BALTIC SEA ENVIRONMENT PROCEEDINGS

No. 45

SECOND BALTIC SEA POLLUTION LOAD COMPILATION

BALTIC MARINE ENVIRONMENT PROTECTION COMMISSION
– HELSINKI COMMISSION –

B A L T I C   S E A   E N V I R O N M E N T   P R O C E E D I N G S

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Preface

At long last and contrary to all rumours, we have finally managed to complete the **Second Baltic Sea Pollution Load Compilation - PLC-2.**

This report represents a new step within the Helsinki Commission in estimating the pollution loads entering the Baltic Sea.

The initial material for the report was collected according to a unified methodology and provided a reasonably substantial overview of the waterborne pollution that reached the Baltic Sea in 1990. We present short descriptions of the sampling, analysis and calculation methodologies used by the participating states and attention is drawn to the shortcomings that have been detected. In addition, summarized information is given on the pollution loads on a sub-region by sub-region basis, as is an overview of the problems to be solved before work can start on a third Pollution Load Compilation.

Data cannot be improved if samples are not taken properly or even not taken at all. For this reason we chose only those three parameters which had been measured by all the Contracting Parties: Biochemical Oxygen Demand within seven days (BOD,), Total Phosphorus (Tot-P) and Total Nitrogen (Tot-N). Although these data sets were obtained using different methods (sampling, analysing or calculating), we decided to display them in table and map form so that a rough idea could be gained about the amount of substances discharged into the Baltic Sea. All other data contain too many gaps to present them in graphic form.

The results are given as follows:

For technical reasons, the data in the tables are given to four decimal digits. The first criterion considered when determining pollution loads was their source. For each sub-region, the loads via rivers are presented first; the corresponding maps have blue captions. The pollution loads from urban areas are given next; their charts have black captions. Finally, the discharges from industry are shown: captions here are red.

The general map of the whole Baltic Sea Drainage Area (Figure 1) was prepared by the National Board of Waters and the Environment of Finland in Helsinki. The other maps were produced using the mainfraime computer at the Federal Maritime and Hydrographic Agency (BSH) in Hamburg. The BSH's in-house programme for the illustration of coastlines was used to do so.

See the following explanations on how to use the maps.

They are drawn in Mercator Projection. To solve the technical problem of combining the data for the three parameters for each source (with their very different ranges) in one figure, the scales have been equalized for each source. Different factors have been calculated for the parameters and they are found in the legend of each map. The factors remain consistent <u>within</u> the same source.

Abbreviations are unavoidable. Please find attached in Annex II a list of abbrs. used in this report.

In the course of the work, from compiling the Guidelines to printing the final report in 1993, significant political changes have taken place in the Baltic Sea region.

We are pleased to note that these changes have added to the complexity and accuracy of the report. The new Contracting Parties quickly took their share of responsibility and became fully involved in the work.

As co-ordinators, we wish to express our gratitude to the representatives of the Contracting Parties for their assistance:

Mr. *Dietrich Brunswig* (Germany), Mr. *Zigfrids Bruvers* (Latvia), Ms *Emelie Enckell* (Finland), Mr. *Romualdas Juknys* (Lithuania), Mr. *Jerzy Rybinski* (Poland), Mr. *Tonny Niilonen* (Denmark), Ms *Tiiu Raia* (Estonia), Mr. *Mikhail A. Soklakov* (Russia) and Mr. *Anders Widell* (Sweden)

who were responsible for presenting national data and checking the results.

The following persons helped us to compile the report:

Ms *Maret Merisaar,* Ms *Elve Lode* and Ms ***Ylle*** *Leisk* from the Tallin Technical University

Ms *Dörthe Hofmann,* Mr. *Wiljried Horn,* Mr. *Andreas Klee* and Mr. *Roland Junker* from the Federal Maritime and Hydrographic Agency in Hamburg

and - once again - Ms *Emelie Enckell* from the Finnish National Board of Waters and the Environment in Helsinki.

We are very grateful to them.

We also wish to express our appreciation to the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety for its financial support in hosting series of expert meetings for the PLC-2 project.

Finally, our special thanks go to the HELCOM Secretariat for the effective technical and financial assistance throughout the project. In particular, we wish to thank Mr. *Vassili Rodionov* (Technological Secretary) and *Ms Satu Tofferi.*

Authors / Co-ordinators of PLC-2

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1 Introduction

This Second Baltic Sea Pollution Load Compilation (PLC-2) has been an international project within the framework of the Helsinki Commission implemented according to HELCOM 10/4 (1988).

The ultimate goals of Pollution Load Compilations (PLCs) are

- to compile the total load of important pollutants entering the Baltic Sea via rivers and from point and non-point sources on the basis of harmonized monitoring methods
- to follow up the longterm changes in the pollution load from various sources
- to determine the priority order of different pollution sources and pollutants
- to assess the efficiency of measures taken to reduce the pollution load and
- to provide information for periodic assessment work.

The task of PLC is carried out in stages. The results of PLC- 1 were published by the Commission in January 1987 in the Baltic Sea Environment Proceedings (BSEP) series No. 20. That document was a first attempt to compile very heterogenous data that had been submitted to the Commission on various occasions. The collected data were often preliminary or based on very rough background information and, therefore, the results of PLC- 1 should not be compared with the PLC-2 data.

In order to improve the quality of the compilation the Guidelines for the Second Pollution Load Compilation (PLC-2) were developed in 1988- 1989 (STC 15/ 16, Annex 12). PLC-2 was exercised as a pilot programme comprising a limited number of parameters and pollution sources (Table 1.1) but, nevertheless, aiming for a basic coverage of the major aspects concerned. The Guidelines defined the aim of the PLC, provided the harmonized methodological basis for data collection and evaluation, i.a., measuring period (the year of 1990), definition of pollution sources, parameters to be controlled, main principles for flow measurements and sampling, methods of chemical analysis as well as calculation and estimation methods and reporting formats.

In order to make the outcome of PLC comparable to the results of the periodic assessment of the state of the marine environment and coastal zones, the list of chemical determinants used for PLC-2 was harmonized to the most possible extent with the Baltic Monitoring Programme (BMP).

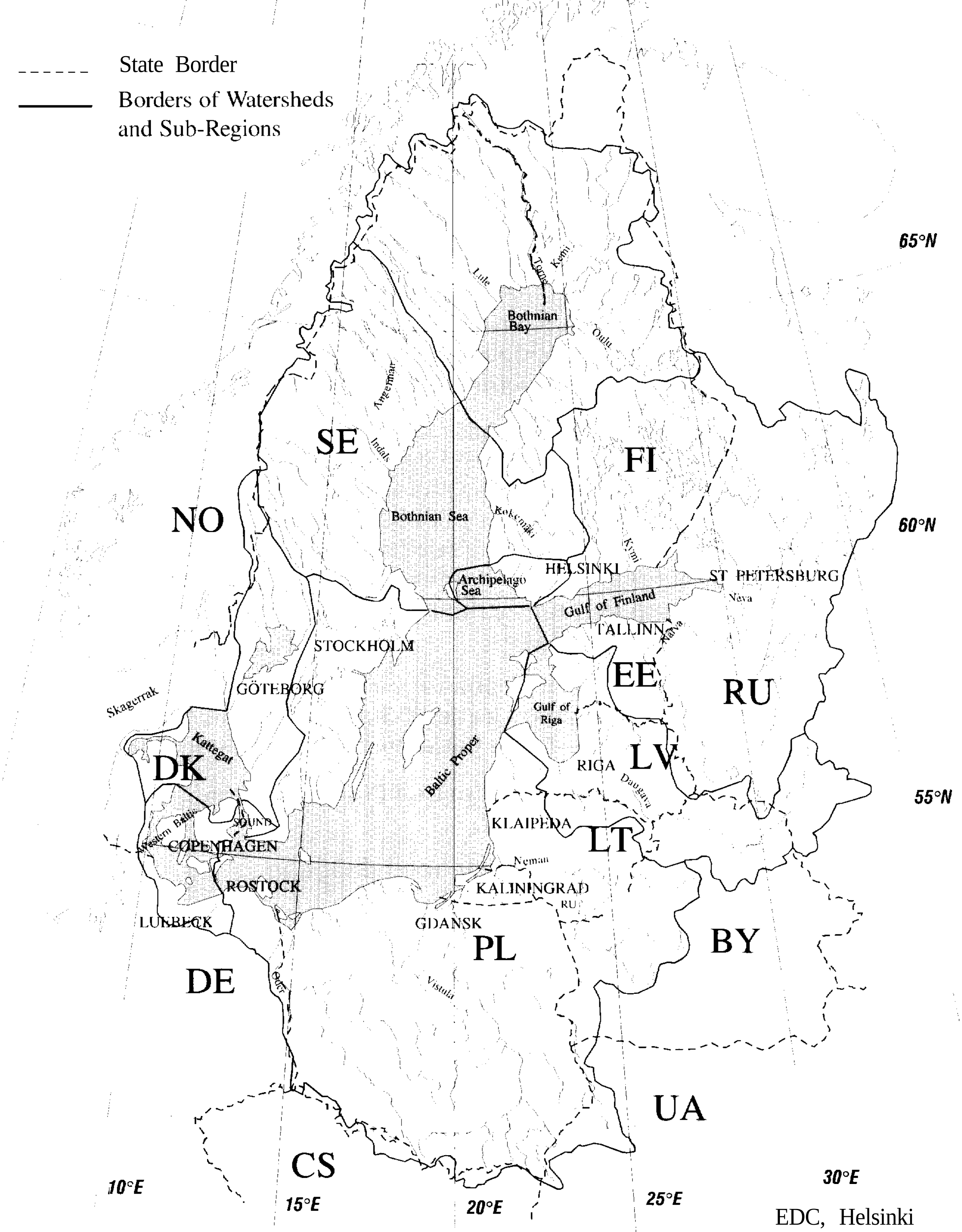
The compilation of the data was guided by the two Lead Countries Germany and the former Soviet Union with support of the HELCOM Secretariat.

For PLC-2 purposes the Baltic Sea was divided into nine sub-regions :

Bothnian Bay	- BOB
Bothnian Sea	- BOS
Archipelago Sea	- ARC
Gulf of Finland	- GUF
Gulf of Riga	- GUR
Baltic Proper	- BAP
Belt Sea and Western Bays	- WEB
The Sound	- sou
The Kattegat	- KAT

The Baltic Sea drainage area and sub-regions are presented in Figure 1. Pollution load data of countries discharging into the same sub-region were summed up.

Fig. 1 . Drainage Basin of the Baltic Sea and Sub-Regions used in the Second Pollution Load Compilation



Three sources of pollution were distinguished: rivers, urban areas and industries. The parameter sets to be measured contained organic matter, nutrients, suspended solids and heavy metals (Table 1.1).

Table 1.1

The parameters measured for PLC-2 according to the Guidelines

Source	Q	Organic matter			Nutrients		Suspended solids	Metals
		BOD	COD	TOC	P	N	SS	
Rivers $Q > 5\ m^3/s$	m^3/s	BOD_7 BOD_{21}[a]	COD_{Mn}[a]	TOC[a]	Tot-P PO_4-P	Tot-N NH_4-N NO_X-N	SS	Hg Cd Cu Zn Pb
Urban areas >10 000 **PE**	$10^6\ m^3/a$	BOD_7	COD_{Cr}	-	Tot-P	Tot-N NH_4-N	-	Hg Cd Cu Zn Pb*
Industries	$10^6\ m^3/a$	BOD_7	COD_{Cr}	-	Tot-P	Tot-N NH_4-N	-	Hg Cd Cu Zn Pb

obligatory parameters for urban areas > 50 000 PE

a alternative

The report contains information about pollution sources compiled according to the agreed sub-regions. Generalized data characterizing the pollution sources and loads as well as general maps are published in this report.

The airborne pollution load is not included in the report because the evaluation of deposition data prepared by EC/EGAP followed different sub-regions, timetables and list of basic parameters. The report on the airborne pollution load 1986- 1990 was published separately in BSEP series No 39.

The presented national information and pollution data are written on floppy disks which enables their reconstruction and use in different model calculations. The contents of the disks is listed in Annex I, and the disks can be obtained from the HELCOM Secretariat.

Despite the adopted Guidelines, the monitoring programme was not fulfilled in all parts and the data about all substances are, therefore. not complete. In order to fill in the gaps, the responsible authorities in some cases had to apply approximate calculation methods, e.g. Tot-N and Tot-P were often calculated from the contents of mineral nitrogen and orthophosphateand BOD, was calculated by using conversion factors etc. The most incomplete data concern heavy metals.

However, even with all the afore mentioned shortages, the report of PLC-2 is a progress in the evaluation of the pollution load of the Baltic Sea Area and serves as a new step to the long-term comparable monitoring and reporting system.

2 Description of the Baltic Sea Drainage Areas

The Baltic Sea drainage area comprises 1 733 850 km’. The division of the drainage area between the states and sub-regions is presented in Table 2. 1. This table is compiled on the basis of the information which have been presented by the Contracting Parties (CPs) and compared with previously printed information (BSEP No. 16, Chapter 2.2.2; and BSEP No.35B, Table 1). The latter contains many mistakes and is, therefore, not taken into account. The total sub-region drainage areas presented in BSEP No. 16 do not correspond to the relevant figures which were calculated for PLC-2, evidently due to different cartographic materials used by the Contracting Parties. These differences are not essential but should be eliminated for future use.

Table 2.1

Division of the Baltic Sea Drainage Area
between the Baltic States and the Baltic Sub-regions
km^2

Sub-region Country	Bothnian Bay	Bothnian Sea	Archipelago Sea	Gulf of Finland	Gulf of Riga	Baltic Proper	Western Baltic	The Sound	Kattegat	Total
Finland	146 000	39 000	9 000	107 300	-	-	-	-	-	301 300
Russia	-	-	-	276 100	23 700	15 000	-	-	-	314 800
Estonia	-	-	-	26 400	17 600	1 100	-	-	-	45 100
Latvia	-	-	-	3 500	48 500	12 600	-	-	-	64 600
Lithuania	-	-	-	-	16 500	48 800	-	-	-	65 300
Poland	-	-	-	-	-	311 900	-	-	-	311 900
Germany	-	-	-	-	-	12 600	10 950	-	-	23 550
Denmark	-	-	-	-	-	1 200	12 400	1 700	15 800	31 100
Sweden	131 000	180 100	-	-	-	84 900	-	2 600	71 600	470 200
Total	277 000	219 100	9 000	413 300	106 300	488 100	23 350	4 300	87 400	1 641 650

including Norwegian drainage area

The drainage areas of the Baltic Proper and the Gulf of Finland range in the same order between 400 000 and 500 000 km’. The Archipelago Sea and the Sound have the smallest drainage areas. Sweden is the country with the biggest territory in the Baltic Sea drainage area. The next ones are Poland, Russia and Finland with drainage areas a bit larger than 300 000 km’. Germany has the smallest drainage area with 23 550 km’. The drainage area outside of the Contracting Parties is > 92 200 km’. Exact information concerning the Norwegian part is lacking. The pollution load carried from these countries via rivers is comparably small - taking into account the retention time and the self purification in the rivers. The division of the drainage areas between Czechoslovakia, Norway, Belarus and Ukraine is presented in Table 2.2.

Table 2.2.

Division of the Baltic Sea Drainage Area between the Non-Contracting Parties

State	Sub-region	Discharge through	River basin	Drainage area, km^2
Belarus (BY)	Gulf of Riga	Latvia	Daugava	25 800
Belarus	Baltic Proper	Lithuania Russia	Nemunas Pregel	46 900
Ukraine (UA)	Baltic Proper	Poland Lithuania	Vistula Nemunas	11 000
Czechoslovakia (CS)	Baltic Proper	Poland	Vistula, Oder	8 500
Norway (NO)	Kattegat	Sweden	n.i.	n.i.
Norway	Bothnian Bay	Sweden Finland	n.i.	n.i.

Much of the pollution load is introduced to the Baltic Sea via rivers. However, due to the lack of information about the anthropogenic part of the river load and the fact that PLC-2 deals only with the direct load into the Baltic Sea, the questions of river load formation are not addressed in this report.

Furthermore, the pollution load discharged by several Contracting Parties includes also the load originating from other countries located upstream or on the other side of the border rivers. PLC-2 does not deal with these questions either.

For a better understanding of the load origin in different sub-regions, general information about the land use in the Baltic Sea drainage area are presented in Table 2.3. A remarkably big part (60-70%) of the territory is covered by agricultural land in Germany, Denmark and Poland. The part of the land used in Estonia, Latvia and Lithuania is 30-50%, while Sweden, Finland and Russia have only 10% of arable lands. Forests, swamps and waterbodies comprise more than 65-90% in Finland, Russia, Sweden and Estonia. In Poland, Lithuania and Latvia they cover 30-50% of the territory whereas in Denmark and Germany they cover only 19-25%.

Table 2.3

Use of land in the Baltic Sea drainage area by countries

%

Countries Land use	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
Urban area	15		2	3.9	6.2	2.5	6.2	2	1.1
Forests	12	39	51	15.2	43.2	27.9	28.4	55	48.8
Arable land incl. grasslands and greenfields	60	30	7	72.3	39.8	49.2	60.1	12	6.2
Water bodies (lake surface)	13	6.2	10	3.5	1.5	1.5	2.6	17	8.1
Marshes, swamps, wetlands		20	27		4.9	6.4		13	12
Others		4.8	3	5.1	4.4	12.5	2.7	1	23.8

More detailed descriptions of the national drainage areas are given below, in geographical order.

2.1 Finland

The whole territory of Finland is 338 000 km’, whereof 300 000 km’ belong to the Baltic Seacatchment area. About 43% of the total Finnish area belong to the catchment area of the Bothnia Bay, 12% to the catchment area of the Bothnian Sea, 3% to the catchment area of the Archipelago Sea and 33% to the catchment area of the Gulf of Finland. About one half of the latter part discharges through the Lake Ladoga via the River Neva into the Gulf of Finland.

The drainage area in Finland is characterized by a big number of lakes and rivers. There are about 56 000 lakes in Finland, with a surface area of at least one hectar. As the lakes are shallow, the mean depth being only about seven meters. their total volume is only 230 km’. The total river flow into the Baltic Sea is 1980 m^3/s.

The length of the coastline, including islands, is 4 400 km at the Bothnian Bay, 6 600 km at the Bothnian Sea. 20 100 km at the Archipelago Sea and 8 000 km at the Gulf of Finland..

The land is dominated by forests (51 %), wetlands (27%) and lakes (10%). The agriculture (7%) is located in the south-western part of Finland. Urban areas cover 2% of the land, rocks 3%.

The Finnish surface waters are basically oligotrophic and contain very little mineral salts. A typical feature of some of the waterbodies is their brown colour, which is caused by the abundance of peat bogs. Many lakes form parts of long water systems, whith slow water exchange. Therefore. the pollution load is partly assimilated in the water systems before it reaches the Baltic Sea. On the other hand, due to the chainlike water systems and the long period of ice-cover (5-7 months), oxygen deficiency in the near-bottom water layers of the lakes is a very common phenomenon. However, 80 % of the total lake area is of excellent or good quality.

In most of the Finnish coastal rivers the waterflow is small. They are characterized by great variations in flow and water quality. The variations can be caused by changes in the state of nature, use of land and, e.g.. by the flow regulation and wastewater loading. The water of small rivers is often turbid due to clay and the contents of humic substances is high.

70% of the total Finnish catchment area are monitored hydrologically and hydrochemically and additionally 20% are monitored hydrologically only. There are six rivers with a flow exceeding 100 m^3/s, 15 rivers with a mean flow between 5 and 100 m^3/s and 10 rivers with a mean flow less than 5 m^3/s but also monitored.

2.2 Russia

The Russian part of the Baltic Sea catchment area is divided into three parts, one draining to the Gulf of Finland. one to the Gulf of Riga and one to the Baltic Proper.

The catchment area of the Gulf of Finland within the borders of Russia is 276 100 km’. This area includes practically all the territory of the St. Petersburg district, eastern part of the Pskov district, almost all of the Novgorod district, north-west parts of the Tver and the Vologda districts, western part of the Archangelsk district and southern part of Karelia. 80% (2 15 600 km’) of the area are drained by the River Neva. The total population of the drainage area in Russia is 8.24 million inhabitants. 80% of them are living in the St. Petersburg district. The catchment area is low and swampy. The main rivers flow through the lakes Ladoga, Ilmen and Chudskoe where the retention time is several weeks. It means that a significant part of pollutants is accumulated in these lakes. The River Neva drainage area includes urban areas (2%), forests (55%), arable land (12%), swamps (13%), lake surface (17%) and others (1%). A part of the catchment area (39 000 km’) is drained by the River Narva into the Gulf of Finland. At the same time 56 200 km’ of the Finnish catchment area is drained through the River Neva into the Gulf of Finland.

Approximately 23 700 km’ of the Russian Baltic Sea catchment area are drained by the River Daugava into the Gulf of Riga. This area is situated west of the Valday Uplands. Seven tributaries of the River Daugava originate there. The largest of them are the River Meza and the River Drissa. The area is low and swampy without any big industrial centres and cities. Forests and agricultural areas are dominating.

The Russian part of the drainage area of the Baltic Proper (Kaliningrad region) is 15 100 km’. The main rivers are the River Pregel and the River Nelma. The total population is 878 000 inhabitants. The whole catchment area is monitored hydrologically and hydrochemically. The biggest part of the drainage areas of the rivers Pregel and Nelma are situated in Belarus and Lithuania.

The catchment area of the Gulf of Riga within the borders of Russia is 24 000 km’.

2.3 Estonia

The whole territory of Estonia is 45 100 km’. The land area of islands is 9% (~ 4 060 km’) and the area of inland waters 6.2% (~ 2 800 km’). The coastline is 3 780 km long, of which 1 240 km run along the continent and 2 540 km around the islands.

About 63% of the territory belong to the catchment area of the Gulf of Finland, 34% to the catchment area of the Gulf of Riga and 3% to the catchment area of the Baltic Proper.

The drainage area of the Gulf of Finland in Estonia covers 26 400 km’ and is populated by 1.265 million inhabitants.

On average, 30% of the catchment area consists of arable land, 39% are covered by forests and 20% by swamps.

The total Estonian river flow into the Baltic Sea is 495 m^3/s.

About 81% of the catchment area is monitored hydrologically and 85% hydrochemically. The River Narva with the long term mean flow (1956- 1982) of 10.9 km^3/a is the main river. About 39 000 km’ (70%) of the watershed of the River Narva belong to Russia.

The northern part of the catchment area of the Gulf of Finland within the borders of Estonia belongs mainly to the karst region. South Estonia mainly belongs to the catchment area of the Lake Chusdskoe, discharging via the River Narva into the Gulf of Finland.

The sub-soil of South Estonia is consisting of sandstone from the devon era. The landscape is covered with small hills, lakes and bogs.

The Estonian catchment area of the Gulf of Rigais I7 600 km’ and it is populated by 295 000 inhabitants. About 20% of the drainage area are covered by arable lands, 44% by forests and 26% by swamps. The basis of West Estonia is clay. The land is low, with bogs and marches.

The main rivers are the River Kasari and the River Parnu. About 48% of the drainage area is monitored hydrologically and 56% hydrochemically.

A small part of South Estonia discharges its river waters via the Latvian river Gauja to the Gulf of Riga.

The western parts of the Islands Saaremaa and Hiiumaa belong to the Baltic Proper catchment area. The territory of that drainage area is 1 100 km’ and it is populated by 10 000 inhabitants. The territory can be characterized by 14% of arable lands, 55% forests and 25% swamps. There are neither rivers nor direct pollution sources related to the PLC-2 control programme.

2.4 Latvia

The territory of Latvia is 64 600 km’. Approximately 95% (6 1 000 km’) of the Latvian territory belong to the drainage area of the Gulf of Riga and the Baltic Proper. The territory is populated by 2.6 million inhabitants i.e. 98% of the total Latvian population.

More than half (77 000 km’) of the area drained by the Latvian rivers is situated on the territory of Russia, Belarus, Lithuania and Estonia. Hereby, the Latvian rivers serve as transit collectors for a remarkable amount of riverwater and, consequently. of pollution from other countries to the Baltic Sea.

The territory of Latvia is even and low. The rivers are not regulated, except the River Daugava.

About 64% of the catchment area of the Gulf of Riga are monitored hydrologically and 79% hydrochemically. For the drainage area of the Baltic Proper these figures are 54% and 43% respectively.

The territory of Latvia is used in the following way: urban areas 6.2%, forested areas 43.2%, agricultural areas 39.8%, bushes 1.9%, wetlands 4.9%, lake surface 1.5% and others 2.5%.

2.5 Lithuania

The territory of Lithuania is 65 300 km’ and it belongs totally to the drainage area of the Baltic Proper. The length of the coastline of Lithuania is 99 kilometers. The population of Lithuania is 3.7 million inhabitants.

The main river is Nemunas, which is discharging to the semiclosed Kursiu marios Lagoon. The retention time of Nemunas discharges in Kursiu marios Lagoon in case of full mixing is four months. The rivers discharging to the Baltic Proper from the Lithuanian territory drain the areas in Belarus (46 900 km’), in Poland (2 405 km’) and in Russia (880 km’). On the other hand, 10 500 km’ of the Lithuanian territory belongs to the drainage area of rivers falling into the Baltic Sea through the Latvian territory.

The Lithuanian territory is dominated by agriculture (49.2%) and forests (27.9%), 2.5% are urban areas, 1.5% lake surface(water bodies), 6.4% wetlands and 12.5% under other different usages.

2.6 Poland

Almost the whole territory (99.7%) of Poland belongs to the drainage area of the Baltic Proper. This area covers 311 900 km’ and is populated by over 38.0 million inhabitants; 61.6% of this population concentrate in urbanized agglomerations. The remaining part of the population are farmers on 60.1%

of the land, (45.9% of the area belongs to arable land, 1.0% to orchards and 13.2% to grasslands). The entire catchment area consists of 28.4% of forests, 2.6% of waterbodies, 3.0% of inhabited area and 3.2% of communication pathways. The drainage area of Polish rivers includes also some 38 530 km’ of Germany, Czechoslovakia, Belarus and Ukraine, populated by about 3 million of inhabitants. On the other hand, 11 300 km’ of Poland, inhabited by nearly 1 million of inhabitants, is located in the drainage area of rivers flowing into the Baltic Sea within the borders of Russia and Lithuania. The length of the coastline of Poland, together with the Hel Peninsula, is 524 km.

Over 35% of the monitored river waters and 40% of the wastewaters flow through lagoons and coastal lakes before entering the sea. These reservoirs with retention times of several weeks are influenced by periodic inpourings of the sea waters. Therefore, monitoring of the pollution load in outflow to the sea is impossible. On the other hand, processes of degradation and pollution accumulation resulting from the long retention time in these reservoirs, cause significant decrease of the pollution load in comparision with the monitored load.

In Poland 80-95% of the total pollution load is discharged to the Baltic Sea via rivers. For this reason the river monitoring was carried out very carefully.

2.7 Germany

The rivers of the Federal Republic of Germany discharge their waters into the Baltic Proper and the Western Baltic.

The main part of the area of Mecklenburg-Vorpommern (12 625 km’) belongs to the catchment area of the Baltic Proper. The length of the coastline along the open sea is 134 km, whereas the bodden coastline is 1 100 km long.

Bodden is a specific term in Germany for shallow bays, seperated by spits of land or islands extended in front of the coast. The bodden coastline is typical for Mecklenburg-Vorpommern.

Owing to changing water levels and currents and the effect of waves, the coastline is always changing. The open sea coastline in particular is affected - 90% of it recedes by 0.2 to 0.4 m per year.

The main rivers in the Baltic Proper area are the Uecker with a drainage area of 2 149 km’, and Peene with a drainage area of 5 110 km’.

The total area of lakes larger than 10 000 m^2 in the drainage area of the Baltic Proper is 142.2 km’.

In the Baltic Proper area of Germany, 928 900 inhabitants have been estimated, that means a population density of 73 inhabitants per km’. Stralsund, Greifswald and Neubrandenburg are the centres of population there. Land use is characterized by agriculture, forestry and food production. About 70% of their combined areas are fields and grasslands, 17% are covered by forest and nearly 4% are taken up by water.

The eastern third of the Federal State of Schleswig-Holstein and the western part of the Federal State of Mecklenburg-Vorpommern belong to the Western Baltic Area. The drainage area is a postglacial moraine landscape and drains to the southern part of the highly structured Western Baltic Sea with its subbasins namely the Kiel Bight, the Bay of Mecklenburg, the Bay of Lübeck and the Fehmarn Belt.

The total length of the coastline is 615 km of which 145 km is open sea coastline belonging to Mecklenburg-Vorpommern and 470 km bodden coastline from which 330 km is situated in Schleswig-Holstein.

Descending from sandy marl as the main soil material, the following types of soil prevail in the catchment area: stagnic or other gleysoils. cambisoils and agrisoils; humic gleysoils and fluvisoils in lowlands and along watercourses.

The total population of the runoff area amounts to about 2.4 million inhabitants. About 1.3 million inhabitants are living in Mecklenburg-Vorpommen area. The main centers of population are Rostock, Wismar and Schwerin with about 438 000 inhabitants. In Schleswig-Holstein the total population of the runoff area amounts to about 1.1 million inhabitants. 50% of them live in cities with more than 80 000 inhabitants. The largest population and industry centres are Kiel, Lübeck, Flensburg and Schleswig.

The drainage area in Schleswig-Holstein contains 9% forests, 6% built areas, 5% inland waters and nearly 80% is used agriculturally.

2.8 Denmark

The whole territory of Denmark is 43 080 km’. whereof about 3 1 100 km’ belong to the Baltic Sea catchment area. The area is mainly covered by Pleistocene tluvio-glacial sedimentary deposits. The relief is low and slopes steeper than 6% only occur in about 3% of the total land mass. The soil type is generally loamy soils in the eastern Denmark while sandy soils dominate in western and northern Jutland.

Denmark has catchments in four sub-regions of the Baltic Sea Area, namely 1 200 km’ in the Baltic Proper, 12 400 km’ in the Western Baltic. 15 800 km’ in the Kattegat and 1 700 km’ in the Sound sub-region. The Danish Baltic Sea catchment area is populated by about 4.4 million inhabitants of 5.1 million total Danish population.

In whole Denmark the arable areas comprise about 60% of the total area, in 1989 56% of the arable area was used for cereals. Forests cover about 12%, while meadows, moorlands and lakes etc. cover about 13% so that nature and cultivated areas cover nearly 90% of the Danish land. The remaining part are consolidated areas, i.e. roads, villages and towns.

The length of the Danish total coastline, including the North Sea coast, is nearly 7 500 km. Presently one third of **the** coastline is occupied by areas with housings. leisure and recreational facilities, industrial grounds or windmill parks.

More than 60% of the Danish drainage area is intensively monitored with numerous stations in the streams and lakes. In 1990 the input of freshwater from the rivers in the Danish Baltic Sea catchment area to the marine areas was about 8 700 million m^3/a equivaling an area specific discharge of about 300 mm. This was nearly 10% more than the average for the preceding decade. Denmark has no really big rivers as none of the three biggest relevant Danish rivers transport more than 20 m^3/s on a yearly average.

2.9 Sweden

The Swedish drainage area of the Baltic Sea is devided between the Bothnian Bay, the Bothnian Sea, the Baltic Proper, the Sound and the Kattegat.

The catchment areas of the Bothnian Bay (130 600 km’, including the catchment area of the River Torne) and of the Bothnian Sea (180 100 km’) are similar in many ways: they are situated in the northern part of Sweden, are rather sparsely inhabitated, are heavily forested and only small areas are agricultural areas (BOB 390 000 inhabitants on 0.2% urban area and BOS 1. 123 million inhabitants on 0.6% urban area; BOB 43% and BOS 53% forested area; BOB 0.8% and BOS 1.9% agricultural area). Furthermore, both areas are rich in wetlands (BOB 17% and BOS 15%) and in lakes (lake surface area - BOB 5.9% and BOS 6.4%). Other areas, including mountains, cover for BOB 33% and for BOS 23%. There are some fairly large rivers with a mean flow exceeding 400 m^3/s in the two regions, e.g. Lule älv, Ume älv, Angermanälven, Indalsälven. Altogether there are about twenty rivers in the two catchment areas with a mean flow above 5 m^3/s.

The catchment area of the Baltic Proper, 84 900 km’, is also heavily forested (52%), but more densely populated than the northern parts (4.109 million inhabitants on 2.6% urban area). The agricultural area is larger than up north and covers 16% of the catchment area. Wetlands and lakesurface area cover 3.2% and 10%, respectively. Other areas, including mountains. cover 16%. The major river in the area is Norrström, the outlet of Lake Mälaren in Stockholm. The mean flow is 156 m^3/s. There are about ten rivers in the catchment area with a mean flow above 5 m^3/s.

The smallest area (2 600 km’) belongs to the Sound. The catchment area is clearly different from the others as it comprises an extensive part of agricultural area (64%). Also the population density differs, as there are no less than 625 000 inhabitants in this small area. The urban area is 6.2%. Small areas are covered by forests (10%), wetlands (0.7%) and lake surface (I .3%). Other areas, including mountains. cover 18%. Five rivers have a mean flow above 2 m^3/s. The major river is Kävlingeån with a mean flow of 12 m^3/s.

The catchment area of the Kattegat is in most ways similar to the one of the Baltic Proper, except for the size (7 1 600 km’). It consists of 1.8% urban area and has 2. I36 million inhabitants. The forested area is 45% while the agricultural area is 12%. Wetlands and lake surface area cover 7.3% and 14.2% respectively. Other areas including mountains cover 20%. The major river (largest in Sweden) is Göta älv (mean flow 53 1 m^3/s). About five more rivers have a mean flow exceeding 20 m^3/s.

3 Description of Measurement and Calculation Methods

Reliability and comparability of the presented data provide for similar or comparable monitoring, i.e. methods of measuring flow rates, frequencies of sampling. analyses and calculation methods. However, the methods used in the different states are not very similar and thus the comparability is just possible, restricted to the order of magnitude. Below, a review of the measuring methods used by different states is presented.

3.1 Measurement and calculation of pollution load via rivers

3.1.1 Flow measurements and sampling frequency

In the PLC-Guidelines there is only one requirement concerning the position of the flow measurement stations: they should be established on the river mouth but above the mixing zone of fresh and saline water. For the hydrological measurement it is important that the river flow is not influenced by the sea water level.

The flow measurement should be organized according to the international hydrological practices.

As it is indicated in the PLC-Guidelines, the sampling frequency should preferably be 12 times per year. but at least 8 times per year with one extra sample during the highest flow.

The representativeness of the samples must be checked. Special sampling devices have to be used, e.g. for heavy metals. On the basis of national reports all sampling is carried out manually. The following sampling frequencies in 1990 were used in different countries:

Finland

Sampling frequency at rivers with a mean flow exceeding 5 m^3/s normally is 12 times per year, for the rivers Oulu, Kokemäen, Karjaan and Kymi 13 times per year. However, the frequency has been extended during autumn and spring so that the total number of samples from twelve rivers in 1990 was 14 to 30. Exceptionally, only 7 samples were taken from Tornionjoki in 1990.

Russia

Sampling frequency for the river Neva and Luga was 12 times per year, for the river Seleznyevka 4 times per year. For the rivers falling into the Vistulan Bay, the sampling frequency for the River Nelma was 5 times per year and for the River Pregel it was 12 times per year.

Estonia

In 1990 the sampling frequency for the River Narva, Purtse and Kroodi was I2 times per year, for the other rivers the frequency was 4 or 5 times per year, for the rivers Kasari and Parnu. flowing into the Gulf of Riga, the sampling frequency was 5 times per year.

Latvia

Samples were taken 12 times per year, only from the River Barta they were taken 6 times per year.

Lithuania

Samples were taken 12 times per year.

Poland

The samples were taken manually, at random, from the main riverine stream. Sampling frequency for the rivers Vistula and Oder was 2 times a week, for the other rivers 1 time per week.

Germany

Samples were taken manually, sampling frequency has been 12 times per year.

Denmark

The sampling frequency varied between 12 and 32 times per year, depending on the annual runoff pattern.

Sweden

Samples are taken once per month.

3.1.2 Methods for calculation and estimation of river discharges

For calculating the annual load discharged to the Baltic Sea via rivers the following methods were mostly used:

1. Mean annual concentration and yearly runoff:

$$L = W \cdot \frac{1}{n} \sum_{i=1}^{n} C_i \tag{1}$$

L - load
W - yearly runoff
C - measured concentration
II - number of measurements.

2. Method of linear interpolation:

$$L = \sum_{i=1}^{12} C_{a_i} \cdot W_{a_i} \tag{2}$$

C_a - arithmetic mean concentration of two following samples
W_a - runoff between two samples

3. Daily flow and daily concentration regression:

$$L = \frac{m}{n} \sum_{i=1}^{n} Q_i \cdot C_{r_i} \tag{3}$$

$$C_{ri} = \frac{a}{Q_i} + b + c \cdot Q_i \tag{3a}$$

Q - daily flow (measured)
C,. - the regression value of concentration for the stream flow
m - conversion factor of units

a, b, c - coefficients typical of each quality parameter, observation station and time series.

4. Mean monthly concentration and mean monthly flow:

$$L = \sum_{i=1}^{12} W_{k_i} \cdot C_{k_i} \tag{4}$$

W_k - monthly runoff
C_k - mean monthly concentration.

5. Representative concentration and flow values for short hydrological period:

$$L = \frac{m}{n} \sum_{i=1}^{n} C_i \cdot q_i \tag{5}$$

C - measured concentration
q - measured flow
n - number of measurements
m - conversion factor of units

Depending on the data and especially on the pattern of the annual runoff and concentration, one of the methods is used. Load computation by means of annual average values of the concentration and flow leads to uncontrolled large errors. This method is not recommended.

On the basis of the national reports presented on the Baltic Sea Pollution Load Monitoring Symposium (April, 1988) and formats with load data the following review about calculation methods is compiled.

Finland

Annual river loads were calculated by multiplying mean concentrations by the monthly mean flows of the rivers (4). Missing values of a month were interpolated linearily with consideration of the season and the geographical zone of the river. The loading estimates for the four sea sub-regions (GUF, ARC, BOS and BOB) were obtained by summing up the loads from each of the rivers of the respective catchment area and by adding the estimated (by interpolation) load from the respective coastal zone to this sum.

Russia

Pollution load from the Russian rivers is calculated on the basis of regression of the daily flow and daily concentration (3).

Estonia

Mean annual concentration and mean annual flow for calculation the pollution load has been used in Estonia (I). The frequency of measurements organized by the Estonian Hydrometeorological Board is low and the results do not allow the use of other calculation methods.

Latvia

Pollution load from the Latvian rivers is calculated on the basis of (3) or (5), depending on the measurement.

Lithuania

Pollution load from the Lithuanian rivers is calculated on the basis of (3) or (5), depending on the measurement method.

Poland

On the basis of extensive data sets the annual loads were calculated from the momentary loads (5), assuming the linear dependence between two measurements of water quality.

Germany

In Mecklenburg-Vorpommern (BAP and eastern part of WEB) the pollution load from rivers is calculated in accordance with (5). In the western part of the Western Baltic the riverine load was calculated according to the equation as recommended by STC 15/16 Annex 12, B.6 :

$$L = \frac{\sum C_i \quad Q_i}{\sum Q_i} \cdot Q_a \tag{6}$$

L - Load
C - Concentration
Q - Flow
Q_a - annual flow

Denmark

In Denmark the following methods for calculation of pollution load are used:

- correlation analysis and continuous integration;
- interpolation methods (2);
- integrative regression methods (3).

The common trapezium-integration method is not recommended, as the error by using this method can be as large as 30-50%.

Sweden

The load of the larger rivers is calculated as the sum of the product of daily measured runoff and daily concentration. That concentration is based on linear interpolation between the results of the samples taken once a month.

The calculated load of the small rivers is based on the monitoring results of the "neighbourhood" rivers.

The calculated load of the minor rivers (=coastal zones) is also based on the monitoring results of the "neighbourhood" rivers.

3.2 Measurement and calculation of pollution load from urban areas and industries

3.2.1 Flow measurement from urban areas and industries

In all the municipal and industrial wastewater treatment plants both the internal operation control and the discharge control are necessary to ensure that plants operate well and up to standards.

As a rule, the operation control system is based on the continuous tlow measurements and registration. Flow measurements are made in open or closed systems. An open system includes channels, flumes or wells. In a closed system the measurements take place in pipes using the different measurement devices like electromagnetic, ultrasonic etc.

Measurement accuracy e.g. in open systems is dependent on the measurement equipment, level measurement method and linearization method. Measurement accuracy for a properly selected and calibrated measurement equipment is ± 5%.

Measurement accuracy for electromagnetic and ultrasonic equipment is also ± 5%. However, the equipment is not always calibrated according to the real flow. As a rule, the error is bigger the bigger the variation of the flow is. Errors up to 20% are still common. With an annual calibration at the main plants the statistical error would not be significant.

The overview of flow measurements used in the Baltic Sea countries, which is presented below, is based on the information submitted officially the Contracting Parties.

Finland

The main methods for measuring the flow rate are open channel measurement with Venturi channel (big plants) or overflow weir (usually V-notch weir). The measuring equipment is usually either a weighing cell or an ultrasonic echo device.

In most cases there is an indication of instant flow recorder and a totalizer to give the cumulative flow. In big plants computers are used to gather the flow rate data so as to give an opportunity to analyse the flow rates more deeply.

The flow measuring techniques applied for the industrial wastewaters are similar to those applied at the municipal sewage works. At big industries continuous measuring with recorders and totalizers are applied for the control of effluents. More than 90% of the total industrial effluents is recorded continuously. The remaining part is mainly measured periodically. Only at very small plants estimates are based on water consumption. Estimates based on pump effects are mainly used for clean cooling waters.

Russia

In the big municipal and industrial wastewater treatment plants, as a rule, a continuous flow measurement is organized in open channels using Venturi or Parshall flumes. At the same time the continuous registration of results is not always guaranteed. Measurement accuracy is normally higher than ± 5%. Unfortunately, there are more than 50% of wastewaters discharged without treatment into the coastal zone. It is impossible to organize the flow measurement control for such kind of discharges. Usually the amounts of discharged wastewaters are estimated on the basis of water consumption, calculated on the basis of pumping time or are calculated on the basis of temporary measurements.

Control of overflows is lacking.

Estonia

Corresponding to the Soviet standards all industrial and municipal purification plants and outflows must be equipped with flow measurement devices. Open flow measurement systems with continuous registration of the flow are designed only and have partly been built already. Unfortunately, the registration systems are not working well, and, as a rule, the flow is calculated on the basis of the pumps parameters and the pumping time. For industries the wastewater flow is often determined on the basis of water consumption.

Overflow frequency is not registered and load is not controlled.

Latvia

Flow measurements should be carried out with the continuous flow measurement and registration equipment. If the flow measurements in industrial and municipal wastewater purification plants are more or less working, the control of unpurified wastewater outlets are only temporary and as a rule, the flow is determined on the basis of water consumption.

Control of overflows is lacking.

Lithuania

Flow measurements are organized on the same level as in Estonia and Latvia. The flow rate is mainly determined on the basis of water consumption or calculated on the basis of pump parameters and pumping time.

Control of overflows is lacking.

Poland

Municipal wastewater treatment plants are supplied with fixed flow measuring devices. Parshalls or Venturi open channels are generally used.

In those urban areas without treatment plant. the amount of wastewater is estimated from the water consumption or from pump efficiency and pumping time.

The industrial wastewater amount is determined directly from the water consumption or from pump efficiency and pumping time.

Control of overflows is lacking.

Germany

In all municipal and industrial sewage treatment plants in Schleswig-Holstein exceeding 10 000 PE the wastewater volume is recorded continuously by means of Venturi channel measurements and displayed as paper records which are available for further evaluations.

In Mecklenburg-Vorpommern the flow rate of the industrial and municipal treatment plants is calculated on the basis of pumping time and pump efficiency.

Stormwater overflows are usually not measured. Specific overflow measurements are available only from the investigation programmes in a few confined areas.

Denmark

The Danish monitoring programme includes the discharges from municipal wastewater treatment plants above 30 population equivalents (PE). Both industries and housholds are connected to the plants.

Most Danish industries discharge to the municipal wastewater treatment plants, but some industries have established wastewater treatment plants on the location and discharge the purified water into the local marine or fresh water.

The Danish monitoring programme includes those industries with a discharge above 30 PE (PE for industries are defined as 4.4 kg Total Nitrogen per year or 1.5 kg Total Phosphorus per year).

The reported data include nearly all direct inputs of wastewater to the sea. Stormwater overflows are measured separately but have been included in the input values from the wastewater treatment plants in the Baltic Sea area. In 1990 the amount of water from the wastewater treatment plants to the Baltic Sea catchment was about 405 million m^3, of which 65 million m^3 were stormwater overflows.

Sweden

All the treatment plants with more than 2000 PE are said to have equipment for the automatic measurement and registration of the flow. For measurement in open channels mainly flumes and weirs are used.

As it is mentioned in the Swedish National Report for the PLC- 2, all presented industrial and municipal treatment plants included into the Report have continuous flow measurements. Information about overflows is lacking.

Summary

In Denmark, Finland, Germany (Schleswig-Holstein) and Sweden the main industrial and municipal wastewater flows are principally measured and registrated continuously with the accuracy of $\pm$ 5%. The frequency of overflows is controlled and the amount of discharged wastewaters are estimated on the basis of different methods.

In Estonia, Latvia, Lithuania, Poland, Russia and Germany (Mecklenburg-Vorpommern) the industrial and municipal wastewater purification plants, as a rule, are equipped with measurement devices, but continuous measurement and registration is not always guaranteed.

The amounts of industrial and municipal wastewaters discharged into the Baltic Sea without purification are usually estimated on the basis of water consumption or calculated on the basis of pumping time and pump effect.

3.2.2 Sampling procedure and frequency

Sampling shall be carried out in such a manner that the samples are representative for the water to be analysed. The following types of sampling are often used:

Grab sample

The grab sample is a random sample taken at a specific time without attention to variation in flow and composition.

Composite sample

A composite sample consists of several grab samples taken over a shorter (daytime) or longer (24-hour, weekly) period. The grab samples included in a composite sample should, in general, be proportional to the flow. If this is difficult to arrange samples may be taken at even time intervals.

Flow proportional sample

A flow proportional sample can be obtained by:

a) the volumes of the included samples are made proportional to the flow while sampling frequency remains constant.

b) the sample volume is constant but sampling frequency is proportional to the flow rate.

On the basis of national reports the following review about sampling used in 1990 is compiled.

Finland

At most municipal plants sampling from the influent and effluent of the treatment plant is accomplished with an automatic composite sampler. The samples are 24-hour flow proportional samples. Bacterial samples are grab samples. For organic micropollutants or heavy metals separate sampling techniques are used, usually manual grab samples. Frequency of control analyses at municipal treatment plants with more than 10 000 PE is at least 24 times per year. At all big industries sampling is accomplished with automatic composite samplers installed at the main effluent channels. Most of these are flow dependent while some of them are time dependent. Sampling frequency depends on the size of the plant as well as on the quality variations in the effluent. At roughly one hundred factories 24-hours sampling and analyses are made 2-7 days per week. At very small factories 4 to 8 hours composite samples are taken manually a few times a year.

Russia

The sampling frequency is determined by authorities taking into account the size of the plant as well as the quality variation in the effluent.

Sampling takes place manually as grab samples.

Estonia

Control sampling takes place manually as grab samples. The following sampling frequency is requested:

$Q <$	500	m^3/day	once per 3 months
$Q =$	500-3000	m^3/day	once per month
$Q >$	3000	m^3/day	once per week

If the variation of flow(Q) and concentration are insignificant, the grab sample should be taken. If the flow rate is stable and concentration variation is significant, the time-proportional sample should be taken. If the variation of flow rate and concentrations are both remarkable, then the flow proportional samples should be taken.

Latvia

Sampling frequency is determined by authorities taking into account the size of the plant as well as the quality of variation in the effluent.

Sampling takes place manually as grab samples.

Lithuania

Sampling frequency is determined by authorities taking into account the size of the plant as well as the quality variation in the effluent.

Sampling takes place manually as grab samples.

Poland

In the big treatment plants the samples are taken automatically. Then from 48 samples collected during the day, the average day sample proportionally to the flow is prepared. In the smaller plants the samples are taken manually. But in some cases the samples were taken at random. Apart from the big industrial plants, the samples are taken at random, generally as average-hour samples. In the big industrial plants the sampling is continuous.

Germany

Five times a year a two hours composite sample is taken. In addition, for pollution load calculation so-called self-control data are used.

In the scope of official monitoring programmes, a two hours composite sample for BOD and COD is taken 4 to 6 times a year in Schleswig-Holstein. Additionally, chemical analyses with a more comprehensive parameter set including nutrients, COD and TOC are made at a higher frequency for in-official permanent plant control. At the greater sewage plants also heavy metals are monitored at regular intervals.

In Mecklenburg-Vorpommen (the former GDR) grab samples are taken manually with different sampling frequences, depending on the size of the municipal and industrial plants. Control analyses are carried out both by the authorities and by the owner of the treatment plant himself. The average sampling frequency is once per month.

Denmark

For Danish wastewater treatment plants the following sampling frequency is used:

Capacity	Number of plants (1988)	sampling frequency
30 < PE ≤ 200	864	2 x
200 < PE ≤ 1000	510	4 x
1000 < PE ≤ 5000	448	12x
5000 < PE ≤ 10000	97	12x
10000 < PE	172	12x

PE Population Equivalent

The number of plants relates to the total Danish catchment area. One control period is 12 months.

In industry the following sampling classes are used:

	BOD [t/a]	COD [t/a]	Tot-N [t/a]	Tot-P [t/a]
C I	0.6 < L ≤ 4.3	1.6 < L ≤ 10.8	0.13 < L ≤ 0.9	0.05 < L ≤ 0.3
c II	4.3 < L ≤ 21.6	10.8 < L ≤ 54.0	0.90 < L ≤ 4.4	0.30 < L ≤ 1.5
c III	21.6 < L ≤ 108.0	54.0 < L ≤ 270.0	4.40 < L ≤ 22.0	1.50 < L ≤ 7.5
c IV	108.0 < L	270.0 < L	22.0 < L	7.5 < L

L Load

Normally the sampling frequency is dependent on the sampling class:

C I	2	samples / control period
c II	4	samples / control period
c III	12	samples / control period
c IV	12	samples / control period

One control period is 12 months.

Each sample is taken as a flow proportional sample from treatment plants above 1 000 PE, while smaller plants with a required sampling frequency of 2-4/period may be allowed to use time proportional sampling. All industrial plants with direct discharges are monitored, this means that no lower limit is applied.

Most samples are taken as flow proportional samples, except for industries where the authority have estimated that the samples taken as time proportional samples will be sufficient.

Sweden

In the municipal and industrial treatment plants automatic continuous flow proportional sampling is carried out. The frequency of sampling is dependent on the size of treatment plant and parameters controlled. The standard sampling frequency for the municipal treatment plants is presented below:

size of treatment plant (PE)	Parameter	Frequency of analyses
10001 - 20 000	Tot-P	2 dp / month
10001 - 20 000	NH,-N, Tot-N	2 dp / month
10001 - 20 000	BOD,, Tot-N	2 dp / month
20 001 -	Tot-P	1 wp / month
20001 -	BOD,	1 dp / week
20001 -	COD,,.	2 wp / month
20001 -	Hg, Cd, Pb,Cu, Zn, Cr and Ni	1 wp / month

dp - daily flow proportional sample
wp - weekly flow proportional sample

Industrial discharges are monitored according to the rules set by the individual permits, which may have the result that some parameters are missing in the individual case. Also the frequency of sampling can differ by industrial branches. Most common sampling methods and frequencies for different industries are presented below:

Wood industry	COD,,., flow proportional sampling, daily. BOD,, flow proportional sampling, monthly. Tot-P and Tot-N, once per week
Metal works	Metals. flow proportional sampling, daily; analyses on composite samples, monthly
Steel works	Flow proportional sampling
Fish farms	Calculated. Nutrient load per ton of fish is estimated to be 13.5 kg P and 92 kg N. Fodder coefficient = 1.75
Oil refinery	COD,,. and BOD,, random samples monthly. Heavy metals: sampling four times a year for 5 days/week
Food industry	Flow proportional sampling
Pulp and paper	Flow proportional sampling
Chemical plants	P and N, random samples weekly; COD,, and BOD_7, random samples, monthly

Summary

In Denmark, Finland, Germany (Schleswig-Holstein) and Sweden in most cases the automatical flow proportional daily-, 24 hour- or weekly composite sampling are used at big plants.

In Estonia. Latvia, Lithuania, Poland and Russia mainly manually taken grab samples with different frequencies are used.

If the different types of composite samples are used, the concentration variation during the 24 hours or weeks have no influence on the load calculations.

If grab samples are taken, the probability of over- or under-estimations of the load is big.

3.2.3 Methods of chemical analyses

In the Guidelines for the PLC-2 the descriptions for the analyses of the substances included to the monitoring programme are presented.

Most of the countries informed that the analytical methods used correspond to the Guidelines.

Finland, Denmark and Sweden

Analysing methods used in Denmark, Finland and Sweden correspond to the Nordic standards and comply with the requirements in the PLC Guidelines. However, the regional authorities in Denmark recommend IS0 standards or equivalent Danish or Nordic standards.

Danish information for industry on organic matter is usually presented as chemical oxygen demand measured as COD,,., while biological oxygen demand is measured as BOD, modified or unmodified. Little information is available on the methods of analysis for total nitrogen and total phosphorus in Denmark. However, the regional authorities traditionally apply recommended IS0 standards or equivalent Danish or Nordic Standards. Information on inputs of heavy metals from wastewater treatment plants or industry is not collected systematically. Such kind of data are only available from ad hoc investigations or, if appropriate, from the specific plants in question.

Russia, Estonia, Latvia and Lithuania

Estonia, Latvia, Lithuania and Russia use for chemical analyses the standard methods adopted by CEMA (Council for Economic Metrical Assistance). These methods of chemical analyses correspond to the Guidelines and ISO standards.

One of the main problems for Poland and the former Soviet Republics is the substitution of BOD, analyses with BOD,. In a few cases BOD, and the corresponding conversion factor are given. The lack of modern equipment, chemicals and special standard substances for calibration equipment have big influence on the results of analyses. In Russia, Latvia and Lithuania total nitrogen is determined as a sum of mineral compounds. In Estonia state the governmental system included only measurement of mineral forms of nitrogen and phosphorus. Total nitrogen and phosphorus were calculated on the basis of the ratio of mineral and total nitrogen or phosphorus correspondingly. using the measurements carried out in different years. Calculated results seem to be higher as compared with Finnish, Russian and Latvian results. A general problem is the correct analyses of Total Nitrogen and Total Phosphorus, as well as the determination of heavy metals. More attention should be paid on the pretreatment of the sample and good laboratory praxis. Equal standards do not guarantee equal results.

Deviations from the calculation methods given in the Guidelines are not reported. Although it is obvious that the Guidelines are not strictly followed, this is probably a minor problem compared to the other sources of errors in the methodology. The most critical factors in the system are sampling frequency, pretreatment of samples, laboratory equipment and flow measurement. The sources of errors may lead to overestimtes as well as to underestimates.

Poland

In Poland analytical control is carried out in accordance with the PLC Guidelines.

When the determinant range is incomplete, the estimation method is used to calculate, for example, Total Nitrogen from BOD load according to the Guidelines. Regarding Total Phosphorus, factor 2.7 g Tot-P/PE/day is used, which is adequate to Polish conditions. To get BOD, from BOD, the conversion factor of 1.17 is used.

The methods of chemical analyses applied are in accordance with the Guidelines. To determine Total Nitrogen, Kjeldahls method is used.

In the case of incomplete analyses of industrial wastewaters, the values of chemical determinants of similar industrial plants are used.

Germany

The German Standard Methods (DEV) used for the examination of wastewater comply with the requirements in the PLC Guidelines. In Mecklenburg-Vorpommern the following deviations from the PLC Guidelines should be noted:

> BOD_5-measurement was carried out without nitrification inhibitor (ATU). In order to get BOD, the conversion factor of 1.17 was used.

3.2.4 Calculation methods

The total load from urban areas and industries should be calculated as a flow weighted total, including overflows at the treatment plant. If some calculation or estimation methods differ from those presented in the Guidelines they had to be reported.

Deviations from the calculation methods given in the Guidelines are notreported. Although it is obvious that the Guidelines are not strictly followed, this is probably a minor problem compared to the sources of errors in the methodology. The most critical factors in the system are sampling frequency, pretreatment of samples, laboratory equipment and flow measurement. The sources of errors may lead to overestimates or underestimates.

4 Pollution load entering the different sub-regions of the Baltic Sea

4.1 Bothnian Bay

4.1.1 Pollution load via rivers

The Bothnian Bay is the northern part of the Gulf of Bothnia. In this report the Quark is also included to the Bothnian Bay. The southern border between the Bothnian Bay and the Bothnian Sea is on the imaginary line HÖRNEFORS - VAASA. The long-term mean tlow of fresh water to the Bothnian Bay is 105 km” per year.

The drainage area of the Bothnian Bay is 276 600 km’. Only a small part of the drainage area belongs to Norway. Drainage areas and hydrologically controlled areas are indicated in Table 4. 1. More than 85% of the drainage area in Sweden and 88% in Finland (the River Torne excluded) is controlled hydrologically .

Table 4.1

Information about the drainage area of the Bothnian Bay

	Finland’	Sweden’	Total
Drainage area [km^2] Drainage area of the reported rivers with measured flow [km’]	136 000 120 000	116 100 111 760	252 100 231 760
Number of reported rivers	12	9	21

The drainage area of the River Torne which is situated on the border between Finland and Sweden is included in the Swedish figures

The drainage area of the Bothnian Bay is well controlled hydrologically and hydrochemically. All rivers are monitored 12 times a year in Sweden and up to 30 times a year in Finland.

The distance of hydrological stations from the sea is between 0 to 22 km in Sweden and between 5 and 18 km in Finland. As a rule, the hydrological stations and the water quality stations are situated in the same place. If located seperately, the water quality stations are situated closer to the sea than hydrological stations. Due to that, the hydrochemically controlled area might be a little bit bigger than the area controlled hydrologically.

The total pollution load that entered the Bothnian Bay via rivers in 1990 is presented in Table 4.2 and Figure 4. 1

Table 4.2

Pollution Load entering the Bothnian Bay via Rivers in 1990
t/a

Determinants	Finland	Sweden	Sum
Q [m^3/s]	1 294.5000	1 805.1100	3 099.6100
BOD_5[*]	n.i.	n.i.	n.i.
BOD,	46 580.0000'	33 2 1 2.9750[3]	79 792.9750
BOD_{21}[a]	n.i.	n.i.	n.i.
TOC"	n.i.	229 055 .0000	> 229 055.0000
s s	197 500.0000	43 000.0000	240 500.0000
COD,,'	n.i.	n.i.	n.i.
COD,,"	4 16 200.0000	1 042 787.0000	1 458 987.0000
Tot-P	1 264.0000	870.1500	2 134.1500
PO,-P	578.5000	141.4910	719.9910
Tot-N	20 130.0000	14 903.7000	35 033.7000
NH,-N	2 245.0000	9 18.4400	3 163.4400
NO,-N	62.0000	181.1210	243.1210
NO,-N	6 238.0000	2 254.4000	8 492.4000
Hg	n.i.	n.i.	n.i.
Cd	0.7400	0.3610	1.1010
CU	28.4000	60.8 150	89.2150
Zn	240.0000	300.2800	540.2800
Pb	2.7500	9.0320	1 1.7820

n.i. no information
not obligatory
[a] alternative
[2] BOD, derived from COD,,
[3] BOD, = TOC x 0.145

As a rule, all phosphorus and nitrogen compounds as well as COD,,, are measured in Swedish and Finnish rivers. Though the PLC-2 Guidelines provide for BOD,(or BOD,) to be measured,the concentration in the Swedish and Finnish rivers is so low, that it does not justify analyses. Heavy metals are also not measured in all rivers. The concentration of mercury is below the detection limit. In Sweden the flow of organic carbon in rivers was also measured in 1990.

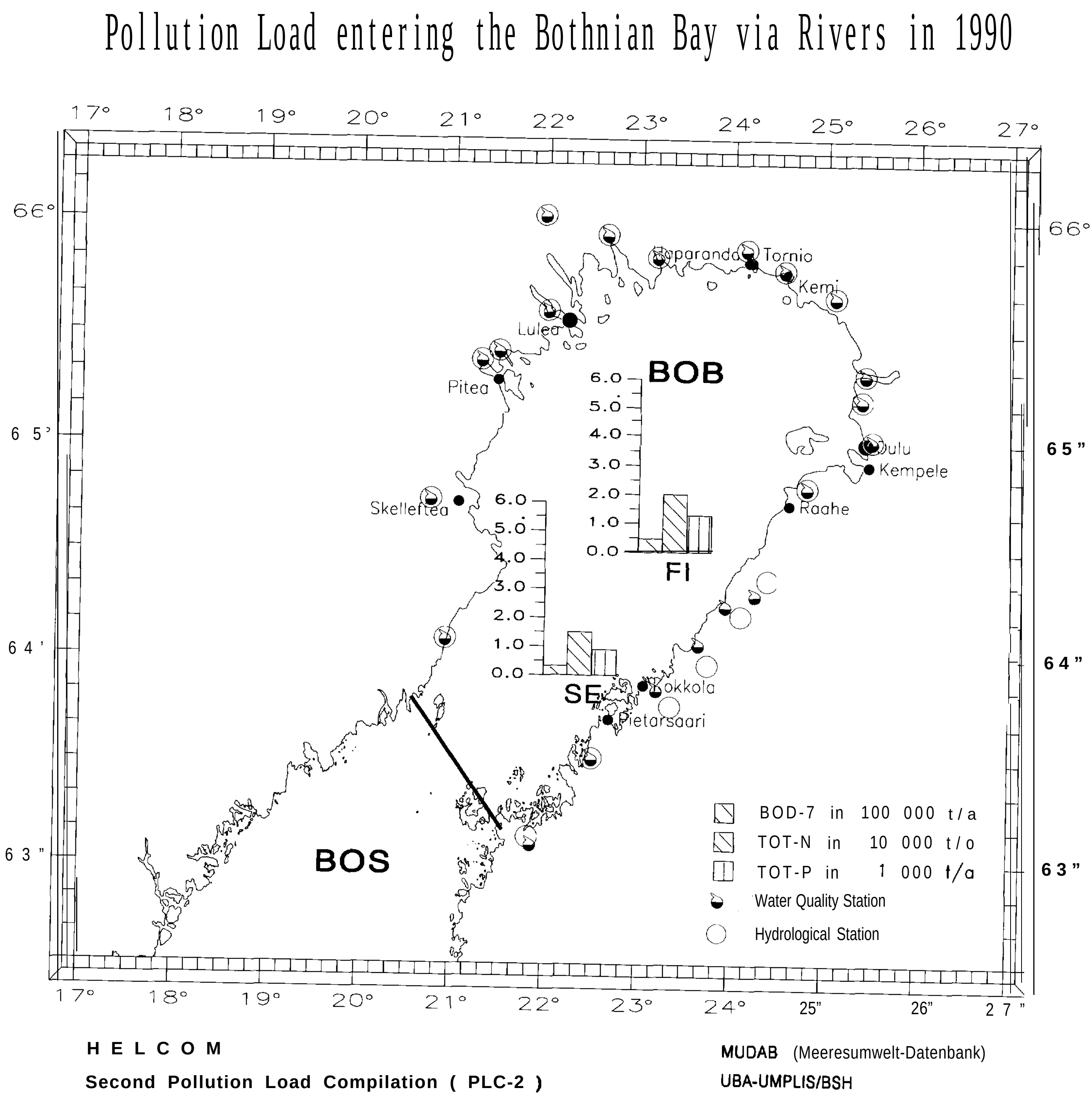


Fig. 4.1 Pollution Load entering the Bothnian Bay via Rivers in 1990

Pollution load entering the different sub-regions of the Baltic Sea

4.1.2 Pollution load from urban areas

On the coastal zone of the Bothnian Bay four Swedish and seven Finnish municipalities are situated, discharging their wastewaters directly into the Bay. The amount of wastewater is 36.45 million m^3/a from the Finnish side and 25.1 million m^3/a from the Swedish side (Table 4.3.). Only two cities, Oulu and Lulea, are bigger than 50000 inhabitants. All eleven municipalities have central purification plants. Six of them have biological-chemical treatment and five chemical treatment. The total amount of people served is 230 000 in Finland and 1.59 000 in Sweden.

Table 4.3

Municipalities discharging into the Bothnian Bay

Finland			
Municipalities	People served	Flow [10^6 m^3/a]	Treatment method
Tornio	14 700	3.50	m b c
Kemi	24 900	4.10	m b c
Oulu	102 400	17.80	c
Kempele	I4 800	I.35	c
Raahe	19 200	1.80	m b c
Kokkola	29 000	3.50	c
Pietarsaari	25 000	4.40	m b c
	230 000	36.45	
Sweden			
Municipalities	People served	Flow [IO” m^3/a]	Treatment method
Haparanda	I9 300	3.50	m b c
Lulea	67 000	10.10	c
Pitea	25 000	5.00	c
Skelleftea	48 000	6.50	m b c
	159 300	25.10	

m mechanical treatment
b biological treatment
c chemical treatment

The load of total phosphorus, total nitrogen, organic matter and heavy metals into the Bothnian Bay from Finnish and Swedish urban areas are presented in Table 4.4. and in Figure 4.2. Finland has not presented data on chemical oxygen demand (COD,,.) and ammonium nitrogen.

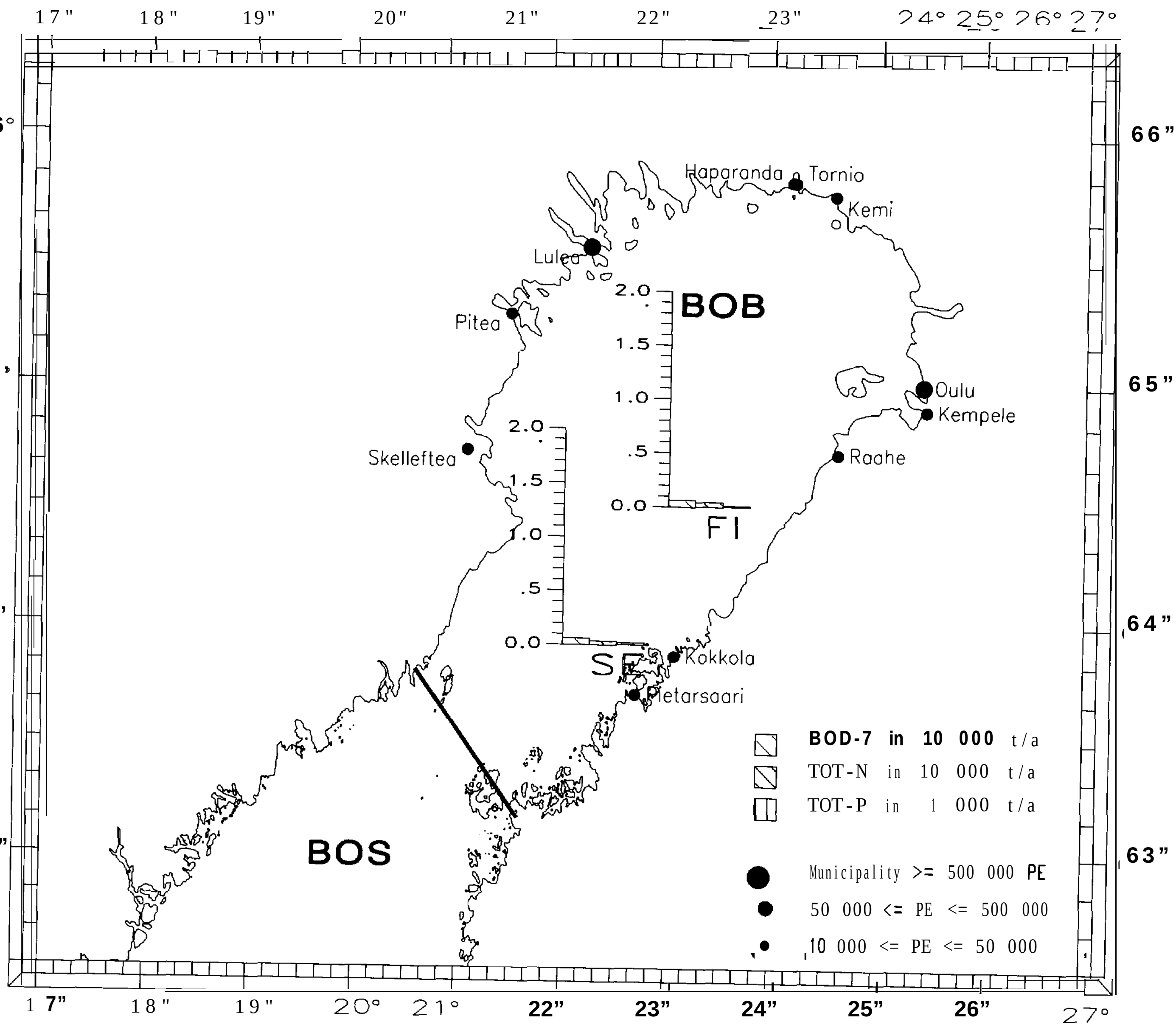
Table 4.4

Pollution Load entering the Bothnian Bay from Urban Areas in 1990 t/a

Determinants	Finland	Sweden	Sum
Q [$10^6 m^3/a$]	36.4500	25.1000	61.5500
BOD_5*	n.i.	n.i.	n.i.
BOD,	1 435.5000	1 295.0000	2 730.5000
BOD_{21}*	n.i.	n.i.	n.i.
TOC*	n.i.	n.i.	n.i.
COD,,.	9 450.0000	3 133.0000	12 583.0000
COD_{Mn}*	n.i.	n.i.	n.i.
Tot-P	17.5000	31.7000	49.2000
Tot-N	999.5000	630.0000	1 629.5000
NH,-N	n.i.	378.0000	> 378.0000
Hg	0.0100	0.0013	0.0113
Cd	0.0020	0.0090	0.0110
cu	0.1500	0.2200	0.3700
Zn	1.0000	0.7700	1.7700
Pb	0.0500	0.0440	0.0940
Number of urban areas	7	4	11

n.i. no information
not obligatory

Pollution Load entering the Bothnian Bay from Urban Areas in 1990



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Second Pollution Load Compilation (PLC-2)

MUDAB (Meeresumwelt-Datenbank)

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Fig. 4.2 Pollution Load entering the Bothnian Bay from Urban Areas in 1990

4.1.3 Pollution load from industries

The Bothnian Bay coastal area is not very heavily industrialized. Seventeen factories are reported to discharge their wastewater directly into the Bay by Finland and Sweden (Table 4.5.). In 1990 one of the three Finnish pulp and paper mills treated their wastewater only mechanically. while two were equipped with an activated sludge plant. The other branch of significance in Finnish industry is steel industry with load of inorganic substances and the main attention concerning the treatment is paid to internal measures and recirculation. A cokery which is connected to the steel plant is using activated sludge treatment.

In the Swedish Ronnskar Metal Works the wastewaters are treated chemically using sulphids and lime for metal precipitation. Steel works in Lulea are using circulation. sedimentation and biological purification. Two food-fibre industries use only mechanical treatment and the other two use internal methods (recirculation) with subsequent sedimentation or aerated lagoons.

Table 4.5

Industries discharging directly into the Bothnian Bay

Finland			
Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Wood-fibre	Wisaforest	b	52.5600
Mineral	Pohjanmaan Sora	m	0.0030
Food processing	5 plants	m b c	0.1280
Metal works	Outokumpu, Tornio	m c i	14.2120
Wood-fibre	Metsae-Botnia, Kemi	m	47.3560
Wood-fibre	Vetsiluoto, Kemi	b m	44.2290
Chemical	Kemira, Kokkola	i	44.7200
Steel	Rautaruukki, Raabe	m b	134.9560
Metal works	Outokumpu, Kokkola	m c	5.1000
Fish farms	**26** plants	wt	n.i.
Sum			> 343.2640
Sweden			
Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Wood-fibre	Karlsborg	b r	26.6000
Fish farms	n.i.	wt	n.i.
Wood-fibre	Munksund	m r	9.8000

Sweden			
Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Metal works Wood-fibre Wood-fibre Steel works	Ronnskar Lovholmen Bure SSAB, Lulea	c m m m b r	I.3000 13 .0000 1.2000 4%.1000
Sum			> 100.0000
Total			> 443.2640

wt without treatment
m mechanical treatment
b biological treatment
c chemical treatment
i internal treatment
r recirculation

Summarized load data are presented in Table 4.6. and in Figure 4.3.

Table 4.6

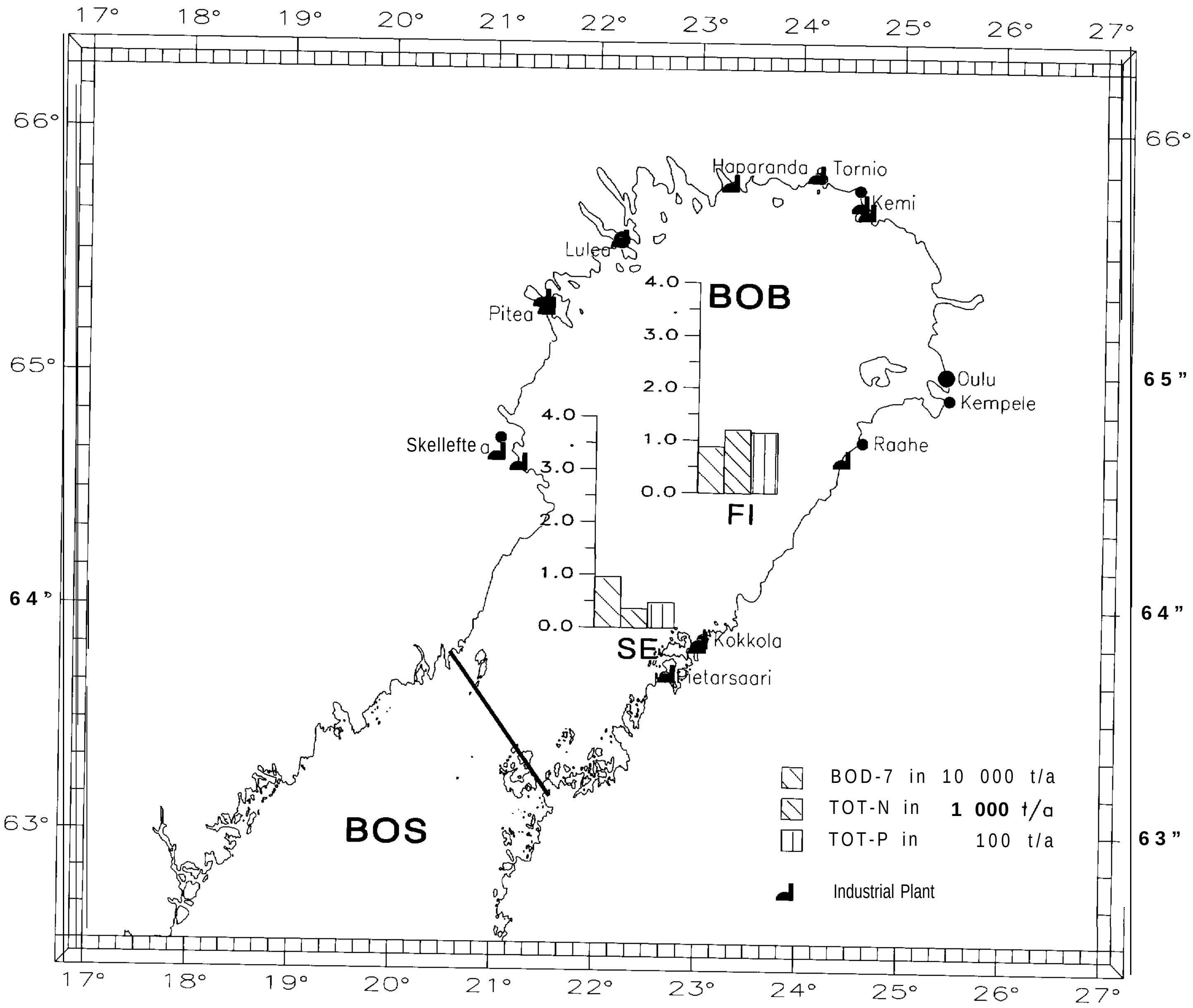
Pollution Load entering the Bothnian Bay from Industries in 1990
t/a

Determinants	Finland	Sweden	Sum
Q [$10^6 m^3/a$]	343.2640	100.0000	443.2640
BOD_5 *	n.ı.	n.i.	n.i.
BOD,	8 932.0000	9 525.0000	18 457.0000
BOD_{21} *	n.ı.	n.i.	n.i.
TOC *	n.i.	n.i.	n.i.
COD,,	70 573.0000	33 815.0000	104 388.0000
COD,,,,,, *	n.i.	n.ı.	n.i.
Tot-P	114.9190	47.2000	162.1190
Tot-N	1 206.4260	36 I .0000	1 567.4260
NH,-N	n.ı.	n.i.	n.i.
Hg	0.0060	0.0300	0.0360
Cd	0.0260	0.1700	0.1960
c u	0.6000	3.4000	4.0000
Zn	12.5940	16.4000	28.9940
Pb	n.i.	1.9400	> 1.9400
Numbers of plants	10	7	17

not obligatory
n.i. no information

In 1990 the main load of organic matter and phosphorus into the Bothnian Bay came from the pulp and paper industry. Steel industries and metal works constituted the main part of nitrogen load. Heavy metal load was measured mainly from metal works and steel industries.

Pollution toad entering the Bothnian Bay from Industries in 1990



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Second Pollution Load Compilation (PLC-2)

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Fig. 4.3 Pollution Load entering the Bothnian Bay from Industries in 1990

Pollution load entering the different sub-regions of the Baltic Sea

4.2 Bothnian Sea

4.2.1 Pollution load via rivers

The Bothnian Sea is the southern part of the Gulf of Bothnia. The southern border of the Bothnian Sea is on the imaginary line SIMPNAS KLUBB - SÖDERARM - SVENSKA BJÖRN - KOKASÖREN - NYHAMN - SALSKAR - UUSIKAUPUNKI.

The long-term mean flow of freshwater into the Bothnian Sea is 85 km^3 per year. About $^2/_3$ of it is of Swedish origin.

The size of the drainage area of the Bothnian Sea is 219 100 km’ , of which 180 100 km’ belong to Sweden and 39 000 km’ belong to Finland.

Information about the drainage areas and the hydrologically controlled areas is presented in Table 4.7. About 87% of the drainage area are hydrologically controlled in both Sweden and Finland.

Table 4.7

Information about the drainage area of the Bothnian Sea

	Finland	Sweden	Total
Drainage area [km’]	39 000	180 100	219 100
Drainage area of the reported rivers with measured flow [km’]	26 996	156 485	183 481
Number of reported rivers	2	12	14

The total load entering the Bothnian Sea in 1990 is presented in Table 4.8. and in Figure 4.4.

In 1990, all rivers were monitored 12 times in Sweden and up to 15 times in Finland. In most cases, the hydrological stations and the water quality stations are situated in the same place. If located seperately, the hydrochemical stations are situated closer to the sea. Due to that the hydrochemically controlled area might be a little bit bigger than the hydrologically controlled area .

As a rule, the oxygen demand in river water in Finland and in Sweden is monitored as COD,, but not as BOD,. Thus Finland and Sweden presented BOD, load data calculated on the basis of COD,,, or TOC. Data about mercury discharges are lacking, too. The concentration of mercury was very often close to the detection limit.

Table 4.8

Pollution Load entering the Bothnian Sea via Rivers in 1990
t/a

Determinants	Finland	Sweden	Sum
Q [m^3/s]	284.3000	2 593.5700	2 877.8700
BOD_5 [a]	n.i.	n.i.	n.i.
BOD,	29 870.0000’	58 666.1 300[3]	88 536.1300
BOD_{21} [a]	n.i.	n.i.	n.i.
TOC”	n.i.	404 594.0000	> 404 594.0000
s s	233 670.0000	n.i.	> 233 670.0000
COD,..	n.i.	n.i.	n.i.
COD,,,”	152 100.0000	1 865 656.0000	2 017 756.0000
Tot-P	763.9000	1 086.7400	1 850.6400
PO,-P	332.4000	164.7260	497.1260
Tot-N	17 160.0000	25 825.0000	42 985 .0000
NH,-N	945 .oooo	802.0500	1 747.0500
NO,-N	8 1 .0000	273.0040	354.0040
NO,-N	7 939.0000	6 170.7000	14 109.7000
Hg	n.i.	n.i.	n.i.
Cd	0.6400	1.0340	1.6740
cu	78.2000	152.8 130	231.0130
Zn	179.6000	809.6300	989.2300
Pb	3.3500	37.7060	4 1.0560

n.i. no information

not obligatory

[a] alternative

[7] BOD, derived from COD,,,

[3] BOD, = TOC x 0.145

Pollution toad entering the Bothnian Sea and the Archipelago Sea via Rivers in 1990

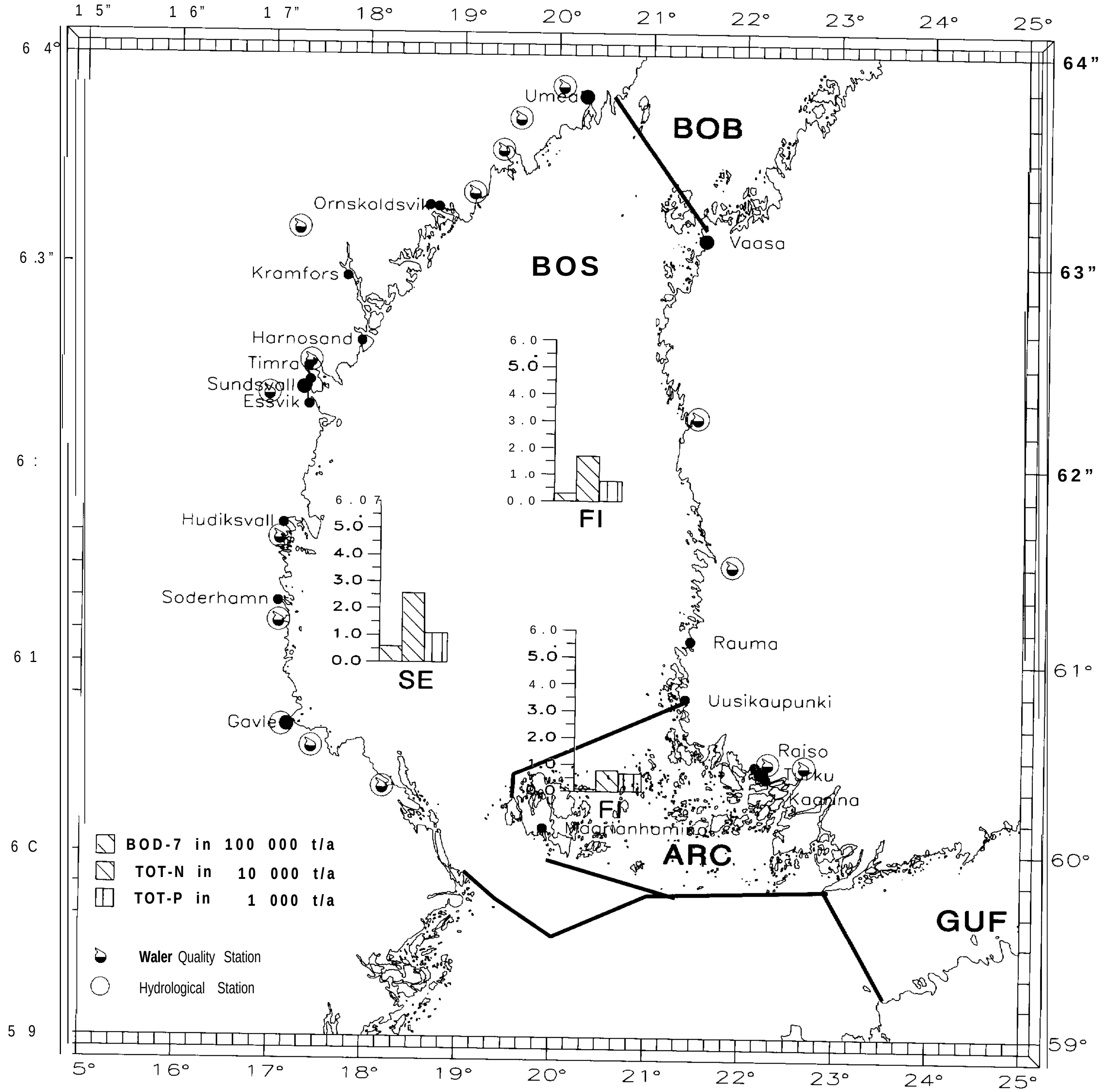

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Fig. 4.4 Pollution Load entering the Bothnian Sea and the Archipelago Sea via Rivers in 1990

4.2.2 Pollution load from urban areas

Two Finnish and twelve Swedish cities with a size bigger than 10 000 inhabitants, discharging their wastewater directly into the sea, are situated on the coastal area of the Bothnian Sea. One Finnish and three Swedish cities are bigger than 50 000 inhabitants (Table 4.9).

Three Swedish cities purify their wastewater biologically. Others, including two Finnish cities, are using biological-chemical purification systems.

Pollution load to the sea is presented in Table 4.10 and in Figure 4.5. Unfortunately, load data about ammonium-nitrogen and heavy metals were not presented by Finland.

Table 4.9

Municipalities discharging into the Bothnian Sea

Finland			
Municipalities	People served	Flow 10^6 m^3/a	Treatment method
Vaasa	54 100	7.00	m b c
Rauma	32 500	3.80	m b c
	86 600	10.80	
Sweden			
Municipalities	People served	Flow 10^6 m^3/a	Treatment method
Umea	62 600	8.80	m b
Ornskoldv 1	15 200	2.00	m b c
Ornskoldv 2	14 600	3.00	m b c
Kramfors	10 100	3.70	m b
Harnosand	21 100	3.20	m b c
Timra	11 000	1.30	m b c
Sundsvall 1	70 000	6.90	m b c
Sundsvall 2	23 000	5.10	m b
Essvik	13 000	2.80	m b c
Hudiksvall	20 600	4.30	m b c
Soderhamn	16 500	3.20	m b c
Gavle	88 000	15.00	m b c
	365 700	59.30	

m mechanical treatment
b biological treatment
c chemical treatment

Table 4.10

Pollution Load entering the Bothnian Sea from Urban Areas in 1990
t/a

Determinants	Finland	Sweden	Sum
Q [$10^6 m^3$/a]	10.8000	59.3000	70.1000
BOD_5*	n.i.	n.i.	n.i.
BOD,	173.3000	882.0000	1 055.3000
BOD_{21}*	n.i.	n.i.	n.i.
TOC*	n.i.	n.i.	n.i.
COD_{Cr}	900.0000	3 647.0000	4 547.0000
COD,,'	n.i.	n.i.	n.i.
Tot-P	8.8000	47.2000	56.0000
Tot-N	292.6000	1 106.0000	1 398.6000
NH,-N	n.i.	664 .0000	> 664.0000
Hg	n.i.	0.0030	> 0.0030
Cd	n.i.	0.0060	> 0.0060
Cu	n.i.	0.4800	> 0.4800
Zn	n.i.	2.0800	> 2.0800
Pb	n.i.	0.0480	> 0.0480
Number of urban areas	2	12	14

n.i. no information
* not obligatory

Pollution toad entering the Bothnian Sea and the Archipelago Sea from Urban Areas in 1990

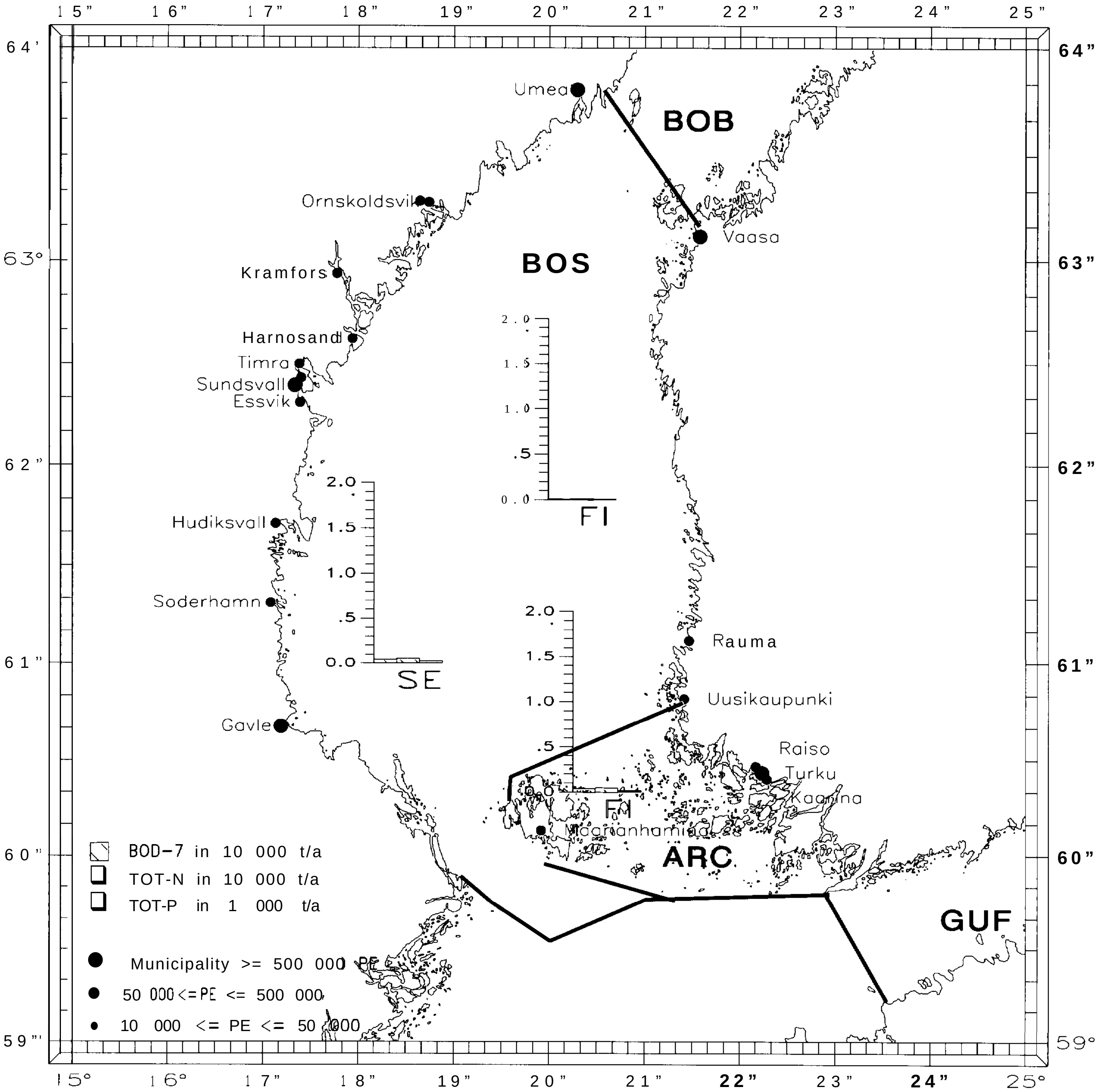

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Fig. 4.5 Pollution Load entering the Bothnian Sea and the Archipelago Sea from Urban Areas in 1990

4.2.3 Pollution load from industries

The main industries discharging wastewater into the sea are pulp and paper mills. There are two mills in Finland and fifteen ones in Sweden, which are located on the coast of the Bothnian Sea.

The chemical industry is also important. In the coastal area of the Bothnian Sea there are six enterprises in Finland of which two are big. In Sweden there are five smaller ones.

The big flow of cooling water used at the Finnish powerplants is also monitored, but the impact is mainly caused by an increase of temperature.

The impact from the other industries is negligible. Information about flow, treatment methods and location of the plants are presented in Table 4.11.

Table 4.11

Industries discharging directly into the Bothnian Sea

Finland			
Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Chemical	Rauma	m	0.05 10
Chemical	Kemira, Uusikaup.	c i	25.7600
Fish farms	33 plants	wt	n.i.
Wood-fibre	YTP, Rauman Paperi	m b	29.1 020
Chemical	Kemira, Vaasa	ph i	0.0470
Wood-fibre	Metsae-B, Kaskinen	b	20.1770
Chemical	Kemira, Vuorikernia	m i	42.7720
Chemical	Suni-Kas	i	n.i.
Surface treatment plant	2 plants	c	0.8920
Power plants	6 plants	m	2 097.9930
Food processing	2 plants	b	0.0070
Chemical	Wiik & Hoeglund	wt	0.6300
Sum			> 2 217.4310

Sweden			
Branch of industry	Name	Treatment method	Flow 10" m^3/a
Wood-fibre	Obbola	i	17.3000
Wood-fibre	Husum	i m	56.0000
Chemical	Berol Nobel 1	b	15.4000
Chemical	Berol Nobel 2	c	0.1200
Wood-fibre	Domsjo	b m i	38.0000
Chemical	Domsjo Klor	c	0.1000
Wood-fibre	Dynas	i c m	13.3000
Wood-fibre	Utansjo	m	3.6000
Wood-fibre	Ostrand	i m	39.9000
Chemical	Casco Nobel	i c	0.2600
Wood-fibre	Ortviken	b	11.8000
Wood-fibre	Iggesund	b	40.3000
Wood-fibre	Sandarne	m i	1 1.5000
Chemical	Bergvik Kemi	c	0.3400
Wood-fibre	Vallvik	i	19.0000
Wood-fibre	Norrsundet	i c	15.3000
Wood-fibre	Skutskar	i	50.0000
Wood-fibre	Hallstavik	i	10.7000
Electronics	Ericsson	c	0.0400
Wood-fibre	Sofiehem	c	2.6000
Wood-fibre	Wifstavarv	m	2.3000
Fish farms	n.i.	wt	n.i.
Sum			> 347.8600
Total			> 2 565.29 10

wt without treatment
m mechanical treatment
b biological treatment
c chemical treatment
i internal treatment
Ph physical treatment(activated carbon)
n.i. no information

The effluents from the Finnish pulp and paper mills are treated biologically. The other industry of significance is mainly inorganic and the wastewaters were treated chemically or mechanically. The main attention has been paid on internal measures and circulation of wastewaters.

The Swedish pulp and paper mills are in most cases using internal treatment method, chemical purification and, in few cases, biological treatment. Chemical and electronic industry use mainly chemical treatment; only two industries are equipped with biological treatment.

The summarized pollution load that entered the Bothnian Sea in 1990 is presented in Table 4.12 and in Figure 4.6. The main polluter of the Bothnian Sea is the pulp and paper industry, contributing the main part of organic, phosphorus and nitrogen load. The load from the chemical industry consists mainly of heavy metals and nutrients. Fishfarming plays an important rôle in regard to phosphorus and nitrogen load.

Table 4.12

Pollution Load entering the Bothnian Sea from Industries in 1990
t/a

Determinants	Finland	Sweden	Sum
Q [$10^6 m^3/a$]	2 217.4310	347.8600	2 565.2910
BOD_5	n.i.	n.i.	n.i.
BOD,	7 211.0000	51 087.0000	58 298.0000
BOD,,	n.i.	n.i.	n.i.
TOC	n.i.	n.i.	n.i.
COD,,	39 267.0000	188 055.0000	227 322.0000
COD_{Mn}	n.i.	n.i.	n.i.
Tot-P	103.1570	252.7000	355.8570
Tot-N	515.9840	2 581.0000	3 096.9840
NH,-N	n.i.	n.i.	n.i.
Hg	0.0080	0.0030	0.0110
Cd	0.0210	n.i.	> 0.0210
Cu	2.0630	0.0200	2.0830
Zn	102.7810	0.2800	103.0610
Pb	0.9930	n.i.	> 0.9930
Numbers of plants	12	22	34

not obligatory
n.i. no information

Pollution Load entering the Bothnian Sea and the Archipelago Sea from industries in 1990

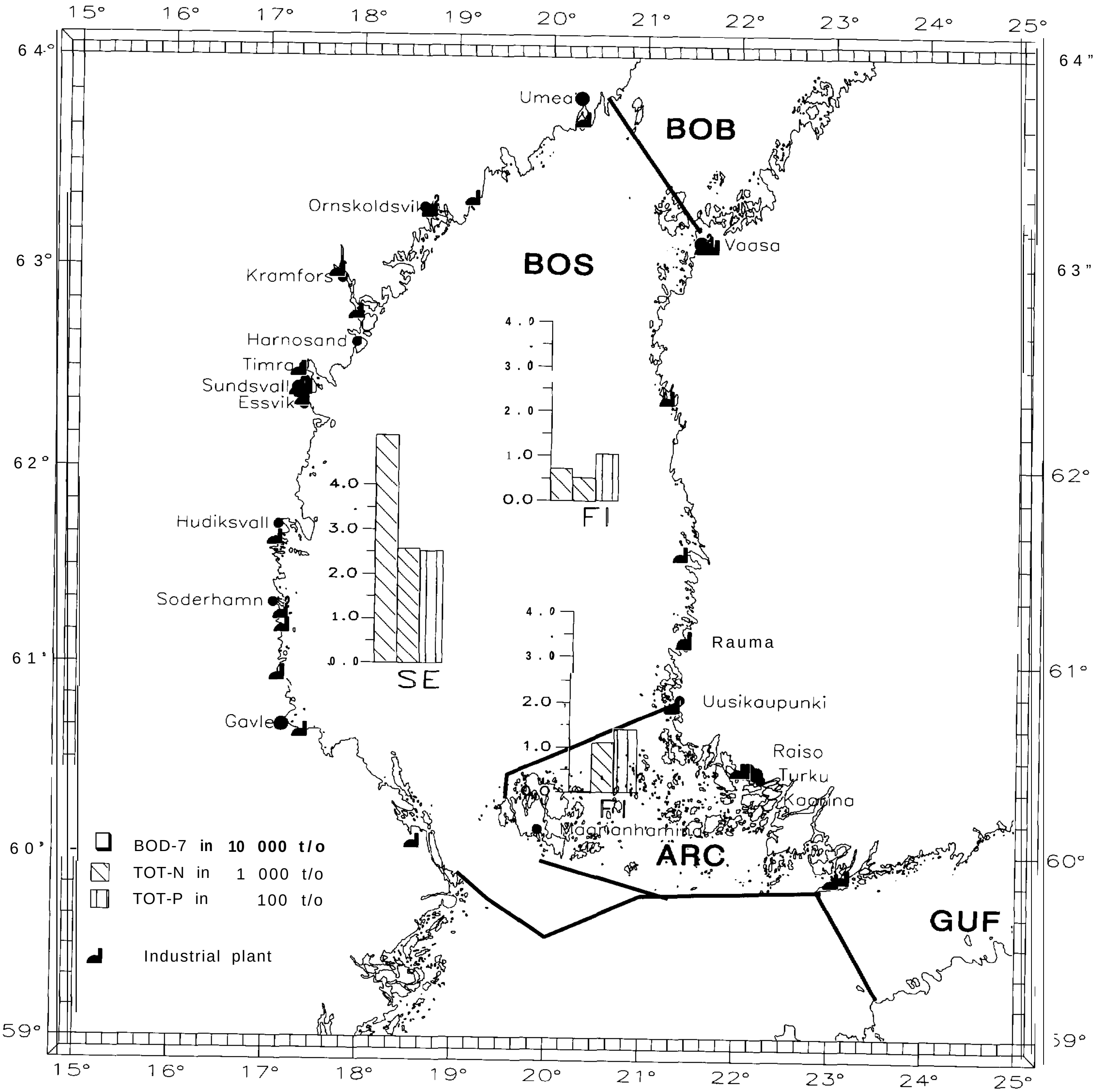

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Fig. 4.6 Pollution Load entering the Bothnian Sea and the Archipelago Sea from Industries in 1990

Pollution load entering the different sub-regions of the Baltic Sea

4.3 Archipelago Sea

4.3.1 Pollution load via rivers

The Archipelago Sea is situated between the Bothnian Sea and the Baltic Proper. The border between the Archipelago Sea and the Baltic Proper is on the imaginary line NYHAMN-KÖKARSÖREN-HANGÖ PENINSULA.

The Archipelago Sea is situated within the Finnish borders. The drainage area of the Archipelago Sea is 9000 km^2 and mainly consists of islands and a coast with small rivers. The hydrologically controlled part of the drainage area amounts only to 28%, the long-term mean flow is 85 m^3/s.

The main rivers discharging into the Archipelago Sea are the River Aura and the River Paimion. Detailed information about the drainage area is presented in Table 4.13.

Table 4.13

Information about the drainage area of the Archipelago Sea

	Finland
Drainage area [km’] Drainage area of the reported rivers with measured flow [km’]	9 000 1517
Number of reported rivers	2

The hydrochemically controlled part is bigger than the hydrologically controlled one, because the water quality station in the River Paimion is situated 16 km closer to the sea than the hydrological station. The pollution load entering the Archipelago Sea via rivers is presented in Table 4.14 and in Figure 4.4. Organic load is measured only as COD,,,, BOD, load is calculated. An estimate for mercury load is lacking. The other heavy metals are measured only in the River Aura.

Table 4.14

Pollution Load entering the Archipelago Sea via Rivers in 1990
t/a

Determinants	Finland
Q [m^3/s]	26.6000
BOD_5*	n.i.
BOD,	7 780.0000’
BOD_{21}[a]	n.i.
TOC”	n.i.
s s	300 600.0000
COD,,.	n.ı.
COD,,,”	29 600.0000
Tot.-P	664.0000
PO,-P	449.0000
Tot.-N	7 870.0000
NH,-N	425 .0000
NO,-N	52.0000
NO,-N	5 648.0000
Hg	n.i.
Cd	0.0200
c u	2.1000
Zn	9.6000
Pb	0.3000

n.i. no information
[a] alternative
not obligatory
[2] BOD, derived from COD,,,

Pollution toad entering the Bothnian Sea and the Archipelago Sea via Rivers in 1990

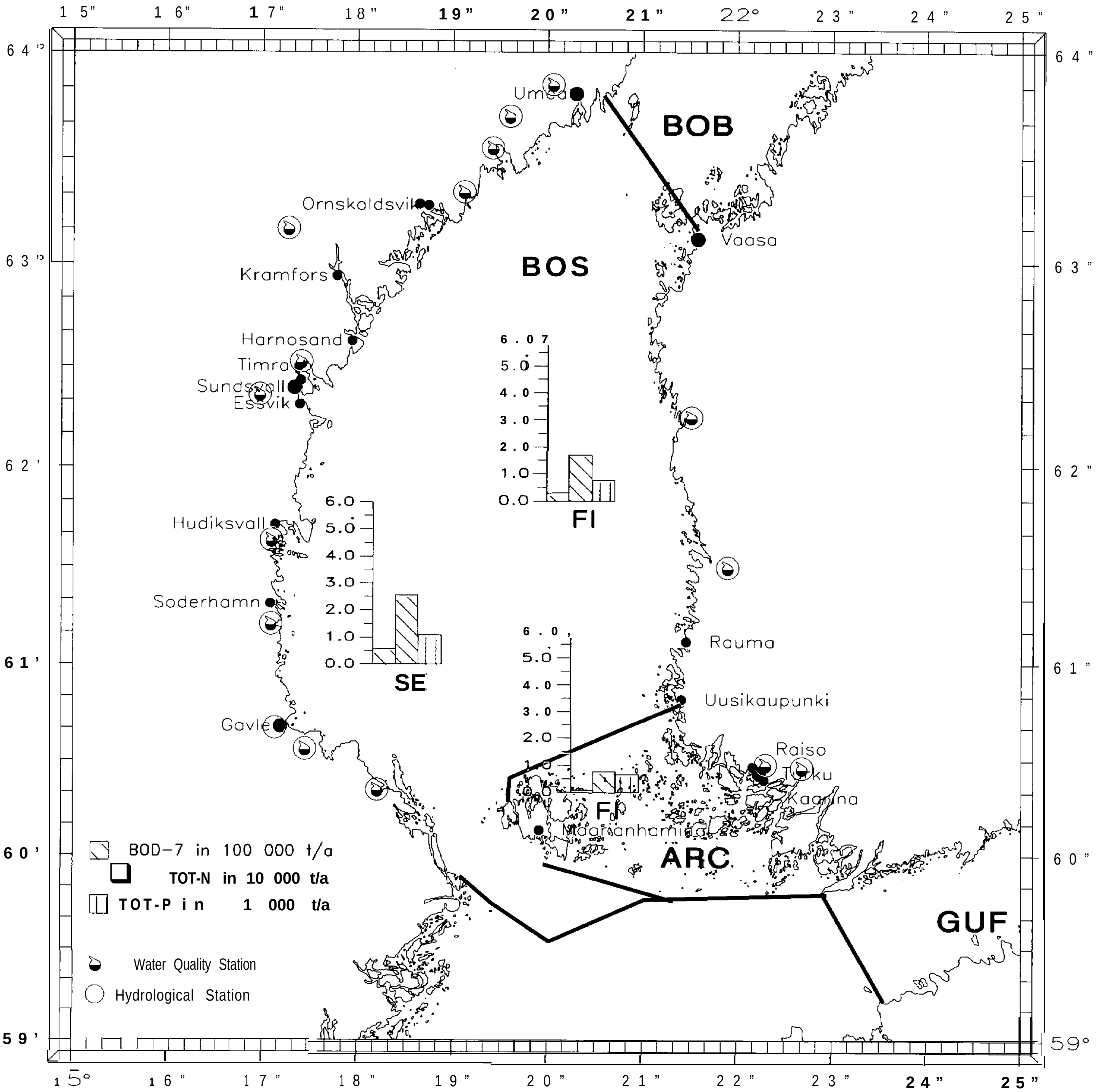

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Fig. 4.4 Pollution load entering the Bothnian Sea and Archipelago Sea via Rivers in 1990

4.3.2 Pollution load from urban areas

Five cities with a total population of 211 900 inhabitants are situated in the coastal area of the Archipelago Sea. The sewage of these municipalities is treated biologically-chemically with the exception of Uusikaupunki. Here. the sewage is treated chemically (Table 4.15).

Table 4.15

Municipalities discharging into the Archipelago Sea

Finland			
Municipalities	People served	Flow $10^6\ m^3/a$	Treatment method
Uusikaupunki	13 200	2.60	c
Raisio	17 700	2.80	m b c
Turhu	13x 100	SO.40	m b c
Kaarina	32 900	3.10	m h c
Maarianhamina	10 000	3.10	m b c
	211 900	63.00	

m mechanical treatment
b biological treatment
c chemical treatment

Pollution load entering the Archipelago Sea from urban areas is presented in Table 4.16 and in Figure 4.5.

Ammonium-nitrogen load was not reported.

Table 4.16

Pollution load entering the Archipelago Sea from Urban Areas in 1990 t/a

Determinants	Finland
Q [$10^6 m^3/a$]	63.0000
BOD,	n.i.
BOD,	741.7000
BOD_{21}*	n.i.
TOC	n.i.
COD_{Cr}	3 100.0000
COD_{Mn}	n.i.
Tot:P	30.9000
Tot.-N	939.5000
NH,-N	n.i.
Hg	0.0090
Cd	0.0080
CU	0.5000
Zn	5.4000
Pb	0.7500
Number of urban areas	5

n.i. no information
* not obligatory

Pollution Load entering the Bothnian Sea and the Archipelago Sea from Urban Areas in 1990

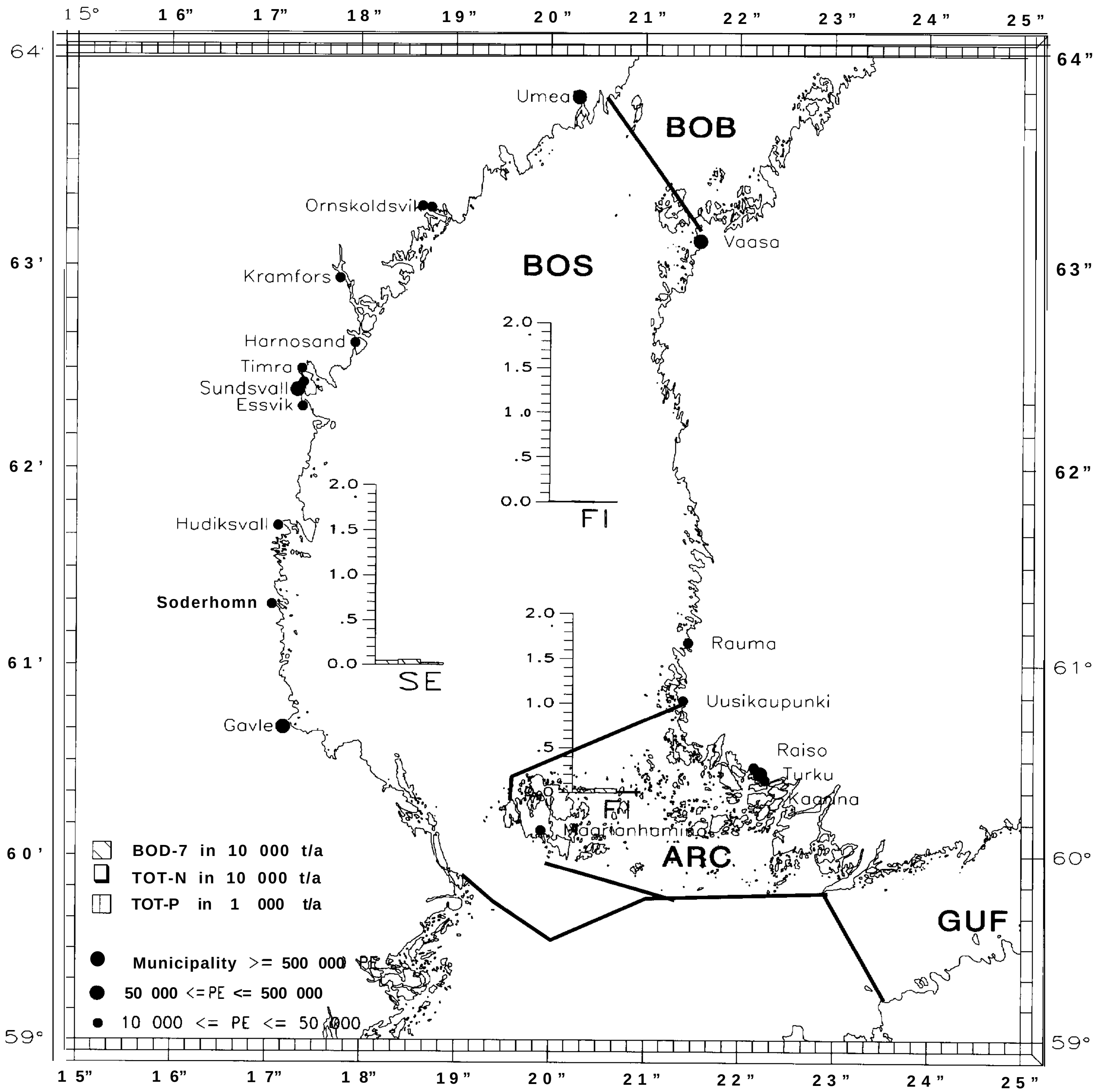

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Fig. 4.5 Pollution load entering the Bothnian Sea and the Archipelago Sea from Urban Areas in 1990

4.3.3 Pollution load from industries

In the drainage area of the Archipelago Sea there are some chemical industries, one oil refinery, surface treatment plants, food processing industry, mineral industry and one power plant . Around the island of Aland and in the area of the Archipelago Sea there are many fish farms (Table 4.17). More than 87% of the waste water flow originate from the power plants.

Table 4.17

Industries discharging directly into the Archipelago Sea

Finland			
Branch of industry	Name	Treatment method	Flow 10” m^3/a
Mineral	2 plants	m	0.9590
Oil refinery	Neste, Naantali	m b c	15.4930
Surface treatment plant	4 plants	c	1.5530
Power plants	TVO, Naantali	m	155.4260
Chemical	Visko	b	0.2600
Food processing	10 plants	m b c	3.1200
Chemical	Forcit	m c	0.3400
Fish farms	120 plants	wt	n.i.
Chemical	Mobiloil	m	0.0170
Sum			> 177.1680

wt without treatment
m mechanical treatment
b biological treatment
c chemical treatment

The pollution load that entered the Archipelago Sea in 1990 from industries is presented in Table 4.18 and in Figure 4.6.

The main pollution problem in this area is caused by nutrients: the inputs from fish farming are more significant than the inputs from industry in this area.

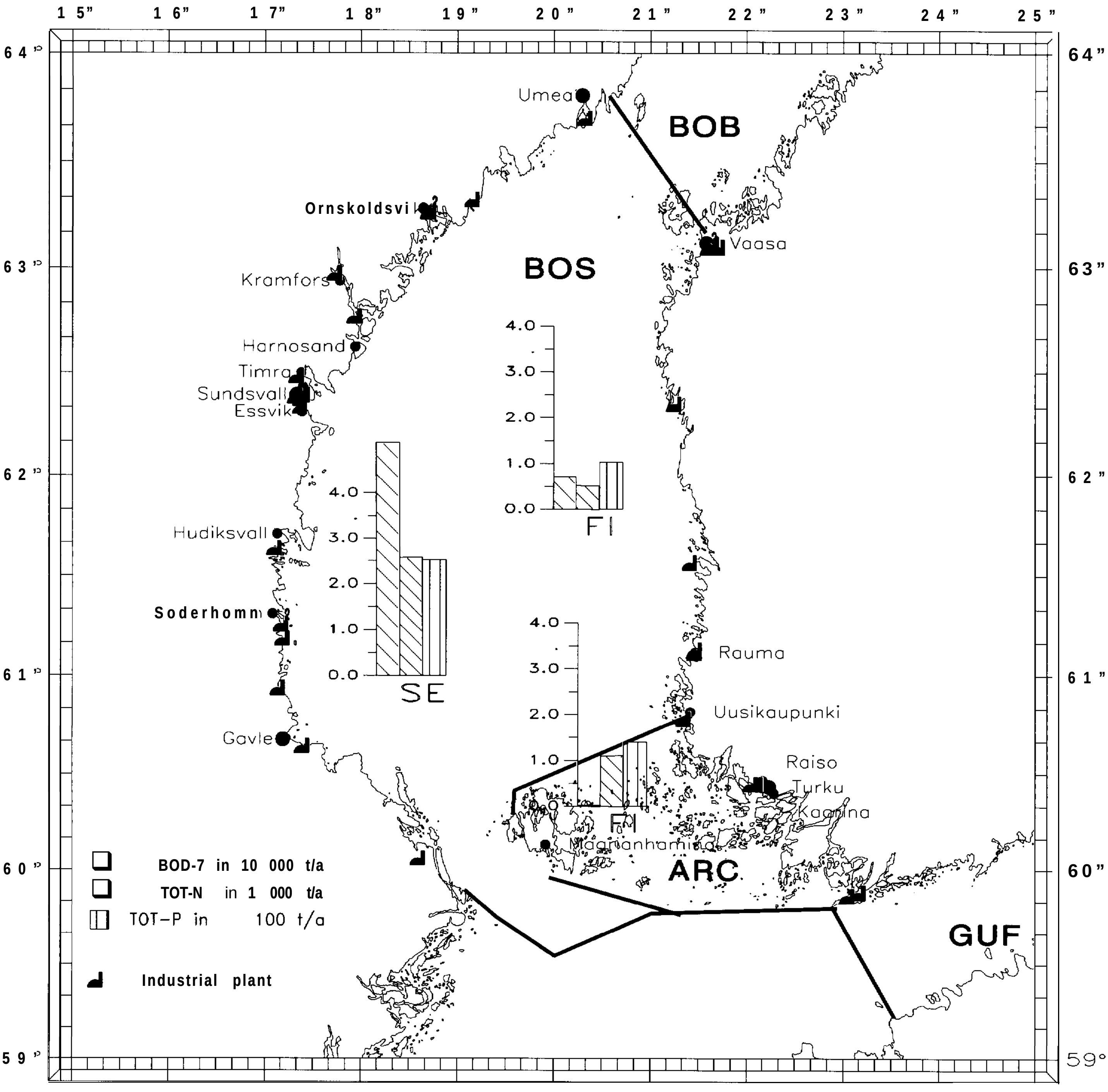
Table 4.18

Pollution load entering the Archipelago Sea from Industries in 1990 t/a

Determinants	Finland
Q [$10^6 m^3/a$]	177.1680
BOD_5*	n.i.
BOD,	202.0000
BOD_{21}*	n.i.
TOC*	n.i.
COD_{Cr}	560.0000
COD,,,:'	n.i.
Tot-P	139.5300
Tot-N	1 101.0960
NH,-N	25.8480
Hg	n.i.
Cd	n.i.
cu	0.3220
Zn	0.5700
Pb	0.0140
Numbers of plants	9

not obligatory
n.i. no information

Pollution Load entering the Bothnian Sea and the Archipelago Sea from Industries in 1990



H E L C O M

Second Pollution Load Compilation (PLC-2)

MUDAB (Meeresumwelt-Datenbank)

UBA-UMPLIS/BSH

Fig. 4.6 Pollution load entering the Bothnian Sea and the Archipelago Sea from Industries in 1990

4.4 Gulf of Finland

4.4.1 Pollution load via rivers

The Gulf of Finland is situated in the eastern part of the Baltic Sea. The border between the Baltic Proper and the Gulf of Finland is on the imaginary line PÖÖSASPEA - HÄNGÖ.

Detailed information about the drainage area of the Gulf of Finland is presented in Table 4.19 . Since most of the Finnish part of the drainage area is drained into the Gulf of Finland via Russian territory (Lake Ladoga - River Neva), Finland is controlling directly only about 41 300 km’ including the flow from Finland to the Lake Ladoga. Russia controls hydrologically the run-off from a bigger territory than the drainage area within its borders. On the other hand, some parts of the Russian and Latvian catchment areas belong to the drainage area of the Lake Chudskoe (Lake Peipsi). They are drained into the Gulf of Finland via the River Narva, which is controlled by Estonia.

Table 4.19

Information about the drainage area of the Gulf of Finland

	Finland	Russia	Estonia	Total
Drainage area [km^2]	107 300	276 100	26 400	409 800
Drainage area of the reported rivers with measured flow [km’]	41 275	228 950	21 545	291 770
Number of reported rivers	4	3	13	20

The hydrological and water quality stations are situated close to the river mouth, in a distance between 5 - 30 kilometers from the sea. An exception is the River Luga, where the hydrological station is situated 60 km from the sea.

In Finland and in Russia the water quality stations and the hydrological stations are situated in the same places, whereas in Estonia the water quality stations are situated closer to the sea. In 1990 the Finnish rivers were monitored 11-14 times per year. In Russia the Rivers Neva and Luga were controlled 12 times per year, the River Seleznevka 4 times per year.

In Estonia only three rivers are monitored 12 times per year. the other rivers are monitored 3 to 5 times per year.

The total pollution load entering the Gulf of Finland via rivers in 1990 is presented in Table 4.20 and in Figure 4.7.

The lack of data is a big problem. Estonia and Russia have not fulfilled the programme in full scale. Information about heavy metals from Estonia is totally missing. There is an evident need for the improvement of pollution load monitoring around the Gulf of Finland since this area is one of the most heavily loaded parts of the Baltic Sea.

Table 4.20

Pollution load entering the Gulf of Finland via Rivers in 1990
t/a

	Finland	Russia	Estonia	Sum
Q [m³/s]	429.0000	2 530.0000	696.7900	3 655.7900
BOD,:	n.i.	95 743 .oooo	34 792.4000	> 130 535.4000
BOD,	34 290.0000’	125 896.0000’	4 1 748.9000’	20 1 934.9000
BOD21[a]	n.i.	n.i.	n.i.	n.i.
TOC“	n.i.	n.i.	n.i.	n.i.
ss	14 1 800.0000	711 160.0000	26142 1 .OOOO	1 114 381.0000
COD,,.:‘	n.i.	n.i.	695 357.0000	> 695 357.0000
COD,,;	143 300.0000	2 291 780.0000	n.i.	> 2 435 080.0000
Tot-P	603.6000	5 320.0000	1 718.1000[6]	7 641.7000
PO,-P	187 .oooo	891.4100	521.4480	1 599.8580
Tot-N	17 260.0000	49 811.5000[4]	42 458.0000”	109 529.5000
NH,-N	766.0000	2 426.3100	1416.3570	4 608.6670
NO,-N	94.0000	705.1900	292.7700	1 091.9600
NO,-N	9 526.0000	46 680.0000	5 353.2400	6 1 559.2400
Hg	n.i.	14.9000	n.i.	> 14.9000
Cd	0.1900	16.1270	n.i.	> 16.3170
CU	24.5000	263.4800	n.i.	> 287.9800
Zn	12.2000	n.i.	n.i.	> 12.2000
Pb	2.2000	305.8600	n.i.	> 308.0600

n.i. no information
not obligatory
a alternative
1 $BOD_7 = BOD_5 \times 1.17$
2 BOD, derived from COD,,
3 Tot-N = NH,-N + NO,-N + NO,-N
6 Tot-N and Tot-P were calculated on the basis of the corresponding ratios of their inorganic compounds

4.4.2 Pollution load from urban areas

In the coastal area of the Gulf of Finland there are 24 cities bigger than 10 000 PE that discharge their wastewaters directly into the sea. Seven of them belong to Finland, nine to Russia and seven to Estonia. Three cities - Helsinki, St. Petersburg and Tallinn - have more than 500 000 inhabitants (Table 4.2 1).

Table 4.21

Municipalities discharging into the Gulf of Finland

Finland			
Municipalities	People served	Flow [$10^6 m^3/a$]	Treatment method
Kirkkonummi	14 500	1.70	m b c
Espoo	224 800	29.20	m b c
Helsinki	640 300	97.60	m b c
Porvoon mlk	14 200	1.80	m b c
Porvoo	20 300	3.50	c
Kotka	28 400	4.20	m b c
Hamina	17 300	n.i.	m b c
	959 800	> 138.00	
Russia			
Municipalities	People served	Flow [$10^6 m^3/a$]	Treatment method
Vyborg	< 500 000	12.30	m
Primorsk	< 50 000	0.70	m
Repino	< 50 000	3.00	m
Sestroretsk	< 50 000	6.33	m b
Kronstadt	< 50 000	24.00	m b 71% wt 29%
St. Petersburg	> 500 000	1 223.00	m b 63% wt 37%
Petrovorets	< 500 000	25.00	m b 72% wt 28%
Lomonosov	< 50 000	7.00	wt
Sosnovy Bor	< 50 000	1.20	m
		1 302.53	

Estonia			
Municipalities	People served	Flow [$10^6 m^3/a$]	Treatment method
Sillamae	20 700	4.32	m b
Kohtla-Jaerve	76 800	14.73	m b
Aseri	3 500	0.39	m
Kunda	5 000	0.93	m b
Loksa	4 300	0.67	m b
Maardu	16 300	6.27	m b
Tallinn	482 900	102.27	m c
	609 500	129.58	

wt without treatment
m mechanical treatment
b biological treatment
c chemical treatment

Most of the Finnish cities have biological-chemical purification, only Porvoo has chemical purification.

In Russia about 60% of the wastewaters of St. Petersburg are treated biologically. The remaining part is discharged without any purification into the Gulf of Finland. For the other seven cities either mechanical treatment or biological treatment was reported. The city of Lomonosow is discharging its wastewater into the Gulf of Finland without any treatment.

In Estonia the wastewaters of Tallinn are treated chemically, Aseri has mechanical treatment and the other cities have biological treatment.

Due to the significant amount of wastewaters and insufficient treatment degree, most of the pollution load into the Gulf of Finland originates from Russia. Information about the load from urban areas into the Gulf of Finland is presented in Table 4.22 and in Figure 4.8.

While the loads of organic matter and phosphorus are controlled more or less according to the Guidelines, the control of nitrogen in Russia and of heavy metals in Estonia and Russia is insufficient. The loads of heavy metals from Russia and Estonia are likely to be big due to numerous big industries connected to the sewers, especially in Russia.

Table 4.22

Pollution load entering the Gulf of Finland from Urban Areas in 1990
t/a

Determinants	Finland	Russia	Estonia	Sum
Q [$10^6 m^3/a$]	138.0000	1 302.5300	129.5810	1 570.1110
BOD_5*	n.i.	n.i.	n.i.	n.i.
BOD,	2 331.1000	5 1 648 .0000	16 048.1400	70 027.2400
BOD_{21}	n.i.	52 580.0000	n.i.	> 52 580.0000
TOC*	n.i.	n.i.	n.i.	n.i.
COD,,	11 750.0000	n.i.	n.i.	> 11 750.0000
COD,,*	n.i.	n.i.	n.i.	n.i.
Tot-P	103.6000	3 488.3060	486.2000	4 078.1060
Tot-N	4 369.1000	21 014.2000	4 661.7000	30 045.0000
NH,-N	n.i.	9 292.1000	2 076.0000	> 11 368.1000
Hg	0.0460	12.1500	n.i.	> 12.1960
Cd	0.0480	2.0000	n.i.	> 2.0480
Cu	2.0200	92.6000	33.0000	127.6200
Zn	12.0000	233.6600	20.9000	266.5600
Pb	0.4000	67.8300	19.7000	87.9300
Number of urban areas	7	9	7	23

n.i. no information
not obligatory

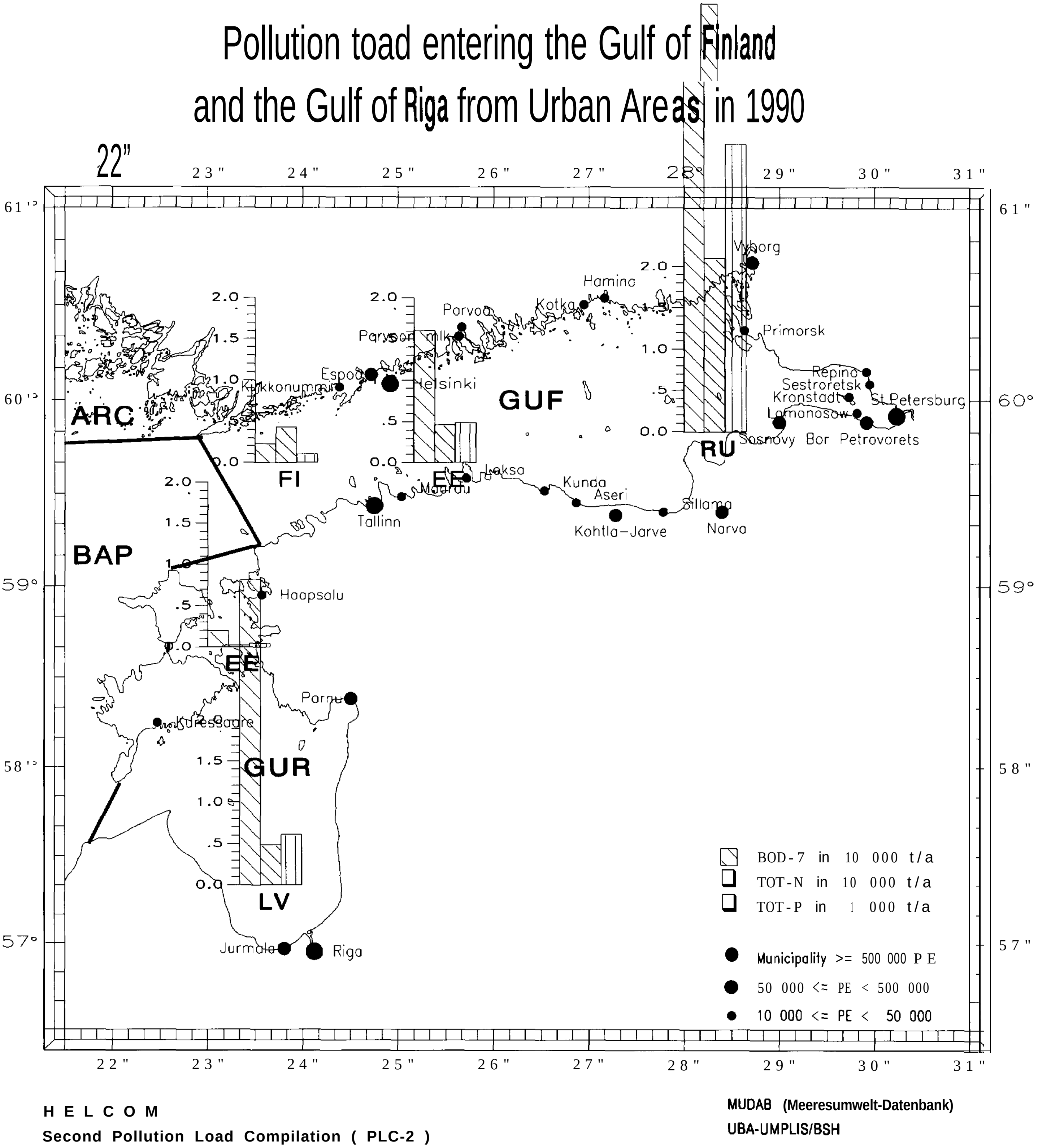


Fig. 4.8 Pollution load entering the Gulf of Finland and the Gulf of Riga from Urban Areas in 1990

4.4.3 Pollution load from industries

The coastal area of the Gulf of Finland is heavily industrialized. In Finland. as a rule, the industries are situated outside the municipalities and have their own wastewater treatment plants. In Russia and Estonia most of the industrial enterprises have their own local pretreatment facilities and are connected to the municipal sewerage systems.

The main industries which are discharging directly into the Gulf of Finland are presented in Table 4.23. The bigger part of these industrial discharges comes from Finland and the smallest part comes from Estonia.

Table 4.23

Industries discharging directly into the Gulf of Finland

Finland			
Branch of industry	Name	Treatment method	Flow [10^6 m^3/a]
Wood-fibre	Tamwood, Tolkkinen	wt	2.9830
Chemical	Neste, Jaeaehdytysv.	i	573.5850
Wood-fibre	Enso-Gutz, Summa	b	8.6190
Chemical	Shell, Store	m	0.0570
Wood-fibre	Keraeyskuitu Oy	m b	0.4230
Surface treatment plant	Nokia, Pikkala	c	0.5960
Chemical	Neste, Chem. Teolkk.	m i	0.0840
Chemical	Neste Alfa	m	0.0120
Chemical	Neste, Chem. Muovit	m c	1.4280
Chemical	Keofinn Oy	m	0.1230
Chemical	Neste, Polystreem	b m c	0.1110
Wood-fibre	Enso-Gutz	b m	17.3320
Chemical	Hangon Puhdistamo	b c	0.1480
Fish farms	26 plants	wt	n.i.
Oil refeneries	Neste, Oeljynjalost	ad b c	5.8640
Steel	Dalsbruk, Koverhar	m	26.9990
Power plants	6 plants	m	1 677.5120
Wood-fibre	YPT, Kotka	m	1.6580
Wood-fibre	Sunila Oy	m	40.1070
Food processing	4 plants	m b c	7.7210
Chemical	Esso, Store	m	0.0890
Sum			> 2 365.45 10

Russia			
Branch of industry	Name	Treatment method	Flow [I 0[6] m³/a]
Pulp and paper mill Shipbuilding Food Agriculture Food Textile Chemical Shipbuilding Pulp and paper mill Mechanical egineerin Fish Chemical Food	Vyborg (I) Vyborg (I) Vyborg (2) Leningrad region (16 St. Petersburg (2) St. Petersburg (1) St. Petersburg (4) St. Petersburg (4) St. Petersburg (3) St. Petersburg (9) Leningrad region (7) Kingisepp Ust-Luga (2)	b c 9% wt 91% wt b 92% wt 8% wt wt c 75% wt 25% c 89% wt 11% wt c 75% wt 25% m 24% wt 76% wt m 86% wt 14%	14.4000 0.3000 0.5000 9.3000 2.7000 3.0000 10.0000 9.1000 4.0000 161.8000 4.9000 1.6000 0.5000
Sum			222.1000
Estonia			
Branch of industry	Name	Treatment method	Flow [10” m³/a]
Fish Chemical Shipbuilding	Narva Sillamae Loksa	m wt m	0.1000 1.9000 0.2880
Sum			2.2880
Total			> 2 589.8390

wt without treatment
m mechanical treatment
b biological treatment
c chemical treatment
i internal treatment
ad adsorption

The small pulp and paper mills in the Kotka region had mainly mechanical treatment in 1990. Other organic wastewaters, discharged by the Finnish industry, are treated biologically. Inorganic waste-waters were treated chemically. Additionally great attention is paid to internal measures and adecrease in the amount of water consumption.

Estonian fish industry in Narva and ship building in Loksa treat their sewage mechanically. Sillamae chemical industry is discharging its industrial wastewater into the Gulf of Finland through a sedimentation pond .

Russian industries purify about 60% of their wastewaters chemically, 1% biologically. 9% mechanically and 30% of the wastewaters are not purified before discharging.

The Pollution load that entered the Gulf of Finland in 1990 from industries is presented in Table 4.24 and in Figure 4.9. The total pollution load from industries to the Gulf of Finland might be bigger than presented in this report due to insufficient control of heavy metals, organic matter, phosphorus and nitrogen load from Estonia and Russia.

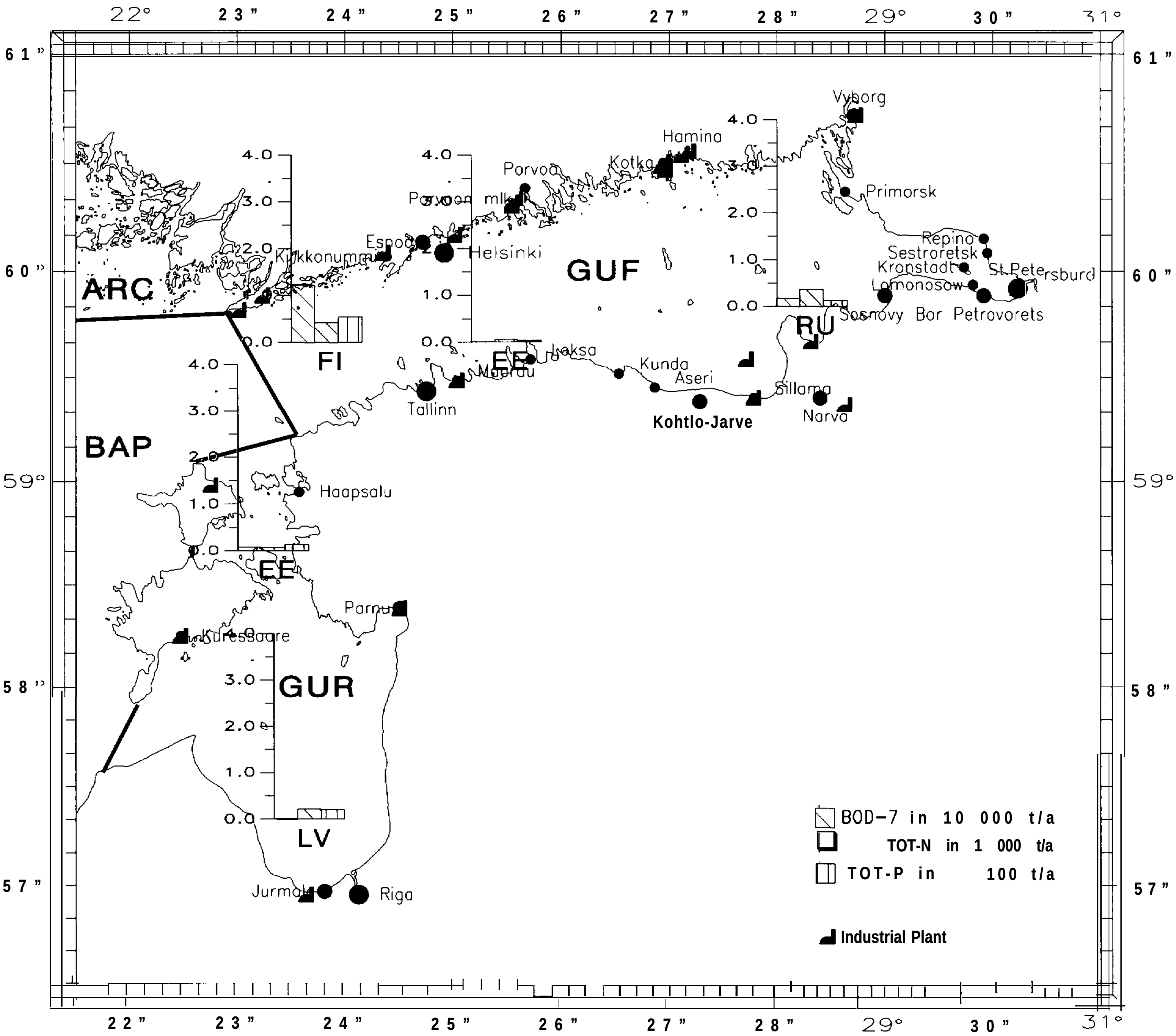
Table 4.24

Pollution load entering the Gulf of Finland from Industries in 1990 t/a

Determinants	Finland	Russia	Estonia	Sum
Q $[10^6 m^3/a]$	2 365.4510	222.1000	2.2880	2 589.8390
BOD_5*	n.i.	n.i.	n.i.	n.i.
BOD,	12 256.0000	1786.5000	281.3800	14 323.8800
BOD_{21}*	n.i.	n.i.	n.i.	n.i.
TOC*	n.i.	n.i.	n.i.	n.i.
COD_{Cr}	44 311.0000	n.i.	n.i.	> 44 311.0000
COD,,*	n.i.	n.i.	n.i.	n.i.
Tot-P	53.8150	12.8200	3.6600	70.2950
Tot-N	423.7550	375.8000	68.3500	867.9050
NH,-N	0.5120	260.0500	28.8300	289.3920
Hg	n.i.	n.i.	1.2000	> 1.2000
Cd	n.i.	0.0100	n.i.	> 0.0100
Cu	0.0200	14.1300	0.4600	14.6100
Zn	n.i.	0.2300	0.4100	> 0.6400
Pb	n.i.	n.i.	0.1800	> 0.1800
Numbers of plants	21	13	3	37

* not obligatory
n.i. no information

Pollution toad entering the Gulf of Finland and the Gulf of Riga from Industries in 1990



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Second Pollution Load Compilation (PLC-2)

MUDAB (Meeresumwelt-Datenbank)
UBA-UMPLIS/BSH

Fig. 4.9 Pollution load entering the Gulf of Finland and the Gulf of Riga from Industries in 1990

4.5 Gulf of Riga

4.5.1 Pollution load via rivers

The Gulf of Riga has three border lines with the Baltic Proper. The western boundary is on the imaginary line OVISI-SORVE, PAMMANA-SÖRU, the northern boundary is on the imaginary line PÖÖSASPEA-TAHKUNA. The Moonsund belongs to the Gulf of Riga. The drainage area of the Gulf of Riga is 127 400 km' and it is divided between Estonia, Latvia, Lithuania and the upper part is shared by Russia and Belarus.

Detailed information about the division of the drainage area of the Gulf of Riga are presented in Table 2.2. The number of rivers as well as the hydrologically and hydrochemically controlled areas are presented in Table 4.25.

Table 4.25

Information about the drainage area of the Gulf of Riga

	Estonia	Latvia	Total
Drainage area [km']	17 600	48 500	66 100
Drainage area of the reported rivers with measured flow [km']	7 790	105 518	113 308
Number of reported rivers	2	4	6

The Estonian part of the drainage area is covered with a network of small rivers of which only two are controlled hydrologically and hydrochemically. 50% of the drainage area are not controlled. The main rivers discharging into the Gulf of Riga belong to Latvia. The biggest of them is the River Daugava, transporting more than 75% of fresh waters to the Gulf of Riga. Hydrological stations on the four rivers are in a distance of 17.5 to 3 1 km from the sea. But two rivers have a very small slope, therefore the River Gauja hydrological station is 60 km far from the sea and the River Lielupe hydrological station is located 110 km from the sea.

For these reasons, a significant part of the drainage area is not controlled hydrologically. The hydro-chemically controlled area is bigger because the water quality stations are situated closer to the sea than the hydrological stations.

The pollution load entering the Gulf of Riga via rivers is presented in Table 4.26 and in Figure 4.13.

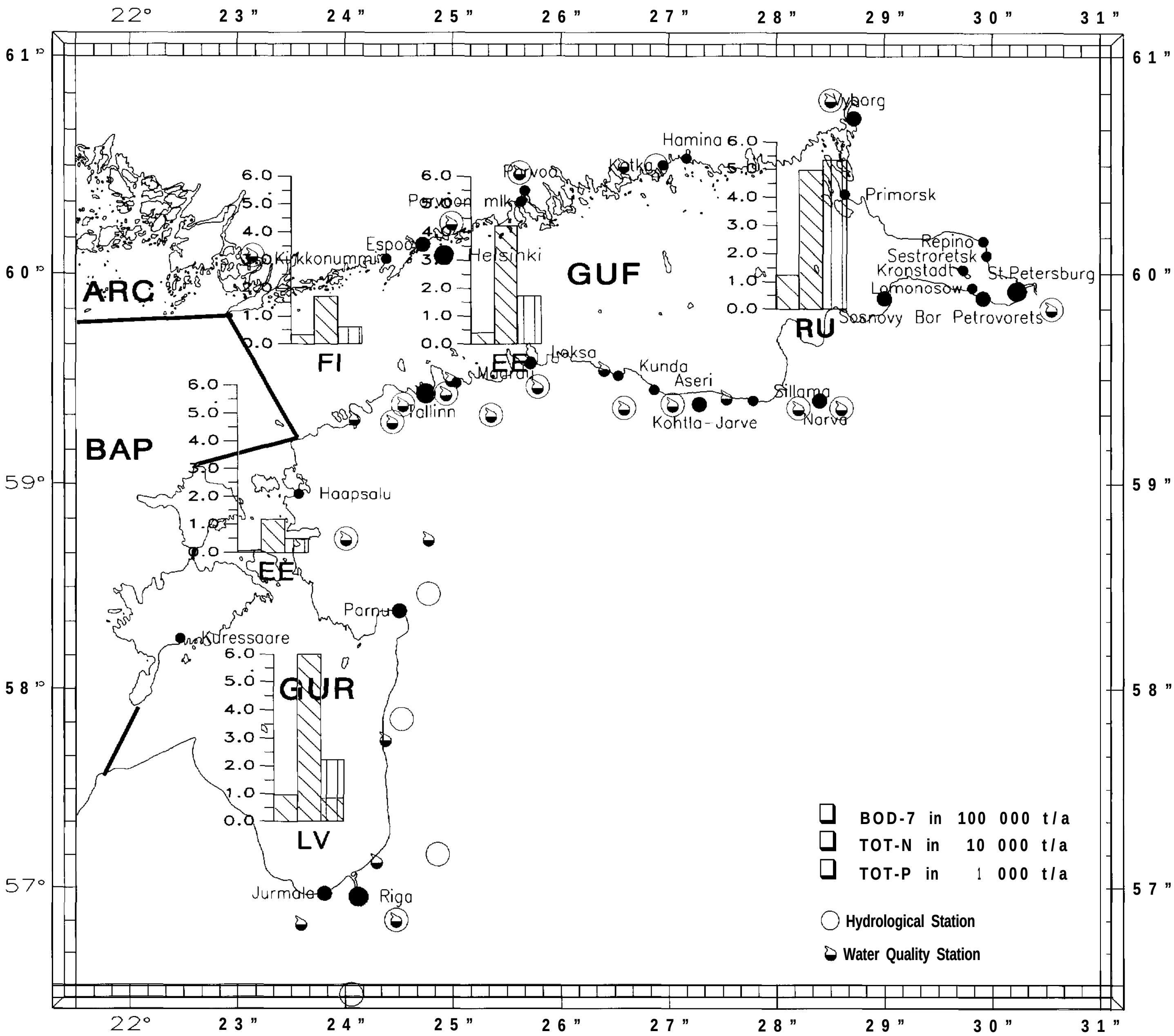
Table 4.26

Pollution Load entering the Gulf of Riga via Rivers in 1990
t/a

Determinants	Estonia	Latvia	Sum
Q [m^3/s]	59.7000	n.ı.	> 59.7000
BOD$_5$[1]	5 308.0000	81 570.0000	86 878.0000
BOD,	6 370.0000	95 436.9000’	IO1 806.9000
BOD$_{21}$[a]	n.i.	n.i.	n.i.
TOC[a]	n.i.	n.i.	n.i.
s s	147 612.0000	2 12 000.0000	359 612.0000
COD,,.	n.i.	1 838 300.0000	> 1 838 300.0000
COD,,,”	n.i.	n.i.	n.i.
Tot-P	489.0000”	2 2 15.9000	2 704.9000
PO,-P	71.2000	2 096.0000	2 167.2000
Tot-N	11 730.0000”	68 235.8000[4]	79 965.8000
NH,-N	50.0500	5 01 1 .0000	5 06 1.0500
NO,-N	378.5600	754.8000	1 133.3600
NO,-N	3 266.0000	62 470.0000	65 736.0000
Hg	n.i.	n.i.	n.i.
Cd	n.i.	n.i.	n.i.
cu	n.i.	35.5300	> 35.5300
Zn	n.i.	120.2300	> 120.2300
Pb	n.i.	n.i.	n.i.

n.i. no information
not obligatory
a alternative
1 $BOD_7 = BOD_5 \times 1.17$
4 Tot-N = NH, + NO, + NO,
6 Tot-N and Tot-P were calculated on the basis of the corresponding ratios of their inorganic compounds

Pollution toad entering the Gulf of Finland and the Gulf of Riga via Rivers in 1990



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MUDAB (Meeresumwelt-Datenbank)
UBA-UMPLIS/BSH

Fig. 4.7 Pollution Load entering the Gulf of Finland and the Gulf of Riga via Rivers in 1990

The main pollution load is transported to the Gulf of Riga via the River Daugava. Load data concerning different substances are not complete. Estonia has not presented information about heavy metals. Latvia has no information about total nitrogen. Total nitrogen is reported as the sum of the mineral compounds.

4.5.2 Pollution load from urban areas

In the coastal zone of the Gulf of Riga there are three Estonian and two Latvian municipalities situated (Table 4.27).

Table 4.27

Municipalties discharging into the Gulf of Riga

Estonia			
Municipalities	People served	Flow 10” m^3/a	Treatment method
Haapsalu	15 500	1.59	m
Kuressaare	16 600	1.12	wt
Paernu	54 200	6.72	m
	86 300	9.43	
Latvia			
Municipalities	People served	Flow 10” m^3/a	Treatment method
Riga	900 000	164.40	m 27% b 8%
Jurmala	60 000	19.51	m b
	960 000	183.90	

wt without treatment
m mechanical treatment
b biological treatment

Only one city is bigger than 500 000 inhabitants, others are significantly smaller. In 1990 two Estonian cities - Haapsalu and Parnu - carried out mechanical wastewater purification. The wastewater of Kuressaare is discharged into the sea without any purification. The Latvian city Jurmala has biological purification. The wastewater of Riga is discharged mainly without treatment directly into the sea.

The summary load is presented in Table 4.28 and Figure 4.8.

Table 4.28

Pollution Load entering the Gulf of Riga from Urban Areas in 1990
t/a

Determinants	Estonia	Latvia	Sum
Q [$10^6 m^3/a$]	9.4260	183.9010	193.3270
BOD,	n.i.	n.i.	n.i.
BOD,	1 956.4000	36 967.0000	38 923.4000
BOD_{21}*	n.i.	n.i.	n.i.
TOC*	n.i.	n.i.	n.i.
COD_{Cr}	n.i.	n.i.	n.i.
COD_{Mn}*	n.i.	n.i.	n.i.
Tot-P	41.7000	607.7600	649.4600
Tot-N	204.8000	4 855.7000	5 060.5000
NH,-N	n.i.	n.i.	n.i.
Hg	n.i.	n.i.	n.i.
Cd	n.i.	n.i.	n.i.
Cu	n.i.	3.3730	> 3.3730
Zn	n.i.	5.1210	> 5.1210
Pb	n.i.	n.i.	n.i.
Number of urban areas	3	2	5

n.i. no information
* not obligatory

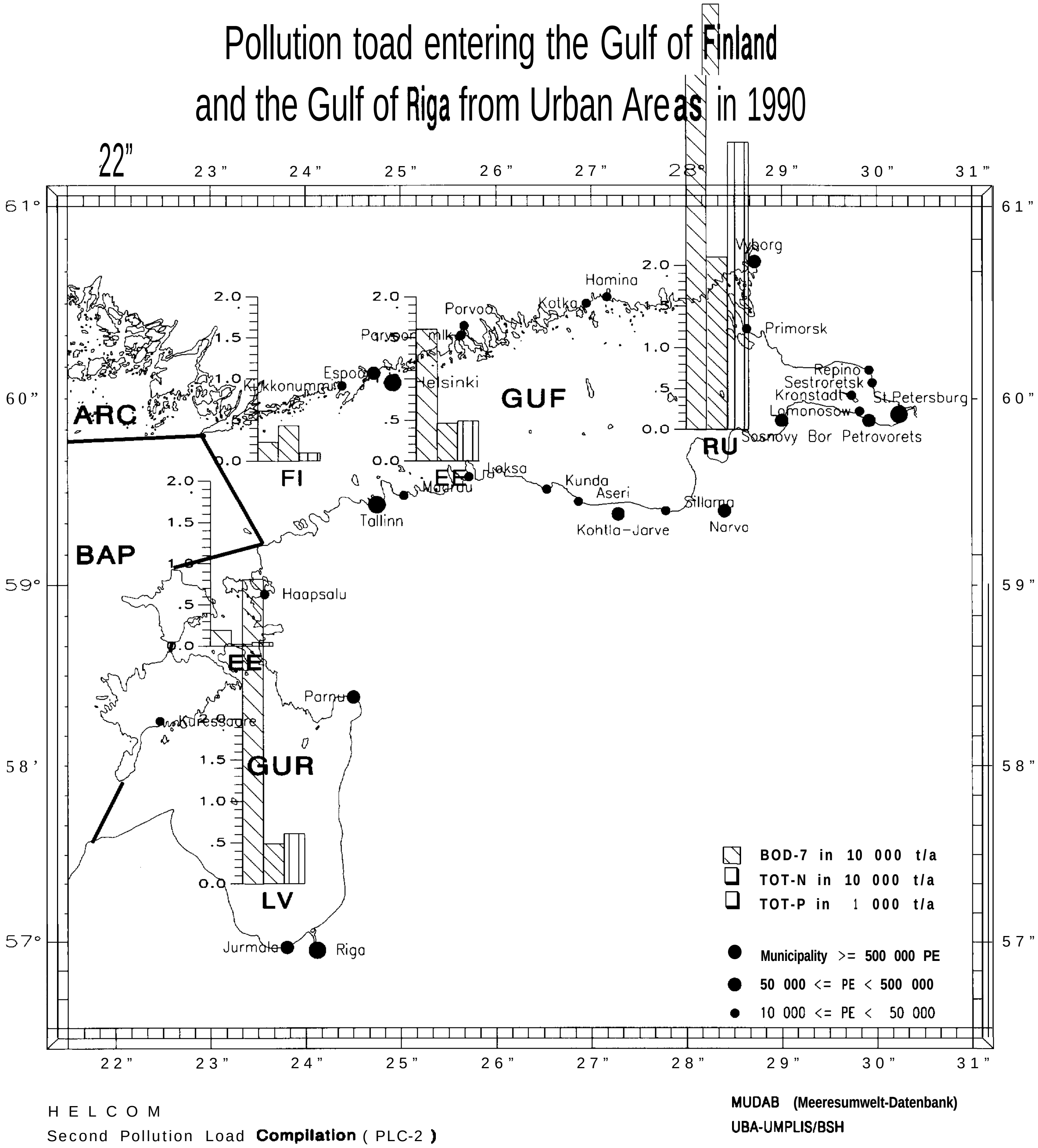


Fig. 4.8 Pollution Load entering the Gulf of Finland and the Gulf of Riga from Urban Areas in 1990

4.5.3 Pollution load from industries

The coastal area of the Gulf of Riga is not heavily industrialized. The main industries are connected to the municipal sewage systems. Latvia only reported information about the Sloka pulp and paper mill (Table 4.29.).

Table 4.29

Industries discharging directly into the Gulf of Riga

Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Estonia			
Fish	Paernu	wt	0.3250
Fish	Laeaetse	wt	0.2340
Fish	Koergessaare	m	0.4380
Wood and fibre	Paernu	m	0.2600
Meat and milk	Kuressaare	wt	0.5250
Sum			1.7820
Latvia			
Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Pulp and paper	Sloka	b	16.4230
Sum			16.4230
Total			18.2050

wt without treatment
m mechanical treatment
b biological treatment

Estonia has presented information about three fish industries, one meat and milk industry and one wood and fibre industry. Three enterprises discharge without treatment, the remaining two have only mechanical treatment. Summarized industral pollution load in 1990 into the Gulf of Riga is presented in Table 4.30 and in Figure 4.9.

The pollution load into the Gulf of Riga from industries is presented only partly. Not all substances are controlled according to the Guidelines.

Pollution toad entering the Gulf of Finland and the Gulf of Riga from Industries in 1990

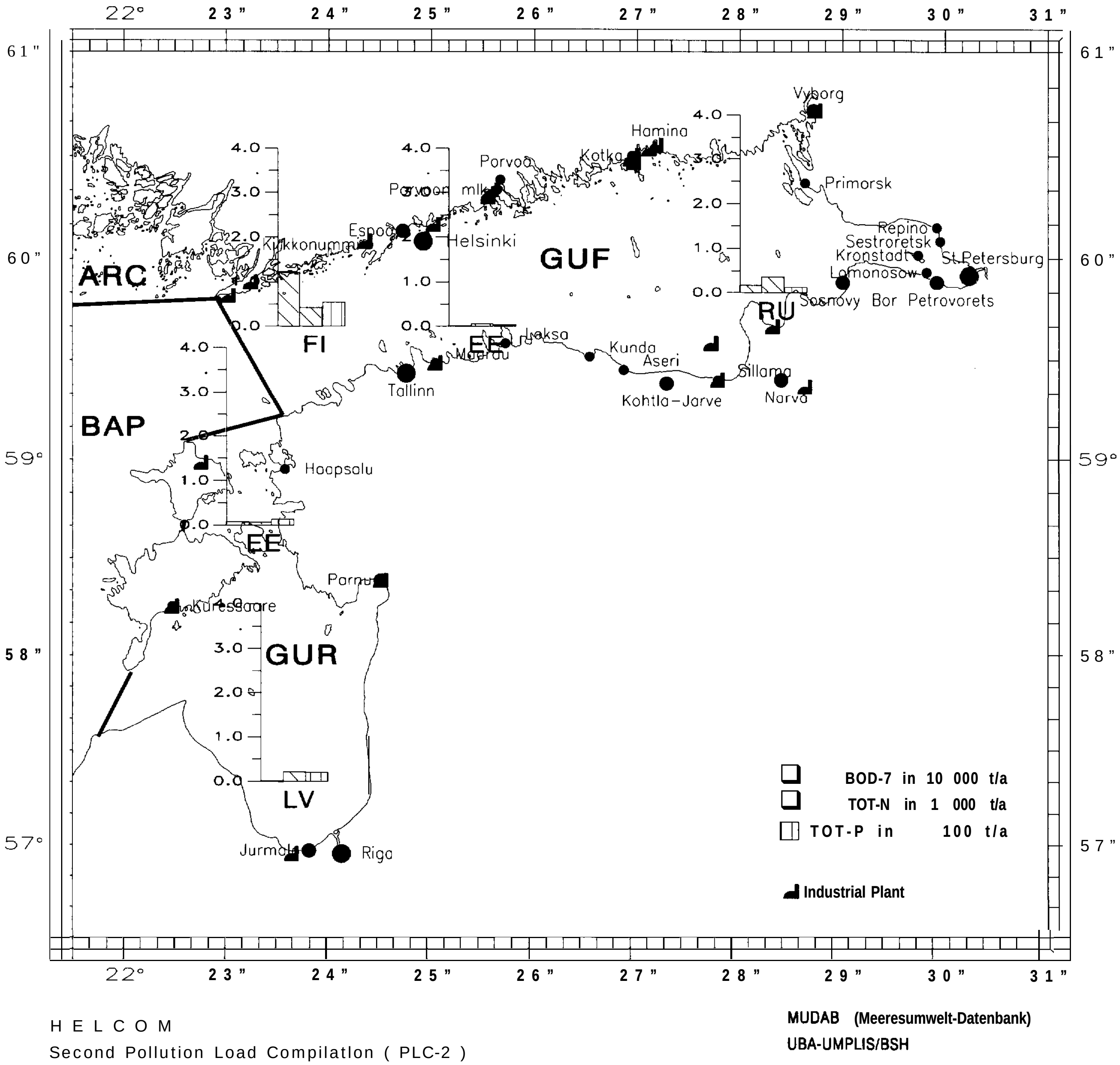


Fig. 4.9 Pollution Load entering the Gulf of Finland and the Gulf of Riga from Industries in 1990

Table 4.30

Pollution Load entering the Gulf of Riga from Industries in 1990
t/a

Determinants	Estonia	Latvia	Sum
Q [$10^6 m^3/a$]	1.7820	16.4230	18.2050
BOD_5 *	n.i.	137.1000	> 137.1000
BOD,	702.2000	160.4070'	862.6070
BOD_{21} '	n.i.	n.i.	n.i.
TOC	n.i.	n.i.	n.i.
COD_{Cr}	n.i.	n.i.	n.i.
COD,,	n.i.	n.i.	n.i.
Tot-P	13.5500	20.7300	34.2800
Tot-N	61.3900	2 19.7000	28 1.0900
NH,-N	50.8000	183.6000	234.4000
Hg	n.i.	n.i.	n.i.
Cd	n.i.	n.i.	n.i.
cu	n.i.	n.i.	n.i.
Zn	n.i.	n.i.	n.i.
Pb	n.i.	n.i.	n.i.
Numbers of plants	5	1	6

not obligatory

n.i. no information

' BOD, = BOD, x 1.17

4.6 Baltic Proper

4.6.1 Pollution load via rivers

The Baltic Proper is the central part of the Baltic Sea. The Baltic Proper borders are determined by the sub-region borders.

The drainage area of the Baltic Proper is 568 973 km’ and it is divided between 8 countries. The Estonian and the Danish drainage areas are the smallest with any significant polluters, which should be reported in accordance with the Guidelines. The biggest drainage areas belong to Poland (3 11 900 km’) and Sweden (84 900 km’).

The Latvian, Lithuanian and Polish rivers drain also the catchments in the territory of Belarus, Czechoslovakia and Ukraine.

Information about the drainage areas of the Baltic Proper are presented in Table 4.3 1.

Table 4.31

Information about the drainage area of the Baltic Proper

	Latvia	Lithuania	Russia	Poland	Germany	Denmark	Sweden	Total
Drainage area [km^2]	12 600	54 700	15 100	311 900	12 600	1 200	84 900	425 700
Drainage area of the reported rivers with measured flow [km^2]	10 000	81 400	6 400	324 204	3 600	n.i.	57 500	> 391 703
Number of re-ported rivers	4	2	2	16	6	n.i.	II	> 41

n.i. no information

Hydrological control stations in the eastern and southern coast are situated mainly far away from the sea due to a low coastal area and a very small slope of the rivers.

Hydrological stations on the Latvian rivers are normally situated at the sea in a distance of 10 to **30** km from the sea. Only one hydrological station on the River Venta is situated at a distance of 83 km.

Hydrological stations in Lithuania are located at a distance of 41 and 112 km from the sea.

Hydrological stations in Poland as a rule, are situated between 10 to 30 km from the sea. Only one station at the River Oder is situated in a distance of 107 km far from the sea. The situation of hydrological and hydrochemical control stations in Germany is similar.

The western coast of the Baltic Proper is higher than the eastern coast and the hydrological stations in Sweden are situated in a distance of 1 to 10 km far from the sea.

A similar situation can be noted in regard to water quality stations - this leads to the fact that the drainage area of the Baltic Proper is not equally controlled in all parts.

The frequency of sampling for water quality control is variable from country to country. In Latvia the control frequency is 12 times per year except for the River Barta, which is monitored only 6 times per year. The control frequency in Lithuania is 12 times per year. Sweden is controlling all its rivers 12 times per year -just as Germany does. The control frequency in Poland is higher than recommended in the Guidelines. The Rivers Vistula and Oder are controlled two times per week and other rivers once per week. The control frequency for the River Pregel is also high - 36 times per year. Information about the control frequency of the River Nelma are lacking.

The pollution load entering the Baltic Proper via rivers is presented in Table 4.32 and in Figure 4.10.

The load figures concerning the Baltic Proper are not complete. Lithuanian, Latvian and Russian figures for total nitrogen are calculated as the sum of all mineral compounds. Other substances are measured more or less according to the Guidelines.

Phosphorus load data from Russia are lacking. Latvian and Lithuanian data for total phosphorus are calculated on the basis of orthophosphate.

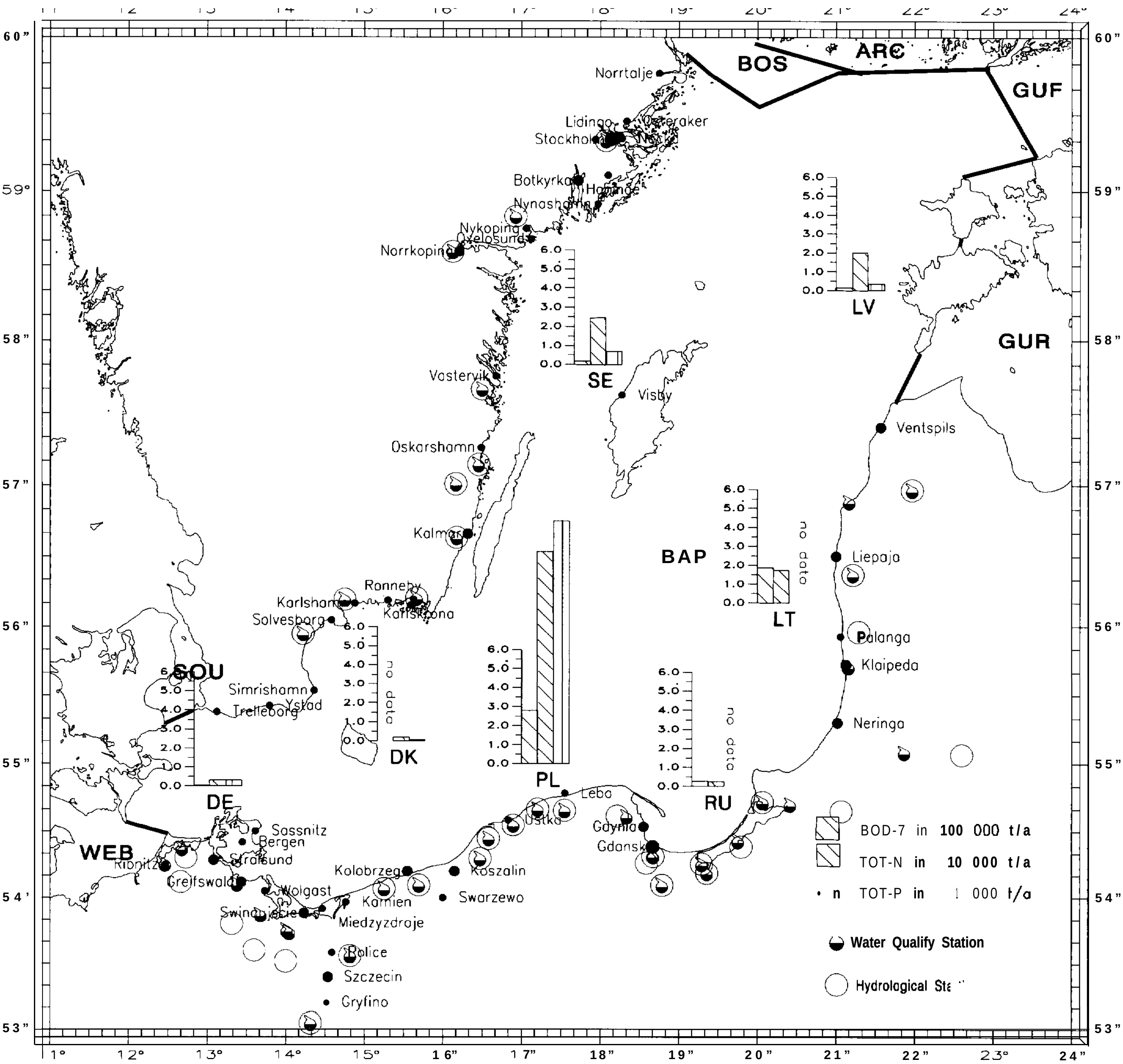
Table 4.32

Pollution Load entering the Baltic Proper via Rivers in 1990
t/a

Determinants	Latvia	Lithuania	Russia	Poland	Germany	Denmark	Sweden	Sum
Q [m^3/s]	n.i.	702.6000	90.0000	1 717.1000	24.8700	5.5500	482.4600	> 3 022.5800
BOD_5 *	12 852.0000	158 787.0000	25 204.0000	237 506.0000	3 031.0000	n.i.	n.i.	> 437 380.0000
BOD_7	15 036.8400[1]	185 780.7900[1]	29 789.6800[1]	277 880.0000[1]	3 546.2700[1]	n.i.	17 828.0400[3]	> 529 861.6200
BOD_{21} [a]	n.i.	211 186.0000	n.i.	346 759.0000	n.i.	n.i.	n.i.	> 557 945.0000
TOC [a]	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	122 952.0000	> 122 952.0000
SS	62 810.0000	922 149.0000	1 340.0000	1 043 914.0000	13 188.0000	n.i.	n.i.	> 2 043 401.0000
COD_{Cr} *	191 730.0000	1 402 278.0000	n.i.	1 361 005.0000	n.i.	10 920.0000	n.i.	> 2 965 933.0000
COD_{Mn} [a]	n.i.	n.i.	1 940.0000	382 387.0000	9 357.0000	n.i.	534 649.0000	> 928 333.0000
Tot-P	315.1000[5]	n.i.	n.i.	12 774.0000	323.0000	63.0000	683.0300	> 14 158.1300
PO_4-P	286.3000	3 236.2000	n.i.	6 286.0000	167.0000	n.i.	193.4290	> 10 168.9290
Tot-N	20 321.2000[4]	17 500.0000	2 639.1800[4]	112 034.0000	3 094.0000	1 930.0000	24 617.8000	182 136.1800
NH_4-N	625.4000	12 184.0000	2 527.8000	24 880.0000	366.0000	n.i.	465.9900	> 41 049.1900
NO_2-N	86.8000	437.0000	91.7800	925.0000	40.0000	n.i.	167.9560	> 1 748.5360
NO_3-N	19 609.0000	4 881.0000	19.6000	45 665.0000	1 469.0000	n.i.	14 569.5000	> 86 213.1000
Hg	n.i.	2.4600	5.5500	13.3000	0.0047	n.i.	n.i.	> 21.3147
Cd	n.i.	n.i.	n.i.	29.1400	0.0070	n.i.	0.2480	> 29.3950
Cu	7.5200	44.7000	6.1500	296.6200	0.5160	n.i.	36.5090	> 392.0150
Zn	16.4200	45.4000	9.0950	2 181.5500	12.7900	n.i.	119.7430	> 2 384.9980
Pb	n.i.	422.7000	88.8800	277.0800	0.1730	n.i.	5.9990	> 794.8320
Cr *	n.i.	n.i.	n.i.	64.2500	0.0890	n.i.	n.i.	> 64.3390
Ni *	n.i.	n.i.	n.i.	176.5100	0.3760	n.i.	n.i.	> 176.8860

n.i. no information
* not obligatory
a alternative
1 $BOD_7 = BOD_5 \times 1.17$
3 $BOD_7 = TOC \times 0.145$
4 $Tot\text{-}N = NH_4 + NO_2 + NO_3$
5 $Tot\text{-}P = PO_4 \times 1.1$

Pollution Load entering the Baltic Proper via Rivers in 1990



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Second Pollution Load Compilation (PLC-2)

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Fig. 4.10 Pollution Load entering the Baltic Proper via Rivers in 1990

4.6.2 Pollution load from urban areas

The coastal area of the Baltic Proper lodges municipalities of six countries (Table 4.33.). Latvia, Lithuania, Russia and Germany have 2 to 6 cities there, all of them being smaller than 500 000 inhabitants. Poland populates this coastal area with 13 cities: one smaller than SO 000, II smaller than 500 000 and one bigger than 500 000 inhabitants (Gdansk). The Swedish municipalities can be classified as follows: 19 smaller than SO 000 , five bigger than SO 000 and one bigger than 500 000 inhabitants (Stockholm). Denmark has a lot of small settlements (< 10 000 PE). The Danish monitoring programme includes the discharges from municipal wastewater treatment plants above 30 PE. The information and load data for the Danish urban areas are presented as sums of the data for the settlements in relevant hydrological reference areas i.e. all urban areas within each reference area are summed up to give one figure (Table 4.33).

Table 4.33

Municipalties discharging into the Baltic Proper

Latvia			
Municipalities	People served	Flow 10” m^3/a	Treatment method
Ventspils	< 500 000	10.80	m b
Liepaja	< 500 000	22.37	m b
		33. I7	
Lithuania			
Municipalities	People served	Flow 10^6 m^3/a	Treatment method
Palanga	< 50 000	5.90	n.i.
Klaipeda	< 500 000	40.30	m
Neringa	< 500 000	0.50	m b
		46.70	
Russia			
Municipalities	People served	Flow IO” m^3/a	Treatment method
Svetly	50 000	1.30	m b
Cherniokehovsk	SO 000	4.60	m b
Sovetsk	so 000	57.30	m b
Svetlogorsk	50 000	1.90	m b
Kaliningrad	380 000	1 16.00	m b
Neman	so 000	29.00	m b
		210.10	

Poland			
Municipalities	People served	Flow 10^6 m^3/a	Treatment method
Gdansk	> 500 000	63.3 1	m
Gdynia	< 500 000	26.1 1	m
Gryfino	< 50 000	2.63	wt
Ustka	< 50 000	2.21	m
Swarzewo	< 50 000	0.81	m b
Szczecin	< 500 000	41.53	m
Kolobrzeg	< 500 000	9.11	m b
Koszalin	< 500 000	21.65	m b
Kamien Porn.	< 50 000	1.10	m
Leba	< 50 000	0.86	m b
Police	< 50 000	2.92	m b
Swinoujscie	< 500 000	4.80	m
Miedzyzdroje	< 50 000	0.88	m
		177.93	

Germany			
Municipalities	People served	Flow 10^6 m^3/a	Treatment method
Ribnitz-Damgarten	17 700	1.69	m b
Stralsund	72 000	12.36	m
Bergen	18 000	1.94	m
Sassnitz	13 800	1.08	m
Greifswald	67 965	6.82	m
Wolgast	17 000	1.20	m
Stralsund	72 000	12.36	m
Bergen	18 000	1.94	m
Sassnitz	13 800	1.08	m
Greifswald	67 965	6.82	m
Wolgast	17 000	1.20	m
	206 465	25.09	

Denmark			
Municipalities’	People served	Flow 10^6 m^3/a	Treatment method
91	94 690	8.13	various
92	663	0.07	various
93	9 625	0.89	various
	104 978	9.09	

Sweden			
Municipalities	People served	Flow 10” m^3/a	Treatment method
Norrtalje	15 500	3.20	m b c
Osteraker	27 000	3.70	m b c
Nacka	30 000	5.90	m b c
Lidingo	322 500	54.50	m b c
Stockholm 1	23 500	4.90	m b c
Stockholm 2	253 000	54.80	m b c
Stockholm 3	563 400	102.20	m b c
Haninge	15 500	2.00	m b c
Botkyrka	235 000	45.60	m b c
Nynashamn	12 500	2.00	c
Nykoping	31 000	6.40	m b c
Oxelosund	14 000	2.30	c
Norrkoping	96 900	15.20	m b c
Visby	23 000	4.50	m b c
Vastervik	30 000	4.90	m b c
Oskarshamn	19 500	3.50	m b c
Kalmar	96 500	5.90	m b c
Karlskrona 1	40 200	3.90	m b c
Karlskrona 2	12 000	3.00	m b c
Ronneby	21 000	2.70	m b c
Karlshamn	13 000	1.70	m b c
Solvesborg	11 500	1.90	m b c
Simrishamn	12 000	1.90	m b c
Ystad	30 000	5.70	m b c
Trelleborg	23 500	3.00	m b c
	1 972 000	345.30	

n.i. no information
wt without treatment
m mechanical treatment
b biological treatment
c chemical treatment
numbers represent reference areas

Only in Sweden, as a rule, biological-chemical purification is practiced. All other countries mainly use mechanical or mechanical-biological treatment for the purification of urban waste water. The pollution load entering the Baltic Proper from urban areas is summarized in Table 4.34 and in Figure 4.11.

A comparison of loads of organic matter between the different countries is only possible on the basis of BOD,. The main organic matter load is coming from Russia and Poland. Loads from the other countries are between 1 000 and 6 000 tons BOD, per year.

The main phosphorus loads are coming from Poland (1 446 t) and Russia (7 18 t). Other countries discharged between 50 and 230 t of total phosphorus into the Baltic Proper in 1990.

The main nitrogen load is coming from Poland (7 630 t), Sweden (7 128 t) and Russia (6 997 t). The Swedish contribution is high due to the fact that the biological chemical purification does not reduce the nitrogen load. The impacts of other countries are smaller, between 200 to 500 t/a.

The urban load data for Latvia and Russia include also the loads from industries (Chapter 4.6.3).

Table 4.34

Pollution Load entering the Baltic Proper from Urban Areas in 1990
t/a

Determinants	Latvia	Lithuania	Russia	Poland	Germany	Denmark	Sweden	Sum
Q [$10^6 m^3/a$]	33.1660	36.7000	2 IO.1000	177.9250	25.0900	9.0883	345.3000	847.3693
BOD_5	n.i.	5 565.0000	n.i.	35 128.0000	4 841.0000	2 226.46 IO	n.i.	> 47 760.46 IO
BOD_7	1 634.0000	6 511.0500[1]	n.i.	41 100.0000[1]	5 663.9700	2 604.9594[1]	2 489.0000	> 60 002.9794
BOD_{21}	n.i.	7 401.5000	92 966.0000	51 288.0000	n.i.	n.i.	n.i.	> 151 655.5000
TOC	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
COD_{Cr}	n.i.	n.i.	n.i.	72 57 I .0000	5 302.9000	4 I7 I.5790	17 018.0000	> 99 063.4790
COD_{Mn}	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
Tot-P	39.8700	231.8100	718.5000	1 446.0000	233.0000	89.5210	133.5000	2 902.2010
Tot-N	466.1000	821.6000	6 997.1000	7 630.0000	1 221.2000	396.1750	7 12x.0000	24 660.1750
NH_4-N	n.i.	n.i.	6 113.4000	4 749.0000	721.9000	n.i.	4 204.0000	> IS 788.3000
Hg	n.i.	n.i.	n.i.	0.0300	n.i.	n.i.	0.0 I93	> 0.0493
Cd	n.i.	n.i.	n.i.	0. I?10	0.1140	n.i.	0.0388	> 0.2738
Cu	0.0090	7.0000	5.2900	12.6800	0.1860	n.i.	3. I800	> 28.3450
Zn	0.1920	5.3000	IS.2000	41.0000	25.7250	n.i.	IO.7200	> 98.1370
Pb	n.i.	n.i.	n.i.	7.5800	1.7340	n.i.	0.3220	> 9.6360
Number of urban areas	2	3	6	13	6	3	25	58

n.i. no information

not obligatory

[1] $BOD_7 = BOD_5 \times 1.17$

Pollution Load entering the Baltic Proper from Urban Areas in 1990

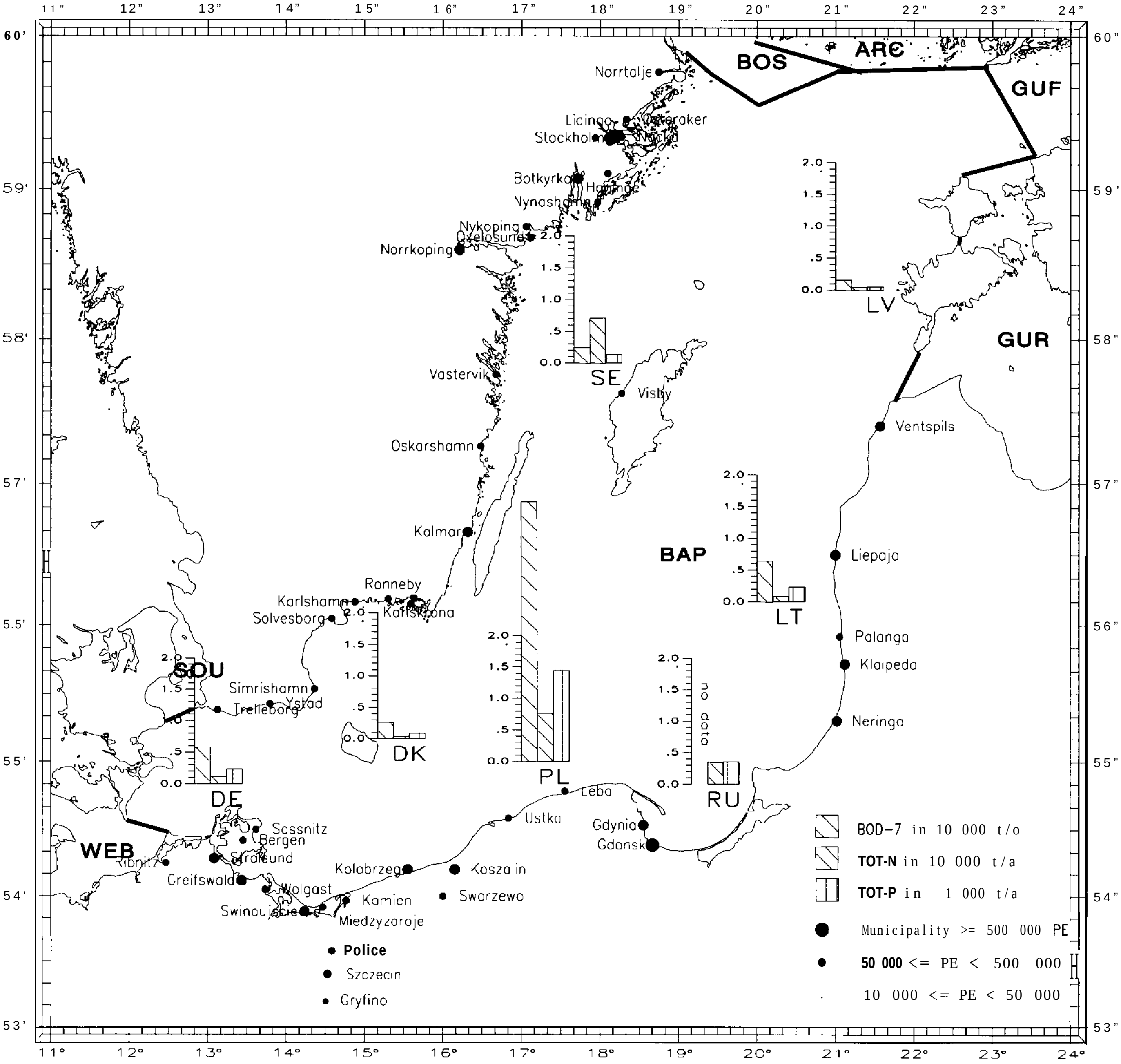

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Fig. 4.1 1 Pollution Load entering the Baltic Proper from Urban Areas in 1990

4.6.3 Pollution load from industries

The industrialization of the coastal area of the Baltic Proper is rather unequal. Relatively heavily industrialized regions are the coastal areas in Russia and Sweden whereas the coastal areas of the other countries are not heavily industrialized. Information about the industries which are discharging their wastewater directly into the sea are presented in Table 4.35. **Latvian and Russian industries are connected to the municipal sewage system and are therefore not indicated separately.** This leads to the fact, that the amount of pollution load from industries can not be marked with figures for those two countries. Conversely, their amount of pollution load from urban areas into the Baltic Proper (Table 4.34) is overrated.

Table 4.35

Industries discharging directly into the Baltic Proper

Lithuania			
Branch of industry	Name	Treatment method	Flow 10” m^3/a
Oil refinery	Mazheikiai oil plant	b	10.3000
Pulp and paper	Klaipeda paper plant	m	8.1000
Oil refinery	Klaipeda oil export	m	1 .0000
Sum			19.4000
Poland			
Branch of industry	Name	Treatment method	Flow 10” m^3/a
Fish and food	Leba Fish Farm	wt	7.2530
Fish and food	Tolkmiko Qwoc.Warz	m	0.4570
Fish and food	Wladyslawowo Szkuner	m	0.2780
Chemical	Police Police	m c b	147.9500
Energy and harbour	Gdynia EC III	m	1.4760
Chemical	Gdansk Pollena	m b	0.0880
Chemical	Szczecin Weglopoch.	m	0.0270
Fish and food	Tolkmiko Zalew	m	0.0950
Metal Works	Szczecin Glinki	m	7.1000
Fish and food	Gdansk Tluszczowe	m	0.3810
Energy and harbour	Szczecin EC	m	2.9190
Energy and harbour	Gdansk Harbour	m	0.3820
Chemical	Szczecin ZNF	m c	0.9180
Fish and food	Ustka Losos	m	0.5000
Metal Works	Gdynia Stoczn.Remont	wt	0.0090
Fish and food	Gdynia Koga	m	0.2600
Chemical	Gdansk ZNF	m c	1.4610
Metal Works	Gdansk Stoczn.Polocn	wt	0.0110
Chemical	Szczecin Chemitex	m	3.7000

Poland			
Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Fish and food	Gdansk ABBA	m	0.0010
Fish and food	Gdynia Rozne	wt	1.0300
Metal Works	Ustka stocznia	wt	0.0430
Oil refenries	Gdansk GZR	m c b	2.2400
Fish and food	Gdynia Miesne	b	0.0710
Energy and harbour	Gdynia Harbour	m	0.3750
Wood fibre	Szczecin Skolwin	m	6.4940
Metal Works	Szczecin Gryfia	m	0.2000
Fish and food	Darlowo Milk	b	0.0720
Fish and food	Gdynia Gorzelnia	m	0.0650
Chemical	Gryfino Dest.Drewna	m	0.4200
Energy and harbour	Swinouijscie Harbour	m	0.7940
Wood fibre	Karlino ZPPW	m b	0.1600
Fish and food	Kolobrzeg Barka	m	0.2900
Fish and food	Ustka Korab	m	0.2800
Metal Works	Gdynia Stocznia Wisl	m b	0.0910
Fish and food	Szczecin Gryf	m	0.7640
Fish and food	Swinouijscie Odra	m	0.6000
Energy and harbour	Gdynia EC I + II	m	0.3670
Fish and food	Gdynia Wroblewski	m	2.3570
Chemical	Gdansk Siarkopol	m	0.4840
Metal Works	Gdynia Puck	m	0.1090
Fish and food	Darlowo Kuter	m	0.1830
Energy and harbour	Gdansk EC II	m	0.5380
Fish and food	Tolkmiko Inne	wt	0.0590
Sum			193.3520

Germany			
Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Foodstuff	Zufa Stralsund	m	1.6270
Sea Transport	Faehrhafen Mukran	b	0.1350
Foodstuff	Zufa Barth	m	0.8520
Light	Faserplattenwerk Rib	b	0.5000
Sum			3.1140

Denmark			
Branch of industry	Name	Treatment method	Flow 10” m^3/a
Food	Aarsdale Fiskesalgs.	wt	0.0060
Food	Bornh. Levertranfab.	wt	0.0090
Sum			0.0150
Sweden			
Branch of industry	Name	Treatment method	Flow 10” m^3/a
Oil refinery	Nynas Petrol	m b	0.5200
Metal works	Gunnebo	i	0.0200
Wood-fibre	Nymolla	c b	32.0000
Food factory	Morbyl. Sugar	c	1.5000
Fish farms	n.i.	wt	n.i.
Steel works	SSAB	i b	60.0000
Wood-fibre	Braviken	m b c	13.1000
Wood-fibre	Djupafors	c	0.5000
Cellulose	Wettex AB	c	0.7800
Wood-fibre	Monsteras	i b	15.8000
Food factory	Karlshamn AB	m b c	0.0300
Metal works	NIFE	i	0.0900
Wood-fibre	Eds Bruk	b c	2.6000
Wood-fibre	Morrum	i	24.3000
Sum			> 151.2400
Total			> 367.1210

wt without treatment
m mechanical treatment
b biological treatment
c chemical treatment
i internal treatment
n.i. no information

Denmark has only two small food processing industries in the coastal zone of the Baltic Proper which are discharging their untreated wastewaters directly into the sea.

Industrial discharges from Germany (Mecklenburg-Vorpommern) are comparatively small. Four industries discharge 3.1 million m^3 of wastewater into the sea. One fifth of it is treated biologically, the remaining part mechanically.

Three Lithuanian industries discharge their wastewater directly into the sea. Half of the 19.4 million m^3 is treated biologically.

Poland has reported the discharges of 44 different industrial enterprises, which can be divided into 5 groups: fish and food, chemical, metal works, wood fibre and energy plants. In the Polish coastal area of the Baltic Proper small fish and food-processing enterprises predominate in number. Regarding the total flow of 193.3 million m^3, more than 76% are originating from the chemical industry “Police”, which uses mechanical, biological and chemical treatments of the wastewater. The other chemical industries and metal works are small there. All these industries are mainly equipped with mechanical purification.

The number of industries located in the Swedish coastal zone is smaller than in Poland but the amount of discharged wastewater is in the same order. The main polluter here is the wood and fibre industry. There are also some food processing factories, metal works and fish farms. As a rule, industries are equipped with biological-chemical purification systems and internal technological purification methods are also used often.

The pollution load entering the Baltic Proper from industries is presented in Table 4.36 and in Figure 4.12. The main organic load, presented as BOD,, is discharged by Sweden (11 966 t) and Poland (4 646 t). The industrial inputs of other countries are significantly smaller. The phosphorus load is two times bigger in Poland than in Sweden but for nitrogen it is vice versa. Despite of the fact that in the Polish coastal area fish- and food-processing industries predominate, the heavy metal load is comparatively big.

Table 4.36

Pollution Load entering the Baltic Proper from Industries in 1990
t/a

Determinants	Lithuania	Poland	Germany	Denmark	Sweden	Sum
Q [$10^6 m^3/a$]	19.4000	193.3520	3.1140	0.0150	151.2400	367.1210
BOD_5	860.1000	3 972.0000	1 457.3800	11.0000	n.i.	> 6 300.4800
BOD_7	1 006.3170[1]	4 645.9000[1]	1 705.1346[1]	12.8700[1]	11 966.0000	19 336.2216
BOD_{21}	1 143.6000	5 797.1000	n.i.	n.i.	n.i.	> 6 940.7000
TOC	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
COD_{Cr}	n.i.	10 394.6000	1 181.7000	n.i.	66 496.0000	> 78 072.3000
COD_{Mn}	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
Tot-P	31.2000	523.2000	9.0500	0.3800	183.1000	746.9300
Tot-N	317.6000	720.8000	3.5600	3.8500	1 417.0000	2 462.8100
NH_4-N	n.i.	282.6000	10.1000	n.i.	17.0000	> 309.7000
Hg	n.i.	0.6283	n.i.	n.i.	n.i.	> 0.6283
Cd	n.i.	5.5000	0.0031	n.i.	0.0080	> 5.5111
Cu	n.i.	16.4310	0.0278	n.i.	n.i.	> 16.4588
Zn	n.i.	166.5330	0.0830	n.i.	0.9200	> 167.5360
Pb	n.i.	26.8330	0.0940	n.i.	0.0520	> 26.9890
Number of plants	3	44	4	2	14	67

not obligatory

n.i. no information

[1] $BOD_7 = BOD_5 \times 1.17$

Pollution Load entering the Baltic Proper from Industries in 1990

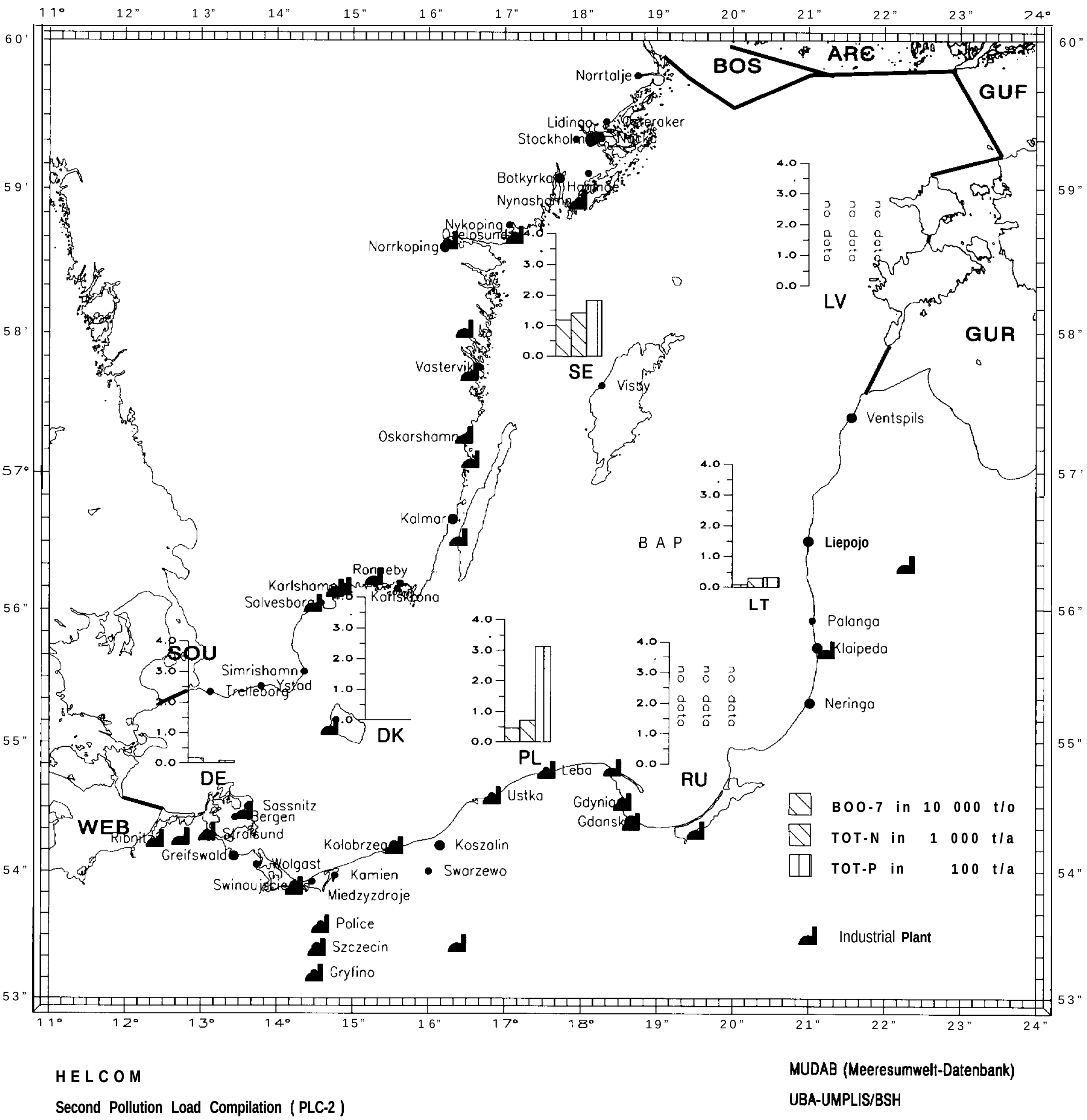


Fig. 4.12 Pollution Load entering the Baltic Proper from Industries in 1990

4.7 Western Baltic

4.7.1 Pollution load via rivers

The Western Baltic or Belt Sea consists of the Bay of Mecklenburg, the Kiel Bight. the Little Belt and the Great Belt. The northern border of the Western Baltic is on the imaginary line HANSENÖRE-GNIBEN and the southern border on the GEDSER-DARSSER ORT line. The drainage area of the Western Baltic is of a size of 23,400 km' and shared by Denmark and Germany in more or less equal parts. The number of rivers and the information about the hydrologically controlled areas are presented in Table 4.37.

Table 4.37

Information about the drainage area of the Western Baltic

	Germany	Denmark	Total
Drainage area [km']	11 000	12 400	23 400
Drainage area of the reported rivers with measured flow [km^2]	5 162	n.i.	> 5 162
Number of reported rivers	6	n.i.	> 6

n.i. no information

The drainage area of Germany is covered with a network of small rivers of which only two are bigger than 5 m^3/s. The other four reported rivers with runoffs between 1 and 4 m^3/s are also controlled hydrologically. Hydrological stations are located 10 to 20 km from the sea, except for the River Trave where it is situated in a distance of 45.8 km from the coast.

As a rule. the hydrochernically controlled area is bigger than the hydrologically controlled one. The sampling frequency is 12 times per year, with the exception of the River Trave which is controlled 26 times per year.

The Danish drainage area is also covered with a network of small rivers ($< 5\, m^3/s$). The information about runoff and loads are presented as sums of the reference area - according to the Danish national reporting system.

The pollution load via rivers into the Western Baltic is presented in Table 4.38 and in Figure 4.13

Table 4.38

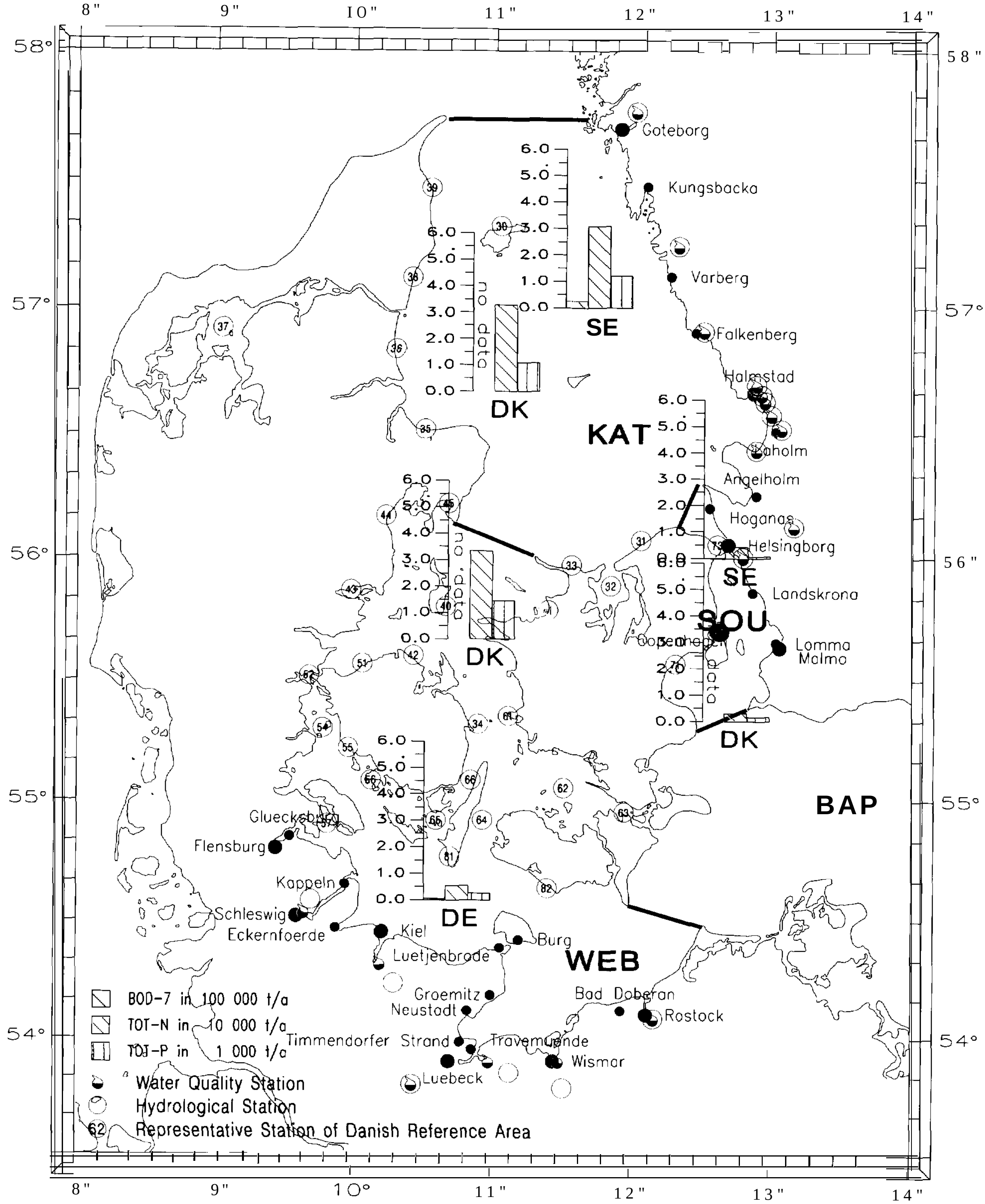
Pollution Load entering the Western Baltic via Rivers in 1990
t/a

	Germany	Denmark	Sum
Q [m^3/s]	32.1200	99.8900	132.0100
BOD[5][a]	2 198.0000	n.i.	> 2 198.0000
BOD,	4 528.2600'	n.i.	> 4 528.2600
BOD[21][a]	n.i.	n.i.	n.i.
TOC[a]	5 589.3000	n.i.	> 5 589.3000
s s	12 268.8000	n.i.	> 12 268.8000
COD,,.:	14 923.43 10	173 400.0000	188 323.4310
COD,,"	5 244.0000	n.i.	> 5 244.0000
Tot-P	254.2300	1 445.0000	1 699.2300
PO,-P	108.0000	n.i.	> 108.0000
Tot-N	5 421.0000	33 400.0000	38 821.0000
NH,-N	358.5100	n.i.	> 358.5 100
NO,-N	54.3900	n.i.	> 54.3900
NO,-N	3 766.5800	n.i.	> 3 766.5800
Hg	0.0053	0.0006	0.0059
Cd	0.0267	0.0020	0.0287
c u	1.2181	0.2510	1.4691
Zn	5.3375	0.6650	6.0025
Pb	0.3813	0.0675	0.4488
Cr[*]	0.0530	n.i.	> 0.0530
Ni[*]	0.1460	n.i.	> 0.1460

n.i. no information
not obligatory
a alternative
1 BOD, = BOD, x 1.17 (only rivers in Mecklenburg-Vorpommern)

The drainage area and the runoff of the Western Baltic are small. Significant phosphorus and nitrogen load as well as comparatively high heavy metal load to the sea are conditioned by intensive agriculture.

Pollution toad entering the Western Baltic, the Sound and the Kattegat via Rivers in 1990



HELCOM
Second Pollution Load Compilation (PLC-2)

MUDAB (Meeresumwelt-Datenbank)
UBA-UMPLIS/BSH

Fig. 4.1 Pollution Load entering the Western Baltic. the Sound and the Kattegat via Rivers in 1990

4.7.2 Pollution load from urban areas

Seventeen German cities with a total population of more than I .5 million inhabitants discharge their wastewaters into the Western Baltic (Table 4.39).

The Danish information about the urban areas are presented in the same manner as for the Baltic Proper (Chapter 4.6.2).

Table 4.39

Municipalties discharging directly into the Western Baltic

Germany			
Municipalities	People served	Flow 10” m^3/a	Treatment method
Flensburg	228 493	12.51	m b c
Gluecksburg	11 927	0.65	m b
Kappeln	15 453	0.85	m b c
Schleswig	62 520	3.42	m b c
Eckernfoerde	32 673	1.79	m b c n d
Kiel-Buelk	450 647	24.67	m b c f
Luetjenbrode (Nord)	37 367	2.05	m b c
Burg/Fehmarn	13 153	0.72	m b c
Groemitz (Cismar)	30 393	1.66	m b c n d
Neustadt/Holstein	28 640	1.57	m b c
Timmendorfer Strand	14 140	0.77	m b c f
Travemuende (Priw.)	29 060	1.59	m b c
Luebeck (Warthestr.)	346 993	19.00	m b c
Luebeck (Ochsenkopf)	30 813	1.69	m b c
Wismar	58 000	4.54	m b
Bad Doberan	12 300	0.53	m
Rostock	250 000	29.99	m
	1 652 572	108.00	

Denmark			
Municipalities?	People served	Flow 1 0^6 m^3/a	Treatment method
44	19.5 068	16.39	various
52	355 178	31.16	various
51	22 590	2.56	various
45	1 328	0.15	various
43	23 895	2.78	various
56	4 027	1.17	various
42	3 393	0.57	various
41	1 100	0.05	various
40	7 709	2.98	various
54	67 951	5.63	various
55	96 614	13.32	various
66	7 730	1.51	various
64	38 080	5.02	various
82	7 187	1.58	various
81	2 900	0.36	various
57	36 680	2.82	various
65	265 199	23.64	various
61	55 350	7.14	various
63	31 716	3.49	various
62	31559	3.62	various
Sum	1 255 254	125.93	

m mechanical treatment
b biological treatment
c chemical treatment
Nitrification
a Denitrification
f Filtration
numbers represent reference areas

Four German treatment plants are bigger than 200 000 PE, the remaining ones are between 10 000 and 60 000 PE. In Schleswig-Holstein almost 90% of the population are connected to treatment plants with biological-chemical treatment. In Mecklenburg-Vorpommern most of the sewage was treated only mechanically.

Information about Danish urban areas are not very detailed.

The pollution load data of Denmark and Germany into the Western Baltic from urban areas is presented in Table 4.40 and in Figure 4.14. Organic matter, phosphorus, nitrogen and heavy metal loads from the urban areas are in the same magnitude as the loads via rivers.

Table 4.40

Pollution Load entering the Western Baltic from Urban Areas in 1990 t/a

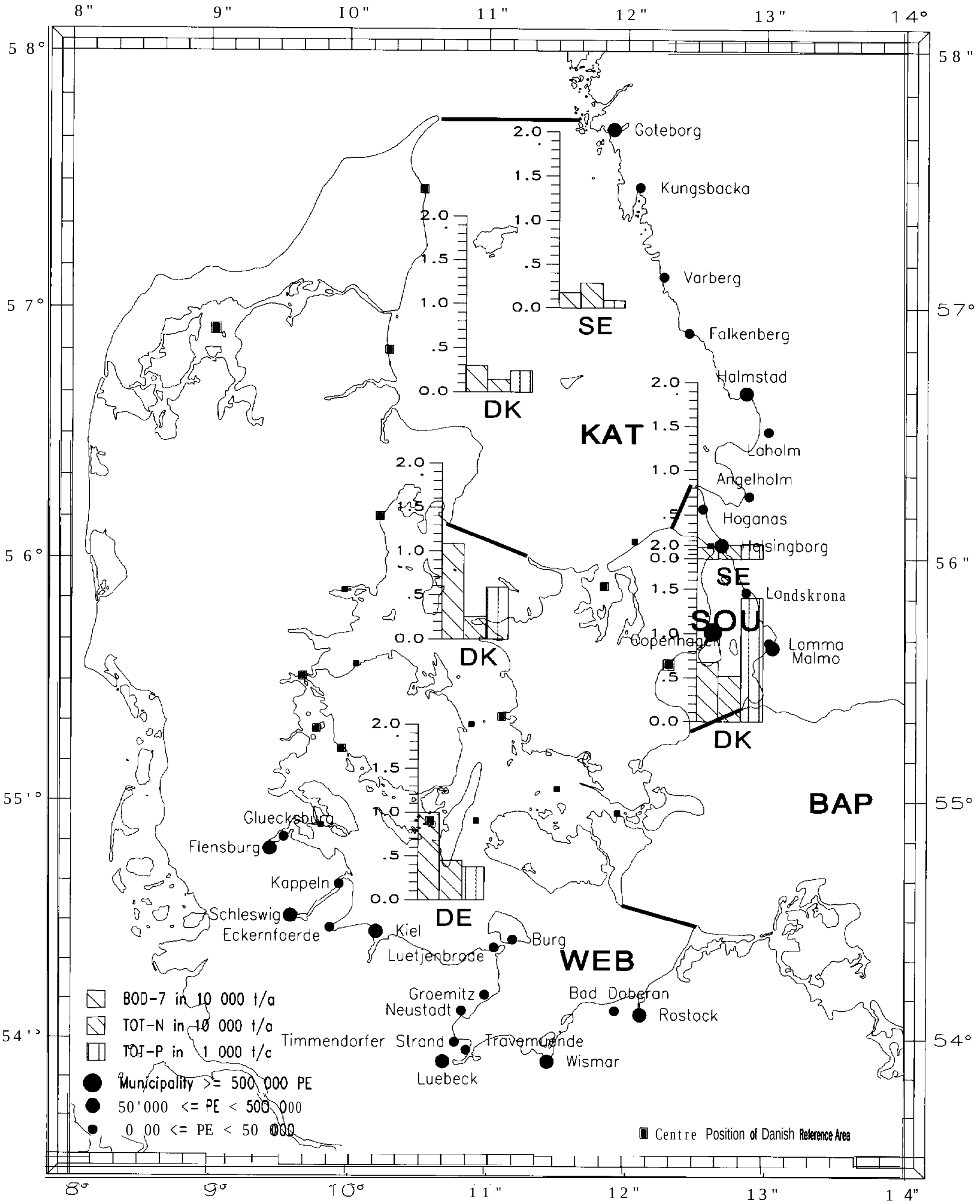
Determinants	Germany	Denmark	Sum
Q [$10^6 m^3/a$]	108.0020	125.9280	233.9300
BOD_5 *	7 792.4000	9 307.0295	17 099.4295
BOD,	9 915.2080’	10 889.2246’	20 804.4326
BOD_{21} *	n.i.	n.i.	n.i.
TOC	1 522.4000	n.i.	> 1 522.4000
COD,,	10 722.8080	23 057.1750	33 779.9830
COD,,, *	n.i.	n.i.	n.i.
Tot-P	373.7400	590.4258	964.1658
Tot-N	4 511.9000	2 560.0739	7 071.9739
NH,-N	3 073.2000	n.i.	> 3 073.2000
Hg	0.0055	n.i.	> 0.0055
Cd	0.1656	n.i.	> 0.1656
Cu	0.8198	n.i.	> 0.8198
Zn	6.2826	n.i.	> 6.2826
Pb	0.5511	n.i.	> 0.5511
Number of urban areas	17	20	37

n.i. no information

not obligatory

1 BOD_7 = BOD, x 1.17 (for Germany only in Mecklenburg-Vorpommern)

Pollution toad entering the Western Baltic, the Sound and the Kattegat from Urban Areas in 1990



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MUDAB (Meeresumwelt-Datenbank)
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Fig. 4.14 Pollution Load entering the Western Baltic, the Sound and the Kattegat from Urban Areas in 1990

4.7.3 Pollution load from industries

In the coastal area of the Western Baltic there are 5 German and 27 Danish industrial plants situated (Table 4.4 1).

Table 4.41

Industries discharging directly into the Western Baltic

Germany			
Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Chemical	Duengemittelwerk Ros	b	1.1070
Foodstuff	Zufa W ismar	m	0.05 10
Chemical	New nonferrous smelt	b	0.5000
Foodstuff	Zufa Schleswig	b c	0.3410
Chemical	Pomosin GmbH, Grosse	b	0.1450
Sum			2.1440

Denmark			
Branch of industry	Name	Treatment method	Flow 10" m^3/a
Chemical	DOW - Danmark	m c	0.0094
Sugar Factories	Assens Sukkerfabriek	m	6.2856
Food	Rahbekfisk A/S	m	0.1500
Iron Steel Works	Danfoss A/S	n.i.	0.2428
Sugar Factories	Sukkerfa. Nykobing K	wt	2.0000
Power Plant	Stigsnaesvaerket Sea	wt	0.0033
Soiltreatment	K.K. Miljoteknik	m	0.4800
Food	Sanovo Foods A/S	wt	0.0360
Paper	Maglemolle Papierfa.	m b c	0.0054
Pulp	Fredericia Cellulose	m	2.5887
Petrochemical	Statoil A/S	m	1.1046
Pharmaceutical	Novo - Nordisk A/S	m	0.8990
Sugar Factories	Sukkerfa. Nykobing K	wt	0.6650
Food	Alfa-Solo; Defoma	n.i.	n.i.
Food	Slagterie Syd, Blans	m b	0.6536
Food	Mette Munk	wt	0.0084
Sugar Factories	Gorlev Sukkerfabrik	m	0.5046
Sugar Factories	Sakskobing Sukkerfa.	m	1.4500
Fertilizer	Kemira Danmark A/S	c	0.4869
Food ies	Baehnckes Delikatess	**m b**	**0.0429**
Petrochemical	Dansk Shell A/S	m	0.5712
Sugar Factories	Nakskov Sukkerfabrik	m	0.8000
Sugar Factories	Sukkerfa. Nykobing S	m	1.1780
Waste Disposal	Stige Ø Losseplad	wt	0.1600
Petrochemical	Kuweit P.R. A/S	m	1.0056
Iron Steel Works	NKT-Tradvaerket A/S	c	0.1380
Vegetable Oil Rafin.	Arhus Oliefabrik A/S	wt	0.0114
Sum			> 2 1.4804
Total			> 23.6244

n.i. no information
wt without treatment
m mechanical treatment
b biological treatment
c chemical treatment

Fifty percent of these plants belong to the group of food-processing industry and the remaining part are chemical, pulp and paper and metal industries.

German industries are equipped with biological purification systems, except one (Zufa Wismar). Danish industries discharge their wastewaters mainly after mechanical treatment directly into the sea. Only one food-processing industry uses biological purification, whereas seven ones discharge without treatment directly into the sea.

4.8 The Sound

4.8.1 Pollution load via rivers

The borders of the Sound are determined by the imaginary lines STEVNS KLINT - FALSTERBO and GILLEJE - KULLEN.

The drainage area of the Sound (4 300 km’) is the smallest among the drainage areas of the sub-regions of the Baltic Sea (Table 4.43).

Table 4.43

Information about the drainage area of the Sound

	Denmark	Sweden	Total
Drainage area [km^2]	1 700	2 600	4 300
Drainage area of the reported rivers with measured flow [km’]	n.i.	202	> 202
Number of reported rivers	n.i.	1	> 1

n.i. no information

The area is shared by Denmark (1700 km^2) and Sweden (2600 km’).

Only one Swedish river with a runoff of 2.0 m^3/s is controlled hydrologically and hydrochemically. The frequency of sampling here is 12 times per year.

The Danish drainage area is covered with a network of small rivers. The information and pollution load data are presented in the same manner as in the preceding chapters.

The pollution load entering the Sound via rivers is presented in Table 4.44 and in Figure 4.13. Due to the small runoffs the riverine load is insignificant compared to other pollution sources.

Table 4.44

Pollution Load entering the Sound via Rivers in 1990
t/a

Determinants	Denmark	Sweden	Sum
Q [m^3/s]	8.9400	20.4 100	29.3500
BOD_5	n.i.	n.i.	n.i.
BOD,	n.i.	488.9400[3]	> 488.9400
BOD_{21}[a]	n.i.	n.i.	n.i.
TOC”	n.i.	3 372.0000	> 3 372.0000
s s	n.i.	n.i.	n.i.
COD,,.!	67 000.0000	n.i.	> 67 000.0000
COD,,,”	n.i.	26 199.0000	> 26 199.0000
Tot-P	159.0000	64.9800	223.9800
PO,-P	n.i.	28.0000	> 28.0000
Tot-N	3 150.0000	4 44 1.0000	7 591 .0000
NH,-N	n.i.	35.0100	> 35.0100
NO,-N	n.i.	33.9600	> 33.9600
NO,-N	n.i.	3 949.0000	> 3 949.0000
Hg	n.i.	n.i.	n.i.
Cd	n.i.	0.0 100	> 0.0100
c u	n.i.	1.0000	> 1 .0000
Zn	n.i.	2.7970	> 2.7970
Pb	n.i.	0.2100	> 0.2 100

n.i. no information
not obligatory
[a] alternative
[3] BOD, = TOC x 0.145

Pollution toad entering the Western Baltic, the Sound and the Kattegat via Rivers in 1990

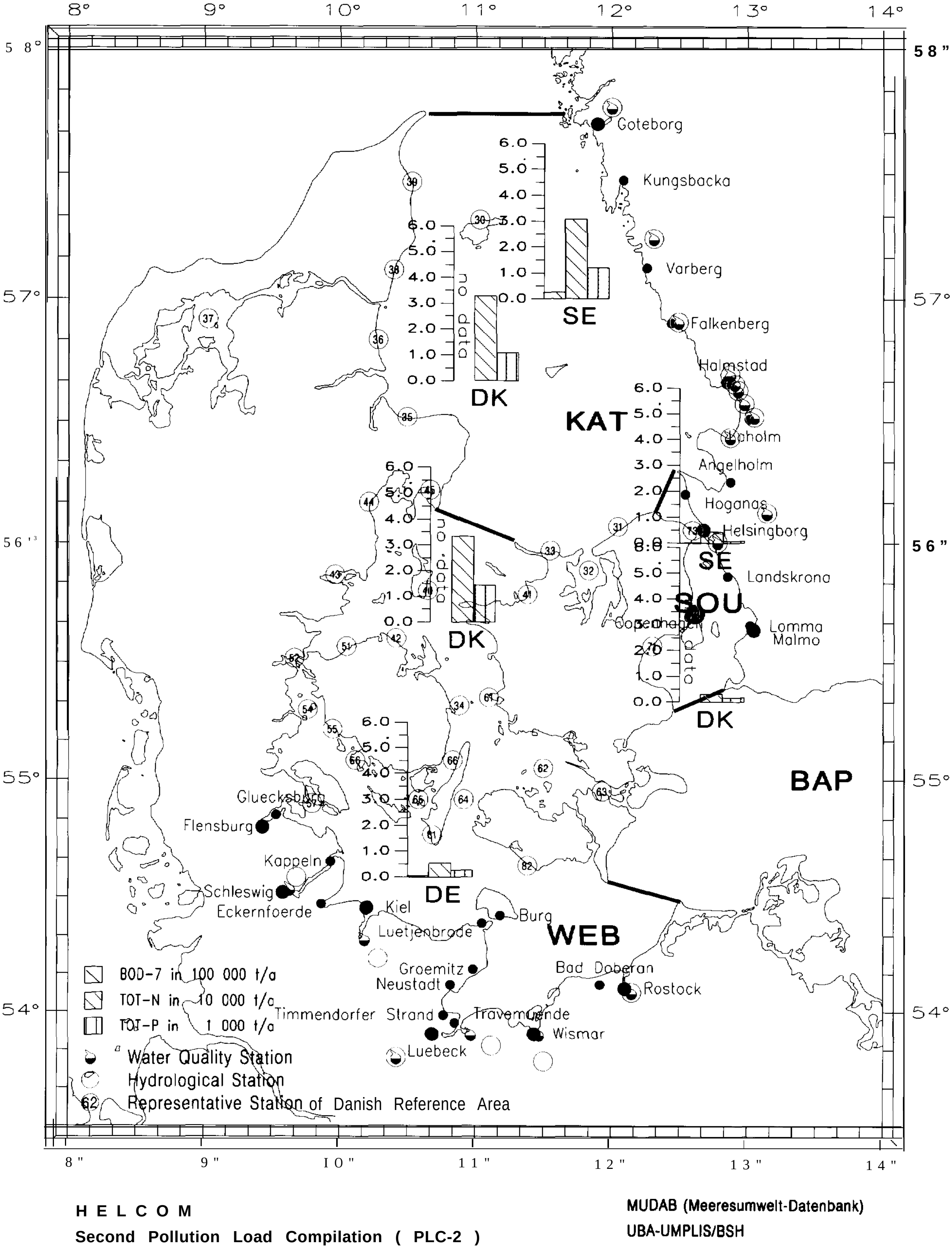


Fig. 4. I3 Pollution Load entering the Western Baltic, the Sound and the Kattegat and via Rivers in 1990

Pollution load entering the different sub-regions of the Baltic Sea

4.8.2 Pollution load from urban areas

Five Swedish cities (six treatment plants), with a total population of 580 000 inhabitants aredischarging their wastewaters into the Sound (Table 4.45). Five treatment plants use biological-chemical purification systems and one has a biological system.

The information about the Danish urban areas is presented in the same manner as in the preceding chapters.

The pollution load entering the Sound from urban areas is presented in Table 4.46 and in Figure 4.14

Table 4.45

Municipalities discharging directly into the Sound

Denmark			
Municipalities#	People served	Flow 10^6 m^3/a	Treatment method
73	20 000	2.55	various
71	516 048	45.35	various
72	1 557 144	128.3 1	various
	2 093 192	176.22	
Sweden			
Municipalities	People served	Flow I 0^6 m^3/a	Treatment method
Malmo 1	44 500	5.30	m b
Malmo 2	362 000	41.50	m b c
Lomma	17 000	1.30	m b c
Landskrona	37 500	5.80	m b c
Helsingborg	101 100	20.30	m b c
Hoganas	18 100	5.00	m b c
	580 200	79.20	

m mechanical treatment
b biological treatment
c chemical treatment
numbers represent reference areas

Pollution load into the Sound from urban areas in 1990 is presented in the Table 4.46 and in Figure 4.23

Table 4.46

Pollution Load entering the Sound from Urban Areas in 1990
t/a

Determinants	Denmark	Sweden	Sum
Q [$10^6 m^3/a$]	176.2 192	79.2000	255.4192
BOD,	5 833.9900	n.i.	> 5 833.9900
BOD,	6 825.7683’	1 322.0000	8 147.7683
BOD,,	n.i.	n.i.	n.i.
TOC	n.i.	n.i.	n.i.
COD,,	22 032.5110	3 585.0000	25 617.5110
COD,,, '	n.i.	n.i.	n.i.
Tot-P	1 399.7920	158.4000	1 558.1920
Tot-N	5 200.1100	1615.0000	6 815.1100
NH,-N	n.i.	970.0000	> 970.0000
Hg	n.i.	0.007 1	> 0.007 1
Cd	n.i.	0.01 17	> 0.01 17
cu	n.i.	5.7200	> 5.7200
Zn	n.i.	4.4800	> 4.4800
Pb	n.i.	0.0730	> 0.0730
Number of urban areas	3	6	9

n.i. no information
not obligatory
' BOD, = BOD, x 1.17

Due to the high purification efficiency the pollution load from Sweden is remarkably low - concerning BOD, and phosphorus concentrations the discharges are very close to the HELCOM Recommendation 9/2.

Pollution toad entering the Western Baltic, the Sound and the Kattegat from Urban Areas in 1990

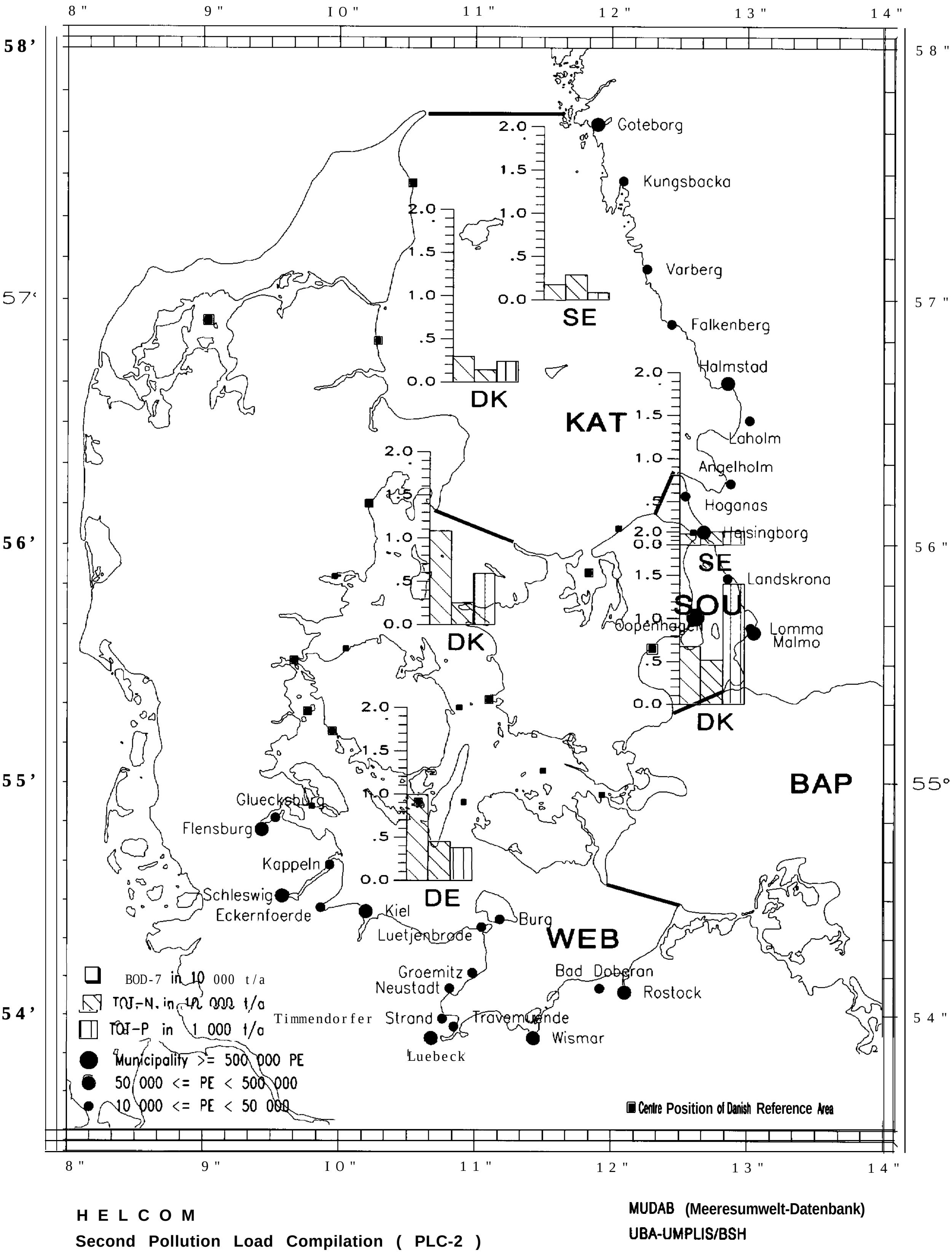


Fig. 4.14 Pollution Load entering the Western Baltic, the Sound and the Kattegat from Urban Areas in 1990

4.8.3 Pollution load from industries

For the coastal area of the Sound two Swedish and seven Danish industries were reported. Six of them are different chemical industries and the remaining ones are pulp and paper, cement and rubber industry (Table 4.47).

Table 4.47

Industries discharging directly into the Sound

Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Denmark			
Cement Works	Stevens Kridtbrud	m	0.6406
Rubber Goods	Codan Gummi	wt	0.1300
Chemical Works	DTH,Kemiafdelingens	m c	0.0985
Chemical	Ferrosan A/S	m	0.1144
Chemical	Pharmacia	n.i.	0.0020
Airport	Kobenhaven Kastrup	n.i.	n.i.
Pulp	Junckers Industrier	m	1.3484
Chemical	Kemisk Vaerk Koge	m b	0.7397
Sum			> 3.0736
Sweden			
Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Chemical	Hydro Supra	i	7.9000
Chemical	Kemira	i	n.i.
Sum			> 7.9000
Total			> 10.9736

n.i. no information
wt without treatment
m mechanical treatment
b biological treatment
c chemical treatment
i internal treatment

The reported Swedish chemical industries are using internal treatment methods. The Danish Junkers Industrier pulp industry, discharging about 50% of the Danish industrial wastewaters to the Sound, has only mechanical treatment. The summarized pollution load entering the Sound from industries is presented in Table 4.48 and in Figure 4.15.

Table 4.48

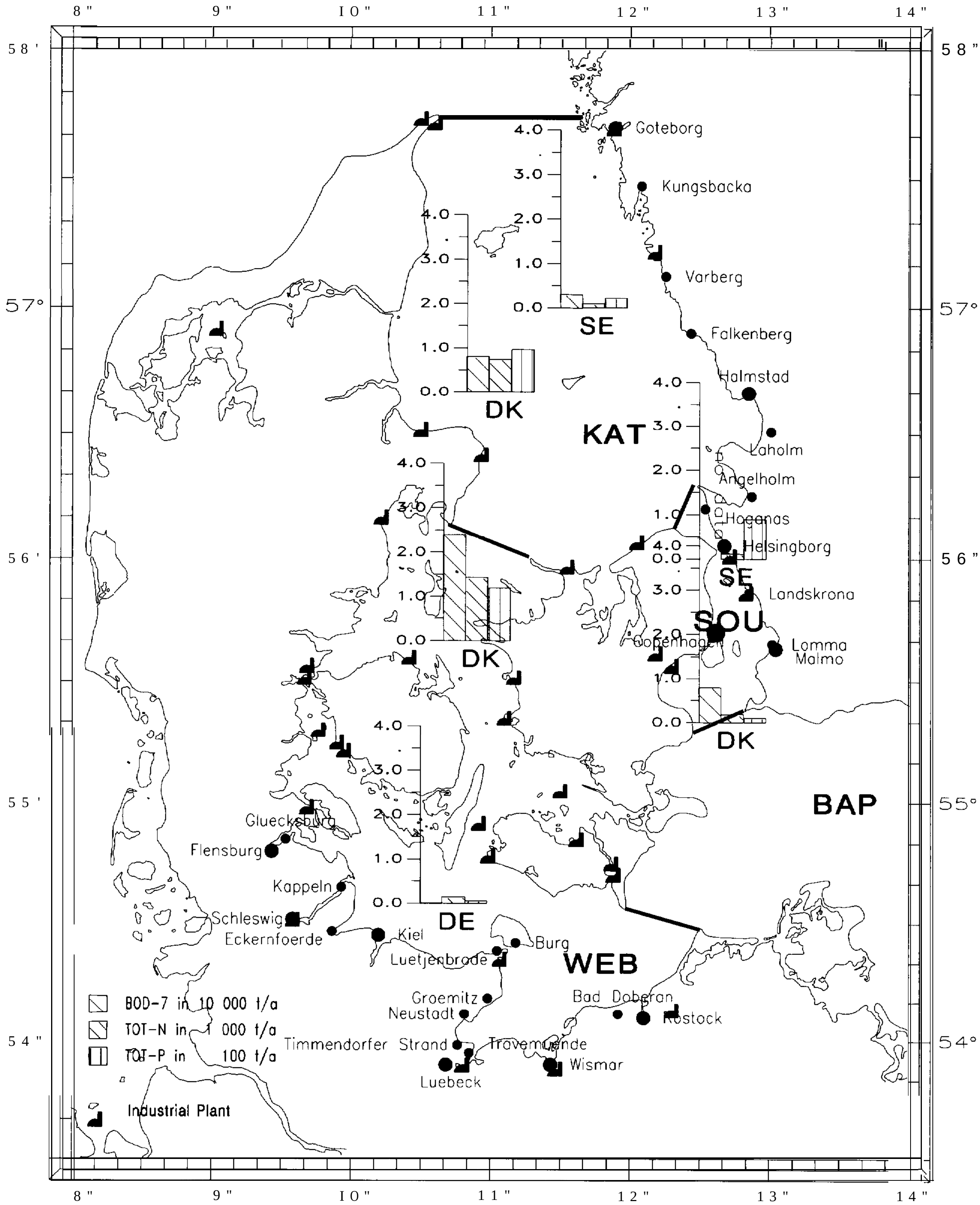
Pollution Load entering the Sound from Industries in 1990
t/a

Determinants	Denmark	Sweden	Sum
Q [$10^6 m^3/a$]	3.0736	7.9000	10.9736
BOD,	6 856.1220	n.i.	> 6 856.1220
BOD,	8 02 1.6627’	n.i.	> 8 02 1.6627
BOD21	n.i.	n.i.	n.i.
TOC’*	n.i.	n.i.	n.i.
COD,,	n.i.	n.i.	n.i.
COD,,, *	n.i.	n.i.	n.i.
Tot-P	10.1010	90.0000	100.1010
Tot-N	192.1370	1 19.0000	311.1370
NH,-N	n.i.	n.i.	n.i.
Hg	n.i.	0.0110	> 0.0110
Cd	n.i.	0.0200	> 0.0200
cu	n.i.	n.i.	n.i.
Zn	n.i.	n.i.	n.i.
Pb	n.i.	0.0250	> 0.0250
Numbers of plants	8	2	10

not obligatory
n.i. no information
1 BOD, = BOD, x 1.17

Comparable data are presented only for phosphorus and nitrogen. Industrial phosphorus and nitrogen load to the Sound is remarkable.

Pollution toad entering the Western Baltic, the Sound and the Kattegat from Industries in 1990



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Second Pollution Load Compilation (PLC-2)

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Fig. 4.15 Pollution Load entering the Western Baltic, the Sound and the Kattegat from Industries in 1990

Pollution load entering the different sub-regions of the Baltic Sea

4.9 The Kattegat

4.9.1 Pollution load via rivers

The Kattegat comprises the waters between the Danish and Swedish coasts within the imaginary lines HASENOREGNIBEN-GILLEJE KULLEN-SKAGEN MARSTRAND. The drainage area of the Kattegat is 78 650 km’ and is shared by Sweden (7 1 600 km’) and Denmark (I 5 800 km^2)(Table 4.49).

Table 4.49

Information about the drainage area of the Kattegat

	Denmark	Sweden	Total
Drainage area [km’] Drainage area of the reported rivers with measured flow [km’]	15 800 n.i.	71 600 63 522	87 400 > 63 522
Number of reported rivers	n.i.	7	> 7

n.i. no information

About 63 500 km’ of the drainage area is controlled hydrologically by Sweden. Hydrological and water quality stations at the Swedish rivers, as a rule, are in the same place and in a distance of 0.5 to 24 km from the sea. Sampling frequency is 12 times per year.

Information about the Danish rivers, which are very small, are presented on the basis of the Danish national reporting system.

The pollution load entering the Kattegat via rivers in 1990 is presented in Table 4.50 and in Figure 4.13.

Table 4.50

Pollution Load entering the Kattegat via Rivers in 1990
t/a

Determinants	Denmark	Sweden	Sum
Q [m^3/s]	163.0800	846.3000	1 009.3800
BOD,	n.i.	n.i.	n.i.
BOD,	n.i.	23 425.7650”	> 23 425.7650
BOD_{21}[a]	n.i.	n.i.	n.i.
TOC”	n.i.	161 557.0000	> 161 557.0000
s s	n.i.	n.i.	n.i.
COD_{Cr}	97 000.0000	n.i.	> 97 000.0000
COD,,”	n.i.	703 137.0000	> 703 137.0000
Tot-P	1 081.4000	1 201.9000	2 283.3000
PO,-P	n.i.	132.3600	> 132.3600
Tot-N	32 961.0000	30 845.0000	63 806.0000
NH,-N	n.i.	744.5000	> 744.5000
NO,-N	n.i.	239.2500	> 239.2500
NO,-N	n.i.	19 955.0000	> 19 955.0000
Hg	0.0023	0.0680	0.0703
Cd	0.0101	0.4450	0.4551
c u	0.4630	33.1540	33.6170
Zn	2.4370	213.6100	216.0470
Pb	0.2510	7.1360	7.3870

n.i. no information
not obligatory
[a] alternative
[3] BOD, = TOC x 0.145

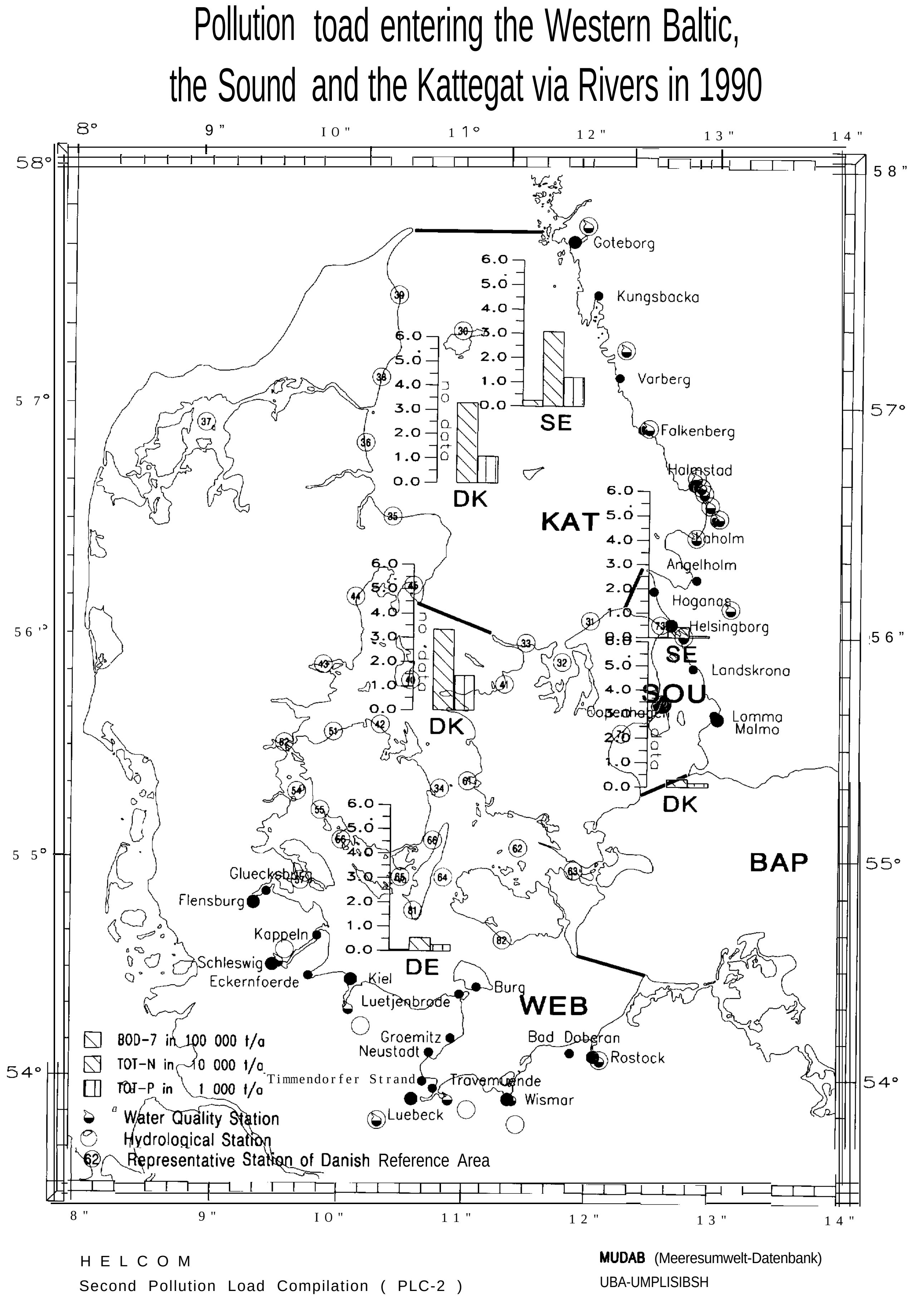

Fig. 4.13 Pollution Load entering the Western Baltic, the Sound and the Kattegat via Rivers in 1990

Pollution load entering the different sub-regions of the Baltic Sea

49.2 Pollution load from urban areas

Seven Swedish cities with a total population of about 210 000 inhabitants are discharging their wastewaters directly into the Kattegat. All cities are equipped with biological-chemical treatment systems (Table 4.5 1). Denmark has presented information about urban areas as sums of small settlements (< 10 000 PE, see previous chapters). As a rule, the wastewater from urban areas is treated biologically in Denmark.

Table 4.51

Municipalities discharging directly into the Kattegat

Denmark			
Municipalities#	People served	Flow 10” m^3/a	Treatment method
38	6 300	0.90	various
39	150 000	7.25	various
37	562 171	53.69	various
30	3 280	0.34	various
35	3 044	0.36	various
34	46 021	5.02	various
33	2 600	0.20	various
32	226 512	17.71	various
31	27 000	3.26	various
36	79 392	6.62	various
	1 106320	95.35	
Sweden			
Municipalities	People served	Flow 10^6 m^3/a	Treatment method
Angelholm	23 400	4.20	m b c
Laholm	17 300	2.20	m b c
Halmstad	60 000	12.10	m b c
Falkenberg	22 200	7.50	m b c
Varberg	25 700	5.70	m b c
Kungsbacka	27 100	4.90	m b c
Goteborg	542 000	119.00	m b c
	717 700	155.60	

m mechanical treatment
b biological treatment
c chemical treatment
numbers represent reference areas

The pollution load entering the Kattegat from urban areas in 1990 is presented in Table 4.52 and in Figure 4.14.

Table 4.52

Pollution Load entering the Kattegat from Urban Areas in 1990
t/a

Determinants	Denmark	Sweden	Sum
Q [$10^6 m^3/a$]	95.3460	155.6000	250.9460
BOD_5 *	2 596.6830	n.i.	> 2 596.6830
BOD,	3 038.1191'	1 805.0000	4 843.1191
BOD_{21}	n.i.	n.i.	n.i.
TOC *	n.i.	n.i.	n.i.
COD,,	7 304.7910	11 086.0000	18 390.7910
COD,,:	n.i.	n.i.	n.i.
Tot-P	241.2810	86.4000	327.6810
Tot-N	1 453.7970	2 920.0000	4 373.7970
NH,-N	n.i.	2 370.0000	> 2 370.0000
Hg	n.i.	0.0152	> 0.0152
Cd	n.i.	0.0345	> 0.0345
CU	n.i.	0.3600	> 0.3600
Zn	n.i.	7.1700	> 7.1700
Pb	n.i.	0.4520	> 0.4520
Number of urban areas	10	7	17

* not obligatory
n.i. no information
1 $BOD_7 = BOD_5 \times 1.17$

Pollution toad entering the Western Baltic, the Sound and the Kattegat from Urban Areas in 1990

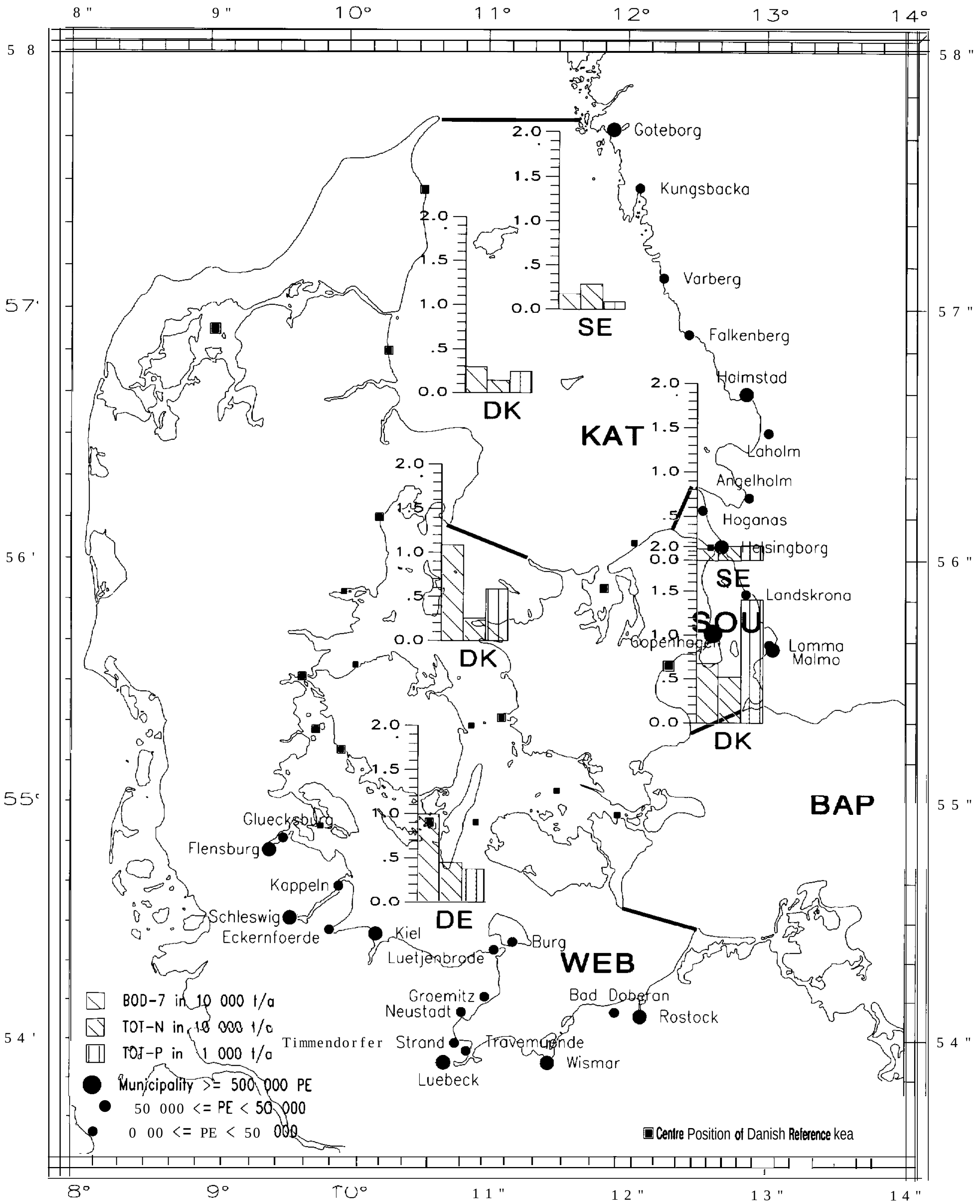

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Fig. 4.14 Pollution Load entering the Western Baltic, the Sound and the Kattegat from Urban Areas in 1990

4.9.3 Pollution load from industries

14 Danish and three Swedish industries are discharging their wastewater directly into the Kattegat (Table 4.53). Nine of the Danish industries are food-processing enterprises and discharge their wastewaters without treatment. One chemical industry (BASF Vitaminfabrik) and the Danska Sprit-fabriker use biological-chemical purification.

Two Swedish oil refineries are discharging their wastewaters directly to the Kattegat after biological treatment. The Swedish wood-fibre plant uses internal methods for purification.

Table 4.53

Industries discharging directly into the Kattegat

Denmark			
Branch of industry	Name	Treatment method	Flow 10^6 m^3/a
Food	Glyngore Limfjord	m	0.7540
Food	Daka Amba, Randers	m b	0.0800
Destillary	Danske Spritfabriker	m b c	0.3 107
Food	Fiskernes Filetfabri	b	n.i.
Food	Fiskernes Fishindus.	wt	6.7950
Food	Priess & Co A/S	n.i.	0.1202
Food	Vilslund Muslingein.	m	0.8560
Airport	Flyvestation Aalborg	m b	0.0730
Pharmaceutical	H. Lundbeck A/S	c	0.0678
Power Plant	VS Nordkraft	wt	n.i.
Food	Pumpest. Vesterhavet	wt	3.1791
Food	Velje Mussels Ind. B	n.i.	0.2850
Food	Velje Mussels Ind. S	n.i.	0.0640
Chemical Works	BASF Vitaminfabrik	m b c	0.4652
Sum			> 13.0500

Sweden			
Branch of industry	Name	Treatment method	Flow 10^6 m/a
Oil refinery	BP	b	1.1000
Oil refinery	Shell	b	1.2000
Wood-fibre	Vaeroe Bruk	i	29.2000
Sum			31.5000
Total			> 44.5500

n.i. no information
wt without treatment
m mechanical treatment
b biological treatment
c chemical treatment
i internal treatment

The summarized total pollution load entering the Kattegat from industries in 1990 is presented in Table 4.54 and in Figure 4.15.

Table 4.54

Pollution Load entering the Kattegat from Industries in 1990
t/a

Determinants	Denmark	Sweden	Sum
Q [$10^6 m^3/a$]	13.0500	3 1.5000	44.5500
BOD_5 *	6 858.4500	n.i.	> 6 858.4500
BOD,	8 024.3865'	3 031.0000	11 055.3865
BOD,, *	n.i.	n.i.	n.i.
TOC*	n.i.	n.i.	n.i.
COD_{Cr}	n.i.	15 361.0000	> 15 361.0000
COD,,'*	n.i.	n.i.	n.i.
Tot-P	96.6700	2 1.2000	117.8700
Tot-N	748.4680	103.0000	85 1.4680
NH,-N	n.i.	n.i.	n.i.
Hg	n.i.	0.0210	> 0.0210
Cd	n.i.	0.0050	> 0.0050
Cu	n.i.	n.i.	n.i.
Zn	n.i.	n.i.	n.i.
Pb	n.i.	0.0230	> 0.0230
Numbers of plants	14	3	17

* not obligatory
n.i. no information
1 BOD, = BOD, x 1.17

Main industrial loads of BOD, phosphorus and nitrogen into the Kattegat are coming from Denmark. The load of organic matter is exceptionally high. Heavy metals are not controlled by Denmark.

Pollution Load entering the Western Baltic, the Sound and the Kattegal from Industries in 1990

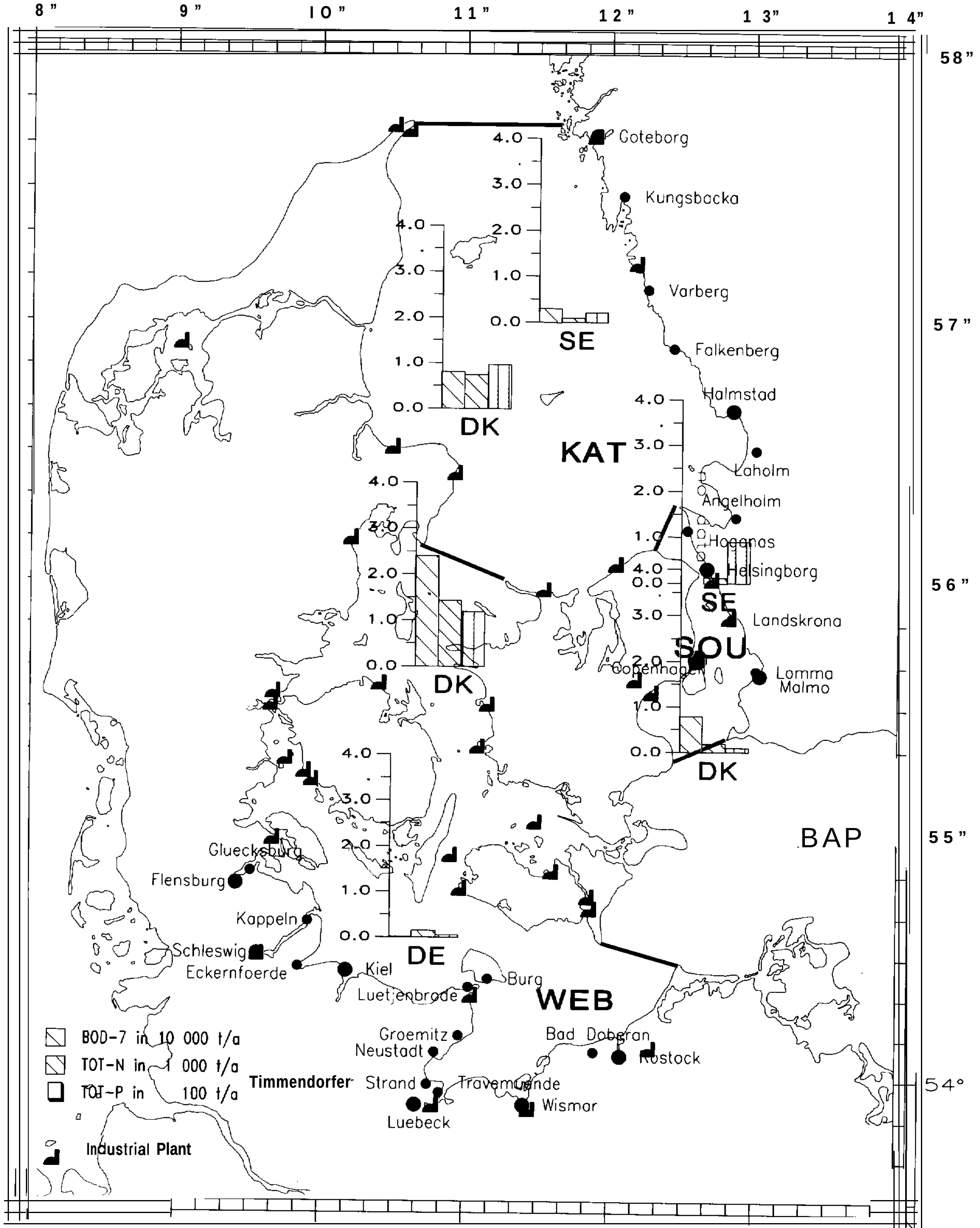

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Fig. 4.15 Pollution Load entering the Western Baltic, the Sound and the Kattegat from Industries in 1990

5 Total pollution load entering the Baltic Sea

In Chapter 4 the pollution load into each sub-region of the Baltic Sea is presented. In this chapter the total pollution load into the Baltic Sea in 1990 is reviewed. Three main determinants - organic matter as BOD,, total phosphorus and total nitrogen - are given. A presentation of a summary review on the basis of the other determinants is impossible due to several reasons: On the one hand, the lists of obligatory parameters by pollution source are not unified, and on the other hand data on BOD,,, TOC, COD,,, COD,,. and heavy metals, submitted by the countries, are not complete. The summed-up totals of the pollution load cannot be said to be based on measurements carried out to all parts according to the Guidelines. Neither can they be said to cover the whole input. The biggest sources of error and lack are probably the insufficient frequency of sampling, especially for untreated wastewater, inadequate flow measurements of point sources and the numerous small sources on the coast which were not required for in the Guidelines. However, this report gives valuable information about the order of magnitude of the load.

The readers might be interested in other displays e.g. pollution load into the Baltic Sea from urban areas or from industries or the specific load of pollutants for sub-regions’ volume or area unit, for one inhabitant etc. As the basic data are not always complete or not reliable such calculations can become a source of unjustified speculations. Therefore only sums are presented in the report. On the other hand it is possible for the readers to make the corresponding calculations themselves, on the basis of the published information and the data on the floppy disk.

5.1 Organic matter load entering the Baltic Sea in 1990

Out of the different parameters for the proof of organic matter load the reported data cover BOD,, which is therefore selected for presentation.

However, in spite of the fact that BOD, was an obligatory parameter for all three pollution sources, the presented data are not complete. Not all the countries measured BOD, or calculated it from BOD,. Thus the conversion factor 1.17 had to be applied, which is scientificly incorrect.

In addition, due to the low concentrations Sweden and Finland have not included BOD, into their national programmes for river studies. This leads to the fact, that the BOD, load introduced into the Baltic Sea via rivers is presented as estimated. Sampling frequency adds its own influence to the reliability of the data. Not all the countries have monitored their rivers 12 times per year, as it is foreseen in the Guidelines.

The loads of wastewater from urban areas and industries have been estimated according to the Guidelines. Big mistakes can appear if the load of untreated wastewater is estimated on the basis of single measurements or water consumption.

In Table 5.1 and in Figures 5.1a and 5. lb the total load of organic matter introduced into the Baltic Sea is presented by pollution source and by sub-region.

Table **5.1**

Organic matter (BOD,) Load entering the Baltic Sea in 1990
t/a

Sub-region	Rivers	Urban Areas	Industries	Total
BOB	79 792.9750	2 730.5000	18 457.0000	100 980.4750
BOS	88 536.1300	1 055.3000	58 298.0000	147 889.4300
ARC	7 780.0000	741.7000	202.0000	8 723.7000
GUF	201 934.9000	70 027.2400	14 323.8800	286 286.0200
GUR	101 806.9000	38 923.4000	862.6070	141 592.9070
BAP	> 529 861.6200	> 60 002.9794	19 336.2216	> 609 200.8210
WEB	> 4 528.2600	20 804.4326	24 141.9754	> 49 474.6679
SOU	> 488.9400	8 147.7683	> 8 021.6627	> 16 658.3710
KAT	> 23 425.7650	4 843.1191	11 055.3865	> 39 324.2706
Total	> 1 038 155.4900	> 207 276.4393	> 154 712.9332	> 1 400 144.8626

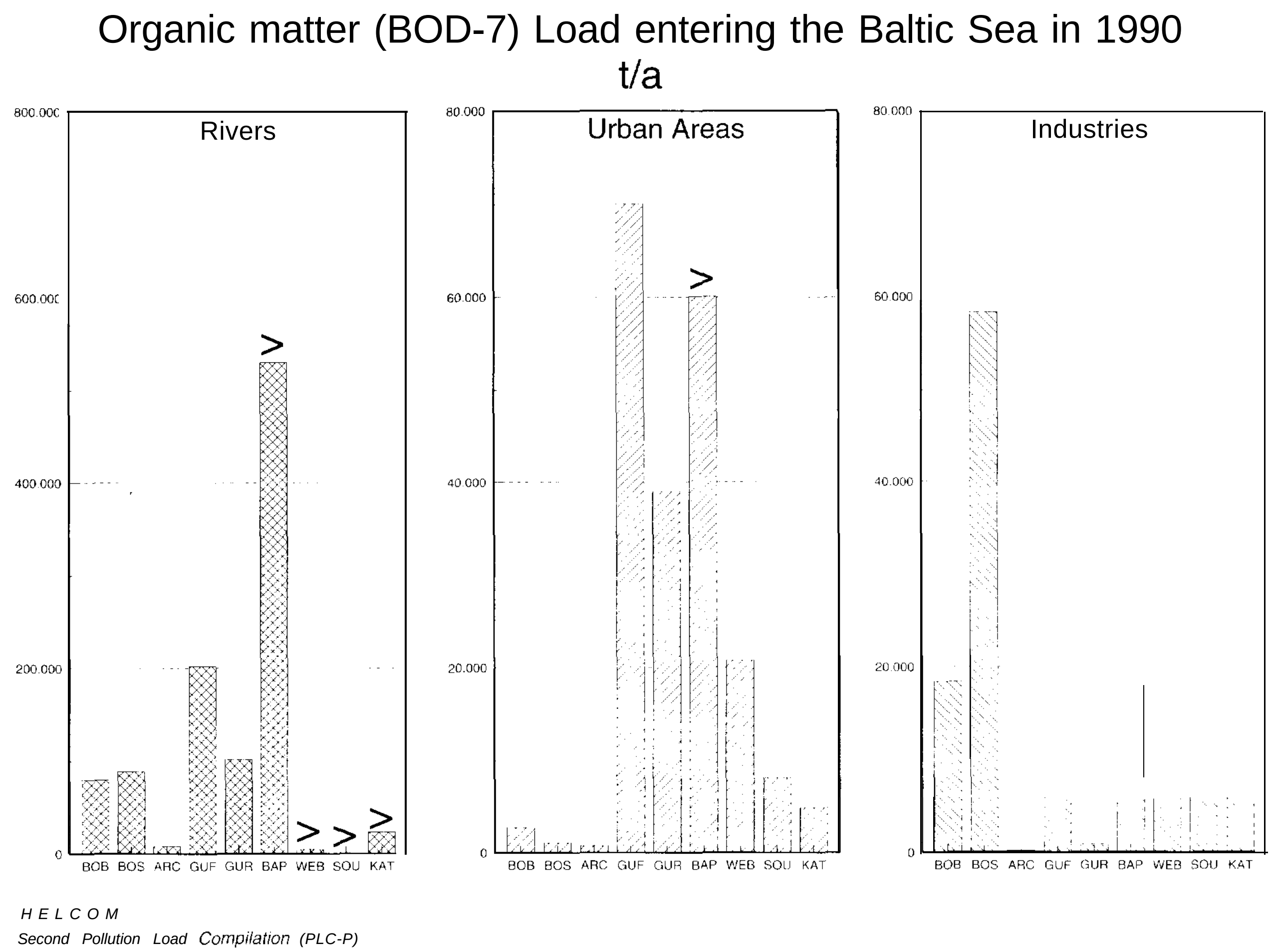

Fig. 5.1a Organic matter (BOD,) Load entering the Baltic Sea in 1990

BOD-7 Load entering the Baltic Sea in 1990

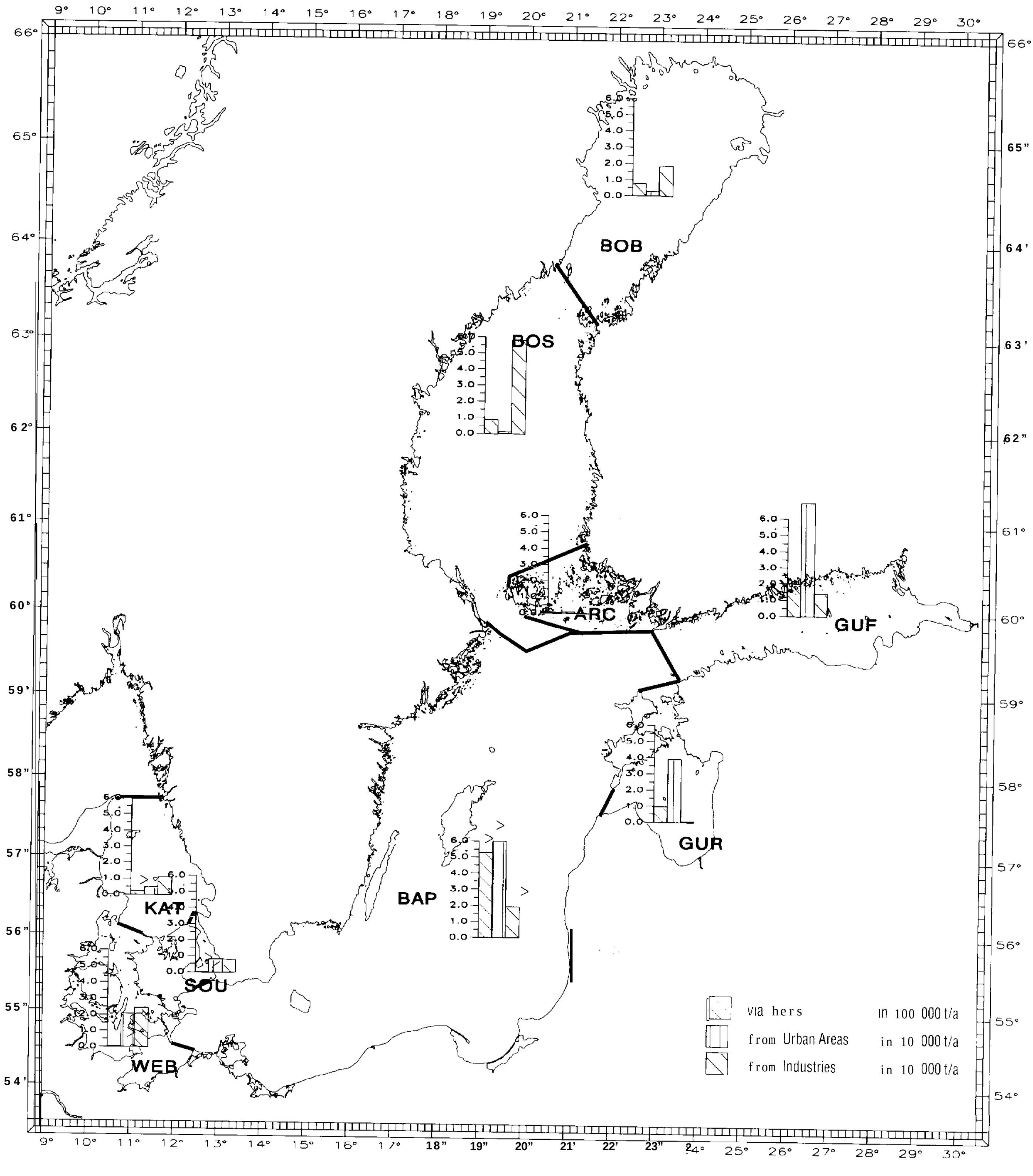

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Fig. 5.1b Organic matter (BOD,) Load entering the Baltic Sea in 1990

5.2 Phosphorus load entering the Baltic Sea in 1990

According to the Guidelines the countries had to present data about the loads of total phosphorus and orthophosphate. For many reasons - already described in the previous paragraph - the data about phosphorus are also incomplete and the real amount of phosphorus carried into the Baltic Sea via rivers and wastewaters can be expected to be higher.

In Table 5.2 and in the Figures 5.2a and 5.2b the total load of phosphorus entering the Baltic Sea in 1990 is presented by source and by sub-region.

Table 5.2

Total Phosphorus Load entering the Baltic Sea in 1990
t/a

Sub-region	Rivers	Urban Areas	Industries	Total
BOB	2 134.1500	49.2000	162.1190	2 345.4690
BOS	1 850.6400	56.0000	355.8570	2 262.4970
ARC	664.0000	30.9000	139.5300	834.4300
GUF	7 641.7000	4 078.1060	70.2950	11 790.1010
GUR	2 704.9000	649.4600	34.2800	3 388.6400
BAP	> 14 158.1300	2 902.2010	746.9300	> 17 807.2610
WEB	1 699.2300	964.1658	123.9090	2 787.3048
sou	223.9800	1558.1920	100.1010	1 882.2730
KAT	2 283.3000	327.68 10	117.8700	2 728.85 10
Total	> 33 360.0300	10 615.9058	1 850.8910	> 45 826.8268

Total Phosphorus Load entering the Baltic Sea in 1990
t/a

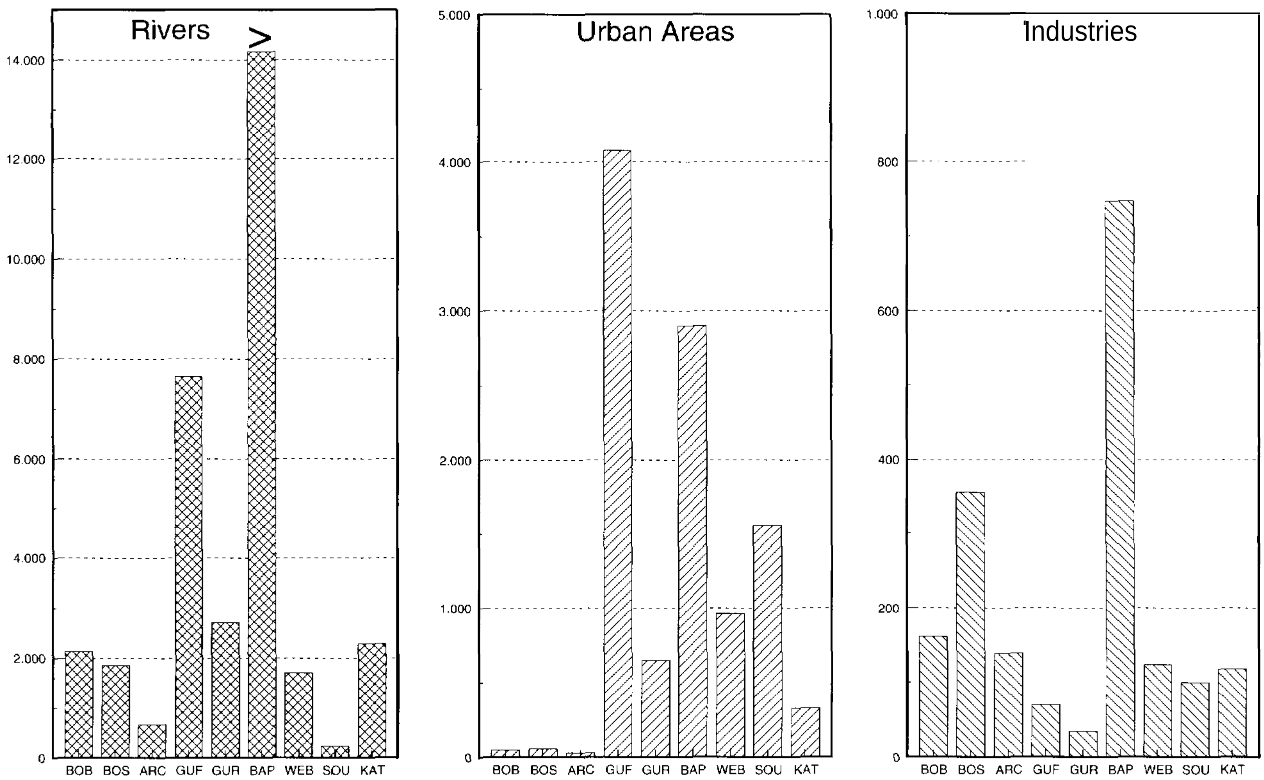

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Fig. 5.2a Total Phosphorus Load entering the Baltic Sea in 1990

Total Phosphorus Load entering the Baltic Sea in 1990

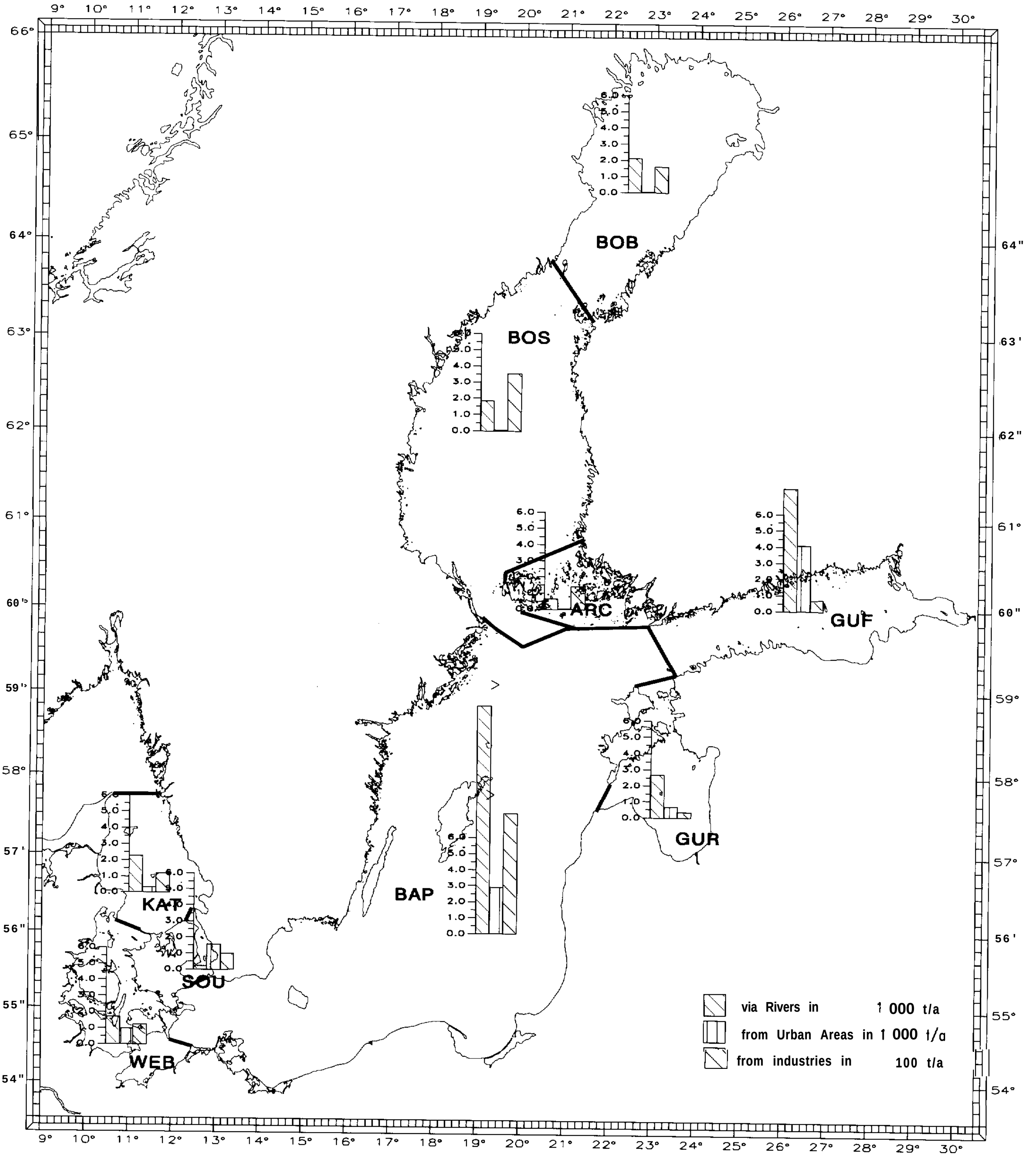

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Fig. 5.2b Total Phosphorus Load entering the Baltic Sea in 1990

Total pollution load entering the Baltic Sea

5.3 Nitrogen load entering the Baltic Sea in 1990

The list of nitrogen compounds, which had to be controlled for different pollution sources, is given in the Guidelines. Total nitrogen is common for all the pollution sources and its load into the Baltic Sea is characterized in Table 5.3.

As for organic matter and phosphorus, the data about nitrogen are not complete, too. The most common problem here is the substitution of total nitrogen with the sum of the different mineral compounds which results in loads smaller than the real ones.

The total load of nitrogen entering the Baltic Sea in 1990 is presented in Table 5.3 and Figures 5.3a and 5.3b .

Table 5.3

Total Nitrogen Load entering the Baltic Sea in 1990
t/a

Sub-region	Rivers	Urban Areas	Industries	Total
BOB	35 033.7000	1 629.5000	1 567.4260	38 230.6260
BOS	42 985.0000	1 398.6000	3 096.9840	47 480.5840
ARC	7 870.0000	939.5000	1 101.0960	9 9 10.5960
GUF	109 529.5000	30 045 .0000	867.9050	140 442.4050
GUR	79 965.8000	5 060.5000	28 1.0900	85 307.3900
BAP	182 136.1800	24 660.1750	2 462.8100	209 259.1560
WEB	38 821 .0000	7 07 1.9739	1 582.9420	47 475.9159
s o u	7 59 1 .0000	6 815.1100	311.1370	14 717.2470
KAT	63 806.0000	4 373.7970	85 1.4680	69 03 1.2650
Total	567 738.1800	81 994.1559	12 122.8580	661 855.1939

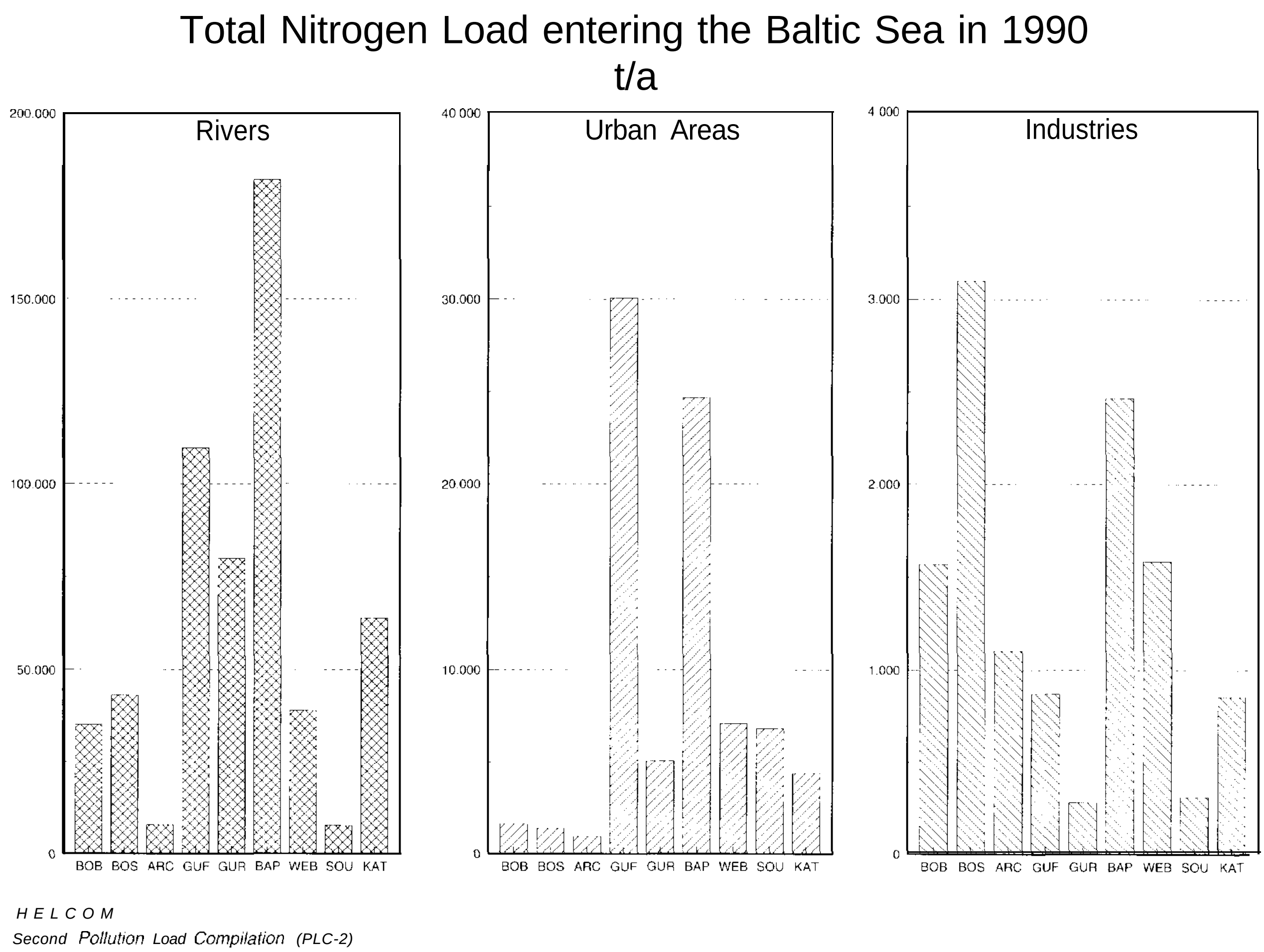

Fig. 5.3a Total Nitrogen Load entering the Baltic Sea in 1990

Total Nitrogen Load entering the Baltic Sea in 1990

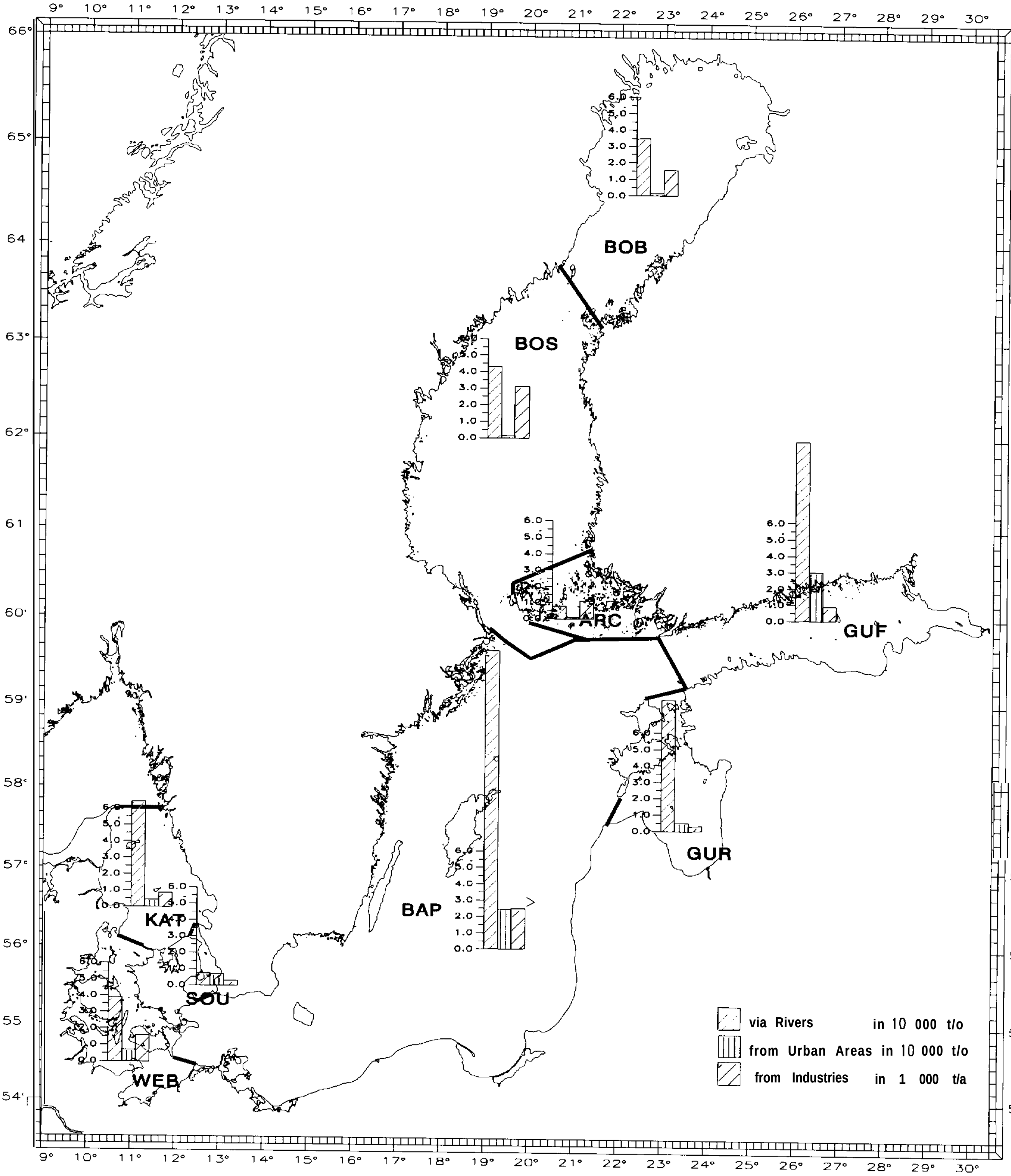

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Fig. 5.3b Total Nitrogen Load entering the Baltic Sea in 1990

6 Discussion

The Second Pollution Load Compilation reports the pollution load of some pollutants that enter the Baltic Sea via rivers and from different point sources located at the coast and determines the priority order of the pollution sources and pollutants. Together with open sea Assessments and coastal Assessments which deal with the effects of the pollution on the natural resources of the Baltic Sea, the PLC-2 can be used for better understanding and estimation of ecological processes in the Baltic Sea influenced by human activities.

The PLC-2 is more complete and precise than the first one, however, many uncertainties remain due to incomplete data sets, inadequate or non-comparable measurement methods and also the fact that the Guidelines for the PLC-2 are covering the main pollution sources only. The Contracting Parties decided during the preparation of the Guidelines not to present information about small rivers ($Q < 5\ m^3/s$), small settlements (< 10 000 PE) and the diffuse loading from the coastal zone between the measured rivers. Information about by-passes and overflows was neither presented. Therefore, the information should be used with care in order to avoid misinterpretation. The data should not be used without the information about the methodologies applied.

The aim of the discussion is to reveal some issues that have arisen in the course of the work and to draw the readers' attention to some problems that need to be solved before the work on the next Pollution Load Compilation (PLC-3) will start. Questions to be discussed concern, *inter alia*, flow measurements, sampling equipment and frequency, chemical analyses, reliability of the PLC-2 data. The scope and the use of future compilations, the structure of the Guidelines and the reporting system should also be considered.

Flow measurement

Flow measurement is a key element in determining the order of magnitude of a discharge.

The river flow in most cases varies more than the concentration. Thus, it is of great importance that the flow is registered continuously in the main rivers. The main rivers in the Baltic Sea drainage area, as a rule, have the permanent hydrological stations corresponding to the "Guidelines for Hydrological Practices" which was prepared and published in 1965. Flow measurement of small and minor rivers without permanent hydrological stations should still be harmonized.

The eastern and southern coast of the Baltic Sea is very low and for that reason the permanent hydrological stations are very often situated far from the coast. Quite often the permanent hydrological stations are situated at a distance of 50-60 km from the coast. The Contracting Parties have not presented the information how they have transferred the measured flow to the river mouth. In the new Guidelines the harmonized calculation method should be presented.

The industrial and municipal wastewater flow from purification plants, as indicated in national reports, is measured and registered continuously. The main difficulties are connected with the measurement of untreated wastewaters, overflows and by-passes. The measurement of untreated wastewater is a problem for the countries in transition, especially for the big cities such as St. Petersburg and Riga, which have a great number of outlets.

As indicated in the national reports, very often the wastewater amounts have not been measured but determined on the basis of water consumption and, therefore, are not precise enough. The problem of control and measurement of the overflows and by-passes, which is a difficult task for all the Contracting Parties, must be solved during the preparation of the new Guidelines.

Sampling equipment and sampling frequency

The main problem in calculating river loads is insufficient sampling frequency. Estonia, Latvia and Russia have not followed the frequency of sampling recommended in the Guidelines. The main task is to increase the sampling frequency from rivers up to at least 12 times per year. Sampling frequency concerning minor rivers ($< 5\ m^3/s$) should also be determined in the new Guidelines. For the big rivers such as Neva, Daugava and Vistula the important question is the sampling procedure which takes into account cross section distribution of concentrations.

Monitoring of the treated wastewaters at big plants in western countries is carried out with automatic samplers that guarantee the needed mean values. In eastern countries, as a rule, grab samples are taken. Monitoring of untreated and mechanically treated wastewaters, which have big concentration and flow variations, is lacking. The load estimates should be based not only on grab sampling and water consumption figures but also on more complete measurements and qualified estimates of the household and industrial wastewater discharges.

In developing the Guidelines for the PLC-3 a special attention should be paid to the sampling of untreated and mechanically treated wastewaters and to the calculation methodology of pollution load.

Chemical analyses

The main problem does not seem to be the differences between national and international standards but the pretreatment of samples and laboratory chemicals, equipment and practice, about which little is known. In most countries not even the central authorities are well acquainted with the field practice. Standards and directives do not seem to be followed to all parts. Some obligatory parameters listed in the Guidelines have been partly ignored by the Contracting Parties. Finland and Sweden have not measured the BOD, in rivers. Denmark, Estonia, Latvia, Lithuania, Poland and Russia have substituted the BOD, with BOD,. Total nitrogen is determined as a sum of the mineral nitrogen in Estonia, Latvia, Lithuania and Russia. Total phosphorus is calculated on the basis of orthophosphate in Latvia, Lithuania and Russia. Only few countries have measured additional paramenters such as BOD_{21}, TOC or COD,,,. Quite often the heavy metal concentrations have not been measured in rivers.

During the PLC-3 preparation phase the first task is to gain a new agreement upon the list of obligatory determinands to be monitored. The second task is to organize a special workshop for intercalibration of obligatory parameters. At least one leading laboratory from each country must take part in this work. Better exchange of information should be organized to guarantee a better comparability of the data.

Reliability of the results of the PLC-2

Naturally, the Contracting Parties are responsible for the quality and reliability of data. The Contracting Parties have not presented any information about quality assurance of data based on careful analyses of the original data and measurement methodologies.

The most significant sources of errors are probably connected to a lack of measurement equipment for untreated wastewaters in the countries in transition. The second problem is ignoring the measurement of some obligatory parameters by the Contracting Parties. The third problem is a lack of information about overflows and by-passes from the Contracting Parties and as well as about diffuse loading to the coastal zone and from small rivers ($< 5\ m^3/s$). The biggest gap in the Finnish and Swedish data may be related to the absence of the loads of small municipalities and scattered settlements along the coastline. The significance of these loads will, however, in Sweden most probably not exceed an increase of 15% to the total Swedish load of nutrients. In Finland the increase might be somewhat higher , about 25%. One of the sources of errors is the recalculation of national data not reported according to the PLC-2 reporting formats.

The sources of errors related to the measurements done, including flow measurement, sampling and analyses, may be systematic as well as non-systematic. The non-systematic errors do not probably affect the total sums of load introduced by source or by country. On the other hand, the systematic errors are probably specific both for the different countries, different sources and different laboratories and might also, to some extent, neutralize each other. A brief look into the original data shows, however, that the systematic errors in many measurements may be of significance for the interpretation of the results. For instance, the calculated load from border rivers, measured by two countries, may for some variables differ significantly from each other and cause respective consequences for the professional interpretation of what is going on in the state of the water quality in the receiving sub-region or estuary. The same kind of systematic differences may also be noted in the results for point sources.

In spite of what has just been said it is believed that the overall results concerning nutrients and BOD, give a rather reliable picture of the order of magnitude of the total load on the Baltic Sea and its sub-regions. The results are, however, too uncertain to be used for scientific purpose without a careful study of the measurement methodologies. For other parameters the lacks and errors were judged too big to allow for an overall presentation.

Databases for the PLC and “Hot Spots”

Data for the PLC database, as a rule, constitute one part of the national pollution load data bases. These contain also information on, *inter alia*, “Hot Spots”, as defined by the HELCOM Task Force project. It is in every aspect logical to coordinate the supplementary information about the “Hot Spots” needed for the HELCOM PITF with the PLC database. But, taking into account the main tasks of the HELCOM and the HELCOM PITF, the system should not be loaded with complementary pollution data from the whole drainage basin. In addition to the problems already discussed, possible introduction of “Hot Spots” in the PLC database will raise new questions to be answered before the compilation of the next report.

The anthropogenic part of the river load

Important aims of Pollution Load Compilations are to determine the priority order of different pollution sources and pollutants and to assess the efficiency of measures taken to abate the pollution. Since a significant part of the pollution is introduced to the sea via rivers, it is of importance to investigate the part of the riverine load caused by human activities. This calls for investigations of the land use and the runoff from agriculture, forestry, peat production and other activities as well as for investigations of point sources such as industries and municipalities upstream the rivers. Especially the load from diffuse sources provides for time-consuming regional research programs. In some countries this kind of investigation has been made and the possibilities to introduce the anthropogenic part of the riverine load in the PLC-3 should be discussed. Moreover, it should be noted that the Ministerial Declaration, 1988 called for this kind of investigations and that the reporting on the reduction of pollution load between the years 1987 and 1995 should be an exercise in this direction.

Pollution load and modelling of impacts

Compiled pollution load data are needed to assess the state of the open Baltic Sea area as well as of the coastal waters. In this context, the load data are also used for modelling and forecasting man-induced changes. However, since some of the land-based pollution load is accumulated and transformed in the estuaries, bays, lagoons and archipelago of the coastal waters, it must be questioned, whether the PLC data as such can be used in large scale models for the open sea. Many local coastal models and some large scale models already exist, but the links between them are not clarified. Many local models provide monthly input load data while the PLC data are collected as annual loads. Thus it seems that modelling and forecasting the state of the Baltic Sea and its coastal areas still need more specific data than those that can be delivered by the PLC. The development of models and their need for data should be discussed within the HELCOM.

Reporting formats and reporting systems

Shortcomings in the implementation of the PLC-2 Guidelines and in the reporting system with respect to time-tables and reporting formats should be carefully analyzed. The Guidelines should be developed accordingly. Moreover, the new Guidelines should include small point sources and untreated waste-waters as well as the runoff from small rivers and coastal zones. Furthermore, the reporting formats should be developed to serve the introduction of “Hot Spots” and the anthropogenic part of the riverine load. Measurement methods should be reported more specifically and the reasons for a lack of data be clarified. The responsibility of updating and correcting of data should as far as possible be delegated to the Contracting Parties.

7 Conclusions

This Second Baltic Sea Pollution Load Compilation (PLC-2) is a result of close cooperation between all the Contracting Parties to the Helsinki Convention. Compared to the First Pollution Load Compilation done in mid 1980's, it is a significant step forward as it gives much more reliable data on the total loads on the Baltic Sea and describes the methodologies used in the different countries.

The Guidelines for the PLC-2 recommended by the Helsinki Commission in 1989 were of great help for the success of the work. In the course of the project it was decided that the data collected should be more detailed than originally recommended. Thus, the volume of the presented data exceeds the amount of information asked for in the Guidelines. This has been possible due to the political changes in the Baltic Sea region and it will serve later attempts to judge upon trends in the pollution loads. However. due to lacks and uncertainties in the PLC-2 data and developing methodologies, trends shall not be easy to document. Moreover, the riverine loads are most dependent on meteorological factors.

With the ratification of the 1992 Convention the Contracting Parties will undertake to protect the Baltic Sea by implementing relevant measures in the whole catchment area. Since it is well known that a big part of the pollution load is transported into the Baltic Sea via rivers, an important task for the next PLC-projects will be to initiate investigations of the anthropogenic sources for the riverine load, especially in the countries where this has not yet been done, and to create files for this kind of data in the database.

To reach the aims of the Pollution Load Compilations as described in the introduction part of this report there are still many problems to be solved. From the experiences obtained the main tasks may be listed as follows:

1. To implement methodology to estimate the pollution load of untreated wastewaters, by-passes and overflows.

2. To implement methodology to estimate the load from agriculture. forestry, peat production, scattered settlements and other activities contributing to the diffuse load.

3. To improve the measurements of riverine load especially with regard to sampling frequency and analytics and to include small rivers and coastal zones in the reporting programme.

4. To review the list of obligatory parameters to be determined together with recommended analyses, and to review the guidelines for sampling, preservation and pretreatment of the sample as well as for calculation methods.

5. To establish a database for the collection of pollution load data, including not only river loads and loads from direct point sources at the coast, but also, e.g., so-called “Hot Spots” and the anthropogenic part of the riverine load.

ANNEX I

Table of Tables on Disk

ANNEX II

Abbreviations

a	alternative
ad	adsorption
ARC	Arcipelago Sea
ATU	Ally1 Thiourea (nitrification inhibitor for BOD measurement)
b	biological
BAP	Baltic Proper
BOB	Bothnian Bay
BOD	biochemical oxygen demand within 5, 7, or 21 days (BOD,, BOD,, BOD,,); measure for the amount of oxygen which is used by microorganisms in wastewater within 5, 7 or 2 1 days at a temperature of 20°C
BOS	Bothnian Sea
BSEP	Baltic Sea Environment Proceedings
BY	Belarus
c	chemical
Cd	Cadmium
CEMA	Council for Economic Metrical Assistance
COD	chemical oxygen demand; measure for the amount of oxidizers which is necessary for the decomposition of pollutants in water
CP	Contracting Party
c s	Czechoslovakia
CU	Copper
d	denitrification
DE	Germany
DEV	German Standard Methods (Deutsches Einheitsverfahren)
DK	Denmark
dp	daily flow proportional sample
EC/EGAP	Environment committee / Expert Group on Atmospheric Pollution
EE	Estonia
f	filtration
FI	Finland
GDR	German Democratic Republic
GUF	Gulf of Finland
GUR	Gulf of Riga
HELCOM	Helsinki Commission
Hg	Mercury
i	internal
IS0	International Standardisation Organisation
KAT	Kattegat
L	Load
LT	Lithuania
LV	Latvia
m	mechanical
n	nitrification
NH,-N	Ammonium-Nitrogen

NO	Norway
NO_2-N	Nitrite-Nitrogen
NO,-N	Nitrate-Nitrogen
Pb	Lead
PE	Population Equivalent (amount of wastewater/capita)
Ph	Physical treatment (activated carbon)
PL	Poland
PLC	Pollution Load Compilation
PLC-2	Second Baltic Sea Pollution Load Compilation
PO_4-P	Orthophosphate-Phosphorus
Q	Flow
r	recirculation
RU	Russia
SE	Sweden
s s	Suspended Solids
STC	Scientific Technical Committee
TOC	Total Organic Carbon
Tot-N	Total Nitrogen
Tot-P	Total Phosphorus
UA	Ukraine
WEB	Western Baltic
wp	weekly flow proportional sample
wt	without treatment
Zn	Zinc