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

April 2006

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

Contents

Acknowledgements

In this note, the authors present the results of a joint project between HELCOM and the Norwegian Meteorological Institute (met.no). The project was financed by HELCOM. The authors would like to thank Mr. Kaj Forsius from HELCOM for his support and help concerning this project, Ms. Janek Pawlak for checking the language and to our colleagues from MSC-W of EMEP in Oslo for cooperation.

EXECUTIVE SUMMARY

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

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.

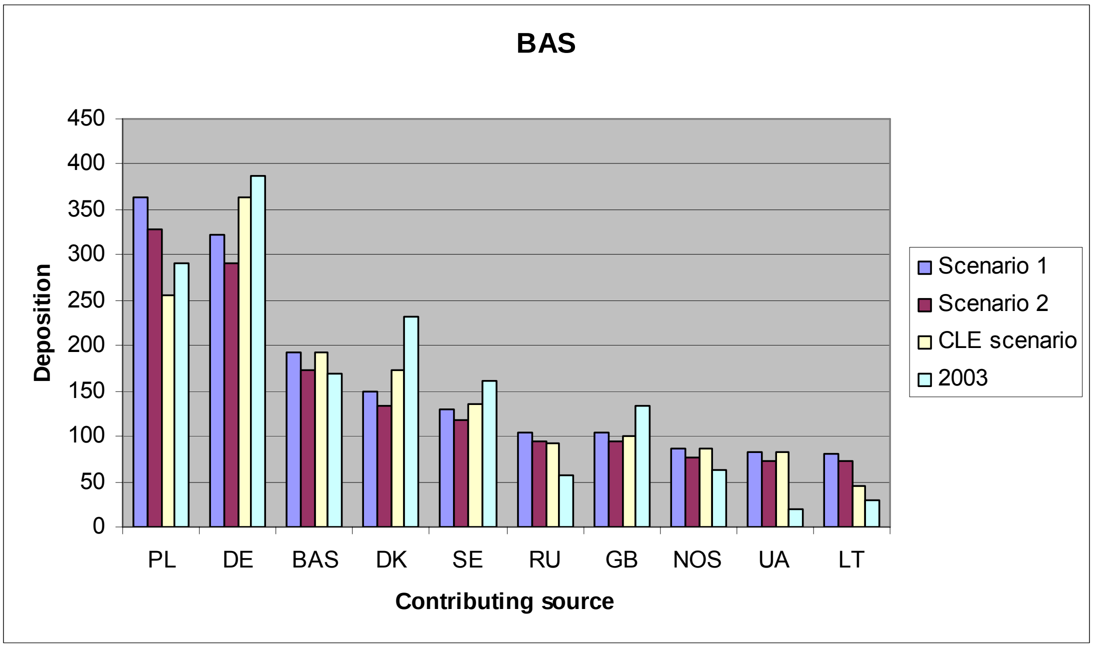


Figure 1. The main emission sources contributing to total nitrogen depositions in the entire basin of the Baltic Sea according to Scenario 1, Scenario 2, the CLE scenario and 2003 data. Unit: 100 tonnes N per year.

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 abovementioned individual countries.

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.

1. INTRODUCTION

HELCOM Heads of Delegation (HOD) 16/2004 established a project using models to assess the implications of different policy 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.

Most of the models considered in the work of HELCOM have so far comprised ecological models related to the assessment of effects in the sea. The bases of the effects models are scenarios of activities on land. Therefore, the aim is to link management scenario models with ecological models in order to assess the focus of measures in future work to reduce nutrient inputs.

The aim of the project is to assess the impact of different agricultural policy scenarios in HELCOM Contracting Parties on nutrient inputs in the Baltic Sea catchment area and on the eutrophication status of the Baltic Sea. The final aim is to enable the identification of cost-effective measures in the different parts of the Baltic Sea catchment area required to achieve good ecological status throughout the Baltic Sea area.

To do this, MARE incorporates the catchment area model in NEST and evaluates the effectiveness regarding inputs, concentrations of nutrients, and selected biological quality parameters in the Baltic Sea as well as the costs of the scenarios.

In March 2005, HELCOM 26/2005 considered airborne nitrogen pollution (Document HELCOM 26/2005, 3/5) and decided to include atmospheric nitrogen depositions to the ongoing HELCOM Project "Assessment of implications of different policy scenarios on nutrient inputs", which at that time only covered waterborne nitrogen inputs to the Baltic and their effects in 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 based on 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 foreseen to be achieved for 2010.

The results hereof should be used as input to the updating of the programmes under the EU NEC Directive in the Member States in 2006 and for proposals for possible modifications to the EU NEC Directive in 2008 (as well as in the revision of the Gothenburg Protocol).

Based on the above decision at HELCOM 26, EMEP received a project from HELCOM with the aim of estimating atmospheric nitrogen deposition to six sub-basins and catchment areas of the Baltic Sea in the year 2010, using emission projections according to the agreed emission ceilings under the EU NEC Directive and the Gothenburg Protocol.

1.1 Sub-basins and catchment areas of the Baltic Sea

As requested by HELCOM, all depositions, as well as source allocation budgets, presented in this report have been calculated for the six sub-basins and catchment areas of the Baltic Sea. The names and acronyms of these regions, as often used in this report, are:

1. Gulf of Bothnia (GUB),
2. Gulf of Finland (GUF),
3. Gulf of Riga (GUR),
4. Baltic Proper (BAP),
5. Belt Sea (BES),
6. The Kattegat (KAT).

Depositions and source allocation budgets have also been calculated for the entire basin and for the entire catchment area of the Baltic Sea. The sub-basins and catchment areas used in the computations are shown in Figure 1.1.

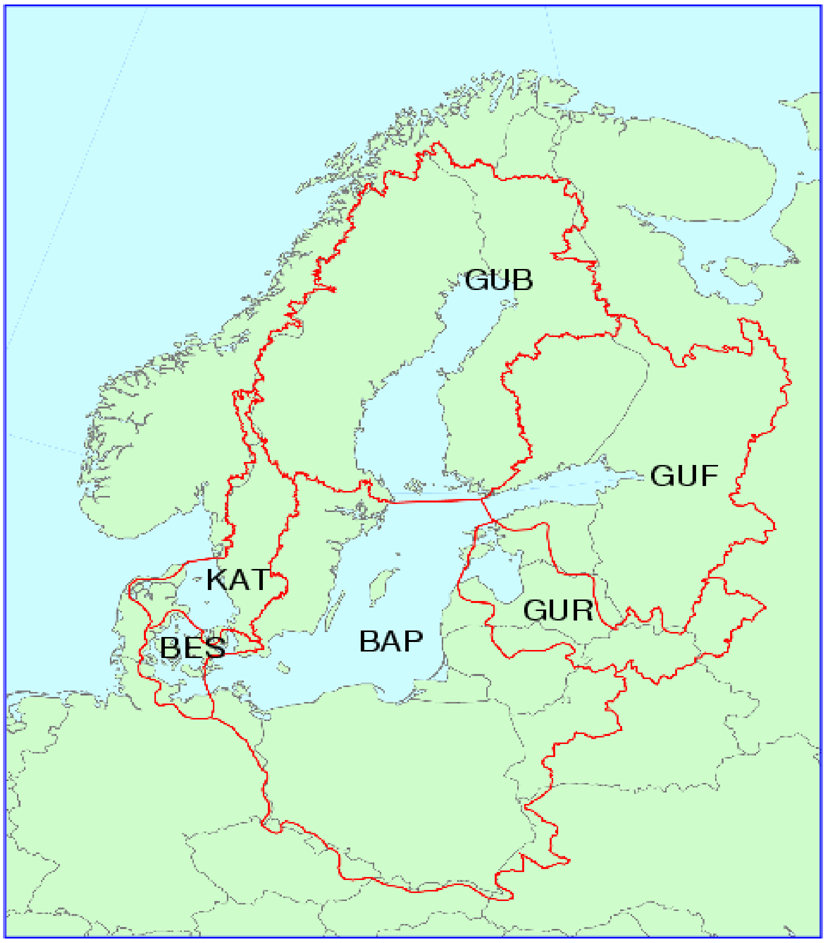


Figure 1.1. The six sub-basins and catchment areas of the Baltic Sea for which the computations presented in this report have been made.

1.2 Country and area codes used in this report

The codes used for EMEP Parties and other sources and areas of interest to EMEP (e.g., European seas) are given in Table 1.1. These codes are used in several places in this report, especially when presenting the results of source-receptor computations.

Table 1.1. Country/region codes for nitrogen emitters and other sources and areas of interest to EMEP used in the report.

AL	Albania	**ATL**	Remaining NE Atlantic Ocean
AT	Austria	**MED**	Mediterranean Sea
BE	Belgium	**BLS**	Black Sea
BG	Bulgaria	**NAT**	Natural marine sources
DK	Denmark	**BY**	Belarus
FI	Finland	**UA**	Ukraine
FR	France	**MD**	Moldova, Republic of
GR	Greece	**EE**	Estonia
HU	Hungary	**LV**	Latvia
IS	Iceland	**LT**	Lithuania
IE	Ireland	**CZ**	Czech Republic
IT	Italy	**SK**	Slovakia
LU	Luxembourg	**SI**	Slovenia
NL	Netherlands	**HR**	Croatia
NO	Norway	**BA**	Bosnia and Herzegovina
PL	Poland	**CS**	Serbia and Montenegro
PT	Portugal	**MK**	Macedonia, Former Yugoslav Rep.
RO	Romania	**KZ**	Kazakhstan
ES	Spain	**GE**	Georgia
SE	Sweden	**CY**	Cyprus
CH	Switzerland	**AM**	Armenia
TR	Turkey	**MT**	Malta
GB	United Kingdom	**ASI**	Remaining Asiatic areas
REM	Remaining Land Areas	**DE**	Germany
BAS	Baltic Sea	**RU**	Russian Federation
NOS	North Sea	**NOA**	North Africa

1.3 Tasks for EMEP in the project

Co-operation between EMEP and HELCOM was established already in 1996. Since then, three EMEP Centres have been preparing joint reports estimating the annual supply of nitrogen, heavy metals, and persistent organic pollutants (POPs) to the Baltic Sea. Presentations of updated emissions, as well as the results of measurements and their analysis, are also included in the annual report. Such an annual report has also been prepared for HELCOM in 2005 (Bartnicki et al., 2005).

The updated estimation and assessment of the current situation concerning the deposition of nitrogen, heavy metals, and POPs to the Baltic Sea is the subject of joint EMEP reports for HELCOM. The main focus of the present project is on future depositions resulting from specific emission scenarios projected for 2010. The following tasks were given to EMEP in the framework of this project:

1. Scenario 1: Update and compilation of nitrogen dioxide and ammonia emissions in 2010 for all EMEP sources following the Gothenburg Protocol, the EU NEC Directive, and Entec projections for shipping emissions.

2. Scenario 2: As for Scenario 1, but with 10 % lower emissions.

3. For both scenarios: Calculation of the atmospheric transport and deposition (wet, dry, oxidized, reduced, and total) of nitrogen for the evaluation of nitrogen loads to six sub-basins and catchment areas of the Baltic Sea in 2010. Calculations will be performed for four different years to take into account inter-annual meteorological variation.

4. For both scenarios: Computations of source allocation budgets for nitrogen deposition in 2010 to six sub-basins and catchment areas of the Baltic Sea on a country basis. Calculations will be performed for four different years to take into account inter-annual meteorological variation.

5. Summary report of results. Transfer of electronic data with results to HELCOM.

The results of this project are described and discussed in this report. Nitrogen depositions in 2010 and source allocation budgets for the same year were obtained by scaling the results of the EMEP model runs for 2010 performed originally with the so-called “Current Legislation” (CLE) Emission Scenario. The CLE emissions were developed at the International Institute for Applied Systems Analysis (IIASA) as emissions to be achieved by the implementation of current standards in each country as estimated by the RAINS model. These emissions have been used as the current EMEP projections for 2010 (Tarrasson et. al., 2005) and both the CLE Emission Scenario and the model results from these scenarios are presented and discussed in this report.

1.4 Meteorological data

In order to estimate atmospheric nitrogen depositions in 2010, both projected emissions data for this year as well as meteorological data are necessary. Meteorological fields are updated every three hours during EMEP model runs. In the case of the forecast for 2010, historical meteorological data must be used. In this study, the authors have used meteorological data for the years 1996, 1997, 1998, and 2000. Estimated nitrogen deposition was calculated as the average over the four meteorological years.

Recently, meteorological fields for the year 2003 have also become available at MSC-W of EMEP, but they were not yet available when the calculations presented in this report were performed. Therefore, the meteorological year 2003 was not included in the computations presented here.

2. NITROGEN EMISSION PROJECTIONS FOR 2010

As requested by HELCOM, the implications of two emission scenarios for 2010 were investigated first in this study.

Scenario 1 assumes the nitrogen oxides and ammonia national emissions as specified in the NEC Directive (NEC, 2001) for fifteen EU countries. The nitrogen oxides and ammonia national emissions as specified in the Gothenburg Protocol (ECE/EB/AIR/85, 2004) are assumed for all countries listed there except those already mentioned in the NEC Directive. Emissions for the Russian Federation and Estonia are taken from a HELCOM publication (HELCOM, 2005). Finally, 2010 projections of nitrogen emissions from the international ship traffic on the Europeans seas are taken from the EMEP database following Entec projections (Entec, 2002). All remaining emission sources of nitrogen are taken from the EMEP database (Tarrason et al., 2005).

In Scenario 2, nitrogen oxides and ammonia annual total emissions for 2010 as specified in Scenario 1 are reduced for the sources listed in the NEC Directive and the Gothenburg Protocol, as well as for the Russian Federation, Estonia, and the European seas. For the remaining EMEP sources, nitrogen oxides and ammonia emissions are the same as in Scenario 1.

In addition, a so-called “Current Legislation” (CLE) Emission Scenario for 2010 is also presented and analysed as an additional contribution from EMEP. The CLE emissions were developed at IIASA as emissions to be achieved by the foreseen implementation of current standards in each country as estimated by the RAINS model.

2.1 National emission ceilings according to the EU Directive

National emission ceilings for nitrogen oxides (units: kt of NO_2 per year) and ammonia (units: kt of NH_3 per year) emissions for 2010, according to EU Directive 2001/81/EC (NEC, 2001), are shown in Table 2.1.

The national emission ceilings presented in Table 2.1 have been designed with the aim of broadly meeting the interim environmental objectives set out in Article 5 of the Directive. Meeting those objectives is expected to result in a reduction of soil eutrophication to such an extent that the Community area with depositions of nutrient nitrogen in excess of the critical loads will be reduced by about 30% compared with the situation in1990.

Among EU 15 countries, the United Kingdom (1167 kt NO_2) and Germany (1051 kt NO_2) are the main projected emitters for 2010. For ammonia, France (780 kt NH_3) and Germany (550 kt NH_3) are the main sources.

During the accession process, national emission ceilings for Latvia were reduced to 61 kt NO_2. This latest value for Latvia (HELCOM, 2005) and the nitrogen emissions shown in Table 2.1 were used in Scenario 1 for the EMEP model run. The same emission sources are also considered in the Gothenburg Protocol; however, the NEC emissions of nitrogen oxides and ammonia projected for 2010 are lower than or the same as those projected by the Gothenburg Protocol presented in the next section.

Table 2.1. National emission ceilings of nitrogen oxides (units: kt of NO_2 per year) and ammonia (units: kt of NH_3 per year) for 2010, according to EU Directive 2001/81/EC.

Country	NO_x	NH_3
Austria	103	66
Belgium	176	74
Denmark	127	69
Finland	170	31
France	810	780
Germany	1051	550
Greece	344	73
Ireland	65	116
Italy	990	419
Luxembourg	11	7
Netherlands	260	128
Portugal	250	90
Spain	847	353
Sweden	148	57
UK	1167	297
EU 15	**6519**	**3110**

2.2 National emission ceilings according to the Gothenburg Protocol

The national emission ceilings for nitrogen oxides and ammonia specified in the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone agreed in Gothenburg, Sweden on 30 November 1999 (ECE/EB/AIR/85, 2004) are shown in Table 2.2.

For the Russian Federation, the Protocol specifies only the emission ceilings for the so-called Pollutant Emissions Management Area (PEMA). In the EMEP domain, nitrogen oxides and ammonia emissions projected for 2010 are 2653 kt NO_2 and 1179 kt NH_3, respectively.

Compared to emission levels in 1990, the main reductions of nitrogen oxides emissions should occur in the Czech Republic (61%), Germany (60%), Sweden (56%), and United Kingdom (56%). The main reductions of ammonia emissions in 2010 compared to 1990 are expected in Denmark (43%), Netherlands (43%), Slovakia (37%), and Czech Republic (35%).

Table 2.2. National emission ceilings of nitrogen oxides (units: kt of NO_2 per year) and ammonia (units: kt of NH_3 per year) for 2010, according to the 1999 Gothenburg Protocol.

Party	Nitrogen oxides	Ammonia
Armenia	46	25
Austria	107	66
Belarus	255	158
Belgium	181	74
Bulgaria	266	108
Croatia	87	30
Czech Republic	286	101
Denmark	127	69
Finland	170	31
France	860	780
Germany	1081	550
Greece	344	73
Hungary	198	90
Ireland	65	116
Italy	1000	419
Latvia	84	44
Liechtenstein	0.37	0.15
Lithuania	110	84
Luxembourg	11	7
Netherlands	266	128
Norway	156	23
Poland	879	468
Portugal	260	108
Republic of Moldova	90	42
Romania	437	210
Russian Federation PEMA	265	49
Slovakia	130	39
Slovenia	45	20
Spain	847	353
Sweden	148	57
Switzerland	79	63
Ukraine	1222	592
United_Kingdom	1181	297
European Community	**6671**	**3129**

After the Russian Federation, the United Kingdom (1181 kt NO_2) and Germany (1081 kt NO_2) are the main projected emitters for 2010, according to the Protocol. In the case of ammonia, Ukraine (592 kt NH_3) and Germany (550 kt NH_3) are the main sources, after the Russian emissions.

2.3 Nitrogen emission projections used for Scenario 1, Scenario 2, and CLE Scenario

National annual total emissions of nitrogen oxides and ammonia used in the model runs in this study are shown in Table 2.3 for both scenarios as well as for the CLE Scenario. Nitrogen emissions from the HELCOM Contracting Parties and from the Baltic Sea are highlighted in yellow in Table 2.3.

2.3.1 Scenarios 1 and 2

All anthropogenic sources in the EMEP area have been taken into account in Table 2.3.

The numbers in Table 2.3 are based on total emission targets for each country, including areas outside the Baltic catchment area, which explains the large figures for, e.g., Russia and Germany. Not all emissions in the Contracting Parties end up in the Baltic Sea. In Scenario 1, the total nitrogen oxides emission target in the EMEP area is approximately 19.5 million tonnes of NO_2, whereas the total ammonia emission target in the EMEP area is slightly above 7 million tonnes of NH_3. Compared to Scenario 1, emission reductions in all EMEP sources in Scenario 2 are 9.2% and 8.7% for nitrogen oxides and ammonia, respectively.

The total nitrogen oxides emissions targets and ammonia emissions targets in the HELCOM Contracting Parties in Scenario 1 are estimated to be 5.3 million tonnes of NO_2 and 2.5 million tonnes of NH_3, respectively.

Rankings of the twenty largest EMEP emission sources of nitrogen oxides and ammonia in 2010, according to Scenario 1, are shown in Figure 2.1.

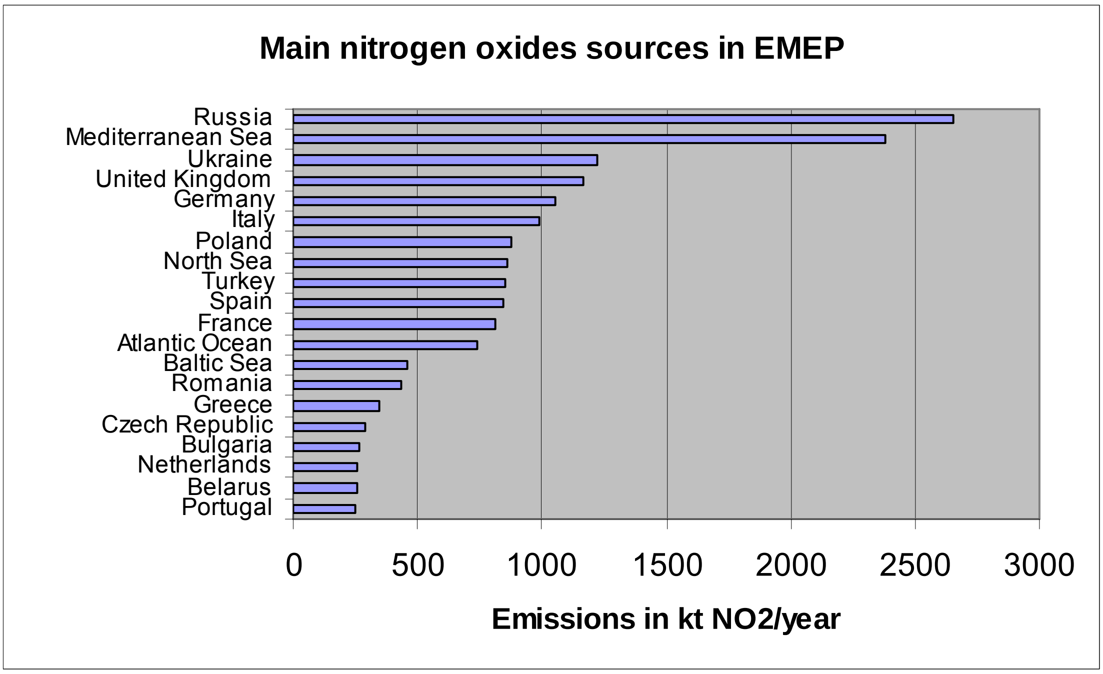
According to the set ceilings and the estimated emissions, the Russian Federation and ship traffic on the Mediterranean Sea are the largest emitters among EMEP sources of nitrogen oxides in 2010, at 2653 kt NO_2 and 2383 kt NO_2, respectively. These first two sources are approximately 50% larger then the next sources on the list: Ukraine (1222 kt NO_2), United Kingdom (1167 kt NO_2), Germany (1051 kt NO_2), and Italy (990 kt NO_2).

The Russian Federation (1179 kt NH_3), France (780 kt NH_3), Ukraine (592 kt NH_3), and Germany (550 kt NH_3) belong to the four countries with the highest ceilings and are the projected four main emitters among EMEP sources of ammonia in 2010. The emission targets for the rest of the countries' sources are much lower, with Poland (550 kt NH_3) and Italy (468 kt NH_3) taking the fifth and sixth places, respectively.

The rankings of the projected national total emissions of nitrogen oxides and ammonia among the HELCOM Contracting Parties (and the Baltic Sea) in 2010 according to Scenario 1 are shown in Figure 2.2.

Table 2.3. National annual total emissions of nitrogen oxides (units: kt of NO_2 per year) and ammonia (units: kt of NH_3 per year) projected for 2010 as used in three scenarios investigated in this study. Nitrogen emissions from the HELCOM Contracting Parties and from the Baltic Sea are highlighted.

Emitter	Scenario 1		Scenario 2		CLE Scenario	
	NOx	NH3	NOx	NH3	NOx	NH3
Albania	27.9	25.9	27.9	25.9	27.9	25.9
Armenia	46.0	25.0	41.4	22.5	13.0	25.0
Austria	102.9	66.2	92.6	59.6	159.9	56.1
Azerbaijan	43.0	25.0	43.0	25.0	43.0	25.0
Baltic Sea	457.5	0.0	411.8	0.0	457.5	0.0
Belarus	254.9	157.8	229.4	142.0	270.9	146.8
Belgium	176.1	74.4	158.5	66.9	232.2	79.4
Black Sea	154.8	0.0	139.3	0.0	154.8	0.0
Bosnia and Herzegovina	54.0	17.3	54.0	17.3	54.0	17.3
Bulgaria	265.5	107.6	238.9	96.8	146.7	123.5
Croatia	97.3	30.1	87.6	27.1	94.3	33.1
Cyprus	21.1	6.3	21.1	6.3	21.1	6.3
Czech Republic	286.1	101.4	257.5	91.3	187.1	68.3
Denmark	126.7	69.3	114.1	62.3	146.7	81.3
Estonia	59.0	28.4	53.1	25.5	27.6	10.8
Finland	170.3	30.8	153.3	27.7	151.3	33.8
France	810.3	780.3	729.3	702.3	1089.4	733.3
Georgia	30.0	97.0	30.0	97.0	30.0	97.0
Germany	1051.2	549.8	946.1	494.8	1182.1	623.7
Greece	344.5	72.5	310.0	65.2	266.4	53.6
Hungary	198.4	89.5	178.6	80.5	135.3	82.5
Iceland	30.0	3.0	30.0	3.0	30.0	3.0
Ireland	65.0	115.8	58.5	104.2	99.0	128.8
Italy	990.1	418.8	891.1	376.9	1006.1	420.8
Kazakhstan	50.2	19.0	50.2	19.0	50.2	18.0
Latvia	60.8	43.8	54.7	39.4	28.9	13.9
Lithuania	110.4	84.4	99.4	75.9	41.2	55.2
Luxembourg	11.0	7.1	9.9	6.4	28.1	6.1
Macedonia	40.6	14.7	40.6	14.7	40.6	14.7
Malta	5.9	1.4	5.9	1.4	5.9	1.4
Mediterranean Sea	2382.8	0.0	2144.5	0.0	2382.8	0.0
Moldova, Republic of	90.6	41.6	81.5	37.5	64.4	44.6
Netherlands	260.3	128.3	234.3	115.5	315.3	144.4
North Africa	96.0	235.0	96.0	235.0	96.0	235.0
North Sea	862.4	0.0	776.2	0.0	862.4	0.0
Norway	156.0	23.0	140.4	20.7	193.0	23.0
Poland	878.3	467.9	790.5	421.1	615.5	327.9
Portugal	249.5	90.3	224.6	81.3	213.6	69.2
Remaining Asiatic areas	79.0	178.0	79.0	178.0	79.0	278.0
Remaining NE Atlantic	740.5	0.0	666.4	0.0	740.5	0.0
Romania	436.5	209.7	392.9	188.7	282.7	284.6
Russian Federation	2653.0	1178.8	2387.7	1060.9	2758.0	834.9
Serbia and Montenegro	167.8	69.3	167.8	69.3	167.8	69.3
Slovakia	130.2	39.0	117.2	35.1	72.1	32.0
Slovenia	45.4	19.9	40.9	17.9	39.4	19.9
Spain	847.3	352.8	762.6	317.5	970.3	381.7
Sweden	148.4	57.3	133.5	51.6	200.5	51.3
Switzerland	79.3	62.6	71.4	56.4	71.2	62.6
Turkey	851.8	240.6	851.8	240.6	851.8	240.6
Ukraine	1222.2	591.9	1099.9	532.7	1184.2	618.9
United Kingdom	1167.4	296.6	1050.6	266.9	1085.3	322.6
EMEP	**19686.3**	**7345.2**	**17867.4**	**6703.9**	**19467.0**	**7025.4**



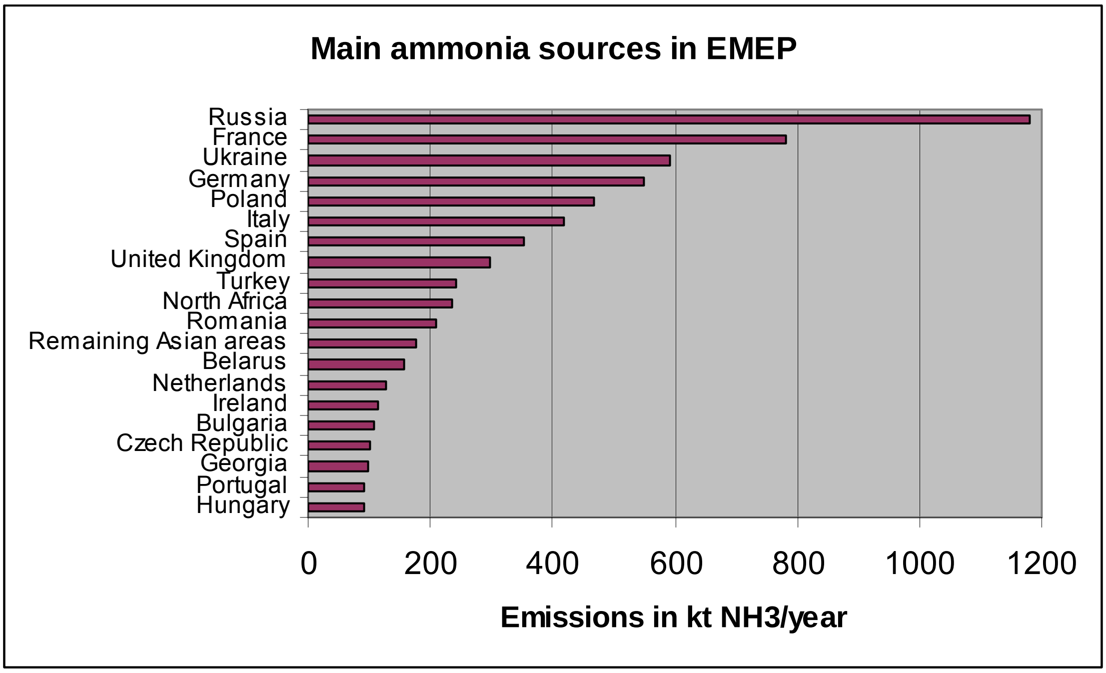
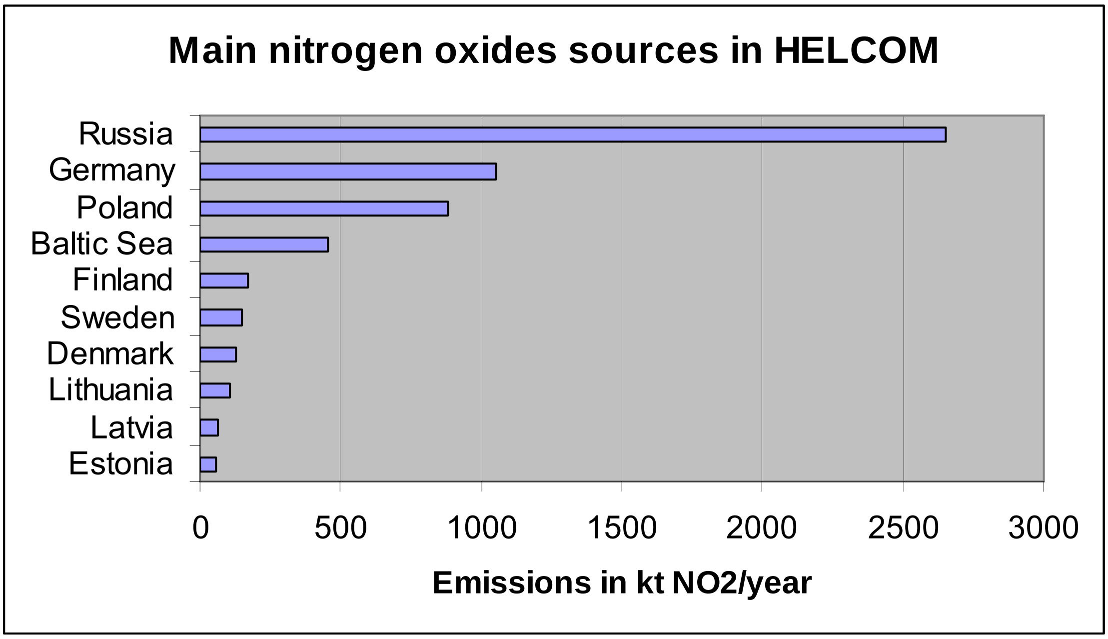


Figure 2.1. Ranking of the twenty largest projected national total emissions of nitrogen oxides and ammonia for 2010 in the EMEP area, according to Scenario 1.



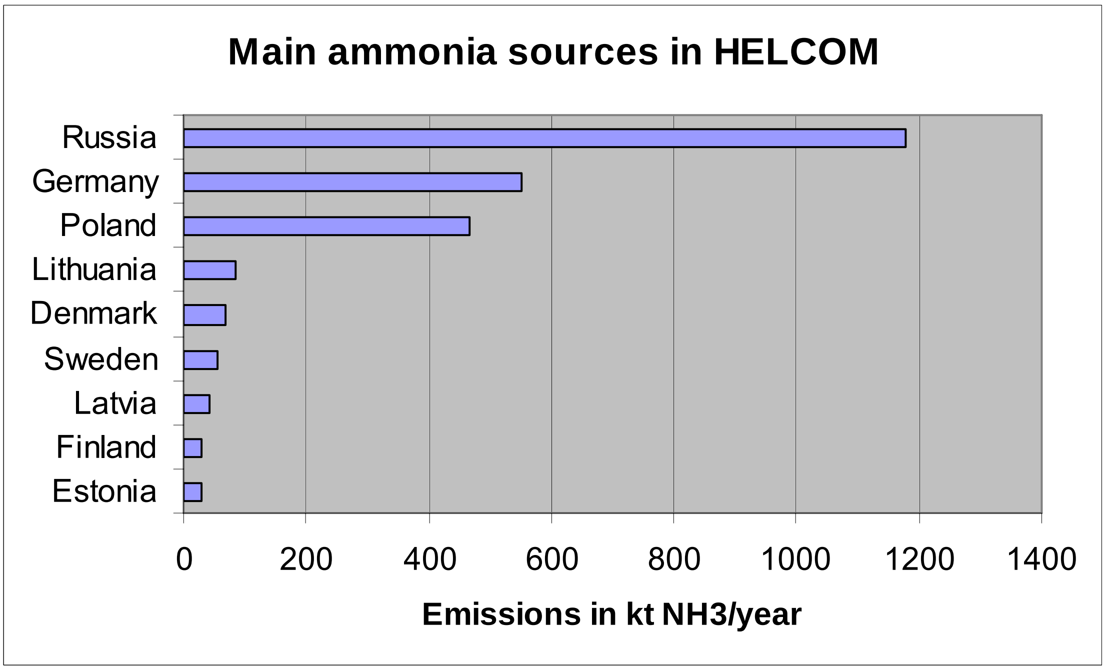


Figure 2.2. Ranking of the projected national total emissions of nitrogen oxides and ammonia for 2010 among HELCOM Contracting Parties and the Baltic Sea, according to Scenario 1.

The Russian Federation is projected to dominate nitrogen oxides emissions among the HELCOM Contracting Parties, with 2653 kt NO_2, followed by Germany (1051 kt NO_2) and Poland (879 kt NO_2). Emissions from the international ship traffic on the Baltic Sea are also a significant source of nitrogen oxides (458 kt NO_2) in the region. Estonia (60 kt NO_2) and Latvia (61 kt NO_2) are at the bottom of the list for nitrogen oxides emissions among the HELCOM countries.

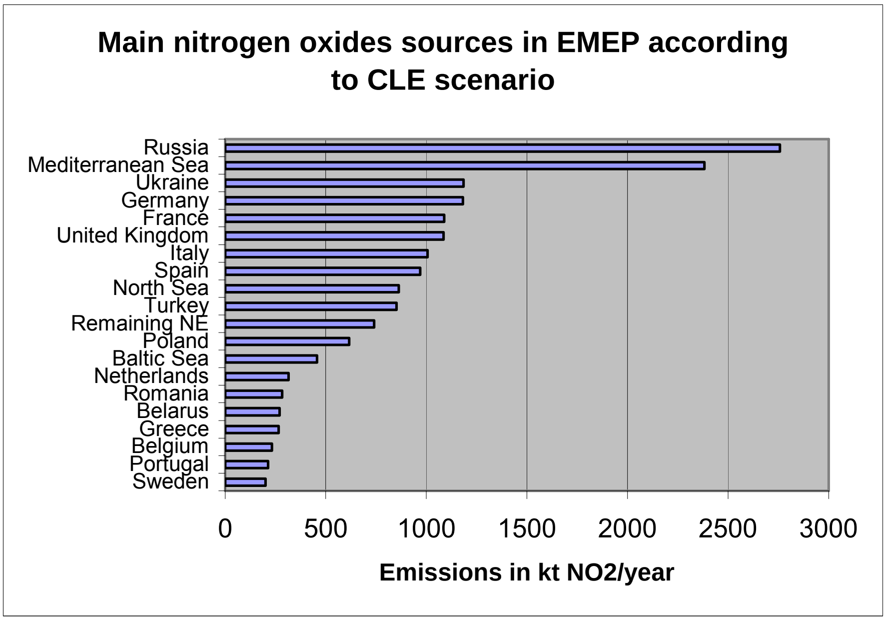
The Russian Federation (1179 kt NH_3) is also projected to dominate ammonia emissions in 2010 among the HELCOM Contracting Parties. Relatively high ammonia emissions can also be noted from Germany (550 kt NH_3) and from Poland (468 kt NH_3). Ammonia emissions in the remaining HELCOM countries are projected to be much lower, with Finland (31 kt NH_3) and Estonia (29 kt NH_3) at the bottom of the list.

2.3.2 CLE Scenario

The total estimated nitrogen oxides emissions in the EMEP area will be approximately 19.5 million tonnes of NO_2, whereas the total ammonia emissions in the EMEP area will be slightly above 7 million tonnes of NH_3, according to CLE projections for 2010. Total nitrogen oxides emissions and ammonia emissions in the HELCOM Contracting Parties are estimated to be 5.5 million tonnes of NO_2 and 1.8 million tonnes of NH_3, respectively.

Rankings of the twenty largest EMEP emission sources of nitrogen oxides and ammonia in 2010 according to the CLE Scenario are shown in Figure 2.3. Russian Federation and ship traffic on the Mediterranean Sea are projected to be the largest emission sources of nitrogen oxides in 2010, at 2758 kt $NO_2$and 2383 kt NO_2, respectively. These first two sources are at least 50% larger than the next sources on the list: Ukraine (1184 kt NO_2), Germany (1182 kt NO_2), France (1089 kt NO_2), and United Kingdom (1085 kt NO_2). The Russian Federation (835 kt NH_3), France (733 kt NH_3), Germany (624 kt NH_3), and Ukraine (619 kt NH_3) are projected to be the four main emission sources of ammonia in 2010. The emissions from the remaining sources are at least 30% lower, with Italy (421 kt NH_3) and Spain (382 kt NH_3) taking the fifth and sixth places, respectively.

Rankings of the projected total national emissions of nitrogen oxides and ammonia among the HELCOM Contracting Parties (and the Baltic Sea) in 2010 according to the CLE Scenario are shown in Figure 2.4. The Russian Federation is projected to definitely dominate nitrogen oxides emissions, with 2758 kt NO_2, followed by Germany (1182 kt NO_2) and Poland (616 kt NO_2). Here again it must be remembered that these figures represent the estimated emissions from the whole country, including areas outside the Baltic catchment area. Emissions from the international ship traffic on the Baltic Sea are also a significant source of nitrogen oxides (458 kt NO_2) in the region. Latvia (29 kt NO_2) and Estonia (28 kt NO_2) are at the bottom of the list for nitrogen oxides emissions among the HELCOM countries. Three countries are projected to dominate ammonia emissions in 2010 among the HELCOM Contracting Parties: Russian Federation (835 kt NH_3), Germany (624 kt NH_3), and Poland (328 kt NH_3).



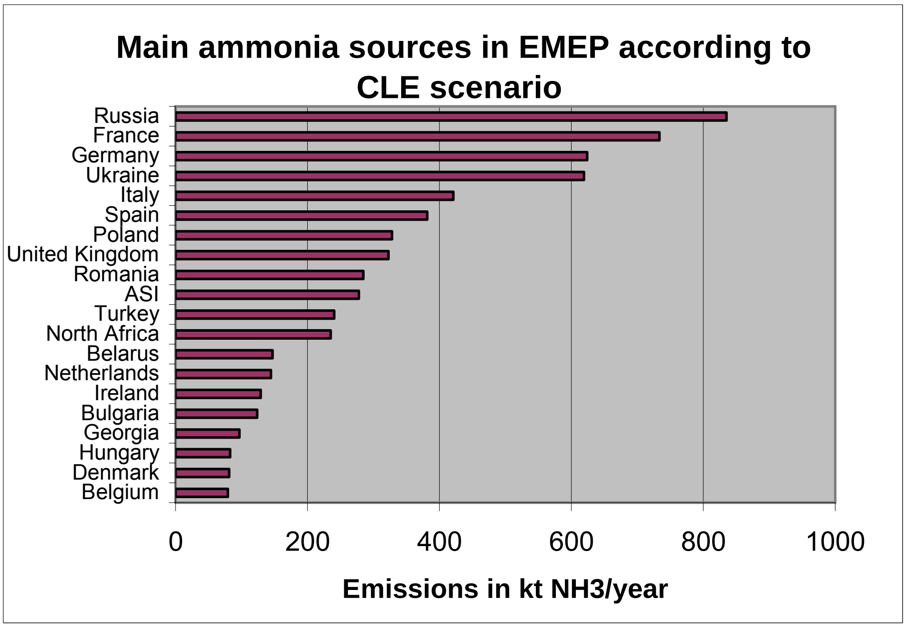


Figure 2.3. Ranking of the twenty largest projected national total emissions of nitrogen oxides and ammonia for 2010 in the EMEP area, according to the CLE Scenario.

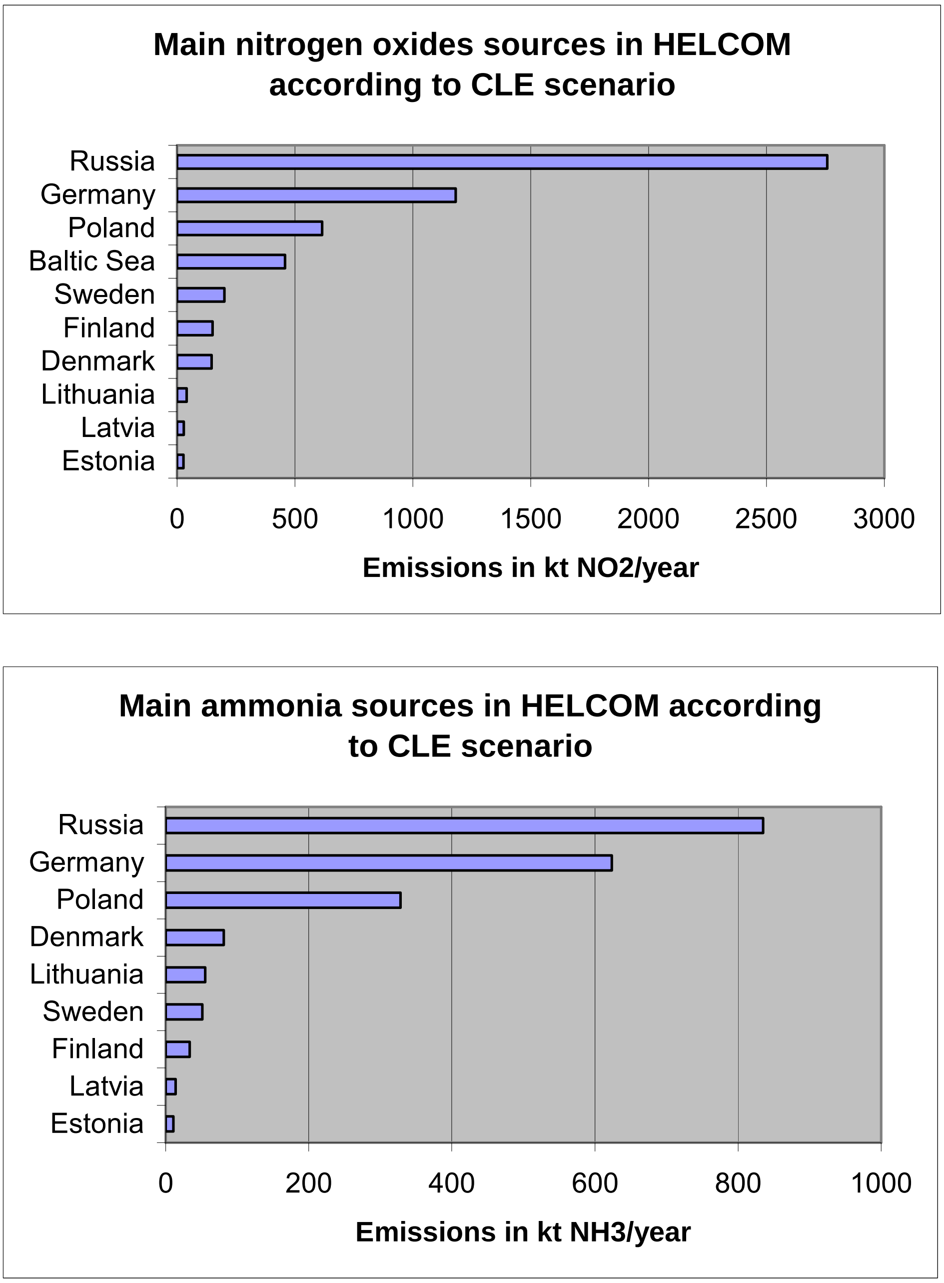


Figure 2.4. Ranking of the projected national total emissions of nitrogen oxides and ammonia for 2010 among HELCOM Contracting Parties and the Baltic Sea, according to the CLE Scenario.

2.4 Spatial distributions of 2010 emissions

2.4.1 Scenarios 1 and 2

Maps with spatial distributions of projected nitrogen oxides emissions in 2010, according Scenario 1 and Scenario 2, are shown in Figure 2.5 and corresponding maps with spatial distributions of projected ammonia emissions are shown in Figure 2.6. As expected, the emission patterns for Scenario 1 and Scenario 2 are similar, both for nitrogen oxides and for ammonia.

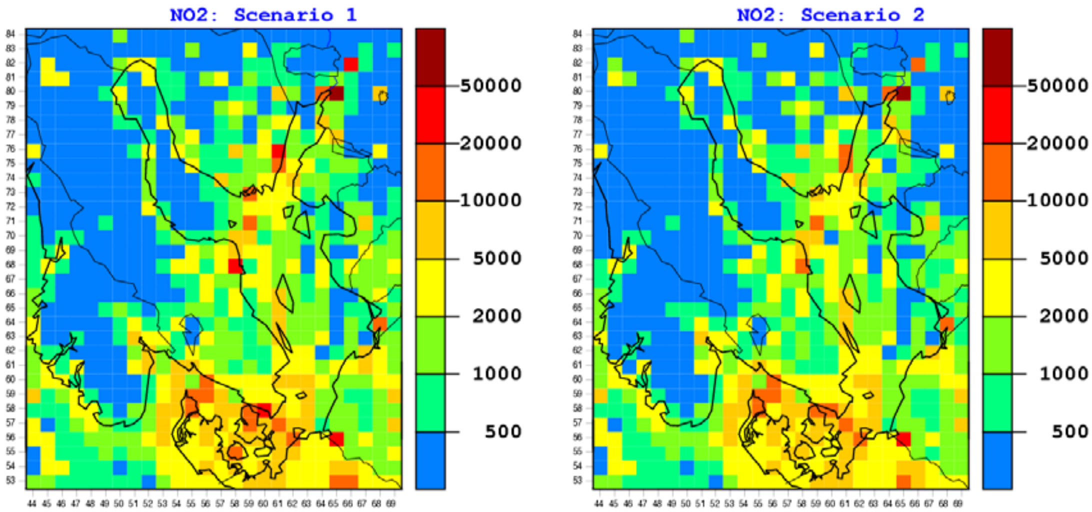


Figure 2.5. Spatial distribution of nitrogen oxides emissions for 2010 according to Scenario 1 (left) and Scenario 2 (right). Units: tonnes of NO_2 per year and per 50 km × 50 km grid cell.

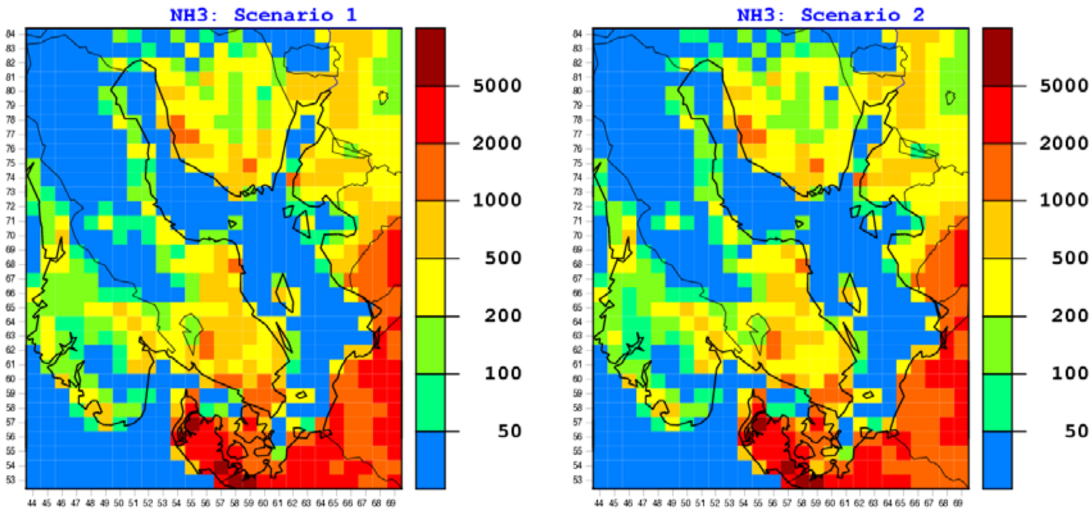


Figure 2.6. Spatial distribution of ammonia emissions for 2010 according to Scenario 1 (left) and Scenario 2 (right). Units: tonnes of NH_3 per year and per 50 km × 50 km grid cell.

2.4.2 CLE Scenario

Maps with spatial distributions of projected nitrogen oxides and ammonia emissions in 2010, according to the CLE Scenario, are shown in Figure 2.7.

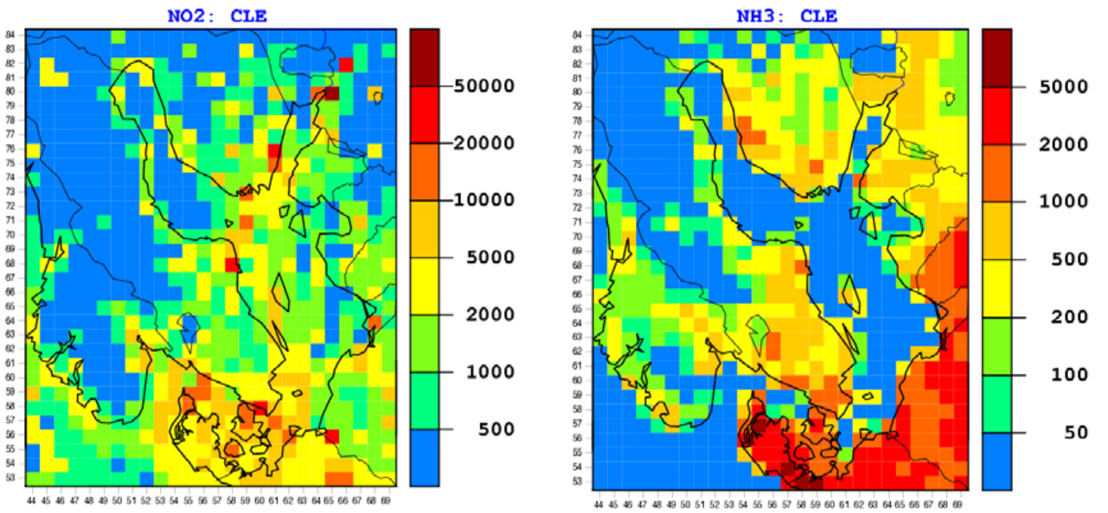


Figure 2.7. Spatial distribution of nitrogen oxides (left) and ammonia (right) emissions for 2010 according to the CLE Scenario. Units: tonnes of NO_2 or NH_3 per year and per 50 km × 50 km grid cell.

2.5 Comparison of nitrogen emission scenarios

2.5.1 Scenario 1 versus 2003 emissions

A comparison of national totals for nitrogen oxides and ammonia emissions in 2003 and in 2010 for HELCOM Contracting Parties and the Baltic Sea is given in Table 2.4. Higher values in 2003 than in 2010 are marked in this table. This comparison shows that many HELCOM Contracting Parties achieved already in 2003 emission levels of nitrogen oxides and ammonia below the ceilings for 2010 imposed by the Gothenburg Protocol and the NEC Directive.

The need for nitrogen oxides emission reductions between 2003 and 2010 can be noted for Denmark (39%), Finland (22%), Germany (26%), and Sweden (28%). Nitrogen oxides emissions from the Baltic Sea are 20% below the 2010 limit, but these emissions increase by approximately 2.5% each year. The sum of nitrogen oxides emissions from all HELCOM Contracting Parties must be reduced by 5% between 2003 and 2010 in order to reach the 2010 emission ceilings. Also, nitrogen oxides emissions in the entire EMEP domain need to be reduced by 5% between 2003 and 2010 to reach the level imposed by the Gothenburg Protocol and the NEC Directive.

Ammonia emissions from three countries, Denmark (29%), Finland (7%) and Germany (9%), need to be reduced in order to fulfil the requirements of the Gothenburg Protocol and the NEC Directive for 2010. The sum of ammonia emissions from all HELCOM Contracting Parties is lower in 2003 than that projected for 2010 by 42%. Ammonia emissions in the entire EMEP domain in 2003 are approximately 41% lower than those projected for 2010.

Table 2.4. Comparison of national totals for nitrogen oxides and ammonia emissions in 2003 and projected for 2010 (Scenario 1) for HELCOM Contracting Parties and the Baltic Sea. Units: kt NO_2 per year for nitrogen oxides emissions and kt NH_3 per year for ammonia emissions.

Country	Nitrogen oxides		Ammonia	
	2003	2010 – Sc1	2003	2010 – Sc1
Denmark	208.7	126.7	97.8	69.3
Estonia	39.2	59.0	7.8	28.4
Finland	218.7	170.3	33.2	30.8
Germany	1428.0	1051.2	600.5	549.8
Latvia	37.3	60.8	15.2	43.8
Lithuania	52.6	110.4	34.0	84.4
Poland	796.0	873.8	325.0	467.9
Russia	2566.0	2653.0	600.0	1178.8
Sweden	206.0	184.4	55.6	57.3
Baltic Sea	380.0	457.5	0.0	0.0
HELCOM	**5580.5**	5289.6	1769.1	2510.5
EMEP	**20656.4**	19686.3	6293.1	7345.2

A comparison of national totals for total nitrogen as the sum of nitrogen oxides and ammonia emissions in 2003 and those projected for 2010 is given in Table 2.5. Higher values in 2003 than those projected for 2010 are marked in this table. This comparison shows that four HELCOM Contracting Parties (Denmark, Finland, Germany, and Sweden) will need to reduce their emission levels of total nitrogen by 2010 in order to reach the ceilings imposed by the Gothenburg Protocol and the NEC Directive for 2010.

Table 2.5. Comparison of national totals for total nitrogen (nitrogen oxides + ammonia) emissions in 2003 and projected for 2010 (Scenario 1) for HELCOM Contracting Parties. Units: kt N per year.

Country	Nitrogen oxides	
	2003	2010 – Sc1
Denmark	144	106
Estonia	18	27
Finland	94	80
Germany	929	834
Latvia	24	30
Lithuania	44	79
Poland	510	538
Russia	1275	1495
Sweden	108	87
HELCOM	3147	3275
EMEP	11710	12040

Maps with spatial distributions of projected nitrogen oxides emissions in 2010 (Scenario 1) and nitrogen oxides emissions in 2003 are shown in Figure 2.8; corresponding maps with spatial distributions of ammonia emissions are shown in Figure 2.9. There are only small differences in the emission patterns for the years 2003 and those projected for 2010, for both nitrogen oxides and ammonia.

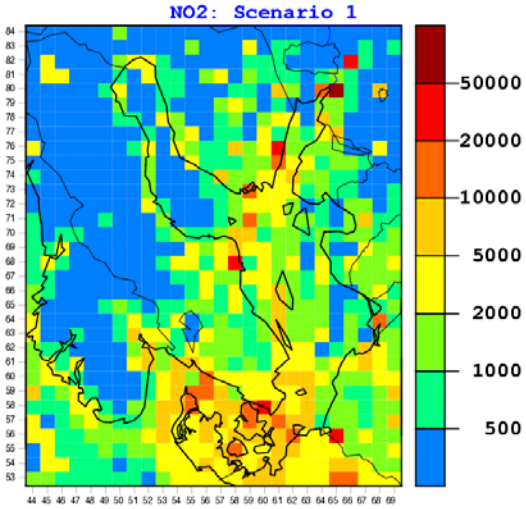


Figure 2.8. Spatial distribution of nitrogen oxides emissions projected for 2010 according to Scenario 1 (left) and nitrogen oxides emissions for 2003 (right). Units: tonnes of NO_2 per year and per 50 km × 50 km grid cell.

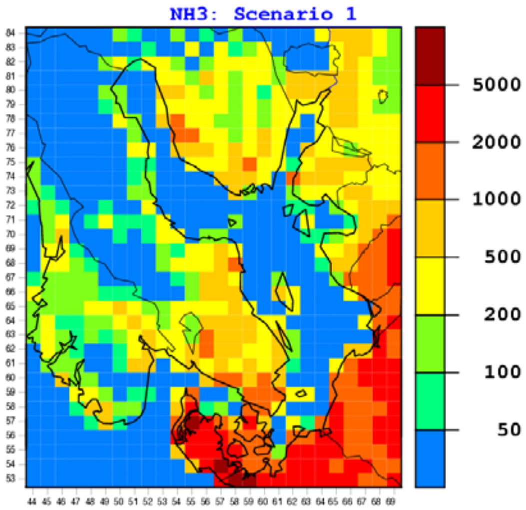


Figure 2.9. Spatial distributions of ammonia emissions projected for 2010 according to Scenario 1 (left) and ammonia emissions for 2003 (right). Units: tonnes of NH_3 per year and per 50 km × 50 km grid cell.

2.5.2 Comparison of CLE Scenario, Scenario 1, and 2003 emissions

A comparison of national totals for nitrogen oxides and ammonia emissions projected for 2010 according to the CLE Scenario and Scenario 1, for HELCOM Contracting Parties and the Baltic Sea, is given in Table 2.6. Higher values projected for 2010 than those in 2003 are marked in this table.

Table 2.6. Comparison of national totals for nitrogen oxides and ammonia emissions projected for 2010, for HELCOM Contracting Parties and the Baltic Sea, according to the CLE Scenario and Scenario 1. Units: kt NO_2 per year for nitrogen oxides emissions and kt NH_3 per year for ammonia emissions.

Country	Nitrogen oxides		Ammonia	
	2010 - CLE	2010 – Sc1	2010 - CLE	2010 – Sc1
Denmark	146.7	126.7	81.3	69.3
Estonia	27.6	59.0	10.8	28.4
Finland	151.3	170.3	33.8	30.8
Germany	1182.1	1051.2	623.7	549.8
Latvia	28.9	60.8	13.9	43.8
Lithuania	41.2	110.4	55.2	84.4
Poland	615.5	873.8	327.9	467.9
Russia	2758.0	2653.0	834.9	1178.8
Sweden	200.5	184.4	51.3	57.3
Baltic Sea	457.5	457.5	0.0	0.0
HELCOM	5151.8	5289.6	2032.8	2510.5
EMEP	19467.0	19686.3	7025.4	7345.2

The CLE Emission Scenario for 2010 can be considered as the most likely description of nitrogen emission levels in 2010. The higher values in the CLE Scenario in comparison with Scenario 1 indicate the countries which may have a problem in reaching 2010 emission levels imposed by the Gothenburg Protocol and the NEC Directive.

Four countries may have potential problems reaching 2010 nitrogen oxides emission levels according to Scenario 1: Denmark, Germany, Sweden, and Russia. Nitrogen oxides emissions from the ship traffic on the Baltic Sea are the same in Scenario 1 and in the CLE Scenario. However, the problem is that the ship emissions are increasing, also after 2010, and in 2020 they will be 13% higher than in 2010, according to the CLE Scenario. The sum of 2010 nitrogen oxides emissions from all HELCOM Contracting Parties is 8% lower in the CLE Scenario than in Scenario 1. Also, 2010 nitrogen oxides emissions from the entire EMEP domain are 6% lower in the CLE Scenario than in Scenario 1.

Only in three HELCOM Contracting Parties are ammonia emissions in 2010 lower in Scenario 1 than in the CLE Scenario: Denmark, Finland, and Germany. The sum of 2010 ammonia emissions from all HELCOM Contracting Parties is higher in Scenario 1 than in the CLE Scenario. Similarly, 2010 ammonia emissions from the entire EMEP domain are higher in Scenario 1 than in the CLE Scenario.

Maps with spatial distributions of projected nitrogen oxides emissions in 2010 (CLE Scenario) and nitrogen oxides emissions in 2003 are shown in Figure 2.10. Corresponding maps of ammonia emissions are shown in Figure 2.11. As in the case of Scenario 1, only small differences in the emission patterns for the years 2003 and 2010 (CLE Scenario) are visible, both for nitrogen oxides and for ammonia.

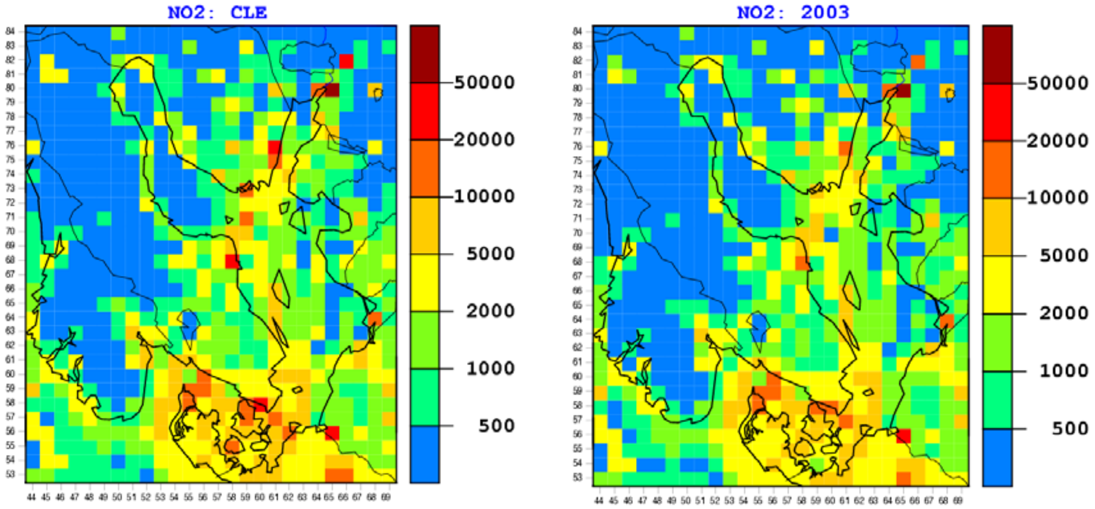


Figure 2.10. Spatial distribution of nitrogen oxide emissions projected for 2010 according to the CLE Scenario (left) and nitrogen oxide emissions for 2003 (right). Units: tonnes of NO_2 per year and per 50 km × 50 km grid cell.

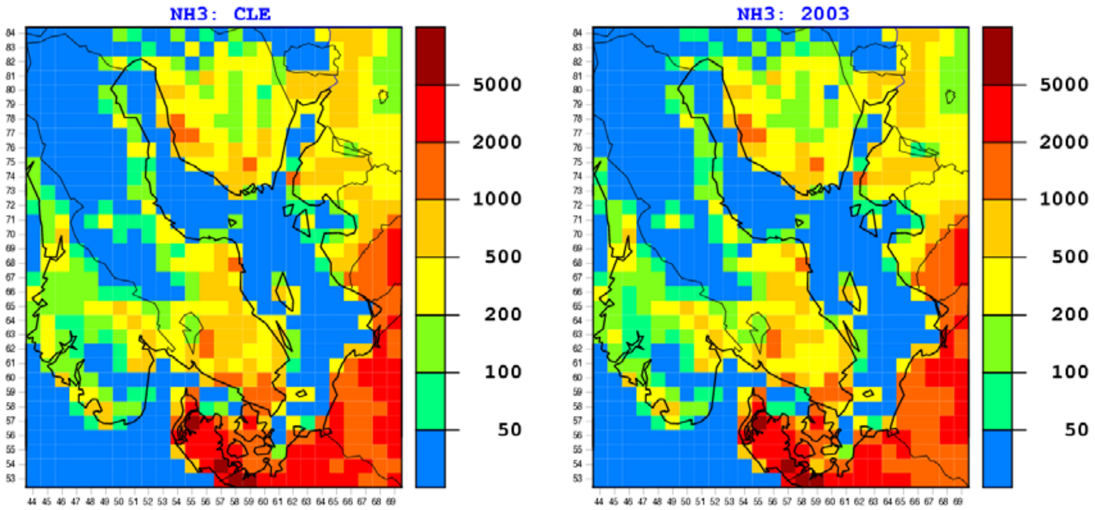


Figure 2.11. Spatial distributions of ammonia emissions projected for 2010 according to the CLE Scenario (left) and ammonia emissions for 2003 (right). Units: tonnes of NO_2 per year and per 50 km × 50 km grid cell.

3. ATMOSPHERIC NITROGEN DEPOSITION INTO THE BALTIC SEA REGION IN 2010

The nitrogen emission inventories described in the previous section have been used to estimate nitrogen depositions in 2010. Because the meteorology for the year 2010 is not known, model calculations had to be performed with existing meteorological data from past years. Meteorological data for the years 1996, 1997, 1998, and 2000 and emission projections for the year 2010 according to the CLE Scenario have been used for the EMEP unified model runs. Final deposition values for the year 2010 were calculated as the average over the four selected years. In this way, it was possible to estimate the uncertainty related to meteorological variability.

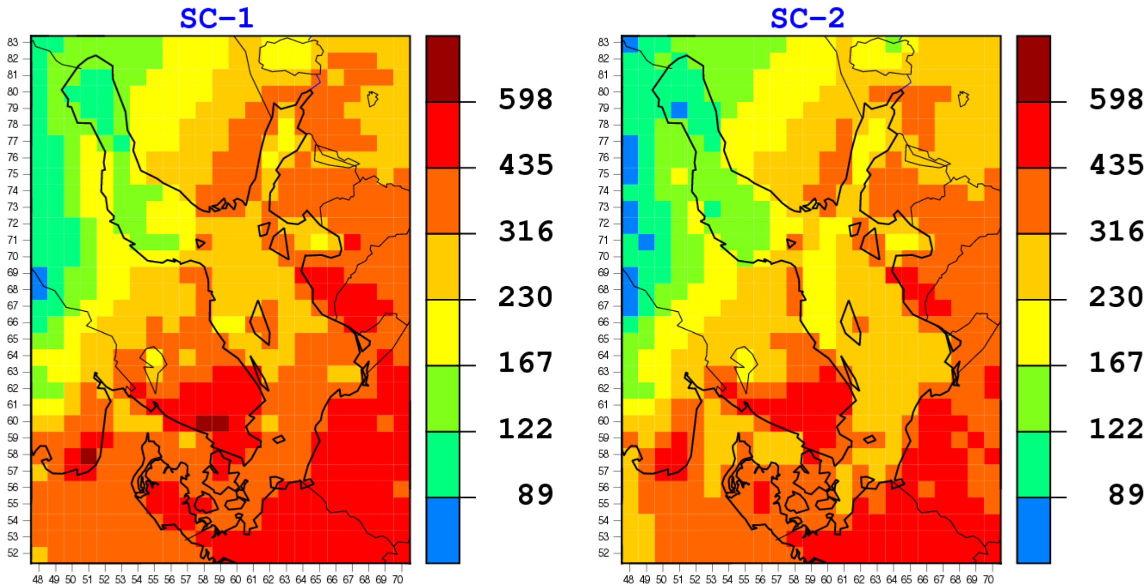
3.1 Deposition maps

Nitrogen depositions from all emission sources in 2010, as well as source-receptor matrices, were available as the model output. Maps were calculated for:

1. annual dry deposition of oxidized nitrogen,
2. annual wet deposition of oxidized nitrogen,
3. annual dry deposition of reduced nitrogen,
4. annual wet deposition of reduced nitrogen,
5. annual deposition of oxidized (dry + wet) nitrogen,
6. annual deposition of reduced (dry + wet) nitrogen,
7. annual dry deposition of (oxidized +reduced) nitrogen,
8. annual wet deposition of (oxidized +reduced) nitrogen,
9. annual wet deposition of total nitrogen.

The above maps for all selected meteorological years are shown in Appendix A for the model runs with Emission Scenario 1, in Appendix B for the model runs with Emission Scenario 2, and in Appendix C for the model runs with the CLE Scenario. There are large differences for the maps based on different years, indicating that the influence of meteorological variability on the results is significant.

Calculated deposition maps for the year 2010, averaged over the four meteorological years, are shown for the three scenarios (Scenario 1, Scenario 2, and CLE Scenario). The maps are shown for oxidized nitrogen, reduced nitrogen, dry nitrogen, wet nitrogen, and total nitrogen in Figures 3.1 to 3.5, respectively. There are some clear, but not large, differences in the maps for different scenarios. These differences are definitely larger than the differences between the maps for different nitrogen emission scenarios shown in the previous section. In particular, the maxima of the depositions calculated with emission Scenario 1 are much less visible in calculations with Emission Scenario 2.



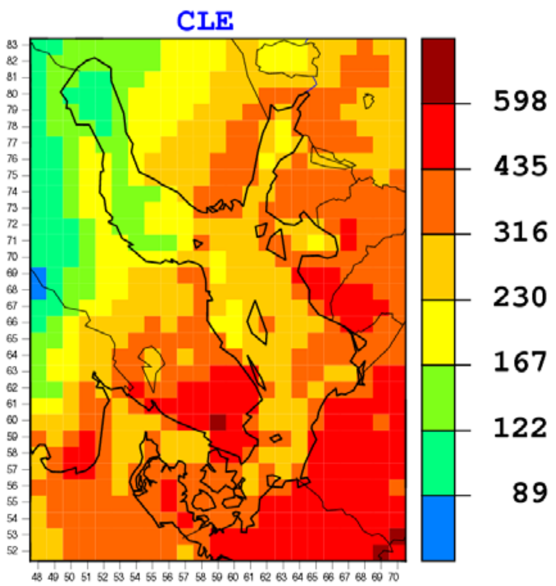
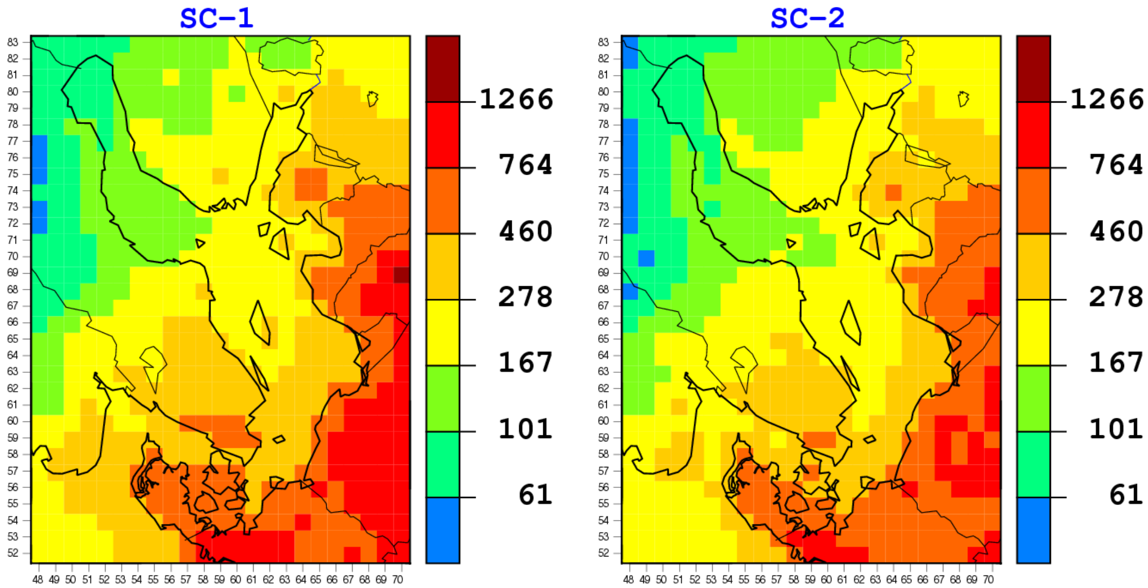


Figure 3.1. Calculated mean annual deposition of oxidized (wet and dry) nitrogen in 2010 according to Emission Scenario 1 (upper left), Scenario 2 (upper right), and the CLE Scenario (bottom). Meteorological data from the years 1996, 1997, 1998, and 2000 were used in the model runs. The calculated mean deposition is the average of the results for the different meteorological years. Units: mg N m^{-2}.



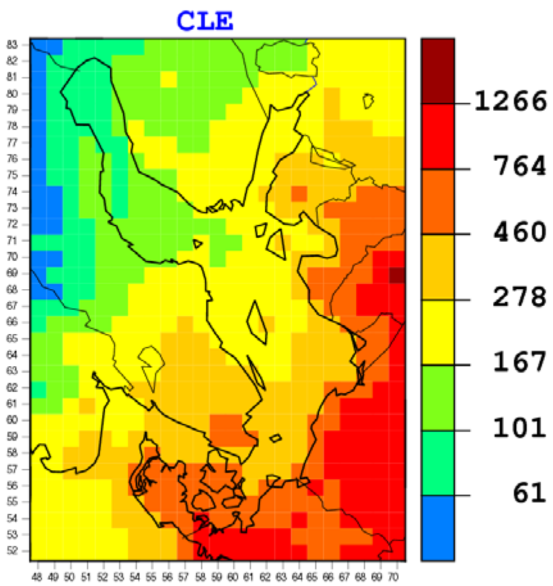


Figure 3.2. Calculated mean annual deposition of reduced (wet and dry) nitrogen in 2010 according to Emission Scenario 1 (upper left), Scenario 2 (upper right), and the CLE Scenario (bottom). Meteorological data from the years 1996, 1997, 1998, and 2000 were used in the model runs. The calculated mean deposition is the average of the results for the different meteorological years. Units: mg N m^{-2}.

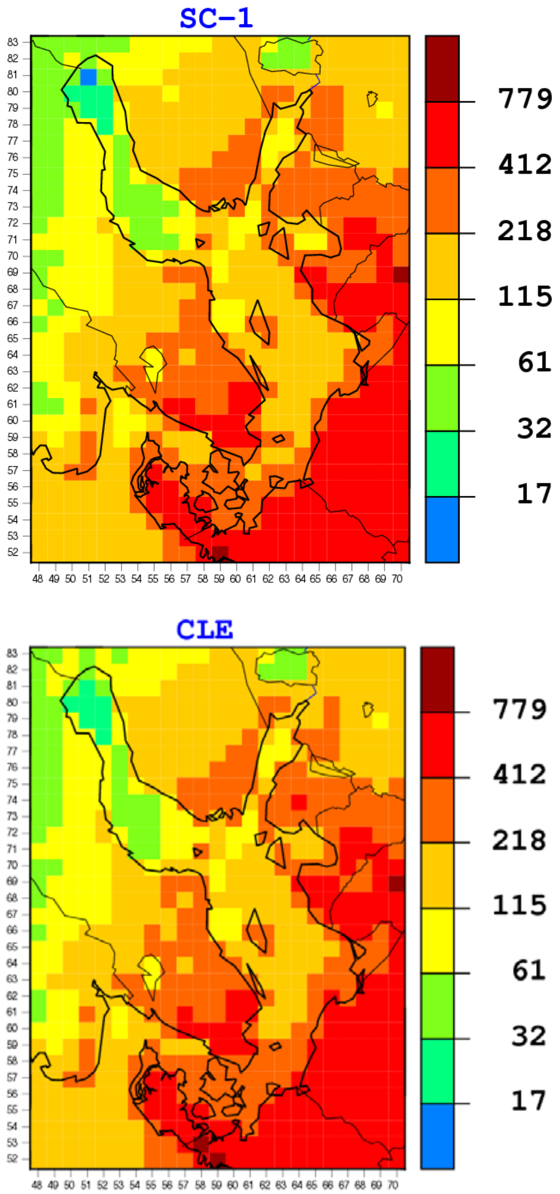


Figure 3.3. Calculated mean annual deposition of dry (oxidized + reduced) nitrogen in 2010 according to Emission Scenario 1 (upper left), Scenario 2 (upper right), and the CLE Scenario (bottom). Meteorological data from the years 1996, 1997, 1998, and 2000 were used in the model runs. The calculated mean deposition is the average of the results for the different meteorological years. Units: mg N m^{-2}.

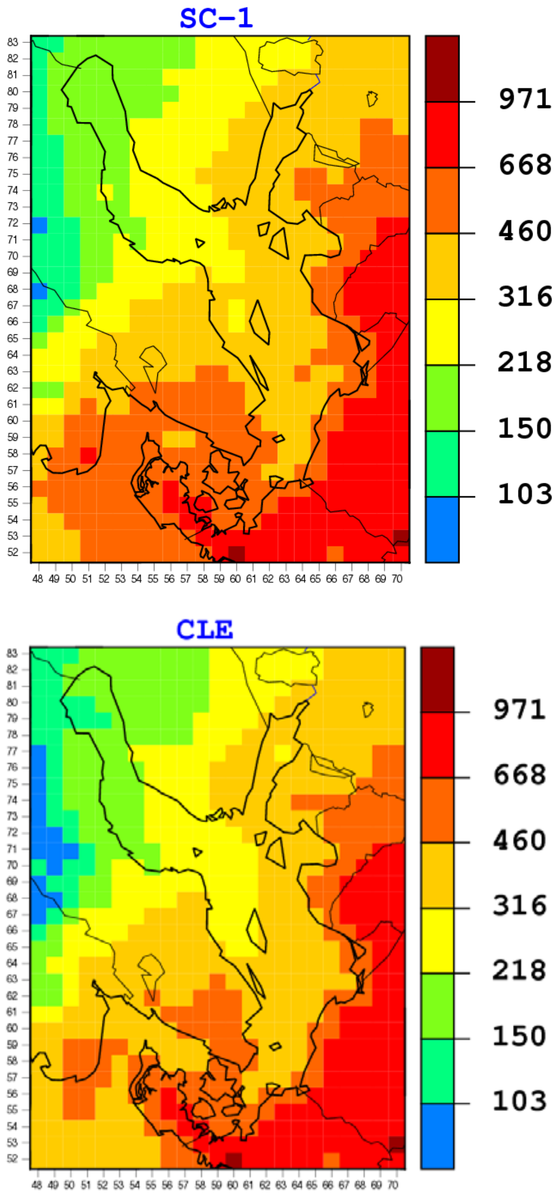


Figure 3.4. Calculated mean annual deposition of wet (oxidized + reduced) nitrogen in 2010 according to Emission Scenario 1 (upper left), Scenario 2 (upper right), and the CLE Scenario (bottom). Meteorological data from the years 1996, 1997, 1998, and 2000 were used in the model runs. The calculated mean deposition is the average of the results for the different meteorological years. Units: mg N m^{-2}.

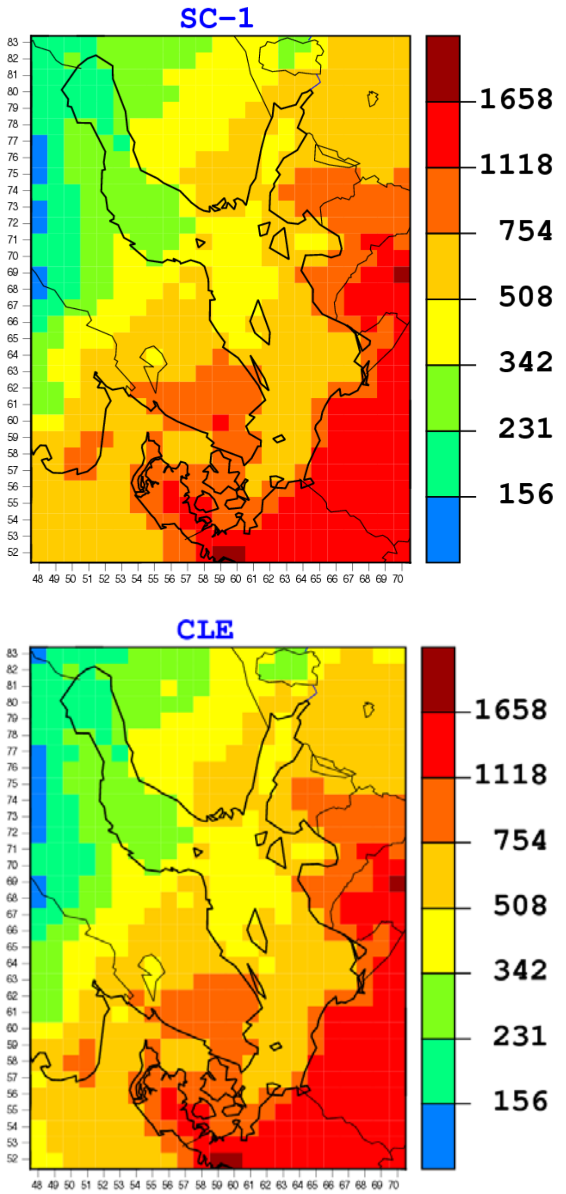


Figure 3.5. Calculated mean annual deposition of total nitrogen in 2010 according to Emission Scenario 1 (upper left), Scenario 2 (upper right), and the CLE Scenario (bottom). Meteorological data from the years 1996, 1997, 1998, and 2000 were used in the model runs. The calculated mean deposition is the average of the results for the different meteorological years. Units: mg N m^{-2}.

3.2 Calculated depositions to sub-basins and catchment areas of the Baltic Sea

Calculated nitrogen depositions to the sub-basins of the Baltic Sea for Emission Scenarios 1, 2, and CLE are given in Tables 3.1, 3.2, and 3.3, respectively. Calculated nitrogen depositions to the catchment areas of the Baltic Sea for Emission Scenarios 1, 2, and CLE are given in Tables 3.4, 3.5, and 3.6, respectively. Calculated depositions are shown for each sub-basin/catchment area for the four meteorological years used in the computations. The deposition in 2010 was then calculated as the average over the four meteorological years.

The locations of the minimum and maximum depositions are slightly different for the different sub-basins/catchment areas, for the different deposition types, and for the different scenarios. However, for most sub-basins and catchment areas, the lowest deposition values can be observed for the meteorological year 1997 and the highest for the year 2000. These are also the same years with the minimum and maximum depositions to the entire Baltic Sea basin and catchment area.

For the GUB, GUF, GUR, and BAP sub-basins and for the entire Baltic Sea basin, the highest depositions of total nitrogen were calculated with Scenario 1, whereas for two southern sub-basins, BES and KAT, the highest depositions were calculated with the CLE Scenario. For most of the sub-basins (GUB, BAP, BES, and KAT) and for the Baltic Sea basin, the lowest depositions of total nitrogen were calculated with Scenario 2; however, for the GUF and GUR sub-basins, the lowest depositions were calculated with the CLE Scenario.

For the GUF, GUR, and BAP catchment areas and for the entire Baltic Sea catchment area, the highest depositions of total nitrogen were calculated with Scenario 1. For three catchment areas, GUB, BES, and KAT, the highest depositions were calculated with the CLE Scenario. For four catchment areas (GUB, GUF, BES, and KAT), the lowest depositions of total nitrogen were calculated with Scenario 2. For the GUR and BAP catchment areas, as well as for the entire catchment area of the Baltic Sea, the lowest depositions were calculated with the CLE Scenario.

For all emission scenarios, all meteorological years, and all sub-basins and catchment areas, the wet nitrogen deposition is much higher, typically two to three times higher than the dry deposition of nitrogen.

The depositions of oxidized and reduced nitrogen to all sub-basins are approximately on the same level, but the deposition of oxidized nitrogen is slightly higher than the deposition of reduced nitrogen in the north and in the middle into the GUB, GUF, GUR, and BAP sub-basins. In contrast, in the south, into the BES and KAT sub-basins, the deposition of reduced nitrogen is higher. The deposition of oxidized nitrogen is also higher than the deposition of reduced nitrogen to the entire basin of the Baltic Sea. In general, there is more oxidized nitrogen deposition than reduced nitrogen deposition into the sub-basins of the Baltic Sea.

With regard to catchment areas, the oxidized nitrogen deposition is higher than the reduced nitrogen deposition into GUB, GUF, and KAT. For GUR, BAP, BES, and the entire catchment area of the Baltic Sea, there is an opposite relationship between oxidized and reduced nitrogen deposition. In general, there is more reduced nitrogen deposition than oxidized nitrogen deposition into the catchment areas of the Baltic Sea.

Table 3.1. Nitrogen depositions to the sub-basins of the Baltic Sea and to the entire basin of the Baltic Sea calculated for 2010 using the meteorology from four different years and as the average over these years. Emission Scenario 1 was used for these calculations. Units: kt N.

Sub-basin	Meteor-ology	Oxidized		Reduced		Total
		Dry	Wet	Dry	Wet	
GUB	1996	6.1	11.8	2.9	8.9	29.7
	1997	5.2	10.2	2.4	6.8	24.6
	1998	6.5	15.0	2.8	11.0	35.3
	2000	6.9	18.7	3.9	15.7	45.1
	MEAN	**6.2**	**13.9**	**3.0**	**10.6**	**33.7**
GUF	1996	2.9	5.2	1.9	5.4	15.3
	1997	2.5	4.1	1.6	3.7	11.9
	1998	3.0	5.5	2.1	4.9	15.4
	2000	3.1	6.4	2.3	5.5	17.3
	MEAN	**2.9**	**5.3**	**2.0**	**4.9**	**15.0**
GUR	1996	2.2	3.3	1.8	3.7	11.0
	1997	1.9	3.3	1.4	3.2	9.8
	1998	2.2	3.5	1.8	3.4	10.9
	2000	2.4	3.9	2.0	3.9	12.2
	MEAN	**2.2**	**3.5**	**1.7**	**3.6**	**11.0**
BAP	1996	23.1	40.1	23.3	39.7	126.2
	1997	19.6	33.3	20.2	31.4	104.4
	1998	22.2	47.1	23.9	43.8	136.9
	2000	22.9	47.1	26.3	44.1	140.4
	MEAN	**21.9**	**41.9**	**23.4**	**39.7**	**127.0**
BES	1996	2.6	4.9	5.1	6.3	18.9
	1997	2.4	3.9	5.6	5.4	17.3
	1998	2.5	5.8	5.5	7.8	21.6
	2000	2.5	5.8	6.1	7.3	21.7
	MEAN	**2.5**	**5.1**	**5.6**	**6.7**	**19.9**
KAT	1996	2.5	4.4	3.5	5.0	15.4
	1997	2.3	4.1	3.4	4.6	14.4
	1998	2.3	5.4	3.5	5.7	16.9
	2000	2.6	6.5	4.0	6.7	19.8
	MEAN	**2.4**	**5.1**	**3.6**	**5.5**	**16.6**
BALTIC SEA	1996	39.4	69.7	38.5	68.9	216.6
	1997	33.9	58.9	34.6	55.0	182.4
	1998	38.7	82.3	39.5	76.5	237.0
	2000	40.3	88.4	44.5	83.2	256.5
	MEAN	**38.1**	**74.8**	**39.3**	**70.9**	**223.1**

Table 3.2. Nitrogen depositions to the sub-basins of the Baltic Sea and to the entire basin of the Baltic Sea calculated for 2010 using the meteorology from four different years and as the average over these years. Emission Scenario 2 was used for these calculations. Units: kt N.

Sub-basin	Meteor-ology	Oxidized		Reduced		Total
		Dry	Wet	Dry	Wet	
GUB	1996	5.5	10.7	2.6	8.1	26.9
	1997	4.7	9.3	2.2	6.1	22.4
	1998	5.9	13.7	2.5	10.0	32.1
	2000	6.3	17.0	3.5	14.2	40.9
	MEAN	**5.6**	**12.6**	**2.7**	**9.6**	**30.6**
GUF	1996	2.6	4.8	1.7	4.9	13.9
	1997	2.3	3.7	1.5	3.3	10.9
	1998	2.8	5.0	1.9	4.5	14.1
	2000	2.9	5.8	2.1	5.0	15.8
	MEAN	**2.7**	**4.8**	**1.8**	**4.4**	**13.7**
GUR	1996	2.0	3.0	1.6	3.4	10.0
	1997	1.7	3.0	1.2	2.9	8.8
	1998	2.0	3.1	1.6	3.1	9.9
	2000	2.2	3.5	1.8	3.5	11.0
	MEAN	**2.0**	**3.2**	**1.6**	**3.2**	**9.9**
BAP	1996	20.9	36.3	21.0	35.9	114.1
	1997	17.8	30.1	18.3	28.3	94.5
	1998	20.1	42.6	21.6	39.5	123.7
	2000	20.7	42.6	23.8	39.9	126.9
	MEAN	**19.8**	**37.9**	**21.2**	**35.9**	**114.8**
BES	1996	2.3	4.4	4.6	5.6	17.0
	1997	2.2	3.5	5.1	4.9	15.6
	1998	2.3	5.2	4.9	7.0	19.4
	2000	2.2	5.3	5.5	6.6	19.5
	MEAN	**2.2**	**4.6**	**5.0**	**6.0**	**17.9**
KAT	1996	2.3	4.0	3.2	4.5	13.9
	1997	2.1	3.7	3.1	4.1	13.0
	1998	2.1	4.9	3.2	5.1	15.2
	2000	2.3	5.9	3.6	6.0	17.8
	MEAN	**2.2**	**4.6**	**3.3**	**4.9**	**15.0**
BALTIC SEA	1996	35.7	63.2	34.8	62.3	195.9
	1997	30.8	53.4	31.3	49.7	165.1
	1998	35.1	74.5	35.7	69.2	214.6
	2000	36.5	80.0	40.2	75.3	232.0
	MEAN	**34.5**	**67.8**	**35.5**	**64.1**	**201.9**

Table 3.3. Nitrogen depositions to the sub-basins of the Baltic Sea and to the entire basin of the Baltic Sea calculated for 2010 using the meteorology from four different years and as the average over these years. The CLE Emission Scenario was used for these calculations. Units: kt N.

Sub-basin	Meteor-ology	Oxidized		Reduced		Total
		Dry	Wet	Dry	Wet	
GUB	1996	6.4	11.4	2.2	10.2	30.2
	1997	5.5	10.1	1.8	7.2	24.6
	1998	6.5	14.4	2.1	11.8	34.8
	2000	7.2	17.1	2.9	16.3	43.5
	MEAN	**6.4**	**13.2**	**2.3**	**11.4**	**33.3**
GUF	1996	3.0	4.9	1.1	5.5	14.5
	1997	2.4	4.1	0.9	3.4	10.8
	1998	2.8	5.0	1.1	4.4	13.3
	2000	3.0	5.8	1.3	5.4	15.5
	MEAN	**2.8**	**5.0**	**1.1**	**4.7**	**13.5**
GUR	1996	2.1	3.0	0.9	3.5	9.4
	1997	1.8	3.3	0.7	3.1	8.9
	1998	2.0	3.2	0.9	3.0	9.1
	2000	2.2	3.6	1.1	3.6	10.6
	MEAN	**2.0**	**3.3**	**0.9**	**3.3**	**9.5**
BAP	1996	23.0	38.5	15.3	40.4	117.3
	1997	21.7	35.1	14.4	32.0	103.1
	1998	22.5	47.1	15.9	44.8	130.3
	2000	24.1	44.7	19.3	44.5	132.6
	MEAN	**22.8**	**41.4**	**16.2**	**40.4**	**120.8**
BES	1996	2.6	5.1	4.6	6.8	19.2
	1997	2.7	4.4	5.2	6.0	18.4
	1998	2.7	6.4	5.1	8.8	23.1
	2000	2.8	6.4	5.7	8.2	23.1
	MEAN	**2.7**	**5.6**	**5.2**	**7.5**	**21.0**
KAT	1996	2.8	4.8	3.0	5.5	16.0
	1997	2.7	4.8	3.1	5.2	15.8
	1998	2.6	5.9	3.1	6.5	18.2
	2000	3.0	7.2	3.7	7.6	21.5
	MEAN	**2.8**	**5.7**	**3.2**	**6.2**	**17.8**
BALTIC SEA	1996	39.9	67.5	27.2	72.0	206.5
	1997	36.8	61.9	26.1	56.8	181.6
	1998	39.0	82.1	28.2	79.3	228.7
	2000	42.2	84.9	34.0	85.7	246.8
	MEAN	**39.5**	**74.1**	**28.9**	**73.5**	**215.9**

Table 3.4. Nitrogen depositions to the six catchment areas of the Baltic Sea and to the entire catchment area of the Baltic Sea calculated for 2010 using the meteorology from four different years and as the average over these years. Emission Scenario 1 was used for these calculations. Units: kt N.

Sub-basin	Meteor-ology	Oxidized		Reduced		Total
		Dry	Wet	Dry	Wet	
GUB	1996	36	48	14	39	137
	1997	31	44	12	31	118
	1998	34	58	13	44	150
	2000	42	74	19	59	193
	MEAN	**36**	**56**	**15**	**43**	**149**
GUF	1996	47	70	22	69	207
	1997	41	66	23	63	194
	1998	51	76	27	72	227
	2000	56	82	31	75	244
	MEAN	**49**	**74**	**26**	**70**	**218**
GUR	1996	23	34	25	46	128
	1997	20	37	23	49	130
	1998	23	37	26	51	136
	2000	25	36	29	46	136
	MEAN	**23**	**36**	**26**	**48**	**132**
BAP	1996	128	187	198	273	786
	1997	118	178	202	264	761
	1998	132	209	206	293	840
	2000	138	205	225	279	848
	MEAN	**129**	**195**	**208**	**277**	**809**
BES	1996	7	11	12	15	46
	1997	7	9	13	13	42
	1998	7	14	13	19	52
	2000	7	14	14	18	53
	MEAN	**7**	**12**	**13**	**16**	**48**
KAT	1996	18	19	14	21	72
	1997	16	18	14	20	68
	1998	16	23	14	24	78
	2000	18	30	16	31	96
	MEAN	**17**	**23**	**15**	**24**	**78**
BALTIC SEA	1996	258	370	286	463	1376
	1997	233	353	288	441	1314
	1998	264	417	300	503	1483
	2000	286	442	334	507	1569
	MEAN	**260**	**395**	**302**	**478**	**1436**

Table 3.5. Nitrogen depositions to the six catchment areas of the Baltic Sea and to the entire catchment area of the Baltic Sea calculated for 2010 using the meteorology from four different years and as the average over these years. Emission Scenario 2 was used for these calculations. Units: kt N.

Sub-basin	Meteor-ology	Oxidized		Reduced		Total
		Dry	Wet	Dry	Wet	
GUB	1996	32	43	13	35	124
	1997	28	40	11	28	107
	1998	31	53	12	40	136
	2000	38	67	17	53	175
	MEAN	**32**	**51**	**13**	**39**	**136**
GUF	1996	43	64	20	63	190
	1997	38	61	22	58	179
	1998	48	70	26	67	210
	2000	52	76	29	69	226
	MEAN	**45**	**68**	**24**	**64**	**201**
GUR	1996	21	31	23	41	117
	1997	19	34	21	45	119
	1998	21	33	23	46	124
	2000	23	33	26	42	123
	MEAN	**21**	**33**	**23**	**44**	**121**
BAP	1996	116	170	179	247	711
	1997	107	161	182	239	688
	1998	120	189	186	265	759
	2000	125	186	203	252	766
	MEAN	**117**	**176**	**188**	**250**	**731**
BES	1996	6	10	11	14	41
	1997	6	8	12	12	38
	1998	6	12	12	17	47
	2000	6	12	13	16	47
	MEAN	**6**	**11**	**12**	**15**	**43**
KAT	1996	16	17	13	19	65
	1997	14	17	13	18	61
	1998	14	21	13	22	70
	2000	17	27	15	28	86
	MEAN	**15**	**21**	**13**	**22**	**71**
BALTIC SEA	1996	235	336	259	419	1248
	1997	212	321	261	400	1193
	1998	240	379	272	456	1347
	2000	260	401	303	459	1423
	MEAN	**237**	**359**	**273**	**434**	**1303**

Table 3.6. Nitrogen depositions to the catchment areas of the Baltic Sea and to the entire catchment area of the Baltic Sea calculated for 2010 using the meteorology from four different years and as the average over these years. The CLE Emission Scenario was used for these calculations. Units: kt N.

Sub-basin	Meteor-ology	Oxidized		Reduced		Total
		Dry	Wet	Dry	Wet	
GUB	1996	37	48	12	46	143
	1997	32	44	10	35	121
	1998	34	56	11	49	151
	2000	41	69	16	64	190
	MEAN	**36**	**54**	**12**	**48**	**151**
GUF	1996	50	67	21	77	215
	1997	38	62	16	62	179
	1998	47	69	19	71	206
	2000	52	74	22	76	223
	MEAN	**47**	**68**	**20**	**71**	**206**
GUR	1996	21	29	16	43	109
	1997	18	34	14	43	109
	1998	21	33	15	44	113
	2000	22	32	17	41	112
	MEAN	**21**	**32**	**15**	**43**	**111**
BAP	1996	119	163	137	251	669
	1997	114	166	140	236	656
	1998	123	193	145	264	725
	2000	131	189	162	253	734
	MEAN	**122**	**178**	**146**	**251**	**696**
BES	1996	7	12	11	17	47
	1997	7	10	13	15	45
	1998	7	15	13	21	56
	2000	8	15	14	20	56
	MEAN	**7**	**13**	**13**	**18**	**51**
KAT	1996	19	20	13	23	75
	1997	17	21	13	22	73
	1998	17	25	13	27	82
	2000	20	31	16	34	101
	MEAN	**18**	**24**	**14**	**27**	**83**
BALTIC SEA	1996	252	339	210	456	1257
	1997	227	337	206	413	1184
	1998	248	391	216	477	1332
	2000	274	409	246	488	1417
	MEAN	**250**	**369**	**220**	**459**	**1298**

3.3 Differences in depositions calculated for Scenarios 1 and 2

To estimate the effects of emissions reductions applied in Scenario 2, the differences in depositions between Scenario 2 and Scenario 1 for all sub-basins and catchment areas of the Baltic Sea were calculated and expressed as a percent of the depositions calculated for Scenario 1.

These differences are shown for all meteorological years and the mean values in Tables 3.7 and 3.8 for Scenarios 1 and 2, respectively. It should be noted that "mean" in Tables 3.7 and 3.8 is not the mean value of the reductions over the four meteorological years, but rather the reduction in the mean depositions in Scenario 2 compared to Scenario 1.

For both sub-basins and catchment areas there is some variability in the calculated deposition reductions, but in both cases the largest reductions can be observed in the dry deposition of reduced nitrogen and the smallest reductions in the dry deposition of oxidized nitrogen.

For sub-basins, the smallest reduction was −7.8% of dry oxidized nitrogen deposition, which occurred in 1997 in the Gulf of Finland (GUF). The largest reduction was −9.9% for dry deposition of oxidized nitrogen in the Belt Sea (BES) in 2000 and for wet deposition of oxidized nitrogen and wet deposition of reduced nitrogen in the Kattegat (KAT) sub-basin in 1997.

Among the catchment areas, the smallest reduction was −6.5% of dry reduced nitrogen deposition, which occurred in 2000 in the Gulf of Finland (GUF). The largest reduction was −9.8%, which occurred in several catchment areas, particularly BES and KAT for different kinds of nitrogen deposition.

Concerning the mean deposition of total nitrogen, the largest reduction in the deposition, −9.8%, can be observed for the Kattegat (KAT) and Belt Sea (BES) sub-basins, followed by the Baltic Proper (BAP) with −9.6%, the Gulf of Riga (GUR) with −9.4%, the Gulf of Bothnia (GUB) −9.2%, and finally the Gulf of Finland (GUF) with −8.7%.

For the catchment areas, the largest reduction in mean total nitrogen deposition, −9.8%, can also be observed for the Kattegat (KAT) and Belt Sea (BES) catchment areas, followed by the Baltic Proper (BAP) with −9.6%, the Gulf of Bothnia (GUB) −9.1%, the Gulf of Riga (GUR) −8.9%, and finally the Gulf of Finland (GUF) with −7.7%.

Table 3.7. Differences in nitrogen depositions to the sub-basins of the Baltic Sea and to the entire basin of the Baltic Sea between Emission Scenario 1 and Emission Scenario 2. Calculations for 2010 used the meteorology from four different years and the average over these years. Emission Scenario 2 was used for these calculations. Units: percent of Scenario 1 depositions.

Sub-basin	Meteor-ology	Oxidized		Reduced		Total
		Dry	Wet	Dry	Wet	
GUB	1996	-9.5	-9.4	-9.7	-9.3	-9.4
	1997	-8.9	-9.1	-9.6	-9.3	-9.1
	1998	-9.0	-9.0	-9.5	-9.1	-9.1
	2000	-9.3	-9.3	-9.5	-9.3	-9.3
	MEAN	**-9.2**	**-9.2**	**-9.6**	**-9.2**	**-9.2**
GUF	1996	-9.0	-8.9	-9.6	-9.1	-9.1
	1997	-7.8	-9.0	-8.6	-9.0	-8.7
	1998	-8.0	-8.3	-8.7	-8.6	-8.4
	2000	-8.4	-8.9	-8.5	-9.0	-8.8
	MEAN	**-8.3**	**-8.8**	**-8.8**	**-8.9**	**-8.7**
GUR	1996	-9.2	-9.2	-9.6	-9.5	-9.4
	1997	-8.8	-9.5	-9.6	-9.6	-9.4
	1998	-9.1	-9.5	-9.6	-9.6	-9.5
	2000	-9.4	-9.5	-9.7	-9.5	-9.5
	MEAN	**-9.1**	**-9.4**	**-9.6**	**-9.5**	**-9.4**
BAP	1996	-9.6	-9.5	-9.8	-9.6	-9.6
	1997	-9.3	-9.5	-9.6	-9.7	-9.5
	1998	-9.5	-9.6	-9.5	-9.6	-9.6
	2000	-9.6	-9.7	-9.6	-9.6	-9.6
	MEAN	**-9.5**	**-9.6**	**-9.6**	**-9.6**	**-9.6**
BES	1996	-9.7	-9.8	-9.8	-9.8	-9.8
	1997	-9.7	-9.8	-9.8	-9.8	-9.8
	1998	-9.8	-9.8	-9.8	-9.8	-9.8
	2000	-9.9	-9.8	-9.8	-9.8	-9.8
	MEAN	**-9.8**	**-9.8**	**-9.8**	**-9.8**	**-9.8**
KAT	1996	-9.7	-9.8	-9.8	-9.8	-9.8
	1997	-9.7	-9.9	-9.8	-9.9	-9.8
	1998	-9.8	-9.8	-9.8	-9.8	-9.8
	2000	-9.8	-9.8	-9.8	-9.8	-9.8
	MEAN	**-9.8**	**-9.8**	**-9.8**	**-9.8**	**-9.8**
BALTIC SEA	1996	-9.5	-9.5	-9.7	-9.6	-9.5
	1997	-9.2	-9.5	-9.6	-9.6	-9.5
	1998	-9.3	-9.5	-9.6	-9.5	-9.5
	2000	-9.5	-9.5	-9.6	-9.6	-9.5
	MEAN	**-9.4**	**-9.5**	**-9.6**	**-9.6**	**-9.5**

Table 3.8. Differences in nitrogen depositions to the catchment areas of the Baltic Sea and to the entire basin of the Baltic Sea between Emission Scenario 1 and Emission Scenario 2. Calculations for 2010 used the meteorology from four different years and the average over these years. Emission Scenario 2 was used for these calculations. Units: percent of Scenario 1 depositions.

Sub-basin	Meteor-ology	Oxidized		Reduced		Total
		Dry	Wet	Dry	Wet	
GUB	1996	-9.4	-9.3	-9.7	-9.2	-9.3
	1997	-8.8	-9.1	-9.6	-9.2	-9.1
	1998	-8.8	-8.9	-9.5	-9.0	-8.9
	2000	-9.1	-9.2	-9.5	-9.2	-9.2
	MEAN	**-9.0**	**-9.1**	**-9.6**	**-9.1**	**-9.1**
GUF	1996	-7.9	-8.2	-8.6	-8.4	-8.2
	1997	-6.8	-8.0	-6.6	-7.8	-7.5
	1998	-6.9	-7.7	-6.7	-7.6	-7.4
	2000	-7.1	-8.0	-6.5	-7.9	-7.6
	MEAN	**-7.2**	**-8.0**	**-7.0**	**-7.9**	**-7.7**
GUR	1996	-8.1	-8.5	-9.2	-8.9	-8.7
	1997	-8.0	-8.8	-9.2	-9.1	-8.9
	1998	-8.6	-9.0	-9.3	-9.2	-9.1
	2000	-8.6	-9.0	-9.3	-9.3	-9.1
	MEAN	**-8.4**	**-8.8**	**-9.2**	**-9.1**	**-8.9**
BAP	1996	-9.5	-9.5	-9.8	-9.7	-9.6
	1997	-9.4	-9.6	-9.7	-9.7	-9.6
	1998	-9.6	-9.6	-9.7	-9.7	-9.7
	2000	-9.6	-9.7	-9.7	-9.7	-9.7
	MEAN	**-9.5**	**-9.6**	**-9.7**	**-9.7**	**-9.6**
BES	1996	-9.7	-9.8	-9.8	-9.8	-9.8
	1997	-9.7	-9.8	-9.8	-9.8	-9.8
	1998	-9.8	-9.8	-9.8	-9.8	-9.8
	2000	-9.8	-9.8	-9.8	-9.8	-9.8
	MEAN	**-9.8**	**-9.8**	**-9.8**	**-9.8**	**-9.8**
KAT	1996	-9.7	-9.8	-9.8	-9.8	-9.7
	1997	-9.7	-9.8	-9.8	-9.8	-9.8
	1998	-9.8	-9.8	-9.8	-9.8	-9.8
	2000	-9.8	-9.8	-9.8	-9.8	-9.8
	MEAN	**-9.7**	**-9.8**	**-9.8**	**-9.8**	**-9.8**
BALTIC SEA	1996	-9.1	-9.2	-9.6	-9.4	-9.3
	1997	-8.8	-9.1	-9.4	-9.3	-9.2
	1998	-8.9	-9.1	-9.4	-9.3	-9.2
	2000	-9.0	-9.2	-9.4	-9.4	-9.3
	MEAN	**-8.9**	**-9.2**	**-9.5**	**-9.3**	**-9.2**

3.4 Comparison of 2010 and 2003 depositions

A comparison of 2003 (Bartnicki et al., 2005) and projected 2010 annual nitrogen depositions to the sub-basins of the Baltic Sea is shown in Table 3.9, and a comparison of 2003 and projected 2010 annual total nitrogen depositions to the catchment areas of the Baltic Sea is shown in Table 3.10.

Table 3.9. Comparison of annual deposition of dry oxidized, wet oxidized, dry reduced, wet reduced, and total nitrogen deposition to the sub-basins of the Baltic Sea for Scenario 1, Scenario 2, the CLE Scenario, and 2003 deposition. Units: kt/year. The lowest depositions for each sub-basin are highlighted.

Sub-basin	Results	Oxidized		Reduced		Total
		Dry	Wet	Dry	Wet	
GUB	2003	7.0	13.6	2.2	11.9	34.8
	2010-Sc1	6.2	13.9	3.0	10.6	33.7
	2010-Sc2	5.6	12.6	2.7	9.6	30.6
	2010-CLE	6.4	13.2	2.3	11.4	33.3
GUF	2003	3.0	4.7	0.8	3.9	12.4
	2010-Sc1	2.9	5.3	2.0	4.9	15.0
	2010-Sc2	2.7	4.8	1.8	4.4	13.7
	2010-CLE	2.8	5.0	1.1	4.7	13.5
GUR	2003	2.3	3.3	0.7	3.0	9.2
	2010-Sc1	2.2	3.5	1.7	3.6	11.0
	2010-Sc2	2.0	3.2	1.6	3.2	9.9
	2010-CLE	2.0	3.3	0.9	3.3	9.5
BAP	2003	25.8	44.2	13.7	38.0	121.6
	2010-Sc1	21.9	41.9	23.4	39.7	127.0
	2010-Sc2	19.8	37.9	21.2	35.9	114.8
	2010-CLE	22.8	41.1	16.2	40.4	120.8
BES	2003	3.2	5.5	5.2	6.3	20.3
	2010-Sc1	2.5	5.1	5.6	6.7	19.9
	2010-Sc2	2.2	4.6	5.0	6.0	17.9
	2010-CLE	2.7	5.6	5.2	7.5	21.0
KAT	2003	3.3	6.2	3.5	6.9	19.0
	2010-Sc1	2.4	5.1	3.6	5.5	16.6
	2010-Sc2	2.2	4.6	3.3	4.9	15.0
	2010-CLE	2.8	5.7	3.2	6.2	17.8
BALTIC SEA	2003	44.7	77.4	26.2	69.1	217.4
	2010-Sc1	38.1	74.8	39.3	70.9	223.1
	2010-Sc2	34.5	67.8	35.5	64.1	201.9
	2010-CLE	39.5	74.1	28.9	73.5	215.9

Table 3.10. Comparison of annual total nitrogen deposition to the catchment areas of the Baltic Sea for Scenario 1, Scenario 2, the CLE Scenario, and 2003 deposition. Units: kt/year. The lowest depositions for each catchment area are highlighted.

Deposition	GUB	GUF	GUR	BAP	BES	KAT	Baltic Sea
2003	158	199	97	665	50	88	1257
Scenario 1	149	218	132	809	48	78	1436
Scenario 2	136	201	121	731	43	71	1303
CLE Scenario	151	206	111	696	51	83	1298

Compared to 2003 depositions, nitrogen depositions calculated for 2010 with Scenario 2 are lower for most of the sub-basins of the Baltic Sea. In particular, the projected deposition of dry oxidized nitrogen is lower in 2010 than the deposition in 2003 in all sub-basins. The deposition of wet oxidized nitrogen is also projected to be lower in 2010 (Scenario 2) than in 2003 in all sub-basins except GUF, where it is on the same level as in 2003.

The deposition of dry reduced nitrogen is projected to be higher in 2010 (all scenarios) than in 2003 for the GUB, GUF, GUR, and BAP sub-basins. The lowest deposition of wet reduced nitrogen is calculated with Scenario 2 for the sub-basins GUB, BAP, BES, and KAT. Wet deposition of reduced nitrogen is lower in 2003 than that projected in 2010 in the GUF and GUR sub-basins.

Annual oxidized dry and wet depositions into the entire basin of the Baltic Sea are projected to be lower in 2010 (all scenarios) than in 2003, but annual reduced dry and wet depositions into the entire basin of the Baltic Sea are projected to be higher in 2010 than in 2003, except for the wet deposition of reduced nitrogen calculated with Scenario 2. Total nitrogen deposition into the entire basin of the Baltic Sea is projected to be higher in 2010 than in 2003 for Scenario 1 and the CLE Scenario.

Compared to 2003 depositions, the total nitrogen depositions calculated for 2010 are higher for three catchment areas of the Baltic Sea: GUF, GUR, and BAP. Also, total nitrogen deposition into the entire catchment area of the Baltic Sea is calculated to be higher in 2010 than in 2003.

These results follow the differences in nitrogen oxides and ammonia emissions in 2003 and in 2010. However, as can be seen from Tables 3.1 to 3.4, the influence of meteorology on the results is significant.

3.5 Uncertainty due to meteorological variability

To assess the variability of computed depositions due to varying meteorological conditions, the standard deviation was calculated for each of the deposition types. The maps of nitrogen depositions in 2010 according to Scenario 1, together with the maps of standard deviations for oxidized, reduced, dry, wet, and total nitrogen deposition are shown in Figures 3.6 to 3.10. An inspection of the maps indicates that the standard deviations of the computed depositions due to varying meteorological conditions are relatively large, up to 20–30% of the computed depositions. The maxima of the standard deviations are located close to the maxima of the computed depositions.

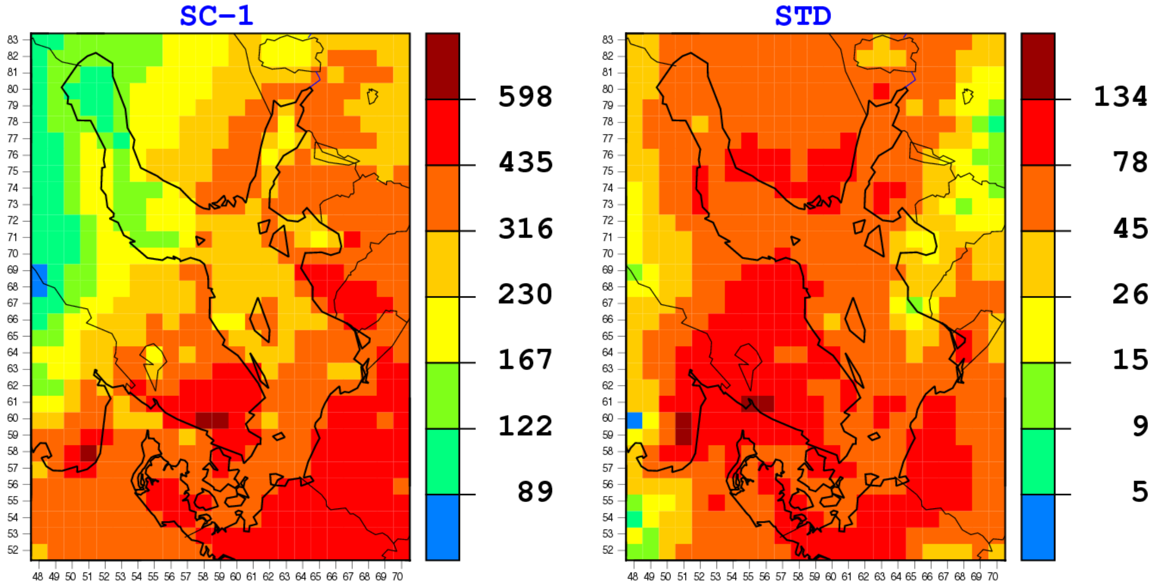


Figure 3.6. Calculated mean annual deposition of oxidized (wet and dry) nitrogen in 2010 according to Emission Scenario 1 for 2010 (left) and the standard deviation of the calculated mean (right). Meteorological data from the years 1996, 1997, 1998, and 2000 were used in the model runs. The calculated mean deposition is the average of the results for the different meteorological years. Units: mg N m^{-2}.

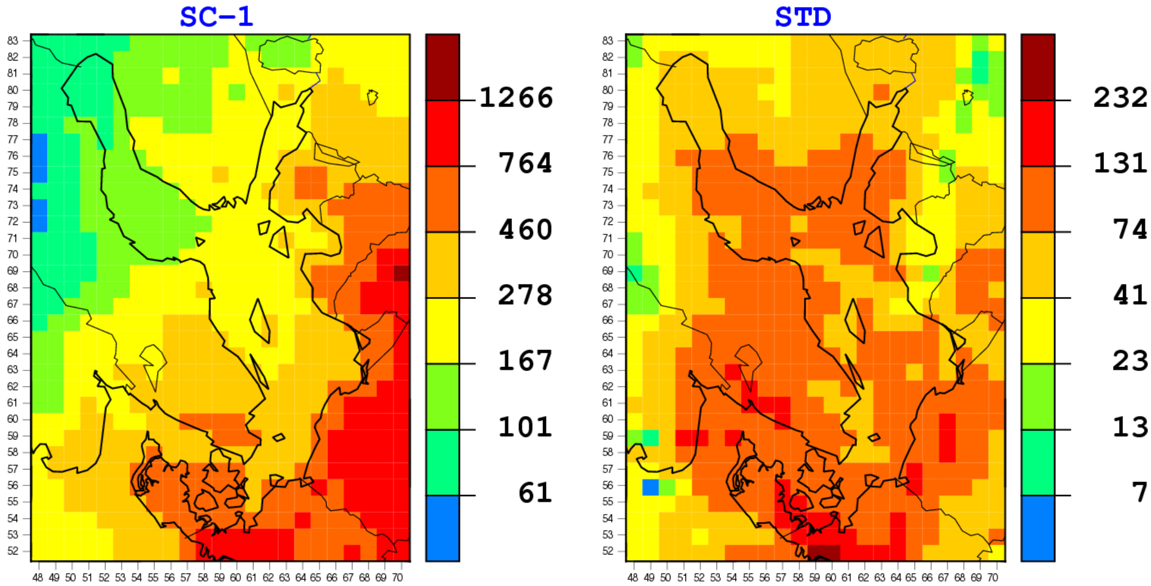


Figure 3.7. Calculated mean annual deposition of reduced (wet and dry) nitrogen in 2010 according to Emission Scenario 1 for 2010 (left) and standard deviation of the calculated mean (right). Meteorological data from the years 1996, 1997, 1998, and 2000 were used in the model runs. The calculated mean deposition is the average of the results for the different meteorological years. Units: mg N m^{-2}.

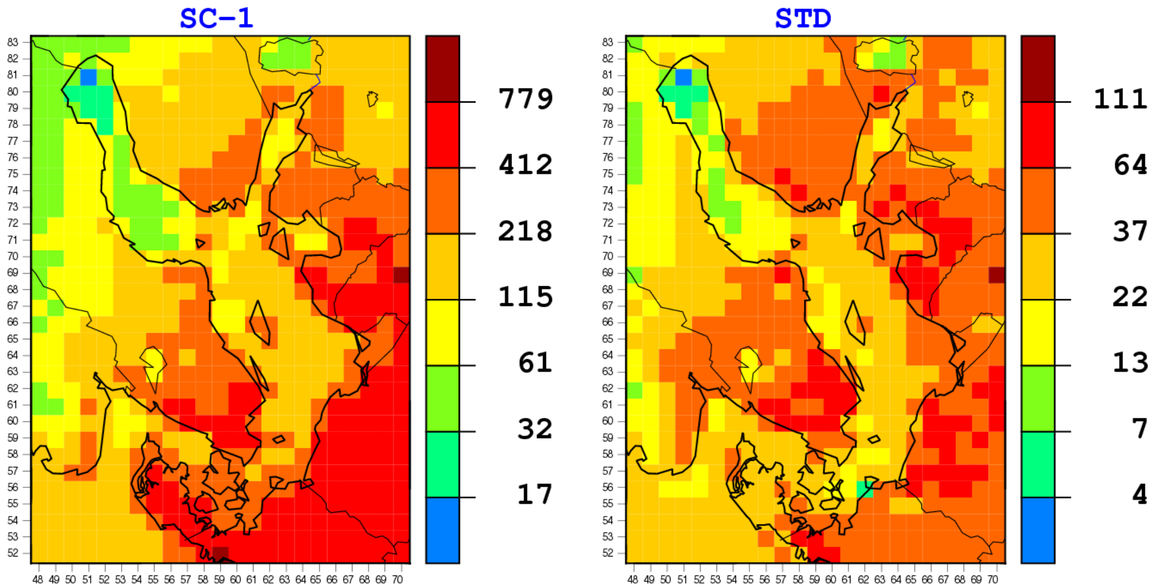


Figure 3.8. Calculated mean annual deposition of dry (oxidized + reduced) nitrogen in 2010 according to Emission Scenario 1 for 2010 (left) and standard deviation of the calculated mean (right). Meteorological data from the years 1996, 1997, 1998, and 2000 were used in the model runs. The calculated mean deposition is the average of the results for the different meteorological years. Units: mg N m^{-2}.

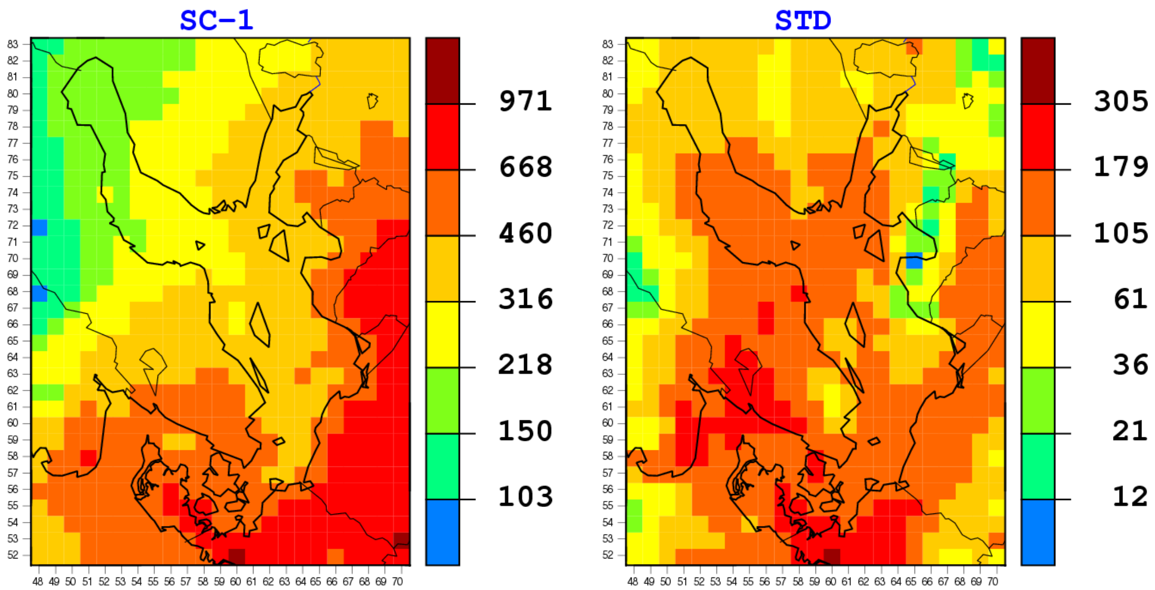


Figure 3.9. Calculated mean annual deposition of wet (oxidized + reduced) nitrogen in 2010 according to Emission Scenario 1 for 2010 (left) and standard deviation of the calculated mean (right). Meteorological data from the years 1996, 1997, 1998, and 2000 were used in the model runs. The calculated mean deposition is the average of the results for the different meteorological years. Units: mg N m^{-2}.

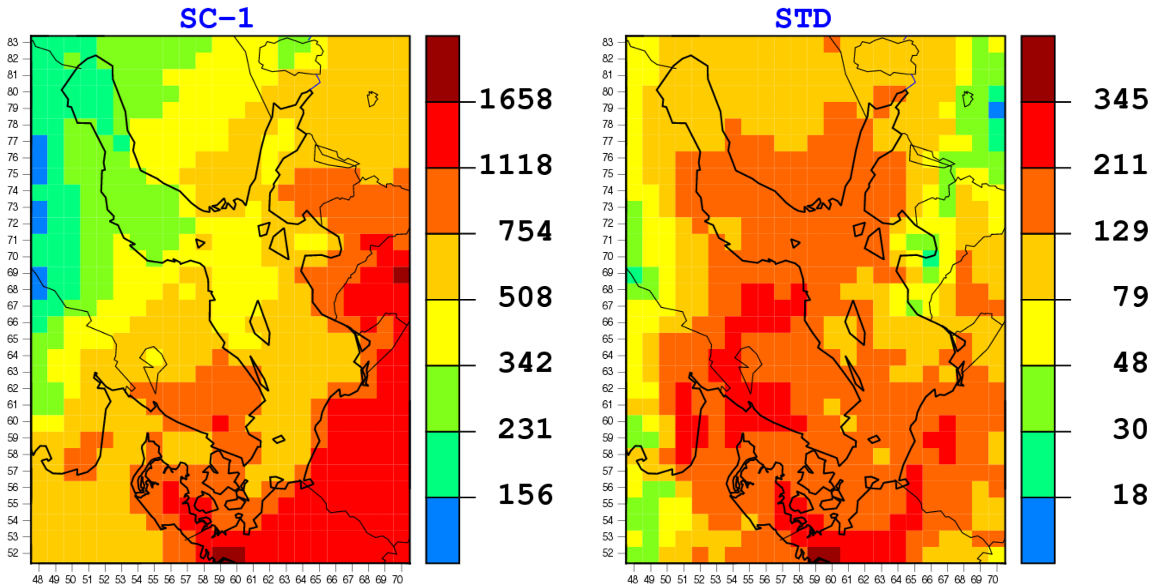


Figure 3.10. Calculated mean annual deposition of total nitrogen in 2010 according to Emission Scenario 1 for 2010 (left) and standard deviation of the calculated mean (right). Meteorological data from the years 1996, 1997, 1998, and 2000 were used in the model runs. The calculated mean deposition is the average of the results for the different meteorological years. Units: mg N m^{-2}.

The computed standard deviation in relation to the computed deposition is the largest for wet deposition (~30%) and the smallest for dry deposition (~10%). It is larger for oxidized nitrogen deposition (~25%) than for reduced nitrogen deposition (~20%). The standard deviation for the total deposition is in the middle, at approximately 22% of the computed total deposition.

The range between minimum and maximum can also indicate the uncertainty due to variable meteorological conditions. These ranges computed for the different meteorological years were expressed as per cent of the calculated mean value of the deposition. The results for Emission Scenario 1 are presented in Tables 3.11 and 3.12 for the sub-basins and for the catchment areas, respectively.

Table 3.11. Relative range of nitrogen depositions to the sub-basins of the Baltic Sea and to the entire basin of the Baltic Sea, calculated for 2010 using the meteorology from four different years. Emission Scenario 1 was used for these calculations. Units: per cent of mean nitrogen deposition over four years.

Sub-basin	Oxidized		Reduced		Total
	Dry	Wet	Dry	Wet	
GUB	28	61	48	84	61
GUF	22	42	35	38	36
GUR	24	18	38	19	22
BAP	16	33	26	32	28
BES	6	38	17	36	22
KAT	10	47	15	38	32
BAS	**17**	**39**	**25**	**40**	**33**

Table 3.12. Relative range of nitrogen depositions to the catchment areas of the Baltic Sea and to the entire catchment area of the Baltic Sea, calculated for 2010 using the meteorology from four different years. Emission Scenario 1 was used for these calculations. Units: per cent of mean nitrogen deposition over four years.

Sub-basin	Oxidized		Reduced		Total
	Dry	Wet	Dry	Wet	
GUB	30	53	46	64	50
GUF	31	22	36	17	23
GUR	20	10	21	10	6
BAP	16	16	13	10	11
BES	3	39	16	35	22
KAT	16	52	15	45	35
BAS	**20**	**22**	**16**	**14**	**18**

Both for Scenario 1 and for Scenario 2, the largest uncertainty due to meteorological variability can be noted for the GUB (Gulf of Bothnia) sub-basin and catchment area, with a relatively low nitrogen deposition.

The relative ranges of the depositions due to variable meteorology are rather large, both for the sub-basins and for the catchment areas of the Baltic Sea. For the deposition of oxidized and reduced nitrogen to the sub-basins and to the entire basin of the Baltic Sea, there is greater variability in the wet than in the dry deposition. The relative ranges of nitrogen deposition to the catchment areas are in general lower than the relative ranges of nitrogen deposition to the sub-basins of the Baltic Sea.

4. SOURCE ALLOCATION BUDGETS FOR 2010

The EMEP unified model has been used to calculate source-receptor relationships for nitrogen deposition to the sub-basins and catchment areas of the Baltic Sea. Computations were performed for Emission Scenario 1, Emission Scenario 2, and the CLE Emission Scenario for the four meteorological years. The source-receptor matrices for 2010 were calculated as the average over all four meteorological years.

4.1 Source allocation budgets for sub-basins

Tables showing the complete contributions of all EMEP emission sources of nitrogen to total (oxidized + reduced) nitrogen depositions to the sub-basins and catchment areas of the Baltic Sea in 2010 are presented in Appendix C (Scenario 1) and Appendix D (Scenario 2), for all four meteorological years and as the average over these four years. The mean source-receptor matrices are also given for the CLE Scenario in Appendix E.

The top ten emission sources contributing to nitrogen depositions in all sub-basins of the Baltic Sea, according to Scenario 1, Scenario 2, and the CLE Scenario, are shown in Figures 4.1 to 4.7.

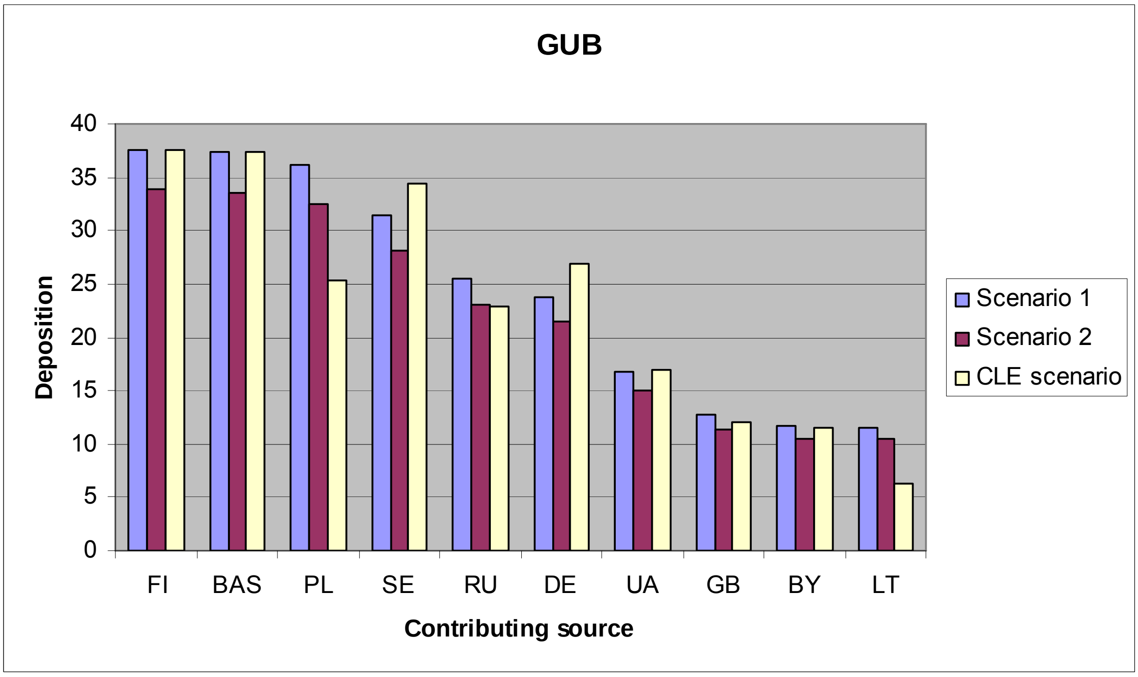


Figure 4.1. The main emission sources contributing to total nitrogen depositions in the GUB sub-basin according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

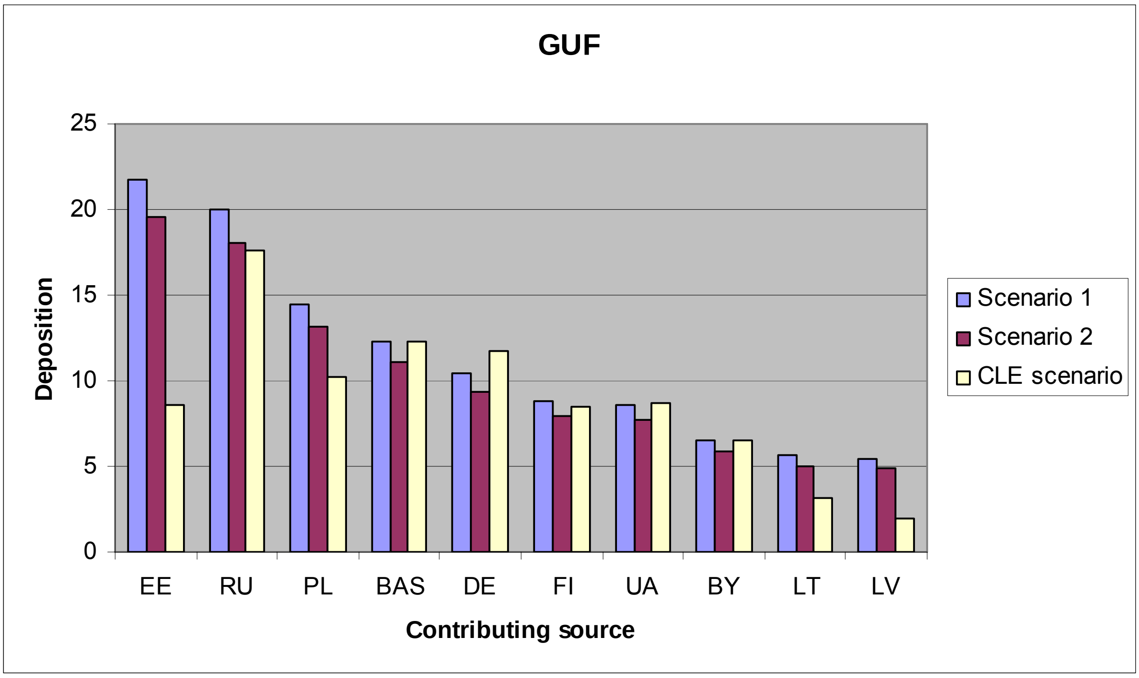


Figure 4.2. The main emission sources contributing to total nitrogen depositions in the GUF sub-basin according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

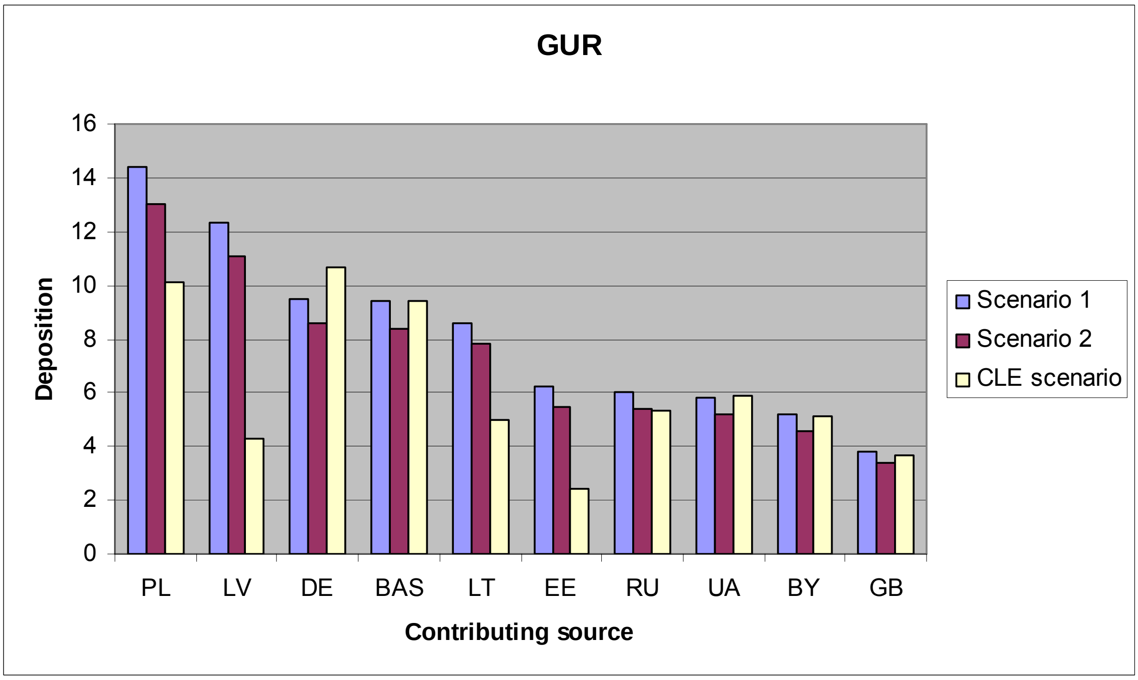


Figure 4.3. The main emission sources contributing to total nitrogen depositions in the GUR sub-basin according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

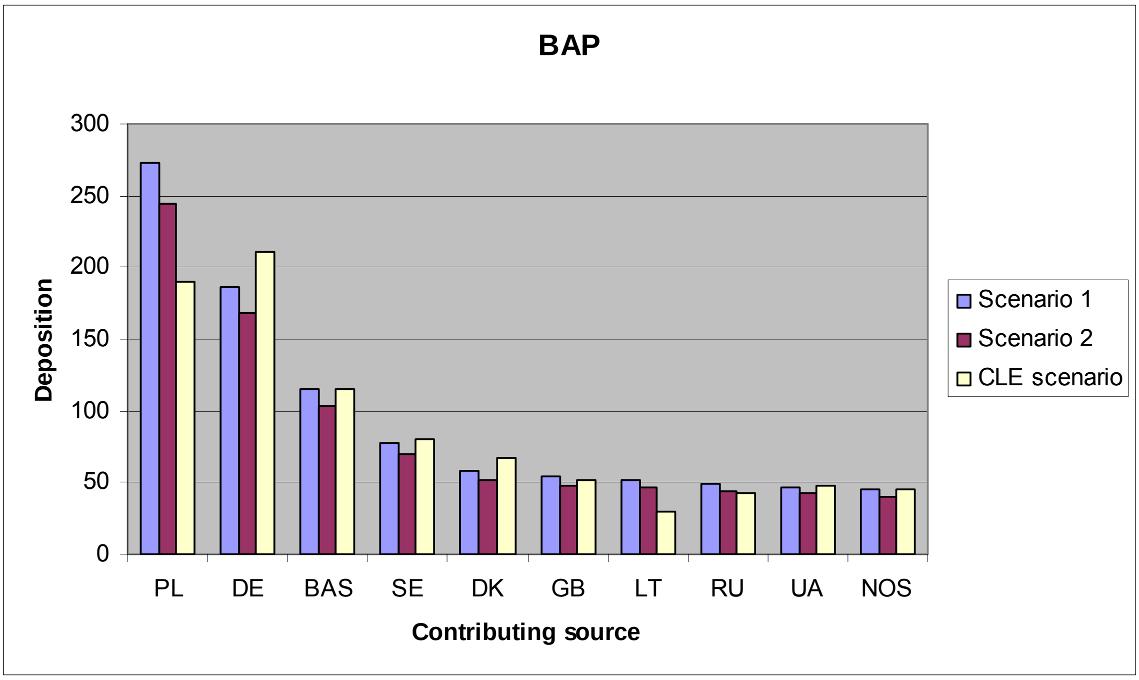


Figure 4.4. The main emission sources contributing to total nitrogen depositions in the BAP sub-basin according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

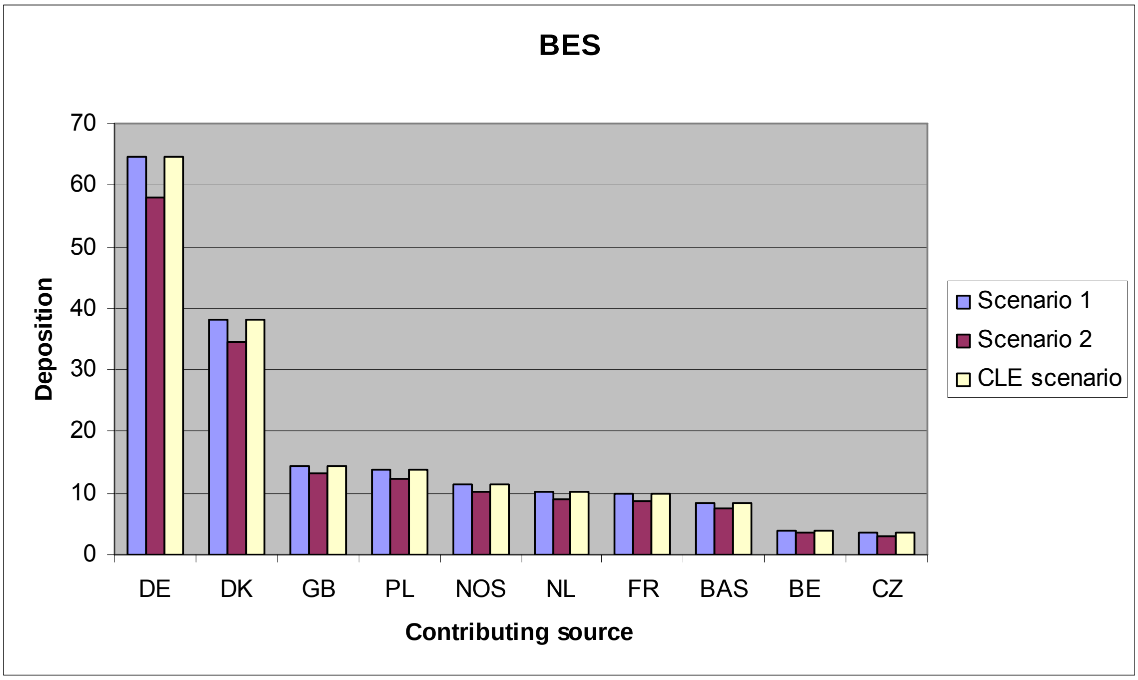


Figure 4.5. The main emission sources contributing to total nitrogen depositions in the BES sub-basin according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

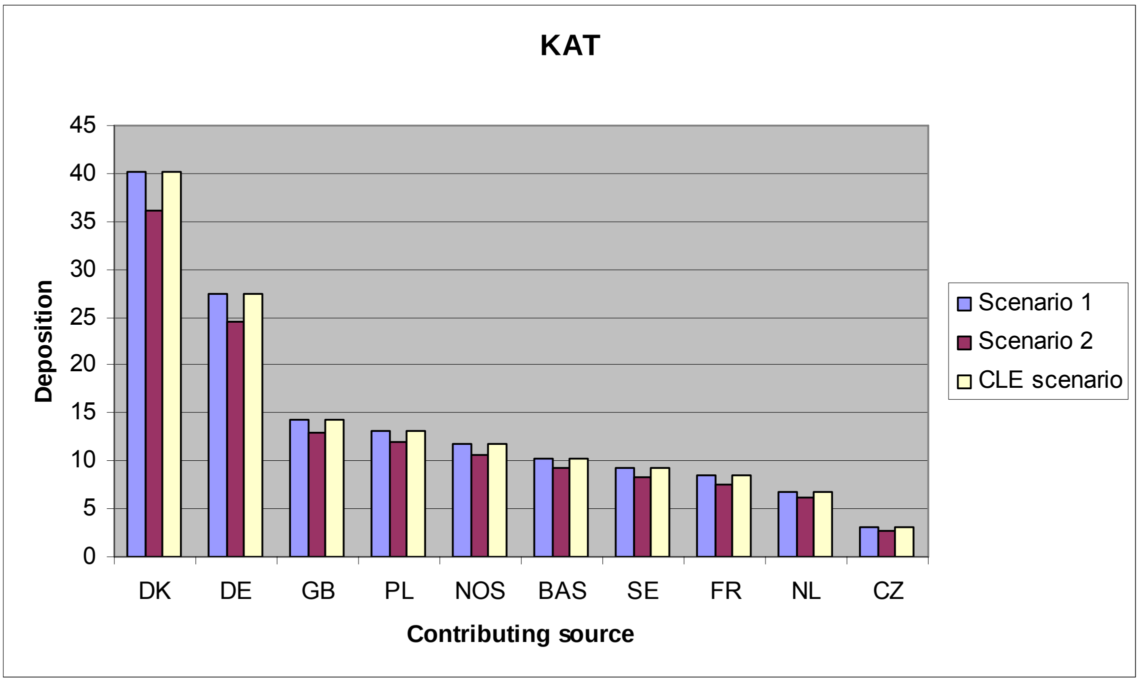


Figure 4.6. The main emission sources contributing to total nitrogen depositions in the KAT sub-basin according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

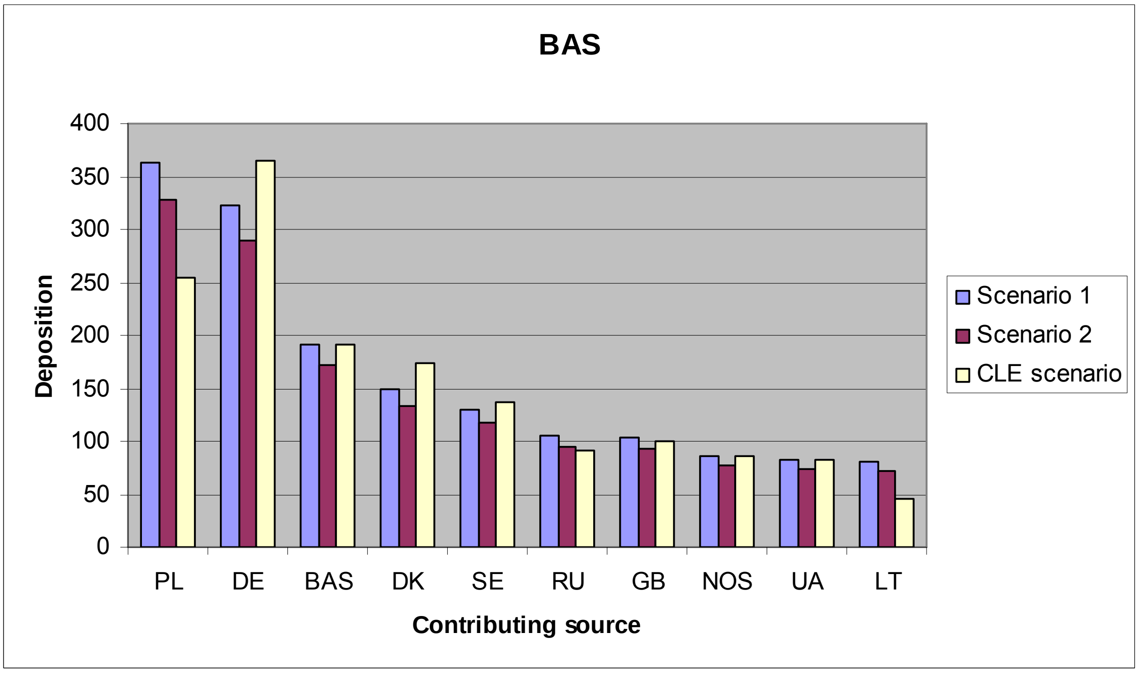


Figure 4.7. The main emission sources contributing to total nitrogen depositions in the entire basin of the Baltic Sea according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

For all sub-basins, the results are similar for Scenarios 1 and 2, but, as expected, contributions in the case of Scenario 2 are lower for all sources and sub-basins, based on the differences in nitrogen emissions. The rankings of contributing sources in these two scenarios are also the same for all sub-basins. The differences are much larger between the CLE Scenario and Scenarios 1 and 2. These differences are especially large for countries such as Latvia, Lithuania, Estonia, and Poland. The rankings are also different for Scenario 1 and the CLE Scenario in four, mainly northern, sub-basins (GUB, GUF, GUR, and BAP) as well as in the entire basin of the Baltic Sea.

According to Scenario 1, there are three major emission sources contributing to the deposition into all sub-basins of the Baltic Sea: Poland, Germany, and ship emissions from the Baltic Sea. 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 depositions in the following sub-basins, respectively. the Gulf of Bothnia, the Gulf of Finland, the Belt Sea, and the Kattegat. Emissions from the Baltic Sea are always present at the top of the ranking for all sub-basins of the Baltic Sea.

A significant contribution to nitrogen depositions into the sub-basins of the Baltic Sea from relatively distant sources can also be noted. The most important distant emission sources are the United Kingdom and ship emissions from the North Sea, especially for the BES and KAT sub-basins.

4.2 Source allocation budgets for the catchment areas

Tables showing the complete contributions of all EMEP emission sources of nitrogen to total (oxidized + reduced) nitrogen depositions in the sub-basins of the Baltic Sea in 2010 are presented in Appendix D for all four meteorological years and as the average for these four years.

The top ten emission sources contributing to nitrogen depositions in all catchment areas of the Baltic Sea are shown in Figures 4.8 to 4.14. Finland, the Russian Federation, Belarus, Poland, Germany, and Denmark are, respectively, the major contributors to nitrogen deposition in the catchment areas of the Gulf of Bothnia, the Gulf of Finland, the Gulf of Riga, the Baltic Proper, the Belt Sea, and the Kattegat. Poland is the largest contributor to nitrogen deposition in the entire Baltic Sea catchment area, followed by Germany and the Russian Federation. Some distant emission sources, for example, the United Kingdom, Ukraine, France, Netherlands, Czech Republic, Norway, and ship emissions on the North Sea also belong to the top ten contributors to nitrogen deposition into some of the catchment areas.

For all catchment areas, there is a significant contribution to the 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.

Nitrogen deposition to the entire catchment area of the Baltic Sea is dominated by emission sources from Poland, contributing approximately two times more than the next source on the list, namely, Germany.

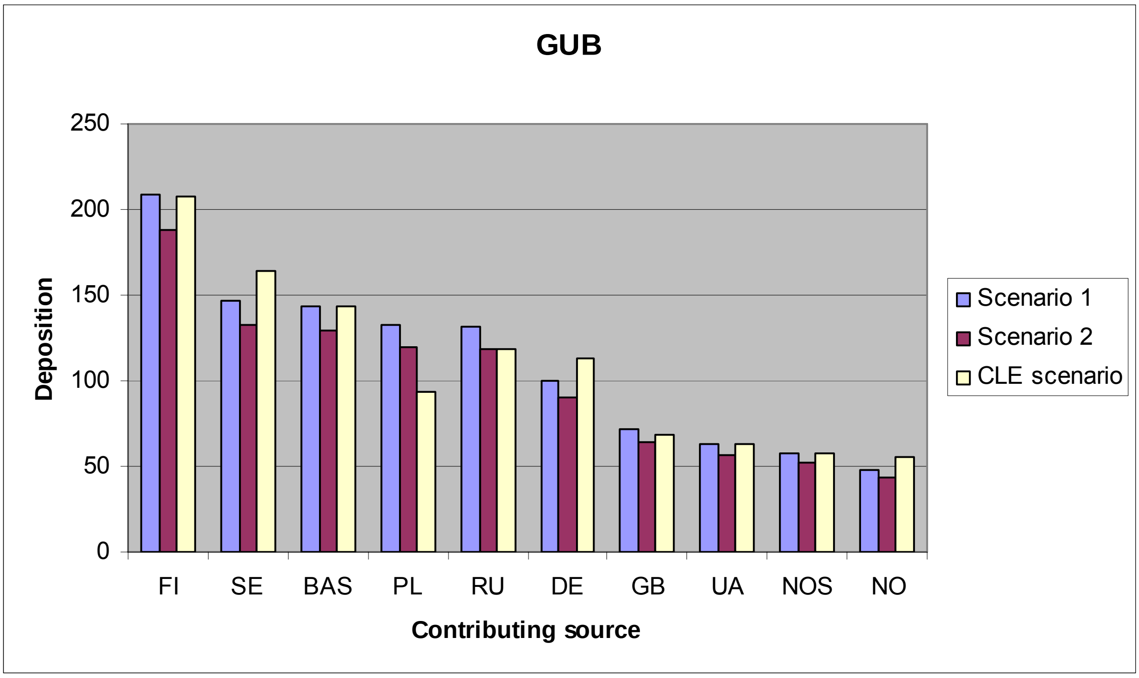


Figure 4.8. The main emission sources contributing to total nitrogen depositions in the GUB catchment area according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

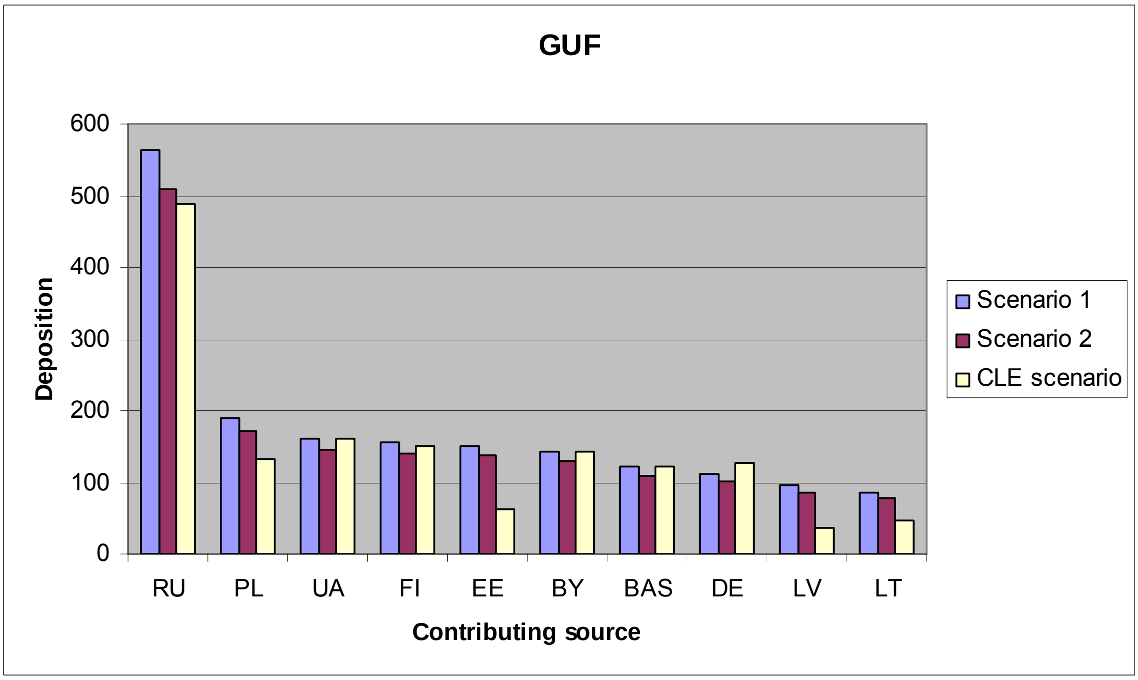


Figure 4.9. The main emission sources contributing to total nitrogen depositions in the GUF catchment area according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

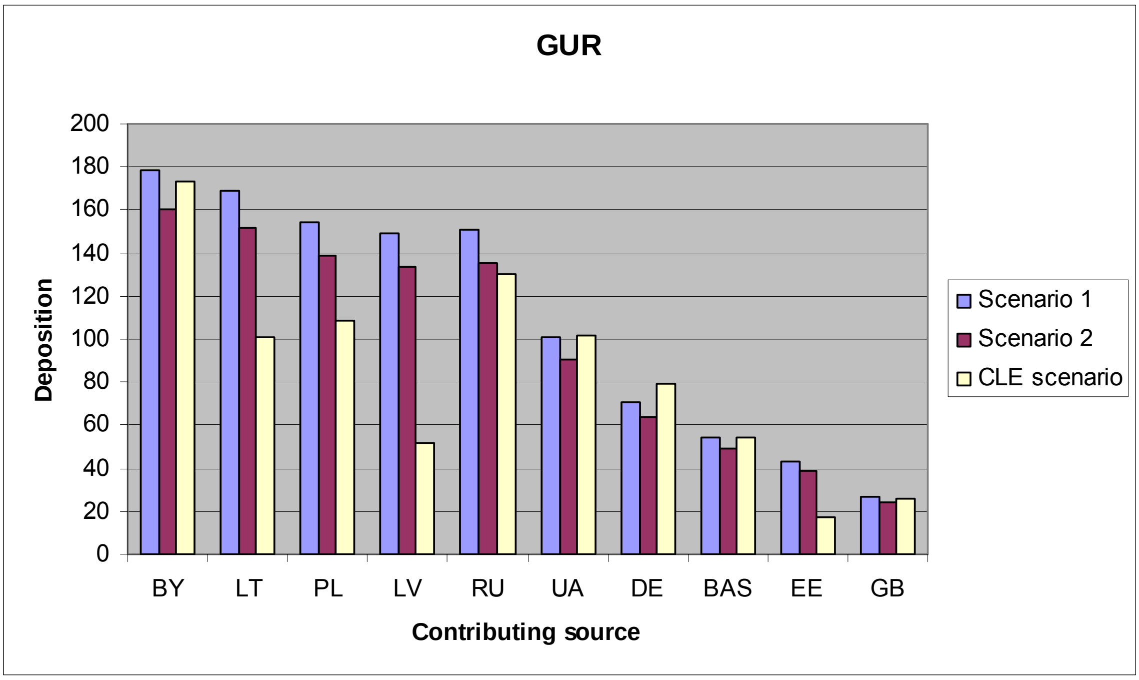


Figure 4.10. The main emission sources contributing to total nitrogen depositions in the GUR catchment area according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

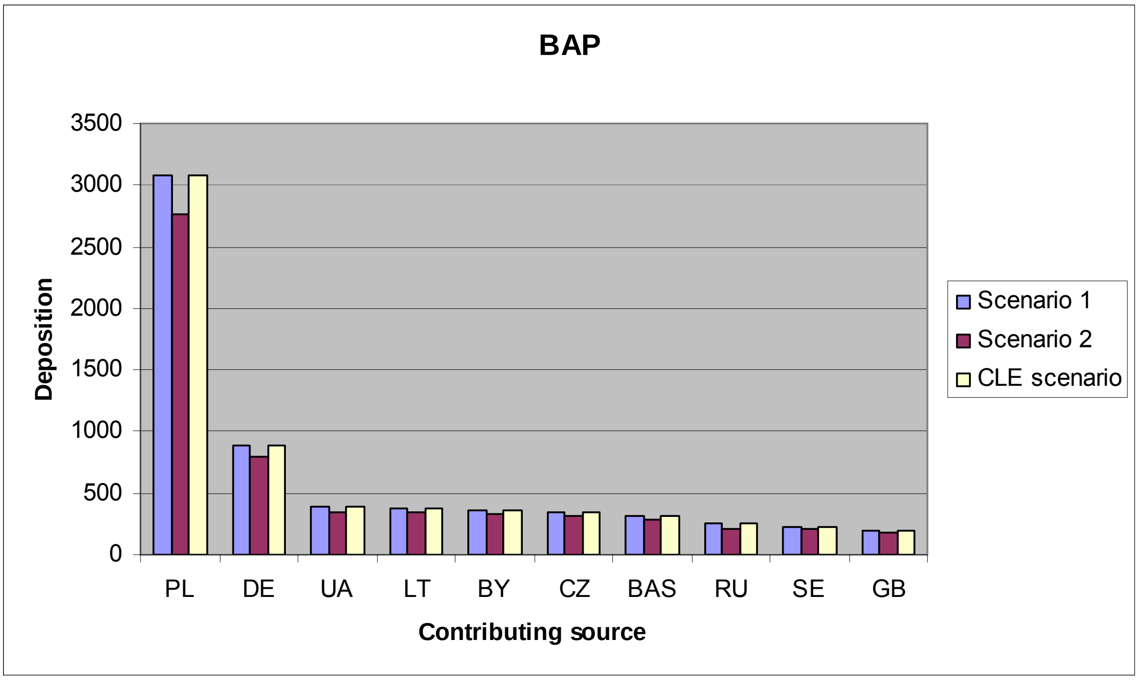


Figure 4.11. The main emission sources contributing to total nitrogen depositions in the BAP catchment area according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

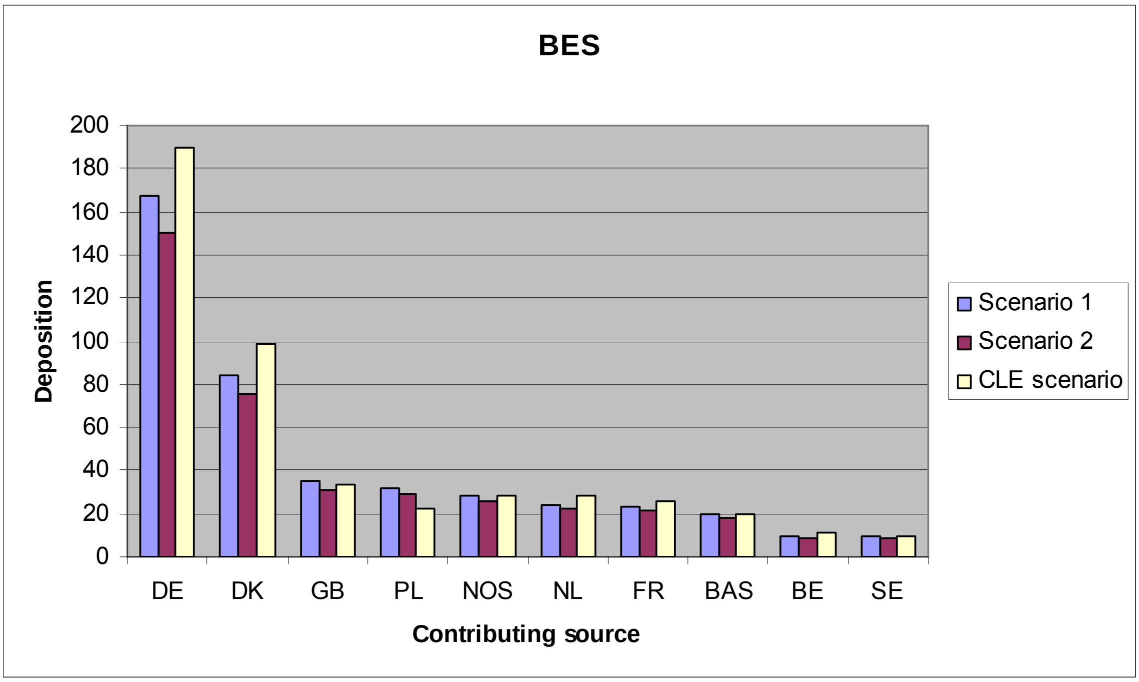


Figure 4.12. The main emission sources contributing to total nitrogen depositions in the BES catchment area according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

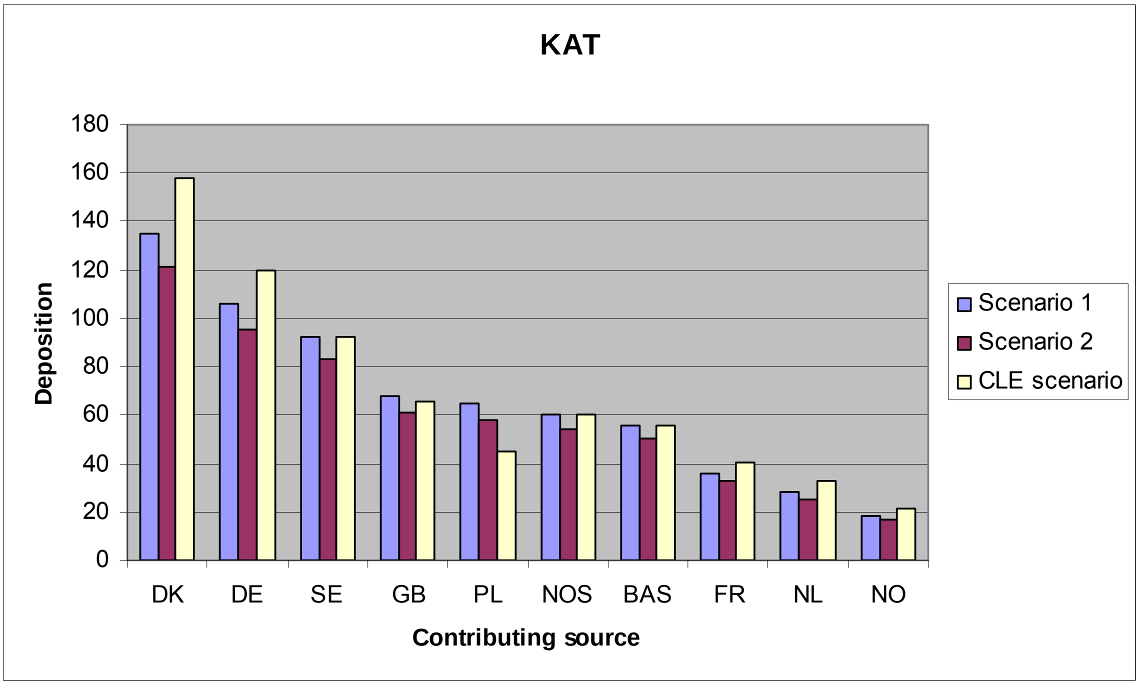


Figure 4.13. The main emission sources contributing to total nitrogen depositions in the KAT catchment area according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

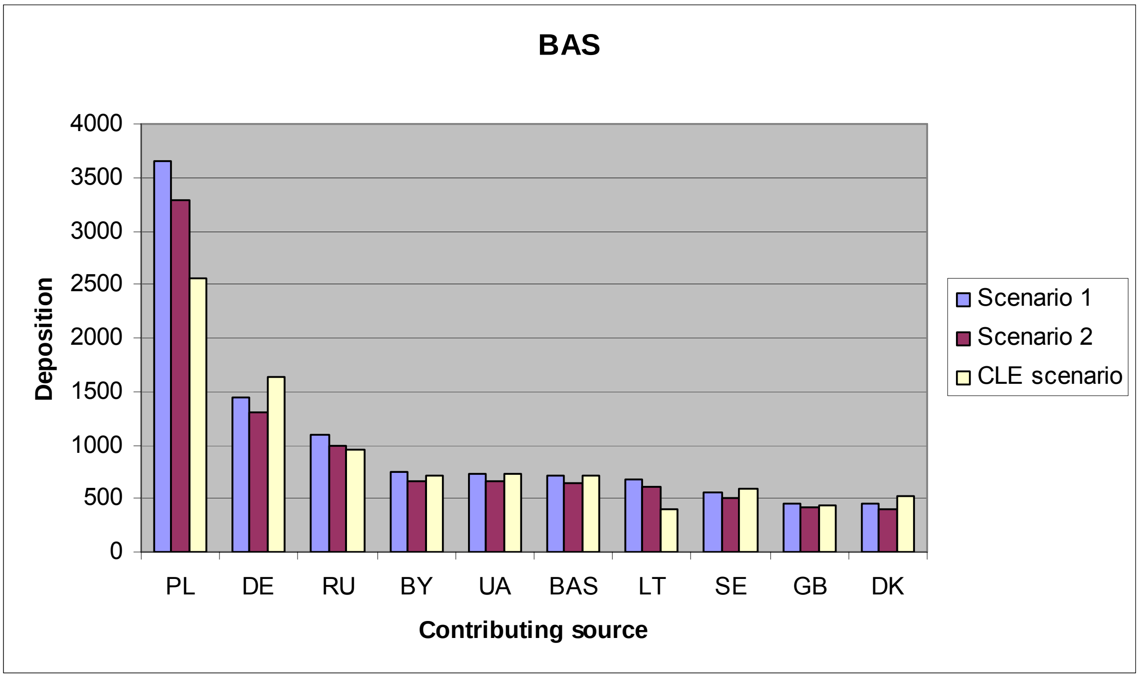


Figure 4.14. The main emission sources contributing to total nitrogen depositions in the entire catchment area of the Baltic Sea according to Scenarios 1, 2, and the CLE Scenario. Unit: 100 tonnes N per year.

4.3 Comparison of 2010 and 2003 contributions

Comparisons of 2010 (Scenario 1, Scenario 2, and the CLE Scenario) and 2003 contributions to nitrogen deposition to the Baltic Sea basin and catchment area are shown in Figures 4.15 and 4.16, respectively.

Compared to 2003, the contribution from four emission sources to the Baltic Sea basin will be reduced in 2010, namely, Germany, Denmark Sweden, and United Kingdom, but contributions from the Baltic Sea, the Russian Federation, the North Sea, Ukraine, and Lithuania will increase. Contributions from Poland will increase according to Scenarios 1 and 2, and decrease according to the CLE Scenario.

In the case of the entire catchment area of the Baltic Sea, there will be an increase in the contribution to the total nitrogen deposition from the Russian Federation, Ukraine, Belarus, the Baltic Sea, and Lithuania in 2010 compared to 2003. In contrast, contributions from Germany, Denmark, Sweden, and the United Kingdom will be lower in 2010 than those in 2003. Contributions from Poland will increase according to Scenarios 1 and 2, and decrease according to the CLE Scenario.

The predicted increase of depositions in 2010 from Ukraine and Latvia is significant, both for the basin and for the catchment area of the Baltic Sea.

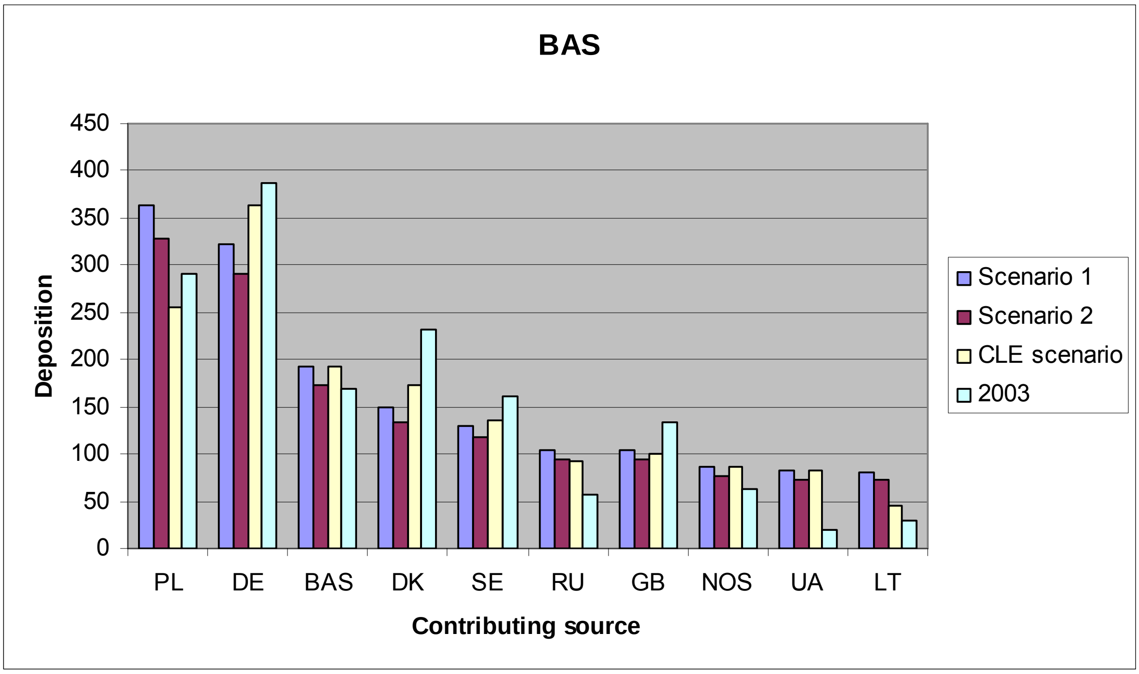


Figure 4.15. The main emission sources contributing to total nitrogen depositions in the entire basin of the Baltic Sea according to Scenario 1, Scenario 2, the CLE Scenario, and 2003 data. Unit: 100 tonnes N per year.

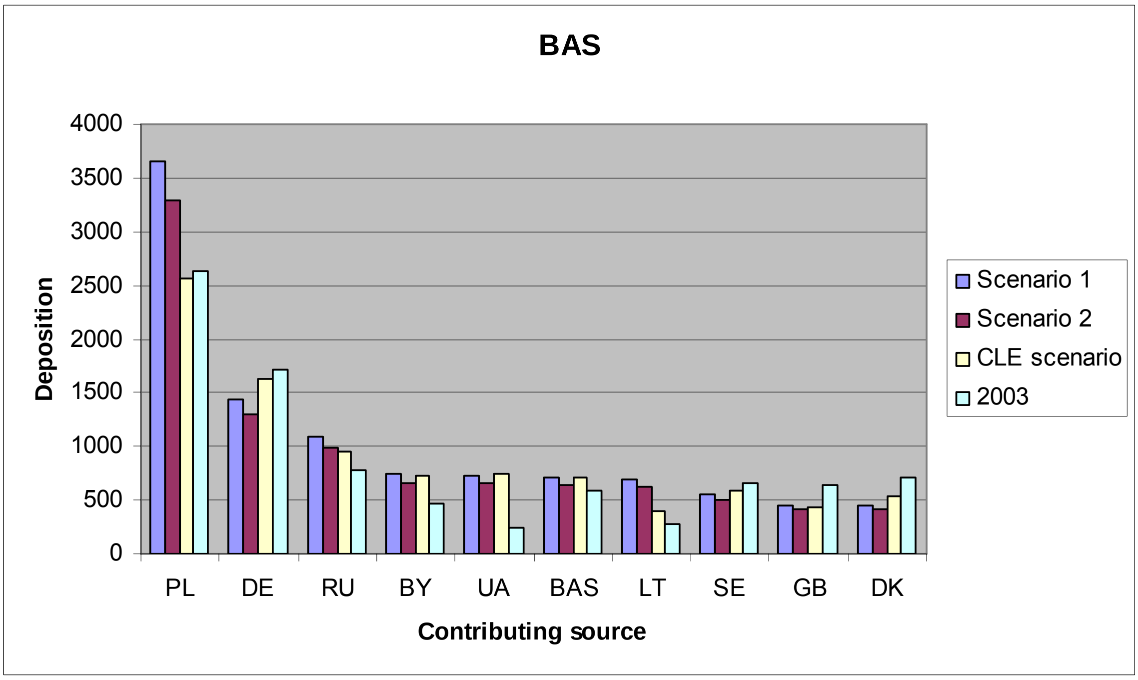


Figure 4.16. The main emission sources contributing to total nitrogen depositions in the entire catchment area of the Baltic Sea according to Scenario 1, Scenario 2, the CLE Scenario, and 2003 data. Unit: 100 tonnes N per year.

4.4 Uncertainty due to meteorological variability

In order to assess the uncertainty related to meteorological variability in computed source-receptor matrices, the relative range of the contributions was calculated in a similar way as for the depositions. The relative range was defined as

$$r = \frac{C_{\max} - C_{\min}}{\overline{C}} \times 100\%$$

where: $C_{\min}$ and $C_{\max}$ are the minimum and maximum contribution, respectively, of a selected emitter to nitrogen deposition during a selected meteorological year, and $\overline{C}$ is the average contribution over all meteorological years.

In Tables 4.1 and 4.2, the most certain and the least certain contributors to the total nitrogen deposition in the sub-basins of the Baltic Sea are presented, respectively, according to the relative range value. Calculated contributions from Sweden, the Baltic Sea, Denmark, and Norway seem to be relatively certain for most of the sub-basins. On the other hand, contributions from distant sources, and especially from Turkey, are rather uncertain for most of the sub-basins. Similar conclusions also apply for contributions to the catchment areas of the Baltic Sea.

Table 4.1. The most certain (as measured by the relative range) contributors to the total nitrogen deposition into each sub-basin of the Baltic Sea. Units: percent of the mean value over four years.

GUB		GUF		GUR		BAP		BES		KAT		BAS	
IS	12	SE	13	DK	13	SE	18	BAS	13	BAS	10	SE	14
SE	19	FI	13	BAS	15	BAS	21	DK	16	DK	25	DK	20
NO	21	BAS	14	EE	17	DK	23	NO	17	NO	25	IS	20

Table 4.2. The least certain (as measured by the relative range) contributors to the total nitrogen deposition into each sub-basin of the Baltic Sea. Units: percent of the mean value over four years.

GUB		GUF		GUR		BAP		BES		KAT		BAS	
GE	219	TR	187	TR	187	TR	225	MT	231	CH	183	TR	199
BG	217	CS	185	CY	181	BLS	190	DE	217	KZ	175	BG	173
TR	213	BLS	181	AL	176	MT	182	UA	217	UA	173	BLS	172

The complete data, including the relative ranges of the EMEP source contributions to nitrogen deposition in the sub-basins and catchment areas of the Baltic Sea, are shown in Tables 4.3 and 4.4, respectively.

Inspection of Tables 4.1 and 4.2 indicates a large variability in the calculated relative ranges depending on the emitter-receptor combination. In general, the relative ranges are larger for the sub-basins than for the catchment areas, simply because the area of each catchment is much larger than the area of the corresponding sub-basin.

Table 4.3. Relative range of EMEP emission source contributions to the total nitrogen deposition into the sub-basins of the Baltic Sea. Units: percent of the mean value over four years.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	193	176	187	169	128	137	166
AM	192	160	143	129	150	146	132
AT	159	115	117	79	37	103	90
AZ	173	174	124	97	160	156	109
BA	145	175	170	141	120	169	138
BE	96	29	38	24	62	97	42
BG	217	172	105	181	21	56	173
BY	88	75	64	93	151	150	78
CH	111	147	121	86	140	183	104
CS	151	185	155	144	103	154	143
CY	139	181	202	132	135	148	132
CZ	118	79	55	55	26	48	60
DE	89	53	35	34	35	68	40
DK	25	20	13	23	16	25	20
EE	49	21	17	80	78	81	26
ES	73	100	78	96	101	130	90
FI	37	13	29	69	140	114	26
FR	74	59	50	46	70	126	61
GB	29	48	52	53	48	50	44
GE	219	167	184	158	217	161	161
GR	189	125	128	169	121	91	156
HR	168	153	138	113	113	101	120
HU	121	149	108	83	93	72	89
IE	23	44	61	32	45	50	31
IS	12	52	48	26	60	53	20
IT	157	165	180	139	89	131	133
KZ	118	159	174	138	204	175	125
LT	85	42	44	71	74	151	56
LU	98	41	43	44	59	128	49
LV	75	38	30	61	41	116	41
MD	162	122	99	124	189	111	126
MK	190	154	137	166	130	127	163
MT	136	137	123	182	231	131	136
NL	78	15	31	36	50	75	30
NO	21	43	62	35	17	25	26
PL	100	70	36	43	75	52	44
PT	87	122	74	94	114	151	101
RO	164	128	96	130	115	56	130
RU	67	67	34	32	71	83	34
SE	19	13	39	18	49	31	14
SI	181	130	124	101	66	85	103
SK	109	119	89	62	71	46	69
TR	213	187	218	225	139	79	199
UA	150	113	79	88	217	173	90
ATL	50	69	59	47	57	73	52
BAS	35	14	15	21	13	10	21
BLS	195	181	162	190	80	65	172
MED	96	112	163	149	53	100	126
NOS	26	24	37	41	40	45	34
ASI	139	160	97	111	114	117	99
NOA	108	156	125	117	37	91	87

Table 4.4. Relative range of EMEP emission source contributions to the total nitrogen deposition into the catchment areas of the Baltic Sea. Units: percent of the mean value over four years.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	191	134	73	95	126	109	102
AM	131	170	127	102	147	144	129
AT	133	72	42	48	38	99	57
AZ	128	169	133	116	159	130	133
BA	147	120	90	87	119	120	95
BE	81	29	42	41	62	88	39
BG	199	97	65	61	24	175	72
BY	75	33	14	31	145	109	25
CH	120	71	38	62	125	153	63
CS	151	124	77	75	107	122	88
CY	116	138	214	72	121	98	116
CZ	108	51	26	31	30	62	35
DE	86	28	28	36	31	71	37
DK	37	8	40	14	16	19	14
EE	24	15	16	63	74	82	4
ES	58	48	90	95	94	108	70
FI	18	10	46	58	134	86	6
FR	68	33	48	53	67	104	56
GB	49	38	56	61	49	32	38
GE	167	136	92	140	213	145	125
GR	172	89	80	74	112	125	78
HR	143	85	70	73	109	92	79
HU	112	84	56	41	83	72	52
IE	38	38	63	35	44	43	25
IS	21	41	33	14	57	29	13
IT	130	87	84	83	83	126	87
KZ	112	152	152	177	201	90	143
LT	64	22	26	11	73	101	4
LU	91	26	44	50	54	125	47
LV	50	17	15	33	43	110	3
MD	167	79	69	100	191	155	88
MK	182	91	44	91	128	123	91
MT	95	91	76	95	216	144	78
NL	77	22	37	38	49	74	30
NO	8	22	59	34	13	14	12
PL	79	33	16	8	66	33	12
PT	72	77	76	85	110	144	87
RO	161	72	52	72	116	136	69
RU	59	51	29	38	67	64	29
SE	22	10	49	14	31	18	11
SI	142	66	59	61	62	80	68
SK	94	76	46	24	63	57	33
TR	158	168	134	72	132	121	101
UA	141	88	81	76	216	115	80
ATL	41	52	54	56	56	70	52
BAS	33	12	22	5	10	17	10
BLS	170	118	98	69	88	151	88
MED	80	71	91	84	47	100	81
NOS	36	30	50	42	38	34	31
ASI	153	158	119	107	112	131	122
NOA	69	96	79	74	30	47	67

5. CONCLUSIONS

As requested by HELCOM, the implications of two emissions scenarios for 2010 have been investigated in the present study. One additional emissions scenario, the so-called CLE (Current Legislation) Scenario, was also included in the study as an additional contribution from EMEP.

Scenario 1 assumed nitrogen oxides and ammonia national emissions as specified in the NEC Directive for fifteen EU countries. Nitrogen oxides and ammonia national emissions as specified in the Gothenburg Protocol (ECE/EB/AIR/85, 2004) were assumed for all countries listed there except those already mentioned in the NEC Directive. Emissions for the Russian Federation and Estonia were taken from a HELCOM publication. The 2010 projections of nitrogen emissions from the international ship traffic on the Europeans seas were taken from the EMEP database following Entec projections. All remaining emission sources of nitrogen were taken from the EMEP – MSC/W database.

In Scenario 2, nitrogen oxides and ammonia annual total emissions for 2010, as specified in Scenario 1, were reduced for the sources listed in the NEC Directive and the Gothenburg Protocol, as well as for the Russian Federation, Estonia, and the European seas. For the remaining EMEP sources, nitrogen oxides and ammonia emissions were the same as those in Scenario 1.

The CLE Emission Scenario was developed at IIASA as emissions anticipated to be achieved by the foreseen implementation of current standards in each country as estimated by the RAINS model.

The following conclusions can be formulated based on the results presented and discussed in this report:

Scenarios 1 and 2

1. The Russian Federation dominates nitrogen oxides emissions among the HELCOM Contracting Parties with 2653 kt NO_2, followed by Germany (1051 kt NO_2) and Poland (879 kt NO_2). Emissions from the international ship traffic on the Baltic Sea are also a significant source of nitrogen oxides (458 kt NO_2) in the region. Estonia (60 kt NO_2) and Latvia (61 kt NO_2) are at the bottom of the list concerning nitrogen oxides emissions among the HELCOM countries.
2. The Russian Federation (1179 kt NH_3) also dominates ammonia emissions in 2010 among the HELCOM Contracting Parties. Relatively high ammonia emissions can also be noted from Germany (550 kt NH_3) and from Poland (468 kt NH_3). Ammonia emissions in the remaining HELCOM countries are much lower, with Finland (31 kt NH_3) and Estonia (29 kt NH_3) at the bottom of the list.
3. The need for nitrogen oxides emission reductions between 2003 and 2010 can be seen in Denmark (39%), Finland (22%), Germany (26%), and Sweden (28%). Nitrogen oxides emissions from the Baltic Sea are 20% below the 2010 limit, but these emissions are projected to increase by approximately 2.5% each year. The sum of nitrogen oxides emissions from all HELCOM Contracting Parties must be reduced by 5% between 2003 and 2010 in order to reach the 2010 emission ceilings. Also, nitrogen oxides emissions in the entire EMEP domain must be reduced by 5% between 2003 and 2010 to reach the level imposed by the Gothenburg Protocol and the NEC Directive.
4. Ammonia emissions from only two countries, Denmark (29%) and Finland (7%), must be reduced in order to fulfil the requirements of the Gothenburg Protocol and the NEC

Directive for 2010. The sum of ammonia emissions from all HELCOM Contracting Parties is lower in 2003 than those projected for 2010 by 42%. Ammonia emissions in the entire EMEP domain in 2003 are approximately 41% lower than those projected for 2010.

CLE Scenario

5. Projected ammonia emissions according to the CLE Scenario account for approximately 7 million tonnes of NH_3 for all EMEP sources and 5.5 million tonnes of NH_3 for all HELCOM sources. The CLE Emission Scenario for 2010 can be considered as the most likely description of nitrogen emission levels in 2010. The higher values in the CLE Scenario in comparison with Scenario 1 indicate the countries which may have a problem in reaching the 2010 emission levels imposed by the Gothenburg Protocol and the NEC Directive.
6. Four countries may have a potential problem reaching 2010 nitrogen oxides emission levels according to Scenario 1: Denmark, Germany, Sweden, and Russia. Nitrogen oxides emissions from the ship traffic on the Baltic Sea are the same in Scenario 1 and the CLE Scenario. However, the problem is that the ship emissions are increasing, also after 2010; and in 2020 they are projected to be 13% higher than in 2010, according to the CLE Scenario. The sum of 2010 nitrogen oxides emissions from all HELCOM Contracting Parties is 8% lower in the CLE Scenario than in Scenario 1. Also, 2010 nitrogen oxides emissions from the entire EMEP domain are 6% lower in the CLE Scenario than in Scenario 1.
7. Only in three HELCOM Contracting Parties are projected ammonia emissions in 2010 lower in Scenario 1 than in the CLE Scenario: Denmark, Finland, and Germany. The sum of 2010 ammonia emissions from all HELCOM Contracting Parties is higher in Scenario 1 than in the CLE Scenario. Similarly, 2010 ammonia emissions from the entire EMEP domain are higher in Scenario 1 than in the CLE Scenario.

Variation

8. The ranges between the minimum and the maximum of calculated depositions to the sub-basins and to the catchment areas are large, indicating significant variation in the deposition depending on the meteorological conditions. The standard deviation of computed depositions due to varying meteorological conditions is relatively large, up to 20–30% of the computed depositions. The maxima of the standard deviations are located close to the maxima of the computed depositions. The computed standard deviation in relation to the computed deposition is the largest for wet deposition (~30%) and the smallest for dry deposition (~10%). It is larger for oxidized nitrogen deposition (~25%) than for reduced nitrogen deposition (~20%). The standard deviation for the total deposition is in the middle of the range.
9. The relative range of the depositions due to variable meteorology is rather large, both for the sub-basins and for the catchment areas of the Baltic Sea. For the deposition of oxidized and reduced nitrogen to the sub-basins and the entire basin of the Baltic Sea, there is more variability in wet than in dry deposition. The relative range of nitrogen deposition to the catchment areas is in general lower than the relative range of nitrogen deposition to the sub-basins of the Baltic Sea. The largest uncertainty due to meteorological variability can be noted for the GUB (Gulf of Bothnia) sub-basin and catchment area, with a relatively low nitrogen deposition.

Deposition

10. There are some clear, but not large, differences in the deposition maps calculated for the different emission scenarios for 2010. These differences are definitely larger than

the differences between the maps for the different nitrogen emission scenarios. In particular, the maxima of the depositions calculated with Emission Scenario 1 are much less visible in the calculations with Emission Scenario 2.

11. For the GUB, GUF, GUR, and BAP sub-basins and for the entire Baltic Sea basin, the highest depositions of total nitrogen were calculated with Scenario 1, whereas for two southern sub-basins, BES and KAT, the highest depositions were calculated with the CLE Scenario. For most of the sub-basins (GUB, BAP, BES, and KAT) and for the Baltic Sea basin, the lowest depositions of total nitrogen were calculated with Scenario 2; however, for the GUF and GUR sub-basins, the lowest depositions were calculated with the CLE Scenario.
12. For the GUF, GUR, and BAP catchment areas and for the entire Baltic Sea catchment area, the highest depositions of total nitrogen were calculated with Scenario 1. For three catchment areas, GUB, BES, and KAT, the highest depositions were calculated with the CLE Scenario. For four catchment areas (GUB, GUF, BES, and KAT), the lowest depositions of total nitrogen were calculated with Scenario 2. For the GUR and BAP catchment areas, as well as for the entire catchment area of the Baltic Sea, the lowest depositions were calculated with the CLE Scenario.
13. For all emissions scenarios, all meteorological years, and all sub-basins and catchment areas, wet nitrogen deposition is much higher, typically two to three times higher, than the dry deposition of nitrogen.
14. Depositions of oxidized and reduced nitrogen to all sub-basins are approximately on the same level, but the deposition of oxidized nitrogen is slightly higher than the deposition of reduced nitrogen in the north and in the middle into the GUB, GUF, GUR, and BAP sub-basins. In the south, into the BES and KAT sub-basins, the deposition of reduced nitrogen is higher. The deposition of oxidized nitrogen is also higher than the deposition of reduced nitrogen to the entire basin of the Baltic Sea. In general, there is more oxidized nitrogen deposition than reduced nitrogen deposition into the sub-basins of the Baltic Sea.
15. In the case of catchment areas, oxidized nitrogen deposition is higher than reduced nitrogen deposition into GUB, GUF, and KAT. For GUR, BAP, BES, and the entire catchment area of the Baltic Sea, there is an opposite relationship between oxidized and reduced nitrogen deposition. In general, there is more reduced nitrogen deposition than oxidized nitrogen deposition into the catchment areas of the Baltic Sea. Compared to 2003 depositions, nitrogen depositions calculated for 2010 with Scenario 2 are lower for most of the sub-basins of the Baltic Sea. In particular, the deposition of dry oxidized nitrogen is projected to be lower in 2010 than in 2003 in all sub-basins. Also the deposition of wet oxidized nitrogen is projected to be lower in 2010 (Scenario 2) than in 2003 in all sub-basins except GUF, where it is projected to be on the same level as in 2003.
16. The deposition of dry reduced nitrogen is projected to be higher in 2010 (all scenarios) than in 2003 for the GUB, GUF, GUR, and BAP sub-basins. The lowest deposition of wet reduced nitrogen is calculated with Scenario 2 for the sub-basins GUB, BAP, BES, and KAT. Wet deposition of reduced nitrogen is lower in 2003 than that projected for 2010 in the GUF and GUR sub-basins.
17. Annual oxidized dry and wet depositions into the entire basin of the Baltic Sea are projected to be lower in 2010 (all scenarios) than in 2003, but the annual reduced dry and wet depositions into the entire basin of the Baltic Sea are projected to be higher in 2010 than in 2003, except for wet deposition of reduced nitrogen calculated with Scenario 2. The total nitrogen deposition into the entire basin of the Baltic Sea is projected to be higher in 2010 than in 2003 for Scenario 1 and the CLE Scenario.
18. Compared to 2003 depositions, total nitrogen depositions calculated for 2010 are higher for three catchment areas of the Baltic Sea: GUF, GUR, and BAP. Also, the

total nitrogen deposition into the entire catchment area of the Baltic Sea is calculated to be higher in 2010 than in 2003.

Source-receptor relations

19. For all sub-basins, the contributions of different emission sources to the deposition in the different sub-basins are similar for Scenarios 1 and 2, but, as expected, contributions in the case of Scenario 2 are lower for all sources and sub-basins, based on the differences in nitrogen emissions. Also, the rankings of contributing sources in these two scenarios are the same for all sub-basins. The differences are much larger between the CLE Scenario and Scenarios 1 and 2. These differences are especially large for countries such as Latvia, Lithuania, Estonia, and Poland. The rankings are also different for Scenario 1 and the CLE Scenario in four, mainly northern, sub-basins (GUB, GUF, GUR, and BAP) and in the entire basin of the Baltic Sea.
20. According to Scenario 1, there are three major emission sources contributing to the deposition into all sub-basins of the Baltic Sea: Poland, Germany, and ship emissions from the Baltic Sea. 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, respectively, the Gulf of Bothnia, the Gulf of Finland, the Belt Sea, and the Kattegat. Emissions from the Baltic Sea are always present at the top of the ranking for all sub-basins of the Baltic Sea.
21. A significant contribution to nitrogen depositions in the sub-basins of the Baltic Sea can also be noted from relatively distant sources. The most important distant emission sources are the United Kingdom and ship emissions from the North Sea.
22. Finland, the Russian Federation, Belarus, Poland, Germany, and Denmark are, respectively, the major contributors to nitrogen deposition in the catchment areas of the Gulf of Bothnia, the Gulf of Finland, the Gulf of Riga, the Baltic Proper, the Belt Sea, and the Kattegat. Poland is the largest contributor to nitrogen deposition in the entire Baltic Sea catchment area, followed by Germany and the Russian Federation. Some distant emission sources, for example, the United Kingdom, Ukraine, France, Netherlands, Czech Republic, Norway, and ship emissions on the North Sea, also belong to the top ten contributors to nitrogen deposition into some of the catchment areas.
23. For all catchment areas, there is a significant contribution to the deposition from ship traffic on the Baltic Sea; however, the contribution to the Belt Sea and the Kattegat sub-basins is larger from the ship traffic on the North Sea.
24. Nitrogen deposition to the entire catchment area of the Baltic Sea is dominated by emission sources from Poland, contributing approximately two times more than the next source on the list, namely, Germany. Compared to 2003, contributions from four emission sources to the Baltic Sea basin are projected to be reduced in 2010, namely, from Germany, Denmark, Sweden, and the United Kingdom. However, contributions from the Baltic Sea, the Russian Federation, the North Sea, Ukraine, and Lithuania are projected to increase. Contributions from Poland will increase according to Scenarios 1 and 2, and decrease according to the CLE Scenario.
25. In the case of the entire catchment area of the Baltic Sea, an increase in the contribution to the total nitrogen deposition from the Russian Federation, Ukraine, Belarus, the Baltic Sea, and Lithuania is projected for 2010 in comparison with 2003. In contrast, contributions from Germany, Denmark, Sweden, and the United Kingdom are projected to be lower in 2010 than in 2003. Contributions from Poland will increase according to Scenarios 1 and 2, and decrease according to the CLE

Scenario. The predicted increase in 2010 depositions from Ukraine and Latvia is significant, both for the basin and for the catchment area of the Baltic Sea.

Uncertainty due to meteorology

26. The standard deviations of computed depositions due to varying meteorological conditions are relatively large, up to 20–30% of the computed depositions. The maxima of standard deviations are located close to the maxima of computed depositions.
27. The computed standard deviation in relation to the computed deposition is largest for wet deposition (~30%) and smallest for dry deposition (~10%). It is larger for oxidized nitrogen deposition (~25%) than for reduced nitrogen deposition (~20%). The standard deviation for the total deposition is in the middle, at approximately 22% of the computed total deposition.
28. Both for Scenario 1 and for Scenario 2, the largest uncertainty due to meteorological variability can be noted for the GUB (Gulf of Bothnia) sub-basin and catchment area, with a relatively low nitrogen deposition.
29. There is a large variability of calculated relative ranges depending on the emitter-receptor combination. In general, the relative ranges are larger for the sub-basins than for the catchment areas, simply because the area of each catchment is much larger than the area of the corresponding sub-basin.
30. Calculated contributions from Sweden, the Baltic Sea, Denmark, and Norway seem to be relatively certain for most of the sub basins. On the other hand, contributions from distant sources, and especially from Turkey, are rather uncertain for most of the sub-basins. Similar conclusions also apply for contributions to the catchment areas of the Baltic Sea.

REFERENCES

Bartnicki, J., Gusev, A., Berg, T., and H., Fagerli (2005) Atmospheric Supply of nitrogen, lead, cadmium and mercury to the Baltic Sea in 2003. Technical Report MSC-W 3/2005. Oslo, Norway.

ECE/EB/AIR/85 (2004) Handbook for the 1979 Convention on Long-range Transboundary Air Pollution and its Protocols. Economic Commission for Europe. United Nations, Geneva, Switzerland.

Entec (2002) Quantification of emissions from ships associated with ship movements between ports in the European Community. Study for the European Commission. http://air-climate.eionet.eu.int/docs/TP2003_8_NECD/ETCACC_TechPaper2003_8_NECD_InitAss_May04.pdf

HELCOM (2005) Airborne nitrogen loads to the Baltic Sea. Helsinki Commission. Baltic Marine Environment Protection Commission.

NEC (2001) Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants. Official Journal of the European Communities, L 309/22.

Tarrason, L., Bendictow, A., Fageli, H., Jonson, J.E., Klein, H., van Loon, M., Simpson, D., Tsyro, S., Vestreng, V., Wind, P., Forster, C., Stohl, A., Amman, M., Cofala, J., Langner, J., Andersson, C., and R. Bergström (2005) Transboundary acidification, eutrophication and ground level ozone in Europe in 2003. EMEP Status Report 2005. Status Report 1. MSC-W of EMEP. Oslo, Norway.

APPENDIX A: DEPOSITION MAPS CALCULATED FOR 2010 BASED ON EMISSION SCENARIO 1

Maps showing spatial distributions of nitrogen deposition in the year 2010 are presented in this Appendix. In the model runs used for the calculation of the maps, annual total emissions from the EMEP Contracting Parties and the latest emissions from the international ship traffic on the European seas as specified by Scenario 1 were used (see Section 2, above). Four different years with meteorological data were used in the calculations. Final maps for the year 2010 were calculated as the average over the four meteorological years.

The following maps are presented here:

1. annual dry deposition of oxidized nitrogen,
2. annual wet deposition of oxidized nitrogen,
3. annual dry deposition of reduced nitrogen,
4. annual wet deposition of reduced nitrogen,
5. annual deposition of oxidized (dry + wet) nitrogen,
6. annual deposition of reduced (dry + wet) nitrogen,
7. annual dry deposition of (oxidized +reduced) nitrogen,
8. annual wet deposition of (oxidized +reduced) nitrogen,
9. annual wet deposition of total nitrogen.

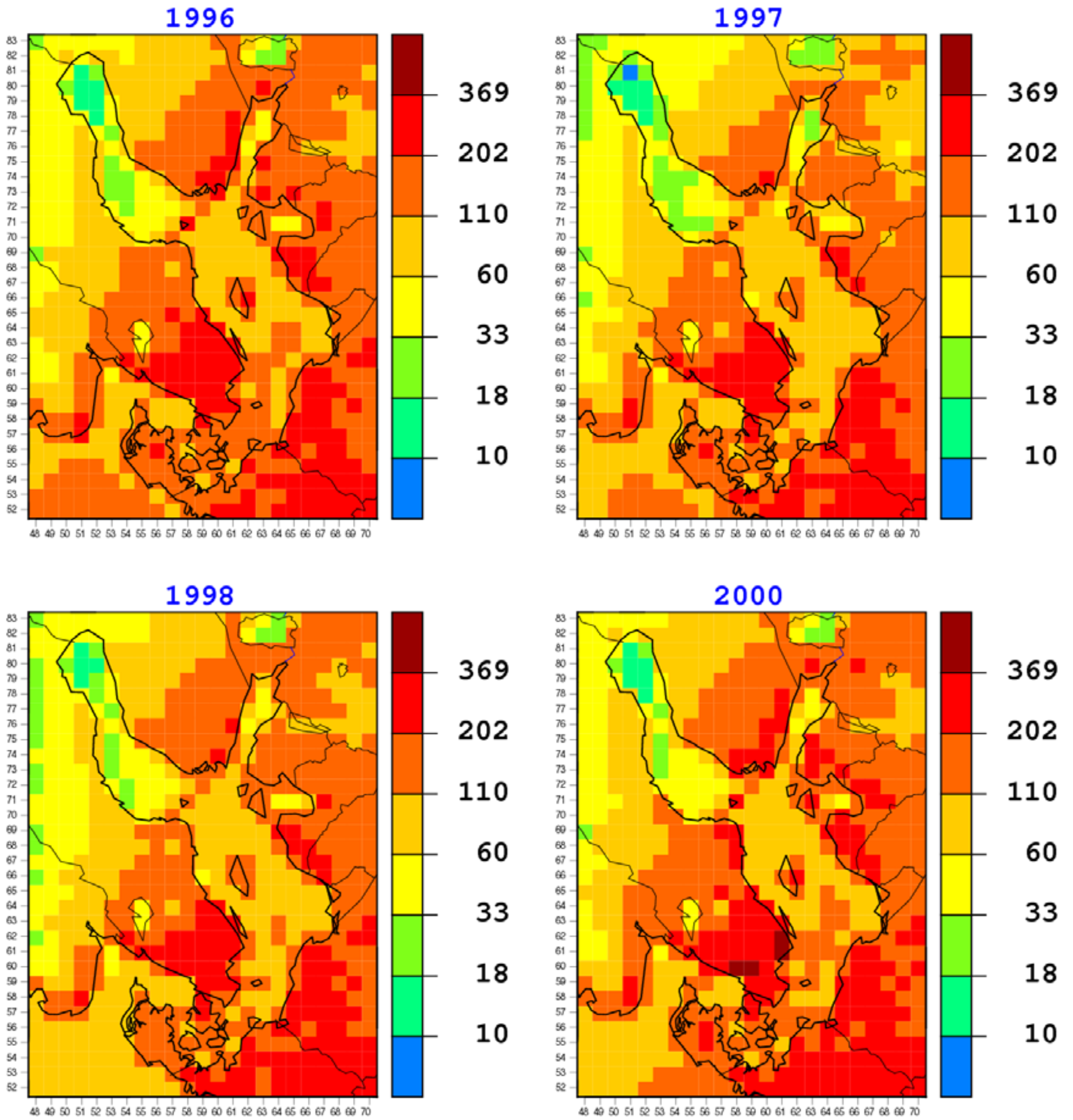


Figure A.1. Calculated annual dry deposition of oxidized nitrogen in 2010 with Emission Scenario 1 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

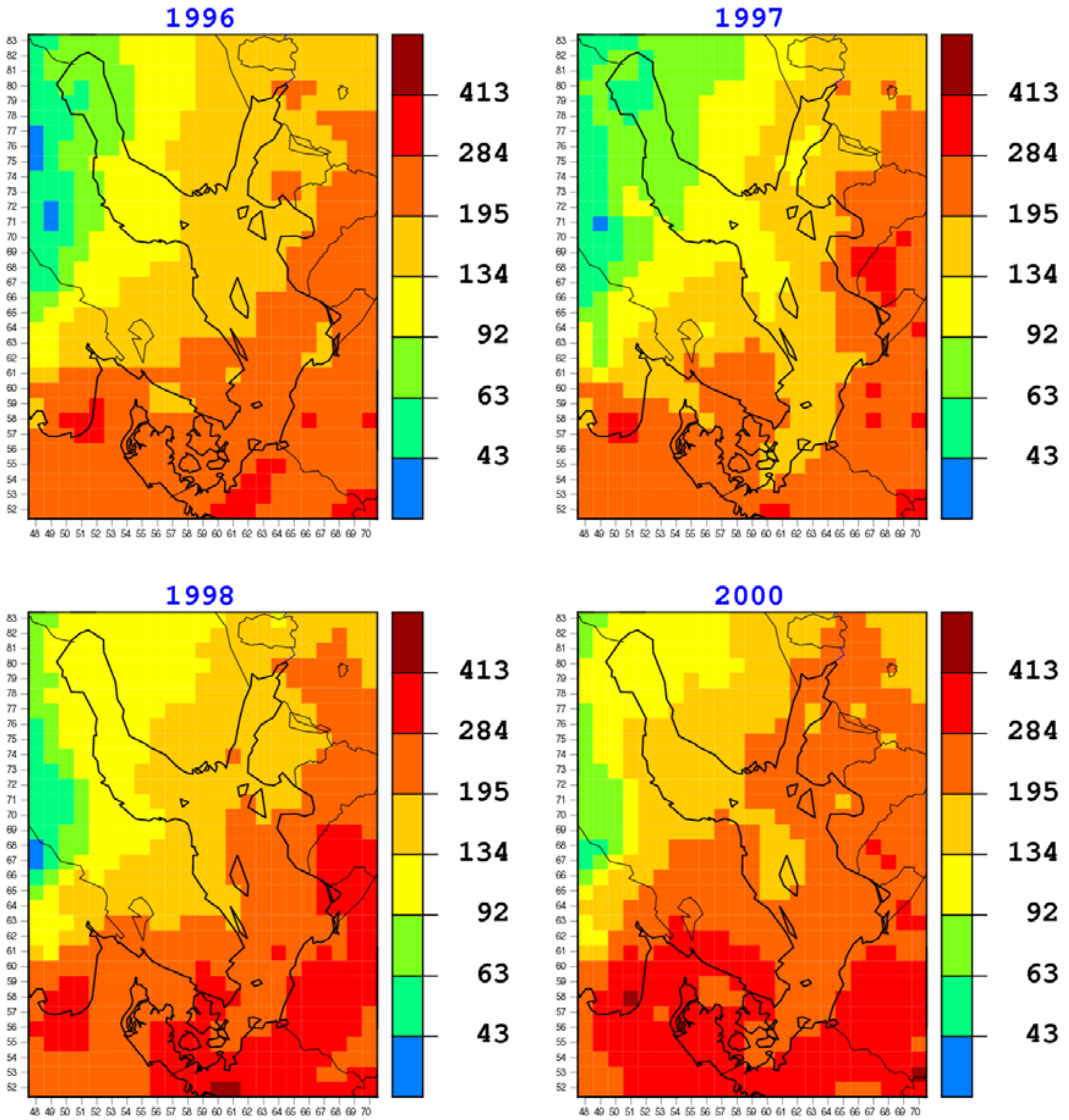


Figure A.2. Calculated annual wet deposition of oxidized nitrogen in 2010 with Emission Scenario 1 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

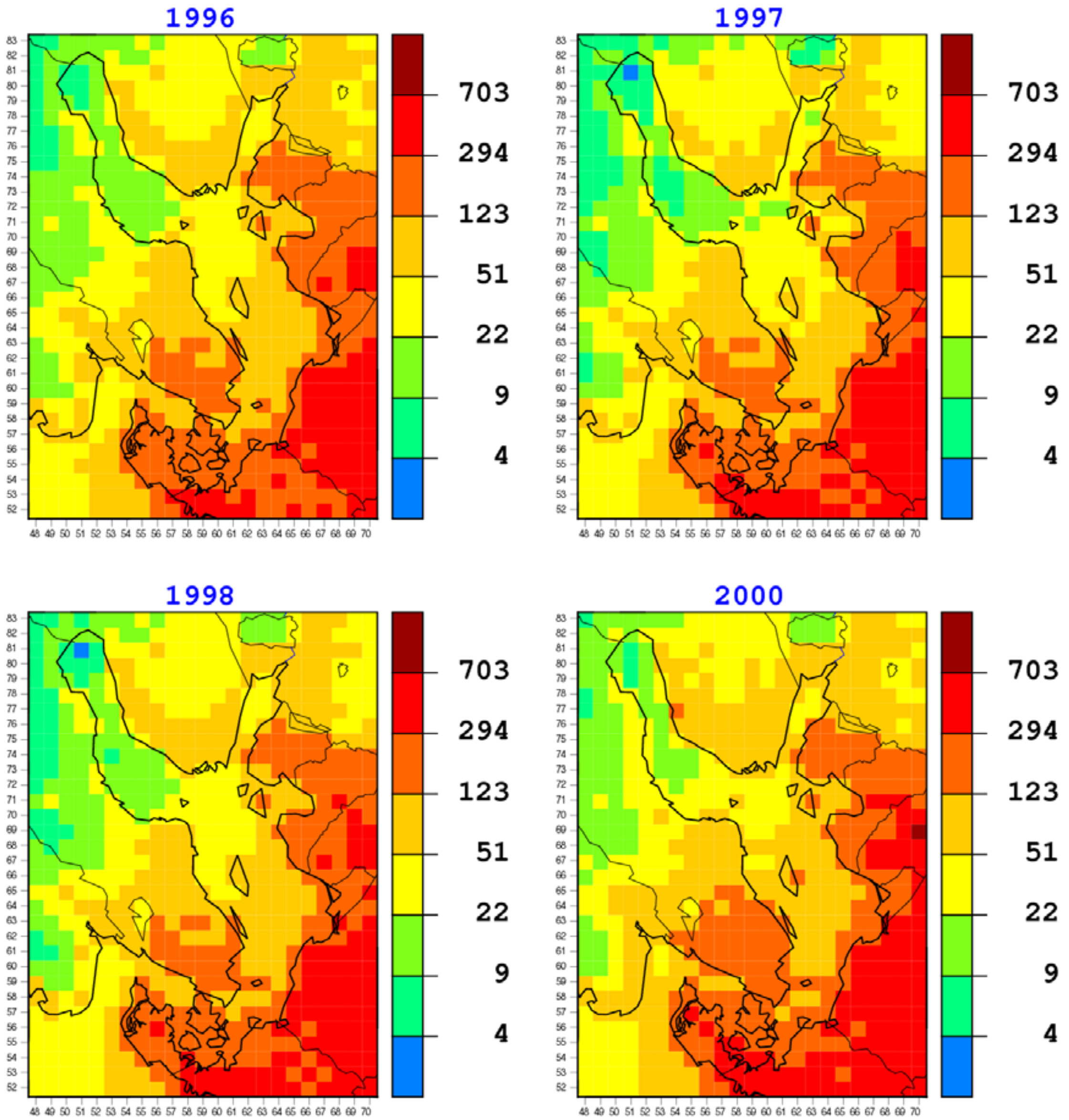


Figure A.3. Calculated annual dry deposition of reduced nitrogen in 2010 with Emission Scenario 1 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

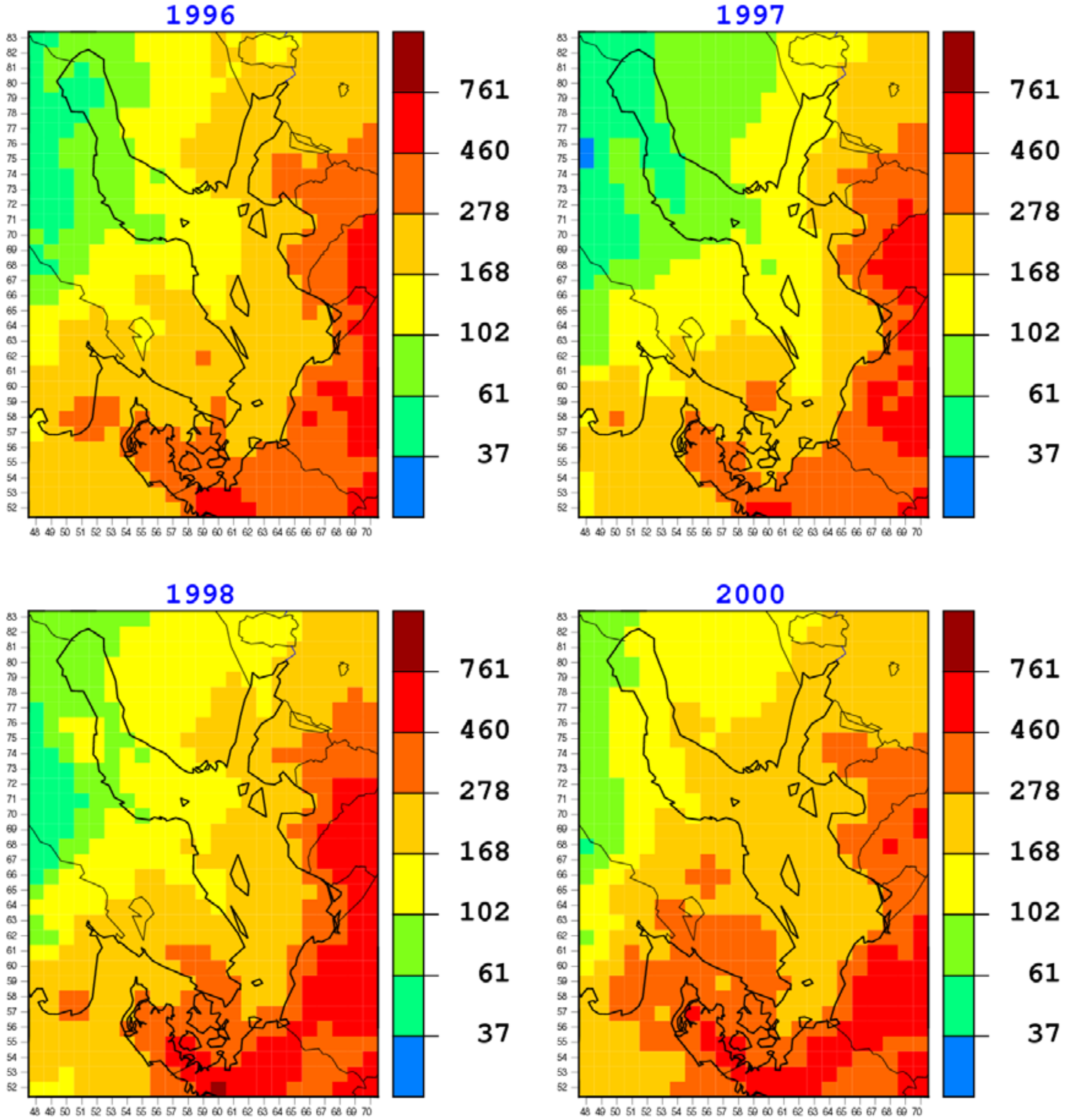


Figure A.4. Calculated annual wet deposition of reduced nitrogen in 2010 with Emission Scenario 1 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

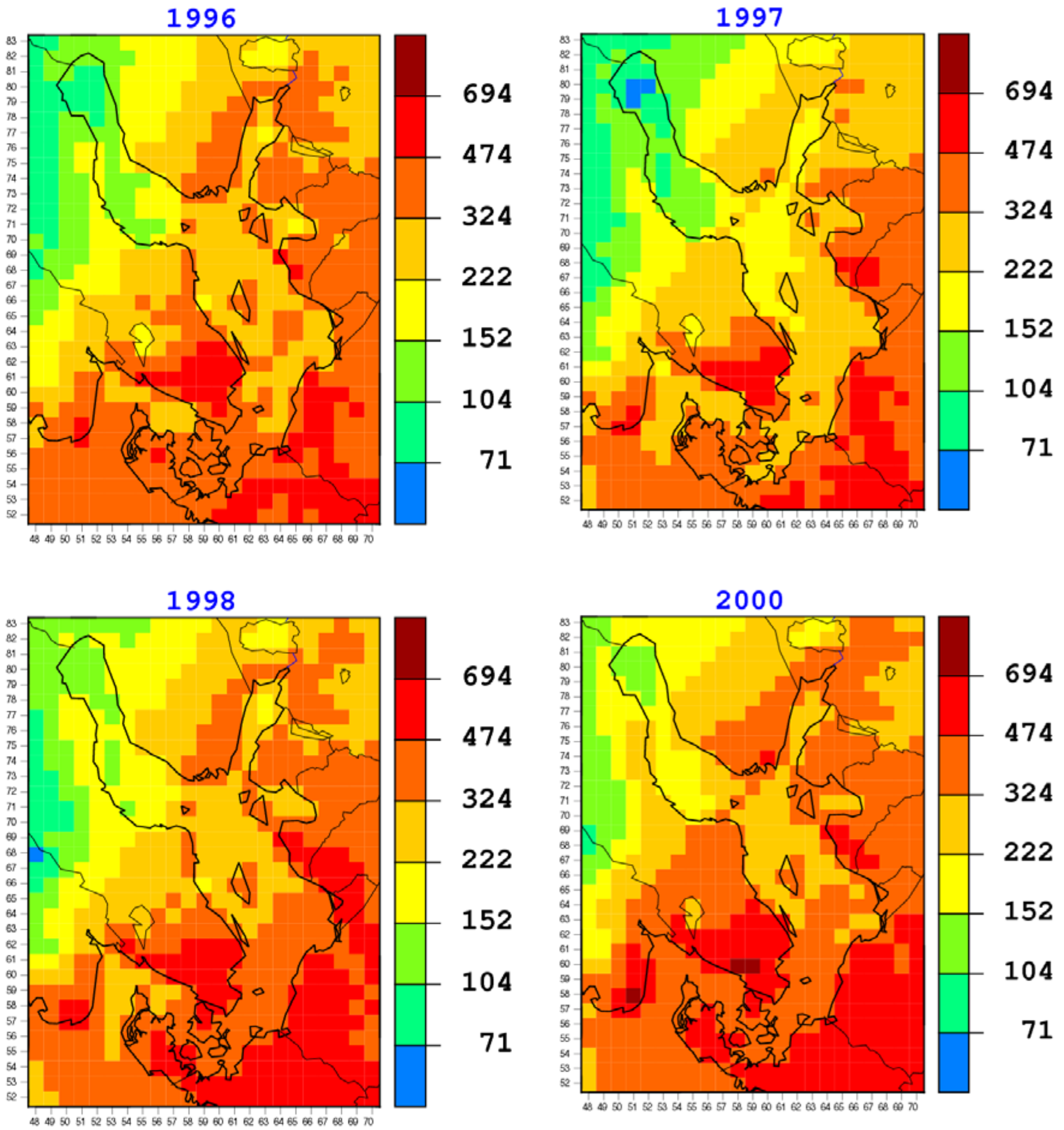


Figure A.5. Calculated annual (dry + wet) deposition of oxidized nitrogen in 2010 with Emission Scenario 1 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

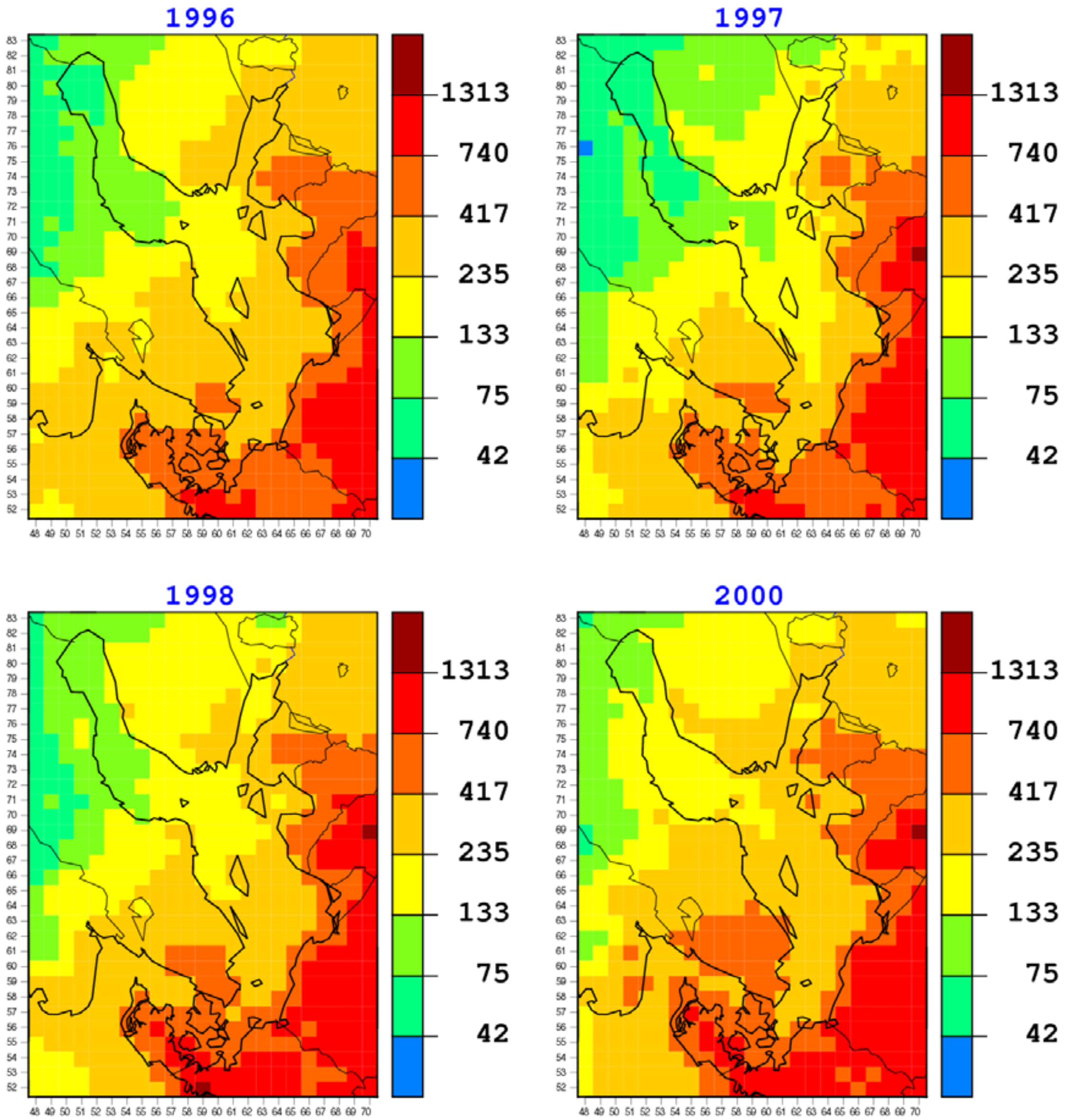


Figure A.6. Calculated annual (dry + wet) deposition of reduced nitrogen in 2010 with Emission Scenario 1 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

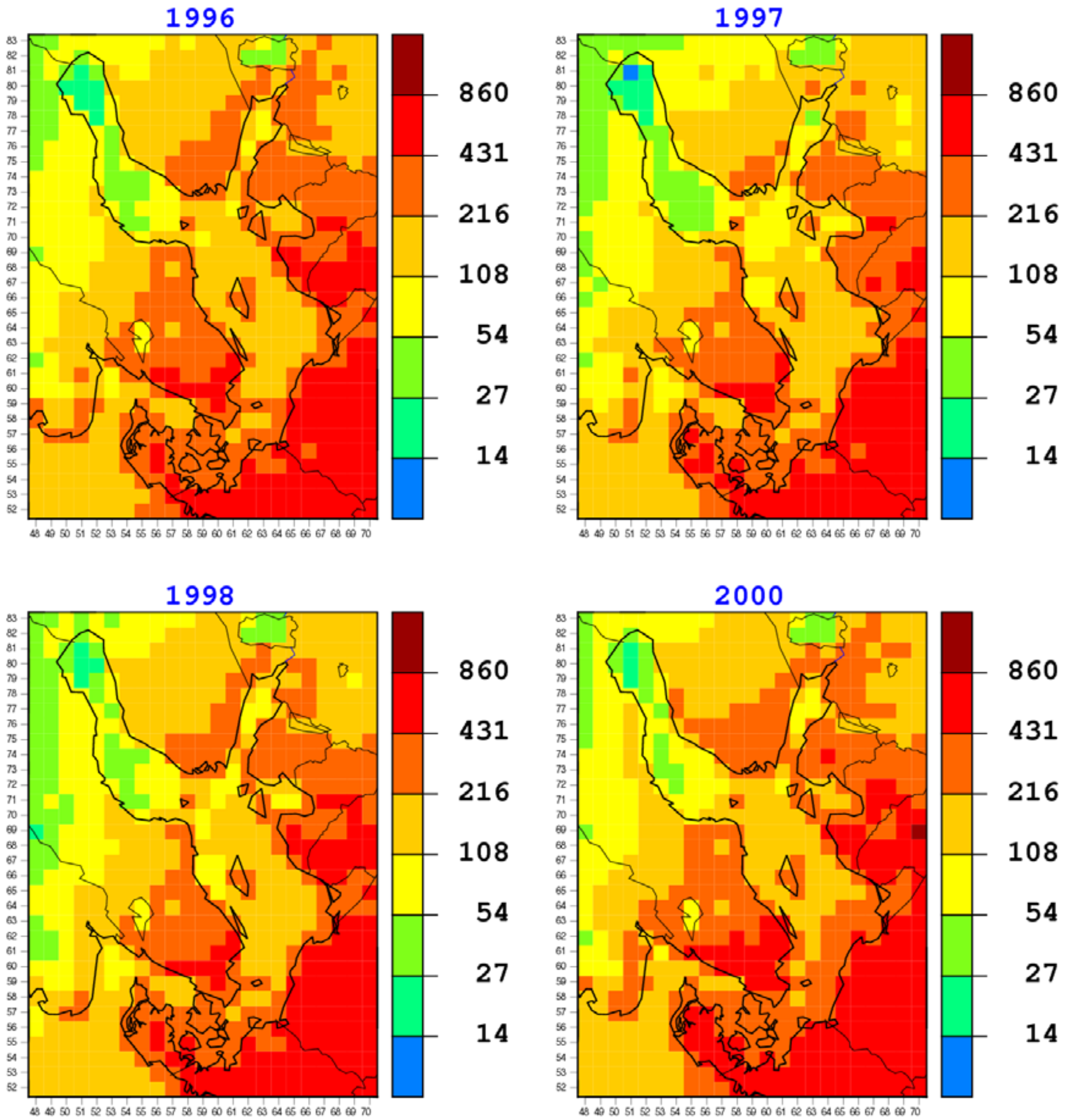


Figure A.7. Calculated annual dry deposition of the sum of oxidized and reduced nitrogen in 2010 with Emission Scenario 1 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

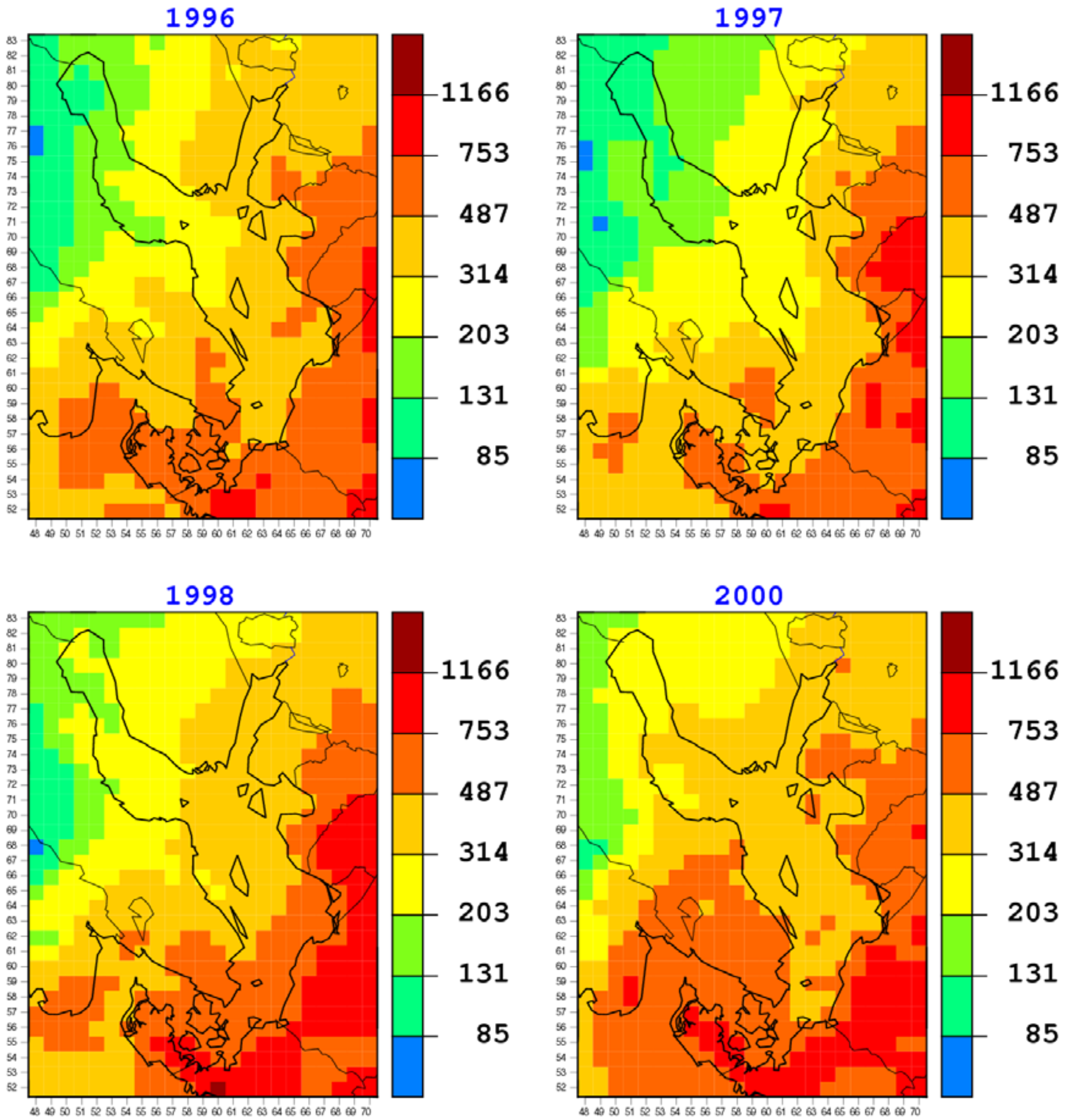


Figure A.8. Calculated annual wet deposition of the sum of oxidized and reduced nitrogen in 2010 with Emission Scenario 1 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

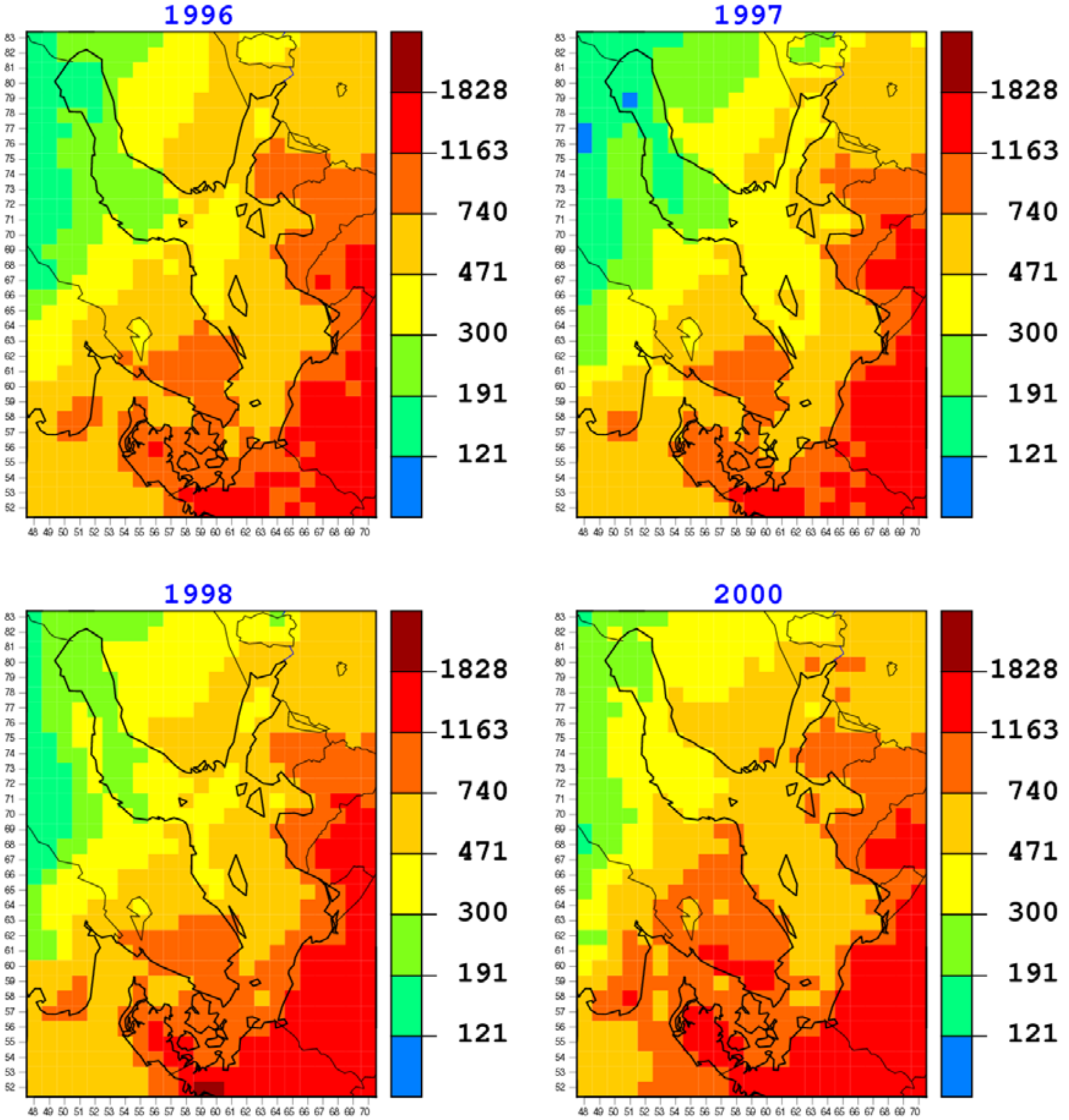


Figure A.9. Calculated annual total nitrogen deposition in 2010 with Emission Scenario 1 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

APPENDIX B: DEPOSITION MAPS CALCULATED FOR 2010 BASED ON EMISSION SCENARIO 2

Maps showing spatial distributions of nitrogen deposition in the year 2010 are presented in this Appendix. In the model runs used for the calculation of the maps, annual total emissions from the EMEP Contracting Parties and the latest emissions from the international ship traffic on the European seas as specified by Scenario 2 were used (see Section 2, above). Four different years with meteorological data were used in the calculations. Final maps for the year 2010 were calculated as the average over the four meteorological years.

The following maps are presented here:

1. annual dry deposition of oxidized nitrogen,
2. annual wet deposition of oxidized nitrogen,
3. annual dry deposition of reduced nitrogen,
4. annual wet deposition of reduced nitrogen,
5. annual deposition of oxidized (dry + wet) nitrogen,
6. annual deposition of reduced (dry + wet) nitrogen,
7. annual dry deposition of (oxidized +reduced) nitrogen,
8. annual wet deposition of (oxidized +reduced) nitrogen,
9. annual wet deposition of total nitrogen.

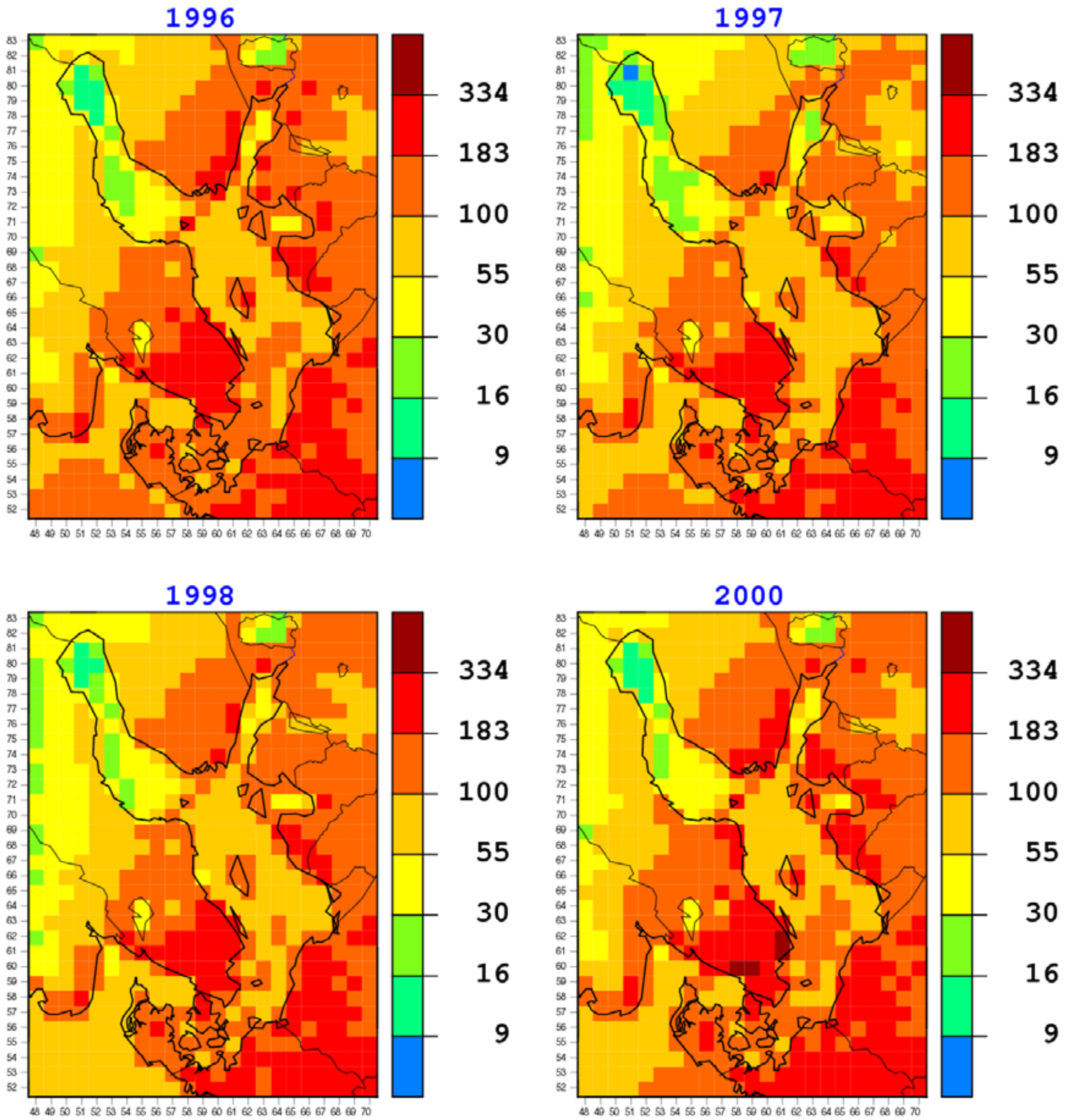


Figure B.1. Calculated annual dry deposition of oxidized nitrogen in 2010 with Emission Scenario 2 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

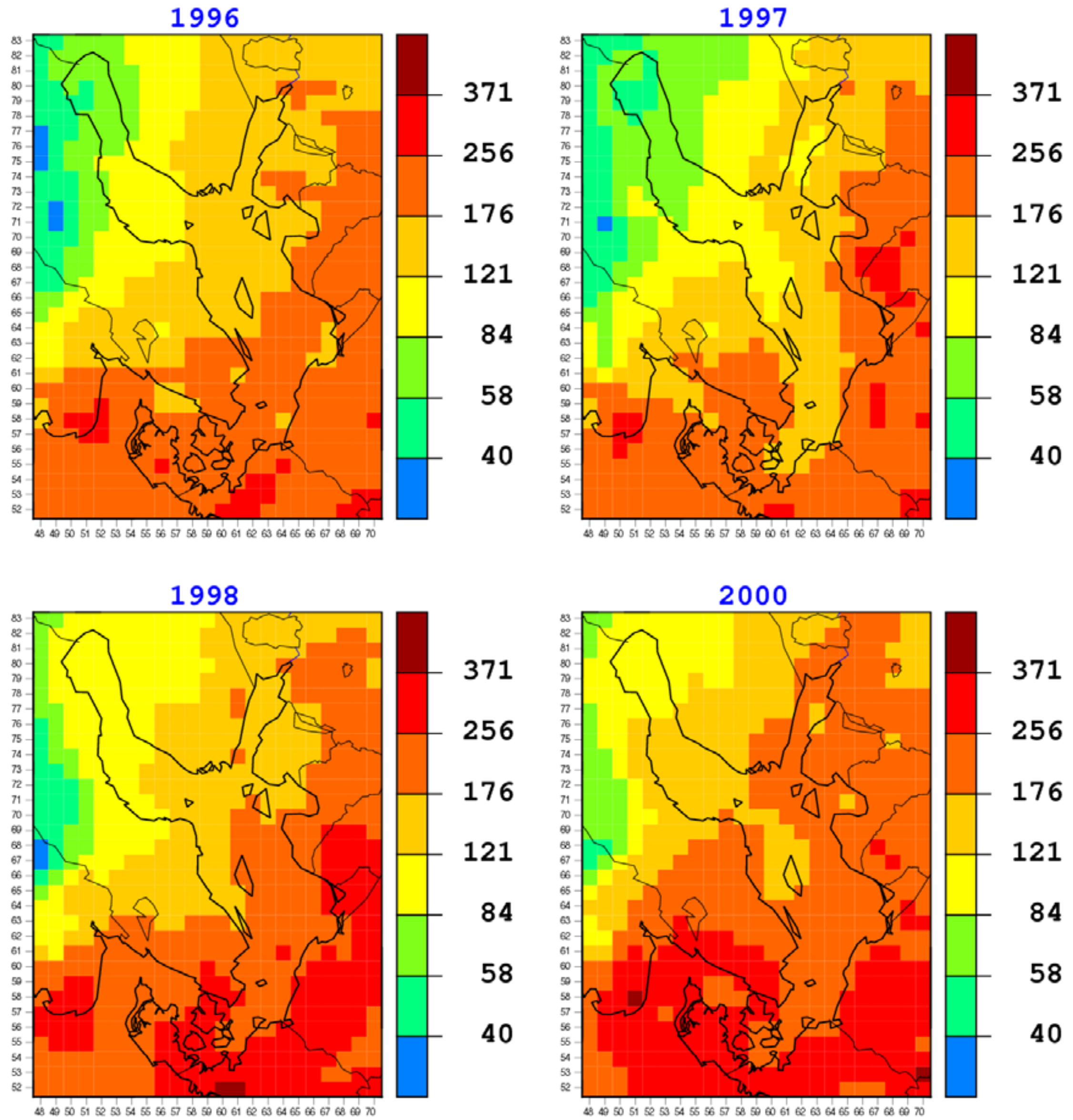


Figure B.2. Calculated annual wet deposition of oxidized nitrogen in 2010 with Emission Scenario 2 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

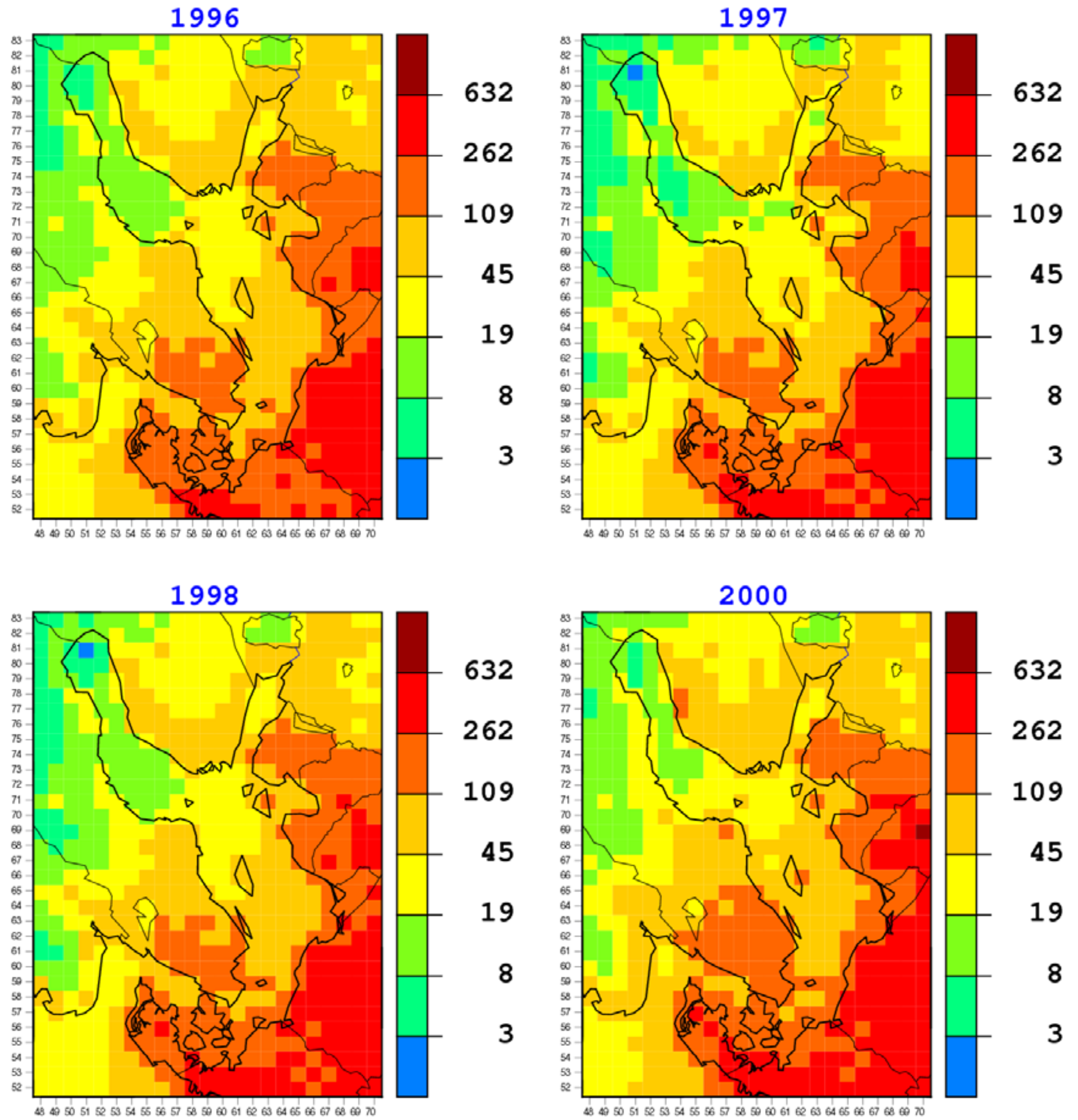


Figure B.3. Calculated annual dry deposition of reduced nitrogen in 2010 with Emission Scenario 2 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

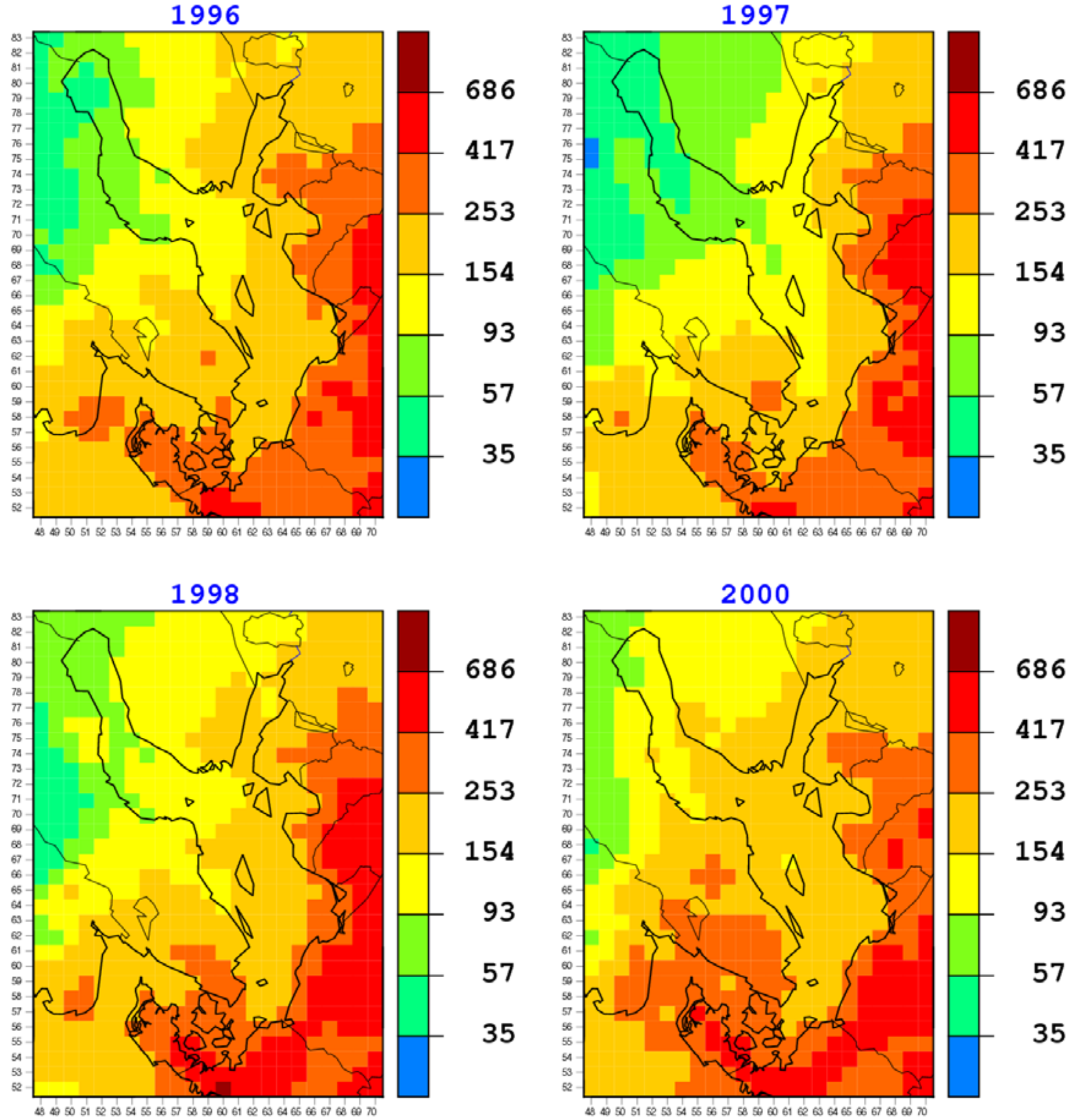


Figure B.4. Calculated annual wet deposition of reduced nitrogen in 2010 with Emission Scenario 2 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

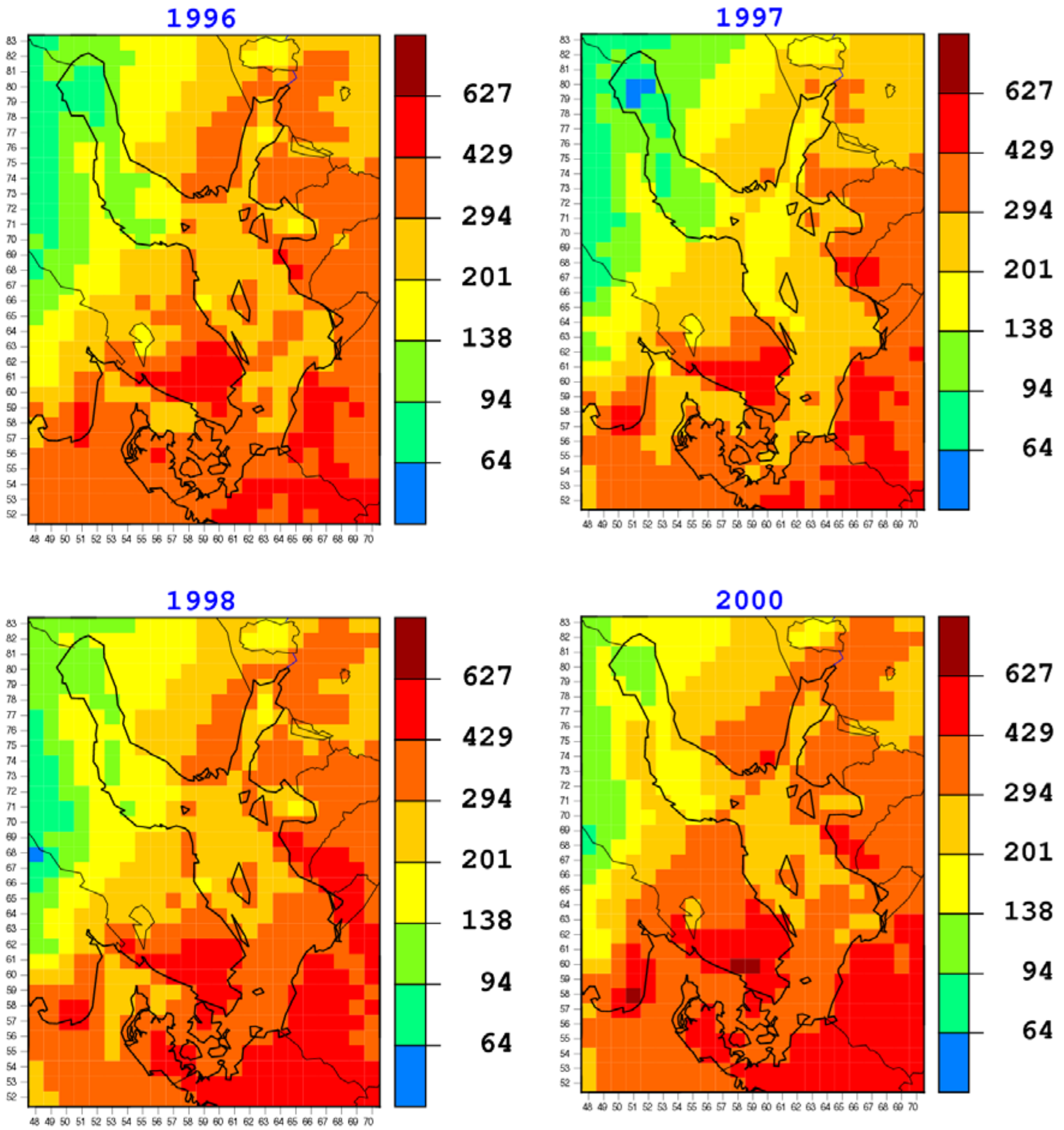


Figure B.5. Calculated annual (dry + wet) deposition of oxidized nitrogen in 2010 with Emission Scenario 2 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

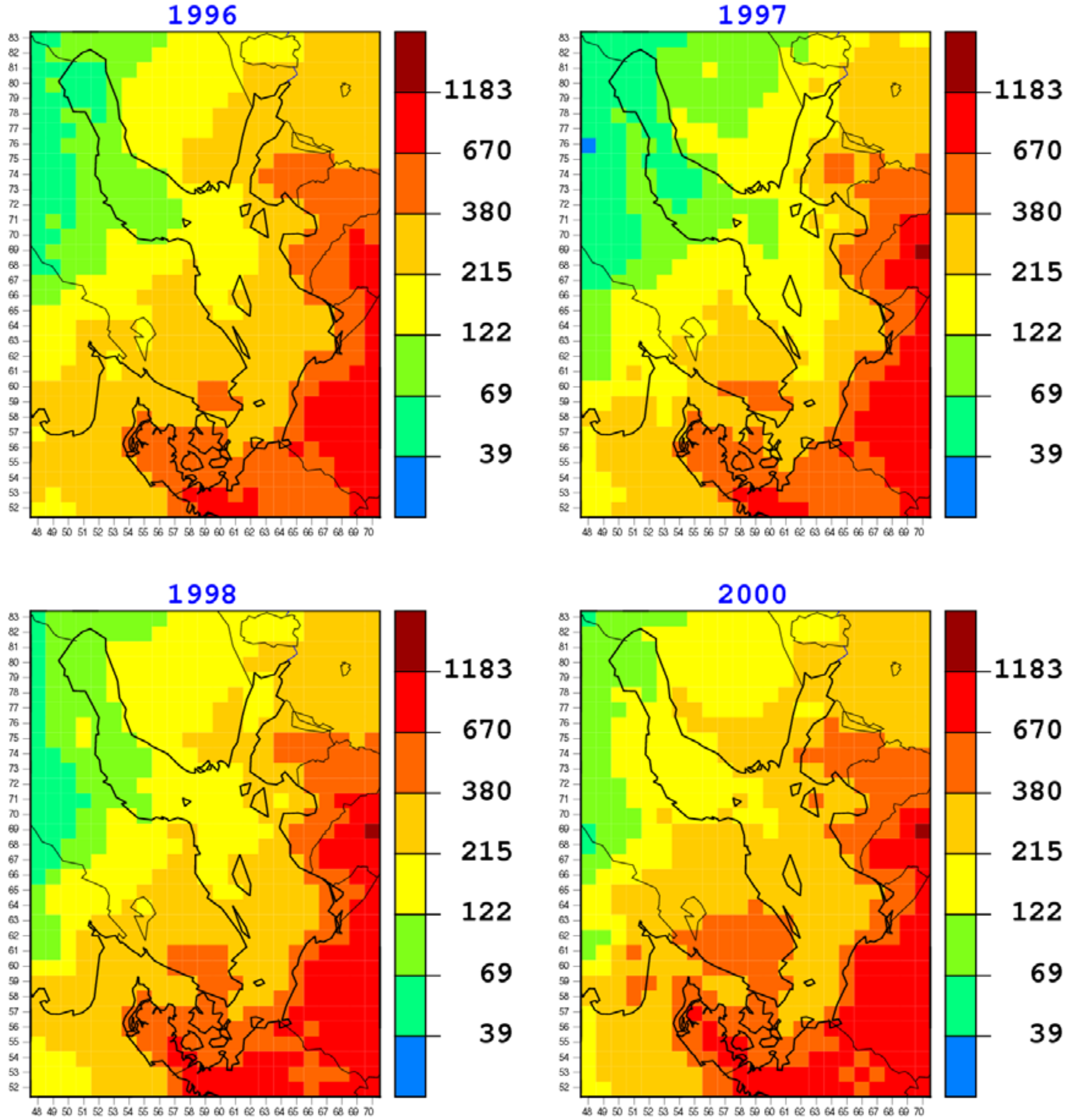


Figure B.6. Calculated annual (dry + wet) deposition of reduced nitrogen in 2010 with Emission Scenario 2 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

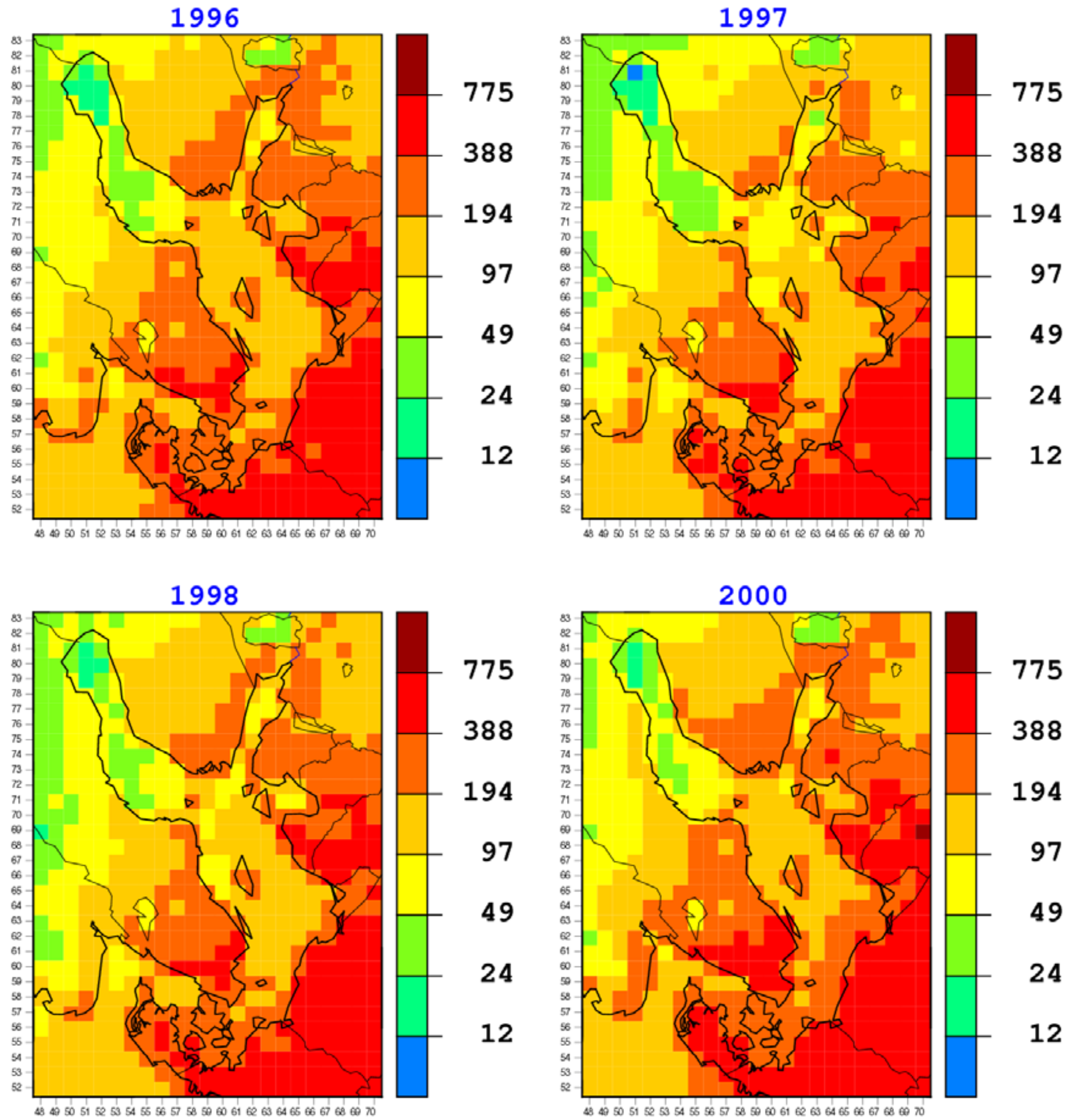


Figure B.7. Calculated annual dry deposition of the sum of oxidized and reduced nitrogen in 2010 with Emission Scenario 2 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

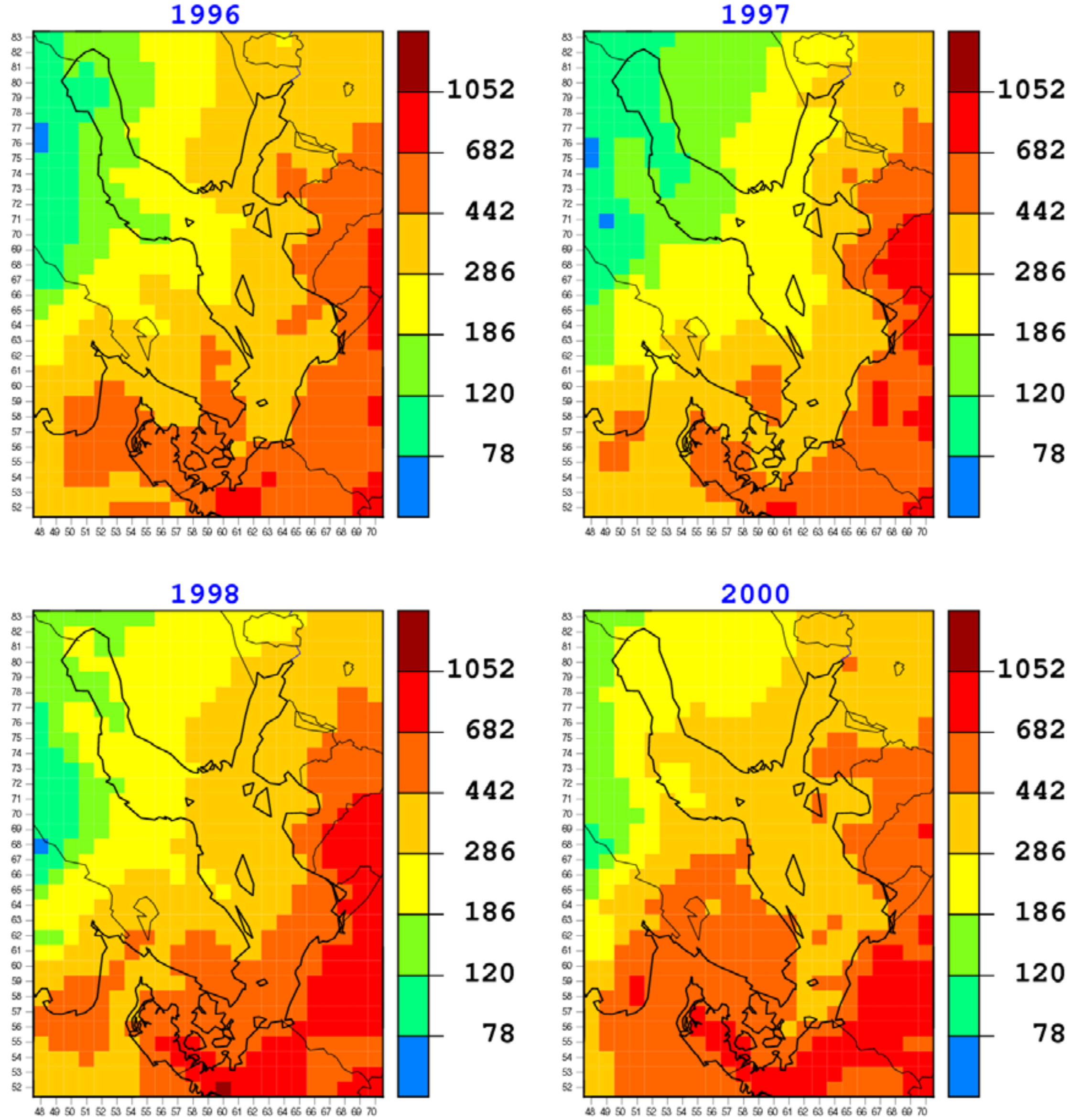


Figure B.8. Calculated annual wet deposition of the sum of oxidized and reduced nitrogen in 2010 with Emission Scenario 2 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

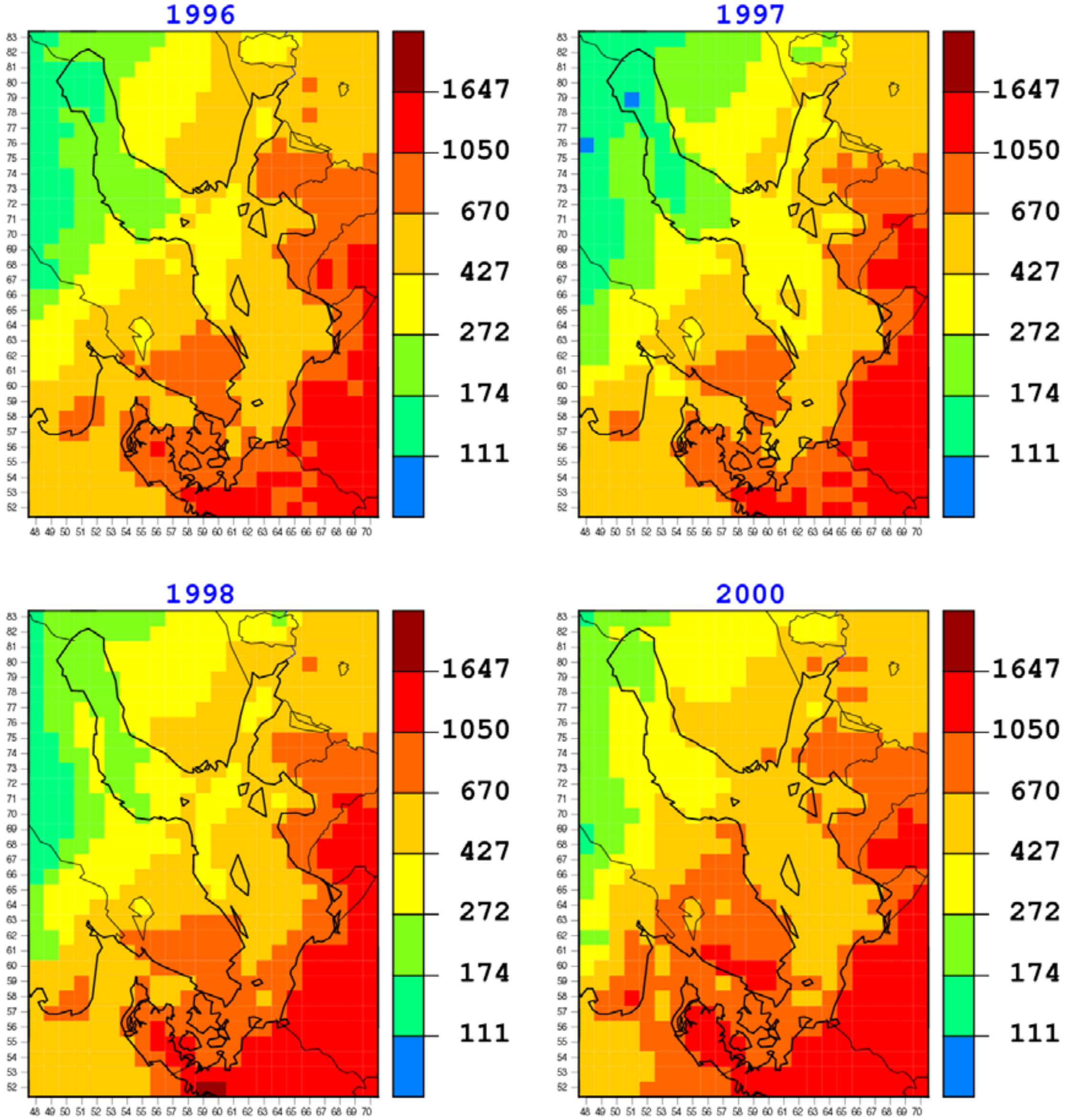


Figure B.9. Calculated annual total nitrogen deposition in 2010 with Emission Scenario 2 for 2010 and meteorological data from the years 1996, 1997, 1998, and 2000. Units: mg N m^{-2}.

APPENDIX C: SOURCE-RECEPTOR MATRICES FOR NITROGEN DEPOSITION IN 2010 BASED ON EMISSION SCENARIO 1

Source-receptor matrices for total (oxidized + reduced) nitrogen in the year 2010 are presented in this Appendix. In the model runs, annual total emissions from the EMEP Contracting Parties as specified in Scenario 1 were used, including the latest emissions from the international ship traffic on the European seas (see Section 2, above). Four different years with meteorological data were used in the calculations. Final source-receptor matrices for the year 2010 were calculated as the average over the four meteorological years.

Annual nitrogen depositions for the year 2010 were calculated for six sub-basins and catchment areas of the Baltic Sea and for the entire Baltic Sea basin and catchment area. Abbreviations for emission sources, sub-basins, and catchment areas used in the tables are explained in Section 1, above.

Table C.1. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with 1996 meteorology and Emission Scenario 1. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.2	0.1	0.0	0.4	0.0	0.0	0.8
AM	0.0	0.0	0.0	0.1	0.0	0.0	0.1
AT	1.1	0.7	0.5	7.9	0.9	0.6	11.7
AZ	0.0	0.0	0.0	0.1	0.0	0.0	0.1
BA	0.2	0.1	0.1	1.1	0.1	0.1	1.7
BE	3.0	1.2	0.7	12.7	3.0	2.2	22.8
BG	0.8	0.7	0.4	2.6	0.1	0.1	4.7
BY	11.0	8.6	6.4	50.0	2.1	2.6	80.9
CH	0.9	0.5	0.2	3.0	0.5	0.4	5.5
CS	1.1	0.6	0.4	4.6	0.3	0.3	7.3
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	4.7	2.6	1.8	27.2	3.9	2.7	42.9
DE	23.5	10.4	8.2	164.7	54.5	21.5	282.7
DK	7.6	3.0	2.3	53.0	35.2	35.4	136.6
EE	8.2	20.6	6.7	19.5	0.3	0.5	55.8
ES	1.9	0.5	0.4	3.4	0.8	0.8	7.7
FI	36.2	8.2	1.9	20.0	0.7	0.8	67.9
FR	7.9	2.9	2.1	31.3	7.6	5.4	57.3
GB	11.6	3.3	2.7	39.9	11.5	10.2	79.2
GE	0.1	0.1	0.0	0.2	0.0	0.0	0.5
GR	0.5	0.3	0.2	1.4	0.1	0.1	2.6
HR	0.4	0.3	0.2	2.7	0.3	0.2	4.1
HU	2.2	1.5	1.1	14.0	1.1	1.0	20.9
IE	0.8	0.2	0.2	2.8	0.7	0.7	5.3
IS	0.1	0.0	0.0	0.3	0.0	0.0	0.5
IT	4.0	2.3	1.1	15.6	1.7	1.3	26.0
KZ	0.1	0.1	0.1	0.4	0.0	0.0	0.7
LT	9.4	6.2	8.5	72.0	1.5	2.7	100.5
LU	0.1	0.1	0.0	0.9	0.2	0.2	1.5
LV	7.3	5.6	12.2	34.1	0.5	1.0	60.8
MD	1.5	0.7	0.5	3.3	0.1	0.1	6.2
MK	0.2	0.1	0.1	0.5	0.0	0.0	0.9
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	5.6	2.2	1.7	26.4	8.3	5.5	49.8
NO	6.4	1.0	0.6	8.9	1.1	1.8	19.7
PL	25.3	18.1	17.0	272.9	20.5	17.8	371.6
PT	0.2	0.1	0.1	0.5	0.1	0.1	1.0
RO	4.8	2.3	1.6	12.8	0.8	0.5	22.8
RU	16.7	13.8	7.0	49.7	2.1	2.5	91.8
SE	29.2	4.9	3.1	70.7	4.0	10.4	122.2
SI	0.3	0.2	0.1	1.9	0.2	0.1	2.8
SK	1.5	1.1	0.8	10.6	0.7	0.7	15.4
TR	0.3	0.4	0.1	0.4	0.0	0.0	1.3
UA	15.0	12.8	7.9	61.6	4.2	3.7	105.1
ATL	0.9	0.2	0.2	2.5	0.5	0.5	4.8
BAS	34.4	12.3	8.7	118.1	9.0	10.4	193.0
BLS	0.1	0.1	0.1	0.2	0.0	0.0	0.5
MED	1.5	0.6	0.3	3.6	0.4	0.4	6.8
NOS	10.0	3.2	2.4	37.0	9.3	9.2	70.9
ASI	0.0	0.0	0.0	0.1	0.0	0.0	0.1
NOA	0.1	0.1	0.1	0.5	0.0	0.0	0.9

Table C.2. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with 1997 meteorology and Emission Scenario 1. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.0	0.0	0.0	0.1	0.0	0.0	0.2
AM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AT	0.8	0.3	0.4	5.2	0.6	0.4	7.7
AZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA	0.2	0.0	0.1	0.5	0.0	0.0	0.8
BE	1.9	1.1	1.1	13.3	3.1	2.1	22.6
BG	0.1	0.1	0.2	0.7	0.1	0.0	1.2
BY	7.1	3.7	3.1	19.0	0.7	0.9	34.5
CH	0.7	0.2	0.3	4.0	0.3	0.2	5.8
CS	0.5	0.1	0.2	1.5	0.1	0.1	2.4
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	2.9	1.3	1.7	22.2	3.0	2.4	33.6
DE	15.6	8.0	9.2	152.4	54.8	22.6	262.6
DK	5.9	2.6	2.5	55.3	38.2	37.6	142.2
EE	7.0	19.3	5.8	11.7	0.3	0.3	44.4
ES	1.7	0.7	0.6	6.4	1.0	0.9	11.4
FI	32.2	9.3	2.5	14.5	0.3	0.4	59.2
FR	7.1	3.5	3.5	38.2	8.0	6.6	66.9
GB	13.8	5.5	4.7	56.5	13.0	14.0	107.5
GE	0.0	0.0	0.0	0.0	0.0	0.0	0.1
GR	0.1	0.1	0.1	0.3	0.0	0.0	0.7
HR	0.4	0.1	0.2	1.9	0.1	0.1	2.7
HU	1.7	0.5	0.6	8.4	0.6	0.7	12.5
IE	0.7	0.3	0.3	3.4	0.8	0.9	6.5
IS	0.1	0.0	0.0	0.3	0.0	0.0	0.5
IT	2.5	1.0	1.0	11.5	1.0	0.7	17.8
KZ	0.0	0.0	0.0	0.1	0.0	0.0	0.2
LT	8.3	4.0	6.4	35.1	0.9	1.1	55.7
LU	0.1	0.1	0.1	0.8	0.2	0.1	1.4
LV	5.5	4.1	10.0	18.5	0.5	0.5	39.2
MD	0.1	0.1	0.2	0.8	0.0	0.0	1.3
MK	0.0	0.0	0.0	0.1	0.0	0.0	0.1
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	3.5	2.2	2.3	28.1	7.9	5.4	49.3
NO	6.3	1.5	1.1	12.4	1.2	2.0	24.6
PL	22.0	8.0	11.7	208.3	11.6	12.6	274.2
PT	0.2	0.1	0.1	1.0	0.2	0.1	1.7
RO	0.8	0.6	0.7	4.4	0.3	0.3	7.0
RU	21.7	17.3	5.8	48.9	1.9	2.1	97.7
SE	28.5	5.6	4.6	84.8	2.7	7.5	133.7
SI	0.2	0.1	0.1	1.4	0.1	0.1	2.0
SK	1.2	0.3	0.4	6.6	0.4	0.5	9.4
TR	0.1	0.0	0.0	0.2	0.0	0.0	0.3
UA	4.6	3.0	3.3	20.2	0.5	0.7	32.3
ATL	1.1	0.4	0.3	4.1	0.8	0.8	7.5
BAS	29.7	11.2	8.9	101.7	8.2	9.5	169.1
BLS	0.0	0.0	0.0	0.1	0.0	0.0	0.2
MED	0.9	0.3	0.3	3.0	0.3	0.2	4.9
NOS	10.0	4.0	3.5	41.4	9.4	10.2	78.6
ASI	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOA	0.1	0.0	0.1	0.4	0.0	0.0	0.6

Table C.3. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with 1998 meteorology and Emission Scenario 1. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.2	0.0	0.0	0.3	0.0	0.0	0.5
AM	0.0	0.0	0.0	0.1	0.0	0.0	0.1
AT	1.3	0.3	0.3	6.6	0.9	0.8	10.1
AZ	0.0	0.0	0.0	0.1	0.0	0.0	0.1
BA	0.2	0.1	0.1	0.7	0.0	0.1	1.2
BE	2.1	1.3	0.9	15.8	4.1	2.2	26.3
BG	0.8	0.2	0.2	2.5	0.1	0.1	3.9
BY	11.2	6.4	5.0	32.5	1.0	1.3	57.3
CH	0.7	0.1	0.1	2.6	0.5	0.3	4.3
CS	0.8	0.3	0.2	2.8	0.2	0.2	4.5
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	5.5	1.8	1.6	35.8	3.4	3.1	51.3
DE	19.5	9.5	9.2	215.4	72.1	25.3	351.0
DK	7.6	2.5	2.7	66.4	41.4	45.4	165.9
EE	11.4	23.1	6.6	15.9	0.3	0.4	57.7
ES	2.9	0.8	0.8	10.7	1.5	1.3	18.0
FI	46.0	8.8	2.2	15.5	0.4	0.6	73.5
FR	8.1	2.8	2.5	41.8	9.2	5.7	70.2
GB	10.7	4.9	4.6	68.5	18.6	17.3	124.6
GE	0.1	0.1	0.0	0.2	0.0	0.0	0.4
GR	0.3	0.1	0.1	1.0	0.1	0.0	1.6
HR	0.6	0.2	0.1	1.9	0.1	0.2	3.1
HU	3.4	0.8	0.6	11.5	0.5	0.5	17.4
IE	0.6	0.3	0.3	3.8	1.1	1.1	7.2
IS	0.1	0.0	0.0	0.3	0.1	0.0	0.5
IT	3.0	0.8	0.5	9.1	2.2	1.8	17.4
KZ	0.1	0.1	0.0	0.2	0.0	0.0	0.4
LT	10.6	5.8	9.3	49.9	1.0	1.2	77.8
LU	0.1	0.1	0.1	1.3	0.2	0.1	1.9
LV	8.8	5.7	13.8	28.3	0.5	0.7	57.8
MD	0.9	0.4	0.3	2.3	0.1	0.1	4.1
MK	0.1	0.0	0.0	0.3	0.0	0.0	0.6
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	4.1	2.2	1.9	37.7	11.5	6.0	63.3
NO	6.3	1.0	0.8	11.6	1.1	2.3	23.2
PL	39.0	16.5	13.4	281.7	12.3	11.4	374.4
PT	0.3	0.1	0.1	1.3	0.2	0.2	2.0
RO	4.3	1.4	1.3	11.4	0.5	0.4	19.4
RU	33.1	27.1	6.1	57.3	2.0	2.0	127.6
SE	34.5	5.1	3.9	84.5	3.2	9.8	141.0
SI	0.4	0.1	0.1	1.2	0.1	0.2	2.0
SK	2.6	0.7	0.5	9.3	0.5	0.4	14.2
TR	0.2	0.1	0.0	0.8	0.1	0.0	1.3
UA	17.6	8.7	5.6	48.1	1.7	1.7	83.5
ATL	1.1	0.3	0.3	4.2	1.0	0.9	7.8
BAS	42.2	12.8	10.1	126.2	8.2	10.4	209.9
BLS	0.1	0.0	0.0	0.2	0.0	0.0	0.4
MED	1.0	0.3	0.1	2.0	0.3	0.3	4.0
NOS	10.7	3.8	3.6	55.3	13.8	13.3	100.5
ASI	0.1	0.0	0.0	0.1	0.0	0.0	0.2
NOA	0.2	0.0	0.0	0.2	0.1	0.1	0.5

Table C.4. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with 2000 meteorology and Emission Scenario 1. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.4	0.1	0.1	0.8	0.0	0.0	1.4
AM	0.1	0.0	0.0	0.1	0.0	0.0	0.2
AT	3.4	0.9	0.8	11.4	0.9	1.2	18.6
AZ	0.1	0.0	0.0	0.1	0.0	0.0	0.1
BA	0.6	0.3	0.2	2.0	0.0	0.0	3.3
BE	4.7	1.5	1.0	16.1	5.4	4.8	33.6
BG	2.3	0.5	0.5	5.9	0.1	0.1	9.4
BY	17.5	7.5	6.0	32.6	0.5	0.6	64.7
CH	1.8	0.7	0.5	6.0	1.3	1.1	11.4
CS	2.2	1.1	0.8	7.3	0.1	0.1	11.7
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	9.6	3.0	2.7	39.4	3.4	3.9	62.1
DE	36.8	13.5	11.4	213.7	77.0	40.0	392.4
DK	7.7	2.8	2.6	55.7	38.4	42.4	149.6
EE	9.6	23.9	5.6	8.5	0.1	0.2	47.9
ES	3.5	1.4	0.9	10.1	2.1	2.6	20.6
FI	35.9	8.8	1.8	9.7	0.2	0.2	56.7
FR	14.0	4.9	3.6	49.9	14.4	16.1	102.8
GB	14.5	4.6	3.4	50.4	15.1	15.7	103.7
GE	0.3	0.1	0.0	0.4	0.0	0.0	0.7
GR	1.0	0.3	0.3	2.6	0.0	0.0	4.3
HR	1.6	0.5	0.4	5.2	0.1	0.2	8.1
HU	5.6	2.4	1.7	19.5	0.5	0.8	30.4
IE	0.8	0.3	0.2	2.9	0.9	0.8	5.8
IS	0.1	0.0	0.0	0.2	0.0	0.0	0.4
IT	10.3	4.2	2.9	33.2	2.7	2.8	56.3
KZ	0.2	0.0	0.0	0.1	0.0	0.0	0.4
LT	18.0	6.3	10.2	50.4	0.8	0.6	86.3
LU	0.3	0.1	0.1	1.1	0.3	0.3	2.2
LV	11.8	6.2	13.2	21.7	0.3	0.3	53.5
MD	2.0	0.6	0.5	4.1	0.0	0.0	7.2
MK	0.4	0.1	0.1	0.8	0.0	0.0	1.3
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	7.6	2.5	1.7	31.4	13.0	10.5	66.7
NO	5.1	1.1	0.7	8.8	1.0	2.1	18.9
PL	58.0	15.5	15.5	325.6	10.3	11.0	436.0
PT	0.4	0.2	0.1	1.5	0.3	0.4	2.9
RO	8.2	2.9	2.1	20.3	0.3	0.4	34.2
RU	30.6	21.7	5.0	42.0	0.9	0.9	101.1
SE	33.3	5.0	3.7	71.3	2.5	9.1	124.9
SI	1.1	0.3	0.3	3.1	0.2	0.2	5.0
SK	3.6	1.3	1.0	12.7	0.4	0.6	19.6
TR	0.7	0.3	0.3	2.3	0.0	0.0	3.6
UA	29.8	9.9	6.4	58.6	0.5	0.7	105.9
ATL	1.5	0.5	0.3	4.3	0.9	1.1	8.6
BAS	42.7	12.8	9.8	112.2	7.9	10.5	196.0
BLS	0.3	0.1	0.1	0.7	0.0	0.0	1.1
MED	2.2	0.9	0.8	8.3	0.4	0.5	13.0
NOS	12.9	4.0	3.0	45.5	13.4	14.5	93.2
ASI	0.0	0.0	0.0	0.1	0.0	0.0	0.2
NOA	0.2	0.1	0.1	0.7	0.0	0.0	1.2

Table C.5. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with meteorology averaged over four years and Emission Scenario 1. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.2	0.1	0.0	0.4	0.0	0.0	0.7
AM	0.0	0.0	0.0	0.1	0.0	0.0	0.1
AT	1.6	0.6	0.5	7.8	0.8	0.8	12.0
AZ	0.0	0.0	0.0	0.1	0.0	0.0	0.1
BA	0.3	0.1	0.1	1.1	0.1	0.1	1.8
BE	2.9	1.3	1.0	14.5	3.9	2.8	26.3
BG	1.0	0.4	0.3	2.9	0.1	0.1	4.8
BY	11.7	6.5	5.2	33.5	1.1	1.4	59.3
CH	1.0	0.4	0.3	3.9	0.7	0.5	6.8
CS	1.2	0.5	0.4	4.0	0.2	0.2	6.5
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	5.7	2.2	2.0	31.1	3.5	3.0	47.4
DE	23.8	10.4	9.5	186.5	64.6	27.4	322.2
DK	7.2	2.7	2.5	57.6	38.3	40.2	148.6
EE	9.0	21.7	6.2	13.9	0.3	0.4	51.4
ES	2.5	0.9	0.7	7.6	1.3	1.4	14.4
FI	37.6	8.8	2.1	14.9	0.4	0.5	64.3
FR	9.3	3.5	2.9	40.3	9.8	8.5	74.3
GB	12.7	4.6	3.8	53.8	14.5	14.3	103.8
GE	0.1	0.1	0.0	0.2	0.0	0.0	0.4
GR	0.5	0.2	0.2	1.4	0.0	0.0	2.3
HR	0.8	0.3	0.2	2.9	0.2	0.2	4.5
HU	3.2	1.3	1.0	13.4	0.7	0.7	20.3
IE	0.7	0.3	0.2	3.2	0.9	0.9	6.2
IS	0.1	0.0	0.0	0.3	0.0	0.0	0.5
IT	5.0	2.1	1.4	17.4	1.9	1.7	29.4
KZ	0.1	0.1	0.0	0.2	0.0	0.0	0.4
LT	11.6	5.6	8.6	51.9	1.0	1.4	80.1
LU	0.2	0.1	0.1	1.0	0.2	0.2	1.8
LV	8.4	5.4	12.3	25.7	0.5	0.6	52.8
MD	1.1	0.4	0.4	2.6	0.1	0.1	4.7
MK	0.2	0.1	0.0	0.4	0.0	0.0	0.7
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	5.2	2.3	1.9	30.9	10.2	6.8	57.3
NO	6.1	1.2	0.8	10.4	1.1	2.1	21.6
PL	36.1	14.5	14.4	272.2	13.7	13.2	364.0
PT	0.3	0.1	0.1	1.1	0.2	0.2	1.9
RO	4.5	1.8	1.4	12.2	0.4	0.4	20.8
RU	25.5	20.0	6.0	49.5	1.7	1.9	104.6
SE	31.4	5.1	3.8	77.8	3.1	9.2	130.4
SI	0.5	0.2	0.2	1.9	0.1	0.1	3.0
SK	2.2	0.9	0.7	9.8	0.5	0.6	14.7
TR	0.3	0.2	0.1	0.9	0.0	0.0	1.6
UA	16.7	8.6	5.8	47.1	1.7	1.7	81.7
ATL	1.1	0.4	0.3	3.7	0.8	0.8	7.2
BAS	37.3	12.3	9.4	114.5	8.3	10.2	192.0
BLS	0.1	0.1	0.1	0.3	0.0	0.0	0.6
MED	1.4	0.5	0.4	4.2	0.3	0.3	7.2
NOS	10.9	3.8	3.1	44.8	11.5	11.8	85.8
ASI	0.0	0.0	0.0	0.1	0.0	0.0	0.1
NOA	0.2	0.1	0.1	0.4	0.0	0.0	0.8

Table C.6. Contribution of EMEP countries (regions) to total nitrogen depositions into the catchment areas of the Baltic Sea. Results of the model run with 1996 meteorology and Emission Scenario 1. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.5	0.9	0.5	3.8	0.1	0.2	5.9
AM	0.2	0.9	0.3	0.4	0.0	0.0	1.9
AT	4.3	8.7	4.6	54.9	2.2	2.6	77.2
AZ	0.1	0.7	0.2	0.4	0.0	0.0	1.5
BA	0.7	1.6	1.0	9.7	0.2	0.5	13.7
BE	13.2	10.8	5.0	47.7	7.1	10.3	94.0
BG	2.7	10.6	6.6	29.0	0.2	0.5	49.6
BY	46.9	160.5	179.4	439.9	4.7	13.6	845.0
CH	3.8	5.7	2.2	17.3	1.4	1.6	32.0
CS	3.3	7.3	4.2	39.2	0.7	1.6	56.3
CY	0.0	0.1	0.0	0.0	0.0	0.0	0.1
CZ	18.5	30.0	16.9	302.7	9.3	11.3	388.8
DE	98.2	106.0	57.0	702.5	143.2	84.2	1191.2
DK	32.4	27.6	12.5	143.2	77.7	120.6	414.0
EE	36.2	141.5	40.2	40.3	0.7	3.5	262.3
ES	7.9	7.7	2.6	18.2	1.9	3.5	41.8
FI	195.9	148.1	12.9	45.9	1.6	6.0	410.4
FR	40.3	33.9	15.1	120.9	18.2	25.4	253.7
GB	73.6	40.3	18.5	134.2	27.3	54.2	348.1
GE	0.6	2.1	0.7	1.8	0.0	0.1	5.4
GR	1.7	4.2	2.7	13.3	0.2	0.4	22.3
HR	1.6	4.0	2.2	23.1	0.7	0.9	32.5
HU	8.2	19.9	11.4	125.3	2.5	4.3	171.7
IE	4.6	2.2	1.3	9.0	1.7	3.0	21.8
IS	0.7	0.3	0.1	0.9	0.1	0.2	2.4
IT	14.1	29.4	12.6	101.8	4.3	6.3	168.6
KZ	0.6	2.4	1.1	2.6	0.0	0.1	7.0
LT	40.5	81.8	142.9	401.1	3.6	14.2	684.2
LU	0.7	0.7	0.4	3.3	0.5	0.6	6.3
LV	31.4	87.9	134.9	98.0	1.2	6.7	360.2
MD	4.0	10.7	7.8	26.9	0.3	0.4	50.1
MK	0.6	1.2	0.6	4.1	0.0	0.1	6.7
MT	0.0	0.0	0.0	0.1	0.0	0.0	0.2
NL	25.2	21.5	10.7	101.6	19.9	23.8	202.7
NO	50.6	14.7	3.7	27.5	2.5	17.5	116.5
PL	102.9	206.4	142.0	2995.3	46.1	67.8	3560.6
PT	1.0	0.8	0.3	2.1	0.2	0.3	4.8
RO	14.1	32.8	22.8	132.7	1.8	3.1	207.3
RU	91.2	380.1	171.5	246.3	4.8	16.2	910.2
SE	137.3	52.1	16.2	214.3	11.0	87.3	518.4
SI	1.1	2.8	1.4	14.7	0.5	0.5	21.0
SK	6.2	14.3	8.6	136.0	1.7	3.2	170.0
TR	1.9	11.9	4.9	4.9	0.1	0.1	23.8
UA	58.2	224.0	147.8	567.7	9.6	18.0	1025.3
ATL	6.3	3.4	1.3	8.3	1.3	2.5	23.1
BAS	134.8	115.1	46.1	314.2	21.4	54.2	685.8
BLS	0.4	2.6	1.7	3.1	0.0	0.1	7.8
MED	5.2	9.0	4.5	26.0	0.9	1.7	47.1
NOS	52.3	35.6	16.0	135.4	22.9	52.5	314.7
ASI	0.2	0.8	0.3	0.6	0.0	0.0	1.9
NOA	0.5	1.2	0.5	3.3	0.1	0.2	5.8

Table C.7. Contribution of EMEP countries (regions) to total nitrogen depositions into the catchment areas of the Baltic Sea. Results of the model run with 1997 meteorology and Emission Scenario 1. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.1	0.6	0.4	1.7	0.0	0.0	3.0
AM	0.0	0.1	0.1	0.1	0.0	0.0	0.3
AT	3.0	5.4	4.9	47.7	1.5	1.8	64.4
AZ	0.0	0.1	0.0	0.1	0.0	0.0	0.3
BA	0.6	0.9	0.8	5.2	0.1	0.1	7.6
BE	10.1	14.0	7.8	54.2	7.3	9.3	102.7
BG	0.5	4.6	3.8	16.3	0.2	0.2	25.5
BY	27.9	113.5	166.4	346.9	1.6	5.0	661.5
CH	2.7	3.5	2.9	22.6	0.9	1.4	33.8
CS	1.6	3.8	3.0	21.5	0.2	0.3	30.5
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	11.7	21.4	20.1	305.3	6.9	9.2	374.6
DE	67.3	100.6	76.8	820.5	144.1	88.3	1297.5
DK	27.9	29.7	19.0	164.8	83.4	126.1	450.9
EE	30.9	148.0	47.0	35.3	0.7	2.7	264.7
ES	10.1	9.6	5.5	34.3	2.4	4.7	66.7
FI	194.1	163.1	20.1	41.6	0.8	4.6	424.3
FR	37.9	43.0	25.9	176.1	19.3	30.6	332.8
GB	75.7	60.7	32.0	214.5	31.1	65.2	479.2
GE	0.1	0.3	0.3	0.3	0.0	0.0	0.9
GR	0.3	2.3	2.1	7.2	0.1	0.1	12.2
HR	1.2	2.5	2.0	17.3	0.2	0.3	23.6
HU	5.6	10.1	8.6	94.9	1.4	2.6	123.3
IE	4.1	3.4	2.3	12.8	1.9	3.9	28.4
IS	0.9	0.4	0.2	1.0	0.1	0.2	2.7
IT	10.2	18.3	12.2	80.1	2.5	3.5	126.9
KZ	0.1	0.3	0.3	0.7	0.0	0.1	1.5
LT	30.3	75.1	164.0	386.6	2.1	7.3	665.4
LU	0.5	0.8	0.6	3.7	0.4	0.5	6.6
LV	23.1	91.3	150.3	91.2	1.1	4.0	361.0
MD	0.5	4.7	3.8	9.1	0.0	0.1	18.3
MK	0.1	0.6	0.5	1.6	0.0	0.0	2.8
MT	0.0	0.0	0.0	0.1	0.0	0.0	0.1
NL	18.8	25.9	15.6	116.2	18.9	21.9	217.3
NO	47.4	17.7	6.7	38.5	2.8	18.2	131.3
PL	90.8	143.9	149.1	2985.4	27.8	53.3	3450.2
PT	1.1	1.2	0.9	5.5	0.4	0.6	9.8
RO	2.9	18.8	13.2	60.7	0.6	1.1	97.2
RU	111.8	549.2	162.0	266.5	4.7	14.2	1108.3
SE	132.1	57.0	26.6	246.5	8.6	83.8	554.5
SI	0.8	1.6	1.3	12.1	0.3	0.4	16.5
SK	4.5	7.1	6.6	111.6	1.0	2.2	133.1
TR	0.2	2.5	2.1	3.6	0.1	0.1	8.6
UA	17.5	83.0	66.5	272.2	1.1	4.4	444.7
ATL	6.9	5.0	2.4	15.0	1.9	4.2	35.5
BAS	120.5	115.4	58.2	309.1	20.3	51.8	675.2
BLS	0.1	0.7	0.6	1.5	0.0	0.0	2.9
MED	3.3	5.4	3.7	21.6	0.6	0.9	35.6
NOS	52.3	48.0	25.3	168.3	23.3	53.2	370.3
ASI	0.0	0.1	0.1	0.2	0.0	0.0	0.4
NOA	0.4	0.9	0.7	3.1	0.1	0.1	5.3

Table C.8. Contribution of EMEP countries (regions) to total nitrogen depositions into the catchment areas of the Baltic Sea. Results of the model run with 1998 meteorology and Emission Scenario 1. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.4	0.4	0.3	2.2	0.1	0.1	3.5
AM	0.2	0.6	0.2	0.5	0.0	0.1	1.5
AT	4.9	5.8	4.4	68.8	2.1	3.4	89.4
AZ	0.2	0.4	0.2	0.4	0.0	0.0	1.2
BA	0.7	1.0	0.8	7.6	0.1	0.2	10.3
BE	10.4	13.7	7.4	71.9	9.9	9.4	122.7
BG	2.7	3.7	3.5	20.8	0.2	0.4	31.3
BY	40.3	154.7	191.0	343.7	2.1	6.5	738.2
CH	2.3	4.2	2.7	26.8	1.2	1.2	38.5
CS	2.7	3.6	3.0	30.4	0.4	0.7	40.8
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.1
CZ	19.8	28.9	21.8	392.0	8.3	12.7	483.3
DE	82.5	111.2	74.2	1022.9	186.5	92.9	1570.2
DK	31.3	29.2	16.8	164.6	90.9	145.9	478.7
EE	39.8	153.2	43.4	32.2	0.7	2.7	272.1
ES	10.4	12.6	7.7	53.6	3.6	5.4	93.2
FI	231.6	146.9	15.1	37.6	0.9	5.1	437.2
FR	33.1	40.2	24.2	215.2	22.4	26.0	361.2
GB	51.2	59.0	33.5	257.1	44.4	75.9	521.1
GE	0.5	1.6	0.5	1.2	0.0	0.1	4.1
GR	0.9	1.6	1.1	6.4	0.2	0.2	10.5
HR	2.5	2.6	2.0	23.4	0.3	0.8	31.6
HU	11.7	13.9	10.6	119.6	1.2	3.3	160.4
IE	3.0	3.1	1.8	13.0	2.5	4.7	28.2
IS	0.7	0.4	0.1	1.0	0.1	0.2	2.6
IT	11.9	15.6	9.9	102.1	5.2	6.6	151.2
KZ	0.8	1.5	0.5	1.0	0.0	0.1	3.9
LT	36.9	93.7	186.8	368.6	2.1	6.3	694.4
LU	0.6	0.8	0.5	5.5	0.6	0.5	8.5
LV	28.9	102.2	153.4	83.2	1.1	3.7	372.6
MD	4.0	6.5	5.2	15.9	0.1	0.6	32.3
MK	0.4	0.5	0.4	2.5	0.1	0.1	3.9
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.1
NL	20.1	25.3	14.7	147.7	27.8	24.0	259.7
NO	47.9	14.3	5.1	33.2	2.6	20.1	123.1
PL	142.6	203.2	166.2	3093.6	28.8	62.8	3697.1
PT	1.1	1.4	0.8	6.5	0.5	0.6	10.9
RO	16.0	20.6	16.6	89.4	1.1	2.7	146.3
RU	1565.8	674.2	140.5	246.2	4.3	11.7	1243.1
SE	153.8	51.8	20.5	242.5	9.5	98.0	576.1
SI	1.7	1.7	1.3	15.8	0.3	0.7	21.5
SK	9.2	11.8	8.6	133.2	1.1	2.9	166.7
TR	1.1	3.2	1.1	4.0	0.1	0.4	9.9
UA	69.4	154.7	95.6	368.0	3.8	11.8	703.3
ATL	6.4	4.7	2.3	16.0	2.4	4.2	36.0
BAS	152.7	123.2	55.5	323.8	19.3	56.3	730.7
BLS	0.4	1.2	0.7	1.9	0.0	0.1	4.3
MED	3.5	4.8	2.2	19.0	0.7	1.1	31.3
NOS	52.3	49.1	27.2	208.3	33.6	63.3	433.9
ASI	0.3	0.5	0.2	0.4	0.0	0.0	1.4
NOA	0.6	0.5	0.3	1.8	0.1	0.2	3.7

Table C.9. Contribution of EMEP countries (regions) to total nitrogen depositions into the catchment areas of the Baltic Sea. Results of the model run with 2000 meteorology and Emission Scenario 1. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	1.2	1.5	0.7	4.6	0.0	0.2	8.2
AM	0.3	0.3	0.2	0.3	0.0	0.0	1.1
AT	10.6	11.0	6.6	77.9	2.2	5.0	113.3
AZ	0.2	0.3	0.1	0.2	0.0	0.0	0.8
BA	2.0	2.8	1.7	12.9	0.1	0.4	19.9
BE	21.2	14.6	6.7	63.6	13.0	20.2	139.2
BG	7.0	9.3	5.6	31.2	0.2	1.2	54.5
BY	60.7	145.5	176.9	326.1	1.2	6.1	716.6
CH	7.1	7.1	3.2	32.8	2.8	4.6	57.7
CS	7.2	11.8	6.2	47.7	0.3	1.6	74.8
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.2
CZ	34.6	36.2	22.1	410.8	8.3	16.9	528.9
DE	153.9	132.4	74.5	1007.5	195.6	159.3	1723.1
DK	40.0	29.6	17.0	154.0	85.3	146.1	472.1
EE	39.2	163.6	43.5	20.1	0.3	1.4	268.0
ES	14.0	12.9	6.5	43.2	4.8	9.9	91.3
FI	212.1	162.1	14.4	24.3	0.4	2.1	415.3
FR	62.5	47.5	24.4	217.3	33.8	62.9	448.2
GB	86.0	56.2	23.7	196.1	36.4	75.1	473.4
GE	0.9	1.2	0.6	1.0	0.0	0.1	3.8
GR	2.9	4.4	2.2	14.0	0.0	0.5	24.0
HR	4.8	5.6	3.7	35.2	0.4	1.0	50.7
HU	17.6	24.6	14.9	145.0	1.3	5.4	208.8
IE	4.4	3.2	1.2	10.7	2.0	3.5	25.1
IS	0.8	0.5	0.2	0.9	0.1	0.2	2.7
IT	32.6	37.6	21.9	175.5	6.3	12.7	286.6
KZ	0.7	1.2	0.3	0.5	0.0	0.1	2.8
LT	56.7	91.1	180.7	359.0	1.8	5.7	695.0
LU	1.2	0.9	0.5	5.1	0.8	1.4	9.9
LV	38.2	104.6	156.6	69.5	0.8	2.2	371.9
MD	6.8	11.3	6.3	19.2	0.1	0.9	44.6
MK	1.1	1.3	0.6	4.5	0.0	0.1	7.6
MT	0.0	0.0	0.0	0.1	0.0	0.0	0.2
NL	38.5	27.0	12.1	123.2	30.8	42.6	274.3
NO	46.6	15.6	5.2	29.9	2.4	18.5	118.3
PL	195.6	204.2	160.7	3234.9	25.2	74.4	3894.9
PT	2.0	1.8	0.9	6.4	0.7	1.4	13.1
RO	27.0	38.9	21.8	117.2	0.7	5.2	210.8
RU	158.3	654.8	128.6	182.1	2.2	8.0	1134.0
SE	165.0	56.3	22.2	226.2	8.1	100.3	578.0
SI	3.2	3.1	2.3	22.1	0.3	0.9	31.9
SK	12.0	16.6	10.6	143.0	1.0	4.0	187.2
TR	2.5	4.7	3.5	7.1	0.0	0.4	18.2
UA	105.8	180.6	92.4	352.9	1.2	13.1	746.2
ATL	9.2	5.8	2.3	15.9	2.2	5.3	40.8
BAS	168.1	130.1	57.1	307.3	19.6	61.1	743.2
BLS	0.8	1.9	1.4	3.0	0.0	0.1	7.2
MED	7.2	10.0	6.0	41.7	1.0	2.4	68.3
NOS	72.9	48.1	21.5	178.2	32.9	72.8	426.5
ASI	0.2	0.3	0.2	0.3	0.0	0.0	1.0
NOA	0.7	1.5	0.8	4.1	0.1	0.2	7.4

Table C.10. Contribution of EMEP countries (regions) to total nitrogen depositions into the catchment areas of the Baltic Sea. Results of the model run with meteorology averaged over four years and Emission Scenario 1. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.6	0.9	0.5	3.1	0.1	0.1	5.2
AM	0.2	0.5	0.2	0.3	0.0	0.0	1.2
AT	5.7	7.7	5.1	62.3	2.0	3.2	86.1
AZ	0.1	0.4	0.1	0.3	0.0	0.0	0.9
BA	1.0	1.6	1.1	8.8	0.1	0.3	12.9
BE	13.7	13.2	6.7	59.3	9.3	12.3	114.7
BG	3.2	7.1	4.9	24.3	0.2	0.6	40.2
BY	43.9	143.6	178.4	364.2	2.4	7.8	740.3
CH	4.0	5.1	2.7	24.9	1.6	2.2	40.5
CS	3.7	6.6	4.1	34.7	0.4	1.1	50.6
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.1
CZ	21.2	29.1	20.2	352.7	8.2	12.5	443.9
DE	100.5	112.5	70.6	888.3	167.4	106.2	1445.5
DK	32.9	29.0	16.3	156.6	84.3	134.7	453.9
EE	36.5	151.6	43.5	32.0	0.6	2.6	266.8
ES	10.6	10.7	5.6	37.3	3.2	5.9	73.3
FI	208.4	155.0	15.6	37.3	0.9	4.5	421.8
FR	43.5	41.1	22.4	182.3	23.4	36.2	349.0
GB	71.6	54.1	26.9	200.5	34.8	67.6	455.4
GE	0.5	1.3	0.5	1.1	0.0	0.1	3.6
GR	1.5	3.1	2.0	10.2	0.1	0.3	17.3
HR	2.5	3.7	2.5	24.8	0.4	0.8	34.6
HU	10.8	17.1	11.4	121.2	1.6	3.9	166.0
IE	4.0	3.0	1.6	11.4	2.0	3.8	25.9
IS	0.8	0.4	0.2	0.9	0.1	0.2	2.6
IT	17.2	25.2	14.2	114.9	4.6	7.3	183.3
KZ	0.6	1.4	0.6	1.2	0.0	0.1	3.8
LT	41.1	85.4	168.6	378.8	2.4	8.4	684.8
LU	0.8	0.8	0.5	4.4	0.6	0.8	7.8
LV	30.4	96.5	148.8	85.5	1.1	4.2	366.4
MD	3.8	8.3	5.8	17.8	0.1	0.5	36.3
MK	0.5	0.9	0.5	3.2	0.0	0.1	5.3
MT	0.0	0.0	0.0	0.1	0.0	0.0	0.1
NL	25.7	24.9	13.3	122.2	24.3	28.1	238.5
NO	48.1	15.6	5.2	32.3	2.6	18.6	122.3
PL	133.0	189.4	154.5	3077.3	32.0	64.6	3650.7
PT	1.3	1.3	0.7	5.1	0.5	0.8	9.6
RO	15.0	27.8	18.6	100.0	1.0	3.0	165.4
RU	131.8	564.6	150.7	253.3	4.0	12.5	1098.9
SE	147.1	54.3	21.4	232.4	9.3	92.4	556.8
SI	1.7	2.3	1.6	16.2	0.3	0.6	22.7
SK	8.0	12.4	8.6	131.0	1.2	3.1	164.3
TR	1.4	5.6	2.9	4.9	0.1	0.3	15.1
UA	62.7	160.6	100.6	390.2	3.9	11.8	729.9
ATL	7.2	4.7	2.1	13.8	2.0	4.1	33.8
BAS	144.0	120.9	54.2	313.6	20.1	55.9	708.8
BLS	0.4	1.6	1.1	2.4	0.0	0.1	5.6
MED	4.8	7.3	4.1	27.1	0.8	1.5	45.6
NOS	57.5	45.2	22.5	172.6	28.2	60.4	386.3
ASI	0.2	0.4	0.2	0.4	0.0	0.0	1.2
NOA	0.6	1.0	0.6	3.1	0.1	0.2	5.5

APPENDIX D: SOURCE-RECEPTOR MATRICES FOR NITROGEN DEPOSITION IN 2010 BASED ON EMISSION SCENARIO 2

Source-receptor matrices for total (oxidized + reduced) nitrogen in the year 2010 are presented in this Appendix. In the model runs, annual total emissions from the EMEP Contracting Parties as specified in Scenario 2 were used, including the latest emissions from the international ship traffic on the European seas (see Section 2, above). Four different years with meteorological data were used in the calculations. Final source-receptor matrices for the year 2010 were calculated as the average over the four meteorological years.

Annual nitrogen depositions for the year 2010 were calculated for six sub-basins and catchment areas of the Baltic Sea and for the entire Baltic Sea basin and catchment area. Abbreviations for emission sources, sub-basins, and catchment areas used in the tables are explained in Section 1, above.

Table D.1. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with 1996 meteorology and Emission Scenario 2. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.2	0.1	0.0	0.4	0.0	0.0	0.8
AM	0.0	0.0	0.0	0.1	0.0	0.0	0.1
AT	1.0	0.7	0.4	7.1	0.8	0.5	10.5
AZ	0.0	0.0	0.0	0.1	0.0	0.0	0.1
BA	0.2	0.1	0.1	1.1	0.1	0.1	1.7
BE	2.7	1.1	0.7	11.4	2.7	2.0	20.5
BG	0.7	0.6	0.4	2.4	0.1	0.1	4.3
BY	9.9	7.8	5.8	45.0	1.9	2.4	72.8
CH	0.8	0.4	0.2	2.7	0.5	0.3	5.0
CS	1.1	0.6	0.4	4.6	0.3	0.3	7.3
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	4.2	2.3	1.6	24.5	3.5	2.4	38.6
DE	21.1	9.4	7.3	148.2	49.0	19.4	254.5
DK	6.8	2.7	2.1	47.7	31.7	31.9	122.9
EE	7.4	18.5	6.0	17.6	0.3	0.4	50.2
ES	1.7	0.5	0.3	3.0	0.7	0.7	6.9
FI	32.6	7.4	1.7	18.0	0.6	0.7	61.1
FR	7.2	2.6	1.9	28.2	6.8	4.9	51.6
GB	10.5	3.0	2.4	35.9	10.4	9.2	71.3
GE	0.1	0.1	0.0	0.2	0.0	0.0	0.5
GR	0.4	0.3	0.2	1.3	0.1	0.0	2.3
HR	0.4	0.3	0.2	2.4	0.3	0.2	3.7
HU	2.0	1.3	1.0	12.6	1.0	0.9	18.8
IE	0.7	0.2	0.2	2.5	0.6	0.6	4.8
IS	0.1	0.0	0.0	0.3	0.0	0.0	0.5
IT	3.6	2.1	0.9	14.0	1.5	1.2	23.4
KZ	0.1	0.1	0.1	0.4	0.0	0.0	0.7
LT	8.5	5.6	7.7	64.8	1.4	2.5	90.4
LU	0.1	0.1	0.0	0.8	0.2	0.1	1.4
LV	6.6	5.0	11.0	30.7	0.5	0.9	54.7
MD	1.3	0.6	0.5	3.0	0.1	0.1	5.6
MK	0.2	0.1	0.1	0.5	0.0	0.0	0.9
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	5.1	2.0	1.6	23.7	7.4	5.0	44.8
NO	5.8	0.9	0.5	8.0	0.9	1.6	17.7
PL	22.7	16.3	15.3	245.6	18.5	16.1	334.5
PT	0.2	0.1	0.1	0.4	0.1	0.1	0.9
RO	4.3	2.1	1.4	11.5	0.7	0.4	20.5
RU	15.0	12.4	6.3	44.8	1.9	2.3	82.6
SE	26.2	4.4	2.8	63.6	3.6	9.3	110.0
SI	0.2	0.2	0.1	1.7	0.2	0.1	2.6
SK	1.4	1.0	0.7	9.5	0.7	0.6	13.9
TR	0.3	0.4	0.1	0.4	0.0	0.0	1.3
UA	13.5	11.5	7.1	55.4	3.8	3.3	94.6
ATL	0.8	0.2	0.2	2.2	0.5	0.5	4.4
BAS	31.0	11.1	7.8	106.3	8.1	9.4	173.7
BLS	0.1	0.1	0.1	0.2	0.0	0.0	0.5
MED	1.4	0.5	0.3	3.3	0.3	0.3	6.1
NOS	9.0	2.8	2.2	33.3	8.3	8.2	63.9
ASI	0.0	0.0	0.0	0.1	0.0	0.0	0.1
NOA	0.1	0.1	0.1	0.5	0.0	0.0	0.9

Table D.2. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with 1997 meteorology and Emission Scenario 2. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.0	0.0	0.0	0.1	0.0	0.0	0.2
AM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AT	0.7	0.3	0.3	4.7	0.6	0.4	7.0
AZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA	0.2	0.0	0.1	0.5	0.0	0.0	0.8
BE	1.7	1.0	1.0	12.0	2.8	1.8	20.3
BG	0.1	0.1	0.1	0.6	0.1	0.0	1.0
BY	6.4	3.4	2.8	17.1	0.6	0.8	31.1
CH	0.6	0.2	0.3	3.6	0.3	0.2	5.2
CS	0.5	0.1	0.2	1.5	0.1	0.1	2.4
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	2.6	1.2	1.5	20.0	2.7	2.2	30.2
DE	14.0	7.2	8.3	137.2	49.3	20.3	236.4
DK	5.3	2.4	2.3	49.8	34.4	33.8	128.0
EE	6.3	17.4	5.2	10.5	0.3	0.3	39.9
ES	1.5	0.7	0.6	5.8	0.9	0.8	10.3
FI	29.0	8.4	2.2	13.0	0.3	0.4	53.2
FR	6.4	3.2	3.1	34.3	7.2	6.0	60.2
GB	12.4	4.9	4.2	50.9	11.7	12.6	96.7
GE	0.0	0.0	0.0	0.0	0.0	0.0	0.1
GR	0.1	0.1	0.1	0.3	0.0	0.0	0.6
HR	0.3	0.1	0.2	1.7	0.1	0.1	2.5
HU	1.5	0.4	0.5	7.6	0.6	0.6	11.2
IE	0.7	0.3	0.3	3.1	0.7	0.8	5.8
IS	0.1	0.0	0.0	0.3	0.0	0.0	0.5
IT	2.3	0.9	0.9	10.4	0.9	0.6	16.0
KZ	0.0	0.0	0.0	0.1	0.0	0.0	0.2
LT	7.4	3.6	5.8	31.6	0.8	1.0	50.2
LU	0.1	0.1	0.1	0.7	0.2	0.1	1.2
LV	5.0	3.7	9.0	16.7	0.4	0.4	35.3
MD	0.1	0.1	0.1	0.7	0.0	0.0	1.1
MK	0.0	0.0	0.0	0.1	0.0	0.0	0.1
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	3.2	1.9	2.1	25.3	7.1	4.8	44.4
NO	5.7	1.4	1.0	11.2	1.1	1.8	22.1
PL	19.8	7.2	10.6	187.5	10.5	11.3	246.8
PT	0.2	0.1	0.1	0.9	0.2	0.1	1.5
RO	0.7	0.5	0.6	4.0	0.2	0.2	6.3
RU	19.5	15.5	5.3	44.0	1.7	1.9	87.9
SE	25.6	5.0	4.1	76.3	2.5	6.8	120.4
SI	0.2	0.1	0.1	1.3	0.1	0.1	1.8
SK	1.1	0.3	0.4	5.9	0.4	0.5	8.5
TR	0.1	0.0	0.0	0.2	0.0	0.0	0.3
UA	4.1	2.7	3.0	18.2	0.4	0.6	29.1
ATL	1.0	0.4	0.3	3.7	0.7	0.8	6.7
BAS	26.7	10.1	8.0	91.5	7.4	8.5	152.2
BLS	0.0	0.0	0.0	0.1	0.0	0.0	0.2
MED	0.8	0.3	0.3	2.7	0.2	0.2	4.4
NOS	9.0	3.6	3.2	37.3	8.5	9.2	70.7
ASI	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOA	0.1	0.0	0.1	0.4	0.0	0.0	0.6

Table D.3. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with 1998 meteorology and Emission Scenario 2. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.2	0.0	0.0	0.3	0.0	0.0	0.5
AM	0.0	0.0	0.0	0.1	0.0	0.0	0.1
AT	1.1	0.3	0.2	5.9	0.8	0.8	9.1
AZ	0.0	0.0	0.0	0.1	0.0	0.0	0.1
BA	0.2	0.1	0.1	0.7	0.0	0.1	1.2
BE	1.9	1.1	0.8	14.2	3.7	1.9	23.7
BG	0.7	0.2	0.2	2.2	0.1	0.1	3.5
BY	10.1	5.7	4.5	29.2	0.9	1.2	51.6
CH	0.6	0.1	0.1	2.4	0.4	0.2	3.9
CS	0.8	0.3	0.2	2.8	0.2	0.2	4.5
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	4.9	1.6	1.5	32.2	3.1	2.8	46.1
DE	17.6	8.6	8.3	193.9	64.8	22.8	315.9
DK	6.8	2.2	2.4	59.7	37.3	40.9	149.4
EE	10.3	20.8	5.9	14.3	0.3	0.4	52.0
ES	2.6	0.7	0.8	9.6	1.3	1.2	16.2
FI	41.4	7.9	2.0	14.0	0.3	0.6	66.2
FR	7.3	2.5	2.3	37.7	8.3	5.1	63.2
GB	9.7	4.4	4.2	61.7	16.7	15.6	112.2
GE	0.1	0.1	0.0	0.2	0.0	0.0	0.4
GR	0.3	0.1	0.0	0.9	0.1	0.0	1.5
HR	0.6	0.1	0.1	1.7	0.1	0.1	2.8
HU	3.1	0.8	0.6	10.4	0.4	0.5	15.6
IE	0.6	0.3	0.3	3.5	1.0	1.0	6.5
IS	0.1	0.0	0.0	0.3	0.1	0.0	0.5
IT	2.7	0.7	0.4	8.2	2.0	1.6	15.7
KZ	0.1	0.1	0.0	0.2	0.0	0.0	0.4
LT	9.5	5.2	8.4	45.0	0.9	1.1	70.0
LU	0.1	0.1	0.1	1.1	0.2	0.1	1.7
LV	7.9	5.1	12.4	25.5	0.5	0.6	52.0
MD	0.8	0.3	0.3	2.1	0.0	0.0	3.7
MK	0.1	0.0	0.0	0.3	0.0	0.0	0.6
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	3.7	1.9	1.7	33.9	10.3	5.4	57.0
NO	5.7	0.9	0.8	10.4	1.0	2.1	20.9
PL	35.1	14.9	12.1	253.6	11.1	10.3	336.9
PT	0.2	0.1	0.1	1.1	0.2	0.1	1.8
RO	3.9	1.2	1.2	10.3	0.4	0.4	17.4
RU	29.8	24.4	5.5	51.6	1.8	1.8	114.8
SE	31.1	4.5	3.5	76.1	2.8	8.8	126.9
SI	0.4	0.1	0.1	1.1	0.1	0.1	1.8
SK	2.4	0.7	0.5	8.4	0.4	0.4	12.7
TR	0.2	0.1	0.0	0.8	0.1	0.0	1.3
UA	15.9	7.9	5.0	43.3	1.5	1.6	75.1
ATL	1.0	0.3	0.3	3.8	0.9	0.8	7.0
BAS	38.0	11.6	9.1	113.6	7.4	9.3	188.9
BLS	0.1	0.0	0.0	0.2	0.0	0.0	0.4
MED	0.9	0.3	0.1	1.8	0.3	0.2	3.6
NOS	9.7	3.4	3.2	49.7	12.4	11.9	90.4
ASI	0.1	0.0	0.0	0.1	0.0	0.0	0.2
NOA	0.2	0.0	0.0	0.2	0.1	0.1	0.5

Table D.4. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with 2000 meteorology and Emission Scenario 2. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.4	0.1	0.1	0.8	0.0	0.0	1.4
AM	0.1	0.0	0.0	0.1	0.0	0.0	0.2
AT	3.0	0.8	0.7	10.2	0.8	1.1	16.7
AZ	0.1	0.0	0.0	0.1	0.0	0.0	0.1
BA	0.6	0.3	0.2	2.0	0.0	0.0	3.3
BE	4.2	1.4	0.9	14.5	4.9	4.3	30.2
BG	2.1	0.5	0.5	5.3	0.1	0.1	8.5
BY	15.7	6.7	5.4	29.3	0.5	0.6	58.2
CH	1.6	0.7	0.4	5.4	1.1	1.0	10.3
CS	2.2	1.1	0.8	7.3	0.1	0.1	11.7
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	8.7	2.7	2.4	35.5	3.1	3.5	55.9
DE	33.1	12.2	10.3	192.3	69.3	36.0	353.1
DK	7.0	2.5	2.3	50.1	34.6	38.2	134.7
EE	8.6	21.5	5.1	7.6	0.1	0.2	43.1
ES	3.1	1.3	0.8	9.1	1.9	2.3	18.5
FI	32.3	8.0	1.7	8.7	0.1	0.2	51.0
FR	12.6	4.4	3.2	44.9	13.0	14.5	92.6
GB	13.0	4.2	3.1	45.3	13.6	14.2	93.4
GE	0.3	0.1	0.0	0.4	0.0	0.0	0.7
GR	0.9	0.3	0.2	2.4	0.0	0.0	3.8
HR	1.5	0.5	0.4	4.7	0.1	0.2	7.3
HU	5.0	2.1	1.5	17.6	0.5	0.7	27.4
IE	0.7	0.2	0.2	2.6	0.8	0.7	5.2
IS	0.1	0.0	0.0	0.2	0.0	0.0	0.4
IT	9.3	3.8	2.7	29.9	2.5	2.6	50.7
KZ	0.2	0.0	0.0	0.1	0.0	0.0	0.4
LT	16.2	5.6	9.2	45.4	0.7	0.5	77.7
LU	0.3	0.1	0.1	1.0	0.3	0.3	2.0
LV	10.6	5.5	11.8	19.5	0.3	0.3	48.1
MD	1.8	0.6	0.4	3.6	0.0	0.0	6.5
MK	0.4	0.1	0.1	0.8	0.0	0.0	1.3
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	6.9	2.3	1.5	28.2	11.7	9.4	60.0
NO	4.6	1.0	0.7	7.9	0.9	1.9	17.0
PL	52.2	14.0	14.0	293.1	9.2	9.9	392.4
PT	0.4	0.2	0.1	1.3	0.3	0.3	2.6
RO	7.4	2.6	1.9	18.3	0.2	0.4	30.8
RU	27.5	19.5	4.5	37.8	0.8	0.8	91.0
SE	30.0	4.5	3.3	64.2	2.2	8.2	112.4
SI	1.0	0.3	0.2	2.8	0.1	0.2	4.5
SK	3.3	1.2	0.9	11.4	0.4	0.5	17.6
TR	0.7	0.3	0.3	2.3	0.0	0.0	3.6
UA	26.8	8.9	5.8	52.7	0.5	0.6	95.3
ATL	1.3	0.4	0.3	3.8	0.8	1.0	7.7
BAS	38.5	11.5	8.8	101.0	7.1	9.5	176.4
BLS	0.2	0.1	0.1	0.6	0.0	0.0	1.0
MED	2.0	0.8	0.7	7.4	0.4	0.4	11.7
NOS	11.6	3.6	2.7	40.9	12.1	13.0	83.9
ASI	0.0	0.0	0.0	0.1	0.0	0.0	0.2
NOA	0.2	0.1	0.1	0.7	0.0	0.0	1.2

Table D.5. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with meteorology averaged over four years and Emission Scenario 2. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.2	0.1	0.0	0.4	0.0	0.0	0.7
AM	0.0	0.0	0.0	0.1	0.0	0.0	0.1
AT	1.5	0.5	0.4	7.0	0.8	0.7	10.8
AZ	0.0	0.0	0.0	0.1	0.0	0.0	0.1
BA	0.3	0.1	0.1	1.1	0.1	0.1	1.8
BE	2.6	1.1	0.9	13.0	3.5	2.5	23.7
BG	0.9	0.3	0.3	2.6	0.1	0.1	4.3
BY	10.5	5.9	4.6	30.2	1.0	1.2	53.4
CH	0.9	0.4	0.3	3.5	0.6	0.5	6.1
CS	1.2	0.5	0.4	4.0	0.2	0.2	6.5
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	5.1	2.0	1.8	28.0	3.1	2.7	42.7
DE	21.5	9.3	8.6	167.9	58.1	24.6	290.0
DK	6.5	2.5	2.3	51.8	34.5	36.2	133.7
EE	8.1	19.6	5.5	12.5	0.2	0.3	46.3
ES	2.2	0.8	0.6	6.9	1.2	1.3	13.0
FI	33.8	7.9	1.9	13.4	0.3	0.5	57.9
FR	8.4	3.2	2.6	36.3	8.8	7.6	66.9
GB	11.4	4.1	3.4	48.4	13.1	12.9	93.4
GE	0.1	0.1	0.0	0.2	0.0	0.0	0.4
GR	0.4	0.2	0.1	1.2	0.0	0.0	2.1
HR	0.7	0.3	0.2	2.6	0.1	0.1	4.1
HU	2.9	1.2	0.9	12.0	0.6	0.7	18.3
IE	0.6	0.2	0.2	2.9	0.8	0.8	5.6
IS	0.1	0.0	0.0	0.3	0.0	0.0	0.5
IT	4.5	1.9	1.2	15.6	1.7	1.5	26.4
KZ	0.1	0.1	0.0	0.2	0.0	0.0	0.4
LT	10.4	5.0	7.8	46.7	0.9	1.3	72.1
LU	0.2	0.1	0.1	0.9	0.2	0.2	1.6
LV	7.5	4.9	11.1	23.1	0.4	0.6	47.5
MD	1.0	0.4	0.3	2.4	0.1	0.0	4.2
MK	0.2	0.1	0.0	0.4	0.0	0.0	0.7
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	4.7	2.0	1.7	27.8	9.1	6.2	51.5
NO	5.4	1.0	0.7	9.4	1.0	1.9	19.4
PL	32.5	13.1	13.0	244.9	12.3	11.9	327.6
PT	0.2	0.1	0.1	1.0	0.2	0.2	1.7
RO	4.1	1.6	1.3	11.0	0.4	0.4	18.8
RU	23.0	18.0	5.4	44.5	1.5	1.7	94.1
SE	28.2	4.6	3.4	70.1	2.8	8.3	117.4
SI	0.4	0.1	0.1	1.7	0.1	0.1	2.7
SK	2.0	0.8	0.6	8.8	0.5	0.5	13.2
TR	0.3	0.2	0.1	0.9	0.0	0.0	1.6
UA	15.1	7.7	5.2	42.4	1.5	1.5	73.5
ATL	1.0	0.3	0.3	3.4	0.7	0.8	6.5
BAS	33.5	11.1	8.4	103.1	7.5	9.2	172.8
BLS	0.1	0.1	0.0	0.3	0.0	0.0	0.5
MED	1.3	0.5	0.3	3.8	0.3	0.3	6.4
NOS	9.8	3.4	2.8	40.3	10.3	10.6	77.2
ASI	0.0	0.0	0.0	0.1	0.0	0.0	0.1
NOA	0.2	0.1	0.1	0.4	0.0	0.0	0.8

Table D.6. Contribution of EMEP countries (regions) to total nitrogen depositions into catchment areas of the Baltic Sea. Results of the model run with 1996 meteorology and Emission Scenario 2. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.5	0.9	0.5	3.8	0.1	0.2	5.9
AM	0.2	0.8	0.3	0.4	0.0	0.0	1.7
AT	3.9	7.8	4.1	49.4	2.0	2.3	69.5
AZ	0.1	0.7	0.2	0.4	0.0	0.0	1.5
BA	0.7	1.6	1.0	9.7	0.2	0.5	13.7
BE	11.9	9.7	4.5	42.9	6.4	9.3	84.6
BG	2.4	9.5	5.9	26.1	0.2	0.5	44.7
BY	42.2	144.5	161.5	395.9	4.2	12.2	760.5
CH	3.5	5.1	2.0	15.6	1.3	1.5	28.8
CS	3.3	7.3	4.2	39.2	0.7	1.6	56.3
CY	0.0	0.1	0.0	0.0	0.0	0.0	0.1
CZ	16.7	27.0	15.2	272.5	8.4	10.1	349.9
DE	88.4	95.4	51.3	632.2	128.9	75.8	1072.1
DK	29.2	24.8	11.3	128.9	69.9	108.5	372.6
EE	32.6	127.3	36.2	36.2	0.7	3.1	236.1
ES	7.1	7.0	2.3	16.4	1.7	3.2	37.6
FI	176.3	133.3	11.6	41.3	1.4	5.4	369.3
FR	36.3	30.5	13.6	108.8	16.4	22.8	228.4
GB	66.3	36.3	16.6	120.8	24.6	48.8	313.3
GE	0.6	2.1	0.7	1.8	0.0	0.1	5.4
GR	1.5	3.7	2.4	12.0	0.1	0.3	20.1
HR	1.4	3.6	2.0	20.8	0.6	0.8	29.3
HU	7.4	18.0	10.2	112.8	2.3	3.8	154.5
IE	4.1	2.0	1.2	8.1	1.5	2.7	19.6
IS	0.7	0.3	0.1	0.9	0.1	0.2	2.4
IT	12.7	26.4	11.4	91.6	3.9	5.7	151.8
KZ	0.6	2.4	1.1	2.6	0.0	0.1	7.0
LT	36.4	73.7	128.7	361.0	3.2	12.8	615.8
LU	0.6	0.7	0.4	3.0	0.4	0.6	5.7
LV	28.3	79.2	121.4	88.2	1.1	6.1	324.2
MD	3.6	9.7	7.0	24.2	0.3	0.4	45.1
MK	0.6	1.2	0.6	4.1	0.0	0.1	6.7
MT	0.0	0.0	0.0	0.1	0.0	0.0	0.2
NL	22.7	19.4	9.6	91.5	17.9	21.4	182.4
NO	45.5	13.3	3.3	24.7	2.3	15.8	104.8
PL	92.6	185.8	127.8	2695.8	41.5	61.0	3204.6
PT	0.9	0.7	0.3	1.9	0.2	0.3	4.3
RO	12.7	29.5	20.5	119.4	1.6	2.8	186.5
RU	82.1	342.1	154.4	221.7	4.3	14.6	819.1
SE	123.6	46.9	14.6	192.8	9.9	78.6	466.5
SI	1.0	2.5	1.2	13.2	0.4	0.5	18.9
SK	5.6	12.9	7.7	122.4	1.5	2.8	153.0
TR	1.9	11.9	4.9	4.9	0.1	0.1	23.8
UA	52.4	201.6	133.1	510.9	8.6	16.2	922.7
ATL	5.6	3.1	1.2	7.5	1.2	2.2	20.8
BAS	121.3	103.6	41.5	282.8	19.2	48.8	617.2
BLS	0.3	2.3	1.5	2.8	0.0	0.0	7.1
MED	4.7	8.1	4.0	23.4	0.8	1.5	42.4
NOS	47.0	32.0	14.4	121.9	20.6	47.2	283.2
ASI	0.2	0.8	0.3	0.6	0.0	0.0	1.9
NOA	0.5	1.2	0.5	3.3	0.1	0.2	5.8

Table D.7. Contribution of EMEP countries (regions) to total nitrogen depositions into catchment areas of the Baltic Sea. Results of the model run with 1997 meteorology and Emission Scenario 2. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.1	0.6	0.4	1.7	0.0	0.0	3.0
AM	0.0	0.1	0.1	0.1	0.0	0.0	0.3
AT	2.7	4.9	4.5	43.0	1.3	1.7	58.0
AZ	0.0	0.1	0.0	0.1	0.0	0.0	0.3
BA	0.6	0.9	0.8	5.2	0.1	0.1	7.6
BE	9.0	12.6	7.0	48.8	6.6	8.4	92.4
BG	0.5	4.1	3.4	14.7	0.2	0.2	23.0
BY	25.1	102.2	149.8	312.2	1.5	4.5	595.3
CH	2.4	3.1	2.6	20.3	0.8	1.2	30.4
CS	1.6	3.8	3.0	21.5	0.2	0.3	30.5
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	10.5	19.3	18.1	274.8	6.2	8.3	337.2
DE	60.6	90.5	69.2	738.4	129.7	79.4	1167.8
DK	25.1	26.8	17.1	148.3	75.0	113.5	405.8
EE	27.8	133.2	42.3	31.8	0.7	2.4	238.3
ES	9.1	8.6	5.0	30.9	2.2	4.2	60.0
FI	174.7	146.8	18.1	37.4	0.7	4.1	381.8
FR	34.2	38.7	23.3	158.4	17.4	27.5	299.5
GB	68.1	54.7	28.8	193.0	28.0	58.7	431.3
GE	0.1	0.3	0.3	0.3	0.0	0.0	0.9
GR	0.3	2.1	1.9	6.5	0.1	0.1	11.0
HR	1.0	2.2	1.8	15.5	0.2	0.3	21.2
HU	5.0	9.1	7.8	85.4	1.3	2.4	111.0
IE	3.7	3.0	2.0	11.5	1.7	3.5	25.5
IS	0.9	0.4	0.2	1.0	0.1	0.2	2.7
IT	9.2	16.4	11.0	72.1	2.3	3.2	114.2
KZ	0.1	0.3	0.3	0.7	0.0	0.1	1.5
LT	27.2	67.6	147.6	348.0	1.9	6.5	598.9
LU	0.5	0.7	0.5	3.3	0.4	0.5	5.9
LV	20.8	82.2	135.3	82.0	1.0	3.6	324.9
MD	0.4	4.2	3.4	8.2	0.0	0.1	16.4
MK	0.1	0.6	0.5	1.6	0.0	0.0	2.8
MT	0.0	0.0	0.0	0.1	0.0	0.0	0.1
NL	17.0	23.3	14.0	104.6	17.0	19.7	195.6
NO	42.7	15.9	6.0	34.6	2.5	16.4	118.2
PL	81.7	129.5	134.2	2686.8	25.0	48.0	3105.2
PT	1.0	1.1	0.8	5.0	0.4	0.6	8.9
RO	2.6	16.9	11.9	54.6	0.5	1.0	87.5
RU	100.6	494.3	145.8	239.8	4.32	12.7	997.5
SE	118.8	51.3	24.0	221.8	7.8	75.4	499.1
SI	0.7	1.5	1.2	10.9	0.2	0.3	14.9
SK	4.1	6.4	6.0	100.5	0.9	2.0	119.8
TR	0.2	2.5	2.1	3.6	0.1	0.1	8.6
UA	15.7	74.7	59.8	245.0	1.0	4.0	400.3
ATL	6.2	4.5	2.2	13.5	1.7	3.8	31.9
BAS	108.4	103.9	52.4	278.2	18.2	46.7	607.7
BLS	0.1	0.6	0.5	1.3	0.0	0.0	2.6
MED	3.0	4.9	3.3	19.4	0.6	0.8	32.1
NOS	47.1	43.2	22.7	151.5	20.9	47.8	333.3
ASI	0.0	0.1	0.1	0.2	0.0	0.0	0.4
NOA	0.4	0.9	0.7	3.1	0.1	0.1	5.3

Table D.8. Contribution of EMEP countries (regions) to total nitrogen depositions into catchment areas of the Baltic Sea. Results of the model run with 1998 meteorology and Emission Scenario 2. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.4	0.4	0.3	2.2	0.1	0.1	3.5
AM	0.2	0.5	0.2	0.4	0.0	0.0	1.3
AT	4.4	5.2	4.0	61.9	1.9	3.1	80.5
AZ	0.2	0.4	0.2	0.4	0.0	0.0	1.2
BA	0.7	1.0	0.8	7.6	0.1	0.2	10.3
BE	9.4	12.3	6.6	64.7	8.9	8.4	110.4
BG	2.4	3.4	3.1	18.8	0.2	0.3	28.2
BY	36.2	139.2	171.9	309.3	1.9	5.9	664.4
CH	2.1	3.8	2.4	24.1	1.1	1.1	34.7
CS	2.7	3.6	3.0	30.4	0.4	0.7	40.8
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.1
CZ	17.8	26.0	19.6	352.8	7.4	11.4	435.0
DE	74.2	100.1	66.8	920.6	167.9	83.6	1413.2
DK	28.1	26.3	15.1	148.1	81.8	131.3	430.8
EE	35.8	137.9	39.1	29.0	0.6	2.5	244.9
ES	9.3	11.3	6.9	48.2	3.2	4.9	83.9
FI	208.5	132.2	13.6	33.9	0.8	4.6	393.5
FR	29.8	36.2	21.8	193.7	20.2	23.4	325.0
GB	46.1	53.1	30.1	231.4	39.9	68.3	468.9
GE	0.5	1.6	0.5	1.2	0.0	0.1	4.1
GR	0.8	1.5	1.0	5.8	0.2	0.2	9.5
HR	2.3	2.4	1.8	21.0	0.3	0.7	28.5
HU	10.5	12.5	9.6	107.7	1.1	3.0	144.3
IE	2.7	2.8	1.6	11.7	2.3	4.2	25.4
IS	0.7	0.4	0.1	1.0	0.1	0.2	2.6
IT	10.7	14.0	8.9	91.9	4.7	5.9	136.1
KZ	0.8	1.5	0.5	1.0	0.0	0.1	3.9
LT	33.2	84.4	168.1	331.7	1.9	5.7	625.0
LU	0.5	0.7	0.4	5.0	0.5	0.4	7.6
LV	26.0	92.0	138.1	74.9	1.0	3.4	335.4
MD	3.6	5.9	4.6	14.3	0.1	0.5	29.1
MK	0.4	0.5	0.4	2.5	0.1	0.1	3.9
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.1
NL	18.1	22.8	13.2	133.0	25.1	21.6	233.7
NO	43.1	12.8	4.6	29.9	2.3	18.1	110.8
PL	128.4	182.9	149.5	2784.2	25.9	56.5	3327.4
PT	1.0	1.2	0.7	5.8	0.5	0.6	9.8
RO	14.4	18.5	15.0	80.4	1.0	2.4	131.7
RU	149.2	607.0	126.5	221.6	3.9	10.5	1118.8
SE	138.4	46.6	18.4	218.2	8.5	88.2	518.5
SI	1.5	1.6	1.2	14.2	0.2	0.6	19.4
SK	8.3	10.6	7.7	119.9	1.0	2.6	150.1
TR	1.1	3.2	1.1	4.0	0.1	0.4	9.9
UA	62.5	139.2	86.0	331.2	3.4	10.6	632.9
ATL	5.8	4.2	2.0	14.4	2.2	3.8	32.4
BAS	137.4	110.9	49.9	291.4	17.4	50.6	657.7
BLS	0.4	1.1	0.7	1.7	0.0	0.1	3.9
MED	3.2	4.3	2.0	17.1	0.6	1.0	28.2
NOS	47.1	44.2	24.5	187.4	30.3	57.0	390.5
ASI	0.3	0.5	0.2	0.4	0.0	0.0	1.4
NOA	0.6	0.5	0.3	1.8	0.1	0.2	3.7

Table D.9. Contribution of EMEP countries (regions) to total nitrogen depositions into catchment areas of the Baltic Sea. Results of the model run with 2000 meteorology and Emission Scenario 2. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	1.2	1.5	0.7	4.6	0.0	0.2	8.2
AM	0.2	0.3	0.2	0.3	0.0	0.0	1.0
AT	9.6	9.9	5.9	70.1	1.9	4.5	102.0
AZ	0.2	0.3	0.1	0.2	0.0	0.0	0.8
BA	2.0	2.8	1.7	12.9	0.1	0.4	19.9
BE	19.1	13.1	6.1	57.3	11.7	18.2	125.3
BG	6.3	8.4	5.0	28.1	0.2	1.1	49.1
BY	54.6	131.0	159.2	293.5	1.1	5.5	644.9
CH	6.4	6.4	2.9	29.6	2.5	4.1	52.0
CS	7.2	11.8	6.2	47.7	0.3	1.6	74.8
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.2
CZ	31.2	32.6	19.9	369.7	7.4	15.2	476.0
DE	138.5	119.2	67.1	906.7	176.0	143.3	1550.8
DK	36.0	26.7	15.3	138.6	76.7	131.5	424.9
EE	35.3	147.2	39.2	18.1	0.3	1.2	241.2
ES	12.6	11.6	5.9	38.9	4.3	8.9	82.2
FI	190.9	145.9	13.0	21.9	0.3	1.9	373.8
FR	56.2	42.7	21.9	195.6	30.4	56.6	403.4
GB	77.4	50.6	21.3	176.5	32.8	67.6	426.1
GE	0.9	1.2	0.6	1.0	0.0	0.1	3.8
GR	2.6	4.0	2.0	12.6	0.0	0.4	21.6
HR	4.3	5.1	3.3	31.7	0.3	0.9	45.7
HU	15.8	22.1	13.4	130.5	1.2	4.9	187.9
IE	4.0	2.9	1.1	9.6	1.8	3.2	22.6
IS	0.8	0.5	0.2	0.9	0.1	0.2	2.7
IT	29.3	33.8	19.7	158.0	5.7	11.4	257.9
KZ	0.7	1.2	0.3	0.5	0.0	0.1	2.8
LT	51.0	82.0	162.6	323.1	1.6	5.1	625.5
LU	1.1	0.8	0.5	4.6	0.7	1.3	8.9
LV	34.3	94.2	141.0	62.6	0.7	2.0	334.7
MD	6.1	10.2	5.7	17.3	0.1	0.8	40.1
MK	1.1	1.3	0.6	4.5	0.0	0.1	7.6
MT	0.0	0.0	0.0	0.1	0.0	0.0	0.2
NL	34.6	24.3	10.9	110.9	27.7	38.3	246.9
NO	42.0	14.0	4.7	26.9	2.2	16.6	106.5
PL	176.0	183.7	144.6	2911.4	22.7	66.9	3505.4
PT	1.8	1.6	0.8	5.8	0.6	1.3	11.8
RO	24.3	35.0	19.6	105.5	0.6	4.6	189.7
RU	142.5	589.3	115.8	63.9	1.9	7.2	1020.6
SE	148.5	50.6	20.0	203.6	7.3	90.3	520.2
SI	2.9	2.8	2.1	19.9	0.3	0.8	28.7
SK	10.8	14.9	9.5	128.7	0.9	3.6	168.4
TR	2.5	4.7	3.5	7.1	0.0	0.4	18.2
UA	95.2	162.6	83.2	317.6	1.1	11.8	671.6
ATL	8.3	5.2	2.1	14.3	2.0	4.8	36.7
BAS	151.3	117.1	51.4	276.5	17.6	55.0	668.9
BLS	0.7	1.7	1.3	2.7	0.0	0.1	6.5
MED	6.5	9.0	5.4	37.5	0.9	2.2	61.5
NOS	65.6	43.3	19.4	160.4	29.7	65.5	383.9
ASI	0.2	0.3	0.2	0.3	0.0	0.0	1.0
NOA	0.7	1.5	0.8	4.1	0.1	0.2	7.4

Table D.10. Contribution of EMEP countries (regions) to total nitrogen depositions into catchment areas of the Baltic Sea. Results of the model run with meteorology averaged over four years and Emission Scenario 2. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.6	0.9	0.5	3.1	0.1	0.1	5.2
AM	0.2	0.4	0.2	0.3	0.0	0.0	1.1
AT	5.1	7.0	4.6	56.1	1.8	2.9	77.5
AZ	0.1	0.4	0.1	0.3	0.0	0.0	0.9
BA	1.0	1.6	1.1	8.8	0.1	0.3	12.9
BE	12.3	11.9	6.1	53.4	8.4	11.1	103.2
BG	2.9	6.4	4.4	21.9	0.2	0.5	36.2
BY	39.5	129.2	160.6	327.7	2.2	7.0	666.3
CH	3.6	4.6	2.5	22.4	1.4	2.0	36.5
CS	3.7	6.6	4.1	34.7	0.4	1.1	50.6
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.1
CZ	19.0	26.2	18.2	317.4	7.4	11.3	399.5
DE	90.4	101.3	63.6	799.5	150.6	95.5	1300.9
DK	29.6	26.1	14.7	141.0	75.9	121.2	408.5
EE	32.9	136.4	39.2	28.8	0.6	2.3	240.1
ES	9.5	9.6	5.0	33.6	2.9	5.3	65.9
FI	187.6	139.5	14.1	33.6	0.8	4.0	379.6
FR	39.1	37.0	20.2	164.1	21.1	32.6	314.1
GB	64.5	48.7	24.2	180.4	31.3	60.8	409.9
GE	0.5	1.3	0.5	1.1	0.0	0.1	3.6
GR	1.3	2.8	1.8	9.2	0.1	0.3	15.5
HR	2.3	3.3	2.2	22.3	0.4	0.7	31.1
HU	9.7	15.4	10.2	109.1	1.5	3.5	149.4
IE	3.6	2.7	1.5	10.3	1.8	3.4	23.3
IS	0.8	0.4	0.2	0.9	0.1	0.2	2.6
IT	15.5	22.7	12.8	103.4	4.1	6.5	165.0
KZ	0.6	1.4	0.6	1.2	0.0	0.1	3.8
LT	37.0	76.9	151.7	341.0	2.2	7.5	616.3
LU	0.7	0.7	0.4	4.0	0.5	0.7	7.0
LV	27.4	86.9	133.9	76.9	1.0	3.7	329.8
MD	3.4	7.5	5.2	16.0	0.1	0.5	32.7
MK	0.5	0.9	0.5	3.2	0.0	0.1	5.3
MT	0.0	0.0	0.0	0.1	0.0	0.0	0.1
NL	23.1	22.4	12.0	110.0	21.9	25.3	214.7
NO	43.3	14.0	4.7	29.0	2.3	16.7	110.1
PL	119.7	170.5	139.0	2769.6	28.8	58.1	3285.6
PT	1.2	1.2	0.7	4.6	0.4	0.7	8.7
RO	13.5	25.0	16.8	90.0	0.9	2.7	148.8
RU	118.6	508.2	135.6	211.8	3.6	11.3	989.0
SE	132.3	48.9	19.2	209.1	8.4	83.1	501.1
SI	1.5	2.1	1.4	14.5	0.3	0.6	20.5
SK	7.2	11.2	7.7	117.9	1.1	2.8	147.8
TR	1.4	5.6	2.9	4.9	0.1	0.3	15.1
UA	56.4	144.5	90.5	351.2	3.5	10.6	656.9
ATL	6.5	4.3	1.9	12.4	1.8	3.6	30.5
BAS	129.6	108.8	48.8	282.2	18.1	50.3	637.9
BLS	0.4	1.4	1.0	2.1	0.0	0.1	5.0
MED	4.3	6.5	3.7	24.4	0.7	1.4	41.0
NOS	51.7	40.7	20.3	155.3	25.4	54.4	347.7
ASI	0.2	0.4	0.2	0.4	0.0	0.0	1.2
NOA	0.6	1.0	0.6	3.1	0.1	0.2	5.5

APPENDIX E: SOURCE-RECEPTOR MATRICES FOR NITROGEN DEPOSITION IN 2010 BASED ON THE CLE EMISSION SCENARIO

Source-receptor matrices for total (oxidized + reduced) nitrogen in the year 2010 are presented in this Appendix. In the model runs, annual total emissions from the EMEP Contracting Parties as specified in the CLE Scenario were used, including the latest emissions from the international ship traffic on the European seas (See Section 2, above). Four different years with meteorological data were used in the calculations. Final source-receptor matrices for the year 2010 were calculated as the average over the four meteorological years.

Annual nitrogen depositions for the year 2010 were calculated for six sub-basins and catchment areas of the Baltic Sea and for the entire Baltic Sea basin and catchment area. Abbreviations for emission sources, sub-basins, and catchment areas used in the tables are explained in Section 1, above.

Table E.1. Contribution of EMEP countries (regions) to total nitrogen depositions into sub-basins of the Baltic Sea. Results of the model run with meteorology averaged over four years and the CLE Emission Scenario. Units: 100 tonnes N yr^{-1}.

CODE	SUB-BASINS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.2	0.1	0.0	0.4	0.0	0.0	0.7
AM	0.0	0.0	0.0	0.0	0.0	0.0	0.1
AT	1.9	0.7	0.6	9.2	1.0	0.9	14.2
AZ	0.0	0.0	0.0	0.1	0.0	0.0	0.1
BA	0.3	0.1	0.1	1.1	0.1	0.1	1.8
BE	3.6	1.6	1.2	17.7	4.6	3.4	32.0
BG	0.9	0.3	0.3	2.6	0.1	0.1	4.2
BY	11.6	6.5	5.1	33.0	1.0	1.3	58.5
CH	1.0	0.4	0.3	3.7	0.6	0.5	6.4
CS	1.2	0.5	0.4	4.0	0.2	0.2	6.5
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	3.8	1.4	1.3	20.6	2.3	2.0	31.4
DE	26.9	11.7	10.7	210.9	73.1	30.9	364.3
DK	8.4	3.2	2.9	67.3	44.9	47.1	173.8
EE	3.8	8.6	2.4	5.7	0.1	0.1	20.9
ES	2.8	1.0	0.8	8.5	1.5	1.6	16.1
FI	37.5	8.5	2.0	14.1	0.4	0.5	62.9
FR	10.7	4.1	3.3	45.7	10.8	9.4	84.0
GB	12.1	4.4	3.7	52.0	14.2	13.9	100.4
GE	0.1	0.1	0.0	0.2	0.0	0.0	0.4
GR	0.4	0.1	0.1	1.0	0.0	0.0	1.7
HR	0.8	0.3	0.2	3.0	0.2	0.2	4.6
HU	2.5	1.0	0.8	10.6	0.6	0.6	16.1
IE	0.9	0.3	0.3	4.1	1.1	1.1	7.9
IS	0.1	0.0	0.0	0.3	0.0	0.0	0.5
IT	5.0	2.1	1.4	17.6	1.9	1.7	29.7
KZ	0.1	0.0	0.0	0.2	0.0	0.0	0.4
LT	6.3	3.1	5.0	30.0	0.6	0.8	45.7
LU	0.3	0.1	0.1	1.7	0.4	0.3	2.9
LV	3.2	2.0	4.3	9.3	0.2	0.2	19.3
MD	1.0	0.4	0.3	2.3	0.1	0.0	4.2
MK	0.2	0.1	0.0	0.4	0.0	0.0	0.7
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	6.2	2.7	2.2	36.1	11.8	8.0	67.0
NO	7.0	1.4	0.9	12.1	1.3	2.4	25.1
PL	25.3	10.2	10.1	190.7	9.6	9.3	255.1
PT	0.2	0.1	0.1	0.9	0.2	0.1	1.5
RO	4.6	1.8	1.4	12.5	0.5	0.4	21.2
RU	22.8	17.6	5.3	42.8	1.5	1.7	91.6
SE	34.4	5.8	4.3	79.6	3.2	9.2	136.5
SI	0.4	0.2	0.1	1.7	0.1	0.1	2.7
SK	1.5	0.6	0.4	6.4	0.3	0.4	9.5
TR	0.3	0.2	0.1	0.9	0.0	0.0	1.6
UA	16.9	8.7	5.9	47.6	1.7	1.7	82.5
ATL	1.1	0.4	0.3	3.7	0.8	0.8	7.2
BAS	37.3	12.3	9.4	114.5	8.3	10.2	192.0
BLS	0.1	0.1	0.1	0.3	0.0	0.0	0.6
MED	1.4	0.5	0.4	4.2	0.3	0.3	7.2
NOS	10.9	3.8	3.1	44.8	11.5	11.8	85.8
ASI	0.0	0.0	0.0	0.1	0.0	0.0	0.2
NOA	0.2	0.1	0.1	0.4	0.0	0.0	0.8

Table E.2. Contribution of EMEP countries (regions) to total nitrogen depositions into catchment areas of the Baltic Sea. Results of the model run with meteorology averaged over four years and the CLE Emission Scenario. Units: 100 tonnes N yr^{-1}.

CODE	CATCHMENT AREAS						Baltic Sea
	GUB	GUF	GUR	BAP	BES	KAT	
AL	0.6	0.9	0.5	3.1	0.1	0.1	5.2
AM	0.1	0.3	0.1	0.2	0.0	0.0	0.7
AT	6.9	9.3	6.1	71.4	2.3	3.7	99.8
AZ	0.1	0.4	0.1	0.3	0.0	0.0	0.9
BA	1.0	1.6	1.1	8.8	0.1	0.3	12.9
BE	17.0	16.4	8.3	72.9	11.2	15.0	140.7
BG	2.8	5.9	4.1	21.0	0.2	0.5	34.5
BY	43.6	142.2	173.0	350.8	2.4	7.7	719.8
CH	3.8	4.9	2.6	23.7	1.5	2.1	38.6
CS	3.7	6.6	4.1	34.7	0.4	1.1	50.6
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.1
CZ	14.0	19.2	13.4	234.5	5.4	8.3	294.8
DE	113.4	127.0	79.7	1003.9	189.5	120.0	1633.6
DK	38.3	33.8	19.0	182.8	98.8	157.7	530.4
EE	15.4	61.6	17.4	13.3	0.3	1.1	109.0
ES	11.9	12.0	6.2	41.8	3.5	6.6	82.0
FI	207.8	150.7	14.6	35.1	0.8	4.2	413.2
FR	50.1	47.5	25.8	208.5	25.9	40.7	398.5
GB	68.7	51.7	25.9	193.2	33.8	65.3	438.6
GE	0.5	1.3	0.5	1.1	0.0	0.1	3.6
GR	1.1	2.4	1.5	7.8	0.1	0.2	13.2
HR	2.6	3.8	2.5	25.3	0.4	0.8	35.4
HU	8.5	13.5	9.0	96.5	1.3	3.1	131.9
IE	5.3	3.9	2.1	14.6	2.5	4.8	33.3
IS	0.8	0.4	0.2	0.9	0.1	0.2	2.6
IT	17.4	25.5	14.3	116.2	4.6	7.3	185.4
KZ	0.5	1.3	0.5	1.2	0.0	0.1	3.7
LT	22.0	46.6	101.2	228.1	1.3	4.5	403.6
LU	1.4	1.5	0.9	7.6	0.9	1.2	13.5
LV	11.8	35.2	51.3	31.0	0.4	1.6	131.2
MD	3.4	7.3	5.1	15.8	0.1	0.5	32.1
MK	0.5	0.9	0.5	3.2	0.0	0.1	5.3
MT	0.0	0.0	0.0	0.1	0.0	0.0	0.1
NL	30.3	29.4	15.7	143.5	28.3	32.8	280.0
NO	55.6	18.4	6.1	37.8	3.0	21.0	141.9
PL	93.2	132.8	108.3	2156.7	22.4	45.2	2558.6
PT	1.1	1.1	0.6	4.2	0.4	0.6	7.9
RO	15.2	27.3	18.4	101.8	1.1	3.1	166.8
RU	118.9	488.1	130.3	200.8	3.6	11.2	953.0
SE	163.7	63.0	24.3	239.3	9.5	92.1	591.9
SI	1.6	2.1	1.5	15.0	0.3	0.6	21.0
SK	5.2	8.0	5.6	91.5	0.8	2.0	113.0
TR	1.4	5.6	2.9	4.9	0.1	0.3	15.1
UA	63.2	161.7	101.5	396.4	4.0	11.9	738.7
ATL	7.2	4.7	2.1	13.8	2.0	4.1	33.8
BAS	144.0	120.9	54.2	313.6	20.1	55.9	708.8
BLS	0.4	1.6	1.1	2.4	0.0	0.1	5.6
MED	4.8	7.3	4.1	27.1	0.8	1.5	45.6
NOS	57.5	45.2	22.5	172.6	28.2	60.4	386.3
ASI	0.2	0.6	0.3	0.5	0.0	0.0	1.7
NOA	0.6	1.0	0.6	3.1	0.1	0.2	5.5