GIWA

Global International Waters Assessment

Baltic Sea

GIWA Regional assessment 17

Lääne, A., Kraav, E. and G. Titova

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Baltic Sea

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Preface

The Global International Waters Assessment (GIWA) has been given the unique task of assessing current problems and future threats of transboundary aquatic ecosystems, considering both environmental as well as socio-economic issues in freshwater and marine ecosystems on the entire globe.

The Baltic Sea, being enclosed by nine countries, has an obvious transboundary character. This is illustrated by a history of more than 100 years of international cooperation around the Sea, starting with the foundation of the International Council for the Explorations of the Sea (ICES) at Copenhagen in 1902.

Since then, the Baltic Sea has been subject to a variety of assessments, reports and discussions. However, the GIWA report is the first to present major environmental and socio-economic issues in a global context. This report is the 18^{th} report published in the series of GIWA regional reports. Similar assessments have been conducted for the Pacific Islands, the Amazon Basin, the Barents Sea and the East African Rift Valley Lakes, to name some examples. The coherent GIWA method enables global comparison of the Baltic Sea region results, thereby providing information and guidance to policy makers.

It is with great pleasure that I welcome the current report that summarises the state of the Baltic Sea.

Harry Liiv
Deputy Secretary General on Environmental Management
Ministry of the Environment, Estonia

Executive summary

The GIWA region 17 Baltic Sea is located in northeast Europe, comprising a catchment area of 1 720 270 km^2, of which nearly 93% belongs to the nine riparian countries; Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. Five upstream states, Belarus, Ukraine, Czech Republic, Slovakia and Norway, account for the remaining 7% of the catchment area. The Baltic Sea is one of the largest brackish water areas in the world, is an almost enclosed sea, connected to the North Sea by the narrow and shallow waters of the Belt Sea and the Sound only. This is a sea comprising of a complex system of water basins, which can be further divided into several gulfs and bays. The physical characteristics of the Baltic Sea including its hydrographic, hydrochemical and biological properties as well as socio-economic characteristics, makes it very sensitive to anthropogenic pressures.

The GIWA assessment evaluated the relative importance of different concerns in the Baltic Sea region. Environmental and socio-economic impacts were assessed under present and future conditions, and overall impacts and priorities were identified. The GIWA assessment ranked Pollution as having severe impact in the region, whereas all of the other concerns except for Global change had a moderate impact. Global change was not considered to have significant impacts in the Baltic Sea region at present. The concerns for the Baltic Sea region were ranked in descending order:

1. Pollution
2. Unsustainable exploitation of fish and other living resources
3. Habitat and community modification
4. Freshwater shortage
5. Global change

There is expected to be no major changes in the future regarding the concerns of Freshwater shortage, Habitat and community modification or Unsustainable exploitation of fish and other living resources. The impact of Global change is however predicted to increase. Environmental protection measures; such as biological wastewater treatment, nitrogen and phosphorus removal, use of best available technology (BAT) and best environmental practice (BEP), are expected to bring about a reduction in the nutrient load in the region, thus decreasing the impact of pollution. Generally no significant change of the region's population size is expected, although in some coastal areas the population may increase due to further migration and urbanisation. Consequently, pressure on the coastal areas will increase.

The issues of eutrophication and overexploitation were assessed causing severe impacts in the region and were also considered as having the most transboundary impacts; the Causal chain analysis was therefore conducted on these two issues. The input of nitrogen has decreased considerably in the Baltic Sea following the implementation of measures by the riparian countries, however eutrophication still remains an urgent problem in most coastal areas. Fishing activities are effecting the species composition and size distribution of the main target species as well as non-commercial fish stocks. Despite regulations, fishing fleets continue to overexploit the fish stocks in the Baltic Sea.

The immediate causes of eutrophication identified in the Causal chain analysis were the aquatic load of nutrients from urban areas and agriculture, and the atmosphere deposition of nitrogen into the Baltic Sea, mainly from the energy and transport sector. The root causes connected to the issue involved difficulties in integrating agriculture, energy and transport policies into a broader environmental context, for example inadequate adoption of modern agricultural technology, lack of investment in wastewater facilities, as well as population growth and increased road and sea traffic.

The causal chain analysis identified the immediate causes for overexploitation to be a combination of high exploitation rates and overutilisation of fishing quotas on the one hand and an oversized fleet capacity on the other. Economic factors such as fishing subsidies, market failure and reform failures, are driving these immediate causes but inappropriate assessment methods and other governance weaknesses are also inhibiting the successful management of the fisheries.

The Policy option analysis aimed to address the root causes identified in the Causal chain analysis. Identified policy options and the mechanisms necessary to solve the problems were identified for the Baltic Sea region, taking into account the international obligations and agreements adopted by the Baltic Sea states during the last two decades. There have been a number of international agreements that have established a framework for reducing the nutrient enrichment of the Baltic Sea and for managing the fisheries resource. The most important of these are the Convention on the protection of the marine environment of the Baltic Sea (Helsinki Convention); the Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and the Belts (Gdansk Convention), and for the EU member states, the Water Framework Directive (WFD).

For aspects concerning eutrophication the following courses of action were identified:

- Integrate agricultural, energy and transport policy with the environmental policy proposed by the European Commission, the Helsinki Commission, the International Baltic Sea Fishery Commission and other international conventions in order to reduce the discharge of nutrients to the Baltic Sea.
- Cooperate with countries outside the EU, such as Russia, Belarus and Ukraine, with the aim to harmonise their environmental legislation with the EU countries, such as adopting the EU Water Framework Directive.
- Support and develop existing agricultural cooperation projects and networks.
- The European Commission is invited further to support the implementation of transboundary environmental projects.
- Governments are invited to support economically the implementation of new environmentally friendly technologies in agriculture, transport and energy production.
- Governments, especially in the new EU countries and Russia, are invited to support investments in wastewater treatment facilities to reduce emissions from heat and electricity production units as well as from road and sea traffic.

Concerning aspects related to overexploitation of living resources the following course of action were identified:

- An integration of fishery policies with economic and environmental strategies in order to strengthen sustainable fisheries.
- Development of comprehensive approaches combining decommissioning schemes and regulatory measures, and the construction of a stabile system of taxation, prices of fuel and materials.
- Establish more stringent control over vessel documentation and fishing statistics.
- Ensure obligatory registration of all catches and all export transactions on land.
- Improve and unify a system of fish auctions for all Baltic countries.
- A creation of appropriate assessment methods leading to the establishment of reliable total allowable catches (TACs).
- Improve the reporting of landings by introducing an electronic network and exchange of this information between Baltic countries.
- Support for the construction of appropriate fishery laws that can efficiently manage the new market conditions is emphasised.

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This report of the Global International Waters Assessment is the result of the regional Task team. The authors would like to recognise the valuable contributions of experts, advisors and representatives of the countries of the Baltic Sea region.

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Abbreviations and acronyms

BAP	Best Agricultural Practice
BAT	Best Available Technology
BEP	Best Environmental Practice
BSP	Baltic Sea Project
BSRP	Baltic Sea Regional Project
CAP	Common Agricultural Policy
CEPI	Confederation of European Paper Industries
CFP	EU Common Fisheries Policy
ELV	Emission Limit Values
ERB	European Baltic cooperation
FAO	United Nations Food and Agriculture Organization
GDP	Gross Domestic Product
GEF	Global Environmental Facility
HELCOM	Helsinki Commission
IBSFC	International Baltic Sea Fishery Commission
ICES	International Council for the Explorations of the Sea
IFI	International Financial Institution
JCP	Joint Comprehensive Programme
JTDP	Joint Transnational Development Programme
LME	Large Marine Ecosystem
MWWTP	Municipal Waste Water Treatment Plant
NGO	Non Governmental Organisation
NEMO	Non-Indigenous Estuarine and Marine Organisms
PHC	Petroleum HydroCarbons
PLC	Pollution Load Compilation
TAC	Total Allowable Catches
TFC	Total Final energy Consumption
UNEP	United Nations Environment Programme
WQO	Water Quality Objectives
WFD	Water Framework Directive
WGA	Working Group on Agriculture
WSSD	World Summit on Sustainable Development

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Regional definition

This section describes the boundaries and the main physical and socio-economic characteristics of the region in order to define the area considered in the regional GIWA Assessment and to provide sufficient background information to establish the context within which the assessment was conducted.

Boundaries of the region

The main objective when defining the geographic boundaries of the GIWA Baltic Sea region was that it should embrace estuarine, coastal and open waters, defined by GIWA as "international waters", that constitute a source and/or recipient of potentially significant transboundary environmental impacts. The Baltic Sea regional boundaries correspond to the boundaries of the Helsinki Convention (HELCOM) area (Figure 1).

The Baltic Sea region was divided according to HELCOM into the following sub-systems: Bothnian Bay, Bothnian Sea, Archipelago Sea, Gulf of Finland, Gulf of Riga, Baltic Proper, Western Baltic, Sound and Kattegat. In order to be able to compare the assessment results with the other GIWA regions, the Baltic Sea was considered as one single system.

Figure 1
Boundaries of the Baltic Sea region.

Physical characteristics

The Baltic Sea, situated between the old Fennoscandian Shield and the North European Plain, is one of the largest brackish water areas in the world. It is a semi-enclosed sea with a surface area of 415 000 km^2 and a volume of 21 700 km^3, thereby representing 0.1% of the world's oceans in area, but only 0.002% of the volume. The Baltic Sea is shallow, with an average depth of about 60 m and a maximum of 460 m. The Sound and the Belt Sea constitute shallow transition areas between the North Sea and the Baltic Sea. Weather conditions determine the volume of high-salinity water from the North Sea which enters the Baltic Sea, taking place at irregular intervals. In the Baltic Sea, a permanent stratification layer exists between an upper water layer of low salinity and a deeper layer of more saline water. The surface salinity decreases from about 30‰ in the Kattegat area to 10‰ in the Arkona Basin, 6-8‰ in the Central Baltic, and from 6‰ to 0.5‰ in the Gulf of Finland and the Gulf of Botnia (Melvasalo et al. 1981). The Baltic Sea coast is highly variable, from deep embayments to extensive archipelagos while other areas have open coasts. The turnover time for water therefore varies widely in the different coastal areas, from less than 1 day at the open coasts to nearly 100 days in the more enclosed archipelagos. This in turn influences how pollution affects the local coastal environment which is impacted by both marine and land-based sources. Generally, the total water exchange during one year is high enough to maintain the vertical density stratification, but too small to renew the deeper waters. The water in the deepest parts, e.g. in the Eastern Gotland Basin, is renewed very irregularly by inflows of sufficiently high salinity. It is estimated that a renewal of the total water mass of the Baltic Sea would take about 25-35 years. Nutrients and hazardous substances therefore have a long residence time in the Sea and accumulate in sediments (Westing 1989).

The Baltic Sea catchment area comprises 1 720 270 km^2, of which nearly 93% belongs to the nine riparian countries; Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden. Sweden has the largest Baltic Sea catchment area with 440 000 km^2, followed by Poland, Russia and Finland, all of which have areas larger than 300 000 km^2. Six of the nations - Estonia, Finland, Latvia, Lithuania, Poland and Sweden - are situated almost entirely within the catchment, while less than half of the land area in Denmark and only one-eighteenth in Germany is situated within the catchment. Only a very small fraction of the total area of the Russian Federation, including St. Petersburg, Leningrad oblast, and Kaliningrad, is found within the catchment (1.7%). The remaining 7% belongs to the five upstream states, which have a relatively insignificant influence on the Baltic Sea. The detailed division of the Baltic Sea catchment area is presented in Table 1.

Table 1 The Baltic Sea region's sub-systems and their catchment areas.

Country	Bothnian Bay	Bothnian Sea	Archipelago Sea	Gulf of Finland	Gulf of Riga	Baltic Proper	Western Baltic	The Sound	Kattegat	Total
Carchemnt area riparian state (km^2)										
Finland	146 000	39 300	9 000	107 000						301 300
Russia				276 100	23 700	15 000				314 800
Estonia				26 400	17 600	1 100				45 100
Latvia				3 400	50 100	11 100				64 600
Lithuania					11 140	54 160				65 300
Poland						311 900				311 900
Germany						18 200	10 400			28 600
Denmark						1 200	12 340	1 740	15 830	31 110
Sweden	113 620	176 610				83 225		2 885	63 700	440 040
Total	259 620	215 910	9 000	412 900	102 540	495 885	22 740	4 625	79 530	1 602 750
Catchment area upstream states (km^2)										
Belarus					258 000	58 050				83 850
Ukraine						11 170				11 170
Czech Rep.						7 190				7 190
Slovakia						1 950				1 950
Norway	1 055	4 855								13 360
Total catchment area (km^2)										
Total	260 675	220 765	9 000	412 900	128 340	574 245	22 740	4 625	86 980	1 720 270

(Source: HELCOM 2002)

Climate

The climate of the Baltic Sea region differs from the rest of Europe. Cold arctic and sub-tropical air masses often collide here, forming a polar front. The amount and intensity of solar radiation varies markedly depending on latitude and season. The air temperature is greatly influenced by season, latitude, and distance from the Sea. In the northern parts of the region, the average mid-winter atmospheric temperature is usually around -12°C, and the average mid-summer temperature +15°C. Whereas in the southern parts of the region, the average winter and summer air temperature is -2°C and +18°C, respectively. The annual variation in air temperature in the different Baltic Sea sub-systems is summarised in Table 2.

Table 2 Annual average air temperature in the Baltic Sea sub-systems.

Sub-system	Average air temperature (°C)						
	1981-1993	1994	1995	1996	1997	1998	1994-1998
Bothnian Bay	0.0	0.0	0.7	0.4	0.9	-0.4	0.3
Bothnian Sea	2.5	2.1	3.0	2.1	3.6	2.8	2.7
Gulf of Finland	3.4	3.1	4.7	3.4	3.9	3.4	3.7
Gulf of Riga	5.3	5.1	6.3	4.9	5.8	5.7	5.6
Baltic Proper	6.9	7.5	7.5	6.0	7.4	7.5	7.2
Belt Sea + Kattegat	7.1	7.6	7.3	6.0	7.6	7.2	7.1
Baltic Sea region	4.3	4.4	5.0	3.9	4.9	4.5	4.6

(Source: HELCOM 2002)

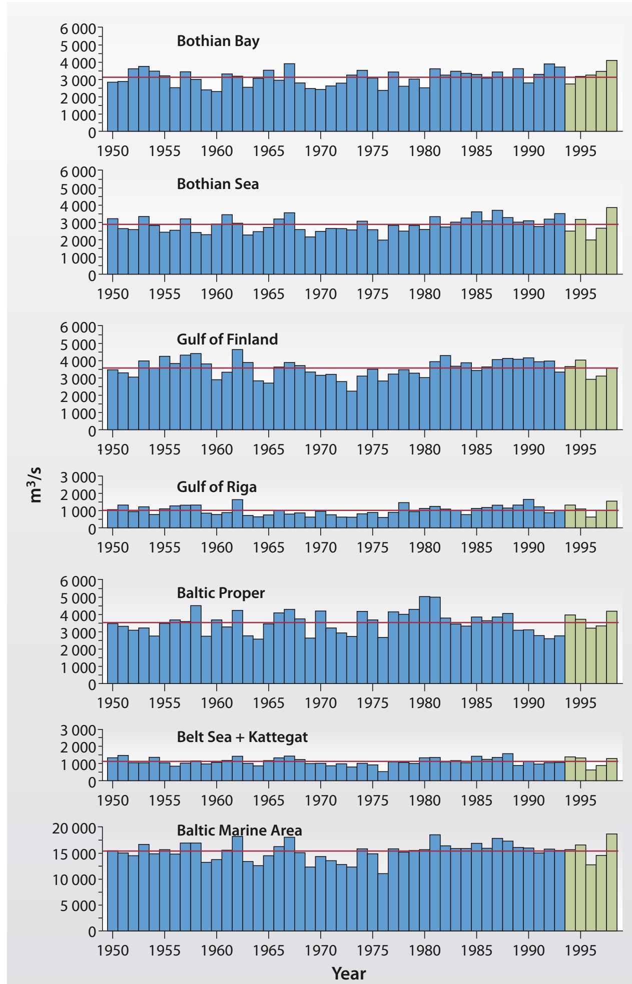


Figure 2 River run-off to the Baltic Sea and its various sub-catchments from 1950 to 1998.

Note: The horizontal lines represent the mean values for the years 1950-1993. (Source: HELCOM 2002)

The region is characterised by relatively uniform seasonal and spatial distributions of precipitation. The major regional difference is whether the precipitation is in the form of rain or snow. As regards the hydrological regime, it is important to note that regional precipitation exceeds regional evaporation substantially. In the northern parts of the region, average annual precipitation is approximately 400 mm (mostly as snow), and in the southern parts of the region about 700 mm. Precipitation falling onto the Baltic Sea surface averages about 620 mm per year (Westing 1989).

Inflow from rivers

Long-term cyclical fluctuations with alternating wet and dry periods are typical for the area. There is significant inter-annual variation in precipitation and, subsequently, the annual run-off cycle. The mean flow rate from all catchment rivers to the Baltic Sea is 15 190 m^3/s (479 km^3/year), of which nearly half drains from the seven largest rivers; Neva (Russia), Vistula (Poland), Daugava (Latvia), Nemunas (Lithuania), the Kemijoki (Finland), the Oder (Poland, Germany) and the Göta Älv (Sweden) (HELCOM 2002). Run-off volumes differ significantly in the various parts of the Baltic Sea catchment area (Figure 2). The average run-off to the Bothnian Bay varies between 10 and 20 $l/s/km^2$, and run-off to the Gulf of Finland ranges from 7 to 9 $l/s/km^2$ (Pitkänen & Lääne 2001). Run-off from Poland and Germany to the southern part of the Baltic Proper is only about 5 $l/s/km^2$.

The annual hydrological regime is characterised by low river discharges at the beginning of the year, and a significant rise in inflow during the spring when discharges peak (HELCOM 1986).

Socio-economic characteristics

The Baltic Sea catchment area is divided between 14 states. Nine of them are riparian states, which have a significant influence on the Baltic Sea. Economically these states can be divided into two groups: old market economy countries (Denmark, Finland, Germany and Sweden) and countries in transition (Estonia, Latvia, Lithuania, Poland, which have acceded the EU in 2004, and Russia). The countries in transition have the most difficult socio-economic problems due to the political and economic changes they underwent in the early 1990s; therefore this section will focus on the latter group.

Political framework

The nine riparian states are democratic. In accordance with the decision of the European Council in Copenhagen 2002 concerning the enlargement of the European Union, 10 states including Estonia, Latvia, Lithuania and Poland, were acceded to the EU in 2004; meaning that all of the riparian states states of the Baltic Sea, except Russia, are members of the Europeian Union.

The political changes of the late 1980s and early 1990s had a significant influence on the economies of these new EU states and Russia. The collapse of the Soviet Union resulted in economic insecurity, which negatively impacted the economies of the states under its immediate sphere of influence (Estonia, Latvia, Lithuania and Poland) as well as in Russia. However, the economies of these states have recovered and their Gross Domestic Product (GDP) is considerably higher than it was in 1990 (Partanen-Hertell et al. 1999). The differences in the development patterns of the last 60 years have nevertheless shaped, to a degree, the socio-economic conditions of these countries.

The situation of the newly acceded countries is compared to that of the other EU countries in the following definition of the region's socio-economic status, while Russia is considered separately. This is due to the difficulties in obtaining information about the Russian regions found within the Baltic Sea region. Statistics on Russia are therefore frequently not included in tables and text. Russia's average socio-economic characteristics are not relevant for analysis in this assessment, as they are significantly different the specific characteristics of the Russian part of the Baltic Sea catchment area.

Population

A fairly stable and largely urbanised population of nearly 85 million people reside within the Baltic Sea catchment area, of which about half live in Poland (Table 3). The urbanisation rate is relatively high in the Baltic Sea catchment area, particularly in Denmark, Sweden and Germany, where more than 80% of the population is living in urban areas (Table 3). The least urbanised countries are Finland, and Poland, in which the urbanisation rate is below 70%. In Estonia, Latvia and Lithuania the urbanisation rate is about 70%, and in the Russian Baltic Sea catchment area the rate is around 75%.

Table 3 Demographic data of the Baltic Sea region, 2002.

Country	Country area (km^2)	Country area in the region (km^2)	Population in catchment area	Population density (inhab./km^2)	Urbanisation rate (%)
Riparian countries					
Denmark	43 100	31 100	4 500 000	145	85
Estonia	45 100	45 100	1 400 000	31	69
Finland	338 200	301 300	5 000 000	17	59
Germany	357 000	28 600	3 100 000	108	88
Latvia	64 600	64 600	2 700 000	42	68
Lithuania	65 200	65 200	3 700 000	57	68
Poland	312 700	311 900	38 100 000	122	63
Russia*	17 100 000	314 800	10 200 000	32	73
Sweden	450 000	440 000	8 500 000	19	83
Upstream countries					
Belarus	207 600	83 850	4 000 000	48	74
Ukraine	603 700	11 200	1 800 000	161	68
Czech Rep.	78 900	7 200	1 600 000	222	75
Slovak Rep.	49 000	2 000	200 000	100	58
Norway	323 900	13 400	0	-	75
Total	20 039 000	1 720 250	85 000 000		

*Note: *About 1.6% (269 500 km^2) of Russia is in the Gulf of Finland catchment area. The population in this area is 8 million, with a population density of 30 inhab./km^2. Kaliningrad constitutes 0.1% of the Russian territory, with a population of 878 000 and a population density of 58 inhab./km^2 (Russian Statistical Yearbook 1998).*
(Source: CIA 2002, Statistics Finland 2002, Central Statistical Bureau of Latvia 2001, Statistics Lithuania 2002, Central Statistical Office 2002, Statistical Office of Estonia 2002b, Statistics Sweden 2002, HELCOM 1998a, Partanen-Hertell et al. 1999, World Bank Group 2004)

The population is primarily distributed in settlements along the coast. Population density in the whole catchment area varies considerably from over 500 inhabitants/km^2 in the urban areas of Poland, Germany and Denmark to less than 10 inhabitants/km^2 in the northern parts of Finland and Sweden (Figure 3). Five capital cities are located on the coastline of the Baltic Sea; Copenhagen, Helsinki, Riga, Stockholm and Tallinn. St. Petersburg is the largest coastal city. Other large cities situated within the catchment area are the two capitals, Warsaw and Vilnius, as well as the cities of Kaliningrad, Lodz, Krakow and Wroclaw.

Generally, no significant changes in population size are expected in the next decade. However, the population is expected to increase in coastal areas close to large cities, due to migration in general and urbanisation

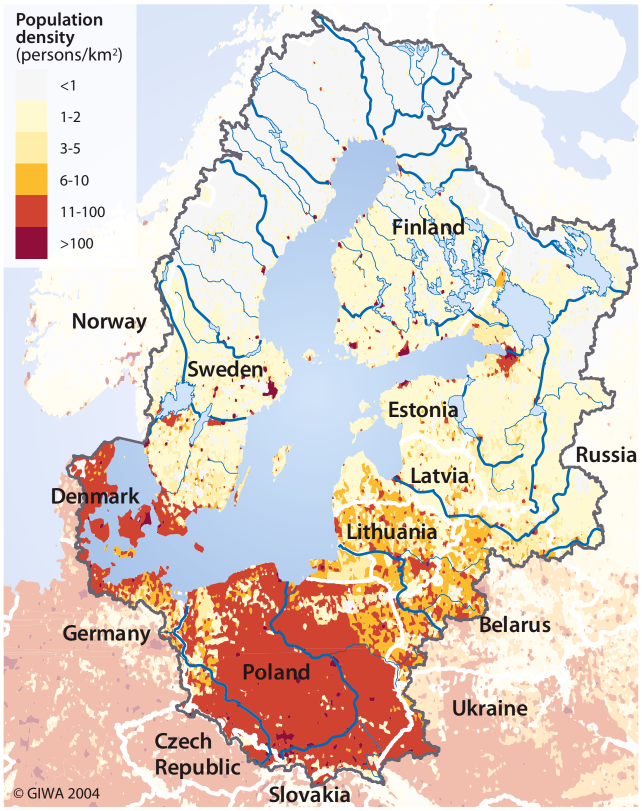


Figure 3 Population density in the Baltic Sea region.
(Source: ORNL 2003)

Table 4 Life expectancy at birth in 2001.

Country	Life expectancy (year)		
	Total population	Female	Male
Denmark	76.9	79.7	74.3
Estonia	70.0	76.3	64.0
Finland	77.8	81.5	74.1
Germany	77.8	81.1	74.6
Latvia	69.0	75.2	63.1
Lithuania	69.4	75.6	63.5
Poland	73.7	78.1	69.5
Russia	67.5	73.0	62.3
Sweden	79.8	82.7	77.2

(Source: CIA 2002)

in particular. As a result of this migration, pressure on the coastal zone is expected to increase.

Life expectancy at birth is one of the most commonly used statistics for assessing the health of a population. This characteristic is directly dependant of the socio-economic development of a country. In recent years, life expectancy rates have increased in all former socialist countries, but they are still considerably lower than the EU member states of before the 2004 enlargement (Table 4).

Economic overview

The economic situation differs widely between the countries in the Baltic Sea region (Table 5). While the regional GDP per capita has increased during the 1990s, the economic gap between the countries acceded the EU in 2004 and the old market economy is narrowing rather slowly. In 2001, GDP per capita in the newly acceded countries was only a third of that in the other EU member states.

The insecure economic situation following the collapse of the Soviet Union negatively impacted the East European countries. The difficult transition to a new economic system, resulted in the GDPs of the recently acceded countries decreasing sharply between 1991 and 1994. By 1995, the recession was over, and economic growth rate accelerated reaching a peak in 1997. However, due to a crisis in the financial sector,

Table 5 Gross domestic product in the Baltic Sea countries.

Country	GDP in 2001* (billion USD)	GDP growth (annual % change)									
		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Denmark	149.8	ND	5.5	2.8	2.5	3.0	2.8	2.1	3.2	1.4	2.0
Estonia	14.3	-8.2	-1.8	4.6	4.0	10.0	5.0	-0.7	6.9	4.5	5.0
Finland	133.5	-1.1	4.0	3.8	4.0	6.3	5.3	4.0	5.7	2.0	2.6
Germany	2 174	-1.8	2.1	1.4	0.5	1.2	2.0	1.8	3.1	0.8	1.8
Latvia	18.6	-14.9	0.6	-0.8	3.3	8.6	3.9	1.1	6.6	6.0	6.0
Lithuania	27.4	-16.2	-9.8	3.3	4.7	7.3	5.1	-3.9	3.3	3.6	4.7
Poland	339.6	4.3	5.2	6.8	6.0	6.8	4.8	4.1	4.1	2.5	3.7
Russia	1 200	-13.0	-13.5	-4.2	-3.4	0.9	-4.9	5.4	8.3	4.0	4.0
Sweden	219	-2.2	4.1	3.7	1.1	2.1	3.6	4.1	3.6	1.7	2.5

*Notes: * Using purchasing power parity rates. ND = No Data.*
(Source: CIA 2002, IMF 2001, Statistics Finland 2002, Central Statistical Bureau of Latvia 2001, Statistics Lithuania 2002, Central Statistical Office 2002, Statistical Office of Estonia 2002b, Statistics Sweden 2002)

Table 6 GDP per capita in the Baltic Sea countries.

Country	GDP per capita (USD using purchasing power parity rates)						
	1993	% of the highest	1994	1995	1996	1997	2001	% of the highest
Denmark	19 920	100	20 990	22 150	23 000	23 690	28 000	100
Estonia	4 030	20.2	4 080	4 420	4 700	5 240	10 000	35.7
Finland	16 220	81.4	17 220	18 510	19 250	20 150	25 800	92.1
Germany	18 940	95.1	19 760	20 650	21 060	21 260	26 200	93.6
Latvia	3 230	16.2	3 370	3 480	3 670	3 940	7 800	27.9
Lithuania	3 850	19.3	3 560	3 780	4 010	4 220	7 600	27.1
Poland	4 850	24.3	5 190	5 740	6 140	6 520	8 800	31.4
Northwest Russia*	4 104	20.6	3 632	3 576	3 488	3 496	8 300	29.6
Sweden	17 330	87.0	18 140	19 270	19 690	19 790	24 700	88.2
Highest	19 920	100	21 250	22 560	23 900	24 450	28 000	100
Lowest	3 230	16.2	3 370	3 480	3 490	3 500	7 600	27.1

*Note: * The GDP per capita for Russia has been calculated on the basis of Russian data (World Bank data source) using an index of 0.8. The index (0.8) is the ratio of Russian sub-system GDP rbl per capita to Russian Federation GDP rbl per capita in 1994-1996 (Russian Statistical Yearbook 1998).*
(Source: World Bank 1999, CIA 2002)

foreign demand began to decline in 1998. The same year saw a crisis in the Russian market and as a result the country's GDP continued to fall up until 1999. In 2000, the growth rate had picked up again and, driven by economic integration with EU member states, Estonia's economy showed a rapid increase of 6.9%, and Latvia of 6.6%. This high rate of growth continued until 2001 and 2002. Since 2000, the increase of GDP in the acceded countries has been considerably higher than in the other EU member states.

Due to the faster economic growth, the economies of the recently acceded countries - calculated on the basis of GDP per capita using purchasing power parities (in USD) - have drawn nearer to the countries with developed economies but still lag far behind (Table 6). Between 1993 and 2001 the GDP per capita in Estonia has grown 2.5 times, in Latvia 2.4 times, in Lithuania 2 and in Poland 1.8 (World Bank 1999, CIA 2002). Although there has been a considerable rise in GDP per capita, it is still only a third of that in countries with a more developed economy in the region.

The unemployment rate, which here is used as an indicator of the level of welfare in the Baltic Sea region, varies considerably between the countries. During the 1990s, the unemployment rate has increased in many of the market economy countries (Table 7), while changes in the labour market of the transition countries are different from those of the earlier EU countries. Growth in unemployment also occurred in the Baltic States and Polish labour markets in the early 1990s. Due to successful economic reforms, the labour market stabilised in 1996-1998 and the unemployment rate remained around 10%. Influenced by the economic crisis in Russia, unemployment increased again at the end of 1998 and reached a peak in 2000, exemplified by a rate of 13.7% in Estonia and 15.1% in Poland. In 2001, the unemployment rate fell in Estonia to 12.4%, while at the same time in Poland and Latvia, unemployment further escalated.

Table 7 Unemployment rates in the Baltic Sea countries.

Country	Unemployment rates* (% of labour force)									
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Denmark	ND	8	7	7	7.8	6.5	5.6	5.2	5.2	5.4
Estonia	2	2	2	2	ND	10.5	12.9	13.7	12.4	11.3
Finland	18	18	17	16	12.6	11.4	10.3	9.8	9.9	10.4
Germany	10	11	13	9	9.5	8.9	8.2	7.5	7.5	7.9
Latvia	5	6	6	7	5.9	6.4	8.4	11.5	12.5	ND
Lithuania	4	4	6	7	6.7	6.5	10.0	11.5	ND	ND
Poland	16	16	15	14	10.3	10.4	13.1	15.1	17.5	ND
Russia	1	2	3	3	ND	ND	ND	ND	ND	ND
Sweden	8	8	8	8	8	6.5	5.6	4.7	4.1	4.1

*Note: ND = No Data. *Unemployment rate is the percentage of the labour force which is without work but available and seeking employment. Definitions of labour force and unemployment differ by country.*
(Source: World Bank1999, Statistics Finland 2002, Central Statistical Bureau of Latvia 2001, Statistics Lithuania 2002, Central Statistical Office 2002, Statistical Office of Estonia 2002b, Statistics Sweden 2002)

Economic inequality between the rich and poor is greater in the transitional countries than in many developed countries in Europe. It is estimated that poverty will affect as many as 15% of the population in Poland during the transformation phase (United Nations 2002). In 2001, the percentage of the population living below the poverty line in Estonia was 17%. When using the subsistence level established by the Government of Estonia as the poverty line, 3% of the population was below this level in 2000 and 2001 (Statistical Office of Estonia 2002a).

As for the future, the recently acceded EU countries are all members of the World Trade Organisation and are steadily moving towards a modern market economy with increasing ties to the West, including the alignment of their currencies with the Euro.

Main economic sectors

The economies of each country are variably divided between the different economic sectors, although there are some general patterns. The dominant sector in the region is the service sector, which accounts for 56 to 75% of the GDP of the countries in the Baltic Sea region. The industrial sector contributes between 22 and 37% to GDP, and the agricultural, forestry and fishing sector 1 to 9% (Table 8).

Table 8 Gross domestic product by sector in the Baltic Sea countries.

Country	GDP by sector (%)			
	Agriculture, forestry and fishing		Industry	Services
	Agriculture	Total		
Denmark	2.3	3	22	75
Estonia	3.4	6	28	66
Finland	0.1	3	28	69
Germany	ND	1	28	71
Latvia	3.9	5	24	71
Lithuania	6.3	9	32	59
Poland	3.3	4	32	64
Russia	ND	7	37	56
Sweden	1.5	2	29	69

Note: ND = No Data. (Source: CIA 2002, Statistics Finland 2002, Central Statistical Bureau of Latvia, 2001, Statistics Lithuania 2002, Central Statistical Office 2002, Statistical Office of Estonia 2002b, Statistics Sweden 2002)

Estonia, Latvia and Lithuania have undertaken enormous economic reforms during the last decade. These countries all have relatively few natural resources, the most important being forest, fish, arable land and local mineral building materials. Estonia is the only country with a significant local energy resource - oil shale. Despite these limitations, they have transformed from being dependent on agriculture and industry into service sector dominant economies. However, there remains considerable differences between the states; while earlier EU member states have established economies based upon advanced high-tech industry, the countries acceded in 2004 are only in transition towards a modern market economy.

Industry

All countries around the Baltic Sea are considered industrialised and during the last six years the industrial sector has experienced considerable growth. The highest growth rates have been recorded in Estonia (47%), Poland (44%) and Finland (43%) (CIA 2002). In Denmark and Sweden, industrial production grew from 20% in 1995 to 23% in 2001. The lowest growth rate during these years was in Latvia, where the effect of the 1998 economic crisis was the largest.

In 2001 the industrial production growth rate varied significantly between the countries. In Latvia it rose to 6.4%; in Estonia, Finland and Sweden it was 5% and in Poland 4.3 to 4.5%. Industrial growth rates were negligible in Denmark with 1.1% and in Germany there was no notable growth at 0.2% (CIA 2002).

The industrial sectors with the most harmful affect on the environment are the pulp and paper, chemical, food processing and mining industries. There are, however, major differences in the processes and technologies employed within the industrial sector of each country, which influences the level of impact industry has on the environment. Industries in the northern and western countries of the region have implemented gradual and fundamental changes to maintain their market competitiveness, and contemporary technology has been used in order to comply with progressively stricter environmental standards (Partanen-Hertell et al. 1999). In contrast to these countries, the industries of the countries acceded in 2004, especially in the metal, pulp and paper, energy and construction sectors are still utilising technologies originally installed when the plants were constructed, in some cases as early as the 1930s. However, since 1990 the situation has changed significantly; industrial production has declined, many older industrial facilities have been closed, renovated or reconstructed to create new profitable and more environmentally friendly units, for example in the paper and pulp industry and food processing industries. The principles for developing the industrial and energy sector in an environmentally sound way were formulated in Agenda 21 for the Baltic Sea Region (Baltic 21 1998a). The ideology behind sustainable development in the industrial sector is based upon maintaining continuity of economic, social, technological and environmental improvements.

Agriculture

The contribution agricultural production makes to GDP has decreased remarkably in recent decades. The recently acceded states still have a consiberably higher share of agriculture in the GDP compared to the other countries (Table 8). This decrease in agricultural production is closely connected with the substantial decline in agricultural employment. In EU, about 5% of the labour force was active in the agricultural sector, while the corresponding figure for the newly acceded countries in 2001 varied from 9 to 20% (Brouwer et al 2001). In addition, the land area used for agriculture has decreased considerably in all Baltic Sea region countries, and varies markedly from 61.3% in Poland to 7% in Finland (Table 9). The decline in agricultural land combined with a reduction in fertiliser application has decreased the impact of agriculture on biological diversity and the aquatic environment.

Table 9 Land use structure in 2001-2002.

Country	Land use (%)			
	Arable land	Forest and wooded land	Inland waters	Others
Denmark	55.7	12.7	1.7	30.6
Estonia	15.5	51.6	8.0	24.9
Finland	7.0	74.8	11.0	7.2
Latvia	29.0	48.1	3.8	19.1
Lithunia	60.6	32.7	4.2	2.5
Poland	61.3	29.4	2.7	6.6
Sweden	7.9	74.1	10.7	7.3

(Source: CIA 2002, Statistics Finland 2002, Central Statistical Bureau of Latvia 2001, Statistics Lithuania 2002, Central Statistical Office 2002, Statistical Office of Estonia 2002b, Statistics Sweden 2002, UN-ECE/FAO 2000)

Forestry

Forest is one of the principal natural resources in the Baltic Sea region. There is a relatively high percentage of forest and wooded land in the Nordic countries (Finland and Sweden, more than 70% of the territory) compared with Denmark (12.7%) (Table 9).

Forestry has constitutes the backbone of the Finnish and Swedish economies as does the wood manufacturing industry for the Danish economy. Governments of these countries have actively promoted sustainable forest management practises for generations. In commercial forestry the utmost consideration is given to the environmental values and cultural heritage of forested areas. Furthermore, the recycling of paper and cardboard and other forest products is widely practiced. Close to 70% of the total Finnish paper and board consumption is collected for recycling, in Sweden the level of recycling is even higher (87%), while Poland is recycling 33% (CEPI 2004).

In Estonia, Latvia and Lithuania, forest products have become some of the most important exports. In 2001, timber and wood products accounted for 18% of Estonia's total exports, with raw timber the main export. Although the quantity raw timber exported has progressively increased, its relative importance is decreasing, as the export market for sawn timber and furniture has significantly grown. Recycling of forest products is undertaken only on a small scale.

Fishery

In the Baltic Sea region the fisheries has traditionally played an important role as a source of food, especially in Estonia, Latvia and Lithuania. Fishing in the Baltic is mainly focused on marine species, but also on some freshwater and anadromous species (i.e. migrate between the sea and rivers). The Baltic Sea ichthyofauna consists of approximately 100 fish species. Cod (*Gadus morhua*), herring (*Clupea harengus*), sprat (*Sprattus sprattus*) and salmon (*Salmo salar*) are the main commercially exploited in marine fisheries and the only species regulated by quotas established by the International Baltic Sea Fishery Commission (IBSFC). These species constitute over 90% of the total catch in the region. Other commercial species, found mainly in coastal waters, are eel (*Anguilla anguilla*), trout (*Salmo trutta*), flounder (*Platichthys flesus*), pike (*Esox lucius*), perch (*Perca fluviatilis*), pike-perch (*Stizostedion lucioperca*), smelt (*Osmerus eperlanus*), blue mussels (*Mytilus edulis*), whitefish (*Coregonus lavaretus*) and shrimp (*Crangon crangon*).

The FAO has highlighted the importance of recreational fisheries and has stated that in many cases it can provide greater economic benefits to local communities than would accrue from subsistence or commercial fishing of the same resource (FAO 1996). Many species are exploited by recreational fishers in the Baltic region, and catches of freshwater fish species are in some cases 10 times higher than the commercial catch. The relative economical value is even higher. In some areas the growing recreational fishery could lead to overfishing (Baltic 21 1998b). Unfortunately, reliable information of catch levels by recreational fisheries is lacking in most Baltic countries except for Finland where amateur fishers (more than 1 million) purchase licenses annually. To gain more information, over 25 000 questionnaires are dispatched every year to these recreational fishers, of which 70% respond (Hilden 1990). Total landings by the recreational fisheries in Finland was approximately 50 000 tonnes in 1998 (Finnish Ministry of Agriculture and Forestry 2003).

Landings of sprat increased during the 1990s, while there was no dramatic change in the landings of herring (Figure 4). Cod catches decreased during this period, as a result of a number of reasons (ICES 2003). Firstly, the breeding success of Baltic cod is dependent on certain environmental conditions. After spawning, their eggs sink into deeper Baltic waters where they drift during incubation. The deep waters are oxygen depleted and if the eggs sink to these waters it can result in a low recruitment of cod. This is what has happened in the central Baltic for the past decade or more. The hydrography of the Baltic Sea is largely determined by the sporadic inflows of saline North Sea water and the intermediate stagnation periods (lowering of salinity). Such a period started in the beginning of 1980s. The other reason for the decline in landingsis severe fishing pressure, with many young fish being caught before they have reproduced.

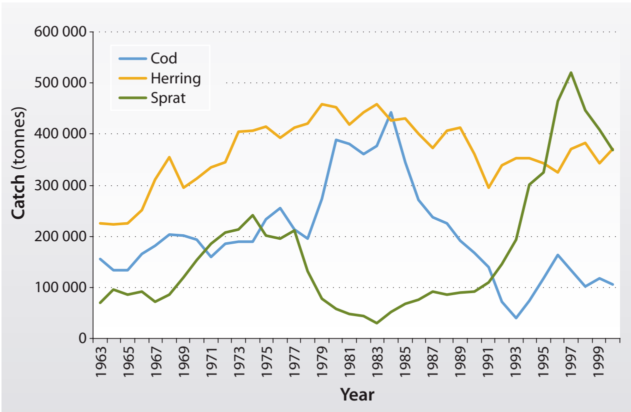


Figure 4 Cod, herring and sprat landings in the Baltic Sea 1963-2000.
(Source: HELCOM 2003a)

The decline of the cod stocks have had considerable economic impacts on the Baltic Sea fisheries. This has led to an economic crisis, and governments subsequently provided funds to assist the most severely affected areas, e.g. Bornholm (Baltic 21 1998b).

Aquaculture

There is a tradition of aquaculture in the Baltic Sea region which is an important alternative to the declining wild fisheries in certain regions today. Aquaculture for human consumption currently equates to about 9% of sea fish landings (Baltic 21 1998b). The production by country and main species in the Baltic area is shown in Table 10. Other species of importance are silver carp, arctic charp, eel and crayfish. However the aquaculture sector can have negative environmental impacts and for example the proportion of direct total nitrogen and phosphorus discharge from industry and fish farms constitute 5% and 8% of the total load to the Baltic (HELCOM 2004a).

Table 10 Aquaculture production for human consumption in 1996.

Country	Production (tonnes)	Main species
Poland	28 088	Carp
Finland	17 311	Rainbow trout
Denmark*	13 120	Rainbow trout
Sweden	6 440	Rainbow trout
Lithuania	1 600	Carp
Germany	1 059	Carp
Latvia	380	Carp
Estonia	195	Rainbow trout
Russia	274	Carp
Total	68 467	

*Note: *The Danish aquaculture figures also include the North Sea catchment area.*
(Source: Baltic 21 1998b)

Transport

The transport sector is of great importance to modern society, mobilising people and goods. There is an increasing demand for transport and more individualised and flexible transport services. The percentage of the countries' GDP attributed to transport is considerable, especially in Estonia, Latvia and Lithuania (Table 11). In these countries the development of the transport sector has been particularly rapid due to the intensity of Russian transit traffic.

Table 11 Share of transport in GDP.

Country	Share of transport in GDP (%)
Denmark	9.4
Estonia	16.3
Finland	8.5
Latvia	13.6
Lithuania	11.1
Poland	6.4
Sweden	7.4

(Source: Statistics Finland 2002, Central Statistical Bureau of Latvia 2001, Statistics Lithuania 2002, Central Statistical Office 2002)

There are extensive shipping routes across the Baltic Sea. Compared to land transport via rail and roads, shipping is a rather slow but relatively sustainable transport mode. Shipping and harbours are of major importance for the import and export of goods, and also for travel via passenger ferries. However, technical and economic development in the transport sector has focused predominantly on road transport in the last 50 years. Today maritime transport, in particular RO/RO and ferry transport (especially the trend towards high-speed ferries, called feeder-ships), requires specific attention regarding energy consumption and their environmental impacts (Baltic 21 1998c). Oil poses the greatest potential impact and hazard from sea transport.

Tourism

Tourism has grown substantially over the past decade and is now one of the major economic activities in the Baltic Sea region. The main reason for this relatively rapid development is explained by the collapse of the Soviet Union, which has opened the borders between the West European and former socialist countries. This development is most notable in Estonia, where tourism has become one of the most important economic sectors. Foreign currency received from tourism services constitute 18% of the total exports of Estonian goods and services. The total contribution to GDP in 1998 from overseas visitors was 15% (including secondary effects), which was double that of 1994 (United Nations 2002). In Finland, tourism accounted for only 1.8% of GDP in 1998, the lowest figure in the region, and in the other countries it was between 3.7% (Sweden) and 4.5% (Latvia, Lithuania, Poland, Denmark) (United Nations 2002). Tourism in the Baltic Sea region is estimated to generate over 35 billion USD annually in foreign income (HELCOM 2002). Forecasts by the World Tourism Organisation indicate higher growth of tourism in the Baltic Sea area compared with other parts of Europe up to 2020.

Figure 5 Bathing tourists at a beach, Köpingsvik, Öland, Sweden. *(Photo: S. Ekelund)*

Tourism is increasingly impacting the environment, especially in the coastal zone and in areas that are of importance to the local flora and fauna, which are naturally attractive to tourists and locals and provide an amenity for recreation and leisure activities. In the Baltic region tourism peaks during the summer months, when its negative impacts are particularly visible. For example, waste disposal systems are placed under greater stress and coastal habitats are disturbed by the influx of visitors. Figure 5 shows bathing tourists at the island of Öland, Sweden.

In the advanced market economies, no major negative environmental or cultural impact from tourism was observed (Baltic 21 1998a). However, in countries acceded to the EU in 2004, rapidly growing and uncontrolled tourism has in many cases endangered and ultimately destroyed environmental assets upon which tourism is ironically dependent. A common understanding and awareness of the relationship between tourism and the environment is needed in order for the industry to be sustainable in the region. Tourists, tourist destinations and tourist business are in the focus of the Tourism Sector Action Programme launched by Agenda 21 for the Baltic Sea Region (Baltic 21 1998a). Likewise, the Helsinki Commission initiated enforcement of the legislation regarding sustainable development of tourism. The tourism sector has the potential to benefit itself by protecting and enhancing the region's natural assets, whilst contributing to sustainable development by supporting the economy in regions where traditional activities are declining, and by initiating good management practices to enhance the environmental quality of the region.

International cooperation

Water protection in the Baltic Sea region is regulated by several international conventions ratified by the Baltic Sea states. The list of conventions and agreements can be found in Annex III.

The Baltic Sea region has a history of more than hundred years of international cooperation. One of the early forms of cooperation in the Baltic Sea region involved the establishment of the International Council for the Explorations of the Sea (ICES). The Council was founded in Copenhagen 1902, as a result of the Stockholm Conference in 1899 and Christiania (Oslo) Conference in 1901. The council was entrusted with the task of carrying out a programme of international investigation of the sea. Today ICES is one of the main organisations coordinating and promoting marine research in the North Atlantic including adjacent seas such as the Baltic Sea and North Sea. The organisation constitutes a focal point for a community of more than 1 600 marine scientists from 19 countries around the North Atlantic. The scientists working through ICES gather information about the marine ecosystem and carry out research to investigate key issues.

From the 1970s to the mid-1990s, the two most important conventions regulating the protection of the environment and living resources of the Baltic Sea were recognised to be the Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and the Belts, signed in Gdansk in September 1973 (Gdansk Convention), soon followed by the Convention of the Protection of the Marine Environment of the Baltic Sea, signed in Helsinki in March 1974 (Helsinki Convention).

The implementing unit for the Gdansk Convention is the International Baltic Sea Fishery Commission (IBSFC), which plays a central role in the management of the Baltic Sea region. Its activities include the gathering, analysis and dissemination of statistics and the undertaking of scientific research. The IBSFC also makes recommendations for the regulation of fishing gear and catch sizes, and for the designation of fishing grounds and seasons. Each year, on the basis of recommendations from the global science community and the ICES, the IBSFC sets total allowable catches (TAC) for the four main commercial species, namely cod, salmon, herring and sprat.

The Helsinki Convention is responsible for the protection of the Baltic Sea from pollution and also for the assessments of the state of the marine environment in the region. The Helsinki Commission (HELCOM), which is responsible for the implementation of the Convention, coordinates a joint monitoring programme of the Baltic Sea. On basis of this programme several assessments on the state of the Baltic Sea and its pollution load were prepared and subsequently published in the Baltic Sea Environment Proceedings series. More than 150 HELCOM Recommendations have been drawn up and adopted by the Commission for the protection of the Sea. As a rule, the recommendations were implemented by the Contracting Parties through amendment of the requirements of the recommendations to national legislation.

In addition, to implement the objectives of the Helsinki Convention, the Joint Comprehensive Programme (JCP), was approved in 1992. This action programme established a framework for sustained cooperation among the Contracting Parties to the Convention, other governments within the region, international financial institutions, and non-governmental organisations, who share a common interest in environmental protection and natural resources management within the sensitive Baltic Sea region. The JCP emerged as a direct result of a meeting of the region's Prime Ministers, and has therefore a particularly high level of political visibility, which has been complemented by sustained broad-based public interest and support for its implementation. The action programme provides an environmental management framework for the long-term restoration of the ecological balance of the Baltic Sea. It is to be implemented through a series of phased preventive and curative actions. The JCP includes all the countries of the drainage basin and was mandated by the resolution endorsed at the Baltic Sea Environment Conference held at Ronneby, Sweden in 1990. At this unprecedented international environmental conference, the participating Heads of Government, High Political Representatives from the region, senior representatives of invited international financial institutions (IFIs) and observers from non-governmental organisations collaborated to create a "shared vision" for environmental management of the Baltic Sea and its drainage basin to be implemented through this action programme. The Helsinki Commission was requested to coordinate the JCP process with the cooperating parties (HELCOM 1998b).

In recent years the Baltic Sea regional development has also become increasingly related to European integration. The EU's environmental regulations are increasingly implemented in the old member states and recently acceded countries in the Baltic region. Russia's non-member partnership and cooperation agreement with the European Commission has also been initiated.

Since 2000 following the adoption of the EU Water Framework Directive, a directive was made on the implementation of water protection in the Baltic Sea states. The aim of the Directive is to maintain and to improve the aquatic environment in the Community including coastal areas up to 10 nautical miles offshore. Its main focus is on water quality, although the full implementation of the Water Framework Directive by 2015 will also improve the overall environmental quality of the Baltic Sea.

In March 2003, the Global Environmental Facility (GEF) Baltic Sea Regional Project (BSRP) was adopted in collaboration with HELCOM. This project will be executed between 2003 and 2008. In order to address the needs of an ecosystem-based approach to resource management; the BSRP was designed under the principles of the Large Marine Ecosystem (LME) concept, focusing on land-based, coastal zone and marine activities. The project includes social and ecosystem management tools for decision makers to address transboundary issues of the Baltic Sea.

Assessment

Table 12 Scoring table for the Baltic Sea region.

Assessment of GIWA concerns and issues according to scoring criteria (see Methodology chapter)

- 0 No known impacts
- 1 Slight impacts
- 2 Moderate impacts
- 3 Severe impacts

The arrow indicates the likely direction of future changes.

- ↗ Increased impact
- → No changes
- ↘ Decreased impact

Baltic Sea	Environmental impacts	Economic impacts	Health impacts	Other community impacts	Overall Score**	Priority***
Freshwater shortage	2* →	1 →	1 →	1 →	1.3	4
Modification of stream flow	1					
Pollution of existing supplies	2					
Changes in the water table	1					
Pollution	3* ↘	2 ↗	2 →	1 ↗	2.1	1
Microbiological pollution	1					
Eutrophication	3					
Chemical	2					
Suspended solids	1					
Solid wastes	1					
Thermal	0					
Radionuclides	1					
Spills	2					
Habitat and community modification	2* →	1 ↗	1 →	1 →	1.4	3
Loss of ecosystems	1					
Modification of ecosystems	2					
Unsustainable exploitation of fish	2* →	2 →	0 →	2 →	1.5	2
Overexploitation	3					
Excessive by-catch and discards	1					
Destructive fishing practices	1					
Decreased viability of stock	2					
Impact on biological and genetic diversity	2					
Global change	0* ↗	1 ↗	1 ↗	1 ↗	1.3	5
Changes in hydrological cycle	1					
Sea level change	0					
Increased UV-B radiation	0					
Changes in ocean CO_2 source/sink function	0					

* This value represents an average weighted score of the environmental issues associated to the concern.

** This value represents the overall score including environmental, socio-economic and likely future impacts.

*** Priority refers to the ranking of GIWA concerns.

This section presents the results of the assessment of the impacts of each of the five predefined GIWA concerns i.e. Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources, Global change, and their constituent issues and the priorities identified during this process. The evaluation of severity of each issue adheres to a set of predefined criteria as provided in the chapter describing the GIWA methodology. In this section, the scoring of GIWA concerns and issues is presented in Table 12.

Freshwater shortage

A fundamental characteristic of the hydrological regime in the Baltic Sea region is that regional precipitation substantially exceeds regional evaporation. In the northern parts of the Baltic Sea region, the average annual precipitation is about 400 mm and in the southern parts about 700 mm. Overall, the precipitation falling onto the Baltic Sea surface averages about 620 mm per year (Westing 1989). Taking into account this level of freshwater availability, the concern of Freshwater shortage was considered to have slight to moderate environmental impacts. The severity of the concerns is not expected to change before 2020. Furthermore, the concern's transboundary aspects are less significant compared with the other concerns.

There have been some localised problems resulting from changes in the water table and the modification of stream flow, although overall these issues were considered to be of only slight environmental significance at present. The Pollution of existing supplies was recognised as the most severe Freshwater shortage issue in the region, which was considered to have moderate impacts.

Environmental impacts

Modification of stream flow

Most of the rivers that flow into the Baltic Sea have been regulated by hydropower dams, which significantly reduce the occurrence of flooding in springtime, but do not change the annual discharge of the rivers. Modification of stream flow and decrease in the occurrence of exceptional discharges due to the construction of dams used for hydropower is therefore not relevant for the region on an annual basis. For instance, analysis of the Narva River hydrograph since the construction of the Narva hydropower plant (Russia) in 1956, has shown that annual flow rate has not changed (Figure 6). This conclusion is also valid for other rivers regulated by dams in the Baltic Sea region.

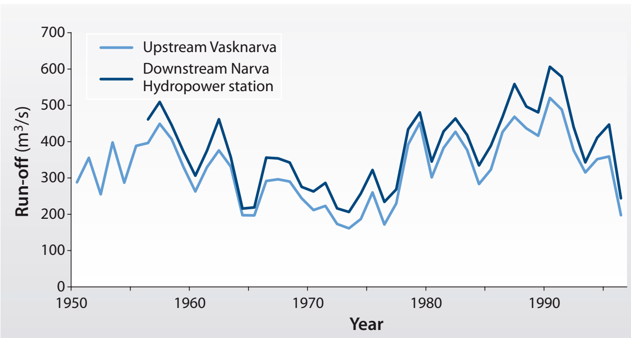


Figure 6 The annual flow rate of the Narva River before and after construction of the dam in 1956.
(Source: EMHI 2000)

However, the natural annual variation in flow rates has altered significantly in some rivers but it is difficult to generalise about the impact of human activities on flow regime (EEA 1995). Other indicators of changes in stream flow such as decreasing trends in annual river flows, declines in the extent of wetlands and changes in the mean salinity of estuaries or coastal lagoons have not been registered. In addition, the issue of modification of stream flow was not considered to be of transboundary relevance in the Baltic Sea region.

Pollution of existing supplies

The pollution of existing supplies was assessed having moderate impacts in the region. According to the European Environment Agency (EEA 1995), the quality of most rivers discharging into the Baltic Sea is fair (moderate organic pollution and nutrient content) or poor (heavy organic pollution, low oxygen concentration, sediment locally anaerobic). In addition, the overexploitation of groundwater in densely populated coastal areas of the Baltic Sea has caused saltwater intrusion in aquifers, which may affect drinking water quality (Figure 7).

Figure 7 Overexploitation of groundwater resources and saltwater intrusion in the Baltic Sea region.
(Source: EEA 1995)

Changes in the water table

Changes in the water table are determined by the level of exploitation of groundwater resources. This issue was assessed to be of slight environmental importance in the Baltic Sea region, as in general groundwater supplies are not overexploited. However, changes in the water table have been more noticeable in certain locations where freshwater demand is high, for example in region close to large urban areas (Figure 7) (EEA 1995).

Socio-economic impacts

The economic impacts of Freshwater shortage were considered to be slight, as although in general freshwater availability is not a limiting factor for economic activities, in some areas it may have a slight influence on municipal water supply and industrial activities. There may be increased costs from finding alternative water supplies, deepening wells, increased pumping, and from intake treatment. At the same time, however, the reduction of groundwater abstraction in some regions (Tallinn, Riga, Vilnius) has caused the water level to rise (EEA 1995), which might lead to a reduction in water supply costs.

The health impacts were also considered to be slight in the Baltic Sea region, as there is some concern for human health regarding the pollution of drinking water by point and non-point sources. The surface water does not meet WHO drinking water standards in rivers/streams draining more than 30% of the catchment area (EEA 1995). The level of chemical contamination and the quality of drinking water is dependent on many factors, including the quality of raw water, the extent and type of treatment, and the materials and integrity of the distribution system. However, there is no information available on the risks of this poor water quality on human health in the region.

Other social and community impacts were considered slight in the region. The people who are mostly affected by freshwater shortage are those who live in densely populated areas and in areas with intensive agriculture where water demand is high. In addition nitrogen compounds may contaminate the groundwater in agricultural regions. Monitoring data supplied by the countries of the region on nitrates in groundwater is very heterogeneous. The nitrate concentrations in the Baltic Sea catchment area only exceed the maximum admissible concentration (50 mg NO_3/l) of water for human consumption in specific locations (Figure 8) (EEA 1995).

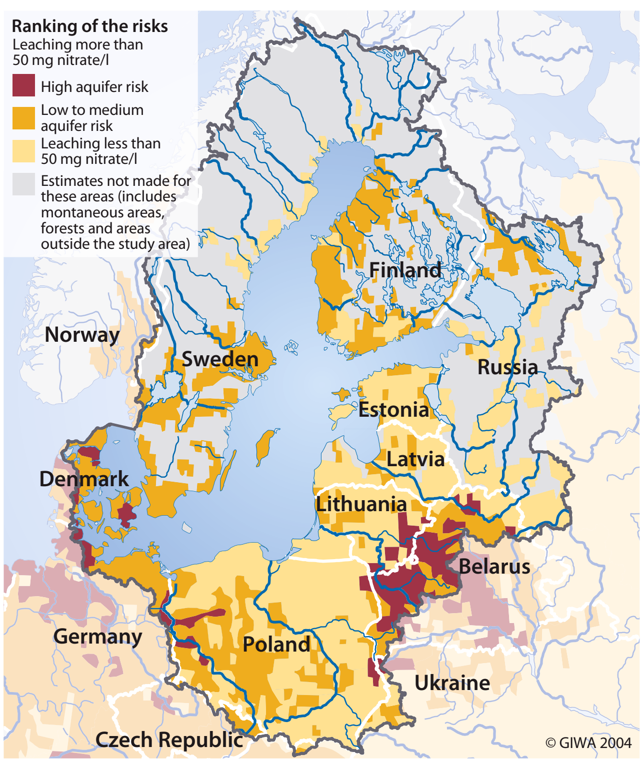


Figure 8 The nitrate hot spots for groundwater.
(Source: EEA 1995)

Conclusions and future outlook

Freshwater shortage is not considered to be an urgent problem for the Baltic Sea region and was considered having a slight overall impact. There are some problems with the pollution of existing supplies, which justified the overall environmental impact of the concern being assessed as moderate. In the future, taking into account the implementation of the Water Framework Directive by the Baltic Sea region countries (except Russia), an improvement in the quality of freshwater is expected, or at least there will be no change in the concern's level of impact in the future. A reduction in water consumption has been recorded in the transitional countries in recent years (Baltic Environmental Forum 2000), which will reduce the pressure on freshwater supplies. The same development was observed in the market economy countries in the mid-1970s during the energy crisis.

IMPACT Pollution

The marine ecosystem of the Baltic Sea is particularly vulnerable to pollution, due to the limited exchange of its water and because of the run-off from a catchment area containing 85 million people. Over the past 10 to 20 years, water pollution in the Baltic Sea region has not increased significantly and has even decreased in certain areas (HELCOM 2003a). However, pollution remains prevalent, particularly euthrophication which is depleting bottom waters of oxygen, oil spills from ships that are threatening birds and mammals, and the persistence of hazardous pollutants that are harming animals and humans alike.

The overall impact of Pollution was assessed as being moderate in the Baltic Sea region. The most alarming issues were eutrophication, which was considered to have a severe impact, and chemical pollution and spills that are having a moderate impact. Microbiological pollution, suspended solids and solid waste were considered to have a slight impact on the Baltic Sea region.

Thermal pollution was considered to have no known impact in the region and is therefore not further discussed. The discharge of cooling water from nuclear power plants and certain large industries has been observed but these were of local nature with no large-scale environmental effects. The assessment of the state of the Baltic Sea (HELCOM 2002) did not deem this issue to be of sufficient importance in the Baltic Sea to be studied.

Environmental impacts

Microbiological

Microbiological pollution was assessed as having a slight impact, as it has caused mainly local problems and only affected recreational activities. During the last decade, the construction of biological wastewater treatment plants in the coastal and catchment areas of the Baltic Sea has reduced the concentrations of microbes in wastewater. Nearly all of the beaches along southeastern coast of the Baltic Sea that were closed in the late 1980s due to the abnormal microbiological conditions were re-opened in the mid-1990s (HELCOM 1993b, HELCOM 1996a). In the older EU countries, the problem was resolved much earlier. From the late 1980s, the countries in transition began to construct biological and biochemical wastewater treatment plants, which became operational by the mid-1990s. The most important treatment plants are located in Tallinn, Riga, Vilnius, Kaunas, Gdansk and Gdynia. The treatment efficiency and the amount of treated wastewater in for example St. Petersburg increased significantly, and the discharge of untreated wastewater has been reduced from 3.2 to 1.42 million m^3/day (Lääne et al. 2002). Moreover, many small coastal municipalities no longer discharge untreated wastewater into the Baltic Sea.

Eutrophication

Eutrophication was considered to have a severe impact in the Baltic Sea region. Large quantities of nutrients are entering the Sea via rivers, coastal run-off and airborne depositions. The issue will be further discussed in the Causal chain analysis.

The process of eutrophication can be explained as a state where concentrations of inorganic nutrients become so high that they lead to excessive production of plants and algae. Eutrophication caused by anthropogenic activities is particularly evident in areas with limited water exchange such as the Baltic Sea. Nitrogen and phosphorus are the predominant nutrients in the Sea causing euthrophication. Nutrient enrichment results in higher primary production of algae in the surface layers and on the shore, followed by higher secondary production. Excessive enrichment may result in large algal blooms. The eutrophication phenomena can affect human health and the recreational amenity of marine coastal areas.

The three main symptoms of eutrophication in the Baltic Sea region are hypoxic conditions in deepwater over widespread areas, increased occurrence of harmful algal blooms, and significant biological changes in the littoral communities (HELCOM 2002). Hypoxic conditions found in deep water between 1996 and 1998 were characterised by repeated changes in the redox regime at the seabed and the formation of hydrogen sulphide, causing an alternating distribution of nutrients. In the western Gotland Basin, oxygen concentrations have fallen since 1993 due to increased stratification of the water column, resulting in the lowest oxygen content since the mid-1980s. At the end of 1998, anoxic conditions prevailed, which initiated denitrification, thus causing nitrogen to escape from the sea into the air. It also caused phosphate to be released from the seabed causing phosphate concentrations to increase. In the Gulf of Finland, enhanced stratification during 1994-1998 caused a rapid decline in deeper-layer oxygen conditions. The mean oxygen concentration in the near-bottom layer during the period 1994-1998 was less than the mean for the previous period 1989-1993 and close to that in the period 1979-1983. In the summer of 1996, extensive anoxia occurred at the sediment-water interface in the eastern Gulf of Finland resulting in phosphate release from the sediment in quantities that almost equalled the total annual riverine load. This additional nutrient supply then became available to the phytoplankton growth cycle (HELCOM 2002).

In 1993 and 1994 the inflows of oxygen-rich salt water adversely affected the benthic communities throughout the open sea areas of the Baltic Proper and the western Gulf of Finland, manifested as short-term increases in biomass and abundance. The subsequent stagnation and hypoxic sediments resulted in considerable decimation of the macrozoobenthos, and in some cases even caused extinction. However, none of the changes in the open sea benthic conditions could be linked to changes in the prevalence of eutrophication (HELCOM 2002).

The second feature is increased occurrence of harmful algal blooms. Algal blooms are naturally occurring phenomena. Due to eutrophication, however, mass occurrences of microscopic algae have increased both in frequency and intensity (HELCOM 2002). These included not only cyanobacterial blooms, but also blooms of dinoflagellates such as *Scrippsiella hangoei, Heterocapsa triquetra, Prorocentrum minimum* and *Gymnodinium mikimotoi,* which caused reddish discoloration of the water. Dinoflagellate blooms were usually relatively short in duration and occurred in all parts of the Baltic Sea region in summer and early autumn. The algal blooms, especially those formed by cyanobacteria like *Nodularia spumigena*, can also be toxic, and thus represent a potential health risk for humans and animals. High biomass blooms also form an aesthetic problem with possible effects on tourism (HELCOM 2003a). A secondary effect of a bloom is that it causes mortality of benthic fauna and depletes oxygen concentrations when a bloom collapses.

Chemical

Chemical pollution was considered to have a moderate impact instead of severe, based on findings that indicate a steady decrease in the concentrations of organochlorine compounds throughout the Baltic Sea region over the past 30 years.

The concentration of metals and organic pollutants has been investigated in sediment and biota samples throughout the Baltic Sea. Of the metals studied in the biota (cadmium, copper, lead, arsenic, mercury and zinc), only cadmium exhibited systematic spatial variation, with the highest concentrations being found in the southern Bothnia Sea and in the Baltic Proper (HELCOM 2002). With the other metals, local variation is observed that is probably related to urban activities, but this is generally less than one order of magnitude. Sediment concentrations of mercury were highest in the Bay of Bothnia and the eastern Gulf of Finland, while concentrations of cadmium, zinc and copper were highest in the central basin of the Baltic Sea. High concentrations of metals in sediments were only recorded in the Bay of Bothnia. Lead seems to be evenly distributed throughout the region (HELCOM 2002).

Concentrations of dioxins in herring and salmon vary regionally. The most contaminated fish are found in the northern part of the Baltic, including herring in the Bothnian Sea, and salmon in the Bothnian Bay (HELCOM 2004b). Transfer of dioxins up the marine food chain can be observed in fish eating birds and their eggs. The concentrations of dioxins in guillemots eggs have decreased to one third of their 1970-levels. These concentrations decreased rapidly until the mid-1980s, but have since remained at roughly the same level. Dioxin concentrations in sediments peaked in the 1970s, but have began to decrease recently (HELCOM 2004b).

The health conditions for many birds of prey and mammals have improved but some species still struggle with reproductive problems. The concentrations of dioxins and PCBs seem to have remained stable during the 1990s, indicating that the substances are still released to the Baltic Sea. The concentrations of most heavy metals monitored in mussels, fish and bird eggs have decreased or remained stable (HELCOM 2001). An exception is cadmium where the concentration has increased in fish from the Baltic Sea during the 1990s. The reason for this increase is unclear (HELCOM 2001). Despite of the implementation of the HELCOM Recommendations to reduce discharges of pollutants into the Baltic Sea, there are indications that chlorinated compounds and other toxicants such as pesticides and PCB/PCT are still released into the environment.

Data about water-borne discharges and atmospheric deposition of heavy metals is not as reliable as that for nutrients, and may be considered as only rough estimates. Reasonable deposition calculations are only available for lead, and only tentatively for cadmium. Between 1991 and 1994, the yearly mean deposition of lead and cadmium to the Baltic Sea was 600 and 25 tonnes per year, respectively (HELCOM 2003a). Due to the lack of data, an accurate assessment of the impacts from heavy metals and persistent organic matter could not be undertaken.

Suspended solids

The impact of suspended solids was considered slight. The quantity of suspended sediments has increased due to a proliferation of phytoplankton in eutrophicated areas and increased coastal erosion in the southern and eastern Baltic Sea. Since hydropower plants have moderated the annual peaks in stream flow, the annual cycle in the supply of suspended solids to the sea has also been affected. However, this issue was considered to be of minor importance in the region, and as a consequence, it has been given little attention in previous reports (Melvasalo et al. 1981, HELCOM 1987a, HELCOM 1990, HELCOM 1996b, HELCOM 2002).

Solid wastes

The amount of litter on beaches and the damage caused to fishing nets by solid waste were used as indicators when making this assessment. The litter comes from a variety of sources. For example, litter from ships and vessels includes normal household waste, cargo holds, discarded fishing equipment, and medical and sanitary articles, while litter from tourists includes plastic bags, bottles and cans. The proportion of waste that is plastic material has increased sharply in recent decades, accounting for more than 90% of the total waste volume, causing significant environmental problems. In Poland for example, the annual coastal beach clean collected 50 to 100 m^3 of waste (HELCOM 2002). However, the influence of solid waste on the Baltic Sea is slight because beaches and tourists areas are regularly cleaned and the amount of litter from ships is minor.

Radionuclides

Minor releases of radionuclides were recorded in the region, but under well-regulated conditions and in compliance with the Radiological Basic Safety Standards. However, the impact of radionuclide pollution is considered slight, because there remains a small element of risk that an accident may occur. The majority of artificial radionuclides found in the Baltic Sea originate from the fallout following the Chernobyl accident in Ukraine, April 1986. The second most important source of radionuclides is the fallout from atmospheric weapon tests during the 1960s. The least significant source of artificial radionuclides is the operational discharges from the eight nuclear power plants within the drainage area of the Baltic Sea region (HELCOM 1995, HELCOM 2002).

Oil spills

The impact of oil spills was considered moderate due to the amount of illegal spills and accidents at irregular intervals. Oil spills may occasionally cause high mortality of sea birds, as well as contaminate the coastal zone. Oil spills pose a serious threat due to the vulnerability of the Baltic Sea, which has a long residence time of water and has a high risk of an accident due to intensity of sea transportation.

More than 500 million tonnes of cargo is transported across the Baltic Sea each year. Approximately 50 ferries have fixed routes between the Baltic ports, and more than 2 000 larger ships, including cargo carriers, oil tankers and ferries, are transiting the Baltic Sea at any given time. Moreover, the amount of maritime traffic is steadily growing (Figure 9). The risk of an accident, and subsequently a spill occurring, may increase due to the high traffic volume.

Despite the designation of the Baltic Sea as a "Special Area" under MARPOL 73/78, which prohibits the discharge of oil/oily mixtures from all ships, many illegal oil discharges are observed in the Baltic Sea. In addition, accidental oil spills occur, although more rarely but with considerable impact. These oil spills have immediate impacts such as contamination of beaches and seabird mortality, and have also had

Point	Number of ships crossing in 2000	Number of ships expected to cross in 2015
1	23 388	31 600
2	34 692	70 100
3	46 476	83 700
4	58 500	105 300
5	75 696	121 100
6	85 296	136 500

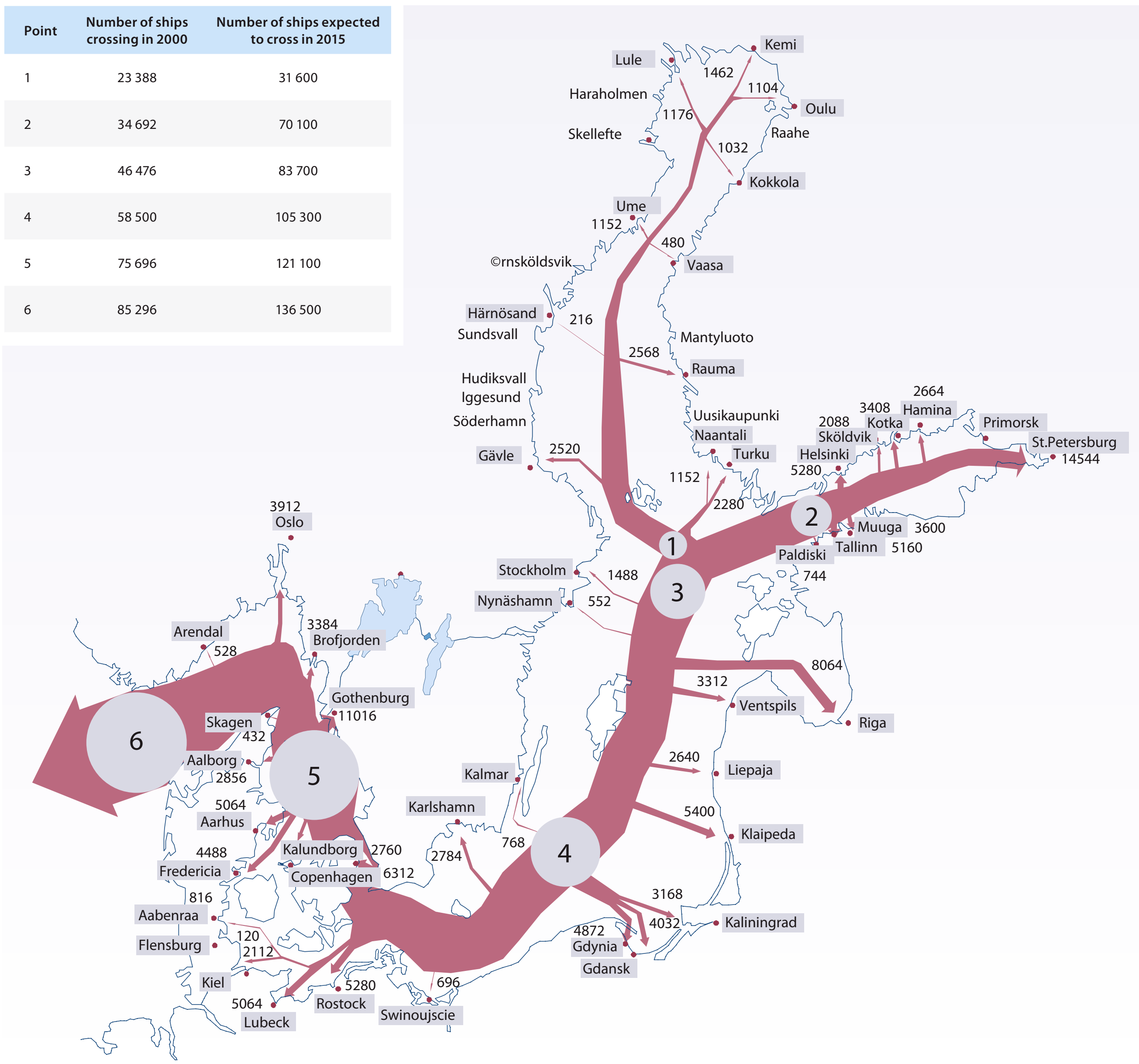


Figure 9 Number of ships, excluding ferry traffic, in the Baltic Sea 2000.
(Source: Rytkönen et al. 2002)

Figure 10 St. Petersburg commercial seaport, at the mouth of the Neva River.
(Photo: Corbis)

long-term effects, for example, increased concentrations of petroleum hydrocarbons (PHC) in sediments. Statistically, the number of oil spill accidents in the Baltic Sea is estimated to be 2.9 per year (HELCOM 1996b). A risk assessment indicates that the statistical number of oil spill accidents will rise to 3.2 if the present oil terminal capacities are fully utilised, and to 4.9 accidents per year if plans to construct new terminals and to enlarge existing terminals are implemented, and the terminals are fully utilised. As a consequence, the predicted amount of oil spilled annually will increase to 775 tonnes and 1 475 tonnes, respectively (HELCOM 2002). Between 1969 to 1995, about 40 major oil spills of more than 100 tonnes were registered in the Baltic Sea region. However, this is not entirely surprising for an area where 7 000 voyages involving the transport of oil take place annually. The number of accidents may rise during the next decade as the sea-borne oil transport is expected to increase from its current level of 77 to 177 million tonnes per year (HELCOM 2002). Figure 10 shows the St. Petersburg commercial seaport, which following the collapse of the Soviet Union became one of the busiest among the newly independent countries and Baltic states.

Socio-economic impacts

Pollution was considered to have a moderate economic impact in the region. This is attributed to the higher transportation costs of raw water and additional expenses for water treatment. Moreover, the costs of preventive measures and of cleaning intakes were considered to increase moderately, while costs regarding tourism and recreational values were expected to fall moderately. Eutrophication, chemical pollution and spills have some effect on fish mortality but it is difficult to accurately assess the economic impact on the fisheries associated with pollution.

Health impacts of pollution in the Baltic Sea region were assessed as moderate. Pollution such as hazardous substances, heavy metals and nitrogen compounds cause different health problems such as allergies, poisonings, chronic inflammations, infectious diseases. Due to the advanced water treatment processes, epidemics or infectious diseases are no longer a problem in the Baltic Sea catchment area. Discharges of untreated wastewater in the market economy countries are practically non-existent, whereas in the countries in transition the percentage is between 7 to 19% except in certain areas in Russia where the figure can be as high as 37% (Lääne et al. 2002). Some problems have also been recorded in the countryside where the nitrogen concentration or microbiological pollution in local shallow wells sometimes exceeds the maximum admissible concentrations (see Figure 8 above). The influence of the toxic algal blooms to the public is local and very limited. Possible health risks arise from consuming contaminated fish. However, the implementation of the EU Directives will limit the use of fish with high dioxin levels, which will reduce the potential health impacts.

Pollution was considered to have only a slight effect on other social and community Impacts. The point and diffuse (agriculture) sources were considered to affect the water quality, which in turn affects the use of water for different purposes. Furthermore, the use of nature for recreational value may be affected as a consequence of pollution such as oil spills and eutrophication.

Conclusions and future outlook

The overall environmental impact of Pollution is presently severe. Over the next 20 years, environmental impacts from pollution were predicted to reduce only to moderate despite improved regulations and the implementation of internationally adopted environmental protection measures such as the EU Water Framework Directives and HELCOM Recommendations. The significant reduction in the discharge of hazardous and biogenic substances at the end of the 20th century was an important step towards reducing the pollution load of the Baltic Sea. However, significant improvements in water quality may take a long time, due to the slow water exchange and the accumulation of large quantities of pollutants in the Baltic Sea.

IMPACT Habitat and community modification

The GIWA concern of Habitat and community modification consists of two environmental issues: loss of ecosystems or ecotones and the modification of ecosystems or ecotones, including community structure and/or species composition. Loss of ecosystem or ecotones was considered to be slight in the Baltic Sea region and as the two issues are closely connected, the assessment of this concern will only focus on the modification of ecosystems or ecotones, which was considered to be of moderate impact.

Environmental impacts

Modification of ecosystems or ecotones

Approximately 90% of the marine and coastal biotopes in the Baltic Sea are to some degree threatened, either by loss of area or reduction in quality (HELCOM 2001, 1998c). According to HELCOM (1998c), 88% of the identified 133 marine biotopes and 13 biotope complexes are exposed to some kind of threat (e.g. eutrophication, contamination, fishery or settlements) and are regarded as endangered or heavily endangered. In 1998, HELCOM compiled a status report on biotopes and biotope complexes in the HELCOM area (HELCOM 1998c), including a classification system for Baltic coastal and marine biotopes. Of the 66 pelagic and benthic marine biotopes described in the report, 2 biotopes were classified as heavily endangered, 58 as endangered, 4 as potentially endangered, and 2 had no data available. This indicates a considerable pressure on the Baltic Sea habitats. Marine habitats are mainly affected by human settlements, pollution and construction along the coastline. The main reasons for the modification of ecosystems were considered to be related to agricultural, municipal and industrial discharges, dredging and excavation of peat and gravel, construction of ports, as well as tourism.

Wetlands, the peat bogs and marshlands were considered to be the most affected habitats with a moderate degree of impact. The peat bogs have been subject to extraction and drainage especially in the northern and eastern Baltic Sea. The marshlands on the other hand have been affected mostly in the southern parts of the Baltic Sea, despite attempts to restore these habitats. Other habitats have been impacted to varying degrees. Littoral belts alongside lakes and ponds are severely affected in the southern Baltic, but only slightly in the northern regions. In running water wetlands (tidal rivers are excluded), drainage and agricultural activity have been the predominant causes of habitat modification. The impact on them was considered slight, although impacts were greatest in the southern regions. There are no known impacts on saline wetlands.

Open or running waters (fast flowing, stony bottomed, and sandy/muddy flood plain rivers) have been affected by pollution and the construction of dams. Standing waters have also been affected to a certain extent, as lakes and ponds have been enriched with nutrients from agricultural activities (diffused discharges) and discharges from point sources (municipal and industrial discharges). The subsequent changes in the trophic status affect the flora and fauna of the impacted areas. The damming of rivers has changed the hydrological regime necessary for salmon to reproduce and caused a decline in their populations (HELCOM 2001). In compensation for these losses, hatcheries have been built to sustain wild salmon stocks. This has led to the loss of distinct populations and a decline in overall genetic variability. Recent estimates indicate that wild salmon reproduction has increased, although yields of juvenile wild salmon in certain rivers are still alarmingly low (HELCOM 2003a).

The coastal marine ecotones have experienced slight to moderate impacts. Sandy foreshores (including dunes) are comparatively sensitive to anthropogenic influences and have been moderately affected by tourism, pollution and construction. Lagoons and estuaries were also considered to have had moderate impacts. Lagoons are threatened by pollution, urbanisation, industry, agriculture and dredging, while estuaries suffer from land-based pollution and construction activities, e.g. harbours. Other habitats considered to be under slight impact in the Baltic Sea region were muddy foreshores and rocky foreshores. Muddy foreshores have been affected by dredging, whereas the rocky foreshores have been impacted by the construction of harbours (for example in Sweden and Finland).

Other benthic marine habitats that have been seriously affected are seagrass and fucus meadows, which have experienced moderate impacts from pollution. Sandy and gravel extraction has had a slight impact on nearby ecosystems. There are no known impacts on mud bottoms, as they suffered from oxygen depletion even before industrialisation. Pelagic habitats (above and below the halocline) have been slightly impacted by changes in light above the halocline and from oxygen depletion below the halocline.

Socio-economic impacts

Generally, the economic impacts of habitat and community modification were considered slight in relation to human needs for aesthetic and recreational values. The loss and modification of ecosystems and ecotones will have serious economic impacts in the future, and considerable investment is needed in order to rehabilitate modified habitats. The economic impact of this concern will therefore increase from slight to moderate in the future.

There have been slight health as well as other social and community impacts associated with the loss and modification of habitats. The capacity for the ecosystems to meet human food demand has been reduced and the degraded environment has caused health risks for the local population. In the future, the situation will improve slightly but because of a low level of confidence, there are no reasons to lower the assessed impact degree.

Conclusions and future outlook

Improvements are occurring due to EU, HELCOM, and NGO activities and the implementation of environmental protection legislation as well as different projects, for example the Baltic Sea Regional project (HELCOM 2003b). Freshwater habitats are generally believed to react more quickly to changes than the larger marine habitats, as they are smaller water bodies and have faster water turnover times. Greater public awareness of the impact of human activities on sensitive habitats is needed, although in many instances it may be too late to rehabilitate the modified ecosystems.

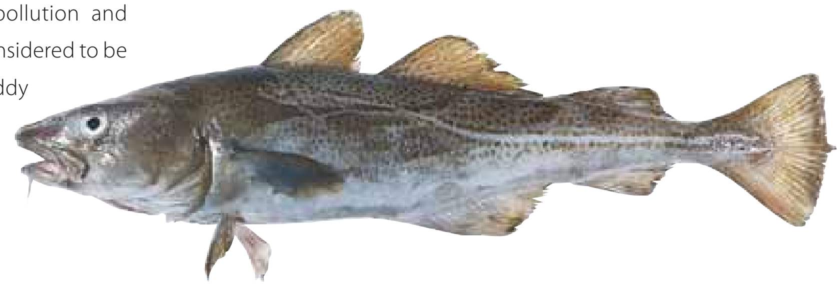


Figure 11 Cod (*Gadus morhua*).
(Photo: W. Savary, Regulatory Fish Encyclopedia)

IMPACT Unsustainable exploitation of fish and other living resources

The overall environmental impact of unsustainable exploitation of fish and other living resources in the Baltic Sea region was assessed as moderate. Overexploitation was considered severe; average annual landings of the most important commercial species (for example cod Figure 11) have decreased two-fold, between the 1980s and 1990s. Since the mid-1800s close to 100 non-indigenous species have been introduced to the Sea as well as escapes from fish farms and the uncontrolled restocking of salmon have altered the composition of ecosystems and affected genetic biodiversity. There has also been decreased viability of stocks in the region due to pollution and diseases, for example the recently discovered mouth disease on pike, crayfish disease in Sweden and salmon M-74 disease. There is expected to be a slight improvement in the future due to the implementation of fishing regulations.

Environmental impacts

Overexploitation

The impact of overexploitation in the Baltic Sea region was considered severe and was chosen for further analysis by the GIWA Task team. For more information and data please refer to the causal chain analysis section.

Total average annual landings of the most important commercial species in the Baltic Sea region have decreased two-fold between the 1980s and 1990s. Cod landings have become 3.5 times smaller over the same period (ICES 1994, 1999, Baltic 21 1998b). Figure 12 shows the changes in landings and mortality of cod, and Figure 13 represents recruitment and spawning stock biomass. Major inflows of saline North Sea water before 1976 led to the highest cod spawning stock biomass in 1980-1985 (Baltic 21 2000). Total lack of inflow in 1980-1992 and only one major inflow in 1993 caused a stagantion period in Baltic deep water and poor recruitment. A minor decrease in eastern cod landings in 1994-1996 (when the salinity increased) was followed by a general decline since 1997. Total landings of cod in 2000 were estimated to be 66 000 tonnes (Walday & Kroglund 2002). The stocks have been highly exploited beyond the levels advised by the ICES. There has not been a reduction in fleet capacity or fishing effort in response to the overexploitation, and fish mortality has increased as stocks have declined (Baltic 21 1998b).

The lack of accurate data for fish landings and an overassessment of resources has led to exploitation beyond the region's biological limits. This was recognised in the Agenda 21 for the Baltic Sea Region, as the main cause for the overfishing of cod, and is also considered a major factor in the depletion of other commercial fish stocks in the Baltic Sea region.

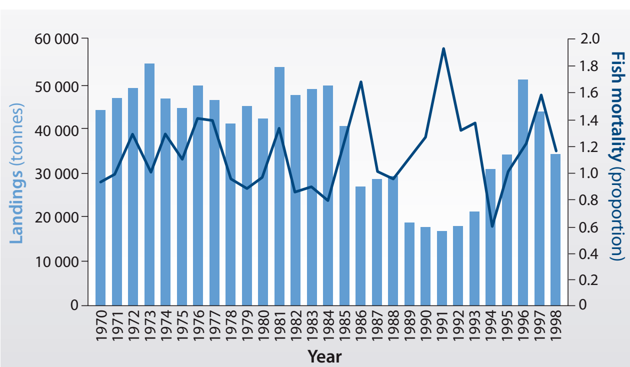


Figure 12 Landings and mortality of cod age 1.
(Source: Baltic 21 2000)

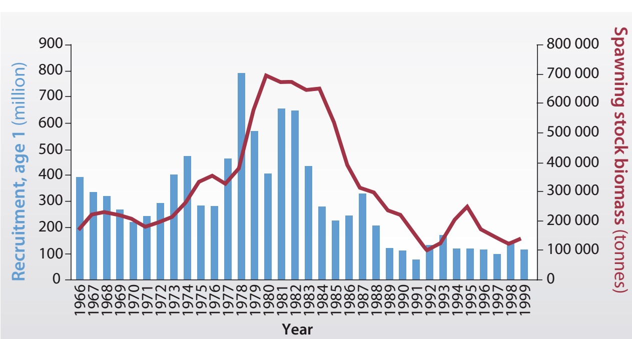


Figure 13 Recruitment and spawning stock biomass of cod age 2.
(Source: Baltic 21 2000)

Excessive by-catch and discards

The total by-catch of fish in the Baltic Sea is unknown, as no quantitative estimates are currently available. However, in some coastal fisheries there may be very high rates of by-catch, such as in the roe fishery (Vendace, *Coregonus alba*). As a result of these discards, the abundance of organic matter may increase, which in turn may contribute to the depletion of oxygen in bottom waters (HELCOM 2002).

By-catch of Harbour porpoises (*Phocoena phocoena*) has been estimated to amount to a few percentages of the population in the Danish and German waters, although this figure is believed to be underestimated. Seals mortality as a result of being caught as by-catches does not seem to have threatened their populations since their numbers are increasing (HELCOM 2002). Based on these findings the influence of this issue was assessed to be slight in the region.

Destructive fishing practices

Some seabeds in the region exposed to trawling recover quickly while some have a longer recovery time (Baltic 21 1998b). Trawling in shallow areas is prohibited, but it is unknown to what extent it does continue. However, relatively few fishers employ illegal fishing techniques and beam trawling, so this issue was considered to have a slight impact.

Decreased viability of stock through pollution and disease

Evidence has been found of decreased viability of stocks in the Baltic Sea ecosystem caused by pollution and diseases (Walday & Kroglund 2002). The presence of pollution such as eutrophication and toxic contaminants may not only spread diseases but also influence species composition, reproduction biology and migratory habits. Examples of diseases include the recently discovered mouth disease on pike, crayfish disease in Sweden, salmon M-74 disease, and diseases in eel and flatfish, from which the eel is yet to recover. The stocks of the naturally spawning salmon (Figure 14) have been significantly depleted after the appearance of the M-74 syndrome in Swedish and Finnish rivers, which was first observed in 1974. In the 1970s-1980s the M-74 mortality was about 15-30 %, but it increased to 60-80% in 1992-1996 and has decreased since 1997 to levels between 15% (1998) and 40% in 1999 (Karlström n/d).

In 1996 production of wild smolt was very limited as a result of disease, with the smallest stocks at risk of extinction. However, the situation has improved considerably in recent years. The viral lymphocystis disease was prevalent in 5 to 38% of flounder larger than 20 cm, with a decreasing spatial trend from the western to eastern parts of the Baltic Sea (HELCOM 1996b). The most externally visible disease of Baltic cod is the bacterial skin ulcer, which has been found on between 15% and 40% of the cod. Its prevalence decreased from the 1980s to 1990s

Figure 14 Salmon (*Salmo salar*).
(Photo: W. Savary, Regulatory Fish Encyclopedia)

(HELCOM 1996a), but according to recent studies (HELCOM 2002), a high prevalence of acute skin ulceration in Baltic cod has been observed in the last few years. There is concern that this disease may cause mortality and thus deplete stocks, and may also reduce the fitness and reproductive potential of surviving cod. Based on these findings the GIWA Task team assessed the impact of this issue to be moderate in the Baltic Sea region.

Impact on biological and genetic diversity

Biological and genetic diversity in the Baltic Sea has been affected by a variety of activities. The uncontrolled restocking of salmon and escapes from fish farms have altered the composition of ecosystems and affected genetic diversity. Fishing is recognised to have both direct and indirect impacts on biodiversity and has caused a loss of habitats and biotopes in certain parts of the Baltic. Foremost are the direct effects caused by the removal of fish and shellfish for landings, and the capture of non-target fish and shellfish and other animals (Baltic 21 1998b). Overfishing has altered the ecological balance of many ecosystems in the region; key biotopes have been depleted, which has modified predator-prey relationships within the food chain.

The introduction of new species into the Baltic Sea ecosystem has been another major factor that has impacted on biological and genetic diversity. Over the past 20 years, a growing number of alien species have been released into the Sea, and as ship traffic increases, more and more 'stowaway species' have arrived (HELCOM 2001). NEMO (Non-Indigenous Estuarine and Marine Organisms) is an inventory of alien species, maintained by a group of non-governmental Baltic marine biologists, which has recorded that close to 100 non-indigenous species have been introduced since the mid-1800s, including plankton, invertebrates, fish, birds and mammals (Table 13) (NEMO 2002). Since 1990, 10 new species have been introduced into the Baltic (Walday & Kroglund 2002). However, it should be noted that these new species have been introduced relatively slowly, and to date, the Baltic system does not appear to be significantly impacted.

Table 13 Introduced species to the Baltic Sea.

Taxon	Number of introduced species
Fishes	29
Crustaceans	21
Molluscs	13
Polychaeta/oligochaeta	7
Phytoplankton	8
Macroalgae	7
Mammals	2
Others	13

(Source: NEMO 2002)

Socio-economic impacts

The economic and other social and community impacts of the unsustainable exploitation of fish and other living resources was considered as moderate. Although in some areas it is more severe, for example in countries where the fisheries has greater significance for the national economy like Poland (EU Enlargement 1998) and Kaliningrad, Russia (Dvornyakov 2000).

The fishing market is affected as fish landings become more variable and uncertain. The reduced landings have also increased unemployment in the fishing sector, and jeopardised income growth. An economic downturn in the fishing sector may lead to increased demand for subsidies and other governmental support. Moreover, stringent protection measures to help fish stocks recover may in the short-term exacerbate the economic impacts (Baltic 21 1998b, FAO 1997).

Increasing unemployment and the loss of fishermen's livelihoods is a growing concern especially in the recently EU acceded countries and Russia. For example, the unemployment level in Russian fishing regions has been identified to be 1.5 to 3.5 times higher than in other sectors of the economy (Dvornyakov 2000). Increasing unemployment associated with the declining fishing resource is having social and community impacts in many communities that have traditionally depended heavily on the fishing industry.

The unsustainable exploitation of living resources was considered as having no known health impact in the region.

Conclusions and future outlook

Fishing activities are affecting the species composition and the size distribution of the main target species as well as non-commercial fish stocks in the Baltic Sea region. The fishing pressure on the stock is one reason why many young fish have been caught before they have reproduced for the first time. The number of fish in the reproductive stage is estimated to be far below the sustainable limit. At such low levels the stock is unlikely to replenish itself. Despite regulations, fishing fleets continue to overexploit the fisheries resource in the Baltic Sea. Concerning the future a slight improvement is anticipated due the implementation of fishing regulations, however, cod stocks are not expected to recover in the near future.

Global change

The GIWA assessment considered that there are currently no known environmental impacts associated with global change, due to there being insufficient data available to make an accurate evaluation. However some changes in the hydrological cycle have been noticed. There are no known impacts of increased UV-B radiation as a result of ozone depletion, as there is currently a lack of information exploring how increased UV-B radiation as a result of ozone depletion has affected the Baltic Sea region. There is either no known impact from changes in ocean CO_2 source/sink function, and an assessment could not be made due to a lack of information. These issues are therefore not further discussed.

Environmental impacts

Changes in the hydrological cycle (climate change scenarios)

Only slight changes in the hydrological cycle were identified, with impacts mainly associated with changes in ice conditions. As a result of climate changes, the break-up of ice on rivers is expected to occur earlier, the frequency of saline water entering the Baltic Sea will be reduced, and there will be an increase in the frequency of heavy storms and floods. The sea surface temperature of the Baltic Sea is expected to increase by 2-4°C and ice is estimated to be 20-30 cm thinner. Climate changes are predicted to increase the water flow entering the Gulf of Finland by 2% during the next 20 years which will result in an estimated increase of the phosphorus load from non-point sources by 4% and load of total nitrogen by 4% (Pitkänen et al. 2004).

Sea level change

It is not known what extent global changes are influencing sea level in the Baltic Sea region, as it is unclear to what extent isostatic movements from the last ice age are influencing this issue. In addition the predicted 2% increase in water flow to the Baltic Sea is not expected to influence sea level (Pitkänen et al. 2004).

Socio-economic impacts

Global changes were assessed to have a slight economic impacts in the Baltic Sea region under present conditions. Concerning the future, more serious impacts are expected due to changes in the hydrological cycle, but it is unclear what impact the other issues may have in the future.

Health impacts were considered to be slight. Other social and community impacts from global changes are connected to certain groups of people, who are more exposed to these changes than others. The degree of these impacts was considered slight. As the confidence level is low concerning the other social and community impacts, the same impact for the future as for the present is appropriate, albeit the situation is getting slightly worse.

Conclusions and future outlook

There is currently insufficient information on the impacts of global changes in the Baltic Sea region, and therefore it was assessed as having no known impact. In the future, the economic and health impacts may increase slightly, yet these were considered minor compared with many of the other assessed concerns.

Priority concerns for further analysis

The GIWA concerns were prioritised in the following order:

1. Pollution
2. Unsustainable exploitation of fish and other living resources
3. Habitat and communtiy modification
4. Freshwater shortage
5. Global change

The most alarming issues were found under the two concerns; Pollution and Unsustainable exploitation of fish and other living resources. Based on the assessment results, the priority issues of eutrophication and overexploitation of fish were selected for the Causal chain analysis since these were identified as the most severe transboundary issues of the Baltic Sea.

Eutrophication has been caused by the excessive input of nutrients; namely nitrogen and phosphorus. According to the conclusions of the most recent HELCOM periodic assessment of the state of the Baltic Sea (HELCOM 2003a), eutrophication remains the most pressing environmental issue in the Baltic. None of the nine Baltic Sea countries have been able to meet the target adopted at the Helsinki Commission in 1988; to halve their total nutrient discharges to the Sea. The countries acceded to the EU in 2004 have managed to come closer to meeting this target than the other EU countries, largely due to political and economic changes. However, a substantial reduction in nutrients from the agricultural sector is still urgently needed (Lääne et al. 2002).

Although landings of commercially important species have been stable at between 0.9 to 1 million tonnes per year, this does not mean fish populations are also stable in the Baltic Sea. Closer analysis of individual species such as sprat and cod reveal wide fluctuations in landings, indicating ecological imbalances. As populations of cod are depleted, the number of sprat increases, reflecting their predator-prey relationship. Studies of the main target species between 1994 and 1998 indicated that the cod, herring, salmon and eel fishery is unsustainable in the Baltic Sea. In order to avoid the collapse of these stocks, there is a need to allow populations to recover to safe biological limits. In accordance with HELCOM's working group on habitats (HELCOMHABITAT) in 2001, sustainable fishery management practices need to be designed that meet the needs of the entire Baltic ecosystem. HELCOM has intensified cooperation with the International Baltic Sea Fishery Commission (IBSFC), including a joint seminar held in February 2002 in Gdynia, Poland. The parties agreed at this seminar on a sustainable fishery management strategy designed to meet the needs of the whole ecosystem, and discussed how to address concerns such as the impact of commercial fishing on the Baltic food web, excessive by-catch, and the change in abundance and distribution of non-commercial fish stocks and main targeted fish species.

Causal chain analysis

This section aims to identify the root causes of the environmental and socio-economic impacts resulting from those issues and concerns that were prioritised during the assessment, so that appropriate policy interventions can be developed and focused where they will yield the greatest benefits for the region. In order to achieve this aim, the analysis involves a step-by-step process that identifies the most important causal links between the environmental and socio-economic impacts, their immediate causes, the human activities and economic sectors responsible and, finally, the root causes that determine the behaviour of those sectors. The GIWA Causal chain analysis also recognises that, within each region, there is often enormous variation in capacity and great social, cultural, political and environmental diversity. In order to ensure that the final outcomes of the GIWA are viable options for future remediation, the Causal chain analyses of the GIWA adopt relatively simple and practical analytical models and focus on specific sites within the region. For further details on the methodology, please refer to the GIWA methodology chapter.

In this section, the root causes of the environmental and socio-economic impacts of the prioritised issues and concerns from the assessment are identified. The concerns of Pollution and Unsustainable exploitation of fish and other living resources were selected as having the most transboudary impacts in the Baltic Sea region. More specifically, eutrophication and overexploitation were the most severe issues under these concerns, which are analysed further in this section. In the case of eutrophication, inputs of phosphorus have decreased considerably in the Baltic Sea following the implementation of measures by the Baltic Sea riparian countries. However, eutrophication still remains an urgent problem in most coastal areas. In the other prioritised issue, overexploitation, fishing activities are affecting the species composition and the size distribution of the main target species as well as non-commercial fish stocks. The fishing pressure on the stock is one reason why many young fish have been caught before they have reproduced for the first time. The number of fish in the reproductive stage is estimated to be far below the sustainable limit. At such low levels the stock is unlikely to replenish itself. Despite regulations, fishing fleets continue to overexploit the fisheries resource in the Baltic Sea. The causal chain diagrams illustrating the causal links for eutrophication and overexploitation are presented in Figure 15 and 28 respectively.

Eutrophication

Environmental and socio-economic impacts

Environmental impacts of eutrophication in the Baltic Sea are for example:

- Loss of commercial valuable fish;
- Loss of benthic fauna;
- Modification of ecosystems and ecotones;
- Toxic algal blooms;
- Oxygen depletion.

Examples of socio-economic impacts are:

- Loss of recreational value;
- Cost of drinking water treatment;
- Infections, diseases and allergies.

Immediate causes

Nutrients released into the aquatic environment and deposited from the atmosphere constitute the immediate causes of eutrophication in the Baltic Sea region.

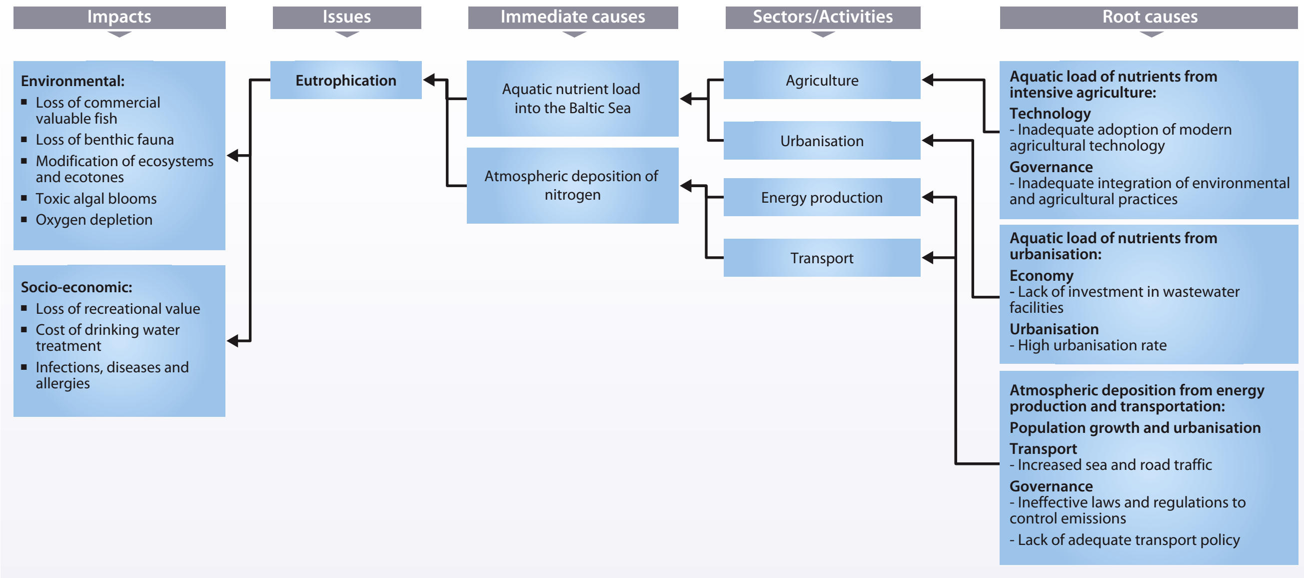


Figure 15 Causal chain diagram illustrating the causal links for eutrophication.

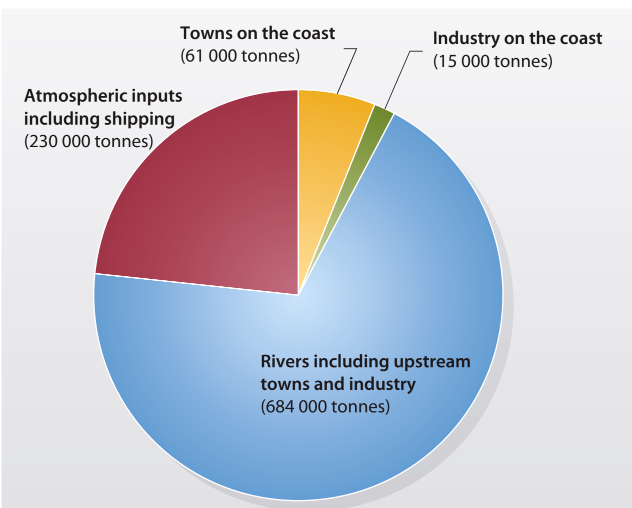


Figure 16 Nitrogen inputs to the Baltic Sea in 1995.
(Source: HELCOM 2001)

Aquatic nutrient loads

The nutrient load entering the Baltic Sea is assessed by the HELCOM Pollution Load Compilations (PLCs) (HELCOM 1987b, HELCOM 1993a, HELCOM 1998a, HELCOM 2004a). Rivers transport the majority of the nutrients from point and diffuse sources to the Baltic Sea (Figure 16). The reports of PLC-2 (HELCOM 1993a), PLC-3 (HELCOM 1998a) and PLC-4 (HELCOM 2004a) presented the sum nutrient load from point and diffuse sources (from agriculture) that enter the Baltic Sea via rivers in the drainage basins, including both anthropogenic and natural (background) contributions. The latest pollution load compilation was PLC-4, which also apportioned nutrients to their source. The following paragraphs are extracts from the PLC-4 Report (HELCOM 2004a).

The majority of nutrient losses and discharges into inland surface waters within the Baltic Sea catchment area are related to anthropogenic activities. In 2000 the discharges from point sources, the losses from diffuse sources (e.g. agriculture, scattered dwellings, stormwater overflows) and natural background losses (natural losses from forest, wetlands and natural meadows) into inland surface waters within the Baltic Sea catchment area for total nitrogen and total phosphorus amounted to 82 2000 tonnes of nitrogen and 41 200 tonnes of phosphorus (Figure 17) (HELCOM 2004a). The major portions of the total nitrogen losses and discharges (58%) and the total phosphorus losses and discharges (53%) originated from diffuse sources. Natural background losses and discharges from point sources for nitrogen amounted to 32% and 10% of the total losses and discharges entering inland surface waters within the Baltic Sea catchment area, respectively. The corresponding figures for phosphorus were 27% and 20%.

The distribution of phosphorus and nitrogen load between the countries of the Helsinki Commission is presented in Figures 18 and 19 , respectively.

In 2000, the total riverine nitrogen load entering the Baltic Sea amounted to 706 000 tonnes (420 kg/km^2). The bulk (81%) of this load was discharged by monitored rivers, with about 40% of the total load originating from the catchment area of the Baltic Proper

(HELCOM 2004a). Approximately 75% of the riverine nitrogen load in the Baltic Proper (286 000 tonnes, 525 kg N/km^2) was discharged by the region's three large rivers: Vistula (117 000 tonnes, 600 kg N/km^2), Oder (53 600 tonnes, 450 kg N/km^2) and Nemunas (46 830 tonnes, 480 kg N/km^2). The second largest proportion of the total nitrogen load entering the Baltic Sea was 17% or 100 400 tonnes (230 kg N/km^2), and was discharged from the Gulf of Finland catchment area, where the River Neva discharged 52 500 tonnes (195 kg N/km^2) (HELCOM 2004a).

In 2000, the total riverine phosphorus load entering into the Baltic Sea amounted to 31 800 tonnes (19 kg P/km^2). The majority (84%) of this load was discharged by monitored rivers, with up to 50% of the total load or 15 640 tonnes (29 kg P/km^2) originating in the catchment area of the Baltic Proper (HELCOM 2004a). Approximately 83% of the load fed to the Baltic Proper, was discharged by the region's three large rivers: Vistula (7490 tonnes, 39 kg P/km^2), Oder (3740 tonnes, 31 kg P/km^2) and Nemunas (1 840 tonnes, 19 kg P/km^2). Roughly 15% or 4 760 tonnes (11 kg P/km^2) of the total riverine phosphorus load

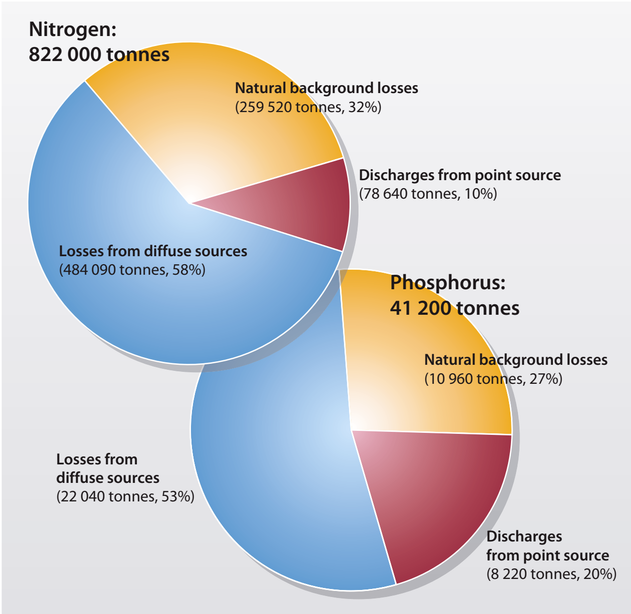


Figure 17 Input of nitrogen and phosphorus to the Baltic Sea region.
(Source: HELCOM 2004a)

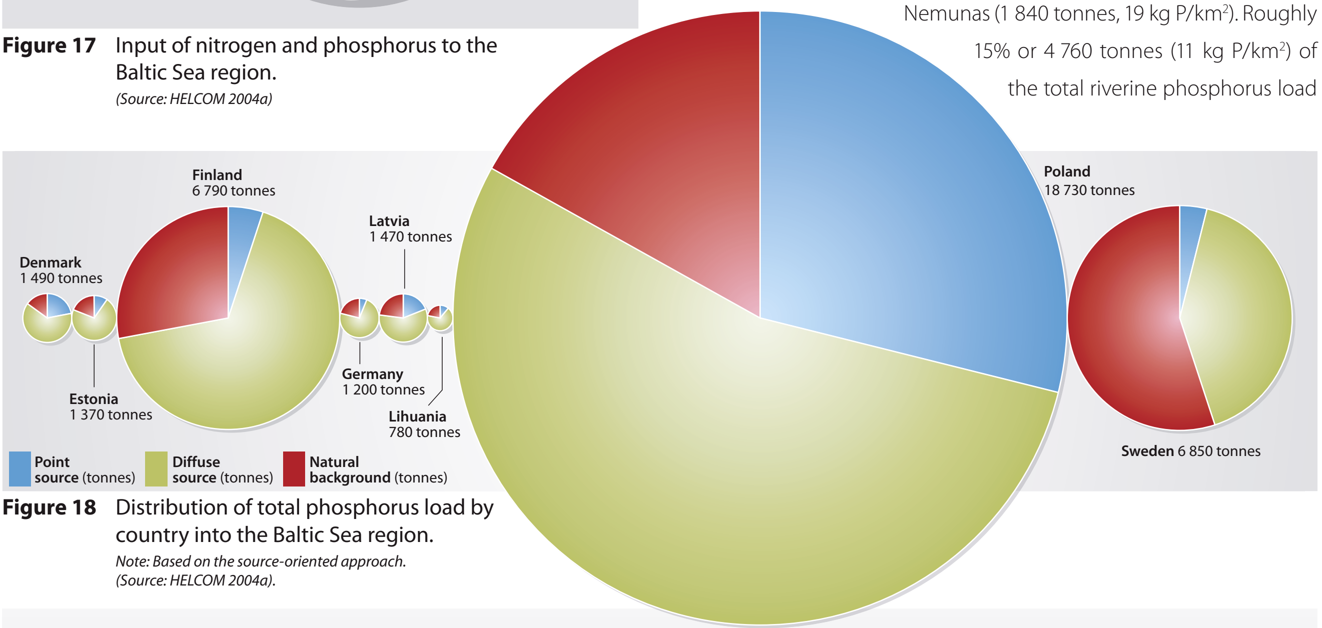


Figure 18 Distribution of total phosphorus load by country into the Baltic Sea region.
Note: Based on the source-oriented approach.
(Source: HELCOM 2004a).

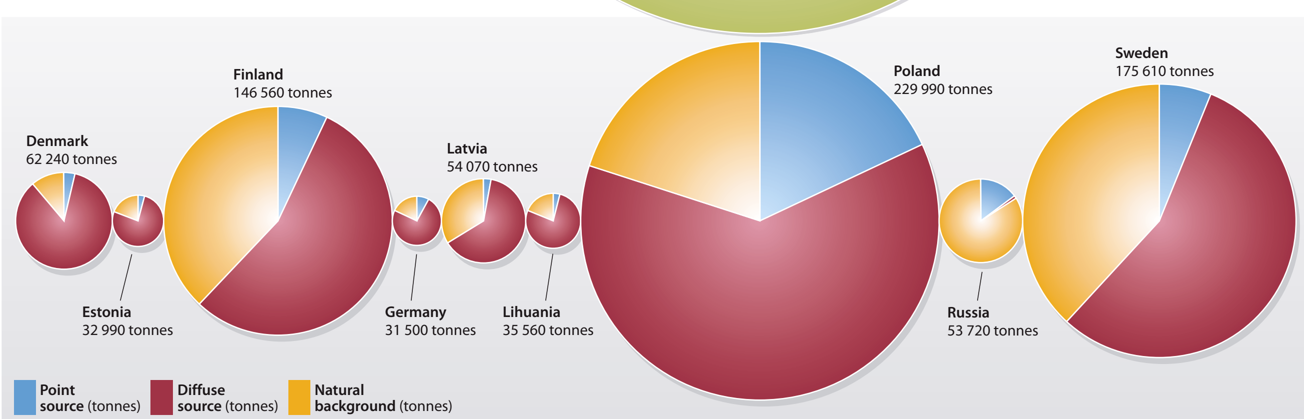


Figure 19 Distribution of total nitrogen load by country in the Baltic Sea region.
Note: Based on the source-oriented approach.
(Source: HELCOM 2004a)

flowing into the Baltic Sea came from the Gulf of Finland catchment area where the River Neva discharged 2 380 tonnes (9 kg P/km^2).

The reported total nitrogen and total phosphorus aquatic discharges entering directly into the Baltic Sea from municipalities, industrial plants and fishfarms amounted to 38 900 tonnes for nitrogen and 2 850 tonnes for phosphorus (HELCOM 2004a). The majority of the total nitrogen and total phosphorus direct discharges were produced by municipal wastewater treatment plants (MWWTPs) which accounted for more than 80% of both total direct nitrogen and total direct phosphorus discharges. Direct discharges from industry constituted 16% of the total direct nitrogen discharges and 14% of total direct phosphorus discharges into the Baltic Sea. Direct nitrogen discharges from industry into the Bothnian Bay and the Bothnian Sea are similar to the direct total nitrogen discharges from MWWTPs. The direct total phosphorus discharges from industry to these regions are about 3 times higher than the corresponding MWWTP discharges, while the direct discharges from fish farms are insignificant.

Atmospheric nutrient deposition

The deposition of nutrients from the atmosphere to the Baltic Sea is not directly linked to atmospheric emissions in the Baltic Sea region but depends largely on transboundary pollutants from adjacent areas. The atmpospheric deposition of nitrogen into the Baltic Sea increased gradually during the 20th century, and was at its highest in the mid-1980s. From 1985 to 1995 the atmospheric deposition was reduced by 10-25%. The mean annual deposition of total nitrogen to the Baltic Sea between 1985 and 1995 was 320 000 tonnes/year (HELCOM 1998b). Figure 20 shows the deposition of nitrogen oxide (NO_3-N) and ammonia (NH_4-N) into the Baltic Sea in 1998. It should be noted that 12-20% of the overall nitrogen deposition to the Baltic Sea comes from shipping (HELCOM 2002).

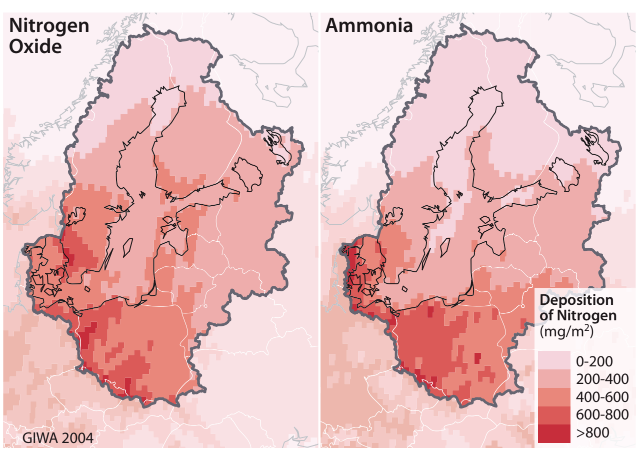


Figure 20 Deposition of nitrogen oxide (NO_3-N) and ammonia (NH_4-N) into the Baltic Sea in 1998.
(Source: HELCOM 2002)

Sector activities

This section discusses the sectors responsible for eutrophication; namely agriculture, urbanisation, energy production and transport.

Agriculture

The main source of nitrogen into the Baltic Sea is agricultural discharges via rivers and is mainly derived from four sources:

- Soil cultivation;
- Use of fertilisers;
- Spreading and storing of manure;
- Intensive and uncontrolled agriculture.

Uncontrolled and intensive agriculture has led to the excessive release of nutrients into the surrounding areas. However, recently agricultural practices have been reformed considerably, and according to the EU Agri-Environmental Programme, which covers most of the GIWA Baltic Sea region, agriculture has become more environmentally friendly, although its impact on watercourses is still alarming. The use of fertilisers is decreasing, and the practise of growing cover crops during the winter is increasing to the target level of 30% of the cultivated area. Livestock densities have fallen, lower grassland fertilisation has rapidly decreased the loss of dissolved phosphorus, and the loss of nitrogen from agricultural areas has also declined. But at the same time, increased tillage and the reduction of land set aside is considered to have contributed to a slight increase in particulate phosphorus losses (Baltic Environment Forum 2000).

To reduce the unnecessary application of artificial and organic fertilisers for crop production, the Helsinki Commission (HELCOM) has established a Working Group on Agriculture (WGA) under the Baltic Sea Joint Comprehensive Environmental Action Programme (JCP). Similar aims are being pursued in the GEF Baltic Sea Regional Project, launched in 2002. The progress on implementing the 1988 HELCOM Ministerial Declaration and the HELCOM recommendations concerning agriculture are discussed in the report "Evaluation of the implementation of the 1988 Ministerial Declaration regarding nutrient load reductions in the Baltic Sea catchment area" (Lääne et al. 2002). According to this evaluation, between 1988 and 1995 there was a reduction in the release of nitrogen and phosphorus into the environment, although there was only a small or negligible decrease of the latter. In Denmark, Finland, Germany and Sweden, there was no recorded decrease in agricultural phosphorus, despite reductions in the use of phosphorus-containing fertilisers. This was due to the historic accumulation of phosphorus in agricultural land. The estimates show that the 50% reduction target for nitrogen and phosphorus will only be achieved by some of the countries in transition. The achievement of this target is less certain for diffuse sources than for point sources, despite various measures designed to reduce inputs into the Sea from agriculture.

The reduction in the release of nitrogen and phosphorus in the transitional countries can be linked with the sharp decrease in agricultural production in Estonia, Latvia and Lithuania, between 1989 and 2000. Land reform, privatisation, the collapse of large collective farms and market changes for meat and other agricultural products, all contributed to the decline in both livestock numbers and use of mineral fertilisers in these countries. These factors also made the distribution of livestock more uniform. Thus, environmental pollution caused by livestock has decreased substantially in these countries (Baltic Environmental Forum 2000).

Compared with other countries in the Baltic Sea region, livestock density (animal units per ha of arable land) and use of mineral fertilisers is low in Estonia and Latvia. Even though Lithuania has a greater livestock density than the other two Baltic states, the current level is considerably lower than in countries such as Germany and Denmark. The Baltic States are also below the maximum density set out in the EU Directive Concerning the Production of Water Against Pollution Caused by Nitrates from Agricultural Sources (170 kg nitrogen per ha of land or approximately 1.7 animal unit per ha). However, production is expected to increase in this region, so the question remains whether the demand for using fertilisers will increase or if more sustainable agricultural practices will be introduced. Both the EU (in the form of the Common Agriculture Programme) and the national EU programmes (which determine the farming conditions), have a considerable influence on this issue. In order to accurately assess the nutrient load of the region there is a need to develop methods for measuring the quantities of nitrogen and phosphorus released from diffuse agricultural sources into surface waters.

Despite the implementation of measures targeted at agriculture, the contribution of nutrients from this sector to the Baltic Sea remains an immediate cause of the eutrophication in the region. Policy options concerning agriculture will be discussed in the following section.

Urbanisation

The discharge of untreated or inadequately treated urban wastewaters is another major source of nutrients. The contribution of nutrients between the late 1980s and 1995 from municipalities located within the catchment area of the Baltic Sea is presented in Figures 21 and 22. Due to changed nutrient load monitoring methods, more recent data on this specific item are not available. Nitrogen and phosphorus discharged from municipalities decreased by 30% and 39%, respectively, during 1980-1995 (Lääne et al. 2002). The 50% reduction target was achieved by the majority of the Baltic Sea countries for phosphorus, while most countries did not reach the target for nitrogen. The most substantial reductions were achieved by the countries in transition (except Poland and Russia) and in Denmark.

The nutrient load reductions achieved in Denmark, Finland, Sweden and Germany (western part) can be attributed to the implementation of protection measures. In Estonia, Germany (former DDR), Latvia, Lithuania, Poland and Russia, the decreases resulted from economic reforms and the construction or improvement of wastewater treatment plants (Lääne et al. 2002).

There is expected to be further reductions in nutrient discharges from municipal point sources. The introduction of chemical phosphorus precipitation, nitrification-denitrification processes, and the enhancement of wastewater treatment will decrease municipal loads in

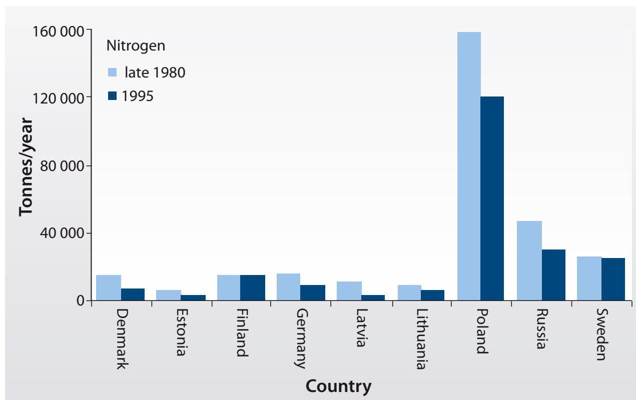


Figure 21 Nitrogen load to water bodies from municipalities between the late 1980s and 1995.
(Source: Lääne et al. 2002)

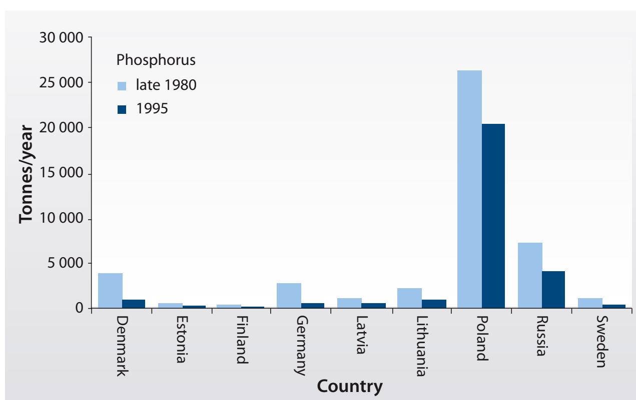


Figure 22 Phosphorus load to water bodies from municipalities between the late 1980s and 1995.
(Source: Lääne et al. 2002)

wastewater. In addition, industrial wastes will be reduced by the further introduction of best available technologies, and greater investment in process technology for wastewater treatment.

Despite these improvements in waste managment, there are regions where urban wastewater is still being discharged into water bodies without treatment or only partially treated. For example, in St. Petersburg, 30% of wastewaters are discharged without any treatment, and a similar situation exists in the Kaliningrad region where construction of wastewater treatment plants is still in the planning phases in the following towns: Kaliningrad, Sovetsk, Neman Gvardeisk and others (Lääne et al. 2002). A comparison of 1995 load figures with recent data published by HELCOM (HELCOM 2004a) shows a considerable reduction in the nutrient load. However, final approval concerning the effects of the implementation of the 1988 Ministerial Declaration concerning nutrient load should be completed by HELCOM.

Energy production and transport

Energy production and transport realease nitrogen compounds into the atmosphere, which is later deposited, thus stimulating eutrophication. Both land and marine transport create significant amounts of air emissions. The energy consumption and exhaust emissions of modern high-speed ships are increasing rapidly. According to model calculations, international marine traffic was the second largest source of nitrogen oxide deposition in the Baltic Sea in 1997 (HELCOM 2002).

The largest contributor of nitrogen compounds (NO_x) to the atmosphere originates from the use of fossil fuels in energy production. Energy production in the Baltic Sea region has increased slightly as indicated in Figure 23 although due to more stringent emission standards,

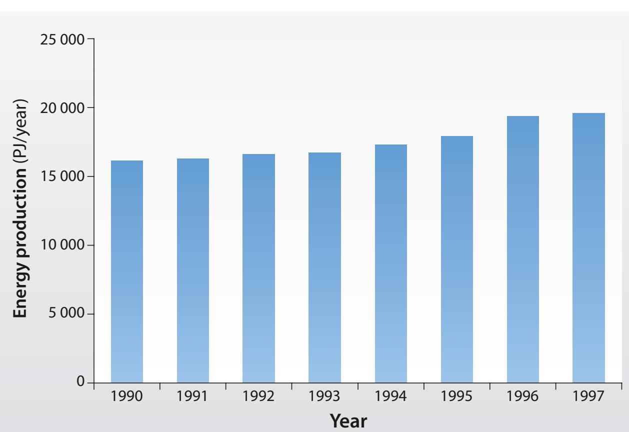


Figure 23 Energy production in the Baltic Sea region.
(Source: Baltic 21 2000)

Table 14 Contribution of the transport sector to NO_x emissions.

Country	Total NO_x emission	Transport sector NO_x emission		
	(tonnes)	(tonnes)	(%)	Per capita (tonnes)
Denmark	321 149	162 218	51%	0.031
Estonia	42 592	15 788	37%	0.01
Finland	308 709	168 499	55%	0.033
Germany	3 82 482	2 282 454	59%	0.027
Latvia	51 629	31 739	61%	0.013
Lithuania	68 957	33 961	49%	0.009
Poland	1 308 424	388 732	30%	0.01
Norway	222 100	127 100	57%	0.029
Russia	6 653 453	905 528	14%	0.0006
Sweden	372 704	286 062	72%	0.030

(Source: Reynolds & White 1997)

emissions did not increase proportionally with energy production (Baltic 21 2000).

Table 14 shows the total NO_x air emissions and the percentage of transport emissions in the Baltic Sea region. The nitrogen emissions from transport are between 14 to 72% of the total emissions, depending to a great extent on transport intensity and industrial emissions (Reynolds & White 1997).

Root causes

Root causes for eutrophication can be divided into aquatic nutrient load, mainly from agricultural activities and urbanisation, and atmospheric deposition from increased energy production and transport.

Aquatic nutrient load from intensive agriculture

High crop production rates have been achieved through the intensive application of artificial and organic fertilisers. However, a part of nutrients from these fertilisers enter surface and groundwaters. The losses are highly dependent on local geophysical conditions, agricultural practices and the technologies employed. The Helsinki Commission, after taking into account the outcomes of the periodic assessments of the state of the Baltic Sea and pollution load compilations, remain concerned about the use of fertilisers despite the reduction between the late 1980s and 1995 (Figures 24 and 25) in all of the Baltic Sea countries. The largest reductions were achieved by the countries in transition, but mainly as a result of the economic recession in the early 1990s.

Greater production of meat and milk at a minimal cost was achieved through increasing livestock densities. This has produced vast quantities of manure and slurry in production areas. In order to minimise nitrogen

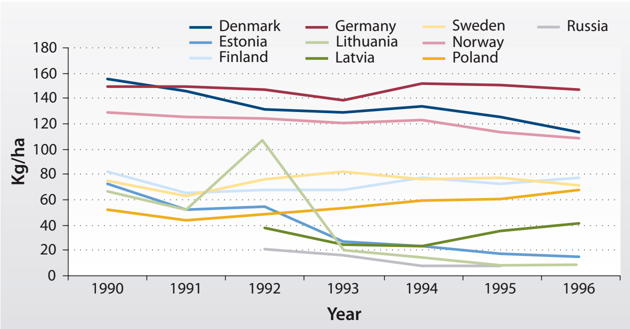


Figure 24 Annually applied nitrogen by mineral fertilisers.
(Source: Baltic 21 2000)

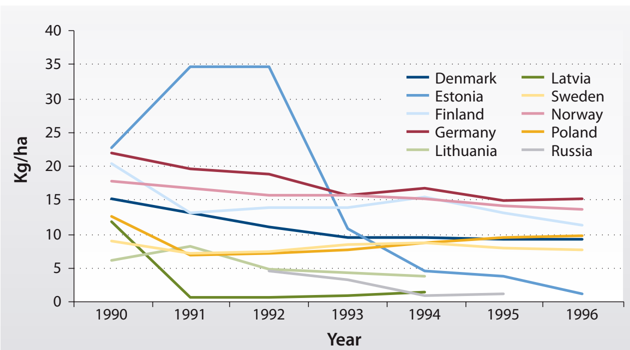


Figure 25 Annually applied phosphorus by mineral fertilisers.
(Source: Baltic 21 2000)

losses to the atmosphere and to surface and groundwater, additional funds are needed for the construction of manure storage facilities and for the long-distance transportation of manure and slurry. Funding is especially problematic for the countries in transition that started the renovation process of large farms in the Soviet era.

The average livestock density of a country indicates not only the possible quantities of manure generated but also the potential releases of nutrients into the environment. Livestock densities are lower in the transitional countries and Poland than in the other countries, in terms of the number of livestock per total arable land in the country (Figure 26). However, at the local level, large production units are common in these countries, despite the considerable change in production levels during the early 1990s, and represent substantial point sources of pollution. The amount of livestock has been greatly reduced in the countries in transition and Poland since the beginning of the 1990s as the export market practically disappeared. At the same time the amount of arable land has also decreased, so the trend regarding livestock units per ha arable land has been relatively stable. Germany, Denmark, Sweden and Finland are characterised by family farms, which have become larger and more specialised in either plant production or animal husbandry.

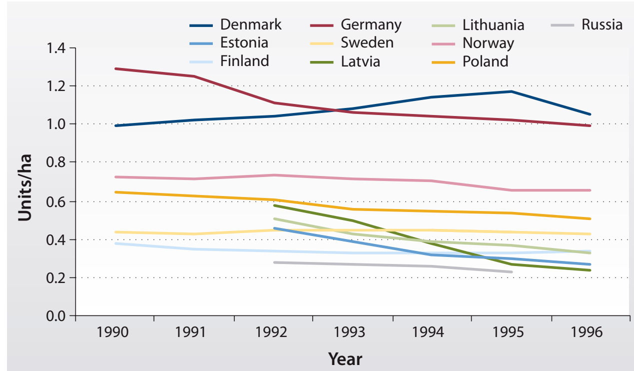


Figure 26 Livestock density in the Baltic Sea countries 1990-1996.
Definition: The livestock density (livestock unit per ha) is an aggregate measure of the number of animals per ha of arable land. The livestock unit has been calculated by using conversion factors (presented in Appendix to HELCOM Recommendation 13/17) for different animals.
(Source: Baltic 21 2000)

Technology – Inadequate adoption of modern agricultural technology

The quantity of fertiliser entering the environment is closely connected to whether appropriate technologies have been employed in agricultural production. Often the agricultural technology is antiquated and the farmers have insufficient funds to invest in modern technology, due to the low value of agricultural products. The former socialist countries still employ highly polluting Soviet technology that was used on collective farms.

The lack of modern technology and best agricultural practice (BAP) can result in extreme erosion and high concentrations of nutrients entering the aquatic environment. Example of BAP could be minimising tilling, direct seeding, soil mapping, associated fertilisation and precision farming, and buffer zones and strips to protect watercourses. However, these practices have not been fully implemented in the region.

Nutrient discharge can occur due to the use of inappropriate technology in cattle farming and a lack of manure and slurry storages. For instance in the southern part of the Baltic Sea region the storage capacity should be at least 6 months and in the northern part 12 months due to climatologic differences. The technologies used in manure spreading are outmoded, with an absence of environmentally sound technologies such as injection and trailing hoses. However, farmers in the Baltic Sea region are increasingly given fiscal and market incentives to make provisions to minimise their impact on the environment, such as agricultural production subsidies and consumer demand.

Governance – Inadequate integration of environmental and agricultural policies

The EU's Common Agricultural Policy (CAP) plays a central role in directing and controlling agricultural policy in the Baltic Sea region.

The CAP gave subsidies to farmers to increase the production of dairy products, beef, veal, cereal and oils seeds, which stimulated the intensification of farming. Production exceeded the environmental optimum, with intensive use of fertilisers and degradation of farming land. There have been few incentives for farmers to adopt environmentally sustainable systems. However, the CAP was reformed in 1992, and now it is less clear what influence the policy has on the environment. Baldock et al. (2002) made a study on how environmental policy is integrated in the CAP. They reported the difficulties in identifying causal links due to the variety of responses by the different nations when applying the common agricultural policy. However, some environmental degradation has been associated with changes in farming practices brought about by the implementation of the CAP.

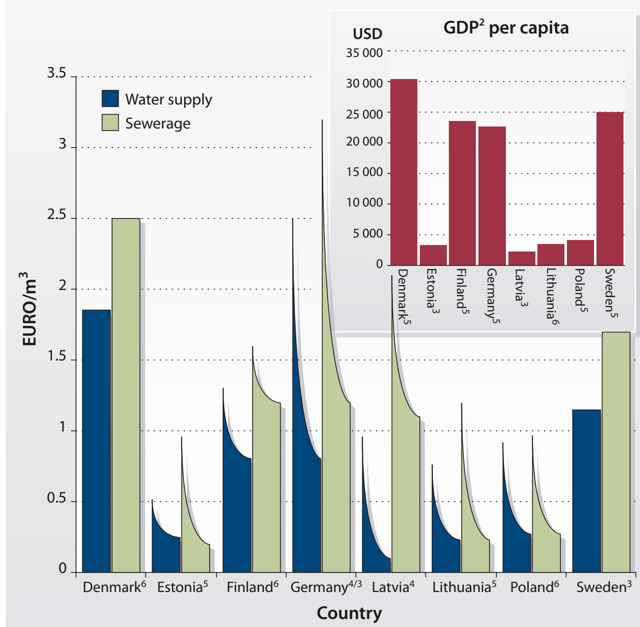
Aquatic load from urbanisation

Economy – Lack of investment in wastewater facilities for municipal and industrial wastes

Insufficient investment in wastewater treatment facilities and collection systems has led to the uncontrolled discharge of pollutants from municipalities and industries. As a rule, the cost of water supply and sewerage services should be recovered by charging the user and waste producer. Unfortunately the GDP of the newly acceded countries is mucher lower than in the Nordic countries and Germany (5-10 times as low) and therefore it is not feasible to recover the costs in these countries.

At present, the countries in the region use a variety of systems for setting water tariffs. However, the introduction of legislation in Estonia, Latvia, Lithuania and Poland, based on the EU Water Framework Directive is expected to make water policy more homogenous. In all these countries operation and depreciation costs are included in the charges, but investment costs are only fully recovered in Finland and Sweden. In Denmark and Germany the majority of investment costs are included, in Lithuania they are only partially, and in Estonia, Latvia and Poland not at all. Correspondingly, water tariffs are significantly lower in the latter countries (Figure 27).

The environmental charges (for water supply and wastewater discharges) are included in the charges for water services in Estonia, Germany, Latvia, Lithuania and Poland, but not in Denmark, Finland and Sweden. All countries have introduced a VAT taxation for recovering the costs of water and sewage services, except Lithuania with regard to water supply services, and Germany and Lithuania with regard to sewerage services. VAT in these countries ranges from 7% to 25%. In Sweden no profit is allowed to made from providing water and sewerage services, as is the same for sewerage services in Germany. In



1) Data from Russia are not included.
2) According to the official exchange rate. Source: International Statistical Yearbook 2000. Central Statistical Office Warsaw 2001 and Statistical Yearbook of the Republic of Poland. Central Statistical Office. Warsaw 2002.
3) 1997. 4) 1998. 5) 2000. 6) 2001.

Figure 27 Water tariffs in the Baltic Sea countries.
(Source: Redrawn from Roman 2002)

Estonia, Latvia, Lithuania and Poland, the legislation provides a formal basis for a profit to made from these services, although charges in these countries currently do not even cover the total cost of providing the services (Roman 2002).

The direct costs related to the water services are fully recovered only in Finland and Sweden. However, full cost recovery as defined in the EU Water Framework Directive is not achieved because the environmental costs are accounted for in the tariff. In Denmark and Germany the degree of cost recovery is high, whereas in Estonia, Latvia, Lithuania and Poland it is low (Roman 2002). The new legislation in the latter countries will enable full recovery of the cost of services, but this will take time to be fully operational. The newly acceded countries, due to fiscal difficulties, have received permission to prolong their implementation of the EU urban wastewater directive (Roman 2002).

Urbanisation – High urbanisation rate

The urbanisation rate is increasing in Estonia, Latvia, Lithuania and Russia, although a large proportion of the population reside within the countryside. This trend is leading to increasing pressure on the environment in urban areas. Further consequences include a reduction in the amount of cultivated area, losses of semi-natural habitats and an increase in fallow land due to poor maintenance of fields and grassland

(Baltic Environmental Forum 2000). The growth in urban population is requiring greater capacity in water supply systems and wastewater treatment plants. Significant investment is needed to upgrade or replace antiquated facilities. The market economy countries have already undergone a similar process.

Atmospheric deposition from energy production and transportation

Population growth and urbanisation

Population growth and urbanisation has increased the demand for heat and electricity, which has consequently required greater oil, gas and coal combustion. This has increased emissions of nitrogen compounds, and thus also the deposition of nitrogen into the Baltic Sea. Laws and regulations have failed to control emissions to reduce nitrogen deposition to the recommended level. The average total final energy consumption (TFC) per GDP in the region is around 12 PJ/billion USD. However, there are major differences between the countries, ranging from 7.7 PJ/billion USD in Denmark to 35.6 PJ/billion USD in Russia in 1997 (Baltic 21 2004a). Besides economic inequality between the countries, the difference in TFC/GDP may also reflect differences in energy consumption patterns and the efficiency of energy generation.

Transports – Increased sea and road traffic

Increased sea and road traffic has resulted in greater emissions. Government transport policy is inadequate with measures to curb emissions proving ineffective. Passenger and freight road traffic is predicted to increase considerably between 2010 and 2030 in former state economy countries, while the importance of less polluting public transport and rail services is expected to decline, or remain static (Table 15). Sea transport is the source of 10-20% of the nitrogen deposited into the Baltic Sea. This form of transport is expected increase, as assessed by COWI Consult in Table 16.

Table 15 Forecast of passenger and freight transport in the recently acceded EU countries and Russia.

Passenger traffic (relative %)	**1995**	**2010**	**2030**
Passenger cars	100	200	400
Public transport	100	100	75
Rail	100	100	75
Freight transport (relative %)			
Road	100	250	400
Rail	100	100	100

(Source: Baltic 21 1998c)

Table 16 Expected growth in volume of trade in the Baltic Sea from 1995 to 2017.

Commodity	**Trade volume** (million tonnes)		**Growth** (%)
	1995	2017	
Break bulk	29	82	186
Dry bulk	61	113	84
General cargo	22	64	186
Liquid bulk	1	2	84
Oil	81	112	39
Total	194	372	92

(Source: COWI 1998)

The emission of NO_2 from industry and traffic follows the same trends as the total emissions. Despite reductions in emissions of some pollutants, the large and increasing number of fossil fuel driven motor vehicles is in conflict with the need to reduce the negative impact on human health and the environment. There is a need to balance the mobility of people and goods, with maintaining the health of the population and environment. Attention needs to be given to maritime transport, particularly RO/RO and ferry transport (including high-speed ferries, called feeder-ships), which are energy intensive (Baltic 21 1998c).

Governance – Ineffective laws and regulations to control emissions and Lack of adequate transport policy

There are a number of barriers to sustainable development in the Baltic Sea region. There is a need to strengthen laws and regulations regarding emissions into the atmosphere from energy production and transport. In Denmark, Finland, Germany and Sweden, laws and regulations were developed in parallel to social and economic development. The countries in transition have reformed their legal systems over the last decade, but only part of the HELCOM recommendations and EU directives have been incorporated into national laws and regulations. However, the national legislation of the countries in transition must be harmonised with EU requirements, and enforced appropriately.

Overexploitation of fish

Environmental and socio-economic impacts

Environmental impacts of overexploitation living resources in the Baltic Sea are for example:

- Considerable changes in the structure and number of fish populations;
- Decline in spawning stock size;
- Decrease in the total landings of the most important commecial species.

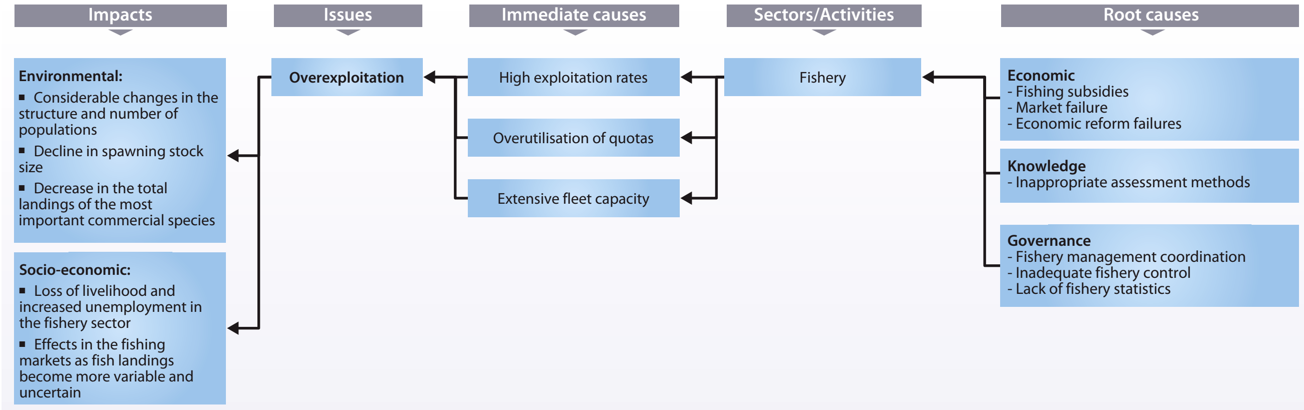


Figure 28 Causal chain diagram illustrating the causal links for overexploitation of fish.

Examples of socio-economic impacts are:

- Loss of livelihood and increased unemployment in the fishery sector;
- Effects in the fishing markets as fish landings become more variable and uncertain.

Immediate causes

The primary immediate causes for the overexploitation of living resources in the Baltic Sea region were considered to be high exploitation rates, overutilisation of quotas and an oversized fleet capacity.

High exploitation rates and overutilisation of quotas

High exploitation rates of cod since the early 1980s has resulted in a decline in stocks and today the stock is no longer considered to be within safe biological limits. Furthermore, the Baltic cod have slower growth rates than the North Sea cod and reach maturity later (at the age of 3 to 5 years). More efficient fishing gear has been employed to catch cod, including demersal trawls, high opening trawls (operating both pelagically and demersally) and gill nets. Gill net fishing increased during the 1990s, and up to 50% of the total catch is currently landed by gill nets (HELCOM 2002). Fishing is unsustainable under the present environmental scenario. Efforts are being made to assess the fisheries of the Baltic Sea, through the acquisition of more accurate catch statistics for commercial species and by further investigating the impacts of fishing activities. Figure 29 shows catches of the main targeted species in the Baltic Sea.

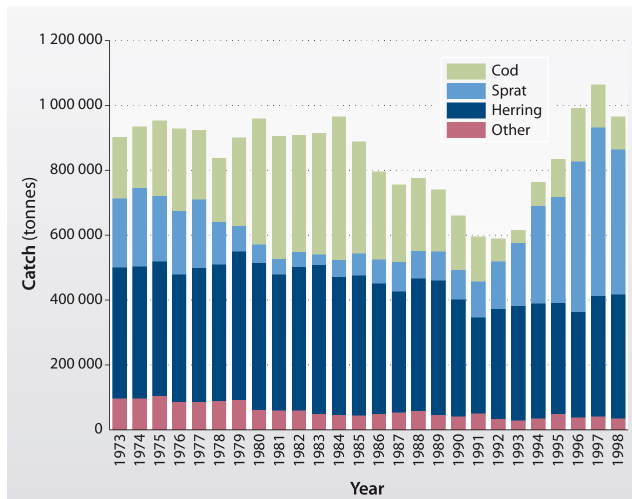


Figure 29 Recorded catches of the main target species in the Baltic Sea between 1973-1998.
(Source: HELCOM 2001)

Extensive fleet capacity

Overexploitation of the fish stocks has also resulted from the expansion of the Baltic Sea fishing fleet. The European Commission has calculated that the EU fleet is 40% larger than that required to carry out sustainable fishing in the Baltic (European Commission 2000). Today, the fishing fleet has a catch capacity that continues to be greater than what the fish stocks can sustain. The fleet capacity in the Baltic Sea countries is presented in Table 17.

Root causes

As the fishery is considered a sector on its own, sector aspects are not discussed in the case of overexploitation. On the basis of further analysis the following root causes were specified:

- Economic: Fishing subsidies, market failure and economic reform failures.
- Knowledge: Inappropriate assessment methods.
- Governance: Fishery management coordination, inadequate fishery control and lack of fishery statistics.

Table 17 Number of fishing vessels per country operating in the Baltic Sea.

Countries	Number of fishing vessels	
	1997	1998
Denmark	1 527	1 376
Estonia	ND	233
Finland	3 987	ND
Germany	ND	2 160
Latvia	222	220
Lithuania	65*	65*
Poland	1 296	1 315
Russia	134	130
Sweden	2 443	ND

*Note: ND = No data. *Only vessels operating in the open sea.*
(Source: Baltic 21 2004a)

The Agenda 21 for the Baltic Sea Region states that irrational fishery management is among the main causes of the overfishing of cod (Baltic 21 1998b). The International Baltic Sea Fishery Commission (IBSFC) has for many years been inflating catching intensity. Social, economic and political reasons are of top priority for the IBSFC while stock stabilisation is not given sufficient consideration. Policies aimed at controlling the exploitation of cod stock have failed, as demonstrated by indicators used to evaluate the biological viability of fish stocks; spawning stock biomass, fishing mortality and recruitment (see Figures 12 and 13 in the Assessment).

Economic

Three major factors constitute the economic root causes of overfishing: fishing subsidies, market failure and economic reform failure. Extensive analytical research supports the conclusion that subsidies for fleet and fishing gear modernisation have resulted in the overexploitation of fish stocks. According to FAO (1993), the EU countries' fishing subsidies were approximately twice as large as necessary. Consequently, all major commercial species in the Baltic Sea were being overexploited by the early 1990s. There are no publications that specifically investigate the impacts of subsidies on fish stocks in the Baltic, but official documents acknowledge that the fishing fleet has excessive capacity in many parts of the Baltic Sea and that there is limited economic profitability for all fishermen (Baltic 21 1998b). Subsidies have stimulated fleet overcapitalisation and led to significant by-catch and discards of small fish species and non-target species, however quantitative estimates are lacking. Yet subsidies aimed at fleet modernisation in the EU countries continue to grow (Iudicello et al. 1999).

Regarding market failures, in order to reduce overfishing, it is necessary to improve the balance between the fishing potential and the biological reality. This can be achieved by reducing the fishing potential or the catches. This process cannot be left to market forces, as the relevant fish stocks may be depleted before equilibrium has been reached. It can only be secured through a comprehensive approach combining decommissioning schemes and regulatory measures, to reduce fishing effort.

The third contributing factor, economic reform failures, is related to privatisation in the former Soviet Union, where most connections between catch and processing have been lost, and financial problems became much sharper. The current system of taxation, fuel and material prices, high tariffs for fish product transportation, and high interest rates has led to the growth of illegal fishing (Titova 2001).

Knowledge

Fish stock monitoring assessments are considered to be inadequate, according to experts from the region. There is a lack of understanding of the current status of the Baltic marine ecosystems, which inhibits the effective assessment of biological resources in order to set appropriate total allowable catches (TACs). Estimates of permissible landings (50% and more) are therefore fundamentally flawed (LME 1990, Sherman et al. 1996, Denisov 2002, Kotenev 2001).

The impacts of long-term natural cycles and anthropogenic pressures on the Baltic Sea ecosystem have not been fully explored. It is therefore difficult to accurately predict future trends in the fisheries. A greater understanding is needed in order for fisheries managers to effectively balance fishing effort, catch capacity of fleets and the estimated long-term average catch levels of the target species. In addition there has been a lack of studies investigating the linkages between fishing subsidies, fishery quotas and auctions administration and the socio-economic status of fishing communities. Confronted with the insufficient knowledge, national policy makers and planners are severely constrained in their ability to promote sustainable fishing practices.

Governance

In most coastal regions of the Baltic, fish is sold directly from the producer or their organisations to the trade and processing industries instead of marketed at auctions. The wholesale and consumer price for fish products vary considerably between the eastern and western regions of the Baltic, reflecting their different economic characteristics. Fish sales and direct landings at dumping prices have been reported, especially in Russia. Producer organisations have failed to exchange information about prices, quantities and quality requirements. The role of auctions is insufficient not only in correlating landing rules with the activities of producer organisations but also with regards to sales.

The Russian system of fishery quota distribution between vessel owners has loopholes. Overexploitation can be proved indirectly by the fact that vessel owners usually get a small quota that is not enough to cover exploitation costs. The fact that vessels keep on fishing for several years proves that their actual catches are much higher than the awarded quota. This is also known as "industrial" poaching (Voytolvsky et al. 2003).

A third problem is data-related. Recently awareness of deterioration in the basic data made available for stock assessment has risen. In some cases there is evidence of miss-reporting of catches (both non-reporting and miss-reporting by area). Fishing effort data (e.g. days or hours fishing) that is provided by national statistical offices is also unreliable. As a result of incomplete submissions, the ICES decided to discontinue the official reporting of effort data and the data is now in most cases reported to the ICES on a voluntary basis (Baltic 21 1998b).

Conclusions

An analysis of the main root causes shows that many of the same root causes apply for the different sectors (agriculture, urbanisation, traffic and energy production, and fishing). The most common root causes are economic problems, technological matters, lack of knowledge and governance.

Concerning eutrophication, the following two immediate causes were identified:

- Aquatic nutrient load into the Baltic Sea;
- Atmospheric deposition of nitrogen.

The following root causes were identified behind eutrophication:

- Aquatic load of nutrients from intensive agriculture:
  - Technology: Inadequate adoption of modern agricultural technology.
  - Governance: Inadequate integration of environmental and agricultural practices.
- Aquatic load of nutrients from urbanisation:
  - Economy: Lack of investment in wastewater facilities.
  - Urbanisation: High urbanisation rate.
- Atmospheric deposition from energy production and transportation:
  - Population growth and urbanisation.
  - Transport: Increased sea and road traffic.
  - Governance: Ineffective laws and regulations to control emissions and Lack of adequate transport policy.

As to overfishing, the immediate causes are high exploitation rates, overutilisation of quotas and too extensive fleet capacity.

The following root causes were identified causing overfishing:

- Economic: Fishing subsidies and market failure.
- Knowledge: Inappropriate assessment methods.
- Governance: Coordination of management, fishery control and fishery statistics.

It is obvious that the follow-up of the selected root causes will be a time-consuming process which cannot be completed without the proper resources. A contributing factor is the implementation of international agreements on environmental protection in the Baltic Sea region. The policy options dealing with the root causes presented in the next section are mainly defined in the Water Framework Directive and in the guidelines and recommendations issued by the Helsinki Commission.

Policy options

This section aims to identify feasible policy options that target key components identified in the Causal chain analysis in order to minimise future impacts on the transboundary aquatic environment. Recommended policy options were identified through a pragmatic process that evaluated a wide range of potential policy options proposed by regional experts and key political actors according to a number of criteria that were appropriate for the institutional context, such as political and social acceptability, costs and benefits and capacity for implementation. The policy options presented in the report require additional detailed analysis that is beyond the scope of the GIWA and, as a consequence, they are not formal recommendations to governments but rather contributions to broader policy processes in the region.

Definition of the problems

The GIWA concerns Pollution and Unsustainable exploitation of fish and other living resources were identified as most important to deal with within the Baltic Sea region. Eutrophication and overexploitation of fish were selected as GIWA priority issues which were highly urgent to consider. According to the findings presented in the Causal chain analysis as well as assessments made by Helsinki Commission (HELCOM 2002), the following key facts are important for the policy option regarding eutrophication and overfishing:

- Eutrophication remains the most pressing problem in the Baltic, as nitrogen and phosphorus inputs are still too high;
- Overexploitation of fish is considered as a severe problem due to the overutilisation of quotas, high exploitation rate and oversized fleet capacity.

Framework for implementing policy options

The policy options identified for this report are closely connected to the basic principles of the Helsinki Convention and EU Water Framework Directive to cater for a harmonised implementation of water protection measures in the Baltic Sea States.

With its origin in the 1970s, international cooperation is well developed in the Baltic Sea region. The legislation and economic base almost meet the needs of environmental protection. Environmental awareness in the Baltic Sea countries is well developed and at a high level in comparison to other GIWA regions (HELCOM, 2003). Educational programmes in progress are, amongst others:

- Baltic University Programme: a network of 180 universities and other institutes of higher learning (Baltic University Programme 2003, 2004);
- Baltic Sea Project (BSP): including about 300 schools (Baltic Sea Project 2004);
- Baltic 21: an Agenda 21 for Education for sustainable development in the Baltic Sea Region (Baltic 21 2002).

The Baltic Sea protection policy concerning eutrophication, overexploitation of fish and other issues was agreed upon at the Helsinki Commission and at the Baltic Sea Fishery Commission. In addition to these, a comprehensive policy for water issues was recently adopted in the EU Water Framework Directive (European Parliament and Council 2000). These activities are in line with Agenda 21 for the Baltic Sea region. Therefore, the identified policy options for protection of the Baltic Sea are well aligned with the above-mentioned policies and will support the implementation of the EU Water Framework Directive and the HELCOM recommendations to guarantee sustainable development in the Baltic Sea region.

All of the Baltic Sea region countries are signatories to the Helsinki Convention and all, but Russia, are members of the European Union since 2004. The Baltic Sea has become almost an internal sea of the European Union. Policies in order to protect the Baltic Sea were defined clearly in the text of the two main documents: the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention 1992) and in the EU Water Framework Directive (WFD) (European Parliament and Council 2000). Other conventions and international agreements are also taken into account but the Helsinki Convention and WFD are the most comprehensive (see Annex III).

The countries ratifying the Helsinki Convention are obliged to implement the requirements laid out in the Convention. In addition, the EU member states have to implement the EU Water Framework Directive before 2015.

According to the EU Water Framework Directive (European Parliament and Council 2000, introductory part, paragraph 18), the Community water policy requires a transparent, effective and coherent legislative framework; and the Community should provide common principles and an overall framework for action. This directive should provide for such a framework and coordinate, integrate, and, in a longer perspective, further develop the overall principles and structures for protection and sustainable use of water in the Community.

The Directive aims at maintaining and improving the aquatic environment, including rivers, lakes, coastal waters as well as groundwaters. The objective is to ensure that all waters meet "good status" by 2015. Control of quantity is an ancillary element in securing good water quality and therefore measures of quantity, serving the objective of ensuring good quality, should also, according to the Directive, be established (European Parliament and Council 2000, introductory part, paragraph 19). In addition to the Water Framework Directive, the implementation of other EU directives such as the Urban Wastewater Treatment Directive (European Council 1991b), the Nitrate Directive (European Council 1991a), the Drinking Water Directive (European Council 1980, 1998), the Habitats Directive (European Council 1992) cover the issues considered by GIWA.

More specific identification of the policy options for eutrophication and overexploitation of fish will be presented below. First the policy options for eutrophication will be presented and then the policy options for overexploitation of fish.

Figure 30 Concentrated bloom of blue green algae, most probably *Nodularia spumigena,* at the eastern coast of Sweden, 2003. *(Photo: Johan Forssblad, IBL Bildbyrå)*

Eutrophication

The immediate causes of eutrophication are aquatic load of nutrients and atmospheric deposition of nitrogen to inland water bodies and into the Baltic Sea. The main sectors responsible for eutrophication identified in the casual chain analysis are agriculture, urbanisation, energy production and transport. Agriculture is responsible mainly for the diffuse inputs of nitrogen compounds due to overfertilisation and uncontrolled manure and slurry disposal. Urban areas are responsible for nutrient inputs from municipalities and industrial enterprises discharging untreated or partly treated wastewaters to the environment. Energy production and transport are responsible for the high emission level of nitrogen, having a significant influence on the deposition rate.

A number of measures have been adopted over the years to halt the negative development of the environmental situation in the Baltic Sea area (HELCOM Recommendations, see achievements and targets below). Some actions have improved the situation, while others have

resulted in the status quo. Often appropriate spatial and temporal monitoring is lacking (especially relating to fisheries activities), making it difficult to detect changes in the environment. The following text will concentrate on measures proposed as well as measures taken by HELCOM and the International Baltic Sea Fishery Commission (IBSFC) regarding eutrophication and exploitation of fish stocks.

Achievements:

- Atmospheric deposition of nitrogen has been reduced by 40% during the last 15 years (HELCOM 2002).
- None of the nine Baltic Sea countries have been able to halve the total aquatic load of nutrients from all sources since the late 1980s by the end of 1995. However, Estonia, Latvia, Lithuania, Poland and Russia have come closer to the 50% reduction targets than the other Baltic countries (Lääne et al. 2002).

Targets:

- Discharge of polluting substances, including nutrients into the Sea, must be reduced, particularly from sewage, agriculture and transport.

The following root causes were identified in the causal chain analysis:

- Aquatic load of nutrients from intensive agriculture:
  - Technology: Inadequate adoption of modern agricultural technology.
  - Governance: Inadequate integration of environmental and agricultural practices.
- Aquatic load of nutrients from urbanisation:
  - Economy: Lack of investment in wastewater facilities.
  - Urbanisation: High urbanisation rate.
- Atmospheric deposition from energy production and transportation:
  - Population growth and urbanisation.
  - Transport: Increased sea and road traffic.
  - Governance: Ineffective laws and regulations to control emissions and Lack of adequate transport policy.

The aim of policy options is to list the different options that could mitigate or solve the problems of eutrophication; i.e. aquatic load of nutrients from agriculture and urbansiation and atmospheric deposition of nitrogen.

Aquatic load from agriculture

Agriculture was discussed at the World Summit Conference on Sustainable Development in Johannesburg in 2002, and was, together with water, energy, health and biodiversity, considered as one of the most important and urgent issues to deal with (WSSD 2002). The HELCOM Ministerial Declaration (1988) aimed at reducing total discharges into the Baltic Sea by 50% within a 10-year period. During the revision of the 1992 Helsinki Convention requirements to prevent and eliminate pollution from agriculture, Annex III of the Convention was revised and an obligation to use the best environmental practice (BEP) was included. Furthermore, new regulations concerning agricultural activity were inserted in Annex III. The new regulations comprise issues dealing with animal density, manure storage, agricultural wastewater and silage effluents, application of organic manure, application rates for nutrients and water protection measures and nutrient reduction areas. Specific requirements proposed by the Helsinki Commission are presented in Box 1. These requirements are minimum requirements for national legislation.

The EU Nitrates Directive (European Council 1991a) aims to reduce water pollution caused or induced by nitrates from agricultural sources and to prevent further pollution of this type. The various steps of implementing the directive include detection of polluted or threatened waters, designation of “vulnerable zones”, establishment of codes of good agricultural practice, action programmes within

Box 1 Specific requirements included in Annex III of the Helsinki Convention in order to decrease eutrophication.

Animal density
To ensure that manure is not produced in excess in comparison to the amount of arable land, there must be a balance between the amount of animals on the farm and the amount of land available for spreading manure, expressed as animal density. The maximum number of animals should be determined with consideration of the phosphorus and nitrogen concentration in manure and the crops requirements of plant nutrients.

Manure storage
Manure storage facilities must be of such a quality that losses do not occur. The storage capacity must be sufficiently large to ensure that manure will only be spread when the plants can utilise the nutrients. The minimum level should be a 6-month storage capacity. Urine and slurry stores should be covered or maintained by a method that efficiently reduces ammonia emissions.

Agricultural wastewater and silage effluents
Wastewater from animal housings should either be stored in urine or slurry stores or else be treated in some suitable manner to prevent pollution. Effluents from the preparation and storage of silage should be collected and directed to urine or liquid manure storages.

Application of organic manures
Organic manure (slurry, solid manure, urine, sewage sludge, composts, etc.) should be spread in a way that minimises the risk of plant nutrient loss and should not be spread on soil that is frozen, water-saturated or covered with snow. Organic manure should be applied as soon as possible after bare soils. Periods shall be defined when no manure application is allowed.

Application rates for nutrients
Application rates for nutrients should not exceed the nutrient requirements of crops. National guidelines should be developed with fertilising recommendations and they should take reference to: a) soil conditions, soil nutrient content, soil type and slope; b) climatic conditions and irrigation; c) land use and agricultural practices, including crop rotation systems; d) all external potential nutrient sources.

Winter crop cover
In relevant regions, the cultivated area should be sufficiently covered by crops in winter and autumn to effectively reduce the loss of plant nutrients

Water protection measures and nutrient reduction areas
a) Surface water: Buffer zones, riparian zones or sedimentation ponds should be established, if necessary. b) Groundwater: Groundwater protection zones should be established if necessary. Appropriate measures such as reduced fertilisation rates, zones where manure spreading is prohibited and permanent grass land areas should be established. c) Nutrient reduction areas: Wetland areas should be retained and where possible restored, to be able to reduce plant nutrient losses and to retain biological diversity.

(Source: The Helsinki Convention 1992)

designated vulnerable zones, and national monitoring. To limit the negative effects linked to agricultural activities, the Nitrates Directive promotes five main principles (European Council 1991a):

1. Crop rotation, soil winter cover and catch crops to limit leaching during wet seasons;
2. Use of fertilisers and manure, with a balance between crop needs, nitrogen inputs and soil supply; frequent manure and soil analysis, mandatory fertilisation plans and general limitations per crop for both mineral and organic nitrogen fertilisation;
3. Appropriate nitrogen spreading calendars and sufficient manure storage, for availability only when the crop needs nutrients, and good spreading practices;
4. "Buffer zones" that is, non-fertilised grass strips and hedges along watercourses and ditches;
5. Good management and restriction of cultivation on steeply sloping soils, and of irrigation.

Lack of modern technology and best agricultural practice (BAP), results high concentrations of nutrients entering the aquatic environment. Governmental financial support for improving the existing agricultural technology is urgently needed.

It is important to increase the cooperation between the countries around the Baltic Sea for attaining sustainable agriculture. According to Baldock et al. (2002) there are difficulties in applying a common agricultural policy. However, several initiatives towards a sustainable agriculture are taken, for example, work on a regional 'Virtual Research Institute on Sustainable Agriculture' has been initiated in the Nordic countries, and similar initiative has been taken in Poland (Baltic 21 2004b). There is a need for further supporting research and projects aimed at increasing knowledge in order to integrate environmental policies with agricultural and other policies.

Aquatic load from urbanisation

The identified root causes of urbanisation were lack of investments and high urbanisation rate. The main tools to control discharges connected to urbanisation in the Baltic Sea are described in the EU Water Framework Directive (European Parliament and Council 2000). Minimum requirements proposed by the European Commission in the Water Framework Directive are as follows:

1. Expanding the scope of water protection to all waters, surface waters and groundwater;
2. Achieving "good status" for all waters by the 2015 deadline;
3. Water management based on river basins;
4. "Combined approach" of emission limit values (ELV) and water quality objectives (WQO) shall be used;
5. Getting the prices right: charges for water and wastewater reflecting the true costs;
6. Getting the citizens involved more closely;
7. Streamlining legislation.

According to the Directive, rivers and lakes will need to be managed by river basin borders instead of administrative boundaries. These approaches mean that a transboundary aspect is clearly included in the Directive. The Directive also recommends that the charges for water and wastewater should reflect the true costs.

The implementation of the EU Water Framework Directive is one of the main measures to meet nutrient discharge targets in the Baltic Sea. Since the goal is to reduce nutrients in the whole catchment area and to adopt a transboundary approach, it is necessary that the EU Water Framework Directive is also implemented in Russia, even if Russia is not an EU member. One example of a transboundary project including Russia in the work for implementing the EU Water Framework Directive is the European Baltic (ERB) cooperation. Nine neighbouring partner-regions in Denmark, Latvia, Lithuania, Poland, Russia (Kaliningrad) and Sweden established contacts on the political level in 1998.

In order to concretise the ERB cooperation, the EU-project SEAGULL was formed in 2002 with the aim of developing a Joint Transnational Development Programme (JTDP) for the entire region (Eurobalt 2004). One of the main objectives is to improve water management and prepare for implementation of the EU Water Framework Directive and the HELCOM Joint Comprehensive Action Programme. In-depth studies in special strategic areas, analyses, preparatory measures and exchange of knowledge are methods used. The project also aims to compare and evaluate different methods for enhanced dialogue and awareness among the citizens and other local stakeholders (Eurobalt 2004).

To further reduce nutrient loads from urban areas and to stop eutrophication of the Baltic Sea, additional measures must be implemented. According to the regulations of the Helsinki Commission, measures such as presented in Box 2 must be implemented. Such measures could prevent pollution from industries and from municipalities.

Box 2 Helsinki Commission, regulations to prevent pollution from industry and municipalities.

Regulation 1: General provisions

In accordance with the relevant parts of the Helsinki Convention, the Contracting Parties shall apply the criteria and measures in this Annex in the whole catchment area and take into account Best Environmental Practice (BEP) and Best Available Technology (BAT) as described in:

Regulation 2: Specific requirements

- Municipal sewage water shall be treated at least by biological or other methods equally effective with regard to reduction of significant parameters. Substantial reduction shall be introduced for nutrients.
- Water management in industrial plants should aim at closed water systems or at a high rate of circulation in order to avoid wastewater wherever possible.
- Industrial wastewaters should be separately treated before mixing with diluting waters.
- Wastewaters containing hazardous substances or other relevant substances shall not be jointly treated with other wastewaters unless an equal reduction of the pollutant load is achieved compared to the separate purification of each wastewater stream. The improvement of wastewater quality shall not lead to a significant increase in the amount of harmful sludge.
- Limit values for emissions containing harmful substances to water and air shall be stated in special permits.
- Industrial plants and other point sources connected to municipal treatment plants shall use Best Available Technology in order to avoid hazardous substances which cannot be made harmless in the municipal sewage treatment plant or which may disturb the processes in the plant. In addition, measures according to Best Environmental Practice shall be taken.
- Pollution from fish-farming shall be prevented and eliminated by promoting and implementing Best Environmental Practice and Best Available Technology.
- Pollution from diffuse sources, including agriculture, shall be eliminated by promoting and implementing Best Environmental Practice.

(Source: The Helsinki Convention 1992)

The Helsinki Commission regulations aim to prevent environmental damage made through discharge of urban wastewater and waste from industrial processes. Depending on their size and designated location, all newly built areas must have urban wastewater collection and treatment systems by the end of 1998, 2000 or 2005 (European Council 1991b). The level of treatment depends on the sensitivity of the receiving water and can be:

- Primary: removal of suspended solids by passing wastewater through settlement or flotation tanks.
- Secondary: biological treatment where wastewater passes through tanks where bacteria eat pollutants and transform them into sludge.
- Tertiary: more advanced treatment that involves nutrient removal or disinfection by means of chlorination, ultraviolet (UV) radiation or ozone treatment.

The Urban Wastewater Treatment Directive (European Council 1991b) concerns collection, treatment and discharge of urban wastewater from agglomeration and treatment and discharge of biodegradable wastewater from certain industrial sectors. Its objective is to protect the environment from the adverse effects of such wastewater discharges.

The EU Member States must ensure that urban wastewater is collected and treated prior to discharge according to specific standards and deadlines. In terms of the treatment objectives, secondary (i.e. biological) treatment is the general rule, with additional nutrient removal in what are considered sensitive areas (tertiary treatment). Implementation of the EU Water Framework Directive and other directives and regulations mentioned above, could raise awareness of the environmental situation and increase the responsibility for the Baltic Sea as a common resource.

Atmospheric deposition

The root causes of atmospheric deposition were identified as: population growth and urbanisation, increased sea and road traffic, ineffective laws and regulations to control emissions and lack of adequate transport policy. There is a need for improving laws and regulations in the region to control emissions. It is also important to implement an adequate governmental policy for transport.

The Air Quality Framework Directive (European Council 1996) covers a revision of previously existing legislation and the introduction of new air quality standards for previously unregulated air pollutants, setting the timetable for the development of daughter directives on a range of pollutants. The list of atmospheric pollutants to be considered includes sulphur dioxide, nitrogen dioxide, particulate matter, lead and ozone.

The Convention on Long-Range Transboundary Air Pollution (UNECE 1979) was signed by 34 governments, including Russia and the European Community. The Convention entered into force in 1983, and has been extended by eight protocols.

In addition to the implementation of the Air Quality Framework Directive and the Convention on Long-Range Transboundary Air Pollution it is suggested that further reduction of nitrogen emission and consecutive reduction of depositions will take place through the implementation of the Kyoto Protocol by the EU countries. For implementation of the Kyoto Protocol in the Baltic Sea region, a harmonised policy should be formulated.

Identified policy options

Concerning the root causes related to eutrophication, the identified course of action involves:

For aspects concerning governance:

- Integrate agricultural, energy and transport policy with the environmental policy proposed by the European Commission, the Helsinki Commission, the International Baltic Sea Fishery Commission and other international conventions in order to reduce the discharge of nutrients to the Baltic Sea.
- Cooperate with countries outside the EU, such as Russia, Belarus and Ukraine, with the aim to harmonise their environmental legislation with the EU countries, such as adopting the EU Water Framework Directive.
- Support and develop existing agricultural cooperation projects and networks.

For economic aspects:

- The European Commission is invited further to support the implementation of transboundary environmental projects.
- Governments are invited to support economically the implementation of new environmentally friendly technologies in agriculture, transport and energy production.
- Governments, especially in the new EU countries and Russia, are invited to support investments in wastewater treatment facilities to reduce emissions from heat and electricity production units as well as from road and sea traffic.

Overexploitation of fish

High exploitation rates and excessive fishing quotas were identified as the main immediate causes of overfishing. The causal chain analysis identified that the root causes behind this issue were mainly poor landing statistics, overestimated quotas due to socio-economic factors and constant overfishing of the most popular commercial species. Despite continuously lowered quotas for cod, herring and salmon since the mid-1990s, the populations have not recovered.

Policy options concerning overfishing in the Baltic Sea region will be managed within the framework of the International Baltic Sea Fishery Commission (IBSFC) which is the main advisory body in the management of living resources in this region. All countries around the Baltic Sea are contracting parties of the Commission, and measures proposed for management of living resources are obligatory to them and have the potential for being of great influence. Other examples of international cooperation of importance in the question of overfishing include the European Union's Common Fisheries Policy and its Fisheries Action Plan, and the UN Food and Agriculture Organization (FAO) and its Code of Conduct for Responsible Fisheries. The policy options presented in this section are based on the work of these organisations.

Fishing subsidies and market failure

The UN Food and Agriculture Organization (FAO) have developed a code of conduct to set out principles and international standards of behaviour for responsible practices. The objective is to prepare guidelines for an effective conservation, management and development of living aquatic resources, with due respect to the ecosystem and biodiversity. Four fishing management measures related to overfishing in the Baltic Sea Region are stated in this context in Box 3.

Box 3 Fishing management measures related to overfishing proposed by FAO.

- States should ensure that the level of fishing permitted is commensurate with the state of fisheries resources.
- Where excess fishing capacity exists, mechanisms should be established to reduce capacity to levels commensurate with the sustainable use of fisheries resources so as to ensure that fisheries operate under economic conditions that promote responsible fisheries. Such mechanisms should include monitoring the capacity of fishing fleets.
- The efficacy of conservation and management measures and their possible interactions should be reviewed regularly.
- States and subregional and regional fisheries management organisations, all according to their respective competencies, should introduce measures for depleted resources and resources threatened with depletion that facilitate the sustained recovery of such stocks. They should make every effort to ensure that resources and habitats critical to the wellbeing of such resources, affected by fishing or other human activities, are restored.

(Source: FAO 1996)

Inappropriate assessment methods

The EC Biodiversity Action Plan for Fisheries includes requirements for the formulation and implementation of strategies that will enable the "conservation and sustainable use of biodiversity" across all policy sectors (Box 4). The overall objective is to define and identify, within the current legislative framework, coherent measures that will lead to the preservation or rehabilitation of biodiversity where it is perceived as being under threat due to fishing or aquaculture activities. Increased research and improved monitoring methods are emphasised.

Box 4 The Biodiversity Action Plan for Fisheries.

The Biodiversity Action Plan for Fisheries includes the following:

- Overall reduction in fishing pressure to promote the conservation and sustainable use of commercially important fish stocks.
- Technical measures with the objective of improving the conservation and sustainable use of commercially exploited fish stocks.
- Technical measures with the objective of reducing the impact on non-target species and habitat.
- Research priorities to secure traditional support for the EU Common Fisheries Policy (CFP).
- Research to provide enhanced knowledge related to biodiversity.
- Monitoring and assessment of the state of commercially important fish stocks.
- Monitoring of other organisms and habitats.

(Source: ECCHM 2004)

Coordination of management, fishery control and fishery statistics

The International Baltic Sea Fishery Commission (IBSFC) has developed the Fisheries Rules for Fisheries Management. These rules include calculations concerning fishing behaviour such as Total Allowable Catches (TACs). The targets suggested by the IBSFC are (Baltic 21 1998b):

- The by-catch of mammals and birds, as well as discard of fish must be reduced;
- Legal protection of threatened marine habitats is needed;
- Improved catch statistics are needed to accurately estimate the fish populations and determine the impact exerted by commercial fishing operations. No-take zones and restrictions in gear use are measures to be taken under consideration.

As a contribution to the Baltic Sea region application of Agenda 21, the IBSFC has also been appointed to develop action programmes for

Figure 31 Cod fishing in the southern Baltic Sea, 1994.
(Photo: Uno Andersson, Sydsvenskan Bild)

the fisheries sector in this region. Action programmes recognised as prioritised in the Agenda 21 for the Baltic Sea are (Baltic 21 1998b):

- Baltic Cod Strategy Plan implementation from 1999.
- IBSFC Salmon Action Plan 1997-2010 (in collaboration with HELCOM in 1997).
- Long Term Strategy for Pelagic Species implementation from 2000.

In addition to the these priority action programmes according to the Baltic 21 (1998b) the targets are to:

- Improve the management resources in coastal areas.
- Increase cooperation in the field of control and enforcement.
- Improve the quality of stock and fisheries assessment.
- Increase sustainable use and preservation of freshwater fish stocks and species.
- Restore habitats that are important to fish and fisheries in inland waters.
- Achieve sustainable aquaculture.
- Improve economic and social stability of the fisheries sector.

As a member of the IBSFC, the EU supports policy measures agreed by the IBSFC, and has incorporated technical measures in its legislation, relating to gear meshes used by vessels and the minimum size of fish caught locally. The European Union's Common Fisheries Policy (CFP) can be divided into four main areas (CFP 2004):

- Conservation, in order to protect fish resources by regulating the amount of fish taken from the sea, by allowing young fish to reproduce, and by ensuring that the regulations are adhered to.
- Structures, in order to help the fishing and aquaculture industries to adapt their equipment and organisations to the constraints imposed by scarce resources and by the market.
- Markets, in order to maintain a common organisation of the market in fish products and to match supply and demand for the benefit of both producers and consumers.
- Relations with the outside world, with the objective of setting up fisheries agreements and to negotiate at the international fisheries organisations for common conservation in deep sea fisheries.

However, the CFP has met strong criticism for supporting structural problems in fisheries, in particular, when giving subsidies to oversized fishing fleets. In 2002, a reform was made in the fisheries policy to address these problems, resulting in new measures as follows (CFP 2004):

- A new policy for the fleets: (i) a simpler fleet policy that puts responsibility for matching fishing capacity to fishing possibilities with the member states; and (ii) phasing out of public aid, while keeping aid to improve security and working conditions on board.
- A better application of the rules, which implies further development in the cooperation among the various authorities concerned and a strengthening of the uniformity of control and sanctions.
- An increase in stakeholders' involvement, which implies that stakeholders, particularly fishermen, need to take a more central role in the CFP management process. Regional advisory councils will be established to integrate the knowledge of fishermen and scientists, together identifying ways of achieving sustainable fisheries.

Identified policy options

Concerning the root causes related to economy and governance, the identified course of action involves:

- An integration of fishery policies with economic and environmental strategies in order to strengthen sustainable fisheries.
- Development of comprehensive approaches combining decommissioning schemes and regulatory measures, and the construction of a stabile system of taxation, prices of fuel and materials.
- Establish more stringent control over vessel documentation and fishing statistics.
- Ensure obligatory registration of all catches and all export transactions on land.
- Improve and unify a system of fish auctions for all Baltic countries.

For causes related to educational aspects the following actions were identified:

- A creation of appropriate assessment methods leading to the establishment of reliable total allowable catches (TACs).
- Improve the reporting of landings by introducing an electronic network and exchange of this information between Baltic countries.

For causes related to legal aspects:

- Support for the construction of appropriate fishery laws that can efficiently manage the new market conditions is emphasised.

Conclusions and recommendations

Eutrophication and overfishing were identified as the main GIWA issues having a severe impact on the state of the Baltic Sea and therefore the causal chain analysis and elaboration of policy options were carried out for these two issues. The other issues, such as pollution of existing freshwater supplies, chemical pollution, oil spills, modification of ecosystems, decreased viability of stock through pollution and diseases, and impact on biological and genetic diversity, having a moderate environmental impact on the state of the Baltic Sea, were not further analysed.

As mentioned in the beginning of the report, the Baltic Sea is almost an internal sea in the European Union. This will affect the environmental policy in the region significantly. The implementation of the EU Water Framework Directive will influence the overall water protection strategy in the region. The purpose of the Directive is to prevent further deterioration of water bodies and to protect and enhance the status of aquatic ecosystems on land and along the coasts, to promote sustainable water use and ensure the progressive reduction of pollution of water bodies.

The EU Water Framework Directive requires that the member states meet the obligations of international agreements, which in the case of the Baltic Sea means continued work under the Helsinki Commission, and that the HELCOM recommendations are followed, which take into account the vulnerability of the Baltic Sea.

The decisions and recommendations of the Helsinki Commission link Russia and the EU together, because compliance by Russia is crucial to the Baltic. The political will of Russia to protect the Baltic Sea environment as well as to improve the living conditions of the population will be needed for the implementation of EU and HELCOM decisions to protect the Baltic Sea and its resources from pollution. The measures implemented in the St. Petersburg and Kaliningrad regions during the last decade have proved that Russia is serious about the implementation of water protection measures. For example construction of wastewater treatment plants in St. Petersburg and Kaliningrad have reduced the pollution load to the Baltic Sea.

For the management of overfishing, policy options are recommended based on the root causes identified in the causal chain analysis. Concerning causes related to economy and governance, the recommended course of action involves an integration of economic policies with environmental strategies, in order to strengthen sustainable fisheries and to establish more stringent control.

For causes related to educational aspects, creation of appropriate assessment methods leading to the establishment of reliable total allowable catches (TACs) is recommended. As regards legal aspects, support for the construction of an appropriate fishery law that can efficiently manage the new market conditions is emphasised. Here it is also important that fishery legislation incorporates the demands for sustainable development. In addition, when establishing a strategy to come to terms with the above issues, a comprehensive integration of the socio-economic and environmental aspects will be of great importance. By recognising these inter-linked environmental/socio-economic impacts, from data gathering to assessment and further on to settled targets, a more solid ground for managing this issues will hopefully be created. The transboundary issues such as eutrophication and fisheries and how to establish a coordinated approach to ecosystem-based management has been addressed in the "Baltic Sea Joint Comprehensive Environmental Action Programme" (JCP), and the governments of the Baltic Sea States should also be involved in the GEF LME Project.

An effective management system includes a coordinated implementation of coastal and open-sea ecosystem-based management practices, which should be based on coordinated national and international financing. The policy options listed are mainly aimed at cooperation actions in the present and in the decades to come between the Baltic Sea states through the Helsinki Commission, the European Union, and the International Baltic Sea Fishery Commission. However, no quick cure can be foreseen. Despite the protection measures in the Baltic Sea, improvement will not be immediate because of the natural slowness of the environment to react and to change. The improvement will start from the coastal zones, moving slowly towards the central parts.

The main suggestions are:

- To integrate environmental policies with agricultural policies by supporting cooperation networks and action programmes.
- To strengthen sustainable fisheries by means of increased cooperation in the field of control and enforcement as well as to integrate fishery policies with economic and environmental strategies.
- To implement the EU Water Framework Directive in all the EU countries situated in the catchment area of the Baltic Sea and to ensure similar actions in Russia.

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Annexes

Annex I
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Sverker Evans	Swedish Environmental Protection Agency	Sweden	International conventions
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Annex II
Detailed scoring tables

I: Freshwater shortage

Environmental issues	Score	Weight	Environmental concern	Weight averaged score
1. Modification of stream flow	1	N/A	Freshwater shortage	2
2. Pollution of existing supplies	2	N/A		
3. Changes in the water table	1	N/A		

Criteria for Economics impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small 0 1 2 3 Very large	1	N/A
Degree of impact (cost, output changes etc.)	Minimum 0 1 2 3 Severe	1	N/A
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	1	N/A
Weight average score for Economic impacts		**1**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small 0 1 2 3 Very large	1	N/A
Degree of severity	Minimum 0 1 2 3 Severe	1	N/A
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	1	N/A
Weight average score for Health impacts		**1**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small 0 1 2 3 Very large	1	N/A
Degree of severity	Minimum 0 1 2 3 Severe	1	N/A
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	1	N/A
Weight average score for Other social and community impacts		**1**	

Note: N/A = Not applied

II: Pollution

Environmental issues	Score	Weight	Environmental concern	Weight averaged score
4. Microbiological	1	N/A	Pollution	3
5. Eutrophication	3	N/A		
6. Chemical	2	N/A		
7. Suspended solids	1	N/A		
8. Solid wastes	1	N/A		
9. Thermal	0	N/A		
10. Radionuclides	1	N/A		
11. Spills	2	N/A		

Criteria for Economics impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small 0 1 2 3 Very large	2	N/A
Degree of impact (cost, output changes etc.)	Minimum 0 1 2 3 Severe	2	N/A
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	2	N/A
Weight average score for Economic impacts		**2**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small 0 1 2 3 Very large	2	N/A
Degree of severity	Minimum 0 1 2 3 Severe	2	N/A
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	2	N/A
Weight average score for Health impacts		**2**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small 0 1 2 3 Very large	1	N/A
Degree of severity	Minimum 0 1 2 3 Severe	1	N/A
Frequency/Duration	Occasion/Short 0 1 2 3 Continuous	1	N/A
Weight average score for Other social and community impacts		**1**	

Note: N/A = Not applied

III: Habitat and community modification

Environmental issues	Score	Weight	Environmental concern	Weight averaged score
12. Loss of ecosystems	1	N/A	Habitat and community modification	2
13. Modification of ecosystems or ecotones, including community structure and/or species composition	2	N/A		

Criteria for Economics impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small — Very large 0 1 2 3	1	N/A
Degree of impact (cost, output changes etc.)	Minimum — Severe 0 1 2 3	1	N/A
Frequency/Duration	Occasion/Short — Continuous 0 1 2 3	1	N/A
Weight average score for Economic impacts		**1**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small — Very large 0 1 2 3	1	N/A
Degree of severity	Minimum — Severe 0 1 2 3	1	N/A
Frequency/Duration	Occasion/Short — Continuous 0 1 2 3	1	N/A
Weight average score for Health impacts		**1**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small — Very large 0 1 2 3	1	N/A
Degree of severity	Minimum — Severe 0 1 2 3	1	N/A
Frequency/Duration	Occasion/Short — Continuous 0 1 2 3	1	N/A
Weight average score for Other social and community impacts		**1**	

Note: N/A = Not applied

IV: Unsustainable exploitation of fish and other living resources

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
14. Overexploitation	3	N/A	Unsustainable exploitation of fish	2
15. Excessive by-catch and discards	1	N/A		
16. Destructive fishing practices	1	N/A		
17. Decreased viability of stock through pollution and disease	2	N/A		
18. Impact on biological and genetic diversity	2	N/A		

Criteria for Economics impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small — Very large 0 1 2 3	2	N/A
Degree of impact (cost, output changes etc.)	Minimum — Severe 0 1 2 3	2	N/A
Frequency/Duration	Occasion/Short — Continuous 0 1 2 3	2	N/A
Weight average score for Economic impacts		**2**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small — Very large 0 1 2 3	0	N/A
Degree of severity	Minimum — Severe 0 1 2 3	0	N/A
Frequency/Duration	Occasion/Short — Continuous 0 1 2 3	0	N/A
Weight average score for Health impacts		**0**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small — Very large 0 1 2 3	2	N/A
Degree of severity	Minimum — Severe 0 1 2 3	2	N/A
Frequency/Duration	Occasion/Short — Continuous 0 1 2 3	2	N/A
Weight average score for Other social and community impacts		**2**	

Note: N/A = Not applied

V: Global change

Environmental issues	Score	Weight	Environmental concern	Weight averaged score
19. Changes in the hydrological cycle	1	N/A	Global change	0
20. Sea level change	0	N/A		
21. Increased UV-B radiation as a result of ozone depletion	0	N/A		
22. Changes in ocean CO_2 source/sink function	0	N/A		

Criteria for Economics impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large (0 1 2 3)	1	N/A
Degree of impact (cost, output changes etc.)	Minimum – Severe (0 1 2 3)	1	N/A
Frequency/Duration	Occasion/Short – Continuous (0 1 2 3)	1	N/A
Weight average score for Economic impacts		**1**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large (0 1 2 3)	1	N/A
Degree of severity	Minimum – Severe (0 1 2 3)	1	N/A
Frequency/Duration	Occasion/Short – Continuous (0 1 2 3)	1	N/A
Weight average score for Health impacts		**1**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large (0 1 2 3)	1	N/A
Degree of severity	Minimum – Severe (0 1 2 3)	1	N/A
Frequency/Duration	Occasion/Short – Continuous (0 1 2 3)	1	N/A
Weight average score for Other social and community impacts		**1**	

Note: N/A = Not applied

Comparative environmental and socio-economic impacts of each GIWA concern

Concern	Types of impacts: Environmental score		Economic score		Human health score		Social and community score		Overall score	Rank
	Present (a)	Future (b)	Present (a)	Future (b)	Present (a)	Future (b)	Present (a)	Future (b)		
Freshwater shortage	2	2	1	1	1	1	1	1	**1.3**	4
Pollution	3	2	2	3	2	2	1	2	**2.1**	1
Habitat and community modification	2	2	1	2	1	1	1	1	**1.4**	3
Unsustainable exploitation of fish and other living resources	2	2	2	2	0	0	2	2	**1.5**	2
Global change	0	1	1	2	1	2	1	2	**1.3**	5

Annex III
List of conventions and specific laws that affect water use in the region

- The Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and the Belts, signed in Gdansk in September 1973 (Gdansk Convention);
- The Convention of the Protection of the Marine Environment of the Baltic Sea, signed in Helsinki in March 1974 (Helsinki Convention);
- The Nordic Environmental Protection Convention, signed in Stockholm in February 1974 (Stockholm Convention);
- The Convention on the Conservation of European Wildlife and Natural Habitats, signed in Bern in September 1979 (Bern Convention);
- The Convention on Long-Range Transboundary Air Pollution, signed in Geneva in November 1979;
- The Convention on the Protection and Use of Transboundary Watercourses and International Lakes, signed in Helsinki March 1992 and entered into force in 1996;
- United Nations Convention of the Law of the Sea (UNCLOS);
- UNESCO World Heritage Convention;
- United Nations Convention on Biological Diversity;
- The Ramsar Convention on Wetlands, signed in Ramsar, Iran, 1972;
- International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78);
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention);
- The European Parlament and the Council of the European Union Directive 2000/60/EC (Water Framework Directive).

The Global International Waters Assessment

This report presents the results of the Global International Waters Assessment (GIWA) of the transboundary waters of the Baltic Sea. This and the subsequent chapter offer a background that describes the impetus behind the establishment of GIWA, its objectives and how the GIWA was implemented.

The need for a global international waters assessment

Globally, people are becoming increasingly aware of the degradation of the world's water bodies. Disasters from floods and droughts, frequently reported in the media, are considered to be linked with ongoing global climate change (IPCC 2001), accidents involving large ships pollute public beaches and threaten marine life and almost every commercial fish stock is exploited beyond sustainable limits - it is estimated that the global stocks of large predatory fish have declined to less that 10% of pre-industrial fishing levels (Myers & Worm 2003). Further, more than 1 billion people worldwide lack access to safe drinking water and 2 billion people lack proper sanitation which causes approximately 4 billion cases of diarrhoea each year and results in the death of 2.2 million people, mostly children younger than five (WHO-UNICEF 2002). Moreover, freshwater and marine habitats are destroyed by infrastructure developments, dams, roads, ports and human settlements (Brinson & Malvárez 2002, Kennish 2002). As a consequence, there is growing public concern regarding the declining quality and quantity of the world's aquatic resources because of human activities, which has resulted in mounting pressure on governments and decision makers to institute new and innovative policies to manage those resources in a sustainable way ensuring their availability for future generations.

Adequately managing the world's aquatic resources for the benefit of all is, for a variety of reasons, a very complex task. The liquid state of the most of the world's water means that, without the construction of reservoirs, dams and canals it is free to flow wherever the laws of nature dictate. Water is, therefore, a vector transporting not only a wide variety of valuable resources but also problems from one area to another. The effluents emanating from environmentally destructive activities in upstream drainage areas are propagated downstream and can affect other areas considerable distances away. In the case of transboundary river basins, such as the Nile, Amazon and Niger, the impacts are transported across national borders and can be observed in the numerous countries situated within their catchments. In the case of large oceanic currents, the impacts can even be propagated between continents (AMAP 1998). Therefore, the inextricable linkages within and between both freshwater and marine environments dictates that management of aquatic resources ought to be implemented through a drainage basin approach.

In addition, there is growing appreciation of the incongruence between the transboundary nature of many aquatic resources and the traditional introspective nationally focused approaches to managing those resources. Water, unlike laws and management plans, does not respect national borders and, as a consequence, if future management of water and aquatic resources is to be successful, then a shift in focus towards international cooperation and intergovernmental agreements is required (UN 1972). Furthermore, the complexity of managing the world's water resources is exacerbated by the dependence of a great variety of domestic and industrial activities on those resources. As a consequence, cross-sectoral multidisciplinary approaches that integrate environmental, socio-economic and development aspects into management must be adopted. Unfortunately however, the scientific information or capacity within each discipline is often not available or is inadequately translated for use by managers, decision makers and policy developers. These inadequacies constitute a serious impediment to the implementation of urgently needed innovative policies.

Continual assessment of the prevailing and future threats to aquatic ecosystems and their implications for human populations is essential if governments and decision makers are going to be able to make strategic policy and management decisions that promote the sustainable use of those resources and respond to the growing concerns of the general public. Although many assessments of aquatic resources are being conducted by local, national, regional and international bodies, past assessments have often concentrated on specific themes, such as biodiversity or persistent toxic substances, or have focused only on marine or freshwaters. A globally coherent, drainage basin based assessment that embraces the inextricable links between transboundary freshwater and marine systems, and between environmental and societal issues, has never been conducted previously.

International call for action

The need for a holistic assessment of transboundary waters in order to respond to growing public concerns and provide advice to governments and decision makers regarding the management of aquatic resources was recognised by several international bodies focusing on the global environment. In particular, the Global Environment Facility (GEF) observed that the International Waters (IW) component of the GEF suffered from the lack of a global assessment which made it difficult to prioritise international water projects, particularly considering the inadequate understanding of the nature and root causes of environmental problems. In 1996, at its fourth meeting in Nairobi, the GEF Scientific and Technical Advisory Panel (STAP), noted that: *"Lack of an International Waters Assessment comparable with that of the IPCC, the Global Biodiversity Assessment, and the Stratospheric Ozone Assessment, was a unique and serious impediment to the implementation of the International Waters Component of the GEF"*.

The urgent need for an assessment of the causes of environmental degradation was also highlighted at the UN Special Session on the Environment (UNGASS) in 1997, where commitments were made regarding the work of the UN Commission on Sustainable Development (UNCSD) on freshwater in 1998 and seas in 1999. Also in 1997, two international Declarations, the Potomac Declaration: Towards enhanced ocean security into the third millennium, and the Stockholm Statement on interaction of land activities, freshwater and enclosed seas, specifically emphasised the need for an investigation of the root causes of degradation of the transboundary aquatic environment and options for addressing them. These processes led to the development of the Global International Waters Assessment (GIWA) that would be implemented by the United Nations Environment Programme (UNEP) in conjunction with the University of Kalmar, Sweden, on behalf of the GEF. The GIWA was inaugurated in Kalmar in October 1999 by the Executive Director of UNEP, Dr. Klaus Töpfer, and the late Swedish Minister of the Environment, Kjell Larsson. On this occasion Dr. Töpfer stated: *"GIWA is the framework of UNEP´s global water assessment strategy and will enable us to record and report on critical water resources for the planet for consideration of sustainable development management practices as part of our responsibilities under Agenda 21 agreements of the Rio conference"*.

The importance of the GIWA has been further underpinned by the UN Millennium Development Goals adopted by the UN General Assembly in 2000 and the Declaration from the World Summit on Sustainable

The Global Environment Facility (GEF)

The Global Environment Facility forges international co-operation and finances actions to address six critical threats to the global environment: biodiversity loss, climate change, degradation of international waters, ozone depletion, land degradation, and persistent organic pollutants (POPs).

The overall strategic thrust of GEF-funded international waters activities is to meet the incremental costs of: (a) assisting groups of countries to better understand the environmental concerns of their international waters and work collaboratively to address them; (b) building the capacity of existing institutions to utilise a more comprehensive approach for addressing transboundary water-related environmental concerns; and (c) implementing measures that address the priority transboundary environmental concerns. The goal is to assist countries to utilise the full range of technical, economic, financial, regulatory, and institutional measures needed to operationalise sustainable development strategies for international waters.

United Nations Environment Programme (UNEP)

United Nations Environment Programme, established in 1972, is the voice for the environment within the United Nations system. The mission of UNEP is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

UNEP work encompasses:

- Assessing global, regional and national environmental conditions and trends;
- Developing international and national environmental instruments;
- Strengthening institutions for the wise management of the environment;
- Facilitating the transfer of knowledge and technology for sustainable development;
- Encouraging new partnerships and mind-sets within civil society and the private sector.

University of Kalmar

University of Kalmar hosts the GIWA Co-ordination Office and provides scientific advice and administrative and technical assistance to GIWA. University of Kalmar is situated on the coast of the Baltic Sea. The city has a long tradition of higher education; teachers and marine officers have been educated in Kalmar since the middle of the 19th century. Today, natural science is a priority area which gives Kalmar a unique educational and research profile compared with other smaller universities in Sweden. Of particular relevance for GIWA is the established research in aquatic and environmental science. Issues linked to the concept of sustainable development are implemented by the research programme Natural Resources Management and Agenda 21 Research School.

Since its establishment GIWA has grown to become an integral part of University activities. The GIWA Co-ordination office and GIWA Core team are located at the Kalmarsund Laboratory, the university centre for water-related research. Senior scientists appointed by the University are actively involved in the GIWA peer-review and steering groups. As a result of the cooperation the University can offer courses and seminars related to GIWA objectives and international water issues.

Development in 2002. The development goals aimed to halve the proportion of people without access to safe drinking water and basic sanitation by the year 2015 (United Nations Millennium Declaration 2000). The WSSD also calls for integrated management of land, water and living resources (WSSD 2002) and, by 2010, the Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem should be implemented by all countries that are party to the declaration (FAO 2001).

The conceptual framework and objectives

Considering the general decline in the condition of the world's aquatic resources and the internationally recognised need for a globally coherent assessment of transboundary waters, the primary objectives of the GIWA are:

- To provide a prioritising mechanism that allows the GEF to focus their resources so that they are used in the most cost effective manner to achieve significant environmental benefits, at national, regional and global levels; and
- To highlight areas in which governments can develop and implement strategic policies to reduce environmental degradation and improve the management of aquatic resources.

In order to meet these objectives and address some of the current inadequacies in international aquatic resources management, the GIWA has incorporated four essential elements into its design:

- A broad transboundary approach that generates a truly regional perspective through the incorporation of expertise and existing information from all nations in the region and the assessment of all factors that influence the aquatic resources of the region;
- A drainage basin approach integrating freshwater and marine systems;
- A multidisciplinary approach integrating environmental and socio-economic information and expertise; and
- A coherent assessment that enables global comparison of the results.

The GIWA builds on previous assessments implemented within the GEF International Waters portfolio but has developed and adopted a broader definition of transboundary waters to include factors that influence the quality and quantity of global aquatic resources. For example, due to globalisation and international trade, the market for penaeid shrimps has widened and the prices soared. This, in turn, has encouraged entrepreneurs in South East Asia to expand aquaculture resulting in the large-scale deforestation of mangroves for ponds (Primavera 1997). Within the GIWA, these "non-hydrological" factors constitute as large a transboundary influence as more traditionally recognised problems, such as the construction of dams that regulate the flow of water into a neighbouring country, and are considered equally important. In addition, the GIWA recognises the importance of hydrological units that would not normally be considered transboundary but exert a significant influence on transboundary waters, such as the Yangtze River in China which discharges into the East China Sea (Daoji & Daler 2004) and the Volga River in Russia which is largely responsible for the condition of the Caspian Sea (Barannik et al. 2004). Furthermore, the GIWA is a truly regional assessment that has incorporated data from a wide range of sources and included expert knowledge and information from a wide range of sectors and from each country in the region. Therefore, the transboundary concept adopted by the GIWA extends to include impacts caused by globalisation, international trade, demographic changes and technological advances and recognises the need for international cooperation to address them.

International waters and transboundary issues

The term "international waters", as used for the purposes of the GEF Operational Strategy, includes the oceans, large marine ecosystems, enclosed or semi-enclosed seas and estuaries, as well as rivers, lakes, groundwater systems, and wetlands with transboundary drainage basins or common borders. The water-related ecosystems associated with these waters are considered integral parts of the systems.

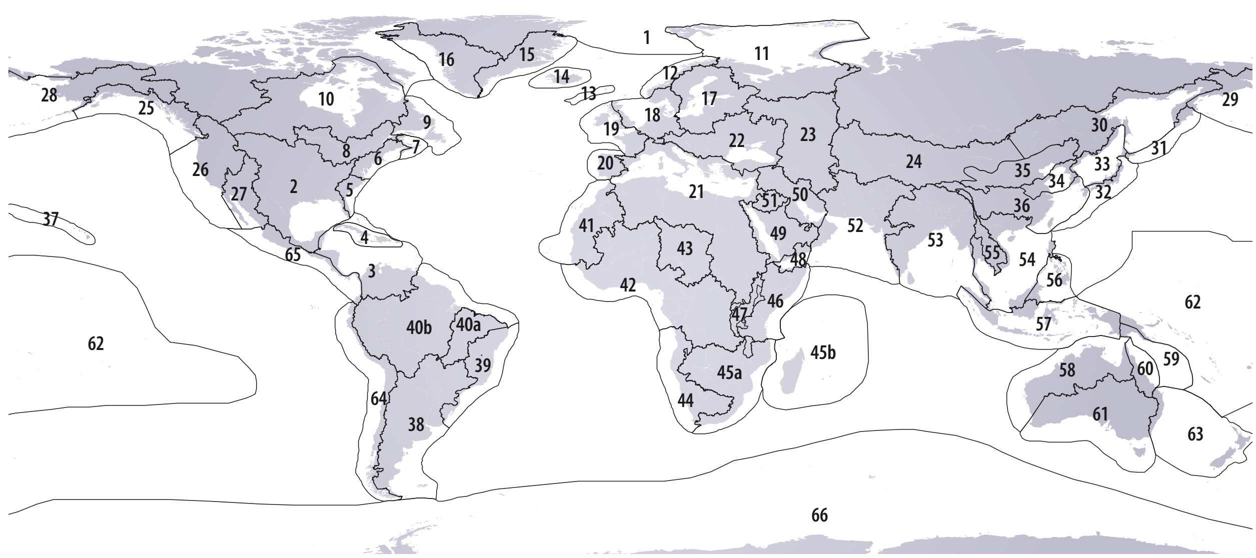
The term "transboundary issues" is used to describe the threats to the aquatic environment linked to globalisation, international trade, demographic changes and technological advancement, threats that are additional to those created through transboundary movement of water. Single country policies and actions are inadequate in order to cope with these challenges and this makes them transboundary in nature.

The international waters area includes numerous international conventions, treaties, and agreements. The architecture of marine agreements is especially complex, and a large number of bilateral and multilateral agreements exist for transboundary freshwater basins. Related conventions and agreements in other areas increase the complexity. These initiatives provide a new opportunity for cooperating nations to link many different programmes and instruments into regional comprehensive approaches to address international waters.

The organisational structure and implementation of the GIWA

The scale of the assessment

Initially, the scope of the GIWA was confined to transboundary waters in areas that included countries eligible to receive funds from the GEF. However, it was recognised that a truly global perspective would only be achieved if industrialised, GEF-ineligible regions of the world were also assessed. Financial resources to assess the GEF-eligible countries were obtained primarily from the GEF (68%), the Swedish International Development Cooperation Agency (Sida) (18%), and the Finnish Department for International Development Cooperation (FINNIDA)



1 Arctic
2 Gulf of Mexico (LME)
3 Caribbean Sea (LME)
4 Caribbean Islands
5 Southeast Shelf (LME)
6 Northeast Shelf (LME)
7 Scotian Shelf (LME)
8 Gulf of St Lawrence
9 Newfoundland Shelf (LME)
10 Baffin Bay, Labrador Sea, Canadian Archipelago
11 Barents Sea (LME)
12 Norwegian Sea (LME)
13 Faroe plateau
14 Iceland Shelf (LME)
15 East Greenland Shelf (LME)
16 West Greenland Shelf (LME)
17 Baltic Sea (LME)
18 North Sea (LME)
19 Celtic-Biscay Shelf (LME)
20 Iberian Coastal (LME)
21 Mediterranean Sea (LME)
22 Black Sea (LME)
23 Caspian Sea
24 Aral Sea
25 Gulf of Alaska (LME)
26 California Current (LME)
27 Gulf of California (LME)
28 East Bering Sea (LME)
29 West Bering Sea (LME)
30 Sea of Okhotsk (LME)
31 Oyashio Current (LME)
32 Kuroshio Current (LME)
33 Sea of Japan/East Sea (LME)
34 Yellow Sea (LME)
35 Bohai Sea
36 East-China Sea (LME)
37 Hawaiian Archipelago (LME)
38 Patagonian Shelf (LME)
39 Brazil Current (LME)
40a Brazilian Northeast (LME)
40b Amazon
41 Canary Current (LME)
42 Guinea Current (LME)
43 Lake Chad
44 Benguela Current (LME)
45a Agulhas Current (LME)
45b Indian Ocean Islands
46 Somali Coastal Current (LME)
47 East African Rift Valley Lakes
48 Gulf of Aden
49 Red Sea (LME)
50 The Gulf
51 Jordan
52 Arabian Sea (LME)
53 Bay of Bengal S.E.
54 South China Sea (LME)
55 Mekong River
56 Sulu-Celebes Sea (LME)
57 Indonesian Seas (LME)
58 North Australian Shelf (LME)
59 Coral Sea Basin
60 Great Barrier Reef (LME)
61 Great Australian Bight
62 Small Island States
63 Tasman Sea
64 Humboldt Current (LME)
65 Eastern Equatorial Pacific
66 Antarctic (LME)

Figure 1 The 66 transboundary regions assessed within the GIWA project.

(10%). Other contributions were made by Kalmar Municipality, the University of Kalmar and the Norwegian Government. The assessment of regions ineligible for GEF funds was conducted by various international and national organisations as in-kind contributions to the GIWA.

In order to be consistent with the transboundary nature of many of the world's aquatic resources and the focus of the GIWA, the geographical units being assessed have been designed according to the watersheds of discrete hydrographic systems rather than political borders (Figure 1). The geographic units of the assessment were determined during the preparatory phase of the project and resulted in the division of the world into 66 regions defined by the entire area of one or more catchments areas that drains into a single designated marine system. These marine systems often correspond to Large Marine Ecosystems (LMEs) (Sherman 1994, IOC 2002).

Large Marine Ecocsystems (LMEs)

Large Marine Ecosystems (LMEs) are regions of ocean space encompassing coastal areas from river basins and estuaries to the seaward boundaries of continental shelves and the outer margin of the major current systems. They are relatively large regions on the order of 200 000 km^2 or greater, characterised by distinct: (1) bathymetry, (2) hydrography, (3) productivity, and (4) trophically dependent populations.

The Large Marine Ecosystems strategy is a global effort for the assessment and management of international coastal waters. It developed in direct response to a declaration at the 1992 Rio Summit. As part of the strategy, the World Conservation Union (IUCN) and National Oceanic and Atmospheric Administration (NOAA) have joined in an action program to assist developing countries in planning and implementing an ecosystem-based strategy that is focused on LMEs as the principal assessment and management units for coastal ocean resources. The LME concept is also adopted by GEF that recommends the use of LMEs and their contributing freshwater basins as the geographic area for integrating changes in sectoral economic activities.

Considering the objectives of the GIWA and the elements incorporated into its design, a new methodology for the implementation of the assessment was developed during the initial phase of the project. The methodology focuses on five major environmental concerns which constitute the foundation of the GIWA assessment; Freshwater shortage, Pollution, Habitat and community modification, Overexploitation of fish and other living resources, and Global change. The GIWA methodology is outlined in the following chapter.

The global network

In each of the 66 regions, the assessment is conducted by a team of local experts that is headed by a Focal Point (Figure 2). The Focal Point can be an individual, institution or organisation that has been selected on the basis of their scientific reputation and experience implementing international assessment projects. The Focal Point is responsible for assembling members of the team and ensuring that it has the necessary expertise and experience in a variety of environmental and socio-economic disciplines to successfully conduct the regional assessment. The selection of team members is one of the most critical elements for the success of GIWA and, in order to ensure that the most relevant information is incorporated into the assessment, team members were selected from a wide variety of institutions such as universities, research institutes, government agencies, and the private sector. In addition, in order to ensure that the assessment produces a truly regional perspective, the teams should include representatives from each country that shares the region.

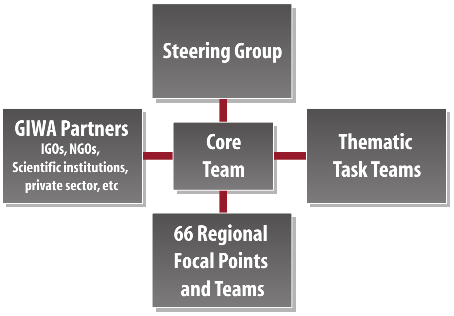


Figure 2 The organisation of the GIWA project.

In total, more than 1 000 experts have contributed to the implementation of the GIWA illustrating that the GIWA is a participatory exercise that relies on regional expertise. This participatory approach is essential because it instils a sense of local ownership of the project, which ensures the credibility of the findings and moreover, it has created a global network of experts and institutions that can collaborate and exchange experiences and expertise to help mitigate the continued degradation of the world's aquatic resources.

GIWA Regional reports

The GIWA was established in response to growing concern among the general public regarding the quality of the world's aquatic resources and the recognition of governments and the international community concerning the absence of a globally coherent international waters assessment. However, because a holistic, region-by-region, assessment of the condition of the world's transboundary water resources had never been undertaken, a methodology guiding the implementation of such an assessment did not exist. Therefore, in order to implement the GIWA, a new methodology that adopted a multidisciplinary, multi-sectoral, multi-national approach was developed and is now available for the implementation of future international assessments of aquatic resources.

UNEP Water Policy and Strategy

The primary goals of the UNEP water policy and strategy are:

(a) Achieving greater global understanding of freshwater, coastal and marine environments by conducting environmental assessments in priority areas;

(b) Raising awareness of the importance and consequences of unsustainable water use;

(c) Supporting the efforts of Governments in the preparation and implementation of integrated management of freshwater systems and their related coastal and marine environments;

(d) Providing support for the preparation of integrated management plans and programmes for aquatic environmental hot spots, based on the assessment results;

(e) Promoting the application by stakeholders of precautionary, preventive and anticipatory approaches.

The GIWA is comprised of a logical sequence of four integrated components. The first stage of the GIWA is called Scaling and is a process by which the geographic area examined in the assessment is defined and all the transboundary waters within that area are identified. Once the geographic scale of the assessment has been defined, the assessment teams conduct a process known as Scoping in which the magnitude of environmental and associated socio-economic impacts of Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources, and Global change is assessed in order to identify and prioritise the concerns that require the most urgent intervention. The assessment of these predefined concerns incorporates the best available information and the knowledge and experience of the multidisciplinary, multi-national assessment teams formed in each region. Once the priority concerns have been identified, the root causes of these concerns are identified during the third component of the GIWA, Causal chain analysis. The root causes are determined through a sequential process that identifies, in turn, the most significant immediate causes followed by the economic sectors that are primarily responsible for the immediate causes and finally, the societal root causes. At each stage in the Causal chain analysis, the most significant contributors are identified through an analysis of the best available information which is augmented by the expertise of the assessment team. The final component of the GIWA is the development of Policy options that focus on mitigating the impacts of the root causes identified by the Causal chain analysis.

The results of the GIWA assessment in each region are reported in regional reports that are published by UNEP. These reports are designed to provide a brief physical and socio-economic description of the most important features of the region against which the results of the assessment can be cast. The remaining sections of the report present the results of each stage of the assessment in an easily digestible form. Each regional report is reviewed by at least two independent external reviewers in order to ensure the scientific validity and applicability of each report. The 66 regional assessments of the GIWA will serve UNEP as an essential complement to the UNEP Water Policy and Strategy and UNEP's activities in the hydrosphere.

Global International Waters Assessment

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The GIWA methodology

The specific objectives of the GIWA were to conduct a holistic and globally comparable assessment of the world's transboundary aquatic resources that incorporated both environmental and socio-economic factors and recognised the inextricable links between freshwater and marine environments, in order to enable the GEF to focus their resources and to provide guidance and advice to governments and decision makers. The coalition of all these elements into a single coherent methodology that produces an assessment that achieves each of these objectives had not previously been done and posed a significant challenge.

The integration of each of these elements into the GIWA methodology was achieved through an iterative process guided by a specially convened Methods task team that was comprised of a number of international assessment and water experts. Before the final version of the methodology was adopted, preliminary versions underwent an extensive external peer review and were subjected to preliminary testing in selected regions. Advice obtained from the Methods task team and other international experts and the lessons learnt from preliminary testing were incorporated into the final version that was used to conduct each of the GIWA regional assessments.

Considering the enormous differences between regions in terms of the quality, quantity and availability of data, socio-economic setting and environmental conditions, the achievement of global comparability required an innovative approach. This was facilitated by focusing the assessment on the impacts of five pre-defined concerns namely; Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources and Global change, in transboundary waters. Considering the diverse range of elements encompassed by each concern, assessing the magnitude of the impacts caused by these concerns was facilitated by evaluating the impacts of 22 specific issues that were grouped within these concerns (see Table 1).

The assessment integrates environmental and socio-economic data from each country in the region to determine the severity of the impacts of each of the five concerns and their constituent issues on the entire region. The integration of this information was facilitated by implementing the assessment during two participatory workshops that typically involved 10 to 15 environmental and socio-economic experts from each country in the region. During these workshops, the regional teams performed preliminary analyses based on the collective knowledge and experience of these local experts. The results of these analyses were substantiated with the best available information to be presented in a regional report.

Table 1 Pre-defined GIWA concerns and their constituent issues addressed within the assessment.

Environmental issues	**Major concerns**
1. Modification of stream flow 2. Pollution of existing supplies 3. Changes in the water table	**I Freshwater shortage**
4. Microbiological 5. Eutrophication 6. Chemical 7. Suspended solids 8. Solid wastes 9. Thermal 10. Radionuclide 11. Spills	**II Pollution**
12. Loss of ecosystems 13. Modification of ecosystems or ecotones, including community structure and/or species composition	**III Habitat and community modification**
14. Overexploitation 15. Excessive by-catch and discards 16. Destructive fishing practices 17. Decreased viability of stock through pollution and disease 18. Impact on biological and genetic diversity	**IV Unsustainable exploitation of fish and other living resources**
19. Changes in hydrological cycle 20. Sea level change 21. Increased uv-b radiation as a result of ozone depletion 22. Changes in ocean CO_2 source/sink function	**V Global change**

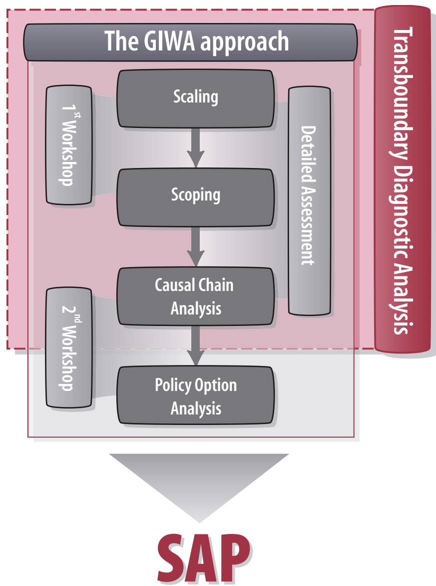

Figure 1 Illustration of the relationship between the GIWA approach and other projects implemented within the GEF International Waters (IW) portfolio.

The GIWA is a logical contiguous process that defines the geographic region to be assessed, identifies and prioritises particularly problems based on the magnitude of their impacts on the environment and human societies in the region, determines the root causes of those problems and, finally, assesses various policy options that addresses those root causes in order to reverse negative trends in the condition of the aquatic environment. These four steps, referred to as Scaling, Scoping, Causal chain analysis and Policy options analysis, are summarised below and are described in their entirety in two volumes: *GIWA Methodology Stage 1: Scaling and Scoping*; and *GIWA Methodology: Detailed Assessment, Causal Chain Analysis and Policy Options Analysis*. Generally, the components of the GIWA methodology are aligned with the framework adopted by the GEF for Transboundary Diagnostic Analyses (TDAs) and Strategic Action Programmes (SAPs) (Figure 1) and assume a broad spectrum of transboundary influences in addition to those associated with the physical movement of water across national borders.

Scaling – Defining the geographic extent of the region

Scaling is the first stage of the assessment and is the process by which the geographic scale of the assessment is defined. In order to facilitate the implementation of the GIWA, the globe was divided during the design phase of the project into 66 contiguous regions. Considering the transboundary nature of many aquatic resources and the transboundary focus of the GIWA, the boundaries of the regions did not comply with political boundaries but were instead, generally defined by a large but discrete drainage basin that also included the coastal marine waters into which the basin discharges. In many cases, the marine areas examined during the assessment coincided with the Large Marine Ecosystems (LMEs) defined by the US National Atmospheric and Oceanographic Administration (NOAA). As a consequence, scaling should be a relatively straight-forward task that involves the inspection of the boundaries that were proposed for the region during the preparatory phase of GIWA to ensure that they are appropriate and that there are no important overlaps or gaps with neighbouring regions. When the proposed boundaries were found to be inadequate, the boundaries of the region were revised according to the recommendations of experts from both within the region and from adjacent regions so as to ensure that any changes did not result in the exclusion of areas from the GIWA. Once the regional boundary was defined, regional teams identified all the transboundary elements of the aquatic environment within the region and determined if these elements could be assessed as a single coherent aquatic system or if there were two or more independent systems that should be assessed separately.

Scoping – Assessing the GIWA concerns

Scoping is an assessment of the severity of environmental and socio-economic impacts caused by each of the five pre-defined GIWA concerns and their constituent issues (Table 1). It is not designed to provide an exhaustive review of water-related problems that exist within each region, but rather it is a mechanism to identify the most urgent problems in the region and prioritise those for remedial actions. The priorities determined by Scoping are therefore one of the main outputs of the GIWA project.

Focusing the assessment on pre-defined concerns and issues ensured the comparability of the results between different regions. In addition, to ensure the long-term applicability of the options that are developed to mitigate these problems, Scoping not only assesses the current impacts of these concerns and issues but also the probable future impacts according to the "most likely scenario" which considered demographic, economic, technological and other relevant changes that will potentially influence the aquatic environment within the region by 2020.

The magnitude of the impacts caused by each issue on the environment and socio-economic indicators was assessed over the entire region using the best available information from a wide range of sources and the knowledge and experience of the each of the experts comprising the regional team. In order to enhance the comparability of the assessment between different regions and remove biases in the assessment caused by different perceptions of and ways to communicate the severity of impacts caused by particular issues, the results were distilled and reported as standardised scores according to the following four point scale:

- 0 = no known impact
- 1 = slight impact
- 2 = moderate impact
- 3 = severe impact

The attributes of each score for each issue were described by a detailed set of pre-defined criteria that were used to guide experts in reporting the results of the assessment. For example, the criterion for assigning a score of 3 to the issue Loss of ecosystems or ecotones is: "*Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by >30% during the last 2-3 decades*." The full list of criteria is presented at the end of the chapter, Table 5a-e. Although the scoring inevitably includes an arbitrary component, the use of predefined criteria facilitates comparison of impacts on a global scale and also encouraged consensus of opinion among experts.

The trade-off associated with assessing the impacts of each concern and their constituent issues at the scale of the entire region is that spatial resolution was sometimes low. Although the assessment provides a score indicating the severity of impacts of a particular issue or concern on the entire region, it does not mean that the entire region suffers the impacts of that problem. For example, eutrophication could be identified as a severe problem in a region, but this does not imply that all waters in the region suffer from severe eutrophication. It simply means that when the degree of eutrophication, the size of the area affected, the socio-economic impacts and the number of people affected is considered, the magnitude of the overall impacts meets the criteria defining a severe problem and that a regional action should be initiated in order to mitigate the impacts of the problem.

When each issue has been scored, it was weighted according to the relative contribution it made to the overall environmental impacts of the concern and a weighted average score for each of the five concerns was calculated (Table 2). Of course, if each issue was deemed to make equal contributions, then the score describing the overall impacts of the concern was simply the arithmetic mean of the scores allocated to each issue within the concern. In addition, the socio-economic impacts of each of the five major concerns were assessed for the entire region. The socio-economic impacts were grouped into three categories; Economic impacts, Health impacts and Other social and community impacts (Table 3). For each category, an evaluation of the size, degree and frequency of the impact was performed and, once completed, a weighted average score describing the overall socio-economic impacts of each concern was calculated in the same manner as the overall environmental score.

Table 2 Example of environmental impact assessment of Freshwater shortage.

Environmental issues	Score	Weight %	Environmental concerns	Weight averaged score
1. Modification of stream flow	1	20	Freshwater shortage	1.50
2. Pollution of existing supplies	2	50		
3. Changes in the water table	1	30		

Table 3 Example of Health impacts assessment linked to one of the GIWA concerns.

Criteria for Health impacts	Raw score	Score	Weight %
Number of people affected	Very small – Very large 0 1 2 3	2	50
Degree of severity	Minimum – Severe 0 1 2 3	2	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	20
Weight average score for Health impacts		**2**	

After all 22 issues and associated socio-economic impacts have been scored, weighted and averaged, the magnitude of likely future changes in the environmental and socio-economic impacts of each of the five concerns on the entire region is assessed according to the most likely scenario which describes the demographic, economic, technological and other relevant changes that might influence the aquatic environment within the region by 2020.

In order to prioritise among GIWA concerns within the region and identify those that will be subjected to causal chain and policy options analysis in the subsequent stages of the GIWA, the present and future scores of the environmental and socio-economic impacts of each concern are tabulated and an overall score calculated. In the example presented in Table 4, the scoping assessment indicated that concern III, Habitat and community modification, was the priority concern in this region. The outcome of this mathematic process was reconciled against the knowledge of experts and the best available information in order to ensure the validity of the conclusion.

In some cases however, this process and the subsequent participatory discussion did not yield consensus among the regional experts regarding the ranking of priorities. As a consequence, further analysis was required. In such cases, expert teams continued by assessing the relative importance of present and potential future impacts and assign weights to each. Afterwards, the teams assign weights indicating the relative contribution made by environmental and socio-economic factors to the overall impacts of the concern. The weighted average score for each concern is then recalculated taking into account

Table 4 Example of comparative environmental and socio-economic impacts of each major concern, presently and likely in year 2020.

Concern	Types of impacts								Overall score
	Environmental score		Economic score		Human health score		Social and community score		
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)	
Freshwater shortage	1.3	2.3	2.7	2.8	2.6	3.0	1.8	2.2	**2.3**
Pollution	1.5	2.0	2.0	2.3	1.8	2.3	2.0	2.3	**2.0**
Habitat and community modification	2.0	3.0	2.4	3.0	2.4	2.8	2.3	2.7	**2.6**
Unsustainable exploitation of fish and other living resources	1.8	2.2	2.0	2.1	2.0	2.1	2.4	2.5	**2.1**
Global change	0.8	1.0	1.5	1.7	1.5	1.5	1.0	1.0	**1.2**

the relative contributions of both present and future impacts and environmental and socio-economic factors. The outcome of these additional analyses was subjected to further discussion to identify overall priorities for the region.

Finally, the assessment recognises that each of the five GIWA concerns are not discrete but often interact. For example, pollution can destroy aquatic habitats that are essential for fish reproduction which, in turn, can cause declines in fish stocks and subsequent overexploitation. Once teams have ranked each of the concerns and determined the priorities for the region, the links between the concerns are highlighted in order to identify places where strategic interventions could be applied to yield the greatest benefits for the environment and human societies in the region.

Causal chain analysis

Causal Chain Analysis (CCA) traces the cause-effect pathways from the socio-economic and environmental impacts back to their root causes. The GIWA CCA aims to identify the most important causes of each concern prioritised during the scoping assessment in order to direct policy measures at the most appropriate target in order to prevent further degradation of the regional aquatic environment.

Root causes are not always easy to identify because they are often spatially or temporally separated from the actual problems they cause. The GIWA CCA was developed to help identify and understand the root causes of environmental and socio-economic problems in international waters and is conducted by identifying the human activities that cause the problem and then the factors that determine the ways in which these activities are undertaken. However, because there is no universal theory describing how root causes interact to create natural resource management problems and due to the great variation of local circumstances under which the methodology will be applied, the GIWA CCA is not a rigidly structured assessment but should be regarded as a framework to guide the analysis, rather than as a set of detailed instructions. Secondly, in an ideal setting, a causal chain would be produced by a multidisciplinary group of specialists that would statistically examine each successive cause and study its links to the problem and to other causes. However, this approach (even if feasible) would use far more resources and time than those available to GIWA[1]. For this reason, it has been necessary to develop a relatively simple and practical analytical model for gathering information to assemble meaningful causal chains.

Conceptual model

A causal chain is a series of statements that link the causes of a problem with its effects. Recognising the great diversity of local settings and the resulting difficulty in developing broadly applicable policy strategies, the GIWA CCA focuses on a particular system and then only on those issues that were prioritised during the scoping assessment. The starting point of a particular causal chain is one of the issues selected during the Scaling and Scoping stages and its related environmental and socio-economic impacts. The next element in the GIWA chain is the immediate cause; defined as the physical, biological or chemical variable that produces the GIWA issue. For example, for the issue of eutrophication the immediate causes may be, inter alia:

- Enhanced nutrient inputs;
- Increased recycling/mobilisation;
- Trapping of nutrients (e.g. in river impoundments);
- Run-off and stormwaters

Once the relevant immediate cause(s) for the particular system has (have) been identified, the sectors of human activity that contribute most significantly to the immediate cause have to be determined. Assuming that the most important immediate cause in our example had been increased nutrient concentrations, then it is logical that the most likely sources of those nutrients would be the agricultural, urban or industrial sectors. After identifying the sectors that are primarily

[1] This does not mean that the methodology ignores statistical or quantitative studies; as has already been pointed out, the available evidence that justifies the assumption of causal links should be provided in the assessment.

responsible for the immediate causes, the root causes acting on those sectors must be determined. For example, if agriculture was found to be primarily responsible for the increased nutrient concentrations, the root causes could potentially be:

- Economic (e.g. subsidies to fertilisers and agricultural products);
- Legal (e.g. inadequate regulation);
- Failures in governance (e.g. poor enforcement); or
- Technology or knowledge related (e.g. lack of affordable substitutes for fertilisers or lack of knowledge as to their application).

Once the most relevant root causes have been identified, an explanation, which includes available data and information, of how they are responsible for the primary environmental and socio-economic problems in the region should be provided.

Policy option analysis

Despite considerable effort of many Governments and other organisations to address transboundary water problems, the evidence indicates that there is still much to be done in this endeavour. An important characteristic of GIWA's Policy Option Analysis (POA) is that its recommendations are firmly based on a better understanding of the root causes of the problems. Freshwater scarcity, water pollution, overexploitation of living resources and habitat destruction are very complex phenomena. Policy options that are grounded on a better understanding of these phenomena will contribute to create more effective societal responses to the extremely complex water related transboundary problems. The core of POA in the assessment consists of two tasks:

Construct policy options

Policy options are simply different courses of action, which are not always mutually exclusive, to solve or mitigate environmental and socio-economic problems in the region. Although a multitude of different policy options could be constructed to address each root cause identified in the CCA, only those few policy options that have the greatest likelihood of success were analysed in the GIWA.

Select and apply the criteria on which the policy options will be evaluated

Although there are many criteria that could be used to evaluate any policy option, GIWA focuses on:

- Effectiveness (certainty of result)
- Efficiency (maximisation of net benefits)
- Equity (fairness of distributional impacts)
- Practical criteria (political acceptability, implementation feasibility).

The policy options recommended by the GIWA are only contributions to the larger policy process and, as such, the GIWA methodology developed to test the performance of various options under the different circumstances has been kept simple and broadly applicable.

Global International Waters Assessment

Table 5a: Scoring criteria for environmental impacts of Freshwater shortage

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 1: Modification of stream flow "An increase or decrease in the discharge of streams and rivers as a result of human interventions on a local/regional scale (see Issue 19 for flow alterations resulting from global change) over the last 3-4 decades."	■ No evidence of modification of stream flow.	■ There is a measurably changing trend in annual river discharge at gauging stations in a major river or tributary (basin > 40 000 km^2); or ■ There is a measurable decrease in the area of wetlands (other than as a consequence of conversion or embankment construction); or ■ There is a measurable change in the interannual mean salinity of estuaries or coastal lagoons and/or change in the mean position of estuarine salt wedge or mixing zone; or ■ Change in the occurrence of exceptional discharges (e.g. due to upstream damming.	■ Significant downward or upward trend (more than 20% of the long term mean) in annual discharges in a major river or tributary draining a basin of >250 000 km^2; or ■ Loss of >20% of flood plain or deltaic wetlands through causes other than conversion or artificial embankments; or ■ Significant loss of riparian vegetation (e.g. trees, flood plain vegetation); or ■ Significant saline intrusion into previously freshwater rivers or lagoons.	■ Annual discharge of a river altered by more than 50% of long term mean; or ■ Loss of >50% of riparian or deltaic wetlands over a period of not less than 40 years (through causes other than conversion or artificial embankment); or ■ Significant increased siltation or erosion due to changing in flow regime (other than normal fluctuations in flood plain rivers); or ■ Loss of one or more anadromous or catadromous fish species for reasons other than physical barriers to migration, pollution or overfishing.
Issue 2: Pollution of existing supplies "Pollution of surface and ground fresh waters supplies as a result of point or diffuse sources"	■ No evidence of pollution of surface and ground waters.	■ Any monitored water in the region does not meet WHO or national drinking water criteria, other than for natural reasons; or ■ There have been reports of one or more fish kills in the system due to pollution within the past five years.	■ Water supplies does not meet WHO or national drinking water standards in more than 30% of the region; or ■ There are one or more reports of fish kills due to pollution in any river draining a basin of >250 000 km^2 .	■ River draining more than 10% of the basin have suffered polysaprobic conditions, no longer support fish, or have suffered severe oxygen depletion ■ Severe pollution of other sources of freshwater (e.g. groundwater)
Issue 3: Changes in the water table "Changes in aquifers as a direct or indirect consequence of human activity"	■ No evidence that abstraction of water from aquifers exceeds natural replenishment.	■ Several wells have been deepened because of excessive aquifer draw-down; or ■ Several springs have dried up; or ■ Several wells show some salinisation.	■ Clear evidence of declining base flow in rivers in semi-arid areas; or ■ Loss of plant species in the past decade, that depend on the presence of ground water; or ■ Wells have been deepened over areas of hundreds of km^2;or ■ Salinisation over significant areas of the region.	■ Aquifers are suffering salinisation over regional scale; or ■ Perennial springs have dried up over regionally significant areas; or ■ Some aquifers have become exhausted

Table 5b: Scoring criteria for environmental impacts of Pollution

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 4: Microbiological pollution "The adverse effects of microbial constituents of human sewage released to water bodies."	■ Normal incidence of bacterial related gastroenteric disorders in fisheries product consumers and no fisheries closures or advisories.	■ There is minor increase in incidence of bacterial related gastroenteric disorders in fisheries product consumers but no fisheries closures or advisories.	■ Public health authorities aware of marked increase in the incidence of bacterial related gastroenteric disorders in fisheries product consumers; or ■ There are limited area closures or advisories reducing the exploitation or marketability of fisheries products.	■ There are large closure areas or very restrictive advisories affecting the marketability of fisheries products; or ■ There exists widespread public or tourist awareness of hazards resulting in major reductions in the exploitation or marketability of fisheries products.
Issue 5: Eutrophication "Artificially enhanced primary productivity in receiving water basins related to the increased availability or supply of nutrients, including cultural eutrophication in lakes."	■ No visible effects on the abundance and distributions of natural living resource distributions in the area; and ■ No increased frequency of hypoxia[1] or fish mortality events or harmful algal blooms associated with enhanced primary production; and ■ No evidence of periodically reduced dissolved oxygen or fish and zoobenthos mortality; and ■ No evident abnormality in the frequency of algal blooms.	■ Increased abundance of epiphytic algae; or ■ A statistically significant trend in decreased water transparency associated with algal production as compared with long-term (>20 year) data sets; or ■ Measurable shallowing of the depth range of macrophytes.	■ Increased filamentous algal production resulting in algal mats; or ■ Medium frequency (up to once per year) of large-scale hypoxia and/or fish and zoobenthos mortality events and/or harmful algal blooms.	■ High frequency (>1 event per year), or intensity, or large areas of periodic hypoxic conditions, or high frequencies of fish and zoobenthos mortality events or harmful algal blooms; or ■ Significant changes in the littoral community; or ■ Presence of hydrogen sulphide in historically well oxygenated areas.

Issue 6: Chemical pollution "The adverse effects of chemical contaminants released to standing or marine water bodies as a result of human activities. Chemical contaminants are here defined as compounds that are toxic or persistent or bioaccumulating."	■ No known or historical levels of chemical contaminants except background levels of naturally occurring substances; and ■ No fisheries closures or advisories due to chemical pollution; and ■ No incidence of fisheries product tainting; and ■ No unusual fish mortality events. If there is no available data use the following criteria: ■ No use of pesticides; and ■ No sources of dioxins and furans; and ■ No regional use of PCBs; and ■ No bleached kraft pulp mills using chlorine bleaching; and ■ No use or sources of other contaminants.	■ Some chemical contaminants are detectable but below threshold limits defined for the country or region; or ■ Restricted area advisories regarding chemical contamination of fisheries products. If there is no available data use the following criteria: ■ Some use of pesticides in small areas; or ■ Presence of small sources of dioxins or furans (e.g., small incineration plants or bleached kraft/pulp mills using chlorine); or ■ Some previous and existing use of PCBs and limited amounts of PCB-containing wastes but not in amounts invoking local concerns; or ■ Presence of other contaminants.	■ Some chemical contaminants are above threshold limits defined for the country or region; or ■ Large area advisories by public health authorities concerning fisheries product contamination but without associated catch restrictions or closures; or ■ High mortalities of aquatic species near outfalls. If there is no available data use the following criteria: ■ Large-scale use of pesticides in agriculture and forestry; or ■ Presence of major sources of dioxins or furans such as large municipal or industrial incinerators or large bleached kraft pulp mills; or ■ Considerable quantities of waste PCBs in the area with inadequate regulation or has invoked some public concerns; or ■ Presence of considerable quantities of other contaminants.	■ Chemical contaminants are above threshold limits defined for the country or region; and ■ Public health and public awareness of fisheries contamination problems with associated reductions in the marketability of such products either through the imposition of limited advisories or by area closures of fisheries; or ■ Large-scale mortalities of aquatic species. If there is no available data use the following criteria: ■ Indications of health effects resulting from use of pesticides; or ■ Known emissions of dioxins or furans from incinerators or chlorine bleaching of pulp; or ■ Known contamination of the environment or foodstuffs by PCBs; or ■ Known contamination of the environment or foodstuffs by other contaminants.
Issue 7: Suspended solids "The adverse effects of modified rates of release of suspended particulate matter to water bodies resulting from human activities"	■ No visible reduction in water transparency; and ■ No evidence of turbidity plumes or increased siltation; and ■ No evidence of progressive riverbank, beach, other coastal or deltaic erosion.	■ Evidently increased or reduced turbidity in streams and/or receiving riverine and marine environments but without major changes in associated sedimentation or erosion rates, mortality or diversity of flora and fauna; or ■ Some evidence of changes in benthic or pelagic biodiversity in some areas due to sediment blanketing or increased turbidity.	■ Markedly increased or reduced turbidity in small areas of streams and/or receiving riverine and marine environments; or ■ Extensive evidence of changes in sedimentation or erosion rates; or ■ Changes in benthic or pelagic biodiversity in areas due to sediment blanketing or increased turbidity.	■ Major changes in turbidity over wide or ecologically significant areas resulting in markedly changed biodiversity or mortality in benthic species due to excessive sedimentation with or without concomitant changes in the nature of deposited sediments (i.e., grain-size composition/redox); or ■ Major change in pelagic biodiversity or mortality due to excessive turbidity.
Issue 8: Solid wastes "Adverse effects associated with the introduction of solid waste materials into water bodies or their environs."	■ No noticeable interference with trawling activities; and ■ No noticeable interference with the recreational use of beaches due to litter; and ■ No reported entanglement of aquatic organisms with debris.	■ Some evidence of marine-derived litter on beaches; or ■ Occasional recovery of solid wastes through trawling activities; but ■ Without noticeable interference with trawling and recreational activities in coastal areas.	■ Widespread litter on beaches giving rise to public concerns regarding the recreational use of beaches; or ■ High frequencies of benthic litter recovery and interference with trawling activities; or ■ Frequent reports of entanglement/ suffocation of species by litter.	■ Incidence of litter on beaches sufficient to deter the public from recreational activities; or ■ Trawling activities untenable because of benthic litter and gear entanglement; or ■ Widespread entanglement and/or suffocation of aquatic species by litter.
Issue 9: Thermal "The adverse effects of the release of aqueous effluents at temperatures exceeding ambient temperature in the receiving water body."	■ No thermal discharges or evidence of thermal effluent effects.	■ Presence of thermal discharges but without noticeable effects beyond the mixing zone and no significant interference with migration of species.	■ Presence of thermal discharges with large mixing zones having reduced productivity or altered biodiversity; or ■ Evidence of reduced migration of species due to thermal plume.	■ Presence of thermal discharges with large mixing zones with associated mortalities, substantially reduced productivity or noticeable changes in biodiversity; or ■ Marked reduction in the migration of species due to thermal plumes.
Issue 10: Radionuclide "The adverse effects of the release of radioactive contaminants and wastes into the aquatic environment from human activities."	■ No radionuclide discharges or nuclear activities in the region.	■ Minor releases or fallout of radionuclides but with well regulated or well-managed conditions complying with the Basic Safety Standards.	■ Minor releases or fallout of radionuclides under poorly regulated conditions that do not provide an adequate basis for public health assurance or the protection of aquatic organisms but without situations or levels likely to warrant large scale intervention by a national or international authority.	■ Substantial releases or fallout of radionuclides resulting in excessive exposures to humans or animals in relation to those recommended under the Basic Safety Standards; or ■ Some indication of situations or exposures warranting intervention by a national or international authority.
Issue 11: Spills "The adverse effects of accidental episodic releases of contaminants and materials to the aquatic environment as a result of human activities."	■ No evidence of present or previous spills of hazardous material; or ■ No evidence of increased aquatic or avian species mortality due to spills.	■ Some evidence of minor spills of hazardous materials in small areas with insignificant small-scale adverse effects one aquatic or avian species.	■ Evidence of widespread contamination by hazardous or aesthetically displeasing materials assumed to be from spillage (e.g. oil slicks) but with limited evidence of widespread adverse effects on resources or amenities; or ■ Some evidence of aquatic or avian species mortality through increased presence of contaminated or poisoned carcasses on beaches.	■ Widespread contamination by hazardous or aesthetically displeasing materials from frequent spills resulting in major interference with aquatic resource exploitation or coastal recreational amenities; or ■ Significant mortality of aquatic or avian species as evidenced by large numbers of contaminated carcasses on beaches.

Table 5c: Scoring criteria for environmental impacts of Habitat and community modification

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 12: Loss of ecosystems or ecotones "The complete destruction of aquatic habitats. For the purpose of GIWA methodology, recent loss will be measured as a loss of pre-defined habitats over the last 2-3 decades."	■ There is no evidence of loss of ecosystems or habitats.	■ There are indications of fragmentation of at least one of the habitats.	■ Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by up to 30 % during the last 2-3 decades.	■ Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by >30% during the last 2-3 decades.
Issue 13: Modification of ecosystems or ecotones, including community structure and/or species composition "Modification of pre-defined habitats in terms of extinction of native species, occurrence of introduced species and changing in ecosystem function and services over the last 2-3 decades."	■ No evidence of change in species complement due to species extinction or introduction; and ■ No changing in ecosystem function and services.	■ Evidence of change in species complement due to species extinction or introduction	■ Evidence of change in species complement due to species extinction or introduction; and ■ Evidence of change in population structure or change in functional group composition or structure	■ Evidence of change in species complement due to species extinction or introduction; and ■ Evidence of change in population structure or change in functional group composition or structure; and ■ Evidence of change in ecosystem services[2].

[2] Constanza, R. et al. (1997). The value of the world ecosystem services and natural capital, Nature 387:253-260.

Table 5d: Scoring criteria for environmental impacts of Unsustainable exploitation of fish and other living resources

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 14: Overexploitation "The capture of fish, shellfish or marine invertebrates at a level that exceeds the maximum sustainable yield of the stock."	■ No harvesting exists catching fish (with commercial gear for sale or subsistence).	■ Commercial harvesting exists but there is no evidence of over-exploitation.	■ One stock is exploited beyond MSY (maximum sustainable yield) or is outside safe biological limits.	■ More than one stock is exploited beyond MSY or is outside safe biological limits.
Issue 15: Excessive by-catch and discards "By-catch refers to the incidental capture of fish or other animals that are not the target of the fisheries. Discards refers to dead fish or other animals that are returned to the sea."	■ Current harvesting practices show no evidence of excessive by-catch and/or discards.	■ Up to 30% of the fisheries yield (by weight) consists of by-catch and/or discards.	■ 30-60% of the fisheries yield consists of by-catch and/or discards.	■ Over 60% of the fisheries yield is by-catch and/or discards; or ■ Noticeable incidence of capture of endangered species.
Issue 16: Destructive fishing practices "Fishing practices that are deemed to produce significant harm to marine, lacustrine or coastal habitats and communities."	■ No evidence of habitat destruction due to fisheries practices.	■ Habitat destruction resulting in changes in distribution of fish or shellfish stocks; or ■ Trawling of any one area of the seabed is occurring less than once per year.	■ Habitat destruction resulting in moderate reduction of stocks or moderate changes of the environment; or ■ Trawling of any one area of the seabed is occurring 1-10 times per year; or ■ Incidental use of explosives or poisons for fishing.	■ Habitat destruction resulting in complete collapse of a stock or far reaching changes in the environment; or ■ Trawling of any one area of the seabed is occurring more than 10 times per year; or ■ Widespread use of explosives or poisons for fishing.
Issue 17: Decreased viability of stocks through contamination and disease "Contamination or diseases of feral (wild) stocks of fish or invertebrates that are a direct or indirect consequence of human action."	■ No evidence of increased incidence of fish or shellfish diseases.	■ Increased reports of diseases without major impacts on the stock.	■ Declining populations of one or more species as a result of diseases or contamination.	■ Collapse of stocks as a result of diseases or contamination.
Issue 18: Impact on biological and genetic diversity "Changes in genetic and species diversity of aquatic environments resulting from the introduction of alien or genetically modified species as an intentional or unintentional result of human activities including aquaculture and restocking."	■ No evidence of deliberate or accidental introductions of alien species; and ■ No evidence of deliberate or accidental introductions of alien stocks; and ■ No evidence of deliberate or accidental introductions of genetically modified species.	■ Alien species introduced intentionally or accidentally without major changes in the community structure; or ■ Alien stocks introduced intentionally or accidentally without major changes in the community structure; or ■ Genetically modified species introduced intentionally or accidentally without major changes in the community structure.	■ Measurable decline in the population of native species or local stocks as a result of introductions (intentional or accidental); or ■ Some changes in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).	■ Extinction of native species or local stocks as a result of introductions (intentional or accidental); or ■ Major changes (>20%) in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).

Table 5e: Scoring criteria for environmental impacts of Global change

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 19: Changes in hydrological cycle and ocean circulation "Changes in the local/regional water balance and changes in ocean and coastal circulation or current regime over the last 2-3 decades arising from the wider problem of global change including ENSO."	■ No evidence of changes in hydrological cycle and ocean/coastal current due to global change.	■ Change in hydrological cycles due to global change causing changes in the distribution and density of riparian terrestrial or aquatic plants without influencing overall levels of productivity; or ■ Some evidence of changes in ocean or coastal currents due to global change but without a strong effect on ecosystem diversity or productivity.	■ Significant trend in changing terrestrial or sea ice cover (by comparison with a long-term time series) without major downstream effects on river/ocean circulation or biological diversity; or ■ Extreme events such as flood and drought are increasing; or ■ Aquatic productivity has been altered as a result of global phenomena such as ENSO events.	■ Loss of an entire habitat through desiccation or submergence as a result of global change; or ■ Change in the tree or lichen lines; or ■ Major impacts on habitats or biodiversity as the result of increasing frequency of extreme events; or ■ Changing in ocean or coastal currents or upwelling regimes such that plant or animal populations are unable to recover to their historical or stable levels; or ■ Significant changes in thermohaline circulation.
Issue 20: Sea level change "Changes in the last 2-3 decades in the annual/seasonal mean sea level as a result of global change."	■ No evidence of sea level change.	■ Some evidences of sea level change without major loss of populations of organisms.	■ Changed pattern of coastal erosion due to sea level rise has became evident; or ■ Increase in coastal flooding events partly attributed to sea-level rise or changing prevailing atmospheric forcing such as atmospheric pressure or wind field (other than storm surges).	■ Major loss of coastal land areas due to sea-level change or sea-level induced erosion; or ■ Major loss of coastal or intertidal populations due to sea-level change or sea level induced erosion.
Issue 21: Increased UV-B radiation as a result of ozone depletion "Increased UV-B flux as a result polar ozone depletion over the last 2-3 decades."	■ No evidence of increasing effects of UV/B radiation on marine or freshwater organisms.	■ Some measurable effects of UV/B radiation on behavior or appearance of some aquatic species without affecting the viability of the population.	■ Aquatic community structure is measurably altered as a consequence of UV/B radiation; or ■ One or more aquatic populations are declining.	■ Measured/assessed effects of UV/B irradiation are leading to massive loss of aquatic communities or a significant change in biological diversity.
Issue 22: Changes in ocean CO_2 source/sink function "Changes in the capacity of aquatic systems, ocean as well as freshwater, to generate or absorb atmospheric CO_2 as a direct or indirect consequence of global change over the last 2-3 decades."	■ No measurable or assessed changes in CO_2 source/sink function of aquatic system.	■ Some reasonable suspicions that current global change is impacting the aquatic system sufficiently to alter its source/sink function for CO_2.	■ Some evidences that the impacts of global change have altered the source/sink function for CO_2 of aquatic systems in the region by at least 10%.	■ Evidences that the changes in source/sink function of the aquatic systems in the region are sufficient to cause measurable change in global CO_2 balance.

The Global International Waters Assessment (GIWA) is a holistic, globally comparable assessment of all the world's transboundary waters that recognises the inextricable links between freshwater and coastal marine environment and integrates environmental and socio-economic information to determine the impacts of a broad suite of influences on the world's aquatic environment.

Broad Transboundary Approach

The GIWA not only assesses the problems caused by human activities manifested by the physical movement of transboundary waters, but also the impacts of other non-hydrological influences that determine how humans use transboundary waters.

Regional Assessment – Global Perspective

The GIWA provides a global perspective of the world's transboundary waters by assessing 66 regions that encompass all major drainage basins and adjacent large marine ecosystems. The GIWA Assessment of each region incorporates information and expertise from all countries sharing the transboundary water resources.

Global Comparability

In each region, the assessment focuses on 5 broad concerns that are comprised of 22 specific water related issues.

Integration of Information and Ecosystems

The GIWA recognises the inextricable links between freshwater and coastal marine environment and assesses them together as one integrated unit.

The GIWA recognises that the integration of socio-economic and environmental information and expertise is essential to obtain a holistic picture of the interactions between the environmental and societal aspects of transboundary waters.

Priorities, Root Causes and Options for the Future

The GIWA indicates priority concerns in each region, determines their societal root causes and develops options to mitigate the impacts of those concerns in the future.

This Report

This report presents the GIWA assessment of the Baltic Sea region, one of the largest brackish water areas in the world. It is a semi-enclosed sea, which together with other physical as well as socio-economic characteristics makes it very sensitive to anthropogenic pressures. Eutrophication remains the most pressing problem in the region, as nitrogen and phosphorus inputs are still too high, despite considerable efforts to reduce discharges. The issue of overexploitation of fish is also considered as a severe problem, mainly due to the overutilisation of fishing quotas, high exploitation rate and oversized fleet capacity. The past and present status and future prospects of these issues are discussed, and they are traced back to their root causes. Policy options to mitigate these problems are proposed, which are closely connected to the basic principles of the Helsinki Convention and EU Water Framework Directive to cater for a harmonised implementation of water protection measures in the Baltic Sea States.

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