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Nutrient Pollution to the Baltic Sea in 2000

Helsinki Commission
Baltic Marine Environment Protection Commission

Contents

Baltic Sea Environment Proceedings

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Abstract

Nitrogen and phosphorus enter the Baltic Sea either as waterborne or airborne inputs. In 2000, these inputs amounted to 1009700 tonnes of nitrogen and 34500 tonnes of phosphorus.

About 75 % of the nitrogen entered the Baltic Sea as waterborne input and 25 % as airborne input. Agriculture and managed forestry contributed almost 60 % of the waterborne nitrogen inputs to the sea, 28 % entered from natural background sources and 13 % came from point sources. The airborne nitrogen input has been calculated as direct atmospheric deposition on the Baltic Sea. It originated from emissions to the air from inside as well as outside the Baltic Sea catchment area and from ship traffic.

It has been estimated that airborne phosphorus input is only 1-5 % of total phosphorus input and is therefore not included in this report. Agriculture together with managed forestry contributed nearly 50 % of the waterborne phosphorus inputs to the sea and point sources and natural background sources each contributed approximately 25 % of the phosphorus input to the Baltic Sea.

HELCOM Recommendations, EU Regulations and national legislation have contributed to stricter controls on industry and municipal wastewater treatment plants. As a result nutrient pollution from point sources has reduced significantly between 1985 and 2000. However, the reduction targets for diffuse sources such as agriculture have not yet been fulfilled. Although a lot of measures have already been taken by many countries, further measures in many regions seem to be necessary to reduce pollution from agriculture. In open sea areas, airborne inputs, which also originate from outside the HELCOM countries, are a main source of nitrogen input. These additional sources are ship traffic on the Baltic Sea as well as non-HELCOM countries outside the Baltic Sea catchment area. The Recommendations section at the end of this report outlines HELCOM activities and goals for addressing these issues.

Preface

This report summarizes and combines the main results from the latest HELCOM airborne and waterborne pollution load compilations and refers to the year 2000. This report deals only with eutrophying nutrients (nitrogen and phosphorus), while the original reports also comprise some hazardous substances.

HELCOM's monitoring activities

To provide reliable information on the state of the marine environment, HELCOM started joint monitoring programmes in the 1970s. To determine the effectiveness of measures taken to reduce pollution in the Baltic Sea and to support the development of HELCOM's environmental policy, reliable data on different pollution sources as well as inputs of harmful substances into the Baltic Sea need to be reviewed. In addition, quantified input data is a prerequisite to interpret and evaluate the environmental status and related changes in the open sea and coastal waters.

To satisfy these needs, approximately every five years, HELCOM has assessed the overall pollution load situation for the whole Baltic Sea area. Baltic Sea-wide waterborne Pollution Load Compilations (PLCs) have been carried out in 1987 (PLC-1), 1990 (PLC-2), 1995 (PLC-3), and 2000 (PLC-4). In PLC-4, a source-orientated approach was used for the first time to quantify the inputs from point sources and diffuse sources into surface waters within the Baltic Sea catchment area.

The emissions to air as well as atmospheric deposition are assessed annually by EMEP Centres acting as consultants for HELCOM. Airborne pollution load compilations have been carried out for HELCOM in 1990, 1995 and 2000 (PLC-Air).

What makes the Baltic Sea so sensitive?

The Baltic Sea, as one of the world's largest bodies of brackish water, is ecologically unique. Due to its special geographical, climatological, and oceanographic characteristics, the Baltic Sea is highly sensitive to the environmental impacts of human activities in its catchment area, which is ca. four times larger than the sea area itself and serves as home to some 85 million people.

The Baltic Sea is only connected to the world's oceans by the narrow and shallow waters of the Sound and the Belt Sea which limits the exchange of water with the North Sea. This means that some of the water may remain in the Baltic for up to 30 years.

Effects of Eutrophication

Since the 1800s, the Baltic Sea has changed from an oligotrophic clear-water sea into a eutrophic marine environment.

Nitrogen and phosphorus are among the main growth limiting nutrients and as such do not pose any direct hazards to marine organisms. Eutrophication, however, is a condition in an aquatic ecosystem where high nutrient concentrations stimulate growth of algae which leads to imbalanced functioning of the system:
- intense algal growth: excess of filamentous algae and phytoplankton blooms;
- production of excess organic matter;
- increase in oxygen consumption;
- oxygen depletion; and
- death of benthic organism, including fish.

1 Introduction

This report aims to give an overview of the amounts of nitrogen and phosphorus entering the Baltic Sea and what their sources are.

Figure 1 shows the countries surrounding the Baltic Sea, as well as the Baltic Sea catchment area and the different sub-regions of the Baltic. **Table 1** gives details of the size of each of the sub-regions of the Baltic Sea catchment area and the run-off in 2000.

The Pollution Load Compilation contains data on the amount of waterborne and airborne nitrogen and phosphorus entering the Baltic Sea. The waterborne inputs encompass inputs via rivers and point sources discharging directly into the sea. The inputs from rivers also include contributions from parts of the Baltic Sea catchment area which lie outside HELCOM countries. Inputs to surface waters within the catchment of the Baltic Sea originating from diffuse sources (such as agriculture, managed forestry, and natural background sources) and from point sources have been quantified to evaluate waterborne sources for inputs to the Baltic Sea.

The airborne inputs in this report refer only to atmospheric deposition on the Baltic Sea and originate from sources inside and outside the catchment area of the Baltic Sea. These sources are taken into account when modelling the nitrogen deposition on the Baltic Sea.

Figure 1.
The Baltic Sea catchment area and sub-basins as defined in PLC-4

Table 1.
Surface areas of the Baltic Sea catchment area sub-regions and total run-off in 2000

Sub-region	**Surface area (km^2)**	**Run-off in 2000 (10^6 m^3/a)**
Bothnian Bay	260675	155480
Bothnian Sea	220765	124150
Archipelago Sea	9000	3840
Gulf of Finland	413100	107340
Gulf of Riga	127840	28750
Baltic Proper	574545	115580
Belt Sea	27365	6670
The Kattegat	86980	42380
Total catchment area	1720270	584190

In the following two chapters on nitrogen and phosphorus inputs, the report will first consider the sources of nutrient inputs within the catchment area, after which the actual inputs to the Baltic Sea will be described.

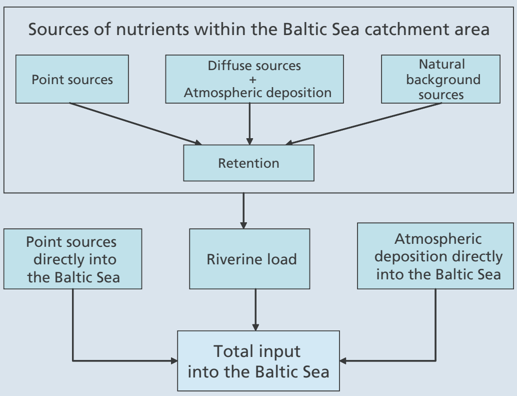
Pathways and sources of nutrient inputs

The land-based nutrient inputs entering the Baltic Sea are either airborne or waterborne. The main pathways of nutrient input to the Baltic Sea are:

- direct atmospheric deposition on the Baltic Sea water surface;
- riverine inputs of nutrients to the sea. Rivers transport nutrients that have been discharged or lost to inland surface waters within the Baltic Sea catchment area;
- point sources discharging directly to the sea.

The different sources for the inputs of nitrogen and phosphorus are from:

- atmospheric emissions of airborne nitrogen compounds emitted from traffic or combustion of fossil fuels (heat and power generation), and from animal manure and husbandry, etc.;
- point sources including inputs from municipalities, industries and fish-farms both discharging into inland surface waters and directly into the Baltic sea;
- diffuse sources, which mainly originate from agriculture, but also include nutrient losses from *e.g.* managed forestry and urban areas;
- and natural background sources, mainly referring to natural erosion and leakage from unmanaged areas and the corresponding nutrient losses from e.g. agricultural and managed forested land that would occur irrespective of human activities.



Large proportions of nutrient loads originate far away from the sea, and even from outside the HELCOM area. Many processes occur after nutrient input into the catchment area which affect their final input into the Baltic Sea. Rainfall and subsequent river run-off, as well as groundwater inflow to inland surface waters, are controlling factors that determine the final amounts of nutrients entering the Baltic Sea. Biological, physical, morphological, and chemical factors also retain and/or transform nutrients within river systems.

Another cause for increased nutrient levels in the sea, especially in the case of phosphorus, is the "internal load": Phosphorus reserves accumulated in the sediments of the sea bed are released back to the water under anoxic conditions. Neither this internal load, nor the amount of nitrogen fixed by cyanobacteria or blue-green algae, is considered in this report.

Remarks about uncertainties

Nitrogen and phosphorus inputs have been compiled for each Baltic Sea sub-region and HELCOM country since the 1980s. It is, however, complicated to form a reliable picture of long-term trends in the total inputs of nutrients into the Baltic Sea. Firstly, total inputs have not been compiled every year. Secondly, not all HELCOM countries have reported total waterborne inputs, or divided the loads for different sectors. Thirdly, some countries have not monitored the same categories every year, and finally, the methods for analyzing nutrient concentrations and for calculating loads have varied between the countries and changed over time.

With regard to air emissions, current data on ship emissions is limited, and as a result the extent of the environmental impacts of international shipping pollution is uncertain. Also, the results of air emissions and atmospheric depositions are based on modelling and therefore are prone to uncertainties.

Despite these uncertainties, the available data does give an indication of the extent of nutrient inputs to the Baltic Sea, with the PLC-4 results as the best and most comprehensive input estimate.

2 Nitrogen

2.1 Sources of nitrogen input

Emissions of nitrogen to the air

The airborne emissions of nitrogen from the HELCOM countries totalled 3215000 tonnes in 2000. This figure is based on total emissions from each country, including areas outside the Baltic Sea catchment area. Of the HELCOM countries, Russia and Germany had the greatest air emissions of nitrogen **(Figure 2)**. Not all emissions from the Baltic Sea countries actually end up in the Baltic Sea.

Inputs of nitrogen to surface waters within the catchment area

Inputs from point, diffuse and natural background sources into surface waters within the catchment area totalled 822000 tonnes. The main contributors were Poland, Sweden and Finland **(Figure 3)**.

The largest inputs of nitrogen originated from diffuse sources **(Figure 4)**.

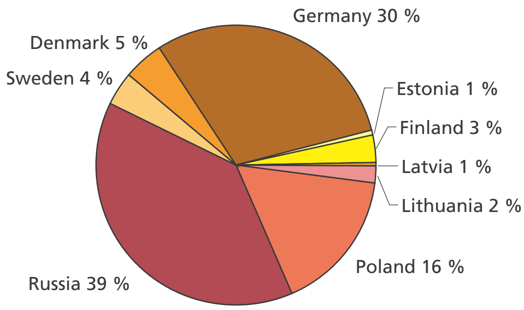


Figure 2.
Proportion of nitrogen emissions to the air from HELCOM countries in 2000[1]

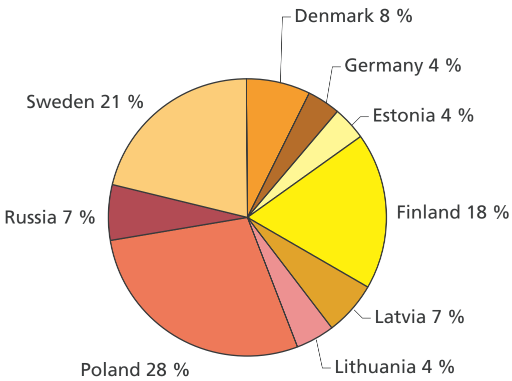


Figure 3.
Proportion of nitrogen inputs from point, diffuse and natural background sources within the catchment area by HELCOM countries in 2000[2]

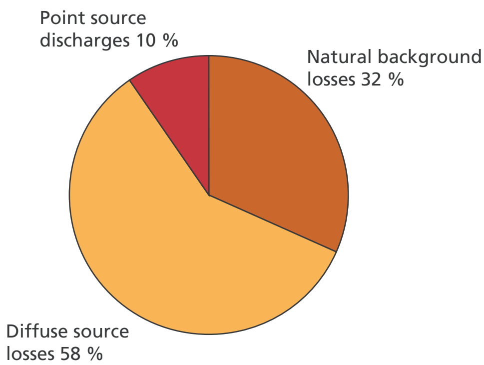


Figure 4.
The input of nitrogen by source into surface waters within the catchment area in 2000[3,4]

[1] Table 1 in Annex 1
[2] Table 2 of Annex 1
[3] Table 3 of Annex 1
[4] Please note that this figure shows an average of the sources of inputs within the whole catchment area. There are, however, significant proportional variations between different sub-regions.

2.2 Inputs of nitrogen to the Baltic Sea

Atmospheric deposition of nitrogen directly on the Baltic Sea

The atmospheric deposition of nitrogen on the Baltic Sea amounted to 264100 tonnes in 2000. This was about a quarter of the total nitrogen input to the Baltic Sea. The main HELCOM contributors were Germany, Poland and Denmark. 38 % of the total atmospheric deposition came from contributors outside the HELCOM area. Further, shipping on the Baltic Sea itself is also a significant source **(Figure 5)**. The top ten contributors, including sources from outside the catchment area are shown in **Figure 6**. The figures refer to emissions from countries as a whole, not only to their areas within the Baltic Sea catchment area.

Total waterborne inputs of nitrogen to the Baltic Sea

Many processes occur while nutrients are transported from the catchment area to the Sea. Nutrient retention is one of such important controlling factor.

In 2000, the total waterborne input of nitrogen to the Baltic Sea was 744900 tonnes. The main contributing countries were Poland, Sweden and Finland **(Figure 7)**. This Figure includes inputs from natural background sources as well as anthropogenic sources.

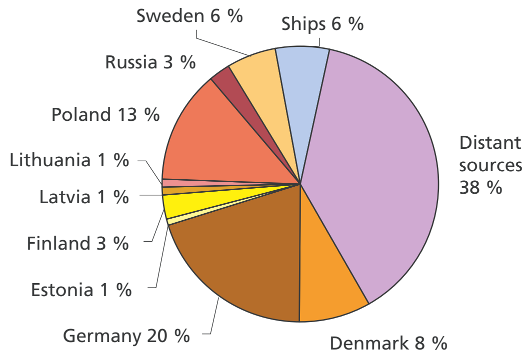


Figure 5.
Proportion of atmospheric deposition of nitrogen on the Baltic Sea by HELCOM contributor in 2000[5,6]

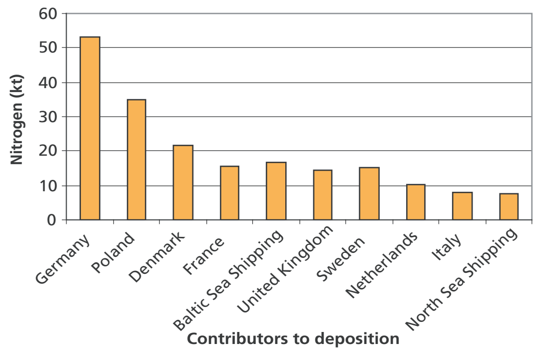


Figure 6.
Top ten contributors to atmospheric nitrogen deposition on the Baltic Sea in 2000[7]

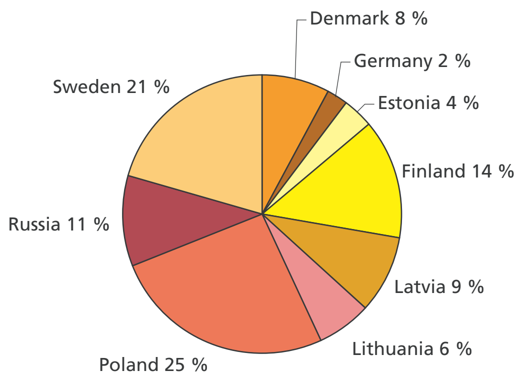


Figure 7.
Proportion of waterborne inputs of nitrogen into the Baltic Sea by HELCOM countries in 2000. These inputs include inputs from natural background sources as well as anthropogenic sources[8]

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[5] Ship emission data exists only for the year 1990 and the same values have been used for all subsequent years.
[6] Table 4 of Annex 1
[7] EMEP 2001
[8] Table 5 of Annex 1

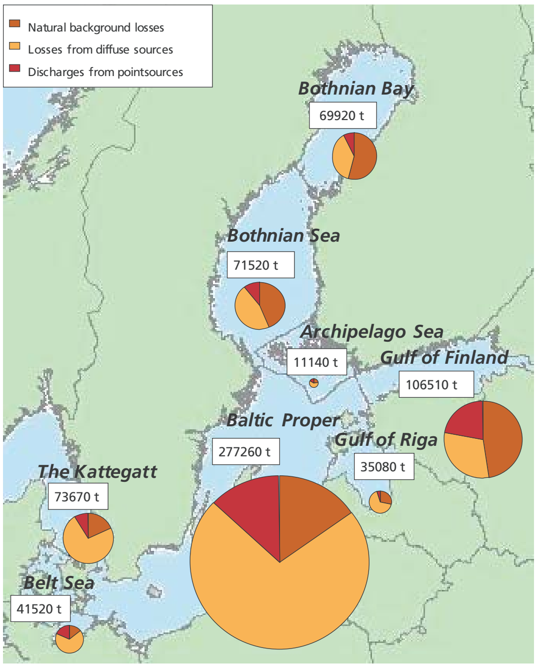

Figure 8.
Proportion of sources contributing to waterborne nitrogen input into the Baltic Sea sub-regions in 2000[9,10]

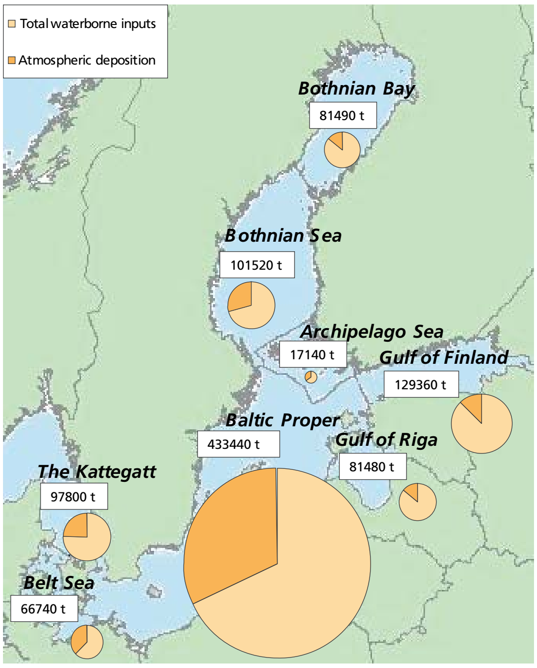

Figure 9.
Proportion of airborne and waterborne nitrogen inputs into the Baltic Sea sub-regions in 2000[11]

The main proportion of waterborne inputs (59 %) was from diffuse sources, especially from agriculture. The second largest proportion was from natural background sources (32 %), and the remaining input was from point sources (10 %). The proportion of the waterborne nitrogen input into each sub-region of the Baltic Sea is related to the size of the catchment area **(Figure 8)**.

Total input of nitrogen to the Baltic Sea

The total input of nitrogen to the Baltic Sea was 1009700 tonnes in 2000, of which 25 % entered as atmospheric deposition on Baltic Sea and 75 % as waterborne inputs **(Figure 9)**.

[9] Table 7 of Annex 1
[10] The proportions of the different sources are based on available data from Contracting Parties, *e.g.* Russian data is incomplete and inputs from Latvia and Lithuania do not include transboundary pollution.
[11] Table 4 and 5 of Annex 1

3 Phosphorus

Phosphorus enters the Baltic Sea mainly as water-borne input, but can also enter as atmospheric deposition. However, it has been estimated that the airborne contribution is only 1-5 % of the total phosphorus input. Therefore, it is not considered in this report.

3.1 Inputs of phosphorus to surface waters within the catchment area

Total phosphorus inputs from point, diffuse and natural background sources into surface waters totalled 41220 tonnes in 2000. The main contributors were Poland, Finland and Sweden **(Figure 10)**.

The largest inputs of phosphorus originated from diffuse sources such as agriculture and scattered dwellings **(Figure 11)**.[13]

3.2. Inputs of phosphorus into the Baltic Sea
The total input of phosphorus to the Baltic Sea was 34500 tonnes in 2000. The main contributors were Poland, Finland, Sweden and Russia **(Figure 12)**. This Figure includes inputs from natural background sources as well as anthropogenic sources.

The main proportion of waterborne inputs (49 %) was from diffuse sources, especially from agriculture and scattered dwellings. The second largest proportion is from point sources (26 %), and the remaining input is from natural background sources (25 %).

The proportion of different sources contributing to the phosphorus inputs to the Baltic Sea sub-regions are shown in **Figure 13**.

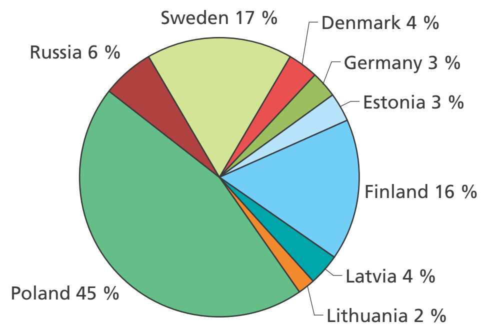

Figure 10.
Proportion of phosphorus inputs from point, diffuse and natural background sources to surface waters within the catchment area by HELCOM countries in 2000[12]

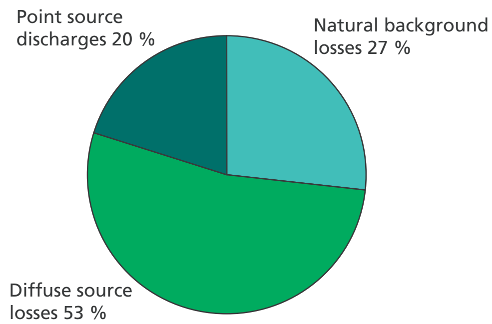

Figure 11.
The input of phosphorus by source into surface waters within the catchment area in 2000[14]

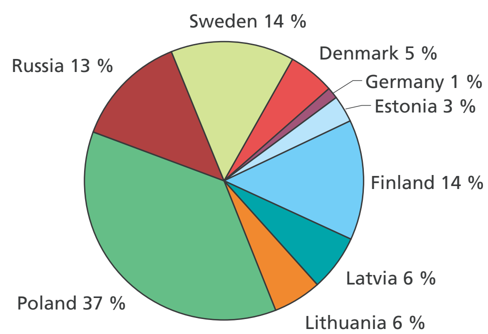

Figure 12.
Proportion of waterborne inputs of phosphorus into the Baltic Sea by HELCOM countries in 2000. These inputs include inputs from natural background sources as well as anthropogenic sources[15]

[12] Table 8 of Annex 1
[13] Table 9 of Annex 1
[14] Please note that this figure shows an average of the sources of inputs within the whole catchment area. There are, however, significant proportional variations between different sub-regions.
[15] Table 10 of Annex 1

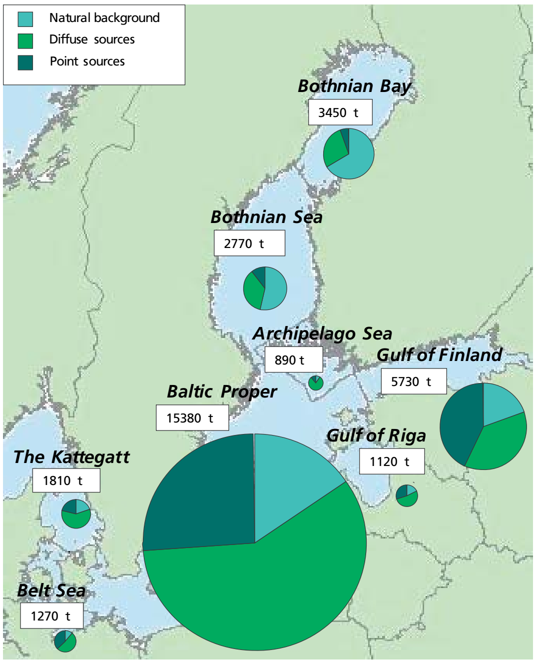

Figure 13.
Proportion of sources contributing to phosphorus inputs into Baltic Sea sub-regions in 2000[16,17]

4 Total nutrient inputs to the Baltic Sea

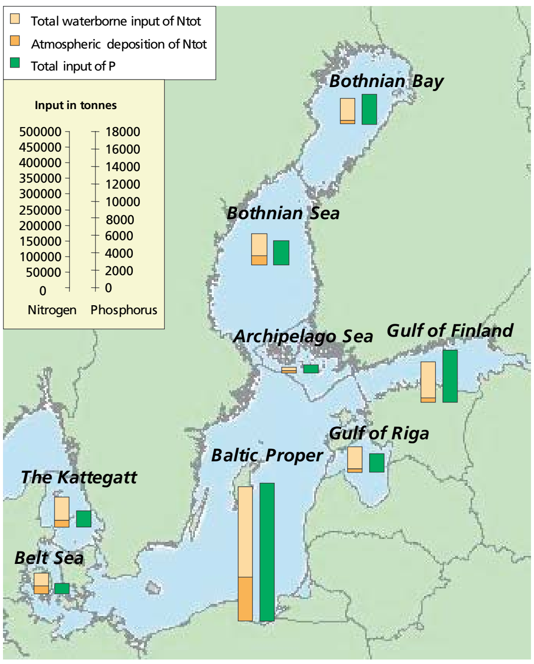

Figure 14.
Total inputs of nitrogen and phosphorus into the Baltic Sea sub-regions in 2000

5. Long-term changes in emissions and inputs

Overall nitrogen air emissions from the HELCOM countries have decreased since the 1980s **(Figure 15)**. The annual atmospheric deposition of nitrogen to the Baltic Sea also seems to have decreased **(Figure 16)**. Although lower emissions should result in lower atmospheric deposition, climatic conditions such as precipitation, dominating wind direction, etc. also influence atmospheric deposition. This explains why results on atmospheric deposition do not vary directly with emissions.

The progress in reducing nutrient discharges from point sources such as municipal and industrial wastewater treatment plants has been good, with the 50 % reduction target for phosphorus achieved by almost all the HELCOM countries. The results, however, should be interpreted with caution as the 1985 data from several countries are based on different methodologies to those used in 2000, and also based on very rough estimates. The results also show that measures to reduce nutrients from agriculture have fallen short of their aims **(Figure 17 and 18)**. This may however also be due to the fact that it can take decades to achieve the full effects of these measures. Further, climatic conditions should be taken into account when comparing figures for agriculture from 1985 with 2000.

Improvement in pollution hot-spots

A list of the most significant pollution source "hot spots" around the Baltic Sea was first drawn up under the Baltic Sea Joint Comprehensive Environmental Action Programme (JCP) in 1992.

Until now, 51 hot spots of the original 132 have been deleted. Today 81 hot spots or sub-hot spots still remain.

Investment and remediation projects carried out at pollution hot spots around the Baltic Sea have contributed substantially towards overall pollution load reductions in the Baltic Sea catchment area.

[18] See Table 1 in Annex 1

[19] Table 13 in Annex 1

[20] See report: *The review of more specific targets to reach the goal set up in the 1988/1998 Ministerial declarations regarding nutrients*, BSEP no.89, 2003.

[21] See report: *The review of more specific targets to reach the goal set up in the 1988/1998 Ministerial declarations regarding nutrients*, BSEP no.89, 2003.

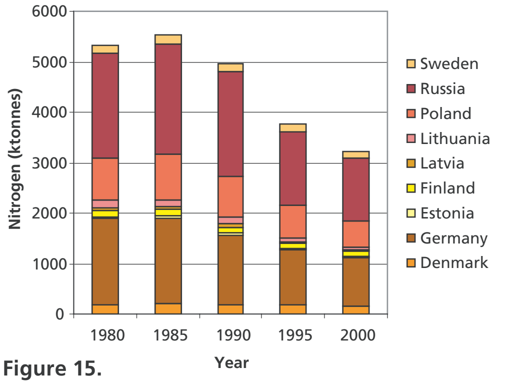

Figure 15.
Annual emissions of nitrogen to the air by HELCOM country between 1980 and 2000[18]

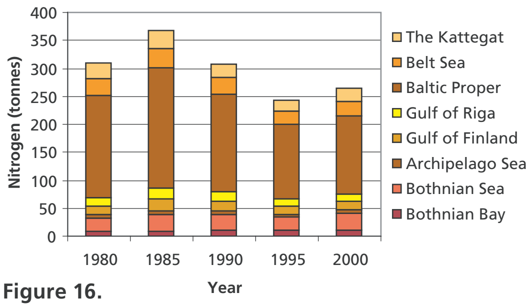

Figure 16.
Atmospheric deposition of nitrogen to the different sub-regions of the Baltic Sea from 1980 – 2000[19]

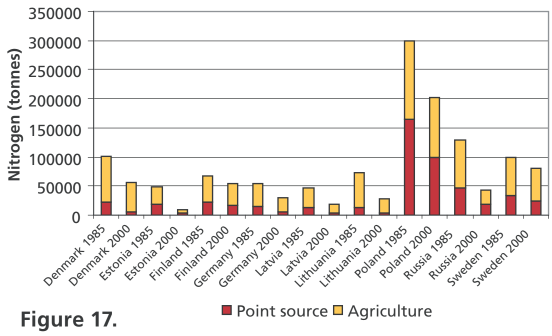

Figure 17.
Nitrogen inputs from point sources and agriculture within the Baltic Sea catchment area by HELCOM countries in 1985 and in 2000[20]

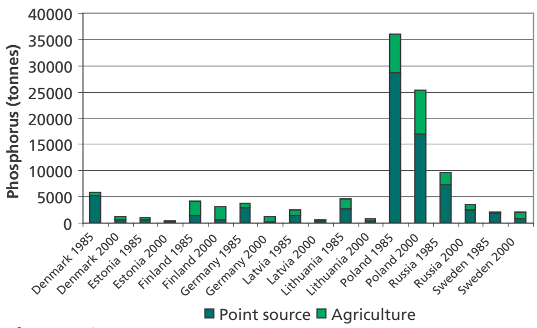

Figure 18.
Phosphorus inputs from point sources and agriculture within the Baltic Sea catchment area by HELCOM countries in 1985 and in 2000[21]

6. HELCOM activities

6.1. Relevant decisions

The Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area was first signed in 1974, with a revised Convention signed in 1992. Its fundamental aim is to encourage the Contracting Parties, individually or jointly, to take all appropriate legislative, administrative or other relevant measures to prevent and eliminate pollution in order to promote the ecological restoration of the Baltic Sea area and to preserve its ecological balance. It contains several Articles that relate to pollution load, amongst others, Articles on:

- harmful substances;
- principles and obligations concerning pollution from land-based sources;
- environmental impact assessment;
- prevention of pollution from ships;
- notification and consultation on pollution incidents; and
- cooperation in combating marine pollution.

Since the beginning of the 1980s HELCOM has also adopted some 200 HELCOM Recommendations for the protection of the Baltic Sea.

In September 1988, the Ministers of Environment of the Baltic Sea States decided that the anthropogenic loading to the Baltic Sea should be reduced by 50 % from 1987 levels by the year 1995. The decision was reaffirmed by a Ministerial Meeting in 1998, which also required the development of more specific targets by the Contracting Parties to reduce by 50 % discharges from point and diffuse sources. Comprehensive official plans to achieve these targets have so far been adopted by national governments in Finland, Latvia and Sweden. Plans to reduce nutrient loads in the other Contracting Parties which are EU members mainly focus on the implementation of the related EU Directives, which also contribute to the reduction of nutrient inputs into the Baltic Sea.

6.2. Relevant HELCOM projects

Nutrient pollution has been a priority for HELCOM since the late 1980s when HELCOM environment ministers set the 50 % reduction targets for nutrient pollution.

Among other activities, HELCOM has initiated the assessment of the sources of airborne nitrogen deposited to the Baltic Sea in order to come up with solutions to reduce pollution from the identified sources. The assessment of the significance of transboundary pollution and the identification of the most important sources of nutrients and selected heavy metals in Belarus, Ukraine and the Czech Republic has also become a priority issue.

In order to come up with concrete proposals to reduce inputs of nutrients, HELCOM is starting an activity where current modelling tools will be used to simulate the impacts of the implementation of the EU Common Agriculture Policy and other policies in the Baltic Sea area. The final aim is to enable the identification of the need for additional measures, and examine where these measures could be implemented most cost-effectively in the different parts of the Baltic Sea catchment area in order to achieve good ecological status throughout the Baltic Sea area.

7. Conclusions and recommendations

7.1. Conclusions

Waterborne inputs constituted the main input of nitrogen (75 %) and phosphorus (nearly 100 %) to the Baltic Sea in 2000. Only for nitrogen were airborne inputs significant, with a contribution of 25 % of total inputs.

Figures for nutrient input from different sources within the Baltic Sea catchment area indicate that the majority of waterborne nitrogen and phosphorus originated from diffuse sources. Input from cultivated land (agriculture) is the main diffuse source, but phosphorus from scattered dwellings is also an important source. Point sources with approximately 13 % of nitrogen and approximately 26 % of phosphorus waterborne inputs to the Baltic Sea is a less important source compared with agricultural sources, but is still very important in some regions. Inputs from natural background sources are in principle unaffected by measures. On average, this source constitutes approximately one quarter of both waterborne nitrogen and phosphorus input to the Baltic Sea. In parts of the Baltic Sea catchment area with low population density and low agricultural or forestry activities, natural background sources are the major contributor of nitrogen and phosphorus inputs.

It has not been possible to evaluate the importance of sources of waterborne nitrogen and phosphorus input originating from the part of the Baltic Sea catchment area situated outside the HELCOM countries. For airborne nitrogen inputs, it is evident that emissions outside the convention area of the Baltic Sea contributed significantly (38 %).

High inputs of *e.g.* nitrogen into the Baltic Sea occur in sub-regions with large catchment areas or where there is intensive agricultural activity, many industries and high population density.

The effects of nutrient input in the Baltic Sea ecosystem are most visible in coastal areas with drastic changes in bottom vegetation, phytoplankton growth, reduction of water clarity, changes in fish populations and oxygen deficiency in the bottom waters leading to the death of benthic animals and fish. These problems have been recorded particularly in the Gulf of Finland and in the Belt Sea – Kattegat area. However, the effects of eutrophication are also clearly visible in the open Baltic Proper in the form of intensified algal blooms.

Through stricter controls on industries and municipalities, significant reductions in point source pollution have been achieved. Further reductions in nutrient discharges from point sources are likely in some HELCOM countries, thanks to the continued implementation of nitrogen and phosphorus removal measures. These measures are required by HELCOM Recommendations, the Industrial Pollution and Prevention Control Directive, the Urban Waste Water Directive and supplementary national regulations. Especially the new EU member countries have in recent years undertaken extensive modernisation plans for both municipal wastewater treatment plants and industries. However, although the significance of point source pollution for the Baltic Sea as a whole is decreasing, the effects of pollution from industries and municipalities can often be observed especially locally. It can also be noted that the proportion of discharges from smaller municipalities and scattered dwellings with no centralised wastewater treatment is increasing and can be considered an important source.

Reducing nutrient losses from agriculture is much more complicated than curbing loads from point sources due to various technical and socio-economic reasons. The implementation of load reduction measures (e.g., Annex III of the Helsinki Convention, the EU's Nitrate Directive and the Water Framework Directive), however, will support further reductions in nutrient inputs from agriculture. There is clearly a considerable time-lag, however, between the implementation of agricultural water protection measures and before the full effects are measurable and visible in inland water bodies and even longer in the Baltic Sea.

7.2 Recommendations

Because it has been envisaged that agricultural production will grow following the EU enlargement, and atmospheric nitrogen deposition to the Baltic Sea makes up a large proportion of nitrogen input to sea, nutrient reduction efforts should particularly address the impact of agriculture and air emissions of nitrogen.

As of spring 2004, eight out of nine HELCOM Contracting Parties are also EU members, meaning that most of the HELCOM Contracting Parties focus on implementing EU Directives and other regulations. It also means that the same strict environmental EU requirements will apply to a much larger proportion of the Baltic Sea's catchment area than before. This will pave the way for HELCOM to concentrate more on specific issues affecting the Baltic Sea environment, where tailor-made regional solutions to specific threats are necessary, or when the unique needs of the Baltic have to be brought to the attention of other international organisations.

It has been acknowledged that in order to combat eutrophication problems (especially in the open sea), nutrient reduction measures should be considered jointly for the whole Baltic Sea region and that HELCOM countries should more comprehensively analyse the relationship between the sources and impacts of nutrient loads in the different parts of the Baltic Sea. Although national measures are essential to improve quality status of local coastal waters, in many Contracting Parties the situation is often also greatly dependent on nutrient inputs received from other HELCOM countries as well as from non-Contracting Parties, such as through water exchange across territorial boundaries and the open sea, as well as from atmospheric deposition.

In a joint effort to address these matters, HELCOM stresses the need:

- to accelerate the process of integrating environmental aspects and sustainable development in agriculture, for instance by implementing the reform of the Common Agricultural Policy;
- to improve agricultural practices towards reduction of diffuse source pollution and adverse environmental effects and more efficient nutrient utilization;
- to continue to implement measures for reducing point source pollution as required by relevant HELCOM Recommendations and EU Directives;
- to continue to elaborate on specific environmental programmes aimed at improving the quality of the Baltic Sea, and;
- to continue efforts to address airborne inputs of nitrogen from land and sea based sources.

In order to facilitate the implementation of the most effective set of measures to combat eutrophication, HELCOM should continue to develop and apply:

- ecological quality objectives for the whole Baltic Sea Area;
- tools for assessing the implications of different policy scenarios on inputs of nutrients and the resulting eutrophication status of the Baltic Sea area or its sub-regions;
- means to produce topical assessment and, when necessary, timely reports on special events; and
- necessary monitoring to allow for appropriate assessments that enable evaluation of whether objectives are being fulfilled and describe the status of the Baltic Sea (including the main parameters to explain its conditions and development).

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Annex 1: Data tables

The data in the tables below are from the sources mentioned in the reference section. Please note that some additional data has been received from HELCOM consultants and some of the tables contain recalculated data.

Table 1.
Emissions of nitrogen to the air by country for 1980 – 2000 (kilo tonnes/year)

Country/Year	1980	1985	1990	1995	2000
DK	186	203	191	175	149
DE	1705	1703	1371	1100	973
EE	41	41	40	22	20
FI	122	119	123	107	99
LV	61	61	61	28	21
LT	137	144	139	72	56
PL	827	909	808	654	520
RU	2085	2178	2076	1461	1253
SE	167	174	146	141	124
Total HELCOM	5331	5532	4955	3760	3215
Ship emissions*	107	107	107	107	107

*Please note that the figures for ship emissions are based on data collected in 1990

Table 2.
Nitrogen inputs to surface waters of the Baltic Sea catchment area in 2000 (tonnes)

Sub-region/ Contracting Party	DK	DE	EE	FI	LV	LT	PL	RU	SE	Total load by sub-region
Bothnian Bay				50858					23247	74105
Bothnian Sea				32046					41654	73700
Archipelago Sea				9651						9651
Gulf of Finland			19139	54006	22			53315		126482
Gulf of Riga			12738		45676	n.i.		n.i.		58414
Baltic Proper	1585	14485	1114		8367	35563	229991	400	46685	338190
Belt Sea	24803	17017							8558	50378
The Kattegat	35857								55465	91322
Total Baltic Sea	62245	31502	32991	146561	54065	35563	229991	53715	175608	822241

n.i. no information available

Table 3.
Sources of nitrogen input into surface waters of the Baltic Sea catchment area in 2000 (tonnes)

Sub-region/ Source	Natural background losses	Diffuse losses	Point source discharges	Total load
Bothnian Bay	40819	30935	2351	74105
Bothnian Sea	37682	32289	3728	73699
Archipelago Sea	2610	6906	136	9652
Gulf of Finland	67330	44635	14518	126483
Gulf of Riga	16834	40006	1573	58413
Baltic Proper	69699	219957	48534	338190
Belt Sea	7314	40079	2984	50377
The Kattegat	17231	69279	4811	91321
Total Baltic Sea	259519	484086	78635	822240

Table 4.
Atmospheric deposition of nitrogen to the Baltic Sea sub-regions in 2000 (kilo tonnes)

Sub-region/ Contracting Party	DK	DE	EE	FI	LV	LT	PL	RU	SE	Ships	Distant sources	Total EMEP
Bothnian Bay	0.28	0.97	0.13	2.28	0.1	0.13	1.1	0.73	1.04	0.71	4.1	11.6
Bothnian Sea	0.84	3.71	0.27	1.73	0.3	0.42	3.45	1.25	2.95	2.34	12.7	30
Archipelago Sea	0.18	0.92	0.09	0.34	0.09	0.1	0.64	0.23	0.4	0.58	2.4	6.0
Gulf of Finland	0.46	1.97	0.91	1.06	0.25	0.25	1.34	1.47	0.71	1.07	6.3	15.8
Gulf of Riga	0.43	1.63	0.2	0.24	0.83	0.32	1.34	0.38	0.51	0.83	4.7	11.4
Baltic Proper	8.46	29.21	0.43	1.31	0.99	1.63	25.49	2.75	8.21	9.76	52	140.2
Belt Sea	5.27	9.32	0.01	0.02	0.01	0.03	0.78	0.06	0.29	0.6	8.6	25
The Kattegat	5.88	5.41	0.01	0.03	0.01	0.01	0.83	0.06	0.97	0.87	10.0	24.1
Total Baltic	21.8	53.14	2.05	7.01	2.58	2.89	34.97	6.93	15.08	16.76	100.8	264.1

Table 5.
Total waterborne inputs of nitrogen into the Baltic Sea sub-regions by country in 2000 (tonnes)

Sub-region/ Contracting Party	DK	DE	EE	FI	LV	LT	PL	RU	SE	Total load by sub-region
Bothnian Bay				42783					27110	69893
Bothnian Sea				27232					44290	71522
Archipelago Sea				11143						11143
Gulf of Finland			15905	20501				77155		113561
Gulf of Riga			9908		60168					70076
Baltic Proper	1635	6136	1061		7325	47885	191166	2033	35995	293236
Belt Sea	23639	12469							5632	41740
The Kattegat	33650								40046	73696
Total Baltic Sea	58924	18605	26874	101659	67493	47885	191166	79188	153073	744867

Table 6.
Discharges of nitrogen directly to the Baltic Sea from point source in 2000 (tonnes)

Sub-region/ Contracting Party	DK	DE	EE	FI	LV	LT	PL	RU	SE	Total by load sub-region
Bothnian Bay				2030					1177	3207
Bothnian Sea				1471					2947	4418
Archipelago Sea				1663						1663
Gulf of Finland			1528	2674				9008		13210
Gulf of Riga			73		1312					1385
Baltic Proper	69	20			239	293	355	2033	4033	7042
Belt Sea	2321	1978							976	5275
The Kattegat	789								1877	2666
Total Baltic Sea	3179	1998	1601	7838	1551	293	355	11041	11010	38866

Table 7.
Inputs of nitrogen to the Baltic Sea sub-regions using source apportionment in 2000 (tonnes)

Sub-region/ Source	Natural background losses	Diffuse sources losses	Discharges from point sources	Total load
Bothnian Bay	37553	26998	5370	69921
Bothnian Sea	31163	32858	7501	71522
Archipelago Sea	2576	6767	1797	11140
Gulf of Finland	50094	32424	23995	106513
Gulf of Riga	9713	23083	2286	35082
Baltic Proper	42307	198484	36469	277260
Belt Sea	6093	27663	7762	41518
The Kattegat	13561	53661	6452	73674
Total Baltic Sea	193060	401938	95201	690199

*Please note that Russian data is incomplete and transboundary pollution into Latvia and Lithuania is not included in these figures

Table 8.
Phosphorus inputs to surface waters of the Baltic Sea catchment area in 2000 (tonnes)

Sub-region/Contracting Party	DK	DE	EE	FI	LV	LT	PL	RU	SE	Total load by sub-region
Bothnian Bay				2649					1470	4120
Bothnian Sea				1375					2247	3622
Archipelago Sea				814						814
Gulf of Finland			938	1949	4			2478		5370
Gulf of Riga			421		1315.96	n.i.		n.i.		1737
Baltic Proper	24	683	14		152	783	18725	59	1657	22097
Belt Sea	581	519							128	1228
The Kattegat	888								1344	2232
Total Baltic Sea	1493	1202	1373	6788	1473	783	18725	2537	6846	41219

n.i. no information available

Table 9.
Sources of phosphorus input into surface waters of the Baltic Sea catchment area in 2000 (tonnes)

Sub-region/ Source	Natural background losses	Diffuse losses	Point Source discharges	Total load
Bothnian Bay	2479	1574	67	4120
Bothnian Sea	2078	1445	98	3621
Archipelago Sea	88	723	4	815
Gulf of Finland	1463	2380	1526	5369
Gulf of Riga	380	1089	268	1737
Baltic Proper	3770	12530	5798	22098
Belt Sea	216	822	189	1227
The Kattegat	489	1477	266	2232
Total Baltic Sea	10963	22040	8216	41219

Table 10.
Total waterborne inputs of phosphorus into the Baltic Sea by country in 2000 (tonnes)

Sub-region/ Contracting Party	DK	DE	EE	FI	LV	LT	PL	RU	SE	Total load by sub-region
Bothnian Bay				2068					1383	3451
Bothnian Sea				1094					1676	2769
Archipelago Sea				901						901
Gulf of Finland			779	777				4473		6029
Gulf of Riga			175		2034					2209
Baltic Proper	35	175	11		173	1896	12645	150	961	16046
Belt Sea	857	312							101	1270
The Kattegat	965								849	1814
Total Baltic Sea	1857	487	965	4840	2207	1896	12645	4623	4969	34489

Table 11.
Discharges of phosphorus directly into the Baltic Sea from point source in 2000 (tonnes)

Sub-region/ Contracting Party	DK	DE	EE	FI	LV	LT	PL	RU	SE	Total load by sub-region
Bothnian Bay				72					53	125
Bothnian Sea				43					177	220
Archipelago Sea				96						96
Gulf of Finland			77	100				1090		1267
Gulf of Riga			11		182					193
Baltic Proper	11	1			31	39	53	150	124	409
Belt Sea	290	24							33	347
The Kattegat	90								100	190
Total Baltic Sea	391	25	88	311	213	39	53	1240	487	2847

Table 12.
Inputs of phosphorus to the Baltic Sea sub-regions using source apportionment in 2000 (tonnes)

Sub-region/ Source	Natural background losses	Diffuse losses	Point Source discharges	Total load
Bothnian Bay	2301	966	187	3454
Bothnian Sea	1477	1001	290	2768
Archipelago Sea	87	707	100	894
Gulf of Finland	1191	2112	2431	5734
Gulf of Riga	202	582	335	1119
Baltic Proper	2394	8940	4049	15383
Belt Sea	146	650	474	1270
The Kattegat	363	1063	387	1813
Total Baltic Sea	8161	16021	8253	32435

*Please note that Russian data is incomplete and transboundary pollution into Latvia and Lithuania is not included in these figures

Table 13.
Atmospheric deposition of nitrogen on the Baltic Sea by sub-region from 1980 – 2000 (kilo tonnes)

Sub-region/Year	1980	1985	1990	1995	2000
Bothnian Bay	8.4	9.3	11.8	10.1	11.6
Bothnian Sea	24.1	28.9	26.6	23.3	30
Archipelago Sea	5.4	7.8	6.3	5.5	6
Gulf of Finland	16.5	20.8	18.2	15	15.8
Gulf of Riga	15	18.3	16.7	11.7	11.4
Baltic Proper	181.3	215.3	173.9	135.1	140.2
Belt Sea	32	35.6	29.6	23.2	25
The Kattegat	27.6	31.8	25.2	19.8	24.1
Total Baltic	310.3	367.8	308.3	243.7	264.1

Annex 2:
Definition of terms as used in this report

Airborne	Nutrients carried or distributed by air
Anoxic	Condition marked by an absence of oxygen
Atmospheric deposition	Airborne nutrients originating from emissions to the air deposited on water surfaces
Catchment area	Refers to the inland surface water areas which drain into the Baltic Sea (also referred to as drainage area)
Diffuse losses	Nutrients lost to water which originate from agricultural lands, managed forestry, urban areas as well as airborne nutrients deposited onto inland surface waters
Emissions	Airborne compounds emitted from traffic or combustion of fossil fuels
Eutrophication	Condition in an aquatic ecosystem where high nutrient concentrations stimulate the excessive growth of algae, which leads to an imbalanced function of the ecosystem
Inland surface waters	Refers to all bodies of water within the Baltic Sea catchment area, including wetlands, rivers and lakes etc.
Natural background losses	Refers to natural erosion from unmanaged areas and the proportion of nutrients lost from agricultural land for instance, irrespective of agricultural activities
Oligotrophic	An aquatic environment deficient in nutrients and rich in dissolved oxygen
Point source discharges	Discharges from municipalities and industries as well as fish farms to inland surface waters or directly to the sea
Riverine loads	The amount of nutrients being carried by large rivers
Waterborne	Nutrients carried or distributed by water

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