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Note that this document was submitted after the established deadline.
It will be decided by the Meeting whether the document can be discussed or is postponed to the next meeting.

Background

Assessment of contribution of different sources to the total nutrient load on the Baltic Sea is one of the major products of the HELCOM PLC assessment. Previous ranking of the sources of nutrient input to the Baltic Sea was based on 2006 data. The current assessment results were obtained from the data on source apportionment 2014 for most of the countries and 2012 for Germany and Poland.

The assessment integrates evaluation of the nutrient inputs into the Baltic Sea via three major pathways. Data on airborne deposition of nitrogen in 2014 were provided by EMEP. The airborne deposition is specified by each HELCOM member state with distinguishing of contribution by Baltic and North Sea ship traffic and by sources outside the HELCOM area. The assessment also includes data on riverine and direct inputs of nitrogen and phosphorus to the Baltic Sea in 2014 reported by countries.

Source apportionment of the riverine input, which is the major pathway for most countries except Germany, is made for 3 categories for all countries: indirect point sources, total diffuse load, and natural background. More detailed classification of the riverine input sources was made for 5 countries – Denmark, Finland, Germany, Poland and Sweden. The classification, in addition to the three above mentioned categories, also includes airborne deposition on the territory and losses from agricultural lands.

This document has ttwo annexes with diagrams illustrating input via major pathways (Annex 1) and different categories of riverine inputs (Annex 2). Annex 2 also contains maps reflecting spatial distribution of the diffuse, agricultural loads and natural background within the Baltic Sea catchment area as well as maps of industrial and municipal direct sources and sea-based aquaculture.

Action requested

The Meeting is invited to consider the draft source apportionment, provide comments on the contents of the document and its illustrative material and agree on submission of the document to HOD 53-2017 for final approval.

Draft sources and pathways of nutrient inputs to the Baltic Sea

Changes in major nutrient sources/pathways 1995-2014

Figures 1-34 of the Annex 1.

Introduction

Based on the reported major sources, riverine loads, direct point-sources, and for Nitrogen also atmospheric deposition the changes in total inputs as well as the proportion of these major sources have been evaluated for the years 1995, 2000, 2006, and 2014 (2012 for Germany and Poland). The results are illustrated as pie charts in Figures 1-34 of the Annex 1 to the chapter. Figures 1 and 18 are showing the changes in Nitrogen and Phosphorus inputs to the whole Baltic Sea, respectively. Figures 2-8 and 19-25 show the changes to the basins for N and P, respectively, and finally Figures 9-17 and 26-34 show the N and P input changes for the different HELCOM countries.

Changes in major Nitrogen sources/pathways

For the entire Baltic Sea, the total Nitrogen inputs are reduced over whole period, and it is especially the share of direct point-sources that is changing over time (Figure 1). This pattern is in common for all the basins in the Southern part of the Baltic Sea, i.e. Baltic Proper, Danish Straits, and Kattegat (Figures 6-8). The countries that display the corresponding pattern are Germany, Denmark, Poland, and Sweden, which are also the countries that dominate the inputs to these basins (Figures 9, 10, 15, and 17). A similar tendency is indicated for the Gulf of Finland (Figure 4), as well as for the two countries Finland and Russia that are mainly responsible for the inputs to the GUF (Figures 12 and 16), but the large total inputs in 2006 partly obscures the possibilities to be certain. Also, the total Nitrogen inputs to the Gulf of Riga decrease over time (Figure 5), but in this case the countries that discharge into the Gulf, Estonia and Latvia, possess quite variable total inputs for the evaluated period (Figures 11 and 13), although there is a tendency for the share of the direct point-sources decrease over time. In addition, Lithuania, discharging into the Baltic Proper, display the same tendencies as the neighbouring countries (Figure 14). For the two remaining basins, Bothnian Bay and Bothnian Sea, the total inputs are not showing any strong tendencies, although the inputs in 2014 appear to be lower than earlier years (Figures 2-3). As the inter-annual variability appear to be substantial, it is quite hard to detect any trends in the shares of the different Nitrogen pathways.

Changes in major Phosphorus sources/pathways

The overall pattern for both the total Phosphorus loads as well as for the proportion of the share of the different pathways is quite different from the patterns for Nitrogen. This is mainly due to that the focus on reduced nutrient loads to the Baltic Sea has been on Phosphorus, as the main regulating nutrient for eutrophication in the Baltic Sea (except from the more saline waters in eg. the Danish Straits and in Kattegat). However, an increased attention has been paid on Nitrogen lately.

Although the focus has been on reducing the P loads for quite a substantial time, the measures to reduce them has been implemented in different time periods in different countries, which is quite evident when comparing the total P loads, as well as the shares of the pathways (Figures 18-34). Some countries like Denmark, Finland, and Sweden started early to reduce the impact from point-sources (direct as well as inland sources) as Waste Water Treatment Plants, which implicate that these early reductions and the effect on the P loads to the Baltic Sea cannot be seen in the HELCOM data, as these measures were implemented mainly before the available time series start. In these countries, measures are nowadays more oriented to the diffuse sources like agricultural losses and scattered dwellings, as the possibilities to further reduce the emissions from WWTPs are comparatively small and quite expensive.

The main tendencies to be revealed in the evaluated period show that for the whole Baltic Sea, as well as for the majority of the basins there is a decrease in the total P loads over time (Figure 18-25), although for Bothnian Sea and the Gulf of Finland the main reduction appear in 2014 (Figures 20-21). The only basin without any obvious reduction in the total P loads is the Gulf of Riga (Figures 22). More or less the same picture is given for the country wise P loads, with general decrease for Germany, Estonia, Poland, and Sweden (Figures 26, 28, 32, and 34), an early decrease (i.e. in 1995) for Denmark (Figure 27), and a late decrease for Finland, Lithuania, and Russia (Figures 29, 31, and 33). No evident trends can be revealed for Latvia (Figure 30).

For the changes in proportions of the different pathways most countries show a decrease in the share of the direct point-sources over time, the main difference is rather how large the change is and when it occurs (Figures 26-33). The only country that do not have any clear trend in changed pathways is Sweden (Figure 34). Consequently, the share of the direct point-sources for most basins as well as the whole Baltic Sea is decreasing over the period evaluated (Figures 18-25). The only exception to this general tendency is the Bothnian Bay where there is no clear trend (Figure 19).

Sources of riverine Nitrogen and Phosphorus loads to the Baltic Sea

Figures 1-3q of the Annex 2.

Introduction

To be elaborated…

Results

In total, the natural background is about 1/3 of the loads of Nitrogen and Phosphorus to the Baltic Sea (Figure 1). This is about twice as large proportion compared to what was estimated in PLC5 (HELCOM 2011). The reason for this large difference is probably due to better estimates in the present assessment. However, there are large differences in the proportion of the natural background loads for the different Baltic Sea basins (Figures 2-8). The largest proportions are to the Gulf of Finland (68% for N, and 59% for P), and Bothnian Bay (65% for both N and P), whereas the lowest proportions are for the Gulf of Riga (12% for N, and 11% for P).

Among the anthropogenic sources, the diffuse sources, mainly from agricultural activities, constitute the major part with 46% of the total riverine Nitrogen loads to the Baltic Sea, whereas 36% of the Phosphorus loads originate from diffuse sources (Figure 1). The large differences in the amount of land utilised for agriculture as well as agricultural practices over the Baltic Sea catchment is also reflected in how much the diffuse sources contribute to the total nutrient loads (Figures 2-8). High impact is found in Gulf of Riga (57% for N, and 42% for P), and for Nitrogen also in Danish Straits (68%), and Kattegat (59%).

The point-sources are another important source for riverine nutrient loads to the Baltic Sea, and constitute 12% of the total Nitrogen loads and 24% of the Phosphorus loads (Figure 1). The variability in importance is even greater than for the other nutrient sources (Figures 2-8). The lowest impact from point-sources are found in the Gulf of Riga (1% for N, and 4% for P), but also for other basins the proportion for Nitrogen is lower than 10%, eg. Bothnian Bay (6-7%), Gulf of Finland and Kattegat (8%). High impact of point-sources is found for the Baltic Proper (18% for N, 33% for P), and for Phosphorus in the Danish Straits (43%).

However, some caution need to be taken when assessing the various riverine nutrient sources to the Gulf of Riga, as large proportions has not been possible to allocate to any specific kind of source. These loads are classified as transboundary as they originate in upstream countries, mainly Belarus (Figure 7). In total, the transboundary loads to the Gulf is 30% for Nitrogen, and 42% for Phosphorus, which increases the uncertainties in source apportionments substantially for this basin. Substantial transboundary loads are also found for the Baltic Proper with 10-11% of the nutrient loads originating in countries upstream the HELCOM countries (Figure 2).

Country-wise source apportionment

It is only with great caution that the source apportionment may be assessed at country or basin-wise, especially since the nutrient allocation modelling may vary from country to country, and do not always follow the HELCOM PLC-Water guidelines (HELCOM 2016). Detailed information on the nutrient sources has only been given by DE, DK, FI, LT, PL, and SE, whereas the other countries have reported a more generalised source apportionment has been given (Figures 9-17).

The most important **German** nutrient source for the Baltic Sea is agricultural activities that make up 63% of the Nitrogen loads, and 42% of the Phosphorus loads (Figure 9). Another important anthropogenic source, especially for P is point-sources (31%), whereas they are less important for N (10%). The natural background level is 18% for N, while it constitutes 21% of the total P loads. The atmospheric deposition is rather limited to 9% for N, and 6% for P.

The nutrient riverine inputs from **Denmark** is to a large extent dominated by agriculture (Figure 10). For Nitrogen, the diffuse loads constitute 74% of the total loads, while for Phosphorus they make up 38% of the loads. The natural background constitutes 19% for N, and 29% for P. Point-sources are very important for the P loads (33%), but less important for N (6%). The contribution of atmospheric deposition is very minor (1% for N, 0.1% for P), due to very limited amount of lake surface areas.

Total diffuse sources are the main contributor to the **Estonian** riverine nutrient loads (Figure 11). Most likely, the major part of these diffuse sources originate within agriculture. For Nitrogen they constitute 64% of the loads, whereas the corresponding proportion for Phosphorus is 75%. The natural background losses are substantial (34% for N, and 21% for P). On the other hand, point-sources are less important for the total loads (2% for N, and 4% for P). No information has been reported on the importance of atmospheric deposition.

For **Finland** the natural background loads are very important and make some 44% and 34% of the total loads for Nitrogen and Phosphorus, respectively (Figure 12). Also, the losses from agriculture are notable with 38% for N, and 53% for P. The point-sources constitute some 10% of the loads, whereas the atmospheric deposition is quite significant, especially for N (8%), and slightly less for P (3%). The comparatively high proportion for the deposition is due to the relatively high amount of lake surface areas in Finland.

The riverine nutrient loads via **Latvia** to the Baltic Sea is highly characterised by transboundary loads from upstream countries, mainly Belarus, and constitute some 37% of the Nitrogen, and 46% of the Phosphorus loads, respectively (Figure 13). These loads have not been possible to allocate to any specific sources, but it may possible to assume that agricultural activities and point-sources may be important sources in these upstream countries, as is the case in the HELCOM countries. Of the Latvian nutrient sources, the diffuse sources are heavily dominating with 53% for N, and 40% for P. Point-sources only make up a small share of the total riverine loads (0.5% for N, 2% for P). No information has been reported on the importance of atmospheric deposition.

The transboundary loads are very important for the **Lithuanian** total nutrient loads to the Baltic Sea (Figure 14), similar to Latvia with Belarus as an important source outside the HELCOM countries. Transboundary Nitrogen loads constitute 25% of the total loads via Lithuania, whereas the corresponding proportion for

Phosphorus is 34%. Also in this case it has been impossible to allocate these loads to any specific sources, but again it may possible to assume that agricultural activities and point-sources may be important sources in these upstream countries, as is the case with the HELCOM countries. Agricultural activities are the major nutrient source for the total Lithuanian loads with 56% for N, and 42% for P. The natural background levels are 12% for N, and 11% for P, whereas point-sources represent 4% the N loads, and 13% of the P loads. Atmospheric deposition only constitutes a smaller fraction of the total nutrient loads (2% for N, and ?? for P).

The nutrient loads from **Poland** are characterised by comparatively large proportions of agricultural loads and loads from point-sources (Figure 15). For Phosphorus, the share from point-sources are even larger than from agriculture (42%, and 34%, respectively). For Nitrogen, the situation is the contrary with 31% from point-sources, and 45% from agricultural activities. The natural background is 16% for N, and 18% for P, whereas the proportion of atmospheric deposition is quite small (3% for N, 1% for P). A rather small fraction of the total loads originates in upstream countries, and these transboundary loads constitute 4-5% of the total loads that reach the Baltic Sea via Poland.

The **Russian** riverine nutrient loads to the Baltic Sea has been reported to mainly consist of natural background losses (Figure 16). In total 83% of the Nitrogen loads are considered to have a natural origin, and the corresponding proportion for Phosphorus is 65%. Of the anthropogenic sources are diffuse sources dominating with 10% for N, and 21% for P, whereas point-sources constitute 6% of the N loads, and 14% of the P loads. No information has been reported on the importance of atmospheric deposition.

The nutrient loads from **Sweden** are to a large degree characterised by a large proportion of natural background losses (Figure 17) with about 54% of the total nitrogen loads, and 66% of the Phosphorus loads. Of the anthropogenic nutrient sources, agriculture and point-sources constitute 25%, and 11% for the total N loads, and 14%, and 16% respectively for the P loads. Atmospheric deposition is important in comparison to most other HELCOM countries, especially for N (10% of total loads), but also for P (4%). The comparatively large impact from the deposition is due to the quite high share of lake surface area in Sweden (approx. 10% of the total land area).

Spatial distribution of nutrient sources to the Baltic Sea

The dominating sources for riverine nutrient loads to the Baltic Sea belong to the diffuse sources. As these sources to a very large degree are dominated by agricultural nutrient losses, there is a very large similarity in the geographical distribution of area-specific Nitrogen and Phosphorus losses from diffuse sources and agriculture (Figures 18-21), as well as compared to the total riverine area-specific losses (Figures 22-23). The highest area-specific losses are found in the South-Southwestern part of the Baltic Proper, the Kattegat, as well as the Eastern part of the Baltic Proper, to the Gulf of Riga and Gulf of Finland. Also the Finnish comparatively small rivers draining to the Bothnian Sea and Bothnian Bay constitute rather high area-specific losses. However, when comparing spatial distributions of area-specific losses, it is important to bear in mind that the size of the catchment area is important as for large water systems eventual hot-spots may be "diluted" if they are incorporated in large areas with less nutrient inputs. This is quite evident when comparing the Finnish rivers draining to the West (Bothnian Sea and Bothnian Bay) and the small rivers draining to the Gulf of Finland, with the larger river systems draining to the Gulf. Also, when comparing the area-specific losses in Finland with the corresponding losses from the considerably larger Swedish rivers to the Bothnian Sea and the Bothnian that, like the Finnish rivers systems, are dominated by nutrient loads from large forested areas considered to be close to natural background levels (Figures 24-25).

The nutrient loads from direct point-sources are to a very large degree dominated by municipal waste water treatment plants (MWWTs), although rather large industrial point-sources exist, especially along the Swedish coast as well as to some degree along the Finnish coast (Figures 26-27). Comparatively many and smaller MWWTs are found along the Finnish, Swedish, and Danish coastlines, whereas the other HELCOM countries mainly have a few larger plants in connection to large coastal cities (Figures 28-29). Nutrient loads from aquacultural activites mainly have an impact in Finland (Åland archipelago/Archipelago Sea), Denmark, and to some extent in Sweden (Figures 30-31).