HELCOM — ENVIRONMENT FOCAL POINT INFORMATION

Estimation of atmospheric nitrogen deposition to the Baltic Sea in 2010 based on agreed emission ceilings under the EU NEC Directive and the Gothenburg Protocol: Executive Summary

Helsinki Commission

Baltic Marine Environment Protection Commission

Authors: Jerzy Bartnicki and Maarten van Loon
Meteorological Synthesizing Centre – West of EMEP
Norwegian Meteorological Institute
P.O. Box 43, N-0313 Oslo, Norway

Coverpage photo: Liudmila Romaniyk

Published by: Helsinki Commission
Katajanokanlaituri 6 B, FI-00160 Helsinki, Finland
Internet: www.helcom.fi

Background

In March 2005, HELCOM 26/2005 considered airborne nitrogen pollution (Document HELCOM 26/2005, 3/5) and decided to include atmospheric nitrogen deposition in the ongoing HELCOM Project “Assessment of implications of different policy scenarios on nutrient inputs”, which currently only covers waterborne nitrogen inputs to the Baltic and their effect in the Baltic Sea. The aim of this project is to use the MARE model to assess scenarios on nutrient inputs and the resulting eutrophication status in order to indicate the most cost-effective measures to be undertaken in the different sub-regions of the Baltic Sea.

HELCOM 26/2005 agreed that EMEP (the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe) should be tasked to assess the changes in the size of the atmospheric nitrogen deposition in relation to the fulfilment of the targets for nitrogen in the Gothenburg Protocol to the UN/ECE Convention on Long-range Transboundary Air Pollution (CLRTAP) and the EU NEC Directive (Directive 2001/81/EC on National Emission Ceilings for Certain Atmospheric Pollutants) and/or the levels anticipated to be achieved in 2010.

The results are intended to be used as input to the updating of the programmes under the EU NEC Directive in the Member States in 2006 and proposals for the possible modification of the EU NEC Directive in 2008, as well as in the revision of the Gothenburg Protocol.

Based on the above decision at HELCOM 26/2005, EMEP has estimated the atmospheric nitrogen deposition to six sub-basins and catchment areas of the Baltic Sea in the year 2010. The calculations have been made based on three scenarios:

1) using emission projections according to agreed emission ceilings under the EU NEC Directive and the Gothenburg Protocol and Entec projections for shipping,

2) 2) as Scenario 1, but 10% lower emissions, and

3) 3) a so-called “Current Legislation” (CLE) Emission Scenario estimating emissions achieved by the implementation of current standards in each country by the RAINS (Regional Air Pollution Information and Simulation) model developed at IIASA (International Institute for Applied Systems Analysis).

The complete report is available on the HELCOM website at: http://www.helcom.fi/publications/en_GB/publications/ .

Nitrogen emissions

Approximately one quarter of the total nitrogen input into the Baltic Sea comes from airborne nitrogen deposited directly into the sea. In addition to direct deposition, some of the nitrogen deposited into the Baltic Sea catchment area reaches the sea via runoff from land. Furthermore, distant sources outside the Baltic Sea catchment area account for almost 40% of the total airborne deposition of nitrogen and this should be considered when evaluating possible further developments and the adequacy of measures taken to reduce airborne nitrogen pollution.

Nitrogen compounds are emitted into the atmosphere as nitrogen oxides and ammonia. Shipping, road transportation, and energy combustion are the main sources of nitrogen oxide emissions in the Baltic Sea region. In the case of ammonia, roughly 90% of the emissions originate from agriculture. Agriculture is the most significant contributor of total airborne nitrogen, accounting for more than 40% of total air emissions of nitrogen from the HELCOM Contracting Parties.

Although reductions of nitrogen oxides were achieved by 2003, the emission ceilings of the Gothenburg Protocol to the UN/ECE CLRTAP and the EU NEC Directive for 2010 may be difficult to achieve for some of the Contracting Parties, especially Germany, Denmark, Finland, and Sweden. Most of these countries have difficulties in decreasing traffic emissions. In contrast, Estonia, Latvia, Lithuania, Poland, and the Russian Federation have already reached the required emission levels.

Regarding ammonia, especially Denmark, Finland, and Germany may have problems to achieve the targets required by the Gothenburg Protocol to the UN/ECE CLRTAP and the EU NEC Directive. Finland was quite close to the target level in 2003 and the other HELCOM Contracting Parties have already achieved the reduction requirement, some by far.

The total estimated nitrogen emission levels in 2010 according to Scenario 1 will increase by approximately 4% compared to 2003 from HELCOM Contracting Parties, although nitrogen oxide emissions are expected to decline by 5%. The same trend can be observed for the whole EMEP area. The ship emissions are expected to increase by 20% according to Entec projections.

The CLE emission Scenario for 2010 has been developed in the frame of CAFE (Clean Air For Europe) project. Comparison of the CLE Scenario with the targets set by the Gothenburg Protocol and NEC Directive indicates that four countries can have a potential problem reaching 2010 to implement the requirements: Denmark, Germany Sweden and Russia.

Deposition to the Baltic Sea

According to the deposition scenarios, the total nitrogen depositions to the Baltic Sea will be higher in 2010 than in 2003 even if the targets in the Gothenburg Protocol and NEC Directive are achieved. The deposition in the CLE-scenario will be somewhat lower that the deposition in 2003. The results also show that there are some differences in the development of nitrogen oxide and ammonia depositions. Nitrogen oxide depositions are projected to decrease in large parts of the Baltic Sea, whereas the ammonia depositions are expected to be higher in 2010 compared to 2003.

These results follow the differences in the anticipated development in the scenarios of nitrogen oxide and ammonia emissions from 2003 until 2010 (as explained above), where the total nitrogen oxide emissions in the scenarios will decrease, whereas the ammonia emissions will increase during this period. The results also show that ammonia depositions are more important in the southern sub-basins of the Baltic Sea compared to northern parts of the Baltic. This is due to the fact that ammonia emissions, which mainly originate from agriculture, are not transported as far as nitrogen oxides.

Table 1. Comparison of annual total nitrogen deposition on the Baltic Sea basins for the CLE Scenario, Scenario 1, Scenario 2, and 2003 deposition. Units: kilotonnes N/year. The lowest depositions for each catchment area are highlighted. (See Section 1.1 for a description of the abbreviations.)

Deposition	**GUB**	**GUF**	**GUR**	**BAP**	**BES**	**KAT**	**Baltic Sea**
2003	34.8	12.4	9.2	121.6	20.3	19.0	217.4
Scenario 1	33.7	15.0	11.0	127.0	19.9	16.6	223.1
Scenario 2	30.6	13.7	9.9	114.8	17.9	15.0	201.9
CLE scenario	33.3	13.5	9.5	120.8	21.0	17.8	215.9

For all three scenarios, there are three major emission sources contributing to the deposition into all sub-basins of the Baltic Sea: Poland, Germany, and ship emissions from Baltic Sea traffic. Poland is the largest contributor to nitrogen deposition in two sub-basins: the Gulf of Riga and the Baltic Proper, and is also the largest contributor to the entire basin of the Baltic Sea. Finland, Estonia, Germany, and Denmark are the largest contributors to nitrogen deposition in the following sub-basins: Gulf of Bothnia, Gulf of Finland, Belt Sea, and Kattegat, respectively. Emissions from Baltic Sea shipping, based on Entec projections, are always present at the top of the ranking for all sub-basins of the Baltic Sea.

It can be also noted that a significant contribution to nitrogen deposition in the sub-basins of the Baltic Sea comes from relatively distant sources. The most important distant emission sources are the United Kingdom and ship emissions from traffic in the North Sea. The results show the great significance of the development of emissions especially in Poland, Denmark, Germany, Ukraine and Lithuania. Poland and Lithuania have already reached the targets, whereas Denmark and Germany still are still quite far from the targets. The significance of emissions from Ukraine is expected to increase. The contribution from Ukraine, which is the ninth largest source, is larger than the contribution from Lithuania, Finland, Latvia, or Estonia. The contributions from France and Belarus are also significant, being the eleventh and thirteenth largest polluters, respectively.

For all catchment areas, there is a significant contribution to nitrogen deposition from ship traffic on the Baltic Sea; however, the contribution to the Belt Sea and Kattegat sub-basins is larger from the ship traffic on the North Sea. According to the scenarios the importance of the ship emissions on the development of the deposition will not be as significant compared to the foreseen development in the above-mentioned individual countries.

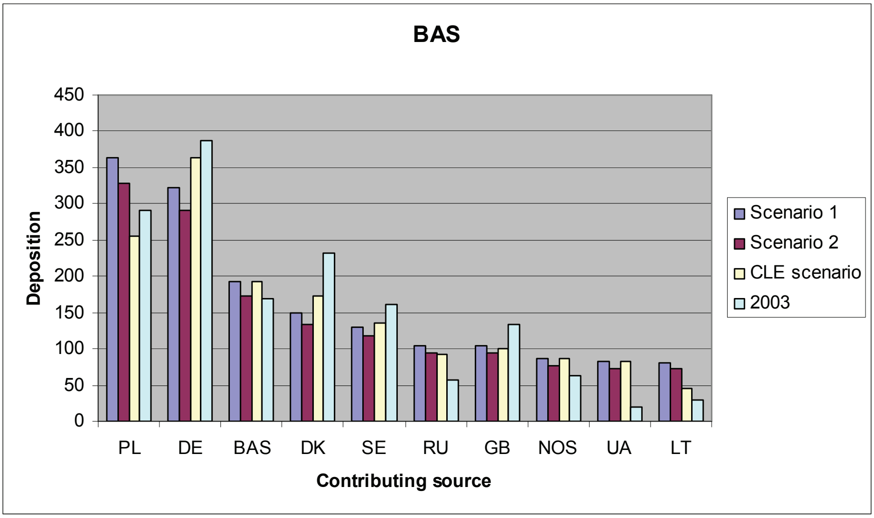

Figure 1. The main emission sources contributing to total nitrogen depositions in the entire basin of the Baltic Sea according to Scenario 1, Scenario 2, the CLE scenario and 2003 data. Unit: 100 tonnes N per year.

Uncertainty due to variable meteorological Conditions

Because meteorological conditions for the year 2010 are not known, nitrogen depositions in 2010 were calculated using meteorological input data from four different past years: 1996, 1997, 1998, and 2000, which were available in the EMEP database. Final deposition values for 2010 were calculated as an average over the four selected years.

A comparison of annual total nitrogen deposition to each catchment area of the Baltic Sea is given in Table 2. There is a large variability in the depositions calculated based on the different meteorology in the four years. This variability can be expressed as the relative range calculated as the difference between the maximum and the minimum deposition in percent of the mean value. The largest variability, 50%, can be observed for the Gulf of Bothnia catchment area and the smallest, 6%, for the Gulf of Riga catchment area. The relative range of the deposition is 18% for the entire catchment area of the Baltic Sea. The relative ranges for the sub-basins of the Baltic Sea are in general larger (22% to 60%) than those for the catchment areas. The relative range for the entire basin of the Baltic Sea is 33%.

Table 2. Comparison of annual total nitrogen deposition to the catchment areas of the Baltic Sea calculated for Scenario 1 based on different annual meteorology. Units: kilotonnes N/year. The lowest depositions for each catchment area are highlighted.

Meteorology	GUB	GUF	GUR	BAP	BES	KAT	Baltic Sea
1996	26.9	13.9	10.0	114.1	17.0	13.9	195.9
1997	22.4	10.9	8.8	94.5	15.6	13.0	165.1
1998	32.1	14.1	9.9	123.7	19.4	15.2	214.6
2000	40.9	15.8	11.0	126.9	19.5	17.8	232.0
Mean	**30.6**	**13.7**	**9.9**	**114.8**	**17.9**	**15.0**	**201.9**

The relative ranges computed for the sub-basins and catchment areas of the Baltic Sea indicate a relatively large uncertainty due to meteorological variability in computed depositions for the year 2010. This uncertainty is at least of the same order as the uncertainty of projected emissions for 2010. For example, assuming 2010 nitrogen emissions as in Scenario 1, nitrogen deposition to the Baltic Sea catchment area can vary between 165 kt N and 232 kt N, depending on meteorological conditions.

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