidelines for the Fourth Pollution Load Compilation (PLC-4):

$$L_{N1995} = 0.01\ (7\,000 \times 7.5 - 5\,500 \times 2.5) = 387 \text{ t/y}$$

$$L_{P1995} = 0.01\ (7\,000 \times 1.0 - 5\,500 \times 0.4) = 48.0 \text{ t/y}$$

Because of a lack of detailed information, loads of nutrients from fish farms in 1988 could only be estimated at a level similar to 1995, based on comparing total production with 1995.

$$L_{N1988} = 390 \text{ t/y}$$

$$L_{P1988} = 50 \text{ t/y}$$

Discharge from agriculture

Table 12.7 Estimated discharges of nitrogen and phosphorus from agriculture.

	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	135 100	94 600	40 500	30
P-TOT	7 390	6 650	740	10

12.1.3 Overall reduction of nutrient load into the environment achieved

During the period between the late 1980s and 1995, a significant decrease can be observed in the pollution load.

Table 12.8 Total discharge of nitrogen into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load in late 1980s (t/y)	Load in 1995 (t/y)	Reduction (t)	Reduction (%)
Direct municipal discharge	7 630	5 852	1 778	23
Indirect municipal discharge	150 100	113 900	36 200	24
Direct industrial discharge	717	740	-23	-3
Indirect industrial discharge	5 148	4 185	963	19
Discharge from fish farms	387	387	0	0
TOTAL from point sources	163 982	125 064	38 918	24
Discharge from agriculture	135 100	94 600	40 500	30

Table 12.9 Total discharge of phosphorus into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load in late 1980s (t/y)	Load 1995 (t/y)	Reduction (t)	Reduction (%)
Direct municipal discharge	1 466	767	699	47
Indirect municipal discharge	24 843	19 626	5 217	21
Direct industrial discharge	523	175	348	67
Indirect industrial discharge	1 778	1 400	378	21
Discharge from fish farms	48	48	0	0
TOTAL from point sources	28 658	22 016	6 642	23
Discharge from agriculture	7 390	6 650	740	10

12.1.4 Description of reasons of the achieved reduction in nutrient loads

Municipal wastewater discharges

The reduction in loads from municipal discharges results from:

- A decrease in water intake for municipal water supply systems from 3 066.1 hm^3 in 1988 to 2 457.1 hm^3 in 1995.
- A decrease in the total amount of municipal wastewater discharged to surface water, from 2 478.1 hm^3 in 1988 to 1 852.4 hm^3 in 1995. The amount of raw wastewater discharged decreased from 1 171.0 hm^3 in 1988 to 594.8 hm^3 in 1995.
- An increase in the number of cities served by wastewater treatment plants from 446 in 1988 to 643 in 1995, and an increase in cities served by biological treatment plants and advanced nutrient removal from 274 in 1988 to 533 in 1995.
- An increase in the population of cites served by wastewater treatment plants from 13 176 900 in 1991 to 15 554 500 in 1995. The population served by wastewater treatment plants represented 55.6 % of total population in 1991 and 65.1 % in 1995.
- An increase in the number of wastewater treatment plants, from 558 in 1988 to 1 226 in 1995 (including new 488 biological treatment plants and with advanced nutrient removal).

Industrial discharges

The reduction of loads from industrial discharges to the rivers of the Baltic Sea catchment area results from:

- A decrease in water consumption for industrial purposes from 10 116.6 hm^3 in 1988 to 8 431.6 hm^3 in 1995.
- A decrease in the number of industrial plants discharging wastewater from 4 779 in 1988 to 3 493 in 1995, and a decrease in the number of plants without any kind of treatment plant from 2 258 in 1988 to 1 904 in 1995.
- A decrease in the amount of total industrial wastewater discharged directly to surface water, from 9 580.7 hm^3 in 1988 to 8 128.5 hm^3 in 1995. Wastewater which required treatment decreased from 1 988.5 hm^3 in 1988 to 1 167.2 hm^3 in the year 1995.
- A decrease in the amount of the raw wastewater from 492.9 hm^3 in 1988 to 105.4 hm^3 in 1995.

Fish farming discharges

There were no observed changes in fish farm production.

Agricultural discharges

The reduction in loads from agriculture results from:

- A decrease in use of artificial fertilisers containing nitrogen from 1 335.4 thousand tonnes in 1988 to 836 thousand tonnes in 1995.
- A decrease in use of artificial fertilisers containing phosphorus (P_2O_5) from 836.7 thousand tonnes in 1988 to 279.0 thousand tonnes in 1995.
- A decrease in the number of animal units from 12 233 thousand in year 1990 to 9 600 thousand units in 1995.
- A decrease in the area of arable land, from 18 783.8 thousand ha in the year 1990 to 18 663.8 thousand ha in 1995.

Another condition which contributed to the reduction of loads from agriculture is the difference in hydrological conditions observed between 1988 and 1995. Total discharge of water from the entire country in 1988 was 61.0 km^3, almost 11 % larger than the discharge in 1995 (54.4 km^3).

12.1.5 Clarification of differences between load figures published earlier

Presented above estimates of loads of nutrients are in accordance with formerly presented values. In the elaborated material data originating from PLC-3 and PLC-2 were widely used.

12.2 Water protection targets

12.2.1 Introduction

In Poland, significant reductions in discharges of nitrogen and phosphorus has been observed since the late 1980s. Reductions in loads discharged to rivers refer to all sources: municipal, industrial and agricultural. This advantageous tendency can be attributed both to the profound socio-economic transformations and implementation of a national ecological policy.

Decrease in loads discharged from municipal sources was caused by, among other factors, 20 % reduction of water consumption during the period 1988–1995, leading to a 25 % reduction of the total amount of municipal wastewater and nearly 50 % reduction of untreated wastewater. The decrease of nutrients loads from industry from 1988–1995 was largely related to the restructuring and modernisation of Polish industry, including a 27 % reduction in number of industrial plans, 17 % reduction of water consumption in industry, and 78 % reduction in the amount of the untreated wastewater discharged from industry.

Loads from agriculture were also reduced, mostly due to a 35 % decrease in use of mineral fertilisers containing nitrogen, 66 % reduction in use phosphorus containing fertilisers and more then 20 % reduction in production of animals.

Over the last decade, numerous initiatives have been undertaken to improve water quality. For example, in the years 1991–1997, about 3.42 billion euros were invested in water protection measures, including 2 billion euros for building of municipal wastewater treatment plants.

The above-mentioned activities have led to reduction of loads of nutrients discharged to the river basins, reflected by changes in loads of nutrients discharged by rivers to the Baltic Sea. Total nitrogen load discharged by rivers amounted to 243 thousand tonnes in 1988 and 202 thousand tonnes in 1995. In case of phosphorus, discharged loads were 16.7 and 13.1 thousand tonnes in 1988 and 1995, respectively.

12.2.2 Laws and national decisions

National Environmental Policy of Poland (NEPP)

Since the beginning of the 1990s Poland has implemented a comprehensive environmental policy based on the principle of sustainable development. This policy was formulated in the document "National Environmental Policy of Poland", adopted by the Parliament of Poland on 10 May 1991.

This document defines basic concepts of environmental protection including, among others:

- Organisation of environmental protection with the system of authority and responsibility;
- Priorities of environmental protection;
- Environmental policy tools; and
- Basic concept of international co-operation.

In the sections concerning water quality protection:

According to paragraph 28, government policy for the management of water resources will be based on (inter alia):

- reduction in allowable concentrations of pollutants deposited into surface waters, and the ground, as well as the introduction of progressively growing charges for disposal in order to significantly improve the quality of surface and deep ground waters;
- according to paragraph 59, within the scope of protection and rational use of water resources, the document formulates the following priorities:
- reduction of pollution loads disposed of by industry and municipalities into the rivers by 50 % through (1) a decrease in the amount of untreated industrial and municipal sewage from 0.5 billion and 1.2 billion m^3 at present to 0.1

billion and 0.6 billion m^3 by the year 2000 respectively, as well as (2) an increase in the rate of highly effective wastewater treatment systems (biological and chemical) in the overall sewage treatment from the present 48 % to 70 % in the year 2000;
- improvement of sanitary conditions in rural areas by supplementing village pipeline water supplies with adequate sanitation solutions.

Regulations concerning surface water protection in Poland

Surface water protection in Poland is based on following regulations:
1. The Act - Water Law of October 24th 1974, with later amendments. (Journal of Law No 38, item 230),
2. The Act of Protection and Forming of the Environment of January 31st 1980 and later amendments (Journal of Law No 49, item 196),
3. The Act of July 20th 1991 about State Inspection of Environmental Protection with later amendments (Journal of Law No 77, item 335),
4. The Act of Public Statistic of June 29th 1995 with later amendments (Journal of Law No 88, item 439),
5. Regulation of the Government of December 27th 1993 about charges and particular usage of water and water devices. (Journal of Law No 133, item 637),
6. Regulation of the Government of November 2nd 1995 about principles and mode of calculation of fines for violation of the standards to be met by wastewater discharged to water or ground (Journal of Law No 79, item 400),
7. Decree of the Minister of Environmental Protection, Natural Resources and Forestry of 5 November 1991 about surface water purity classification and specific cases, where wastewater can not be discharged, and maximum permissible values of indicators of wastewater discharged to the water bodies and to the ground. (Journal of Law No 116, item 503),
8. Regulation of the Government of May 19th 1999 about discharge of wastewater to sewerage system being a municipal property (Journal of Law No 50, item 501),
9. The Act about fertilisers and their use of July 26th 2000 (Journal of Law No 89, item 991). This document regulates issues of fertilisers market, fertiliser application, prevention of hazards to humans, animals and the environment, that could arise from transportation, storage and use of fertilisers, and agrochemical services in agriculture.

Basic conditions for surface water quality and requirements concerning the concentration of pollutants in wastewater discharges, set in the Decree of the Minister of Environmental Protection, Natural Resources and Forestry of November 5th 1991 are presented below.

The Decree defines a three-grade classification of inland surface water:
1. Class I – water good for:
   a) providing the population with drinking water,
   b) providing plants requiring high quality water (potable water),
   c) life of the *Salmonide* family fish in the natural habitat.
2. Class II – water used for:
   a) living the fish other then *Salmonide* in natural conditions,
   b) breeding the stock,
   c) recreation, water sports and public bathing.
3. Class III – water used for:
   a) providing plants that do not require potable water
   b) irrigation of arable land, gardens and greenhouses.

Table 12.10 Maximum permissible levels of nutrients in surface waters in division for three quality classes.

No	Parameter	Unit	Quality Class I	II	III
1	NH_4-N	mg N_{NH4}/l	1	3	6
2	NO_3-N	mgN_{NO3}/l	5	7	15
3	NO_2-N	mgN_{NO2}/l	0.02	0.03	0.06
4	N-TOT	mgN/l	5	10	15
5	Dissolved phosphate (PO_4-P)	mgP/ l	0.2	0.6	1.0
6	P-TOT	mgP/l	0.1	0.2	0.4

Table 12.11 The highest permissible levels of nutrients in wastewater discharged into waters and ground.

No	Parameter	Unit	Value
1	Ammonia nitrogen	mg N_{NH4}/l	6.0
2	Nitrate nitrogen	mgN_{NO3}/l	30.0
3	Total nitrogen	mgN/l	30.0
4	Total phosphorus	mgP/l	5.0

Main legal instruments for enforcement and control

A. Fees

According to the Act – Water Law of October 24th 1974, all enterprises in Poland pay for water abstraction and discharge of wastewater to the surface waters. All enterprises/plants (whether having a water law permit or not) are obligated to measure the quantity of water abstracted and wastewater discharged. Each year, plants are obliged to submit information by January 31 on the abstracted water and discharged wastewater to the Provincial Authority (Voivodship Office). Information is provided in the Informative Chart on Water and Wastewater.

B. Fines

Provincial (Voivodship) inspectorates of environmental protection (in Polish – WIOS), according to the Act of July 20th 1991 about State Inspection of Environmental Protection, are obliged to control discharges from industrial and municipal point sources and to evaluate the level of fines, if necessary. According to the Regulation of the Government from November 2nd 1995, results of the measurements of quality and quantity of discharged wastewater are the basis for calculation of fines, when the limits defined in the water law permit are exceeded with (e.g. too high concentrations of pollutants in wastewater).

C. Statistical obligations

According the Act of Public Statistic from June 29th 1995, a national data base on the quality and quantity of wastewater discharged from the plants/enterprises to surface waters operates in the Main Statistical Office (in Polish – GUS). Industrial and communal enterprises located in the Province (Voivodship) are obligated to submit reports on their water management to provincial statistical offices. Information on abstracted water and discharged wastewater are submitted separately for industrial and municipal enterprises. Based on this information, specific reports and inventories are to be prepared in the provincial statistical offices, e.g. according to administrative division of the region, industry branch, etc. Data from Provinces (Voivodships) are gathered and processed in the Main Statistical Office and published in statistical yearbooks for the entire country.

D. Monitoring of surface water

The Inspectorate of Environmental Protection (IEP), in accordance with the Act from July 20th 1991 about State Inspection of Environmental Protection, is responsible for surface water quality monitoring in Poland. The State Surface Water Monitoring Program is conducted by the Institute of Meteorology and Water Management, Provincial Inspectorates of Environmental Protection and the Institute of Environmental Protection. In the national monitoring programme, measurements are conducted on 361 river monitoring stations and 9 lakes. For rivers, the frequency of nutrient measurements is 12 to 24 times per year. Nutrients are obligatory parameters in both rivers and lakes.

Data originating from the sources set by existing legal regulations do not ensure full control of the amount of nutrients discharged to water. The main reasons are as follows:

- in many cases, emission information is provided by discharging enterprises in their reports.
- mandatory control and reporting regarding nutrients cover only enterprises that have nitrogen and phosphorus included in their water law permit.

12.2.3 Scientific background programs

National programs

"Strategy of the Protection of Water Resources from Pollution"

From 1994–1997, a research project entitled "Strategy of the Protection of Water Resources from Pollution; the perspective of human health and nature protection, and economic needs" was conducted. The project (PBZ 2802) was ordered by the Ministry of Environmental Protection, Natural Resources and Forestry, and financed by the Committee of Scientific Research. The goal of the project was to develop the scientific background for the selection of a general strategy to protect Polish water resources from pollution. The strategy prepared under that project covers the period from 1995 through 2020 and addresses, among other items, the following issues:

- strategy and activities aimed at reduction of loads of pollution from municipal sources;
- strategy and activities aimed at reduction of loads of toxic pollutants;
- strategy and activities aimed at reduction of loads of nitrogen;
- strategy and activities aimed at reduction of loads of phosphorus;
- strategy and activities aimed at reduction of loads of diffused pollution originating from agriculture.

This project was co-ordinated by the Institute of Meteorology and Water Management, and involved numerous research institutions including the Institute of Environmental Protection (Warsaw), Institute of Ecology of Industrial Areas (Katowice), National Geological Institute (Warsaw) and other research institutions related to industry.

In the project reports the following issues are discussed:

- identification of main sources of pollution in Poland,
- balance of pollutants discharged to surface waters, including nutrients, in the years 1994–1995,
- strategy and main areas of activities aimed at reduction pollution in the period of 1995–2020,
- identification of necessary legal regulations,

- determination of parameters of necessary investments in water protection and estimation of required resources, and
- identification of main areas of other non-investment activities (e.g. in agriculture).

Results of this project contributed to the development of the Polish statement in negotiations with the European Union.

The Oder Program (Program dla Odry) (ongoing)
In 1999, the Ministry of Environmental Protection, Natural Resources and Forestry initiated this program with an objective to co-ordinate numerous activities, studies and projects that have been developed for the Oder region, including:

- the Program of Rapid Interventions to Protect the Oder River from Pollution, prepared by the International Commission of the Protection of the Oder from Pollution (currently, Program of the Improvement of Water Purity);
- the Program of anti-flood protection (component B), financed by the loan from the World Bank;
- the National Program of Rebuilding and Modernisation, developed after the flood in 1997;
- the Oder 2006 Program;
- the International Oder Project;
- the Program of the Polish-Dutch Institutional Co-operation in the Catchment "MATRA"; and
- other initiatives on the regional and super-regional scale, aimed at the protection and re-naturalisation of ecosystems, protection of cultural heritage, and tourism development.

International programs

Study of the Odra River
A pre-feasibility study of the Odra river basin, as a component of the Baltic Sea environmental programme, was prepared under the leadership of BCEOM, Société Francaise d'Ingénierie. The study area covered the entire drainage basin of the Odra river in the Czech and Slovak Federal Republics, Poland and Germany, and the Stettiner Haff (Zalew Szczecinski). The objective of the study was to prepare a priority action program to control and reduce pollution of the Baltic Sea from the Odra river basin in line with the 1988 Baltic Sea Declaration. The target objective was the adoption of measures by the countries in the region to reduce the 1987 emission levels by 50 % by 1995.

Diffuse Entries in Rivers of the Odra Basin
In 1997–1999, the Polish Academy of Science (PAN) and Deutscher Verband fur Wasserwirtschaft und Kulturbau e.V. (DVWK) conducted a joint project to investigate the quantity of diffuse entries in the rivers of the Odra catchment area and the Pomeranian Bay to develop decision facilities for an integrated approach on water protection. The aim of the project was to estimate diffuse pollutants (nitrogen and phosphorus) entries into the rivers in Oder catchment area and to prepare a nutrient balance for the entire catchment based on methodology and models used in Germany. In phase III of the project, completed in 2001, point and non-agricultural sources of nutrients in the catchment in Germany, the Czech Republic and Poland were included.

Third Pollution Load Compilation Programme (PLC-3)
The HELCOM periodic programme "Third Pollution Load Compilation" (PLC-3), conducted in 1995, dealt with discharges of loads to the marine environment of

the Baltic Sea via rivers, coastal areas and direct point sources. Under PLC-3, Poland as a participant of this programme collected and elaborated information about:

- riverine inputs of pollution into the Baltic Sea,
- inputs from coastal zones,
- direct discharges from point sources into the Baltic Sea including:
  – municipal effluents and
  – industrial effluents.

The project covered discharges of pollution from the Vistula, Odra and Pomeranian rivers and 96 point sources, including 18 wastewater treatment plants that discharged wastewater directly to the Baltic Sea.

Fourth Pollution Load Compilation Programme (PLC-4) (ongoing)
By the end of 2001, HELCOM Contracting Parties should collect data for the Fourth Pollution Load Compilation. It includes an inventory of point and non-point pollution sources of the entire catchment of the Baltic Sea located within the borders of Contracting Parties. In the case of Poland, it covers nearly the entire surface of the country, with more then 2000 point sources.

As part of PLC-4, data will be collected on:

- riverine inputs into the Baltic Sea
- impact from coastal areas
- discharges from point sources:
  – to the Baltic Sea
  – to rivers in the catchment area of the Baltic Sea
- balance of nutrients in the whole catchment area of the Baltic Sea for:
  – point sources of pollution
  – diffused sources
  – natural background emissions
  – retention in the catchment.

In Poland, work on PLC-4 is co-ordinated by the Inspectorate of Environmental Protection.

12.2.4 Implementation of EU Directives

Poland developed a national negotiation statement concerning environmental issues. The statement was accepted by the Polish European Integration Committee on 27 September 1999 and adopted by the Government on 5 October 1999. In the statement, the Polish government indicated 31 December 2002 as the date of its preparedness for accession to the European Union, and declared an obligation that by that date Poland would implement *acquis communautaire* regarding environmental issues. Poland also applied for transition periods with regard to the following EU Directives:

- Directive 91/271/EEC from 21 May 1991, on the treatment of municipal wastewater (paragraphs 3, 4, 7)
- Directive 91/676/EEC from 12 December 1991 on the protection of waters from pollution resulting from nitrates used in agriculture.

Directive 91/271/EEC
The most relevant requirement in this Directive, concerning the treatment of municipal wastewater, is the obligation to have sewerage systems built in all urban agglomerations with a load of more than 2 000 person equivalent (PE), by 31

December 2005. Beginning from 1 January 2006, all wastewater discharged from such urban areas must undergo biological treatment (or other method with equivalent efficacy). Moreover, EU members have been obliged to define receiving water bodies susceptible to eutrophication. Municipal wastewater discharged to such receivers must undergo tertiary treatment (i.e., nutrient removal) with a minimum reduction of total nitrogen by 70–80 %, and total phosphorus by 80 %.

Poland developed an investment program to meet Directive's requirements. Realisation of the designed investments is planned during the transition period, assuming no changes in the system of financing of environmental protection activities in Poland (i.e., a large contribution of ecological funds). Availability of significant resources from pre-accession funds and EU structural funds would accelerate this process.

The Polish investment program includes:

- Building of new wastewater treatment plants in 130 cities with more than 2 000 PE (including 3 cities with more than 100 000 PE), and biological treatment plants in all agglomerations with more than 5 000 PE.
- Modernisation of existing wastewater treatment plants to ensure treatment quality defined by EU regulations
- Building of sewerage systems in agglomerations where such systems are lacking, and upgrading of existing system, where necessary. It is estimated that 48 cities would require building of new systems, and about 4 000 000 urban inhabitants would be connected to the system.

As a priority, wastewater treatment plants in cities with more than 100 000 inhabitants would be built. The estimated costs of developing municipal sewerage systems can total 8.9 billion euros. During the transition period, all cities inhabited by more than 5 000 people would be provided with sewerage systems, and 25 % of people living in villages and smaller towns (2 000–5 000 inhabitants) would be connected to the system. In the remaining areas to which the Directive 91/271/EEC applies, alternative safe systems for the elimination of municipal wastewater would be developed.

The estimated cost of building and modernisation of wastewater treatment plants is 2.3 billion euro. Because of high costs of implementation of EU regulations concerning municipal wastewater treatment and time required to complete all design activities, Poland has applied for transition periods to implement the Directive's Articles 3, 4 and 7:

- A transition period of 10 years – by 31 December 2015, for discharge of wastewater from agglomerations inhabited by 10–15 000 PE, and towns inhabited by 2–10 000 PE.
- A transition period of 13 years – by 31 December 2015, for discharge of wastewater from agglomerations with more than 15 000 PE
- A transition period of 8 years – by 31 December 2010, for discharge of wastewater from agglomerations with more than 100 000 PE.

Directive 91/676/EEC

The Directive, concerning protection of water from pollution resulting from agricultural use of nitrates includes requirements for:

- the determination of susceptible areas, where water bodies are particularly exposed to nitrogen compounds;
- the development of Good Agricultural Practice and to promote their implementation.

For farms located in susceptible areas, the Directive requires implementation of control programs of fertilisation and control of nitrite compounds runoff. Estimated costs needed to meet the Directive's requirements (assuming that only part of the country will be classified as nitrogen-susceptible) is 3 billion euros. Building of reservoirs for the manure represents major part of these costs. The estimated cost of one reservoir is close to 5 000 euros. Realisation of this element of the investment program would require state subsidies.

Poland has already undertaken certain actions to implement this Directive. Principles of the Good Agricultural Practice have been established. On 26 July 2000, the Polish Parliament adopted the Act on fertilisers and their use, adopting some of EU Directive regulations.

Poland applied for 8 years' transition period in implementing Directive 91/676/EEC, taking into account the following conditions:

- the necessity of building of high number of manure reservoirs,
- the need to prepare proper locations for storage of fertilisers and to develop plans of mineral fertilisation, and
- the long time period needed to disseminate and implement principles of Good Agricultural Practice.

12.2.5 Investments in water protection

The increasing importance of environmental protection, including water quality protection, in Poland is reflected by the gradual increase in investments and the growing contribution of environmental protection to GNP. Table 12.12 below presents an inventory of investments in water quality protection as a part of total environmental protection investments and GNP.

Table 12.12 Selected environmental protection investments in Poland in 1993–1997 (in million euros).

Investments	1993	1994	1995	1996	1997
Water protection	368.45	371.68	370.21	639.70	804.88
Air protection	279.36	349.42	540.05	1 063.51	1 011.17
Surface protection	67.10	65.33	95.89	107.39	137.77
Total	716.56	789.29	101.41	1 817.35	1 960.19
Contribution of ecological investments in total economic investments (expressed as %)	6.1	6.3	6.7	9.4	8.1
Contribution of environmental protection investments into GNP (expressed as %)	1.0	1.0	1.1	1.7	1.6

12.2.6 Conclusions

Reduction of nitrogen and phosphorus loads discharged to water observed between 1988 and 1995 resulted from profound economical transition occurring during that period and consequent enforcement of legal regulations concerning water quality protection.

Activities of the Inspection of Environmental Protection, including monitoring of river water quality and control of discharges from point sources proved to be efficient, contributing to a progressive reduction of loads of nutrients discharged to the Polish part of the Baltic Sea catchment.

Research and studies (including international programs) conducted in the 1990s have improved knowledge of sources of nutrient pollution in Poland. The knowledge about the modes of transportation of nutrients from point and diffuse sources is also gradually improving.

Further progress in reducing nutrient loads depends on the rapid completion of the process of adjustment of Polish law to the European Union standards. Compliance with emission standards set by the Directive 91/271/EEC, once achieved by Poland, would ensure fulfilment of Polish obligations within the Helsinki Convention. Increased financial resources for environmental protection in Poland, especially those for water protection, will ensure continuous progress in reducing loads of nutrients discharged to Polish rivers.

Available information on the sources of nutrient pollution in Poland strongly support the necessity of rapid implementation of the state monitoring of point sources of pollution, which would become a basis for balances of the principal pollution parameters based on comprehensive data. Incomplete information about point sources hinders the process of setting more specific goals concerning sources of nutrients discharging to rivers in the Polish part of the Baltic Sea catchment.

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13 Russian national report on nutrient loads

Alexander Shekhovtsov, State Centre for Environmental Programmes

13.1 Nutrients loads and reductions achieved

13.1.1 Methods used for calculation

Municipal and industrial discharges

St. Petersburg is the largest pollution source in the Baltic Sea catchment area within the territory of the Russian Federation. The pollution load of the city was calculated on the basis of a statistical report on the ecological condition of St. Petersburg and the Leningrad region. The results were compared with data published in a special issue of the European Water Pollution Control Association publication [1]. The load of untreated wastewater discharges was calculated using analyses of untreated wastewater multiplied by the volume of untreated wastewater.

The load of nitrogen and phosphorus from 1987 for the Leningrad, Novgorod, Pskov and Kaliningrad regions were taken from regional reports to the Parliament on the ecological status of the regions [2]. It was however, not possible to separate direct and indirect municipal and industrial discharges for the year 1987 on the basis of this report. As a rule for the former Soviet Union, industrial wastewater was primarily treated together with municipal wastewater in municipal wastewater treatment plants (MWWTP), and thus there is no data available to assess separately industrial loads. Therefore the discharges from MWWTPs are taken as part of the municipal load. Taking into account that only inorganic nitrogen and phosphorus compounds were measured in the late 1980s in the former Soviet Union, the overall load from municipalities and industries is underestimated.

Loads of nitrogen and phosphorus for 1995 were also taken from the regional reports to the Parliament [3]. The 1995 data were more specific, and therefore direct and indirect discharges were separated, however, it was not possible to separate municipal and industrial discharges.

The load figures included in these reports were calculated mainly on the basis of monitoring data. In the late 1980s, flow measurement systems, sampling methods and sampling frequencies corresponded to Guidelines adopted by the Ministry of Land Reclamation and Water Management of the Soviet Union [4]. Only for municipal wastewater treatment plants larger than 50 000 PE were continuous flow measurements used. In other cases wastewater volume was normally assessed using data on water consumption. For industrial point sources both methods were used. Composite or grab samples from treated or untreated wastewater were taken 1 to 4 times per week for municipalities larger than 50 000 PE; in other cases grab samples were used. Standard chemical analysis methods adopted by the Ministry of Land Reclamation and Water Management of the Soviet Union were used [5]. Loads from sewage systems and industrial plants were calculated using various calculation methods depending on measurement and sampling frequency.

The monitoring data concerning municipal and industrial sewage effluents served as the basis for calculating the load figures included in the State Statistical Reports on water consumption and wastewater discharges "2-water" [6]. A comparison of the load data with information obtained from PLC-2 [7] and PLC-3 [8] reports was impossible due to the different initial information and calculation methods.

In the Baltic Sea catchment area there are some small fish farms. Due to a lack of information concerning production figures and food consumption, it was impossible to calculate loads of nitrogen and phosphorus to water bodies.

Agriculture

It is quite difficult to estimate anthropogenic discharges from agriculture, especially for the late 1980s. At the time, there was no research concerning the washout of nitrogen and phosphorus compounds from agricultural land. Data concerning fertiliser and manure use in the catchment area of the Baltic Sea were taken from regional reports to Parliament on the ecological status of the regions [2, 3]. As a result of the economic collapse in the early 1990s, there was a significant reduction in the use of fertilisers and manure by agriculture.

Taking into account that Leningrad, Novgorod, Pskov and Kaliningrad regions are geographically similar to the three Baltic States, and the use of fertilisers and manure was roughly equivalent, agricultural loads were calculated using the same coefficients as those used in Estonia. The load figures from agriculture do not include background load.

13.1.2 Nitrogen and phosphorus discharge to water bodies

Discharge from municipalities and industries

Based on the calculation methods described in Section 13.1.1, direct and indirect discharges of nutrients from municipal wastewater treatment plants were calculated. The results are presented in Tables 13.1 and 13.2 respectively.

Table 13.1 Discharges of nitrogen and phosphorus from municipalities and industries entering directly to the Baltic Sea.

N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995(t/y)	Reduction (%)
37 323	24 302	35	5 353	3 395	37

Table 13.2 Discharges of nitrogen and phosphorus from municipalities and industries entering into surface freshwater in the Baltic Sea catchment area.

N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995(t/y)	Reduction (%)
9 078	5 976	34	1 901	778	59

Agriculture

Based on the methodology described in Section 13.1.1, nutrient loads from agriculture into the environment were estimated. The results are presented in Table 13.3.

Table 13.3 Estimated discharges of nitrogen and phosphorus from agriculture.

Nutrient	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	82 736	24 028	58 708	71
P-TOT	2 452	1 008	1 444	59

The reductions in the nitrogen and phosphorus discharges are mainly a result of the economic collapse in industry and agriculture starting in the early 1990s. The use of nitrogen and phosphorus fertilisers was reduced in the Russian Federation from the late 1980s to 1995 more than 6 times (from 96.5 kg/ha in 1985 to 14.1 kg/ha in 1995). Milk and meat production in the Baltic Sea catchment area declined 59 % (996 000 t) and 46 % (207 300 t) according to Russian annual statistics.

From the late 1980s to 1995, in the Leningrad, Novgorod, Pskov and Kaliningrad regions the area of arable land decreased by 9 %, and the number of cattle and pigs by 27.4 % and 36 % respectively (Table 13.4). The consumption of fertilisers and manure declined about 90 %. All those changes had a large influence in the reduction of nitrogen and phosphorus discharges to water bodies.

Table 13.4 Supplementary indicators concerning the anthropogenic load from agriculture.

Indicators		Late 1980s	1995	Decrease	Decrease (%)
Arable land (ha)		2 310 800	2 100 700	210 100	9
Total number of cattle		1 515 564	1 100 300	415 264	27
Total number of pigs		1 031 347	658 000	373347	36
	Consumption of fertiliser (t/y)	351 240	153 30	335 910	96
	Consumption of manure (t/y)	175 610	33 610	142 000	80
N	Use of fertilisers and manure (kg/ha)	2 107	233	1 874	89
	Annual discharge (t/y)	82 736	24 028	58 708	71
	Discharge (kg/ha y)	358	114	244	68
	Losses of fertilisers (%)	16	49		
	Consumption of fertiliser (t/y)	161 760	840	160 920	99
	Consumption of manure (t/y)	59 050	21 010	3 8040	65
P	Use of fertilisers and manure (kg/ha)	956	104	852	89
	Annual discharge (t/y)	2 452	1 008	1 444	59
	Discharge (kg/ha y)	11	5	6	55
	Losses of fertilisers (%)	1	5		

In principle such large load reductions to the freshwater systems in the Russian part of the Baltic Sea catchment area should somehow be reflected in the riverine load. The agricultural load from Russia is transported to the Baltic Sea via the following rivers: Neva, Narva, Daugava, Nemunas and Pregol. Taking into account that all the above-mentioned rivers also transport discharges from Finland, Estonia, Latvia, Lithuania, Belarus, Ukraine and Poland, it is difficult to assess the Russian part of the load reduction. In addition in the catchment areas of those rivers are many large lakes and reservoirs, such as Lake Ladoga, Lake Ilmen, Lake Peipsi, and the Riga and Kaunas reservoirs which also greatly influence the water quality of those rivers.

The investigations carried out by Raspletina between 1989 and 1995 concerning the water quality of the Neva river confirm the reductions achieved by Russia. The Neva river phosphorus load is presented in Table 13.5 [9]. The 1996 load figure is from the Project D71-424-1D828 launched by Finland [10].

Table 13.5 The River Neva phosphorus load changes between 1989 and 1996.

	1989	1990	1991	1992	1993	1994	1995	1996
Phosphorus load (t/y)	2 410	2 180	2 200	1 900	1 370	1 670	1 550	1 738
Concentration (µg/l)	29	26	27	21	18	22	18	

13.1.3 Overall reduction of nutrient load into the environment achieved

During the period between 1980s and 1995, a significant decrease can be observed in the pollution load, as shown in Table 13.6.

Table 13.6 Total discharge of nitrogen into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load in late 1980s (t/y)	Load in 1995 (t/y)	Reduction (t)	Reduction (%)
Direct municipal and industrial discharge	37 323	24 302	13 021	35
Indirect municipal and industrial discharge	9 078	5 976	3 102	34
TOTAL from point sources	46 401	30 278	16 123	35
Discharge from agriculture	82 736	24 028	58 708	71

Significant reductions in nitrogen loads from agriculture have been achieved in Russia. The reduction of municipal and industrial loads is attributable to the construction of new and reconstruction of old wastewater treatment plants, and to the reduction of water consumption and reduction of industrial production. The reduction of industrial and agricultural load is mainly a result of economic changes during the period.

Table 13.7 Total discharge of phosphorus into the environment in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration.

Source	Load in late 1980s (t/y)	Load in 1995 (t/y)	Reduction (t)	Reduction (%)
Direct municipal and industrial discharge	5 353	3 395	1 958	37
Indirect municipal and industrial discharge	1 901	778	1 123	59
TOTAL from point sources	7 254	4 173	3 081	43
Discharge from agriculture	2 452	1 008	1 444	59

Table 13.7 shows the significant reductions in the phosphorus load from agriculture have occurred during the period from the late 1980s to 1995. A detailed distribution of the nitrogen and phosphorus load from the territory of the Russian Federation is presented in Table 13.8

Table 13.8 Municipal, industrial and agricultural loads to water bodies in the 1980s and 1995.

1987 (ST. PETERSBURG)	Q 10^6 m^3/d	mgN/l	mg P/l	Load tN/d	Load tP/d	Load tN/y	Load tP/y
Untreated	3.2	22.4	3.4	71.7	10.9	26 091.5	3 960.3
Central	1.5	8.9	1.2	13.4	1.8	4 859.4	655.2
Northern	0	0	0.0	0.0	0.0	0.0	0.0
Total	4.7					30 950.9	4 615.5
Load to the environment in Leningrad region in 1987						5 197.0	1 516.0
Load to the environment in Novgorod region in 1987						2 528.0	95.4
Load to the environment in Pskov region in 1987						1 353.0	290.0
Agricultural load from Leningrad region in 1987						66 019.0	1 930.0
Municipal and industrial load from Kaliningrad region						6 372.0	737.0
Agricultural load from Kaliningrad region						16 717.0	522.0
Grand Total in the mid-1980s						129 136.9	9 705.9
1995 (ST. PETERSBURG)	Q 10^6 m^3/d	C mgN/l	C mg P/l	Load tN/d	Load tP/d	Load tN/y	Load tP/y
Untreated	1.42	22.4	3.4	31.8	4.8	11 578.1	1 757.4
Central	1.5	8.9	1.2	13.4	1.8	4 859.4	655.2
Northern	0.94	13	0.9	12.22	0.9	4 448.1	318.2
Total	3.86					20 885.6	2 730.8
Direct load from Vyborg in 1994–1995 (Gulf of Finland year)						182.0	68.0
Direct load from other sources (Gulf of Finland year)						996.0	188.0
Indirect municipal load from Leningrad region in 1995						977.0	151.0
Indirect industrial load from Leningrad region in 1995						1 218.0	270.0
Indirect agricultural point source load from Leningrad reg.						428.0	66.0
Indirect industrial load from Novgorod reg. In 1995						2 462.0	137.0
Indirect industrial load from Pskov region in 1995						891.0	154.0
Load from agriculture in the catchment area of the Gulf of Fin						22 287.0	878.0
Municipal and industrial load from Kaliningrad region						2 238.0	408.0
Agricultural load from Kaliningrad region						1 741.0	130.0
Grand Total in 1995						54 305.6	5 180.8
Reduction achieved between 1987–1995						74 831.3	4 525.1

13.1.4 Clarification of differences between load figures published earlier

As was mentioned in Section 13.1.1, the comparison of load data with information obtained from the PLC-2 and PLC-3 reports was impossible due to different initial data and calculation methods.

13.2 Water protection targets

In 1998 the "National Environmental Action Plan of the Russian Federation for 1999 to 2001" (NEAP) was prepared. The NEAP was developed to determine effective ways to improve the environmental situation in Russia and was adjusted to reflect the main provisions of the long- term economic and social policy of the country.

The purposes of the NEAP include: improvement of the environmental situation in the Russia Federation, unfavourable health impact abatement, conservation of the life-supporting function of the biosphere, and strengthening the participation of Russia in international environmental protection activities. The NEAP included provisions to:

- decrease of polluted wastewater discharges to water bodies providing their self-restoration;
- stabilise storage volumes of household and industrial wastes and decrease storage volumes of hazardous wastes that cause secondary pollution of soils and waters.

Therefore NEAP contributed to the environmental improvement in the Baltic Sea catchment area (including natural complexes of the Onezshkoye and Ladozshkoye Lakes and the Neva Bay). In addition to the NEAP the following activities have been planned and are under implementation in the Kaliningrad region, St. Petersburg and the Leningrad region.

Kaliningrad Region

To reduce nutrient discharges from the territory of the Kaliningrad region in the period 1995–2000, the following programmes and actions were planned:

- a programme for reduction of discharges to water bodies in the Baltic Sea catchment area envisages construction of biological wastewater treatment plants (BWWTP) in the following towns: Kaliningrad, Sovetsk, Neman, Gvardeisk and others.
- a comprehensive programme for the total elimination of untreated wastewater discharges to water bodies envisages the construction/reconstruction of sewer systems and treatment plants in the following towns of the region: Kaliningrad, B. Isakovo, Nivenskoye, Mamonovo, Gvardejsk, and Krasnogvardejsk.
- a programme of measures to transfer pulp-and-paper mills to environmentally clean technologies.
- an Action Programme for prevention of the environment pollution by wastes from livestock and maintenance of 45 treatment plants, arrangement of 35 burial grounds for animal refuse.

Leningrad Region

In order to improve the environmental situation in the region, the Administration of St. Petersburg and Leningrad oblast developed different programmes which are now being implemented:

- The Environment Protection Action Programme for 1996–2005. The Programme envisages development of laws concerning:
  – Neva River protection;
- Neva River Bay protection and use;
  – the Gulf of Finland protection and use;
  – Saint-Petersburg inland channels protection and use;
  – Leningrad region ground waters protection.
- The Programme for construction of water protection facilities in order to protect the Baltic Sea according to the international commitments of the Russian Federation.
- The Programme for construction of anti flooding facilities in St. Petersburg.

Along with these measures, a more effective reduction of nutrient discharges is hampered by lack of sufficient municipal wastewater treatment capacities. This problem can be solved after the Southwestern Waste Water Treatment Plant is put into operation in St. Petersburg.

As far as prospective plans for nutrient loads reduction are concerned, reduction activities in the Russian part of the Baltic Sea area are planned within the framework of the Federal Programmes "Ecology and Natural Resources of the Russian Federation" (for the period 2002–2010) and "Social and Economic Development of the North-Western Administrative Region of Russia" (up to 2010). These programmes will be adopted by the Russian Government this year. According to preliminary information, the Federal Government will be responsible for 10 % of the total expenses of the programme. The remaining 90 % of the expenses should be covered by regions.

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Swedish national report on nutrient loads

14

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14.1 Nutrient loads and reductions achieved

14.1.1 Methods of calculation/assessment

Gross load has been calculated for point-source discharge and root zone leaching from arable land for flow-normalised conditions in 1987 and 1995, respectively. For nitrogen, these calculations also consider retention processes in groundwater (below the root zone), lakes, and rivers that affect each source during its transport towards the sea, so that the net load to the sea is calculated. The retention is computed using the HBV-N model as described by Swedish EPA [1] and Arheimer and Brandt [2,3]. The average retention for inland municipal sewage is 37 %, for industries 39 %, and for freshwater fish farms 40 %. These figures are valid for both 1987 and 1995, while the retention for arable discharge differs between the years according to allocations of set-asides that are excluded from the load calculations.

Municipal discharges

Estimations are mainly based on measured nutrient discharge. Municipal sewage treatment plants in Sweden have different levels of sampling procedures depending on their size, as shown in Table 14.1. The calculation of pollution load from the larger cities (>20 000 PE) is based upon at least 25 samples per year, and water flow through the treatment plants is measured continuously. The pollution load is calculated as the product of annual flow and flow-weighted concentration. Thus the reported pollution load from the municipal treatment plants is considered to be a fairly accurate assumption of true discharges. The overflows from larger municipalities are usually included in the figures provided. Chemical analyses were performed in accordance to Swedish and Nordic standards (e.g., potassium peroxodisulphate digestion, autoanalyser).

Table 14.1 Sampling frequencies of Swedish treatment plants.

Size of treatment plant (PE)	Parameter	Frequency of analyses[1]
201–2 000	P-TOT, N-TOT	8 dp/year
2 001–10 000	P-TOT, N-TOT	2 dp/month
10 001–20 000	P-TOT	2 dp/month
10 001–20 000	NH_4-N, N-TOT	2 dp/month
>20 000	P-TOT	1 wp/week
>20 000	NH_4-N, N-TOT	1 dp/week

1) dp = daily, continuous sampling proportional to the flow during 24 hrs.
wp = weekly, continuous sampling proportional to the flow

For nitrogen, measurements were not available for 1987. Thus discharge was calculated based on population equivalents (PE) and the assumed treatment level for each plant. The assumed person equivalent was then 12 g N/person day, and the average treatment level 20 % (i.e., 3.5 kg/person yr). A total of 7.33 million persons were then connected to municipal sewage treatment (e.g., 86 % of the Swedish population). In addition to the requested data, phosphorus loads from municipalities were also estimated for the early 1980s, since most reduction measures had already been introduced in the 1970s and early 1980s in Sweden. This will give a fairer picture of impacts of the Swedish measures taken.

Industrial discharges

Calculations are based on measured nutrient-discharge values reported by industries, or prescribed loads in individual permits (Table 14.2). Chemical analyses were performed in accordance to Swedish and Nordic standards.

Table 14.2 Basis of calculation methods for different industrial branches.

Industrial branch	Calculation method
Pulp and paper	Measured P-TOT and N-TOT (once a week)
Refineries	Nutrient discharge as prescribed in the single permits
Chemical plants	Measured P-TOT and N-TOT (random samples weekly)
Other branches	Nutrient discharge as prescribed in the single permits

Fish farming

The load from both freshwater and marine farms were calculated by multiplying the production levels by emission factors [4], which are indicated in Table 14.3.

Table 14.3 Emission factors used for calculation of load from Swedish fish farms.

Nutrient	Emission factors (g/kg net production)		Reduction (%)
	1987	1995	
Nitrogen	70	56	20
Phosphorus	10	7	30

Agriculture

Export coefficients have been multiplied by the area of Sweden's arable land in the Baltic Sea drainage basin, based on information of crop cultivation from SCB (1996) in 1988 and 1995, respectively. Thus the total area of arable land used in this study does not include fallow or set-asides. For 1988 the crop-cultivated arable land is assumed to cover 2 600 000 ha, and 2 400 000 ha in 1995.

National export coefficients reported describe arable leaching without consideration to natural leaching from these soils. As the HELCOM agreements only include anthropogenic sources, the natural background (Table 14.4) must thus be subtracted from the total agricultural load. For Swedish conditions, the natural background discharge of nitrogen from arable land is considered to be similar to flow-normalised leakage from grassland. By using the SOIL-N model for various soil types and climatological regions, the average background value has been estimated at 3.85 kg N/ha year for the root zone (i.e. gross load) and 2.02 kg N/ha year for discharge to the sea, i.e., net load after retention [5]. For phosphorus, an average leaching coefficient for forest on 0.15 kg P ha year [6] is considered to be background discharge and subtracted from the arable leaching in order to calculate the anthropogenic load.

Table 14.4 Natural background load from arable land within the Swedish part of the Baltic Sea basin.

Year	Gross N load (t/y)	Net N load (t/y)	Gross P load (t/y)
1987	9 970	5 230	390
1995	9 200	4 830	360

Nitrogen

Average export coefficients for arable land in the southern half of Sweden was calculated and then extrapolated to arable land in northern Sweden in order to derive total national load from arable land. The area of arable land in northern Sweden is rather small. The reported values consider flow-normalised load for arable land with prevailing agricultural practices for the years 1987 and 1995 respectively. Export coefficients were calculated using two different methods (described below), revealing slightly different results (Table 14.5).

Arheimer and Brandt [3]: Process-based modelling by using a field-scale model (SOIL-N) combined with a catchment-scale model (HBV-N) in 4 000 sub-basins in southern Sweden [2]. The model was calibrated against measured time-series in 110 sites for water discharge and 722 sites for riverine-nitrogen concentrations, and evaluated in 32 independent sites. For arable land different combinations of soil, crops, and fertilisation regime in different agricultural regions (a total of 486 combinations) were considered. The modelling included ten years of daily simulation to avoid an overriding influence of weather during specific years or seasons.

Johnsson and Hoffmann [7]: Process-based modelling by using only the field-scale model (SOIL-N) with meteorological data from nine agricultural regions. Different combinations of soil, crops, and fertilisation regime were considered in each region, as indicated above. The modelling included ten years of daily simulation to avoid an overriding influence of weather during specific years or seasons. However, less attention was paid to spatial hydrometeorological variability than in the approach described above.

Table 14.5 Calculations of gross nitrogen leaching from arable land in the Swedish part of the Baltic Sea drainage basin, using two slightly different methods. The natural background load (from Table 14.4) is subtracted to derive the anthropogenic load.

	Arheimer and Brandt, 2000				Johnsson and Hoffmann, 1998	
	GROSS LOAD		NET LOAD		GROSS LOAD	
	1987	1995	1987	1995	1987	1995
N export coefficient (kg N /ha y)	29	24	15	13	30	22
N export from arable land (tonnes N /y)	75 100	57 400	38 900	31 100	77 700	52 600
Anthropogenic load (tonnes N /y)	65 100	48 200	33 700	26 300	67 700	43 400
Reduction		26 %		22 %		36 %

Phosphorus

No large-scale mapping of phosphorus leaching from arable land has been done for all of Sweden. However, as part of the future PLC-4 reporting, phosphorus leaching will be estimated for the year 2000, and these calculations will include the entire Swedish surface. Until then, various field studies are available, which show that average export coefficients for arable land vary considerably among regions, fields and soil types, as shown in Table 14.6.

Andersson [6] shows that the variation may be more than two orders of magnitude, which indicates the large range of uncertainty involved in the estimates given.

Löfgren and Olsson [8] based their export coefficients for phosphorus on measured time-series for several years from 17 fields. They established a regression model that included water flow and then applied the expression on different climatological regions in Sweden. The average water discharge for the period 1975–87 was used in the calculations.

SCB [9]: Long-term averages from several monitoring fields at the Swedish University of Agriculture (SLU) were used. The value is from personal communication between Statistics Sweden and Marcus Hoffmann, SLU.

Table 14.6 Calculations of gross phosphorus leaching from arable land in the Swedish part of the Baltic Sea drainage basin, using export coefficients from three different field surveys. The natural background load (from Table 14.4) is subtracted to derive the anthropogenic load.

	Andersson, 1982 min.	max.	Löfgren & Olsson, 1990 average for: 1975–87	(M. Hoffman, pers.comm.) SCB, 1995
P export coefficient (kg P/ha y)	0.01	2.0	0.22	0.3
P export from arable land (tonnes P/y)				
1987	26	5 200	570	780
1995	24	4 800	530	720
Anthropogenic load (tonnes P /y)				
1987		4 800	180	390
1995		4 400	170	360

Although it might be tempting, the various export coefficients in Table 14.6 should not be compared as if they represented the leaching rate during different time periods. Differences in results only reflect differences in the underlying assumptions and calculation methods, and do not include any possible changes caused by changes in agricultural practices. The reduction in phosphorus losses is thus only caused by a decrease in the area of arable land.

Since diffuse sources and especially nutrient leakage from arable land are so difficult to estimate properly, complementary information on fertilisation, based on information from Statistics Sweden, [10], is provided in Table 14.7. Phosphorus in particular shows a radical decrease in input, but it should be noted that no indications of a corresponding decrease in leaching can yet be found for monitored fields (e.g. [11]).

Table 14.7 Agricultural input of commercial fertilisers in Sweden for three different years.

Commercial Fertiliser	1980 (t/y)	1988 (t/y)	1995 (t/y)	Reduction (%)
Nitrogen	202 000	186 000	173 000	14
Phosphorus	41 000	28 000	19 000	54

14.1.2 Nitrogen and phosphorus discharge to the environment

Municipal discharges

Based on the methodology described in Section 14.1.1, the direct and indirect discharges to the Baltic Sea of nutrients from Swedish municipal wastewater treatment plants were calculated, (Table 14.8 and 14.9).

Table 14.8 Discharges of nitrogen and phosphorus from Swedish municipalities entering directly to the Baltic Sea.

	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Total	14 135	12 925	9	655	235	64

Table 14.9 Discharges of nitrogen and phosphorus from Swedish municipalities entering into surface freshwater in the Baltic Sea catchment area.

	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Total	11 500	12 080	–5	375	175	53
Total including retention	7 200	7 600	–5	–	–	–

Industrial discharges

Based on the methodology described in Section 14.1.1, the direct and indirect discharges to the Baltic Sea of nutrients from Swedish industries were calculated (Table 14.10 and 14.11).

Table 14.10 Discharges of nitrogen and phosphorus from Swedish industries entering directly to the Baltic Sea.

Industry	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Chemicals		310				
Petrochemicals		50				
Iron and steel		70				
Food processing		5				
Pulp & paper		2 540				
Total	4 478	2 975	34	573	325	43

Table 14.11 Discharges of nitrogen and phosphorus from Swedish industries entering into surface freshwater in the Baltic Sea catchment area.

Industry	N-TOT late 1980s (t/y)	N-TOT 1995 (t/y)	Reduction (%)	P-TOT late 1980s (t/y)	P-TOT 1995 (t/y)	Reduction (%)
Chemicals	1 400					
Mining and metals	200					
Iron and steel	130					
Non-ferrous metals	100					
Pulp & paper	780					
Other	300					
Total	2 910	2 180	25	200	150	25
Total including retention	1 800	1 300	28			

Fish farming

Based on the methodology described in Section 14.1.1, the load of nutrients from Swedish fish farms was calculated (Table 14.12).

Table 14.12 Estimated discharges of nitrogen and phosphorus from Swedish freshwater and marine fish farms.

	Freshwater fish farms			Marine fish farms			Total reduction	
	Load late 1980s (t/y)	Load 1995 (t/y)	Reduction (%)	Load late 1980s (t/y)	Load 1995 (t/y)	Reduction (%)	(t)	(%)
N-TOT	80	180	–125	215	120	44	–5	–2
N-TOT incl. ret	50	100	–100					
P-TOT	10	31	–210	26	21	20	–16	–44

Agriculture

Based on the methodology described in Section 14.1.1, the nutrient discharge from Swedish arable land to the Baltic Sea was calculated (Table 14.13).

Table 14.13 Estimated discharges of nitrogen and phosphorus from Swedish arable land to the Baltic Sea.

	Load in late 1980s (tonnes/year)	Load in 1995 (tonnes/year)	Reduction (tonnes)	Reduction (%)
N-TOT	65 100	48 200	16 900	26
N-TOT including retention	33 700	26 300	7 400	22
P-TOT	390	360	30	8

14.1.3 Overall reduction achieved of nutrient load to the environment

During the period between the 1980s and 1995, significant decreases can be observed in the pollution load of nutrients. The overall objective to reduce the pollution load from Sweden by 50 % has been realised for phosphorus, but not yet for nitrogen (Table 14.14 and 14.15). It should be noted that most reduction measures for phosphorus had already been implemented in Sweden by the late 1980s.

Table 14.14 Total discharge of nitrogen in the late 1980s and 1995 and reductions achieved to implement the 1988 Ministerial Declaration. The table presents both gross load in the drainage basin and actual net load input to the Baltic Sea (i.e., including retention).

Source	Load in late 1980s (t/y)	Load in 1995 (t/y)	Reduction (tonnes)	Reduction (%)
Gross municipal discharge	25 635	25 005	630	2
Net municipal discharge	21 335	20 525	810	4
Gross industrial discharge	7 388	5 155	2 233	30
Net industrial discharge	6 278	4 275	2 003	32
Gross load from fish farms	295	300	–5	–2
Net load from fish farms	265	220	45	17
Gross load from arable land	65 100	48 200	16 900	26
Net load from arable land	33 700	26 300	7 400	22
TOTAL GROSS LOAD	98 418	78 660	19 758	20
TOTAL NET LOAD on the sea	61 578	51 320	10 258	17

Table 14.15 Total discharge of phosphorus in the early 1980s, late 1980s, 1995 and reductions achieved to implement the 1988 Ministerial Declaration. The table presents only the gross load in the drainage basin.

Source	Load in early 1980s (t/y)	Load in late 1980s (t/y)	Load in 1995 (t/y)	Reduction (tonnes)	Reduction (%)
Municipal discharge	2 000	1 030	410	1 590 / 620	80 / 60
Industrial discharge	> 773	773	475	2980	39
Load from fish farms	> 36	36	52	–16	–44
Discharge from arable land	> 390	390	360	30	8
Total Gross Load	> 3 199	2 229	1 297	1 902 / 932	60 / 42

14.1.4 Explanation of reductions achieved

Municipal discharges

Reduced nutrient load was achieved through improved treatment methods in municipal treatment plants. It should be noted that in Sweden most of the improved phosphorus treatment in municipal plants took place during the 1970s. Compared to the load during the late 1960s, 93 % of the Swedish phosphorus load has already been reduced (Table 14.16). This high level of reduction already achieved will be taken into account in discussing of future tasks for phosphorus reduction in Sweden.

Table 14.16 Total phosphorus load to both coastal and inland recipients from municipal treatment plants during the second half of the 1900 century.

Municipal discharges (tonnes/year)	1960s	1980	1987	1995	Reduction (%)
Phosphorus	6 200	2 000	1 030	410	93

Industrial discharges

Reduced nutrient load was achieved through improved wastewater treatment methods and, additionally, to a lesser degree also changes in production methods.

Fish farming

The nutrient loads from freshwater fish farms presented in this report are considerably lower in 1987 than in 1995, but the Swedish interpretation is that the 1987 figures are too low, probably due to an inadequate reporting procedure that year. According to emission factors (presented in Table 14.3), fish farms have reduced their load per production unit through more efficient feeding routines and lower levels of nutrients in fodder. The marine farms show a corresponding decrease in their nutrient load to the sea.

Agriculture

Nitrogen

The modelled gross reduction in nitrogen load from agriculture [3] is mainly a consequence of set-asides and changed crop composition, which include more grass ley and less cereals. In addition, leakage concentrations from individual crops were decreased due to increased nitrogen use efficiency [7]. However, it should be noted that these improved agricultural practices have not yet revealed any reduced export from agricultural catchments in Sweden. On the contrary, the leaching trends are increasing slightly [12], probably due to the high levels of nitrogen storage within the soil. It is not yet known how long the time lag will be between the introduction of reduction measures and decreased export, and this time lag was not included in the modelling. Most probably the time lag depends on the physiographical and hydrometeorological conditions of each field.

Phosphorus

No large-scale mapping of phosphorus leaching from arable land has been done for all of Sweden, and the difference in loading between 1987 and 1995 has not been estimated. Nevertheless, reduced leaching is expected since the phosphorus input to the agricultural sector in the form of commercial fertilisers has decreased by about 60 % over this period. So far, this decrease in input cannot be noted in the monitoring data from arable fields. This is also presumed to be effect of the large storage capacity within soils, and it is not yet known how long the time lag will be before any effects may be noted.

14.1.5 Clarification of differences between load figures and previous estimates

Municipal discharges

Nitrogen: The value presented in PLC-2 was considerable lower than the present estimates for 1987, due to errors in the PLC-2 calculations. The prior value was based on too few measured values and reflected incorrect assumptions for person-equivalents and reduction efficiency among treatment plants. The present value corrected these errors. The values for 1995 and PLC-3 show good agreement.

Phosphorus: For phosphorus also, the value presented in PLC-2 was considerably lower than the present estimates for 1987. No good explanation for this discrepancy has been found, but it is of minor importance since the overall reduction in phosphorus load from the 1960s is more than 90%. Data from PLC-3 and estimates for 1995 show better agreement.

Industrial discharges

Nitrogen: The load reported in PLC-2 should be used for 1987, as it was based on careful investigations and collections of measurements. Later reconstruction of the load is of lower quality. PLC-3 values and estimates for 1995 show good correspondence.

Phosphorus: Also for phosphorus the load reported in PLC-2 should be used for the year 1987 as it was based on careful investigations and collections of measurements, while a later reconstruction is of lower quality. PLC-3 and estimates for 1995 show fairly good correspondence.

Fish farming

No comparison with previous estimates has been performed.

Agriculture

It is very difficult to estimate diffuse leaching, and the values that are reported are extremely sensitive to the methods used and the assumptions taken. Thus, load calculated with different methods or resolution of input data shall not be compared. However, relative changes in load between different years may be achieved by using the same degree of input data and the same method. This has been done for nitrogen in Sweden (see above). Phosphorus is only affected by areal changes of arable land in the calculations presented.

14.2 Water protection targets

14.2.1 Introduction

The Swedish Parliament has stated 15 national goals for the environment, which shall be reached within one generation (MJU 1998/99:06 rskr 183). One of the goals is "No Eutrophication", which means that the concentrations of nutrients in soil and water shall not lead to any negative impact on human health, biodiversity or the possibilities for the overall use of water and soil. For the coastal zone and the sea, the goal specifies that the conditions prevailing during the 1940s should be reconstructed and that the contribution of nutrients to the sea should not cause any eutrophication. The national targets to reach the environmental goal will be discussed and decided upon in the Swedish Parliament during 2001.

To facilitate the implementation of the goals, the Swedish Environmental Protection Agency (Swedish EPA) has proposed several more specific sub-goals [13], but no formal decision on reduction targets has yet been taken by the Swedish Parliament. One proposed sub-goal is that the Swedish coastal zone and the marine environment shall provide good ecological status by the definitions of the EU Water Framework Directive. This means among other things that:

- Concentrations of nitrogen and phosphorus, and biodiversity, may only differ slightly from typical conditions.
- Oxygen deficits caused by eutrophication from human activities will be very rare.

- The most exposed areas has improved by year 2010, regarding nitrogen and phosphorus concentrations and biodiversity, at least by one class according to the Swedish EPA criterion.
- The Swedish riverine load of nitrogen from human activities to the marine environment south of the Bothnian Sea has been reduced by 40 % of the 1995 level by the year 2005 (i.e., agreements within HELCOM).

According to Swedish policy, high priority will continue to be given to international efforts, as the goal for the marine environment cannot be reached without co-operation among nations. The reduction goal should be regionalised, which means that the reduction targets may differ between catchments based on environmental conditions [13]. The implementation of the EU Water Framework Directive may have large influence on future water policy in this direction, as it prescribes specific management plans for individual river basins. Thus, Sweden supports the use of a problem-orientated approach, which focuses on the environmental conditions in the Baltic Sea, and implies that different reduction targets, based upon e.g. critical loads or ecological quality objectives are set for different coastal areas and catchments with the aim to achieve the most cost-effective solution towards the overall 50 % reduction target. Furthermore, it means that efforts should be directed towards the increase of additional reduction measures in the areas of priority concern for the Baltic Sea (HELCOM EXTRA 99).

Sweden also supports the load-orientated approach, which focuses on actual inputs to the marine area rather than on the discharge at the source. To estimate the impact of each source on the marine load, retention during the transport in the freshwater system must be calculated for at each source. Additionally, natural background values must be estimated for diffuse sources, as only the anthropogenic part of the load is to be reduced by 50 % according to the HELCOM agreements (HELCOM EXTRA 99).

In the report "Nitrogen from land to sea" [1] several measures to reduce the nitrogen load on the sea are proposed in order to reach the original 50 % HELCOM target. It was then obvious that measures must also be taken in less sensitive areas to reach the HELCOM goal. The total cost for Swedish society to reduce the nitrogen load was estimated at some 50–60 million euro per year. The preliminary Swedish judgement is that it will be very difficult to reach the HELCOM goal of nitrogen reduction to the sea by 2005, mainly due to the difficulties involved in reducing leaching from arable land [13, 14]. Many of the new recommendations need some time before they can be fully implemented. Furthermore, even if the measures proposed were to be implemented today, there is a considerable time lag in soils and sediments before the effects would be noted in the riverine load to the sea.

14.2.2 Targets for reduction of point-source pollution

There is an on-going improvement of nitrogen treatment for 70 Swedish municipalities with discharge directly to the sea, and this improvement is estimated to reduce the load by 5 000 tonnes nitrogen compared to the load in 1995 [13]. In addition, the revised EU directive for treatment plants will force the larger municipal treatment plants (>100 000 PE) to reduce their discharge by almost 2 000 tonnes per year. All together, this will reduce the nitrogen discharge by some 30 % (Table 14.17).

Table 14.17 Swedish targets for reduction of N load from municipalities by the year 2010 according to the Swedish EPA [13].

Load in 1995:	Proposed Measures	Reduction target (t/y)	gross %	net %	Total cost (euros/y)
Gross: 25 005 t					
Net: 20 525 t	Ongoing	7 000	28	34	–
	Additional	1 500	6	7	3–6 million
	Total:	8 500	34	41	3–6 million

To further reduce the load of both phosphorus and nitrogen by the year 2010, the Swedish EPA [13] propose the following additional targets:

- Further extension and optimisation for some municipal treatment plants to improve the nitrogen reduction,
- Strategic improvement of discharge pipelines,
- Improvements of treatments for rural households that which are not connected to municipal treatment, and
- Local treatment of urban drainage water.

These additional targets are estimated to reduce nitrogen loads by 1 500 tonnes per year, which means that more than 40 % of the 1995 net load would be reduced by 2010. The total cost for the additional targets are estimated at 3–6 million euro per year. However, no decision for these additional targets has yet been taken by the Swedish Parliament.

The Swedish industrial load of nitrogen is rather modest; nevertheless, it may be necessary to also reduce these sources in sensitive areas. Specific targets for industrial sources are considered to be of greatest importance for phosphorus reduction and should be focused on industries with discharge to inland waters and the Baltic Proper.

Fifty percent of the industrial discharge of both nitrogen and phosphorus originate from pulp and paper mills. It is estimated that half of the industrial nitrogen net load should be able to be reduced by the year 2005 [13]. The costs involved have not been calculated so far (Table 14.18), and there is no decision taken on these targets.

Table 14.18 Swedish targets for reduction of N load from industries by the year 2005 according to the Swedish EPA [13].

Load in 1995:	Proposed Measures	Reduction target (t/y)	gross %	net %
Gross = 5 155 t. Net = 4 275 t.	Improved treatment	2 137	41	50

14.2.3 Targets for reduction of diffuse pollution from agriculture

The Swedish national policy to reduce nutrient leaching from arable land includes several instruments, such as legal regulations for manure treatment and bare fields, advice to farmers regarding best environmental practices (which has been provided for free since the 1980s), taxes on commercial fertilisation (since 1984), and research and development grants provided to assess various reduction measures [14]. A number of factors have been identified as particularly important for nitrogen leaching:

- the intensity of livestock production and management of manure.
- the time for ploughing and spreading of manure on the fields.

- choice of crops in the crop rotation, and amount of fertilisers.
- bare fields without vegetation during the winter (i.e., increased leaching).
- wetlands and open ditches close to the fields (i.e., reduced leaching).

Measures that reduce the phosphorus discharge includes decreased fertilisation, changed livestock nutrition, reduced livestock density, carbonating of soils, and construction of protection zones between fields and open ditches or streams.

No decision on national targets to reduce the load from arable land has yet been taken by the Swedish Parliament. However, the Swedish Agricultural Board [14] has analysed how to reduce the nitrogen discharge to the sea by another 30% within the agricultural sector. It is stated that about 12 000 tonnes nitrogen per year of the discharge from arable land must be reduced to fulfil the targets, but nevertheless, two other alternatives (for 10 000 tonnes and 6 000 tonnes, respectively) have also been presented by the Agricultural Board.

Consideration has been given to the efficiency of measures, estimated total effect, cost-effectiveness, total cost, and instruments available to implement the measures among farmers. The main proposal includes the same increasing trend in set-asides as have been experienced in Sweden during the last years, and the present taxes on commercial fertilisers. In addition, it is assumed that measures will be taken due to changed legislation, increased advising activities, and economical compensation and subsidies from the state. Proposed measures, their effects and cost is presented in Table 14.19. All measures are not assumed to be taken at once and some measures will not provide full effects until some time has passed. Therefore, the target reduction will be 5 300 tonnes per year in 2005, while the 10 000 tonnes reduction is assumed to be reached in 2020 (Table 14.19).

To reach the overall goal of 40 % reduction for Swedish marine load, another 2 000 tonnes has to be reduced. This reduction is proposed to be located to the southernmost counties in Sweden, where the arable leaching is largest and the retention is lowest. Possible measures include permanent set-asides, changed crop

Table 14.19 Swedish targets for reduction of N load from arable land by the year 2005 and 2020 according to the Swedish Agricultural Board [14].

	TARGETS BY YEAR 2005				TARGETS BY YEAR 2020			
Proposed measures	(t/y)	Reduction target 2005 gross (%)	Total cost (euro/year)	Cost per kg reduced N (euro)	(t/y)	Reduction target 2020 gross (%)	Total cost (euro/year)	Cost per kg reduced N (euro)
Load in 1995:								
Gross = 48 200 tonnes								
Net = 26 300 tonnes								
Decreased arable area	500	1			1 800	4		
Decreased fertilisation intensity	500	1			750	2		
Rules for manure application	1340	3	1.2 mill.	1	2 090*	4	19 mill.*	24*
Education, information, advises	1100	2	3.7 mill.	3	1900	4	4 mill.	2
Subsidies for:								
* set-asides	500	1	2.8 mill.	5	500	1	2.8 mill.	5
* catch-crops	210	0.5	3.4 mill.	16	390	1	6.4 mill.	16
* no autumn ploughing	260	0.5	1.5 mill.	6	480	1	2.7 mill.	6
* constructed wetlands	850	2	4.2 mill.	5	2 100	4	11 mill.	5
Total at sources (gross load)	5 260	11	16.8 mill.		10 010	21	45.9 mill.	
Retention (25 %)	–1 315				-2 502			
Total to the sea (net load)	3 945	15	16.8 mill.		7 508	29	45.9 mill.	

**) This figure includes the introduction of a system for detailed manure calculations and personal advice to individual farmers.*

rotation, wetlands, decreased intensity and changed livestock production (Table 14.20). These additional measures are not considered to be realised voluntarily by the farmers. Thus, it is suggested to wait for the evaluation of the measures taken according to Table 14.19, before introducing these more severe efforts [14]. The total cost to full-fill the HELCOM agreement for the Swedish agricultural sector is estimated at 58–79 million euro (Table 14.20).

Table 14.20 Additional Swedish targets to achieve 40% reduction of N load from arable land according to the Swedish Agricultural Board [14].

Load in 1995: Gross = 48 200 tonnes Net = 26 300 tonnes	Proposed measures	Reduction target (t/y)	(%)	Total cost (euros/year)	Cost per kg reduced N (euro)
	targets by 2020	10 010	21	45.9 mill.	
	Additional:	2 000	4		
	– set-asides			33 mill.	17
	– wetlands			12 mill.	6
	– decreased intensity				
	– reduced livestock				
	Total at sources	12 010	25	58–79 mill.	
	Retention (25 %)	–3 000			
	Total to the sea	9 010	35	58–79 mill.	

Conclusions

Sweden has well-developed proposals with specified reduction targets on how to reduce the nutrient discharge to the Baltic Sea. These national proposals focus on the most eutrophied areas, and on sources for which the efforts will give most results and thus be most cost-effective (i.e., they are problem oriented and source-

Table 14.21 Summary of Swedish targets to reduce nitrogen load from 1995 levels.
(1995 levels = 78 600 tonnes N/yr for gross load and 51 300 tonnes N/yr for net load reaching the sea.
Note that no Parliamentary decision has yet been taken on either the targets or timetable.)

Sector	Targets by 2005 Reduction Target (t/y)	Total reduct. (%) Gross	Net	Cost (million euro/year)	Targets by 2020 Reduction Target (t/y)	Total reduction (%) Gross	Net	Cost (million euro/year)
Municipal treatment plants	7 000	9	14	–	8 500	11	17	3–6
Industry	2 137	3	4		2 137	3	4	
Agriculture	5 260[1]	7		16.8	12 010[1]	15		> 58
	3 945[2]		8		9 007[2]		18	
Total: gross	14 397	19		16.8	22 647	29		> 65
Total: net load	13 082		26		19 644		39	

[1]) *Reductions achieved according to a source-oriented approach.*
[2]) *Reductions achieved according to a load-oriented approach (i.e. considering actual input to the marine area).*

oriented). However, no Parliamentary decision has yet been taken for individual targets.

The preliminary Swedish judgement is that it will be very difficult to reach the HELCOM goal of nitrogen reduction to the sea by 2005, mainly due to the difficulties involved in reducing the leaching from arable land. According to the Swedish targets proposed so far, 26 % of the load to the sea will be reduced by the year 2005, while 39 % will be reduced by the year 2020 (Table 14.21). This is in line with the HELCOM goal, but not within the HELCOM timetable. However, no Parliamentary decision has yet been taken, either for the targets or the timetable.

The total cost of the Swedish reductions proposed for nitrogen discharge to the sea is estimated at more than 65 million euro per year (Table 14.21).

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Appendix 1. Comparison of agricultural load

Comparison of nitrogen discharges from agriculture in the late 1980s.

1 Country	2 Arable land (ha)	3 Fertilisers (t/y)	4 Discharge (t/y)	5 Fertilisers (kg/ha)	6 Losses (kg/ha)	7 Losses (%)
DEN	1 985 700	467 990	79 000	236	40	16.9
EST	1 120 000	163 900	30 200	146	27	18.4
FIN	2 271 000	329 504	45 500	145	20	13.8
GER	1 896 400	422 300	35 200	223	19	8.3
LAT	1 688, 000	290 740	33 800	172	20	11.6
LIT	3 255 200	495 456	59 500	152	18	12.0
POL	18 783 841	2 550 000	135 100	136	7	5.3
RUS	2 310 800	526 850	82 700	228	36	15.7
SWE	2 590 300	273 000	65 100	105	25	23.8

Losses (6) = discharge (4) / arable land (2) x 1 000
Losses (7) = discharge (4) / fertilisers (3) x 100

All data are taken from the answers to the questionnaire adopted by TC INPUT 4/99

Comparison of nitrogen discharges for 1995.

1 Country	2 Arable land (ha)	3 Fertilisers (t/y)	4 Discharge (t/y)	5 Fertilisers (kg/ha)	6 Losses (kg/ha)	7 Losses (%)
DEN	1 934 250	436 500	53 800	226	28	12.3
EST	1 128 000	43 000	12 600	38	11	29.3
FIN	2 302 000	258 320	37 000	112	16	14.3
GER	1 896 400	258 100	26 100	136	14	10.1
LAT	1 713 000	47 324	17 100	28	10	36.1
LIT	2 958 300	146 956	35 500	50	12	24.2
POL	18 663 821	1 897 900	94 600	102	5	5.0
RUS	2 100 700	48 940	24 000	23	11	49.0
SWE	2 386 900	238 000	48 200	100	20	20.3

Losses (6) = discharge (4) / arable land (2) x 1 000
Losses (7) = discharge (4) / fertilisers (3) x 100

Comparison of phosphorus discharges from agriculture for the late 1980s

1 Country	2 Arable land (ha)	3 Fertilisers (t/y)	4 Discharge (t/y)	5 Fertilisers (kg/ha)	6 Losses (kg/ha)	7 Losses (%)
DEN	1 985 700	62 290	670	31	0.34	1.08
EST	1 120 000	37 780	360	34	0.32	0.95
FIN	2 271 000	84 053	2 650	37	1.17	3.15
GER	1 896 400	79 400	600	42	0.32	0.76
LAT	1 688 000	138 349	1 010	82	0.60	0.73
LIT	3 255 200	180 909	1 810	56	0.56	1.00
POL	18 783 841	935 500	7 390	50	0.39	0.79
RUS	2 310 800	220 810	2 450	96	1.06	1.11
SWE	2 590 300	50 000	390	19	0.15	0.78

Losses (6) = discharge (4) / arable land (2) x 1 000
Losses (7) = discharge (4) / fertilisers (3) x 100

Comparison of phosphorus discharges for 1995

1 Country	2 Arable land (ha)	3 Fertilisers (t/y)	4 Discharge (t/y)	5 Fertilisers (kg/ha)	6 Losses (kg/ha)	7 Losses (%)
DEN	1 934 250	48 740	580	25	0.30	1.2
EST	1 128 000	6 560	250	6	0.22	3.8
FIN	2 302 000	50 271	2 600	22	1.13	5.2
GER	1 896 400	40 200	640	21	0.34	1.6
LAT	1 713 000	16 643	510	10	0.30	3.1
LIT	2 958 300	30 593	890	10	0.30	2.9
POL	18 663 821	466 900	6 650	25	0.36	1.4
RUS	2 100 700	21 850	1 010	10	0.48	4.6
SWE	2 386 900	41 000	360	17	0.15	0.9

Losses (6) = discharge (4) / arable land (2) x 1 000
Losses (7) = discharge (4) / fertilisers (3) x 100

Appendix 2. List of abbreviations.

B	biological treatment
BAT	Best available technology
BOD	biochemical oxigen demand
BWWTP	biological wastewater treatment plant
C	chemicaly treatment
COD	Chemical oxigen demand
CORINE	Land cover data
DVWK	Deutscher Verband fur Wasserwirtschaft und Kulturbau e. V.
EIA	Environmental impact assessment
EPA	Environmental Protection Agency
EU	The European Union
EU/DG XI	The Directorate General Environment, Nuclear Safety and Civil Protection of the Commission of the European Communities
FAO	Food and Agricultural Organization
FEI	The Finnish Environment Institute
FRG	Federal Republic of Geramny
GDR	German Democratic Republic
GIS	Geographical information system
GNP	The gross national product
PE	Population equivalent
HELCOM	Baltic Marine Environment Protection Commission, the Helsinki
HELCOM EXTRA 99	The extraordinary meeting of the Helsinki Commission in 1999 Commission
HELCOM LAND	Land-based Pollution Group of the Helsinki Commission Helsinki Commission Baltic Marine Envi-ronment Protection Commission
IEP	The Inspectorate of Environmental Protection
IPPC	The Integrated Pollution Prevention Control Directive
JCP	Joint Comprehencive Programme
LU	Animal unit
M	mechanical treatment
MINDEC 88	The 1988 Ministerial Declaration
MONERIS	Modelling Nutrient Emissions in River Systems
MWWTP	municipal wastewater treatment plants
N	nitrogen / nitrogen removal
NES	The National Environment Strategy
NEAP	The National Environment Action Plan
NEPP	The National Environmental Policy Plan (in Chapter 10)
NEPP	The National Environmental Policy of Poland (in Chapter 12)
NERI	The Danish National Environmental Research Institute
OECD	Organization of European Cooperation and Development
OSPAR	Convention for the Protection of the Marine Environment of the North-Atlantic
P	Phosphorus
PAN	The Polish Academy of Science
PLC-4	The Fourth Baltic Sea Pollution Load Compilation Report
SMHI	The Swedish Meteorological and Hydrological Institute
SAPARD	The Rural Development Plan programme "Environmentally friendly methods in agriculture" for the EU accession countries
SLU	The Swedish University of Agriculture
TC INPUT	The Working Group on Inputs to the Environment of the Helsinki Commission
UNTR	Untreated wastewater
UWWTD	The EU Urban Waste Water Treatment Directive 91/271/EEC

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Abstract

The report summarises the development of nitrogen and phosphorus loading in the Baltic Sea catchment area between the late 1980s and 1995, as well as the reduction achieved. The national loading figures have been collected in long-term monitoring programmes, which, however, differ among countries, especially regarding diffuse loading. Some of the loading figures for the late 1980s have been calculated based on background statistics and/or model calculations, without the possibility of verification by monitored data. The loading figures for 1995 are, for the most part, calculated from the data obtained in monitoring programmes. The country-specific reduction figures were produced by the national experts of the Project Team, and the overall results and their comparison are based on these estimates.

The total point source loads of nitrogen and phosphorus decreased by 30 % and 39 %, respectively. The 50 % reduction target was achieved for phosphorus by almost all the Baltic Sea countries, while most countries did not reach the target for nitrogen. Decreases of diffused loading could be found in nitrogen loads, while decreases in phosphorus remained smaller or negligible. In Denmark, Finland, Germany and Sweden, no decreases could be found in agricultural phosphorus, despite reductions in the use of phosphorus-containing fertilisers due to the surplus of phosphorus in agricultural land. The estimates suggest that the 50 % reduction target would have been reached by some countries in transition for both N and P.

In general, the reductions were biggest both for point and non-point sources in the transition countries, due to fundamental changes in their political and economical systems in the early 1990s. In EU member countries, the observed decrease was usually smaller and was based on water protection measures implemented during the period. This development strengthened also in the countries in transition during the 1990s. Denmark, Finland, Germany (Western part) and Sweden had already achieved reductions in point source loading in the 1970s and 1980s. This partly explains lower reductions from point sources in these countries between the late 1980s and 1995.

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Asiasanat	typpi, fosfori, pistekuormitus, hajakuormitus, kuormitusvähennys, kuormitustavoite, vähennystoimenpide, 1988 ministerijulkilausuma, Itämeren valuma-alue	
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Evaluation of the implementation of the 1988 Ministerial Declaration regarding nutrient load reductions in the Baltic Sea catchment area

This report suggests answers to the following questions:

- What was the extent of nutrient loading in the Baltic Sea catchment area in the late 1980s and in 1995?
- How much has nutrient loading to the environment been reduced by the Contracting Parties of the Helsinki Convention?
- What kind of reduction targets have been elaborated by the Contracting Parties to achieve a 50 % reduction of nutrient loading as specified by the 1988 Ministerial Declaration?

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