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An issue brief on current Nordic-Russian
co-operation & capacity building

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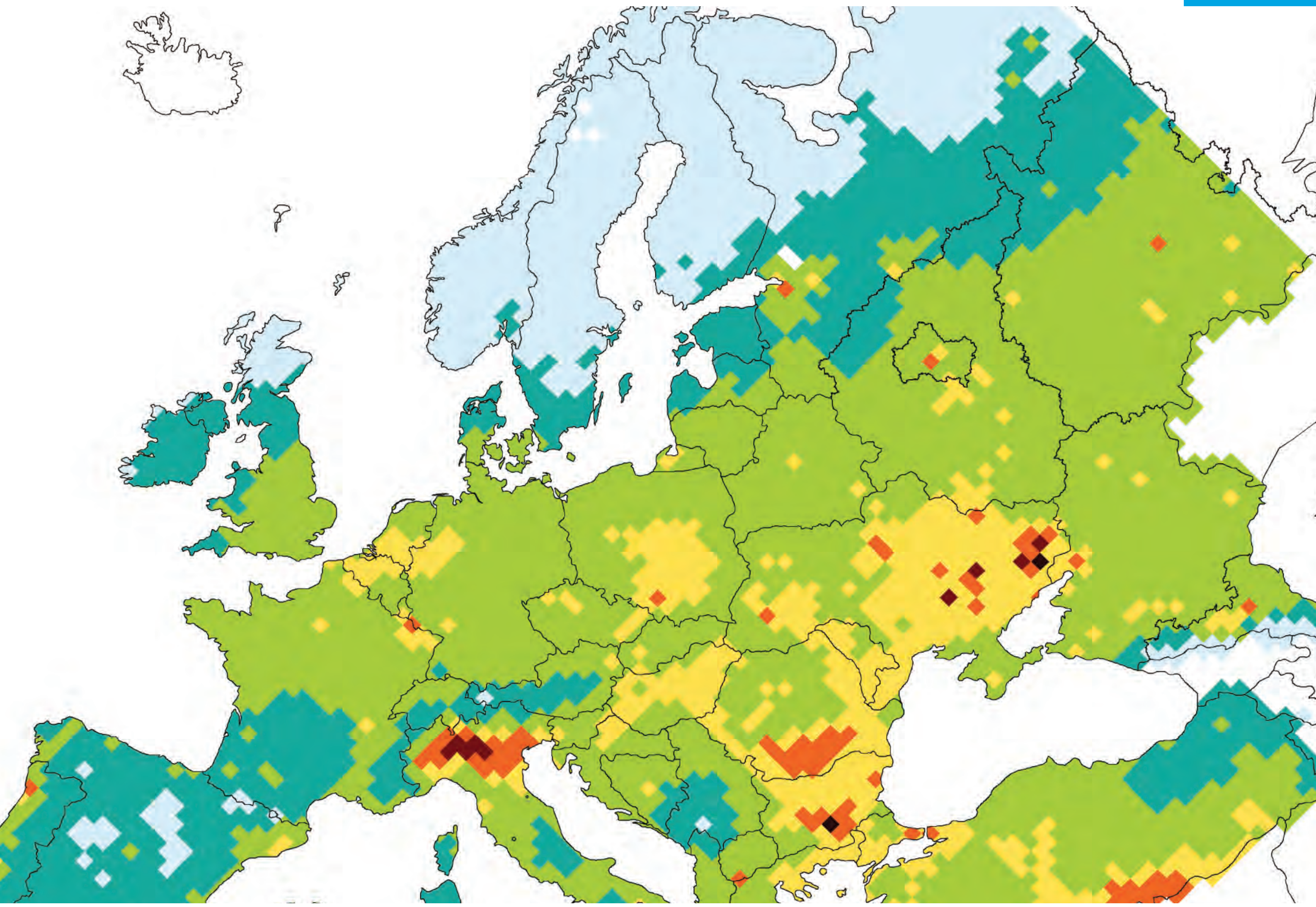

Enabling Russian Use of Air Pollution Policy Models

- An issue brief on current Nordic-Russian co-operation & capacity building

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This issue brief targets international air pollution policy stakeholders, environmental researchers engaged in international co-operation activities, and the interested general public.

Key Messages

Through scientific and technical collaboration between the Russian Federation and the Nordic Countries, and with additional support from the International Institute for Applied System Analysis, Russia has developed capacity to

- design cost-effective air pollution emission abatement strategies, and to analyse national and regional economic-, human health-, and environmental impacts associated with these strategies
- analyse and scrutinise policy suggestions developed under the UN-ECE Convention on Long Range Transboundary Air Pollution, especially the revision of the 1999 Gothenburg protocol to abate acidification, eutrophication, and ground level ozone
- analyse air pollution co-benefits from Russian climate policies.

In addition our studies show that

- the Russian Federation in contrast to Western European countries is not expected to experience improvement in air quality in the future
- the future emissions of air pollutants from the Russian Federation constitute a growing relative risk to the mainland Nordic countries if no further action is taken
- the cooperation between Russian Federation and Nordic countries has formed a fruitful basis for further cooperation.

Recommendations for further development

International and national air pollution policy efforts require continuous development of modelling and scenarios for key sectors (energy, industry, transport, and agriculture).

To increase the level of engagement in air pollution issues in Russia it is important to disseminate information on regional impacts within Russia and to support continued communication between regional and federal authorities in Russia as well as between the Russian Federation and other countries.

Given the established analytical capacity in the Russian Federation, it is now possible to expand the international cooperation to analysis of

- cost effective reduction strategies for short lived climate pollutants and their impacts in the Arctic region
- ozone damages to vegetation and human health
- co-benefits between climate change and air pollution policies in the Russian Federation.

Enabling Russian Use of Air Pollution Policy Models

The purpose of this issue brief is to highlight air pollution problems and policy options in the Russian Federation and to provide information on the benefits of Nordic-Russian co-operation over the last couple of years, as well as to provide suggestions for ways forward.

WHY BOTHER ABOUT AIR POLLUTION?

Some of Europe's most sensitive ecosystems to air pollution are located in the Nordic countries and the North-Western parts of Russia. In these regions, some of the first and most severe occurrences of fish death were reported in the 70's as a result of surface water acidification. It was also shown that the main origin of the acidification was atmospheric deposition of sulphur compounds, often transported over long distances, and that the solution to the problem could only be achieved through common actions in many countries.

The Nordic countries were active in the establishment of the UN-ECE 1979 Convention on Long-range Transboundary Air Pollution (CLRTAP) and the reduction of European emissions of air pollution, achieved through a series of protocols agreed under the Convention. The latest protocol is the recently revised 1999 Gothenburg protocol to abate Acidification, Eutrophication and ground level ozone, which in the revised version also includes control of fine particulate matter to reduce adverse health impacts. In the southern part of Scandinavia, particularly Denmark and southern Sweden, large scale exceedance of the critical loads (i.e. deposition above levels where damage to the ecosystem can be expected) for nutrient nitrogen (eutrophication) is still found. The major exceedances are especially found on naturally nitrogen-poor habitats such as mires and forests. Acidification damages are also still of concern for some areas of the Nordic countries.

During the last 10-15 years air pollution has also been identified as a cause of adverse human health effects, and even premature death . These effects are caused by exposure to (inhalation of) particulate matter pollution. And even more recently, the consideration of climate forcing impacts of certain air pollutants has been identified as an important challenge, especially for emission sources affecting the Arctic.

Due to the international agreements under the CLRTAP and EU legislation, emissions in large parts of Europe have decreased significantly with corresponding reductions in deposition and exposure. However, the Russian Federation is one of the CLRTAP countries which have yet to sign and ratify the Gothenburg protocol (and the revised version), and thereby commit to increase the domestic efforts to reduce emissions.

HOW TO GET RUSSIA MORE ACTIVE IN THE INTERNATIONAL AIR POLLUTION ISSUES

In 2010, The Nordic Council of Ministers launched a co-operation project aimed at expanding on-going co-operation (see info box) and a continuation of capacity building among Russian experts in assessing long-range pollution and its reduction by including EMEP/MSC-W modelling together with the GAINS modelling (see glossary at the end of this brief). In this project activities included data inventory capacity building, EMEP/MSC-W model capacity building, EMEP/MSC-W modelling and GAINS model development, as well as updating information on present emissions and scenarios for Russia to the models. The GAINS model development required EMEP/MSC-W modelling and expertise from MetNorway and IIASA.

In addition to these two project partners, the project also included partners already involved in a Swedish-Finnish-Russian co-operation project: IVL Swedish Environmental Research Institute (Stefan Åström, Katarina Yaramenka, Karin Kindbom, and Maria Lindblad); the Finnish Environment Institute (SYKE) and later Metropolia (Antti Tohka); and the Scientific Research Institute for Atmospheric Air Protection (SRI) in Russia (Irina Morozova, Yulia Ignateva, Alexander Romanov, and Kristina Volkova). The project partners from IIASA were Chris Heyes, Janusz Cofala, Wolfgang Schöpp, and Robert Sander. From MetNorway Svetlana Tsyro and Semeena Valiyaveetil were key project partners.

HOW IMPORTANT ARE RUSSIAN EMISSIONS FOR THE NORDIC COUNTRIES?

Currently, Russia is one of the important contributing countries to deposition of sulphur and nitrogen, and thereby to problems related to acidification and eutrophication in the Nordic countries. In 2010, the Russian Federation contributed with 2, 22, 3, and 8 per cent of the sulphur deposition in Denmark, Finland, Norway and Sweden, respectively. The corresponding numbers for oxidised nitrogen was 12, 32, 13, and 16 per cent, and for reduced nitrogen 3, 16, 3, and 6 per cent . Furthermore, when exploring scenarios for future development, the relative importance of Russian emissions will most likely increase.

Following the best available emission projection estimates of today, the Russian share of Nordic deposition of sulphur, oxidised nitrogen, and concentrations of fine particulate matter can be expected to increase by 2030 . This is a consequence of expected reduction of emissions in the EU, together with a much smaller expected reduction in emissions from the Russian Federation. For SO_2, Russian emissions might even increase. For emissions of ammonia however the relative share of emissions between EU and Russia is expected to stay more or less constant up until 2030.

Still, in 2030 the Nordic countries are expected to experience problems with acidification (mainly Norway and Sweden), eutrophication (Denmark, Finland, and Sweden) and human health (all countries) due to air pollution. The population in Denmark, Finland, Norway, and Sweden is expected to have an average reduced life

PROJECT HISTORY

Given the importance of the EMEP/MSC-W and GAINS model in the international air pollution policy development any country that lacks sufficient understanding of the models and data used, and thereby of the model results, can find it difficult to use the model results as decision support in negotiations. During the international workshop Saltsjöbaden III (2007) air quality experts and representatives from Eastern European, Caucasus and Central Asia (EECCA) countries discussed ways forward to increase participation of the EECCA countries in the CLRTAP. During the discussions experts from the EECCA countries stressed the importance of further capacity building and knowledge transfer to the EECCA countries, in order to enable increased engagement in the CLRTAP.

With this as a background Sweden initiated a Swedish-Finnish-Russian co-operation programme in 2008. This programme focused mainly on Russian understanding and usage of the GAINS model and enabled Russian experts to increase their scientific capacity and participation in the relevant working groups of the CLRTAP. However, the GAINS model needed to be further adapted in order to be more useful and to allow for analysis of cost-effective emission reduction within Russia. This since Russia is a large country with strong influence from regional authorities on environmental issues. This in turn required a further development of the GAINS and the EMEP/MSC-W models to fit Russian needs, which could be achieved through an enlarged cooperation between Russia and the Nordic countries. This brief mainly covers the results from this enlarged cooperation.

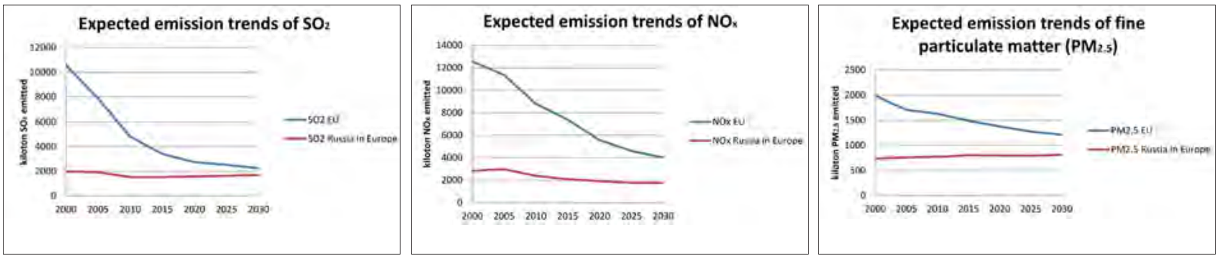

Figure 1. SO_2, NO_x, and $PM_{2.5}$ emissions trends from 2000 to 2030 for EU and European Russia.

expectancy of some 2-4 months per person due to emissions of air pollutants (for persons over 30 years of age). These numbers hide a much larger reduction of life expectancy for sensitive persons. So with expected environmental and human health problems in 2030, and a likely increase in the Russian share of these problems, it makes sense for the Nordic countries to engage in an enhanced participation of the Russian federation in international air pollution policies.

HOW TO ESTIMATE TODAYS NUMBERS AND SCENARIOS FOR THE FUTURE

The policy development under CLRTAP has already from its start been closely connected to scientific research, monitoring, data collection and modelling. Modelling has been necessary to understand the complexity of the issues. Currently, two of the most policy-oriented (decision support) models are the EMEP/MSC-W model and the GAINS model. But many other scientific efforts and many other scientific models contribute to the process.

The EMEP/MSC-W model is is a chemical transport model that can simulate how emissions from countries disperse and are deposited over Europe. More information on the model and its open-source version is available at: http://www.emep.int.

The GAINS model is an integrated assessment model that uses a bottom-up approach for quantifying current and future air pollution emissions, abatement potentials and abatement costs for the countries in the UN-ECE region.

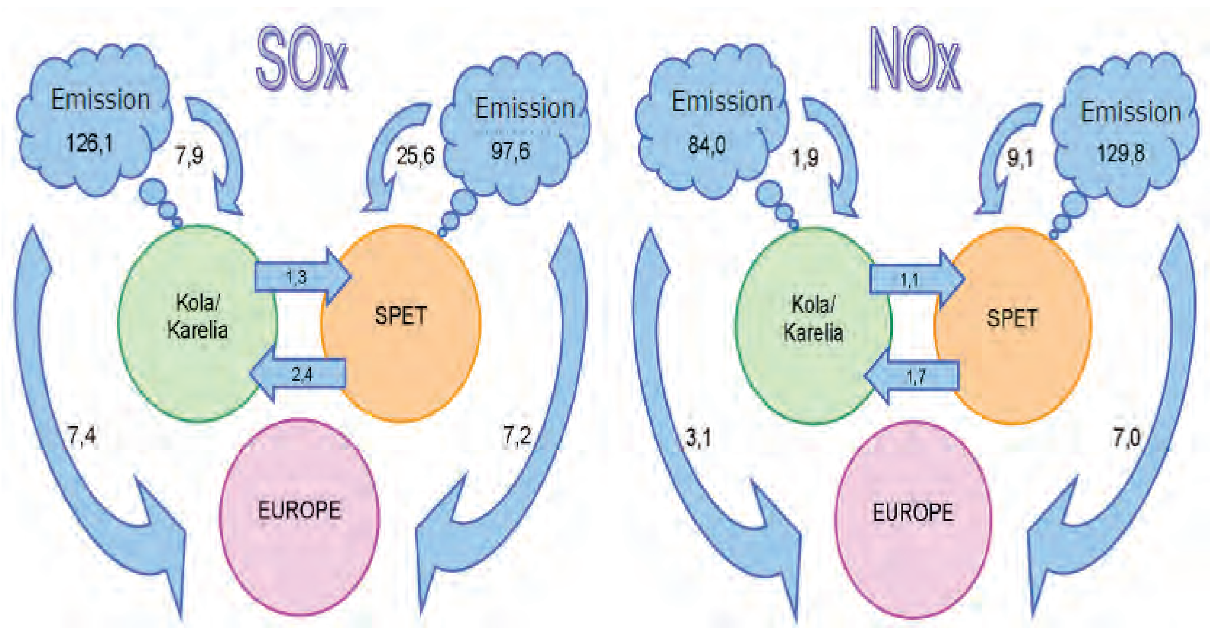

Figure 2. 2005 SO_x and NO_x emission dispersion from the previous version of GAINS Europe regions KOLK and SPET. Dispersion calculated with the open source EMEP/MSC-W model (kton)

More information about the model and the online versions of the model is available at: http://www.iiasa.ac.at/web/home/research/researchPrograms/GAINS.en.html.

IMPORTANT OUTPUTS FROM THE NORDIC RUSSIAN CO-OPERATION

Air pollution budgets for Russia (based on the EMEP/MSC-W model)

As an example of what can be done with the EMEP/MSC-W model, the project group calculated the transfer of air pollution between two Russian regions (Kola/Karelia & SPET) included in the earlier version of the GAINS Russia model. Figure 2, on the previous page, presents the transfer of pollutants between the analysed regions and the EU.

Continuing the development of EMEP/MSC-W modelling capacity, the open source version of the model was for example also used to calculate sulphur transport between several administrative Russian regions (oblasts), se Figure 3.

As is seen in Figure 3, the Kola Peninsula (in orange) that borders both Finland and Norway, stands out as a very important contributor of sulphur deposition in the North-Western region of Russia. Sulphur deposition in the Nordic countries was however not calculated in this analysis.

Supporting policy decisions - Update and development of the GAINS Russia model

The earlier version of GAINS Russia divided the European part of Russia into administrative regions that are currently not optimal for policy analysis. Therefore, this version of the model was obsolete from an administrative perspective. As an effect of the activities performed in this project, the updated GAINS Russia contains regions with higher administrative relevance. The difference between the earlier and updated regionalisation is shown in Figure 4.

In order to perform integrated assessments for Russian regions the new regionalisation needed to be updated with emission transfer matrices, based on EMEP/MSC-W source-receptor calculations, in the GAINS Russia model. Such matrices are crucial for the calculation of environmental and human health impacts from air pollution emission scenarios. In this project the EMEP/MSC-W model was used to calculate emission dispersion and to develop the emission transfer matrices necessary. Figure 5 shows how emissions of SO_2, NO_x, and NH_3 from the GAINS Russia regions Volga FD and North-Western FD are dispersed and deposited. Similar calculations were performed for all considered pollutants and all considered regions.

By using the project results from the EMEP/MSC-W model, the project group could develop the GAINS Russia model to analyse environmental and human health impacts for specific Russian emission scenarios. In Figure 6 the geographical distribution of potential future health impacts caused by Russian emissions is shown. These health impacts are expressed as premature deaths from long-term exposure of fine particulate matter in the Russian federation. The same results are also shown in Table 1.

As can be seen in Table 1, the region including Moscow can in this scenario actually expect to increase the adverse health impacts caused by air pollution by 2030 due to increase in emissions. When including emissions from all European countries, as is done in the GAINS Europe model, the average loss in life expectancy in the European part of Russia will stay more or less constant at 7 months for the same scenario (2010, 2020, and

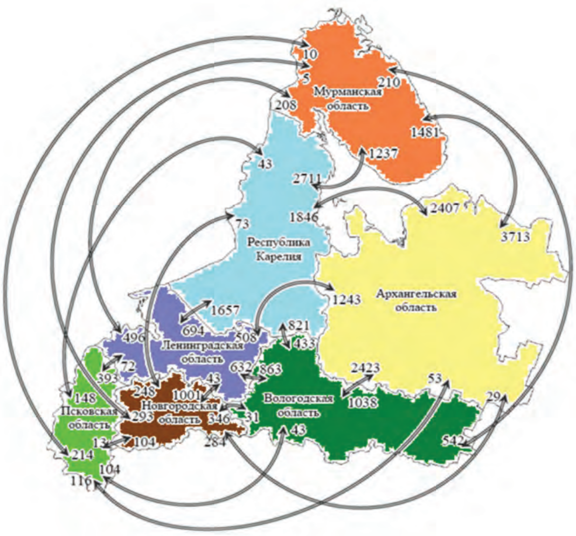

Figure 3. 2008 Sulphur emission dispersion between North-Western Russian oblasts of the Russian Federation (ton S). Dispersion calculated with the open source EMEP/MSC-W model.

Regions in European Russia:
Earlier GAINS Russia

Regions in European Russia:
Updated GAINS Russia

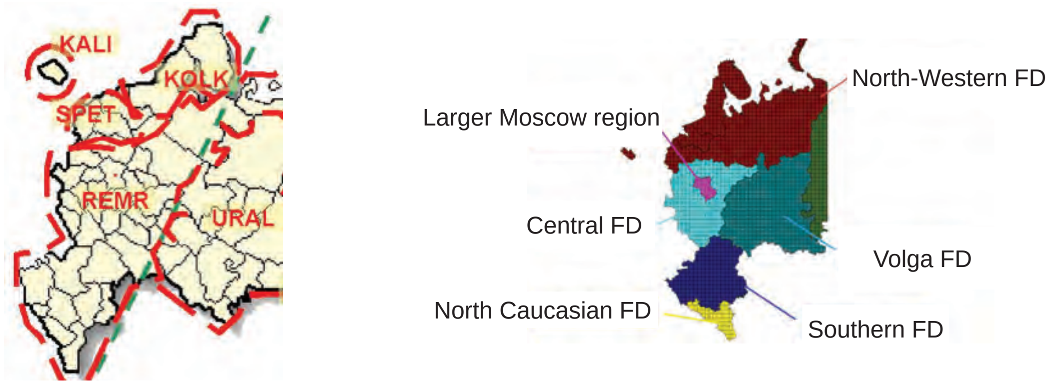

Figure 4. Geographical region of the old and new GAINS Russia.

2030). The Nordic countries can for the same time period expect a decreased loss in life expectancy in the range of 20 - 33 per cent.

Basically, Russia is expected to miss out on a large improvement in human health if no action is taken.

Policy analysis

So what can be done to reverse the projected trend of deteriorating air quality, and what will it cost the European Russian regions? In order to get an idea on policy options and costs, the project group made an analysis based on the latest indicated policy ambition from the Russian Federation.

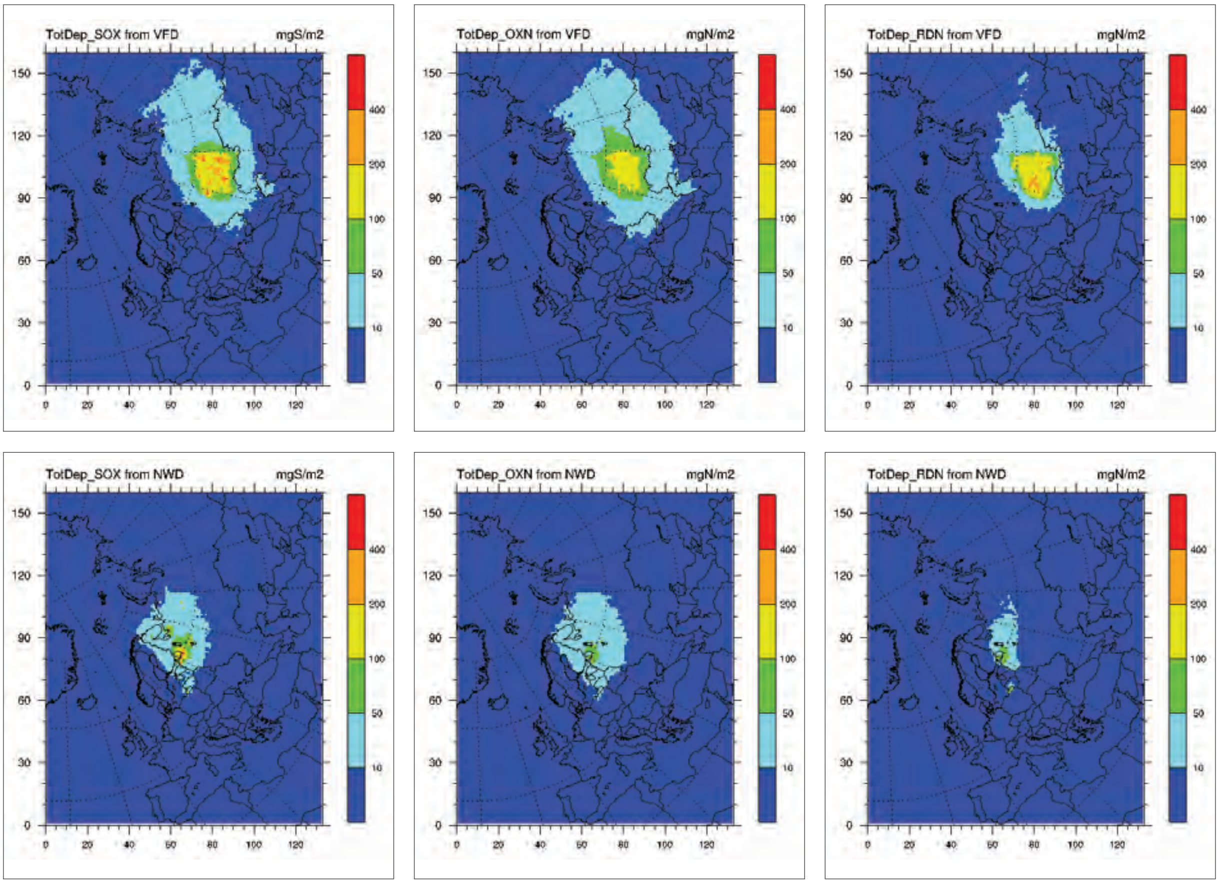

Figure 5. Deposition patterns of SO_2, NO_x, and NH_3 emissions from the regions Volga FD and North-Western FD.

	2010	2020	2030
Larger Moscow region	4	4	5
Northern Caucasian FD	3	3	3
North-western FD	2	3	3
Central FD	2	2	2
Southern FD	3	3	3
Volga FD	3	3	3
Total	3	3	3

Table 1. Average loss in life expectancy for population over 30 years of age (months/cap) calculated with GAINS Russia. (GAINS model Scenario: PRIMES_BL2010_REF_Dec11)

In 2012, the Russian Federation indicated that it would analyse the possibility to reduce the 2005 air pollution emissions levels with 5 per cent by 2020 for the European part of Russia. In this project, using the new GAINS Russia model, and data for the year 2010 as an approximation of emission levels in 2005, the project group analysed cost effectiveness of abatement measures in selected sectors for some of the Russian regions in Europe 2020. The result from one of these analyses is shown in Table 2.

The results showed that it would be more cost effective for the North-Western Federal District of the Russian Federation to invest in NO_x –emission reducing technologies in power plants than in industry (~400 €/ton NO_x vs. ~1050 €/ton NO_x). Furthermore, the use of low sulphur fuel in industries would be sufficient and cost efficient in order to reach an SO_2 emission reduction of 5 per cent for that sector (~65€/ton SO_2 vs. ~80€/ton SO_2 for desulphurisation of flue gases). Similar calculations were performed for some of the other regions represented in GAINS Russia.

It is however important to stress that the GAINS Russia model contains a database with emission abatement measures that would enable analysis of much larger emission reductions. These emission abatement measures were used in calculations for the latest EU air pollution policy report by IIASA. In the IIASA report, the central policy scenario

	NO_x		SO_2					
Emission reduction technology	Improvement of combustion technologies and selective catalytic reduction		Desulphurisation of flue gases		Use of low sulphur fuel		Lime Injection	
Sector	Reduction, kiloton (kton)	Cost. mill. €/year	Reduction, kton	Cost. mill. €/year	Reduction, kton	Cost. mill. €/year	Reduction, kton	Cost. mill. €/year
Power industry (new and existing power plants)	7.15 (5%)	2.9					18.6 (5%)	2.4
Fuel combustion in industry	2.85 (5%)	3.0	11.05 (5%)	0.9	11.05 (5%)	0.7		

Table 2. Selected emission abatement options that would have achieved a sector-specific 5% reduction of emissions compared to 2005 levels of NO_x and SO_2 in the North-western Federal District and associated abatement costs, 2020.

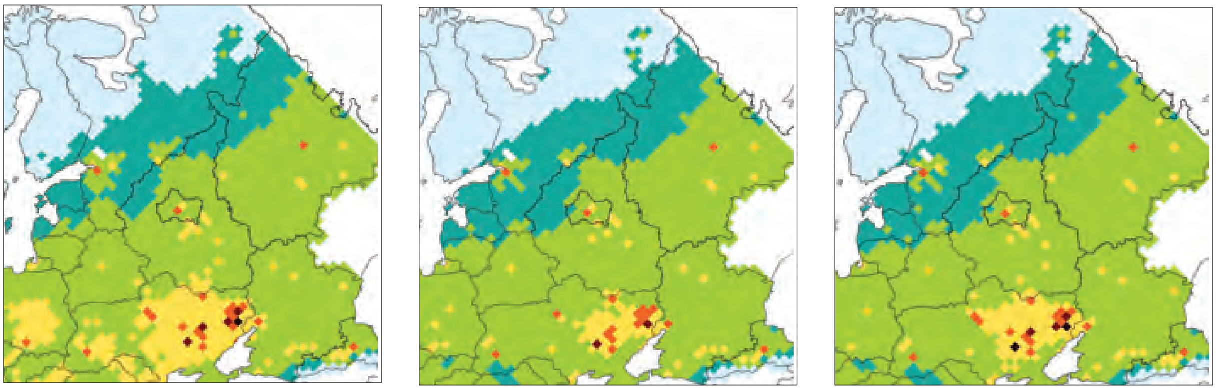

Figure 6. Average loss in life expectancy for population over 30 years of age, geographical distribution (GAINS Model Scenario: PRIMES_BL2010_REF_Dec11)

calculates EU emission reductions of SO_2: 77 per cent; NO_x: 65 per cent: $PM_{2.5}$: 50 per cent; NH_3: 27 per cent; and NMVOC: 54 per cent; relative to 2005. These reductions (some of which are already planned) are achieved by implementation of a number of cost effective abatement measures represented in the GAINS model.

WHAT CAPACITY CAN BE ACHIEVED WITH SOME EFFORT?

As a result of the mentioned efforts the European scientific network that works with air pollution has been expanded to also actively include Russian scientists. This expansion has enabled capacity building and fruitful communication between experts, policy makers and stakeholders. Occasional cultural misunderstandings in the communication between project partners at the very earliest stage of the co-operation are overcome and project activities could after the initial phase be performed efficiently. Russian experts are now regular participants and presenters at several scientific meetings. These experts also communicate scientific results to Russian stakeholders and policy makers (see info box) and are thus contributing with scientific support to the Russian authorities.

TRAINING SESSIONS, WORKSHOPS, AND COMMUNICATION EFFORTS

March 2010 – EMEP/MSC-W model training
June 2011 – GAINS model scenario analysis workshop

Project communication:
May 2010 - Project presentation at CLRTAP TFIAM 38
Nov. 2010 – Presentation of project interim results at the Russian Ministry of Environment
Feb. 2011 - Project presentation at CLRTAP TFIAM 39
March 2011 – Project presentation at the scientific conference Atmosphere 2011
May 2011 - Project presentation at CLRTAP TFIAM 40
April 2012 – Project seminar at Atmosphere 2012
May 2012 - Project presentation at CLRTAP TFIAM 41
Sept. 2012 – Project report to CLRTAP EMEP Steering Body
April 2013 - Presentation of project final results at the Russian Ministry of Environment
April 2013 - Project presentation at CLRTAP TFIAM 42

POLICY IMPLICATIONS AND RECOMMENDATIONS

So what does this mean for the development of international air pollution policy? This and earlier projects have provided the Russian Federation with deepened understanding and competence in EMEP/MSC-W and GAINS modelling. From a Nordic perspective it implies that negotiators now can push towards higher emission control ambitions during communications with Russian counterparts. Russian domestic efforts to improve the Russian emission inventory submitted to the EMEP/CLRTAP, and to analyse policies, such as the ambition levels of the revised Gothenburg protocol should be encouraged. The established Russian capacity and results from the scenario analysis could even be taken one step further; involving that Nordic stakeholders should encourage their environmental, energy, and industry ministries to include the issue of air pollution during discussions with their Russian counterparts. Even though the issue of air pollution has gained increased attention more efforts are needed in order to bring the question high enough on the agenda for actions to be taken.

FUTURE OPTIONS

This project has expanded the analytical capability of air quality experts in the Russian Federation, but further development would be beneficial. Still there is need for continued GAINS Russia development, especially for the emission control database and the impact analysis features. It is also important to continue research on the development of regional emission scenarios for the energy, industry, transport and agricultural sectors in the Russian Federation. Factors that may significantly shift emission levels and emission patterns in the future are the continued economic growth, and the possible increase in shipping in the Northeast Passage.

Furthermore, from a policy perspective it is also important to develop routines for an administrative pathway between federal and regional authorities that are currently working relatively independent with air pollution issues. This requires continued sharing of information on regional impacts within Russia, and the interdependency of regions. From a more scientific perspective, possible challenges involve research enabling analysis of cost effective reduction of short lived climate pollutants in the Russian Federation and impacts on the Arctic region, as well as analysis of co-benefits between Russian air pollution and climate change policies. Analysis of ozone damages can also be of interest.

Project conclusions

Several different types of results have been achieved during the course of the project. The results range from specific EMEP/MSC-W modelling efforts to specific GAINS model scenario analysis.

The results connect nicely to each other and are examples of how

- the Russian Federation has gained competence in EMEP/MSC-W modelling
- how the GAINS Russia model, with the help of EMEP/MSC-W source-receptor modelling, has been updated and developed to include almost all the features of the GAINS Europe model
- the Russian Federation now has the capacity to perform data inventory and scenario analysis on how cost effective air pollution abatement strategies affect emissions, emission abatement costs, and environmental and human health impacts.

Several issues still remain, such as data inconsistencies between international estimates from the International Energy Agency and the regional fuel consumption estimates delivered by Russian regional administrations. This inconsistency motivates a regular process for data collection and updating of model input parameters. Another issue is the need for continuous development of the GAINS Russia model, which is natural for such a complex modelling system as the GAINS model.

The model still needs additional efforts in form of consistency checks and functionality checks etc. These issues are by no means exclusive for the Russian Federation but apply for all countries and regions that perform research in this area. Data inventories, modelling checks and updates are always on-going activities.

Today, the Russian Federation can perform studies with the GAINS Russia model on air pollution policy options and analyse the region-specific and intra-regional impacts on emissions, acidification, eutrophication, human health, as well as emission abatement costs for the European regions. This provides Russian authorities with a useful decision support tool. So the efforts spent on co-operation activities between Nordic countries and the Russian Federation in the field of air pollution can be considered successful.

GLOSSARY

Term	Explanation
Atmosphere	Explanation Annual Russian air pollution research conference
CLRTAP	1979 Convention on Long Range Transboundary Pollution
EMEP/MSC-W model	The chemical transport model developed at the CLRTAP Meteorological Synthesizing Centre - West (MSC-W) hosted by met.no (MetNorway), under the auspices of the Co-operative programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe, financed in accordance with the 1984 Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP protocol)
GAINS model	Greenhouse Gas - Air Pollution Interaction and Synergies model, developed and maintained by IIASA
Gothenburg Protocol	CLRTAP 1999 Gothenburg protocol to abate Acidification, Eutrophication, and ground level ozone
IIASA	International Institute for Applied System Analysis
NH_3	Ammonia
NO_x	Nitrous oxides (NO and NO_2)
$PM_{2.5}$	Fine particulate matter with a diameter of 2.5 micrometre or smaller
SO_2	Sulphur dioxide
SO_x	Sulphur oxides (SO_2, SO_4^{2-})
TFIAM	CLRTAP Task Force on Integrated Assessment Modelling
UN-ECE	United Nations Economic Commission for Europe

FURTHER READING

A more thorough presentation of project activities, methods, and results is found in the report Åström S., et al., 2013, Capacity building on decision support for air pollution policies – results from Nordic-Russian co-operation, IVL report B2131 (forthcoming, will be available at: http://www.ivl.se/english/startpage/publications.4.4a08c3cb1291c3aa80e80001357.html)

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