Original Research

Identification of Chemical Pollution Problems and Causes in the Baltic Sea in Relation to Socio-Economic Drivers

K. Skowrońska[1]*, W. Chrzanowski[2], J. Namieśnik[1]***

[1]Department of Analytical Chemistry, [2]Department of Physical Chemistry,
Chemical Faculty, Gdańsk University of Technology, Narutowicza 11/12, 80-952 Gdańsk, Poland

Received: 26 August 2008
Accepted: 16 April 2009

Abstract

Drivers, pressures, state changes, impacts and responses (DPSIR) is a general framework for organising information about the state of the environment. The idea of the framework derives originally from the field of social studies. Now it is being applied on a much wider scale, in particular for organizing systems of indicators in the context of environmental studies and also sustainable development.

Many datasets on Baltic pollution, the state of its environment, infrastructure, emissions and monitoring networks are available. Yet without suitable tools they cannot be used properly and effectively. This paper contains a review of the current state of the Baltic region and the most useful sources of relevant information. A partial analysis – including only drivers, pressures and state changes – was carried out. To this purpose two tools were utilized: an experts' poll and reports of organizations – providers of the datasets. The former resulted in the following top three Ds, Ps and Ss: D – urban waste (1), transport, shipping (2), agriculture (3); P – rivers (1), direct discharges (2), atmospheric deposition (3); and S – decrease in population density (1), individual effects (scope for growth, imposex, endocrine disruption) (2), tissue pathology (3). Moreover, both methods produced similar results, which brings us to the conclusion that instead of providing new analytical/experimental programs, the existing databases could be better utilized. The significance of rivers should also be stressed.

Limitations in access to the data were specified. These were, first of all, lack or gaps in the datasets both in spatial and temporal scale. Differences in the data formats and the principle of data presentation – tables are preferred over graphs and maps – should also be mentioned.

Keywords: DPSIR, the Baltic Sea, pollution control, monitoring systems, pollution legislation, data collections

Introduction

The Environment is a common good. The protection of this good is of great importance – the number of current actions targeted at it proves it best. Environmental protection activities are carried out on many levels, as reclamation/preservation of terrains, monitoring programs or educational campaigns.

The monitoring programs are the ones that lay within the authors' area of interest. The common results of all monitoring programs, regardless of their aims, are datasets. Most of the monitoring efforts are publicly funded, the results of which should be published and widely shared [1].

*e-mail: chemanal@pg.gda.pl,
**e-mail: wojtek@chem.pg.gda.pl

Access to the data collected by environmental monitoring systems is crucial for enabling public participation within any environmental decision-making process. However, these data are not always available to the public, and usually are not available in a format that is understood by all the different policymakers [2].

The general problem, from this point of view, is to prepare environmental data in a way, or format, acceptable for non-scientists. The DPSIR approach is the chance to find a common language between scientists and policymakers.

Environmental management requires information about the state of its subject. This information is gathered within a wide spectrum of monitoring programs. The problem is that most of these programs are managed individually and the results can be incompatible, if not inconsistent. The attempt at introducing unification in monitoring was made within the European Union, in the form of the Water Framework Directive [4].

In the case of such a vast area as the Baltic Sea basin, besides the incompatibility of the monitoring results, political and economic issues play the main role. Differences in environmental regulations between individual countries, different types of economies and of land/water usage make coherent management difficult.

As a supporting management tool, the DPSIR approach could be implemented. An attempt at doing so for the Baltic Sea basin is presented in this paper.

The Baltic Sea Situation

Physical Description of the Baltic Sea

The Baltic is an inland sea. The total catchment area comprises 1,720,270 km^2 and nine countries border the sea: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia, and Sweden. The Baltic Sea catchment area is almost four times larger than the sea itself and is inhabited by almost 80 million people. The sea also receives surface water drainage from five other countries: Belarus, the Czech and Slovak republics, Norway, and Ukraine. The Baltic Sea may be divided into five main parts: Bothnian Bay, the Gulf of Finland, the Gulf of Riga, the Baltic proper and the Belt Sea (more detailed divisions are sometimes used). From the national point of view, the largest portion of the Baltic Sea catchment area, 440,000 km^2, belongs to Sweden. The next largest national catchment areas are those of Poland, Russia and Finland, all of which are larger than 300,000 km^2. Germany has the smallest proportion of the catchment area, 28,600 km^2. Looking by the sub-basin catchment areas, the Baltic Proper and the Gulf of Finland are the largest, at 575,000 km^2 and 410,000 km^2, respectively, and the Archipelago Sea and the Sound have the smallest catchment areas [3].

The mean depth of the Baltic Sea is only 53 m, but the maximum depth reaches down to 459 m. The Baltic Sea contains 21,547 km^3 of water and annual freshwater inflow from the rivers amounts to ca. 2% of this volume [4, 5].

Salinity, Water Exchange and Oxygen Level

The Baltic Sea is connected to the North Sea by narrow and shallow sounds between Denmark and Sweden. The main area of the Baltic is divided into a series of basins separated by shallow sills that obstruct efficient water exchange. Each of these basins has its own water exchange characteristics. Time of total exchange of water with the North Sea is in the range of 25-35 years. Therefore, the environmental conditions of the Baltic Sea depend on the fresh water input from rivers, on precipitation, and on the limited inflow of more saline water from the North Sea. Without the constant but relatively small influx of saline water through the Danish straits, the Baltic Sea would have been transformed into a gigantic freshwater lake a long time ago. The brackish water of the Baltic Sea is a mixture of seawater from the North Sea and freshwater from rivers and rainfall. The salinity of its surface waters varies from around 20 in the Kattegat to 1-2 in the northernmost Gulf of Bothnia and the easternmost Gulf of Finland, compared to 35 in the open oceans. Thus, a clear salinity gradient exists from the almost oceanic conditions in the northern Kattegat to the almost freshwater conditions in the Bay of Bothnia [4-6].

A salinity barrier also exists between the surface and the seabed of the Baltic. Saline water, which is heavier than fresh water, flows along the bottom of the sea. The fresh water on the surface of the sea does not mix with the saline water underneath. A marked stratification of salinity (halocline) exists throughout the Baltic Sea at a depth of about 40-70 meters. The salinity barrier prevents the exchange of substances, i.e. oxygen, nutrients, and also pollutants, between these two layers. In summer, another type of barrier occurs – a thermocline. This boundary separates surface waters into two layers: a wind-mixed surface layer down to a depth of 10-25 m, and a deeper, denser and colder layer extending down to the seabed. The environmental conditions differ significantly between these layers, separated by both the thermo- and halocline [4-6].

Due to the limited water exchange, an oxygen deficient zone occurs near the bottom of many parts of the Baltic Sea. Anaerobic bacteria growing in this zone break down organic matter and release hydrogen sulphide. Both oxygen deficiency and hydrogen sulphide production make the bottom of the Baltic Sea almost lifeless. The size of the seabed with impaired conditions varies from year to year and may reach 100,000 km^2 (1/4 of the Baltic Sea).

Only major deep-water inflows that bring large volumes of oxygen-rich water into the Baltic Sea can improve the living conditions in the deeper bottom layers. Unfortunately, this type of inflow is quite rare. Since 1976, only a few major inflows have been observed and none were recorded between 1983 and 1992. In January 1993, a major deep-water inflow occurred after 16 years of stagnation, but it was an isolated event. The next big one, in 2003, ended another long-lasting stagnation period [4-6].

The 2003 event transported approximately 200 km^3 of cold and oxygenated water into the Baltic Sea, importing a total of 2 Gt (2×10^{12} kg) of salt. It ranks twenty-fifth on the

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Table 1. Drivers, Pressures and State Changes proposed in the poll.

DRIVER	PRESSURE	STATE CHANGES
Oil & Gas (drilling activities)	Atmospheric deposition	Sub-lethal and lethal effects
Transport & Shipping	Ballast waters	Sub-cellular
Urban Waste	Rivers	Cellular
Roads	Direct Discharges (including pipelines)	Tissue – Pathology
Ports & Harbours	Oil Spills (accidents)	Individual (scope for growth, imposex, endocrine disruption)
Chemical Industry	Storms/rainfall/diffuse discharges	Population (density, biomass, age structure, mortality, behaviour – e.g., migration habits)
Power Generation	Erosion	Community (diversity)
Aquaculture (mariculture)	Methane natural inputs	participant's choice - Functional diversity
Agriculture (pesticides, herbicides, etc.)	participant's choice - physical constructions	participant's choice - ecosystem
Construction (wind farms, ports, oil rigs, etc.)	participant's choice - climate	
Defense (military)		
Tourism		
Land use (flood defence, developments)		
Mineral Extraction		
participant's choice – fishing		
participant's choice - climat change		
participant's choice - Coastal zone area urbanization		
participant's choice - various industries		

list of the 97 major Baltic inflow (MBI) since 1897. In May 2003 oxygen content of 3.96 ml/l could be measured. Such high concentrations had been detected only twice before, during the 1930s and in May 1994. Until May 2004, the arrival of the inflow could be detected successively also in the northern and western Gotland Basin, and most of the deep basins were free of hydrogen sulphide. However, because no new MBI has taken place since January 2003, the oxygen situation soon started to deteriorate. The system returned back to anoxic conditions in the middle of 2004 in the deep waters of Bornholm and the eastern Gotland Basin as well [4-6].

Discussing water exchange, riverine inflow should not be neglected. The total long-term mean flow rate via all rivers entering the Baltic Sea is 15,190 m^3/s (479 km^3/h), of which nearly half drains into the Baltic Sea via the seven largest rivers:

- the Neva,
- the Vistula,
- the Daugava,
- the Nemunas,
- the Kemijoki,
- the Oder,
- the Götaälv.

The long-term mean flow rates of these rivers and the divisions of the river catchment areas among individual countries are presented in Table 3 [6].

Most of the pollutants observed in the Baltic Sea are introduced via rivers. The air path is important in the case of nitrogen, but this work focuses on chemical pollution, not eutrophication. Since river catchment areas often include the territory of more than one country, the pollution loads discharged by some countries also include loads originating in other countries upstream or on the other side of the border rivers [6].

To clarify the origins of the loads in different subbasins, general information on land use (Table 4) in the Baltic Sea catchment area for the year 2000 is included. Large parts (60-70%) of the German, Danish and Polish sections of the catchment area consist of agricultural land (Table 4). The percentage of agricultural land in Estonia, Latvia and Lithuania is 30-50%, while only ca. 10% of the catchment areas in Sweden, Finland and Russia is agricultural land, mainly in the southern parts of Sweden and Finland. Forests, peatlands and inland waters constitute 65-90% of the catchment areas in Finland, Russia, Sweden and Estonia. In Poland, Lithuania and Latvia these features account for 30-50% of the catchment area, whereas in Denmark and Germany they cover only 19-25% [5].

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Table 2. Heavy metals and pesticides – a brief description.

SECTORS: CHEMICAL INDUSTRY, URBANIZATION Heavy metals (Pb, Cu, Cd)	
Pressure	- diffuse discharges of heavy metals – waste disposal, landfills, urban and agricultural runoff, contaminated sediments erosion
	- atmospheric deposition
	- transport of heavy metals via rivers
Indicator measure	- kg/year of industrial discharges of heavy metals
	- fragmentary information about concentration of heavy metals in sewage sludge
	- estimates of release of heavy metals by industry
	- emissions to atmosphere
Geographical scope	Information is usually related to catchments in particular areas of the Baltic. Data from Poland, Latvia, Lithuania, Germany and Norway were very detailed. EMEP provided useful information about production by different branches of industry.
Timescale	For heavy metals up to 10 years
Data source/Data	In Poland, Environmental Protection Institute, connected to the Environmental Protection Ministry.
	EEA, EPER (EU), HELCOM
	Technical and Scientific reports, scientific publications
SECTORS: AGRICULTURE AND CHEMICAL INDUSTRY pesticides/biocides (especially lindane, hexachlorobenzene and DDT)	
Pressure	- diffuse discharges (runoff)
	- transport via rivers
	-direct discharges from chemical industry
Indicator measure	- kg/year of discharges of pesticides/biocides (chemical industry, agricultural)
	- estimation of diffuse emissions from agriculture area
Geographical scope	Information is usually related to catchments in particular areas of the Baltic. Data from Poland, Latvia, Lithuania, Germany and Norway were very deatiled. EMEP provided useful information about production by different branches of industry.
Timescale	For biocides/pesticides, up to 5 years
Data source/Data	In Poland, Environmental Protection Institute, connected to the Environmental Protection Ministry.
	EEA, EPER (EU), HELCOM
	Technical and Scientific reports, scientific publications

The particular geography and physical properties of the Baltic Sea make it very sensitive and ecologically unstable. The level of complication makes this area an object of several models with different spatial scales [7].

Pollutants in the Baltic Environment – an Overview

The issue is not only "what is the pollution?," but "where is the pollution released into the environment?" Based on HELCOM documents, a list of the "hot spots" was used to make an assessment [6].

The majority of the hot spots are concentrated in the southeastern Baltic. Most of them are municipal, in the second place – industrial, then agricultural. Spatial arrangement of the hot spots is correlated with population density, type of land cover and land usage.

The southeastern part of the Baltic catchment is mainly arable land with a population density higher than in the northern part. Ranking of the hot spot types also fits our experts' ranking of drivers and pressures, described later.

The hot spots are strongly connected with emissions. Emission into the air has a secondary impact on Baltic conditions, with the first place belonging to rivers, but it cannot

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Table 3. Division of river catchment area for the seven largest rivers flowing into the Baltic Sea [5].

River/States	Neva	Vistula	Nemunas	Daugava	Oder	Gotaalv	Kemijoki	Total
Long-term mean flows and measurement periods								
[m³/s]	2,488	1,081	664	637	574	572	553	6,569
period	1859-1988	1951-1990	1811-1995	1881-1914 1924-2000	1951-1990	1961-1990	1961-1990	-
Lenght [km]	74[a]	1,047	937	1,020	854	90[b]	600	4,622
Catchment areas [km²]								
Finland	56,200						49,470	105670
Russia	215,600		3,170	27,000			1,660	244130
Estonia				2,360				2360
Latvia			90	23,700				23840
Lithuania			46,700	1,860				48560
Poland		168,700	2,510		106,060			277270
Germany					5,590			5590
Sweden						42,780		42780
Belarus		12,600	45,450	33,300				83850
Ukraine		11,170						11170
Czech					7,190			7190
Slovakia		1,950						1950
Norway						7,450		7450
Total	271,800	194,420[c]	97,920	88,220	118,840	50,230	51,130	859450

a) length of the Neva to Lake Ladoga, b) length of the Götaälv to Lake Vänem, c) without the delta.

be omitted. On the other hand, air emissions are very often transboundary and problems – especially for modellers – can occur. EPER's database provides information about emission into air and water, but without distinguishing between sea and other types of water. (It should be stressed that information is limited only to Finland, Norway, Sweden, Denmark and Germany [8].)

When the individual chemicals were considered, the most useful information was the list of hazardous substances provided by HELCOM and the information provided by the European Commission and Water Framework Directive [3, 9, 10]. On the basis of those sources the following list was compiled:

- Alkanes (short-chained chlorinated paraffins (SCCP), chloroform (trichloromethane)).
- Phenols (nonylphenolethoxylate and products of their degradation/transformation, nonylphenol).
- Xylenes (musk xylene).
- Organic oxygen compounds (diethylhexylphthalate, dibutylphthalate).
- Metallic compounds (cadmium, lead, mercury and selenium compounds).
- Pesticides/Biocides (1,2-dibromoethane, acrylonitrile, aldrin, aramite, beta-HCH, chlordane, chlordecone (kepone), chlordimeform, DDT, dieldrin, endrin, fluoroacetic acid and derivates, HCH, heptachlor, hexachlorobenzene, isobenzane, isodrin, kelevan, lindane, mirex, morfamquat, nitrophen, pentachlorophenol, quintozene, toxaphene).
- Organotin compounds.
- Polycyclic halogenated aromatic compounds (hexabromobiphenyl, PCB, PCT (mixtures), TCDD, PCDD, PCDF (dioxins & furanes)).
- Polycyclic aromatic hydrocarbons (PAH).

Data Organization and Access Problems

In spite of the many potential sources of information on the state of the Baltic Sea, some problems regarding data availability and quality may be enumerated. These were, first of all, lack or gaps in the datasets both in spatial and temporal scale. Differences in the data formats and the principle of data presentation should also be mentioned.

The majority of data have been published in the form of reports, articles, maps or graphic presentations, thus reaching raw data may cause some problems. Different time scales, analytical methods and uncertainty assessment, provided by different sources/organizations also complicate the task.

Another problem was the quality of the data, which was rather difficult to estimate. As a conclusion, it may be said that for selected pollutants, where tabularized data are available, it is possible to carry out further work. The meta-

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Table 4. Percentages of the Baltic Sea catchment area under various land uses by country [4].

Countries/Land use	Denmark	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
Urban areas	14	3	2	4	2	5	6	2	3
Forests (incl. mountains)	16	44	51	15	44	31	29	55	70
Farmland (incl. grasslands)	66	30	7	72	39	54	60	12	6
Inland waters (lakes)	1	5	10	4	1	4	3	17	8
Wetlands and peatlands	1	17	27	-	5	2	-	13	12
Other	2	1	3	5	9	4	2	1	1

data chart, based on databases accessible via the Internet, contains dataset with satisfactory amounts of data – these pollutants were described in Table 2.

The issue of data availability may also be illustrated by the fact that when our metadata chart was compared with HELCOM's list, the common part of these two sets contained only the following pollutants: heavy metals, DDT, lindane, hexachlorobenzene, and hexabromobiphenyl.

For these substances the availability of data is satisfactory, while it has to be kept in mind that the most often monitored doesn't always mean the most harmful for the environment.

Materials and Methods

DPSIR Approach

Driving forces (drivers), pressures, state changes, impacts and responses (DPSIR) is a general framework for organizing information on the state of the environment. Particularly useful for policy-makers, DPSIR builds on the existing Organization for Economic Cooperation and Development model and offers a basis for analysing the inter-related factors that impact the environment [11].

The framework assumes cause-effect relationships between the interacting components of social, economic, and environmental systems, which are (Fig. 1):

- Driving forces of environmental change (e.g. industrial production);
- Pressures on the environment (e.g. discharges of waste water);
- State of the environment (e.g. water quality in rivers and lakes);
- Impacts on population, economy, and ecosystems (e.g. water unsuitable for drinking);
- Response of society (e.g. watershed protection) [12].

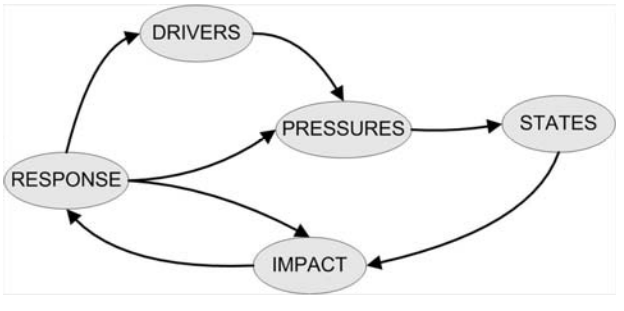

Fig. 1. DPSIR model.

The DPSIR approach had been implemented for the Baltic Sea Region before, at least on a regional scale [7]. As mentioned above, many of the currently running or already closed monitoring programs produced huge amounts of data, which could be used in DPSIR conceptual modelling. It is worth mentioning that in this approach expert opinion-based knowledge is greatly appreciated. Hence, besides the databases of different kinds, also reports and publications could be used as sources of information. Moreover, the DPSIR approach could be implemented for a whole basin or on a local scale (e.g. the Gulf of Gdańsk). This is extremely important, since the availability of the monitoring data/knowledge could differ considerably between individual sub-regions. For example, the aforementioned Gulf of Gdańsk alone has been widely described [13-16] and may become an excellent subject for a case study and implementation of models.

DPS Assessment for the Baltic Sea

As the first step, assessment of Drivers, Pressures, and State Changes for the Baltic Sea area was carried out. Two types of sources of information were considered:

1. information gathered by organizations involved in Baltic protection:
2. experts' opinion (a poll organized by the authors)

Resources of the following organizations provided data for the study:

- HELCOM (The Helsinki Commission) [9];
- EEA (European Environmental Agency) [17];
- EMEP (Co-operative programme for monitoring and evaluation of the long range transmission of air pollutants in Europe) [18];
- EPER (European Pollutant Emission Register) [8];
- EuroCat (European Catchments, Catchment Changes And Their Impact On The Coast);
- environmental ministries of the coastal countries [19].

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The criteria chosen to define what constitutes a pollution problem are described as follows:
- environmental state concentrations above EQS (Environmental Quality Standard) and EAC (Ecotoxicological Assessment Criteria) of hazardous substances,
- indicators of state changes and biological effects,
- decision if inputs or pressures are significant (chemical is still in use, it is not a past problem, etc.),
- analysis of reports about the state of the Baltic Sea, human activities and results of the monitoring program in the region of the Baltic Sea.

A suitable poll chart was created (Table 1) where we suggested a number of entries in the three (D, P, S) categories. The list was based on the aforementioned criteria. Leading scientists from oceanographic, environmental and ecological institutions and universities from the Baltic States were invited to participate. They were asked to add priority factors to the pressures, drivers and states selected.

Finally, of top importance were the drivers, pressures and state changes that were chosen on the basis of:

a) frequency of appearance in the datasets,
b) places in rankings/statistics.

These findings were compared with

c) results of the expert's poll.

Results and Discussion

On the basis of the poll (40 returns were obtained), the following items were chosen:

Human activities as sources of pollution (Drivers):
- urban waste (1);
- transport, shipping (2);
- agriculture (3).

Pathways for inputs (Pressures):
- rivers (1);
- direct discharges (2);
- atmospheric deposition (3).

State Changes (indicators: chemical concentrations in the biota, sediments and water)
- decrease in population density (1);
- individual effects (scope for growth, imposex, endocrine disruption) (2),
- tissue pathology (3).

The relative importance of the three most frequently chosen items for D, P and S is presented in Fig. 2. It may be noticed that the best agreement among the experts was reached on Pressures. The great diversity in their opinions is markedly visible for State changes.

Comparing these results with our assessment based on information provided by HELCOM and other aforementioned resources, one can claim that the opinions regarding drivers and pressures are consistent. In the case of "state changes," the most frequently stressed one (by external sources like the European Environment Agency) is endocrine disruption, which ranks third according to the experts participating in our poll.

After specifying Ds, Ps and Ss, there was a need to select some pollutants (substances or groups of substances) for further case study purposes. Also here, the reports from the organizations mentioned above provided priceless help. Especially useful was the list of main hazardous substances, harmful for the Baltic, provided by HELCOM. The "life cycles" of the chemicals were also considered. As a result, pesticides and heavy metals were selected as the subject of a more detailed assessment. For this purpose, information required by the DPSIR approach is given in Table 2.

According to the poll, experts chose riverine input as the main pressure or pathway. The same conclusion could be drawn by looking into data on the Baltic Sea catchment. Rivers densely cover the whole area of the catchment. When this fact is combined with information about the hot spots, it becomes obvious that rivers as a pressure cannot be neglected. Most of the industry and arable facilities are placed near a river. That is what makes rivers so important a pressure, related to the majority of human activities. Rivers are the receivers of the pretreated sewage from the industry facilities, runoff and sewage from the agricultural areas, runoff from the communication paths (transported via the combined sewage system), dry disposal washed off the roofs and other surfaces, as well as runoff from dumping grounds. Finally all of this is transported, via rivers, to the final receptor – the Baltic. Some systems of wastewater treatment are still insufficiently efficient and the quality of some of the others is poor.

On the basis of this work, it is possible to construct a full DPSIR model. Looking at the collected information, the main areas of interest – problems for the Baltic Sea may

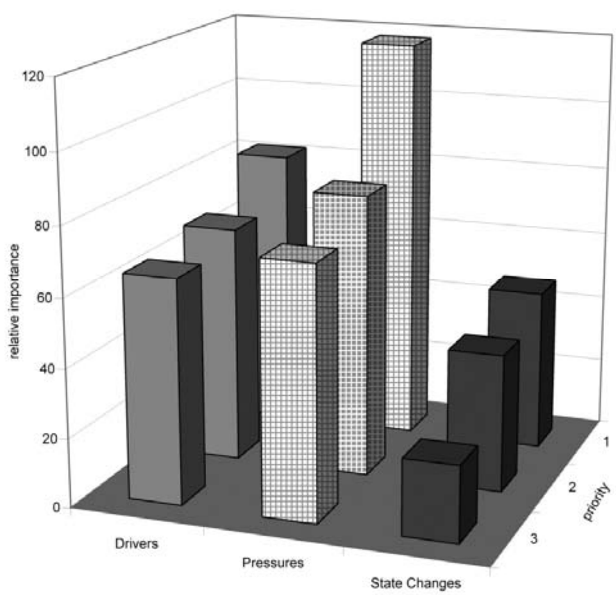

Fig. 2. Relative importance of top three Drivers, Pressures and State changes chosen in the poll. In the three categories, the "winners" are: D – urban waste (1), transport, shipping (2), agriculture(3); P – rivers (1), direct discharges (2), atmospheric deposition (3); S – decrease in population density (1), individual effects (scope for growth, imposex, endocrine disruption) (2), tissue pathology (3).

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be identified, confirming the usefulness of the DPSIR method. In light of the current situation – huge amounts of datasets are available, most of them not used properly or not used at all, there is a great need for environmental supporting tools such as DPSIR models.

The potential problems in implementation of the model may be listed as follows:

- a branched system of rivers, in connection with concentration of facilities (municipal, agricultural and industrial type) results in very efficient ways of transporting pollutants to the Baltic,
- the high fraction of arable land, especially in the southern part of the Baltic catchment, results in problems with pesticides/biocides,
- due to the poor water exchange ratio, some substances like PCB's or DDT still remain a problem, despite bans or restrictions on their usage,
- in general, the geophysical properties of the Baltic as an inland sea are the basic problem with preservation and protection of its environment, because the time the pollutants stay in the environment is relatively long, despite the actions being taken (regulations and restrictions).

The main factors considered during preparation of the metadata chart, database and selection of datasets for subsequent scenario analysis and modelling work were: availability, form of publication and quality of the data. Focusing on a few selected sources of data – for the Baltic: HELCOM, EEA, EPER and EMEP – seems to be a suitable approach. Additional information from the environmental protection ministries may also be helpful.

Conclusions

The main goal of this publication was to present a brief geophysical picture of the Baltic Sea, to identify the main chemical pollution problems regarding environmental protection, and to specify the drivers, pressures and state changes. Major pressures (urban waste), drivers (rivers) and states changes (decrease in population density) were identified for the Baltic Sea basin in two ways. Both ways – available data analysis and an experts' poll – yielded very similar results. Riverine input as the most important driver may become an issue in full implementation of a DPSIR model for the Baltic as a whole. An analysis of the individual pollutants gave an impression that some substances no longer used (like DDT – one of the pesticides) should still be considered as a threat to the environment. Generally, heavy metals and pesticides should be treated as the most dangerous pollutants in the Baltic region.

Looking at the data availability, there was a clear picture of limitation connected with access to these data. There are gaps – both spatial and temporal, in the datasets. Some organizations, both governmental and non-governmental (NGOs), make their reports available to the public, and it is done in dataset form (numerical). At this moment, HELCOM, EEA, EMEP, and EPER data and the information provided by environmental ministries are most valuable. On the other hand, a lot of data in the report format (texts, charts, with no or poor content of numerical data) exist. Both types may be useful, but once the data become the input of a DPSIR-based model, some degree of uniformity will be desirable. Also, there is a lack of measurement in different matrices (water, sediments and biota). Maybe some transport models between matrices should be taken into consideration, as a support for the DPSIR approach.

Acknowledgements

This work was supported by the European Lifestyle and Marine Ecosystem (ELME) Project (http://www.elme-eu.org), contract No. 505576, carried out within the 6th Framework Programme, SUSTDEV-2002-3.III.2.1 – Generating models of socioeconomic impacts on biodiversity and ecosystems.

We would also like to thank all the experts from the research and environment managing institutions around the Baltic who have participated in our poll, for the time spent and the valuable comments.

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