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Background report on

AIR POLLUTION SITUATION IN THE BALTIC STATES

- A PREFEASIBILITY STUDY

Gun Lövblad and Christer Persson

CONTENTS

BACKGROUND REPORT ON

AIR POLLUTION SITUATION IN THE BALTIC STATES

- A PREFEASIBILITY STUDY

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1 INTRODUCTION

In this prefeasibility study we have compiled the information given by the core group, collected during several visits to the Baltic states. In addition to this we have included information available from different western European studies. The prefeasibility study will cover the southern to western part of Estonia, the entire Latvia and the northern part of Lithuania.

We have made an overall evaluation of the plausibility of available data and also pointed out obvious diagreements and gaps of knowledge. The conclusion of the study is how to compile the data further in order to be able to meet with the goals of the study:

To point out major air pollution sources.

To correlate the air pollution dispersion and deposition to pollution introduced into the rivers and further into the Baltic Sea.

2 DATA AVAILABLE

In our attempts to obtain best possible emission and air pollution measurement data for Latvia, Estonia and Lithuania, we have used information from the following references.

(a) Latvian Environmental Protection Committee: "Air Quality Management in Latvia 1990"

(b) Documents collected in Latvia by the core team.

(c1) Nordic Project Fund (NOPEF) "Environmental situation and project identification in Latvia. Helsinki 1991

(c2) Nordic Project Fund (NOPEF) "Estonia and partly Latvia and Lithuania

(d) Utlandsrapport från Sveriges Tekniska Attachéer "Miljöteknik i Baltikum"

(e) EMEP Meteorological Sythesizing Centre - West:Iversen T, Halvorsen N, Mylona S and Sandnes H. 1991. "Calculated budgets for airborne acidifying components in Europe 1985, 1987, 1988, 1989 and 1990. Norwegian Meteorological Institute. EMEP/MSC-W Report 1/91.

(f) Pacyna J.M., Larssen S. and Semb A., 1991. European survey for NO_x emissions with emphasis on eastern Europe. Atm Env Vol 25A, 425-439, 1991.

(g) Asman W.A.H. and Jaarsveld H.A., 1990. A variable resolution statistical transport model applied for ammonia and ammonium. National Institute of Public Health and Environmental Protection. Holland.

(h) Galvonaite A. et al. Background air pollution monitoring in Lithuania. Lithuanian Scientific Research Institute for Scientific-Technical Information and Technical-Economical Analysis. Vilnius 1990.

(i) EMEP: Pedersen U. et al. Data Report 1988. Part 1: Annual summaries. EMEP/CCC-Report 4/90.

(j) Estonian Nature Management, Scientific Information Centre: Environment 89. Tallinn 1990.

3 EMISSIONS OF AIR POLLUTION

In some of the references the total sum of all different types of air pollution compounds are given. Unfortunately, that type of information is not possible to use for further studies and is not included in the survey presented here.

3.1 Emissions of sulphur

3.1.1 National emissions

The emissions of sulphur in Latvia are estimated from data given by EMEP, reference (e), and from references (a) - (d) above. The data given by (a)-(d) all state between 25 000 and 30 000 tonnes of SO_2-S for the year 1989. The EMEP emission is about twice as high. (Is there any confusion about the unit, tonnes of S or tonnes of SO_2). The EMEP emission data base seems most complete, but the given emission data needs further evaluation.

EMEP emission data, (e), gives a SO_2-S emission value of 237 000 tonnes S/a for Estonia, Latvia, Lithuania and Kaliningrad together. We have made a simplyfied distribution of the emissions, given by EMEP, to the three Baltic states and we arrive at the following rough values for the SO_2-S emission.

Estonia	100 000 tonnes S/a
Latvia	60 000 tonnes S/a
Lithuania	70 000 tonnes S/a .

3.1.2 Point source data

Some major point sources for SO_2 are given in the table below.

Country/City		Point source	SO_2-S (t/a)	Reference
Estonia (1989):				
Narva		Pribaltijskaja GRES	29 800	(d, partly c2)
Narva		Estonskaja GRES	32 000	(d, partly c2)
Tallinn		P/O Estonfosforit	12 00	(d)
Tallinn		Iru	4 300	(d)
Tallinn		Heat and Power Plant	1 700	(d)
Kohtla-Järve		P/O Slantsechim	2 800	(d, partly c2)
Kohtla-Järve		Power Plant	3 200	(d, partly c2)
Kunda		P/O Estonskij Tsement	32 00	(d)
Latvia (1989):				
Riga		TPP-2	4 600	(b)
"	*	TETs-2	4 700	(d)
"		Thermal Power Plant-2	5 160	(c1)
Daugavpils		P/O Chimvolokno	710	(d)
"	*	P/O Chimvolokno	no realistic value	(c1)
Olaine		Olaine TETs	1 180	(d)
		Balderajskij KKPD	1 210	(d)
Riga		Jugla paper mill	30	(c1)
Riga		Jaunciems paper mill	43	(c1)
Ligatne		Ligatne paper mill	320	(c1)
Sloka		Pulp and paper mill	12	(c1)
Daugavpils		Thermal Power Plant 1+2	4 300	(c1)
"	*	-"-	1 600	(b)
Olaine		Thermal Power Plant	2 660	(c1)
Riga		Therm Pow Pl, Imanta	220	(c1)
	*	-"-	130	(b)
Riga		Therm Pow Pl, Zasulauks	130	(c1)
"	*	-"-	55	(b)
Riga		Therm Pow Pl, Adrejsala	240	(c1)
"	*	-"-	105	(b)
Riga		Therm Pow Pl -1	1 110	(c1)
Riga	*	-"-	130	(b)
Lithuania (1989):				
Between Kaunas and Vilnius		*Litovskaja GRES (Power Plant)*	*"Large"*	*(d)*
Mazeikiai		*Oil refinary and power plan*	*"Large"*	*(d)*

* = Same source

As indicated in the table above, the references have in some cases very large differences in reported emission values for the same power plant or industy. The emission data needs further consideration.

3.2 Emissions of nitrogen oxides

3.2.1 National emissions

Total emission values for NO_x-N are given in references (b), (c1), (c2), (e) and (f). The emission values given by references (e) and (f) are higher than values presented in the other papers. Reference (b) gives a national total NO_x-N emission for Latvia of 10 300 tonnes N/a and reference (c1) gives 3 900 tonnes N/a for all stationary sources in Latvia. The total NO_x-N emission (1988) in Estonia is 7 120 tonnes N/a according to reference (c2).

However, references (e) and (f) seem to be based on the most complete emission surveys, although emission values are not explicitely given for each of the three Baltic states. We have done a preliminary division of emissions on the the three states. Thus, based on reference (e) we get:

Estonia	16 000 tonnes N/a
Latvia	15 000 tonnes N/a
Lithuania	14 000 tonnes N/a .

Based on the careful study by Pacyna et al, reference (f), which refer to emission for the year 1985, we have done the following rough estimation for each of the Baltic states. The emission data in (f) is given in 150x150 km^2 gridsquares.

Estonia	17 000 tonnes N/a
Latvia	21 000 tonnes N/a
Lithuania	20 000 tonnes N/a .

3.2.2 Traffic emissions

Some information about emissions of NO_x from mobile sources has been possible to obtain. The values are given in the table below.

Country	NO_x-N (tonnes/a)	Reference
Estonia	6 000 (1985)	(f)
Latvia	846 (1989)	(d)
	6 330 (1989)	(a)
	12 500 (1985)	(f)
	6 700 (1988)	(b)
Lithuania	10 000 (1985)	(f)

The emission value given by reference (d) is far to low. The most complete emission survey is found in reference (f). Based on (f), we have done a rough estimation for each of the Baltic states. The emission data in (f) is given in 150x150 km^2 gridsquares.

3.2.3 Point source data

Some major point sources for nitrogen oxides (NO_x) are given in the table below together with their emissions per annum.

Country/City	Point source	NO_x-N (tonnes/a)	Reference
Estonia (1989):			
Narva	Pribaltijskaja GRES	1 615	(d)
Narva	Estonskaja GRES	2 285	(d)
Tallinn	P/O Estonfosforit	185	(d)
Tallinn	Iru	122	(d)
Latvia:			
Riga	TETs-2	810	(d)
" *	Therm Pow Pl-2	990	(c1)
Daugavpils		80	(d)

Lithuania

No information available.

* = Same source

3.3 Emissions of ammonia

3.3.1 National emissions

The following data have been found or have been possible to estimate from the given references.

Country	NH_3-emission (tonnes/a)	Reference
Estonia	1 053	(c2)
	33 000	(e)
	34 000	(g)
Latvia	161	(b)
	70 000	(e)
	60 000	(g)
Lithuania	65 000	(e)
	90 000	(g)

The references (b) and (c2) probably only include industrial emissions and therefore give much too low values. Reference (e) gives a total value for the three Baltic states. We have done a rough division of emission data on each of the states based on information in reference (e).

From reference (g) we have estimated a mean NH_3-emission per unit area for each of the three Baltic states. These emission values have then been multiplied by the geographical area for Estonia (45 100 km^2), Latvia (63 700 km^2) and Lithuania (65 200 km^2).

3.3.2 Point source data

References (a)-(d) give NH_3-emission data for some few point sources. The point source values are, however, very small compared to emissions from agriculture, which are included in references (e) and (g) and included in the national emissions. Therefore, no point source information is presented here.

3.4 Emissions of heavy metals

3.4.1 National emissions

Reference (b) gives some values for Latvia. However, the emissions seem to be very much underestimated. Therefor, no information is presented here.

3.4.2 Point source data

Only very limited data have been obtained. For some point sources in the north-eastern region of Estonia, in the Narva Kohtla-Järve area, reference (c3) gives the following emissions:

Pb 57 tonnes/a
Zn 32 tonnes/a
Cu 23 tonnes/a
Hg 3.8 tonnes/a.

3.5 Hydrocarbons

3.5.1 National emissions

No data available

3.5.2 Traffic emissions

The hydrocarbon emission is 11 500 tonnes/a according to reference (a). Compared with the emission of CO, which is presented below, the hydrocarbon emission seems low. Emission data needs further evaluation.

3.6 Carbon monoxide

3.6.1 National emissions

The total CO-emission (1989) in Latvia is 375 000 tonnes/a according to reference (c1).

3.6.2 Traffic emissions

The CO-emission (1989) from traffic in Latvia is 340 000 tonnes/a according to references (a) and (c1).

4 AIR POLLUTION MEASUREMENTS

4.1 Air pollution concentrations in urban areas

Air quality standards in the Soviet Union are presented in (a). An extensive compilation of the air pollution in Latvia is made by the Latvian Environmental Protection Committee. The situation of air pollution in 11 Latvian towns during 1986 - 1990 are presented in (a).

For NO_2, the method of measurement seem to be somewhat insensitive. The lower limit of detection seems to be 20 µg/m^3. NO_2 concentration are difficult to compare between different monitoring sites when nothing is known about the site in relation to adjacent traffic. Another difficulty is the lack of information about procedure for sampling and analyses. However, the early mean concentrations presented seem in many of the minor towns, to be of about the same level as in many small and medium size Swedish towns where the measurements refer to sites away from direct street air pollution. If the Latvian data represent the street environment situation, the values are lower than in Swedish urban areas. In Riga the yearly means are about twice as high as the mean level in central Stockholm and Göteborg. The measurements in the Swedish cities refer to sites away from direct street pollution, but we have no information about where the measurements are done in Riga. The two latest years about 20 % of the measurements in Riga exceeded the standards.

Also the method for SO_2 seem to be insensitive. The lower level of detection seems to be 5 - 10 µg/m^3. There are great variations in results between the years. However, in many of the smaller towns, the yearly means are of the level below or around 10 µg/m^3, i.e. the same order of magnitude as in southern Sweden. The two latest years, the same relatively low levels were also observed in Riga. Ventspils was the only town where the yearly means exceeded Soviet standards, 50 µg/m^3.

From the presented results yearly dust levels seem to be constant and relatively high yearly means in all towns, including Riga, 100 µg/m^3. The reported maximum levels indicate severe dust problems.

Many towns seem to have problems with CO. The yearly mean levels, 1 mg/m^3 indicate that periodically high levels will occur. However, we do not know exactly where the monitoring is carried out. The percent of measurements exceeding the standards are however low. In all towns less than 10 % of the measurements exceeded the Soviet standard, 5 mg/m^3. In Riga the maximum levels reported are very high, clearly higher than in the other towns.

The measurements of ammonia show very high values in relation to Sweden. Can there be something wrong with the results, or are the values due to local emissions?

The pollution of some other components in air in Latvian towns are presented as an exceedance factor in relation to Soviet standards (c). It is not obvious by the report if thedaily or the annual standards or both are exceeded. The data indicate local pollution problems near sources:

for ammonia in Olaine and Liepaja
for phenol at Valmiera, Riga, Liepaja and Olaine
for benzpyrene at Ventspils and Liepaja
for benzene at Riga and Olaine.

There are also some information about the air quality in Estonian and Lithuanian towns. An air pollution monitoring net of several stations at Tallinn, Kohtla-Järve and Narva is used to measure 13 different pollutants. Sulphur dioxide, nitrogen dioxide and dust levels as yearly means presented in (j) are high compared to Swedish conditions though the measurements between 1985 and 1989 show a generally decreasing trend: 100 - 80 µg SO_2/m^3 in Tallinn, 200 - 100 µg dust/m^3 in Narva and 60 - 20 µg NO_2/m^3 in Tallinn and Narva. More information is needed for a further evaluation of this possible trend.

Exceedances of the Soviet Union standards are observed in both Tallinn and Kothla-Järve and Kivioli.

In Vilnius (d) a few reported values indicate the same yearly pollution levels as is measured in the Latvian towns. The situation in Kaunas is described as better than in Vilnius, due to less traffic.

As in Latvia, in some areas around point sources, the pollution situation is reported to be considerable. Areas mentioned are around the oil shale industry in north-eastern Estonia, Kohtla-Järve, Narva and Tallinn.

As a conclusion, there seems to be problems in urban areas in the Balitc states. Generally there seem to be obvious problems with dust and carbon monoxide. Also, in some areas for example in Estonia there are local problems with sulphur and nitrogen dioxide. However, it is also clear that we do not have the complete information on all air quality measurement results.

4.2 Air pollution concentrations in background areas

Information on the regional air pollution situation can be obtained from the EMEP project results. EMEP is the co-operating programme for monitoring and evaluation of the long range transmission of air pollutants in Europe. It is run within the UN-ECE as part of the work to the Convention of the Long Range Transboundary Air Pollution.

The EMEP air pollution measurements in the Baltic states 1988 show that the levels of SO_2, NO_2 and particulate sulphate are of the same level or lower than in southern Sweden. (The measurements are not made with the same method and comparisons of results may be uncertain.) The maps in Figure 1 show the annual mean concentrations over Europe as evaluated by EMEP.

An evaluation of the air pollution in Lithuania, (h), based to a large extent on long term monitoring data from Preila and some other stations also indicate a situation very much the same as in Sweden. Measurement results are obtained for SO_2, NO_2, particles, heavy metals and ozone. The highest levels of sulphur dioxide are seen in connection with transports of air masses from the south. There are higher levels during winter time for SO_2 as well as for NO_2. Monthly mean concentrations of SO_2 varies from 2 to 20 µg/m^3 and for NO_2 from 5 to 16 µg/m^3. The long term trend for NO2 is increasing. In contrast to Sweden however, the long term trend for SO_2 is mentioned to be slightly

increasing. Can this be due to relatively local pollution trends?

The ozone measurements show that also the ozone situation is much the same as in southern Sweden, usually with a range between 10 and 100 µg/m^3 and episodic values up to over 160 µg/m^3. The yearly averages of O_3 at Preila seem to be somewhat lower than in Sweden. The ozone is, as in Sweden, largely a regional pollution problem.

Though the base for comparison is small, the concentrations of some particulate heavy metals in air (Pb, Ni) seem to be of the same order of magnitude as in southern Sweden and the concentrations of others (such as Cr, Mn and Ti) may be higher in Lituania. However, it must be kept in mind that there are few results to compare and the methods for sampling and analysis differ. Sector analysis indicate that the metals are of southerly origin. Soil erosion may be a major source for Mn and Ti. The others seems to be of anthropogenic origin.

It seems that of most of the air pollution components in background areas are of the same order of magnitude as in Sweden. This is found by most of the monitoring results, but is also indicated by EMEP model calculations, reference (e).

4.3 Precipitation and deposition measurements

Precipitation analyses reported show very different results. The measurement results obtained within the EMEP programme (i) cover the background areas, away from the pollution sources, show precipitation concentrations of sulphate which are generaly lower in the Baltic states than in southern Sweden. The same is observed for nitrate in precipitation. It should be pointed out that the procedures for sampling and analysis are not the same. Maps of annual mean concentrations according to the EMEP measurements are presented in figure 2. Also the wet deposition is lower in the Baltic states according to these measurements. The concentration of ammonium is of the same level as the most polluted stations Vavihill and Hoburg in southern Sweden.

Precipitation studies in Latvia reported in (c) show that the major part of the country receives acid precipitation, mainly in the eastern and southeastern parts of Latvia. The EMEP station Rucava has the lowest mean pH value of all. All stations including the station reporting data to the WMO international network (the mean pH is around 6 and can be as high as 7.5) indicates an impact of alkaline dust.

Also in Lithuania the precipitation is acid at most monitoring sites. Precipitation studies at Preila and other background stations in Lithuania (h) show a lower pH range in precipitation than i Latvia, from 3.3 ton 6.8. In 80 % of the samples pH is less than 5.6. The data show small regional differences.

Anion concentrations in precipitation are dominated by sulphate in background areas (h) and (a). The concentration of sulphate, 2 -3 mgS/l, are up to twice as high as in southern Sweden. The nitrate concentrations are 1 - 1.3 mgN/l in Latvia (a) and 0.5 - 0.6 mgN/l in Lithuania (h). The Lithuanian values are as expected somewhat lower than the concentrations in southern Sweden.

At urban stations the precipitation is more polluted and pH is higher than in background areas. This is due to impact of alkaline dust. The sulphate con-

centrations are higher in urban than in background areas. At some of the reported Estonian stations (urban areas only? There is no information) the sulphate concentrations (j) are high; yearly weighted averages between 2 and 6 mgS/l. The nitrate concentrations are relatively low 0.3 - 0.4 mgN/l. There is no information about the sites.

Also deposition (wet end dry) of different polyaromatic hydrocarbons, in particular benz(a)pyrene was measured at many stations over Lithuania.

The dry deposition contribution is not taken into consideration by the measurements mentioned above. No throughfall measurements seem to have been made in the Baltic states, as far as we have found.

The results in background air are somewhat confusing. There are variations in the reported values for background air in different parts of the Baltic states. It is uncertain if these variations are real or due to use of different procedures for sampling and analysis, or if some background stations are influenced by local sources. The more polluted precipitation, indicated by high pH values and higher sulphur concentrations, is observed in urban areas and near sources. Sulphur and dust pollution seem to be a greater overall problem than nitrogen pollution.

Comparing with Sweden, the highest concentrations of sulphate and nitrate in Sweden are seen at Hoburg on the isle of Gotland. This is a fact that may be an indication a somewhat higher level in the Baltic state, due to influence from sources south of the Baltic states or from sources in the Baltic states.

4.4 Heavy metals in moss

Heavy metals analysis in moss (sphagnum magellanicum) are made in Latvia by Ilgerts Nicodemus at the University of Latvia but unfortunately we have not been able to obtain a report on the data. Parts of the results are presented as maps in (c1), Figure 3. In some cases it is not possible to find local sources to increased levels. Lithuanian emissions may be an explantion for high Cr and Hg concentrations in moss. The town of Riga is another obvious source.

5 DISPERSION OF AIR POLLUTANTS - ESTIMATES BASED ON AVAILABLE MODEL CALCULATIONS

Dispersion model calculations can be used to estimate the air pollution contributions from different sources. In order to make careful calculations, these dispersion models have to cover the relevant geographical scale and be adapted to relevant topography, meteorological information etc.

At this first stage of our study we can only utilize already excisting model calculations. On the local scale we have no calculations available from the Baltic states. Thus, we have only been able to do some estimates based on calculations for similar types of sources in Sweden. On the European scale, the European cooperative programme EMEP has made calculations for sulphur and nitrogen. The EMEP calculations are, however, made with a coarse resolution and can only be used for some overall estimates.

5.1 Large scale dispersion of emissions from the Baltic states - comparisons to the long range transport of air pollution

Within EMEP, the co-operative programme for monitoring and evaluation of the long range transmission of air pollutants in Europe, reference (e) in section 2, large scale dispersion calculations have been performed. A model over Europe with a grid resolution of 150 x 150 km^2 have been used for calculations of long range transport of oxidized sulphur, oxidized nitrogen and reduced nitrogen.

Tentative analyses of EMEP-results concerning the Baltic states have been used in this study in order to illustrate the importance of emissions within the Baltic states in comparison to the long range transport of air pollutants. However, it is very important to realize that the EMEP-model, which is the base for these tentative analyses, has a smallest geographical resolution of 150 km. Thus, smaller scale maxima in the air pollution pattern are not described.

The presented maps in Figures 4-9 are tentative analyses based on regional scale dispersion calculations by EMEP. Given values refer to averages for the years 1985/87/88/89/90.

In Figures 4-6 tentative large scale analyses of the contributions from emissions within Estonia-Latvia-Lithuania-Kaliningrad concerning oxidized sulphur, oxidized nitrogen and reduced nigrogen are presented. The relations between the contributions from each country should be roughly the same as the relations between their emission values, which are given in section 2. In Figures 7-9 the contributions from the long range transport are presented.

5.1.1 Sulphur deposition

For oxidized sulphur the contribution *from the Baltic states* to the deposition is about 300-500 mgS/m^2,a over Estonia and about 300-400 mgS/m^2,a over Latvia and Lithuania. For the Gulf of Riga the contribution from the Baltic states is estimated to be about 200 mgS/m^2,a.

In Figures 7-9 *the long range transport* (= the contributions from emission sources outside the Baltic states) are given. For sulphur deposition the long

range transport contributes to about 1000 mgS/m^2,a over the Baltic states and to about 800 mgS/m^2,a over eastern part of the Baltic Sea. Thus, about one third of the surphur deposition is estimated to be caused by emissions within the Baltic states. That is a rather large local contribution compared to for example the situation in the Nordic countries.

The *total* calculated sulphur deposition is the sum of the contribution from the Baltic states and the long range transport. The total deposition is varies between 1100-1800 mgS/m^2,a for the Baltic states and is about 1200 mgS/m^2,a over the Gulf of Riga.

5.1.2 Nitrogen deposition

For the nitrogen deposition, the main contribution *from the Baltic states* are caused by reduced nitrogen, which gives a deposition of about 300-500 mgN/m^2,a. The estimated contribution of oxidized nitrogen from the Baltic states is only about 20 mg N/m^2,a.

The long range transport causes about 250-300 mg N/m^2,a of reduced nitrogen deposition and about 300-500 mg N/m^2,a of oxidized nitrogen deposition. Thus, about 60 % of the deposition of reduced nitrogen are caused by emissions within the Baltic states, a very large local contribution. On the other hand only about 5% of the deposition of oxidized nitrogen is estimated to be caused by emissions within the Baltic States.

The *total* deposition of reduced nitrogen over the Baltic states is about 600-800 mgN/m^2,a and the total deposition of oxidized nitrogen is about 300-500 mgN/m^2,a.

For the Gulf of Riga the model calculations give a total deposition of about 400 mgN/m^2,a of oxidized nitrogen and about the same amount of reduced nitrogen. Only about 5% of the oxidized nitrogen deposition over the Gulf of Riga is estimated to be emitted within the Baltic states, while about 50% of the reduced nitrogen deposition probably are caused by emissions, mainly from agriculture, within the Baltic states.

Other model calculations of reduced nitrogen deposition by Asman et al in reference (g) give similar results as the EMEP-calculations. From (g) we have estimated the following total reduced nitrogen deposition:

Estonia	250 - 450 mgN/m^2,a
Latvia	450 - 700 -"-
Lithuania	450 - 850 -"-
Gulf of Riga	250 - 400 -"- .

5.2 Local dispersion around point sources

For a complete dispersion calculation detailed information about emission, stack height and surrounding buildings is needed, which is not available at present. However, by means of old results from the SMHI local dispersion model we have tried to make very rough estimates of the air pollution contribution locally around some few of the major point sources, which are explixitly given in section 2. In these estimates we have assumed chimney heights around 100 m for the studied sources.

We find that i.e. for the major sources in the Narva region and for Riga Thermal Power Plant 2, the 99-percentiles for 1h mean values of SO_2, caused by these sources, might exceed the old Swedish standard of 750 $\mu g/m^3$. Besides, in Sweden, normally, the contribution from one source is not permitted to exceed about 200 $\mu g/m^3$.

6. CONCLUSIONS

From the data available about emissions and air quality in the Baltic States we can conclude:

- There are uncertainties in reported emission data. Differences and obvious disagreements make an assessment of the situation difficult. More information is needed for further evaluation. It is important that emission values are reported separately for individual pollutants. The total sum of pollutants emitted is impossible to use.

- For deposition of nitrogen, the reduced nitrogen (ammonia) is of major importance in the Baltic states. There are less problems with oxidized nitrogen. The reduced nitrogen, mainly originating from agriculture, is also to a much greater part of local Baltic origin compared to the oxidized nitrogen, see Figures 5, 6, 8 and 9.

- The deposition of sulphur is dominated by long range transport, see Figures 4 and 7, but the local contributions are more important compared to the situation in the Nordic countries.

- In urban areas and around point sources there are obvious problems with local air pollution. Measurement data indicate high concentrations of carbon monoxide, dust and ammonia in urban air. Very high concentrations of benzene, polyaromatic hydrocarbons and other toxic compounds are reported from industrial areas. There seem generally to be less problems with nitrogen dioxide. There is some confusion about SO_2. In urban air the measurements indicate relatively small problems except for some major point source areas.

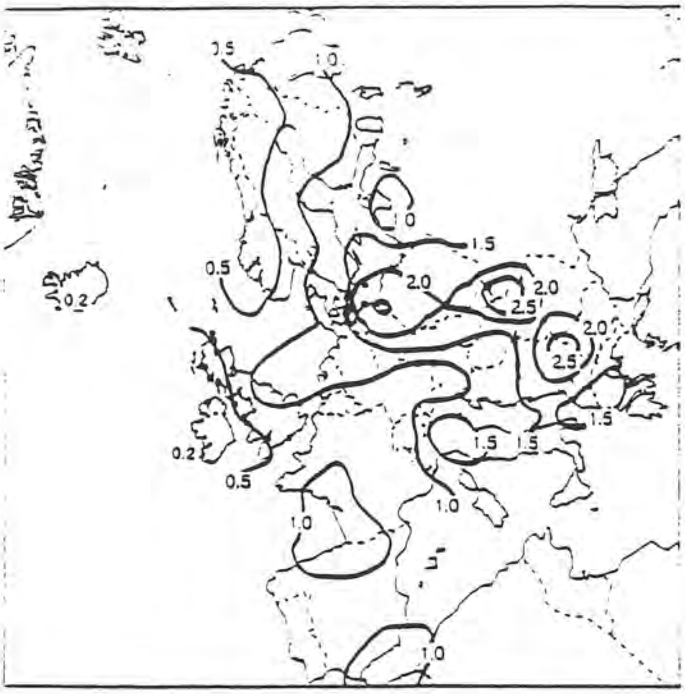
- In background air, measurements indicate that the pollution situation seem to be much the same as in southern Sweden. The European evaluation made by EMEP indicate the same. Some background stations are probably locally influenced by alkaline dust. This is indicated by high pH values in precipitation at some stations. The EMEP evaluation of th regional air pollution, however, indicate pH valuess sligthly higher than in Scandinavia. There are disagreements in the precipitation chemistry results, for example for sulphate and nitrate. More information of siting is needed for an assessment of the situation.

It would be valuable for the future environmental studies for the Baltic states to have a national air pollution model as a tool. Such a dispersion model, combined with air pollution measurements, could be used for environmental studies for different regions in the Baltic states. A mesoscale model for parts of the Baltic states is reported in (h), but no detailed information is available.

In Sweden, today, an air pollution model for different regions is used in the environmental planning. A similar model should be possible to apply for the Baltic states. A very large amount of geophysical information can be handled in such a model. A suggested model area with 10x10 km^2 gridsquares are illustrated in Figure 10. The grid can of course be rotated in order to suite excisting data bases. The Swedish regional air pollution model is described and operational applications are presented in:

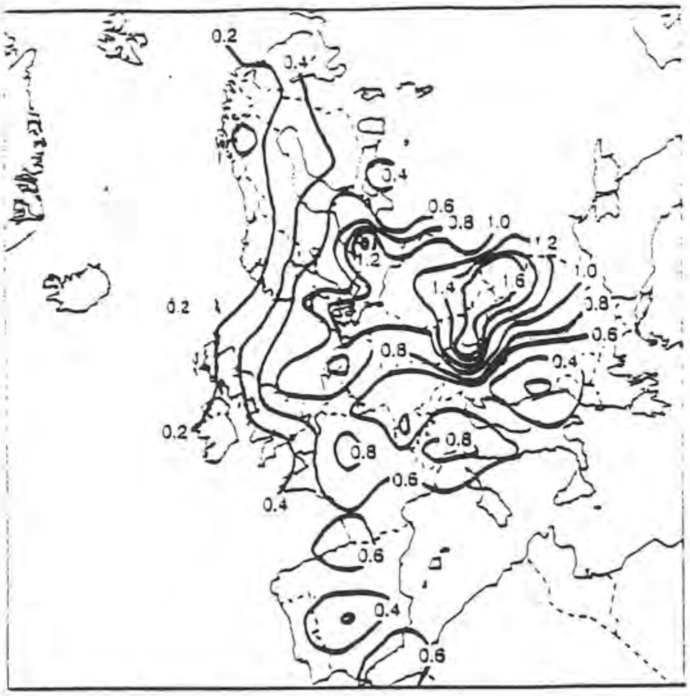
- Persson C and Robertson L. 1991. An operational regional air pollution model applied to different scales. Chemistry and the Environment Conference, Salzburg, Austria.

- Persson C and Robertson L. 1991. Spridningsberäkningar för Skåneregion - Nuläge och framtidsscenarier, SMHI Rapporter.

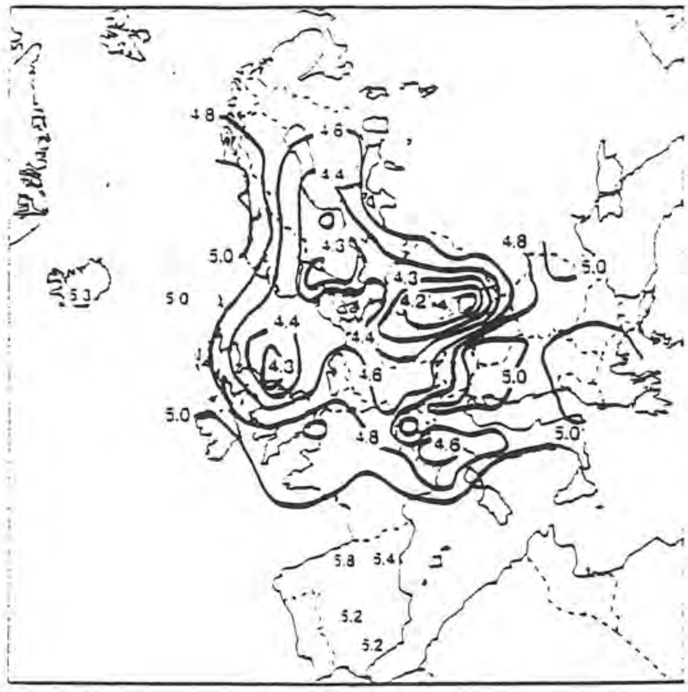


Sulphate in precipitation 1988.
Annual mean concentrations (mg S/l).

Nitrate in precipitation 1988.
Annual mean concentrations (mg N/l).

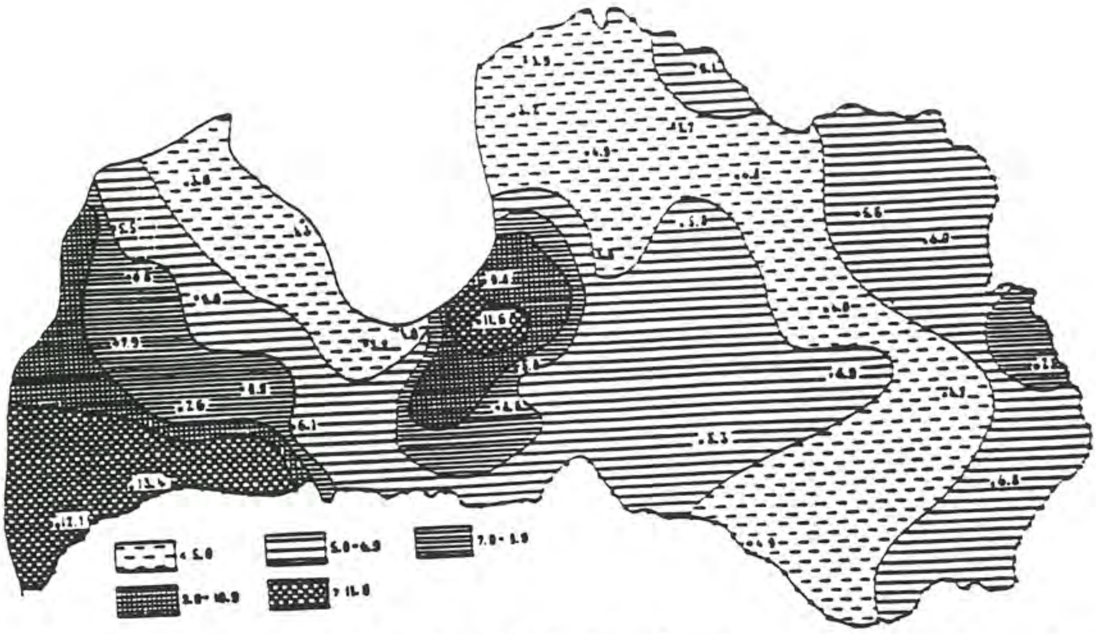


Ammonium in precipitation 1988.
Annual mean concentrations (mg N/l).

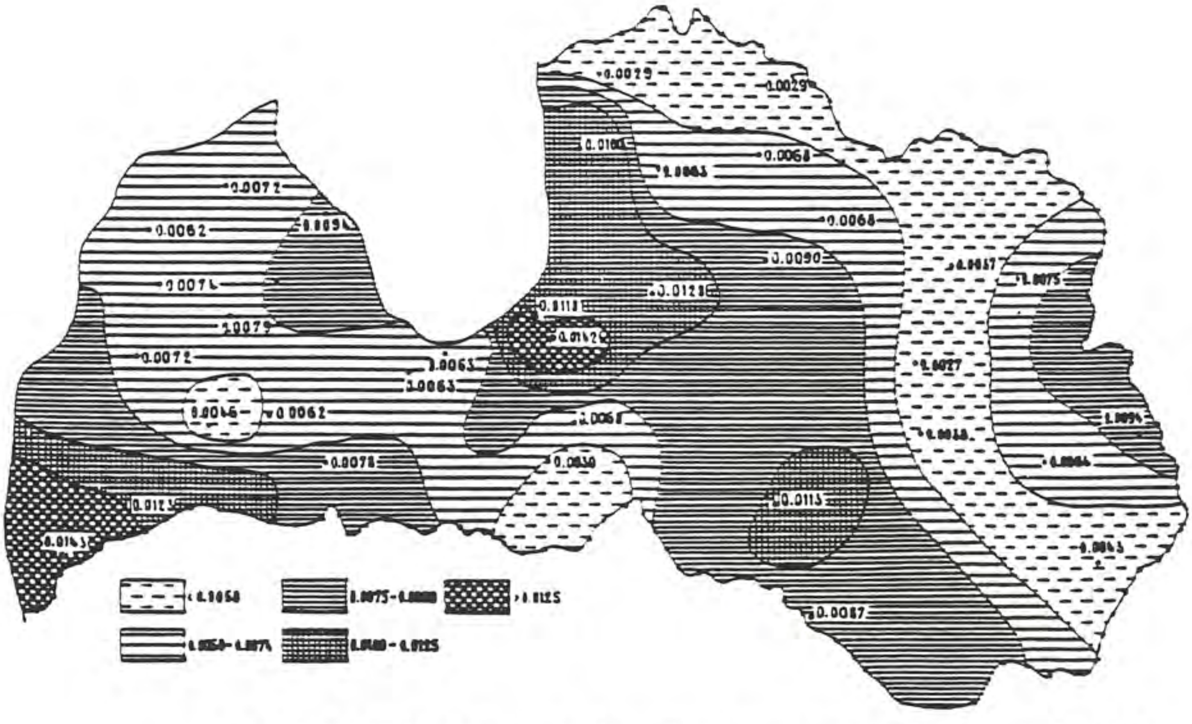


pH in precipitation 1988.
Annual mean values.

Figure 2. Annual mean concentrations in precipitation according to the EMEP measurements.



Cr_{tot} Content (mg/kg) in shagnum magellanicum brid. In upland bogs.



Hg Content (mg/kg) in shagnum magellanicum brid. In upland bogs.

Figure 3. *Heavy metal analyses in moss.*

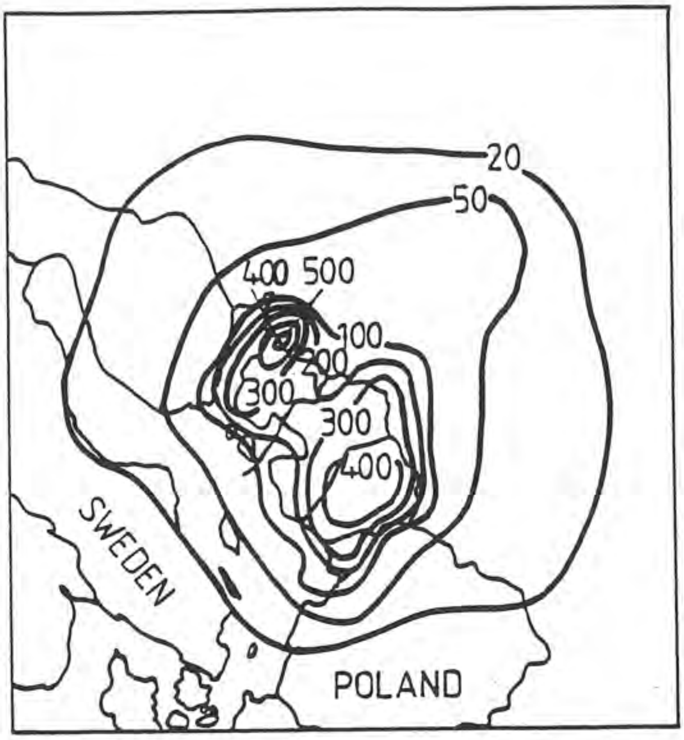


Figure 4. Calculated deposition of oxidized sulphur (mg/m^2,a as S) caused by emissions within Estonia-Latvia-Lithuania-Kaliningrad.

Figure 5. Calculated deposition of oxidized nitrogen (mg/m^2,a as N) caused by emissions within Estonia-Latvia-Lithuania-Kaliningrad.

Figure 6. Calculated deposition of reduced nitrogen (mg/m^2,a as N) caused by emissions within Estonia-Latvia-Lithuania-Kaliningrad.

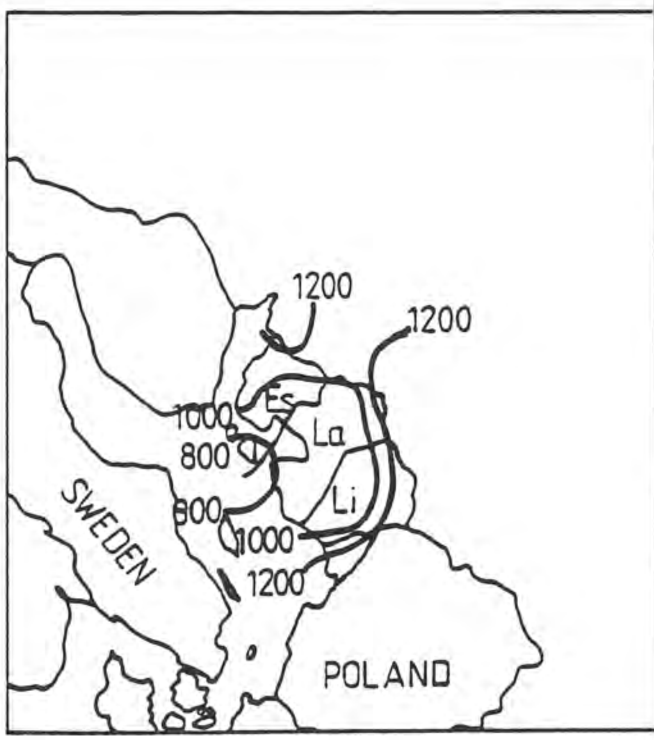


Figure 7. Calculated background deposition of oxidized sulphur (mg/m^2,a as S) caused by emissions outside the area Estonia-Latvia-Lithuania-Kaliningrad.

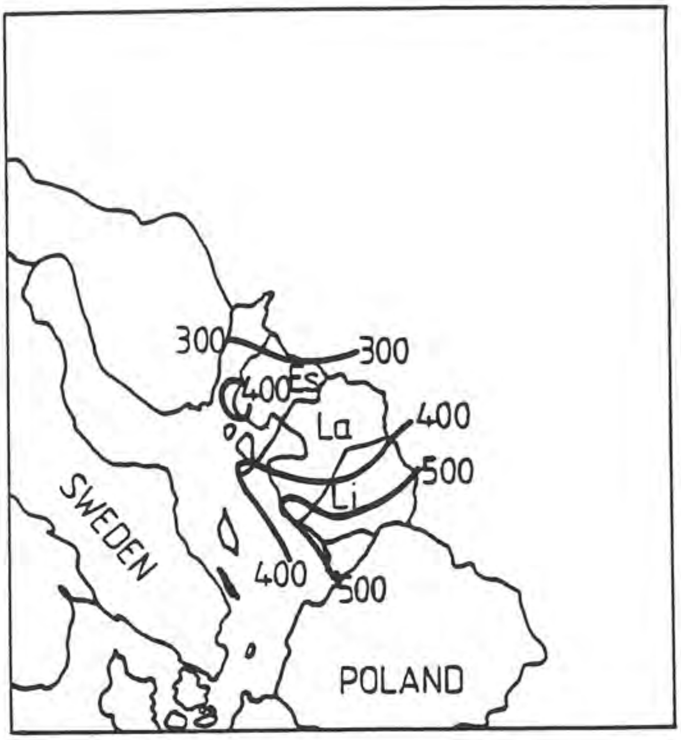


Figure 8. Calculated background deposition of oxidized nitrogen (mg/m², a as N) caused by emissions outside the area Estonia-Latvia-Lithuania-Kaliningrad.

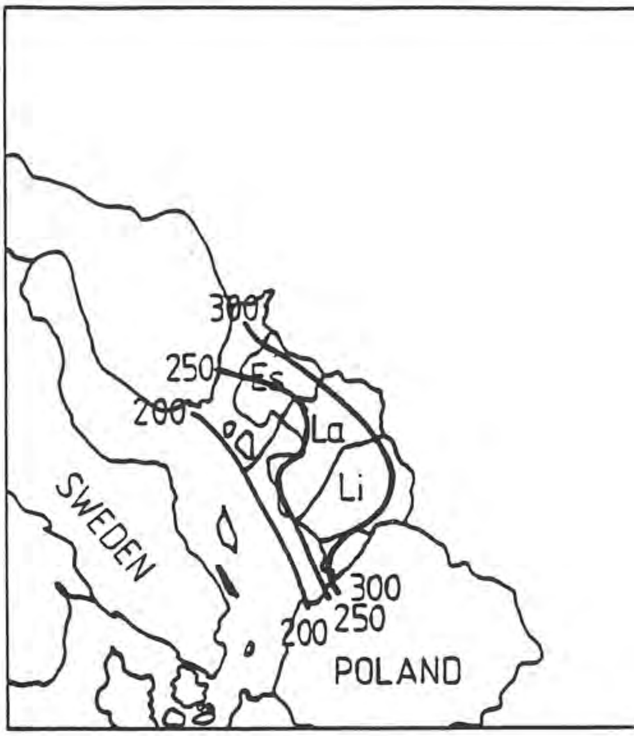


Figure 9. Calculated background deposition of reduced nitrogen (mg/m², a as N) caused by emissions outside the area Estonia-Latvia-Lithuania-Kaliningrad.

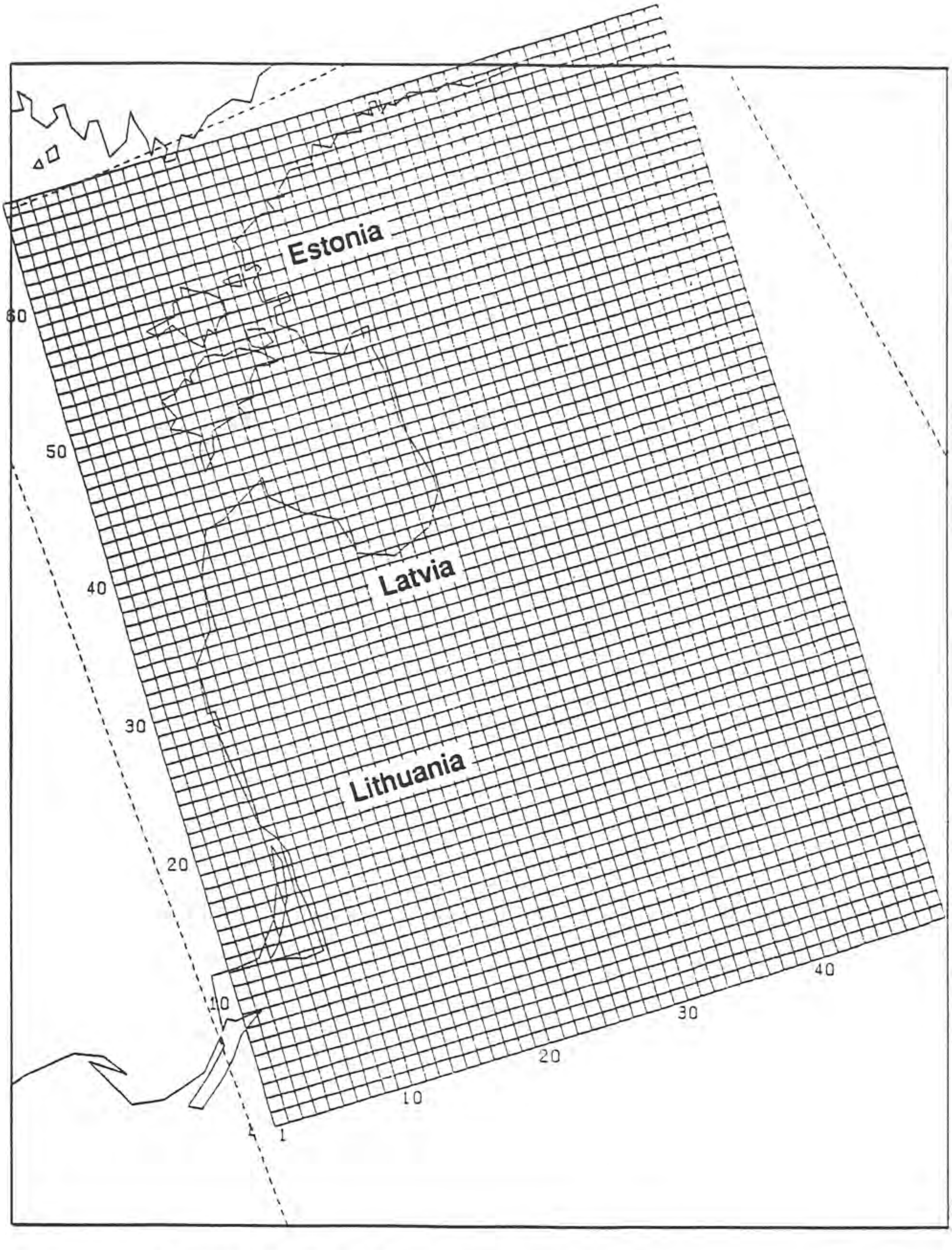


Figure 10. *Suggested model area for a regional scale air pollution model for the Baltic states. Size of gridsquares = 10x10 km^2.*

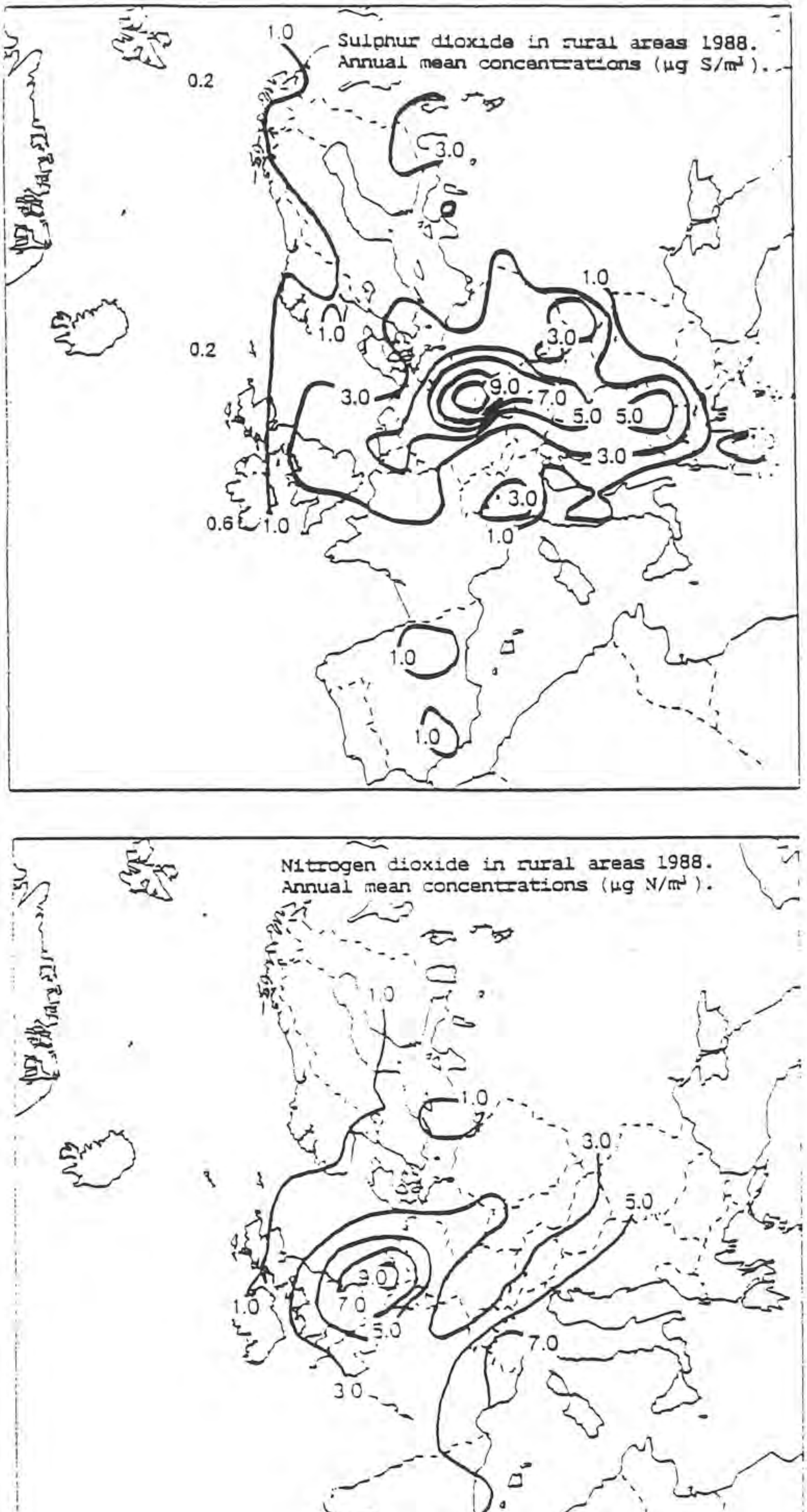


Figure 1. Annual mean concentrations over Europe as evaluated by EMEP.