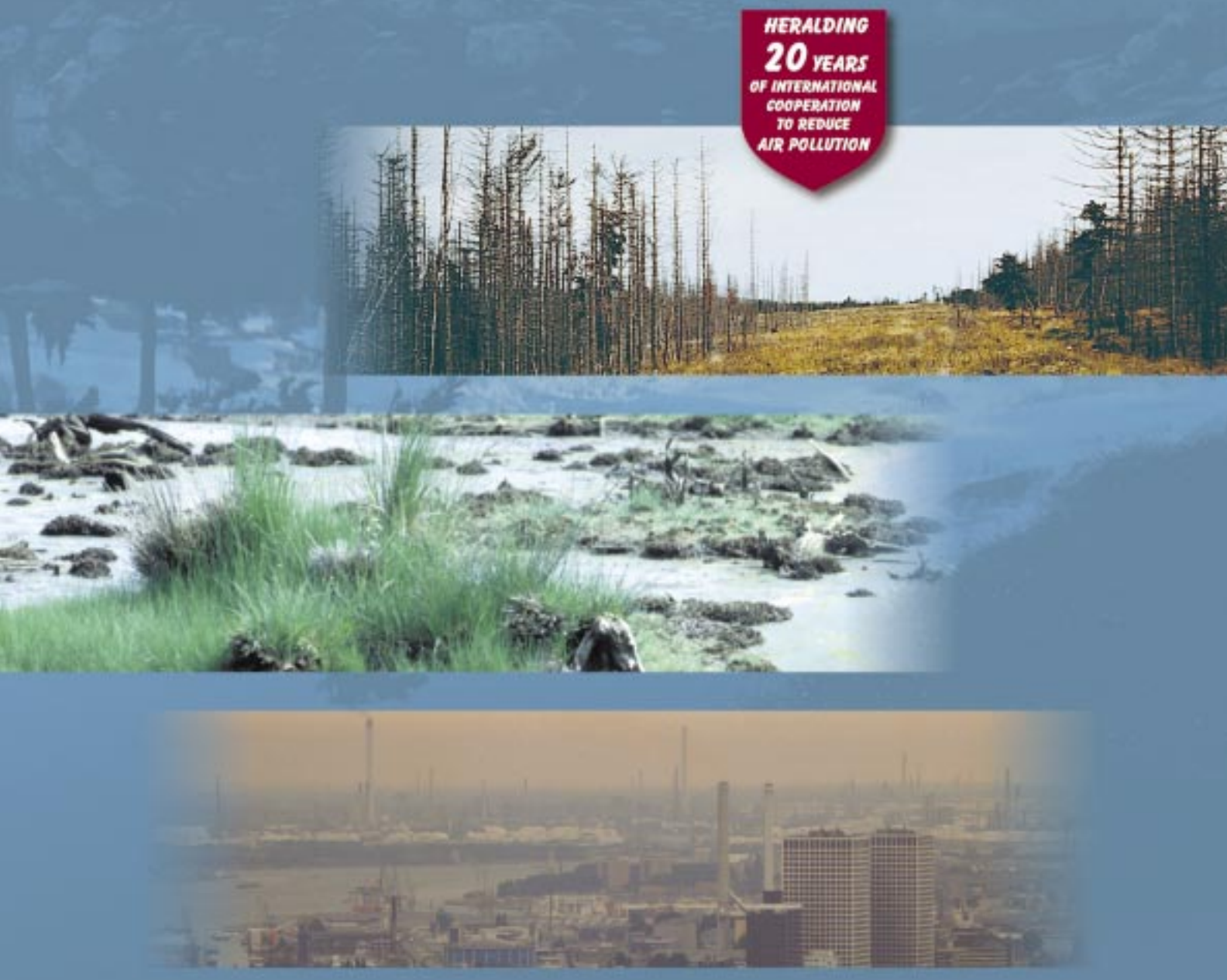
Protocol to Abate Acidification, Eutrophication and Ground-level Ozone



UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

The Convention on Long-range Transboundary Air Pollution

Making a Difference

In its first 20 years, the Convention on Long-range Transboundary Air Pollution has broken new ground in environmental law-making. It has paved the way for extensive and fruitful cooperation among 44 nations in the United Nations Economic Commission for Europe (UN/ECE) region to meet specific environmental targets. It has delivered legally binding protocols covering those air pollutants having the greatest impact on the environment and public health. **Most importantly, it has brought about tangible results in reducing emissions and improving the health of the environment.** Its focus is clearly regional, yet the Convention sets an example for other regions and for global action.

The Convention has helped to reduce sulphur emissions by more than 50% in Europe

The Convention's trade marks have been

- *The close interplay between science and policy:* Policy development builds on a sound scientific foundation generated by an international network of experts from all relevant scientific disciplines, and on region-wide environmental monitoring.
- *Its flexible and innovative approach to setting commitments:* Building on new advances in science, it has introduced the critical loads approach, integrated assessment and new risk assessment procedures. An advanced compliance regime has been designed to ensure effective implementation.
- *Its focus and productivity:* Since coming into force in 1983, the Convention has generated eight protocols.

The secret behind the Convention's remarkable achievements lies both in the flexible framework which it provides for Parties to take new initiatives and join forces to solve common environmental and health problems and in the broad political backing it has enjoyed. The Convention's success is also due to its non-bureaucratic mode of operation, its effective secretariat and its extensive network of skilled and dedicated scientists and experts; in short, the Convention machinery enjoys a unique spirit of cooperation.

The Convention is flexible in accommodating the situations and initiatives of its Parties

The Protocol to Abate Acidification, Eutrophication and Ground-level Ozone is probably the most sophisticated environmental agreement so far and marks a leap forward in international law-making. It also initiates a new phase in the life of the Convention, featuring increased emphasis on implementation, compliance, review and extension of existing protocols. Two main challenges arise: Parties must resist complacency and avoid lulling themselves into the false belief that the problem of transboundary air pollution has now been solved. And, we must ensure that the scientific network is sustained with adequate financing. Meeting these challenges is essential if the Convention is to continue to fulfil its mission.

JAN THOMPSON
CHAIRMAN OF THE EXECUTIVE BODY
CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

GÖTEBORG, SWEDEN • NOVEMBER 1999

Protocol to Abate Acidification, Eutrophication and Ground-level Ozone

Introduction

This innovative multi-effect, multi-pollutant Protocol is the eighth protocol to the Convention on Long-range Transboundary Air Pollution and is the most sophisticated to date. The Protocol will simultaneously address acidification, eutrophication and ground-level ozone, which continue to have serious effects throughout the United Nations Economic Commission for Europe (UN/ECE) region. It promotes action within the region and sets an example for action worldwide.

This brochure introduces the Protocol: the environmental concerns generating the need for action; the strong and innovative basis for commitments; the actual obligations; and the environmental, health and financial benefits that will arise as Parties apply it.[1] Production of this brochure was coordinated and financed by the Governments of Canada, the Netherlands and Switzerland. An Internet version is also available with direct links to other sites mentioned in this text.[2]

ACIDIFICATION

EUTROPHICATION

GROUND-LEVEL OZONE

[1] The text of the Protocol can be found at http://www.unece.org/env/lrtap
[2] Link to Internet version at http://www.unece.org/env/lrtap

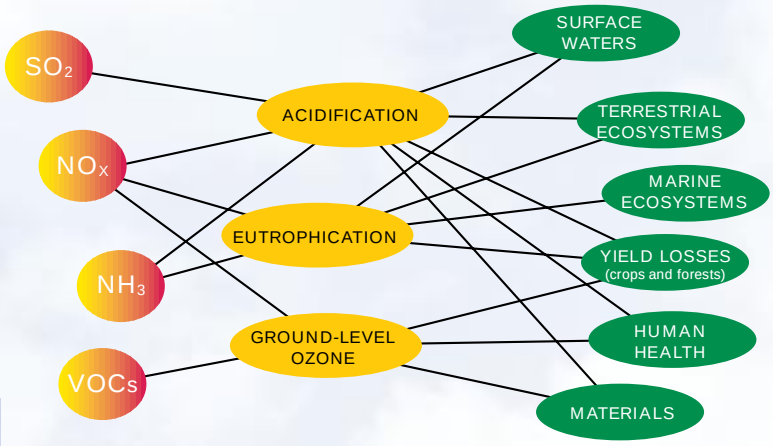
Environmental Concerns

The Protocol's Objectives

Driving the negotiation of this Protocol were serious concerns about the environmental and human health effects of air pollution from energy generation, industrial sources, motor vehicles and agriculture.

Acidification continues to affect fish populations and forest soils in sensitive areas of Europe and North America and to cause corrosion of buildings and monuments. Sulphur (SO_2) and nitrogen oxides (NO_X) have been identified as the main culprits, and ammonia (NH_3) from agricultural activities adds to the problem.

In sensitive areas, high levels of nitrogen deposition from nitrogen oxide and ammonia emissions result in **eutrophication**. The increase of this plant nutrient in natural ecosystems causes some plant species to grow excessively and others to disappear. In coastal and inland waters, blooms of algae deplete oxygen, affecting plants, fish and other life forms – and often these algae are toxic to animals and humans. Excess nitrogen deposition directly increases nitrate concentrations in groundwater normally used for drinking and also causes nitrogen to leach from soils, increasing the acidification of surface and ground waters.

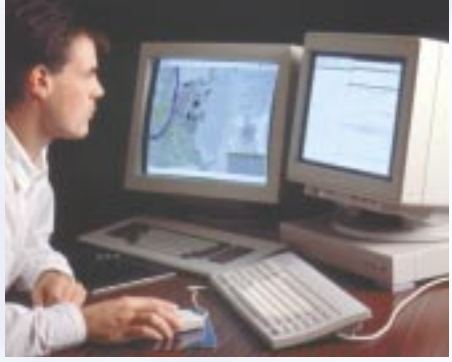


Industrial and motor vehicle emissions have increased **ground-level ozone** — a key component of summer smog — to levels three to four times those of the pre-industrial era. This pollutant, formed from a mixture of nitrogen oxides and volatile organic compounds (VOCs), has significant effects on human health and vegetation. Ground-level ozone in both Europe and North America affects lung function, particularly in children and asthmatics, either from short-term exposure to high ozone levels or from longer exposure to lower levels. Ozone also causes leaf injury in plants, including crops and trees, significantly reducing plant growth and crop yield, and causes some materials — particularly organic materials such as paints and rubber — to disintegrate.

Finally, the pollutants targeted by the Protocol also form **particulate matter**, which has a very serious impact on public health, causing severe respiratory problems.

That the same pollutants are clearly contributing to different adverse environmental and health effects emphasizes the need for an integrated approach to addressing these concerns.

Modelling for the Protocol was carried out at the International Institute for Applied Systems Analysis (IIASA) in Austria.



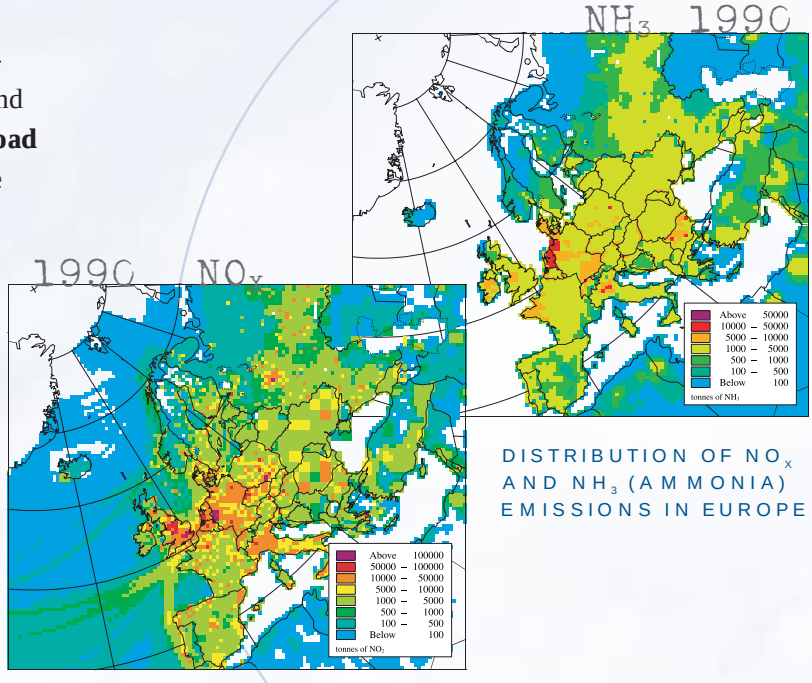
The Scientific Foundation

An Innovative and Effective Approach

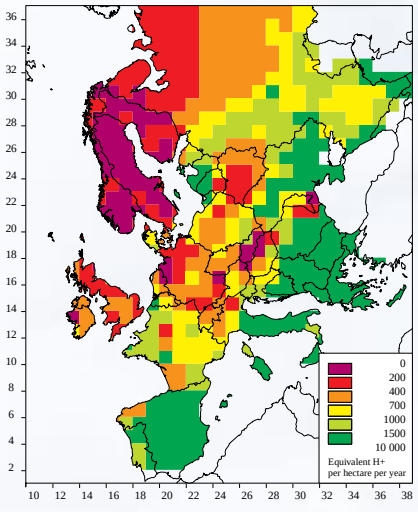
The aim of the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone is to cut emissions of sulphur, nitrogen oxides, volatile organic compounds and ammonia, in a cost-effective way, to prevent adverse environmental and health effects. In **Europe**, a model based on the effect of each country's emissions and the costs of emission reduction measures guided the negotiation of emission reductions for each European Party.

The sensitivity of different ecosystems was a key factor in the modelling exercise, given the long-term goal of the Protocol to protect ecosystems from pollution. The critical load — the maximum amount of deposition an ecosystem can receive in the long term without significant damage — varies considerably from one region to another according to soil and other conditions. **Under this Protocol, critical load maps were drawn up for the whole of Europe by the Convention's Working Group on Effects**.

The link between a country's emissions and the resulting environmental problem was also taken into consideration. In the case of acid deposition, the emissions from some countries may be deposited in areas with little or no deposition above the critical load. Countries in this situation will have to make relatively small emission cuts. Conversely, countries that contribute significantly to deposition exceeding critical loads will have to make larger cuts. **The European monitoring and evaluation programme (EMEP) developed acid deposition patterns for each country's emissions, using atmospheric dispersion models and information from its extensive measurement network.**[3] Eutrophication effects on ecosystems and ground-level ozone effects on both human health and vegetation were assessed in a similar manner.



DISTRIBUTION OF NO_x AND NH_3 (AMMONIA) EMISSIONS IN EUROPE



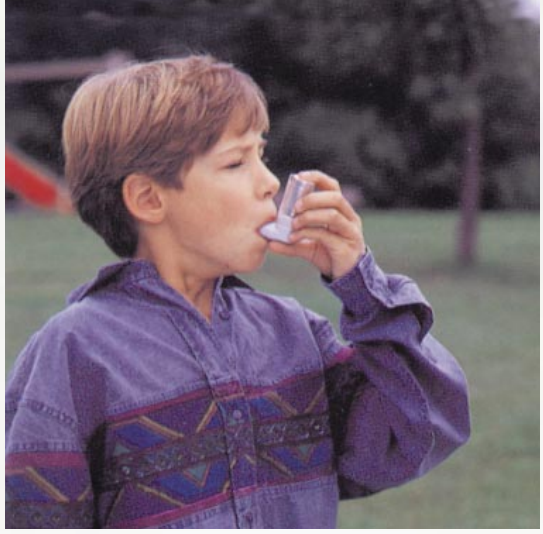
CRITICAL LOAD MAP FOR ACIDITY

This map shows the maximum level of acidity an area can receive in the long term without significant damage.

[3] See: http://www.emep.int

Finally, costs were incorporated into the modelling. Where, for example, two countries contribute equally to excess deposition but the cost of taking action is much lower in one than in the other, the country with the lower cost will have to make greater emission cuts.

The process of combining all this information (critical loads, deposition patterns, abatement costs) to estimate the emission reductions required of each country is called "integrated assessment." In practice, this is done by a mathematical model that, depending on how ambitious countries wish to be in reducing excess deposition, estimates the national emission reductions that would fulfil the "ambition level" and gives the lowest costs for all the countries taken together.[4]

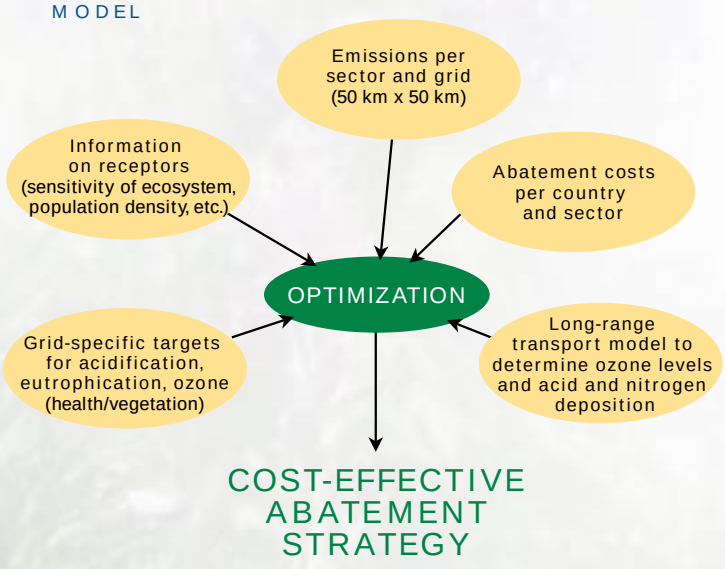


Ground-level ozone affects lung function, particularly in children and asthmatics. Child using an inhaler to control asthma symptoms.

It must be noted that while the model results strongly guided the negotiations, the commitments made by Parties were also influenced by domestic considerations.

As **North America** is not covered by EMEP activities, it was not included in the above modelling exercise. Canada and the United States tailored their commitments to the North American context, consistent with the Convention's flexible approach.

THE INTEGRATED ASSESSMENT MODEL



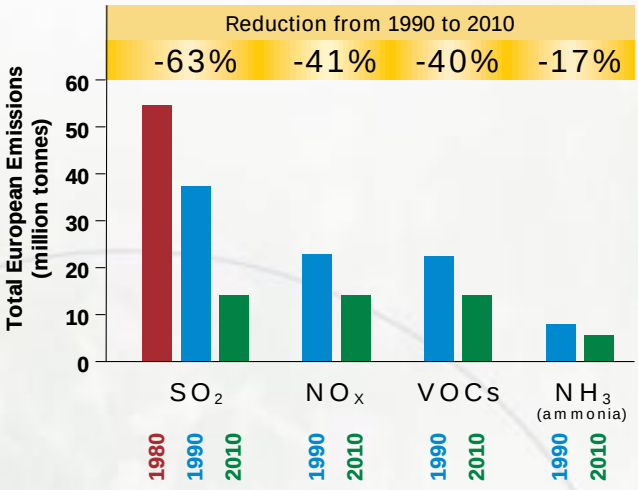
[4] More information on the Regional Air Pollution Information and Simulation (RAINS) model can be found at http://www.iiasa.ac.at/~rains/

Protocol Obligations

Obligations for Europe

The Protocol's main feature is mandatory emission ceilings for SO_2, NO_X, VOCs and ammonia to be met by the year 2010. Meeting the targets will require significant emission reductions in many countries — some by as much as 90%. The few countries whose emissions cause little damage will be required to stabilize their emissions.

EMISSION REDUCTIONS FOR EUROPE



NOTE: Numbers for individual Parties can be found in annex II to the Protocol.

In addition to these mandatory overall emission ceilings, the Protocol contains obligations pertaining to the specific sources of the emissions.

For certain **new stationary and mobile sources** Parties are required to apply limit values that set the maximum amount of a pollutant that may be emitted from a specific source. Stationary sources include large combustion plants, electricity production and industrial processes such as metal production and dry cleaning. Parties must also apply limit values to existing stationary sources where technically and economically feasible. For both new and existing stationary sources Parties may apply strategies other than limit values, provided that they achieve equivalent overall results in reducing emissions. Parties have also stated that best available techniques (BAT) should be used in new and **existing stationary** and **mobile sources**, taking into consideration the measures outlined in guidance documents.

A further obligation requires Parties to take measures where appropriate to reduce emissions of VOCs associated with the use of **products** such as paints, protective coatings and aerosols. Parties have agreed to consider stronger commitments in future and to use agreed-upon criteria in selecting products for control.

Soybean leaf damaged by exposure to ozone.

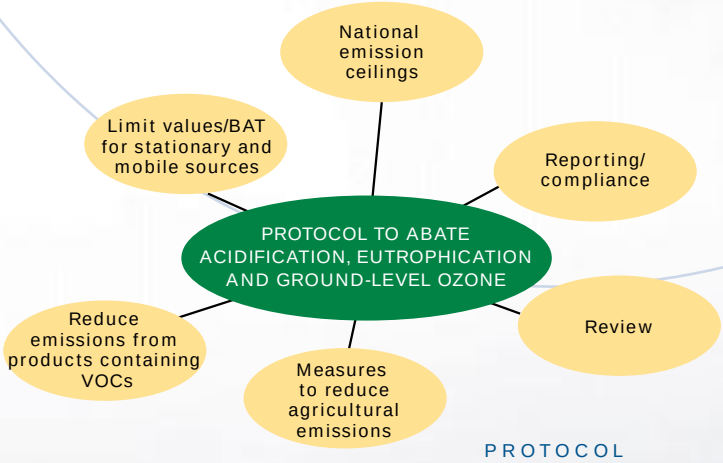
MANURE INJECTION

Directly injecting manure into fields reduces the ammonia emissions.

In addition to these specific obligations, as with all protocols, individual Parties will be required to **report** on how they are applying this multi-effect, multi-pollutant Protocol, and that information will be used by the Implementation Committee to assess whether Parties are complying with their obligations.

Parties will regularly **review** progress under the Protocol and assess whether the region is on track to meeting its long-term environmental and health goals. **The review process may lead to further negotiations and revisions to the Protocol to ensure that its objectives are reached.**

Finally, the Protocol requires Parties to take measures to control ammonia emissions from agriculture — making this the first Protocol to the Convention to address the **agricultural** sector. For example, large pig and poultry farms will be required to control ammonia emissions from animal housing and manure storage and application.



PROTOCOL OBLIGATIONS

Link with the Climate Change Convention

As both this Protocol and the United Nations Framework Convention on Climate Change deal with health and environmental impacts caused by emissions related to energy use, they will reinforce each other — in both effects on the environment and savings in implementation costs. Measures taken to reduce the use of fossil fuels to meet climate change commitments will reduce emissions of sulphur, nitrogen oxides and volatile organic compounds, making it easier to meet commitments under this Protocol. Conversely, measures taken to reduce emissions under this Protocol will reduce emissions of carbon dioxide.[5]

[5] Further information on the Framework Convention on Climate Change can be found at http://www.unfccc.de

Protocol Obligations

Obligations for North America

In North America, major initiatives to be finalized over the next couple of years will address the transboundary problems of ground-level ozone and acidification. To accommodate the timing of these initiatives, Canada and the United States will bring their emission reduction commitments into the Protocol when they ratify it.

In April 1999, Canada and the United States announced their intention to complete negotiation — in the year 2000 — of an ozone annex to the 1991 Canada–United States Air Quality Agreement. Both countries intend to negotiate emission reductions for NO_X and VOCs in areas contributing to transboundary pollution.

Major domestic initiatives are also ongoing in each country. In Canada, the federal and provincial governments are working to establish a new Canada-wide Standard for ground-level ozone and implementation plans to achieve the standard. This will result in substantial NO_X and VOC emission reductions. In the United States, the Clean Air Act requires the continued development and implementation of an aggressive regulatory programme for stationary and mobile sources. The United States will continue to strongly pursue regional and local programmes to reduce pollutants that cause ground-level ozone pollution.

The Canada-Wide Acid Rain Strategy for Post-2000 is intended to be the next step towards achieving critical loads for sulphate deposition in Canada and will include negotiation of new sulphur emission ceilings. In the United States, sulphur commitments under the Protocol will be based on the requirements of the Clean Air Act, which include reducing annual sulphur dioxide emissions from electric utilities to one-half of 1980 levels and achieving a permanent national cap on these emissions by 2010. A new annual standard for fine particulates and a regulation to substantially improve visibility are also expected to require additional reductions in sulphur dioxide emissions.

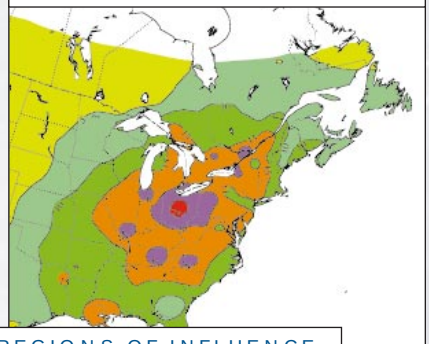
The Protocol does not include any ammonia-related obligations for Canada and the United States as there is no evidence that eutrophication is an issue of transboundary concern in North America.

TRANSBOUNDARY AIR POLLUTION IN NORTH AMERICA

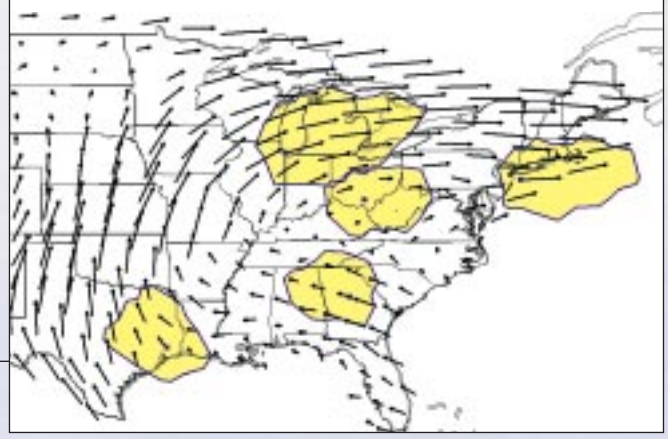
There is clear scientific evidence that both ground-level ozone and acidification are transboundary issues in North America. The windflow patterns shown below contribute to the widespread regional ground-level ozone episodes that are common in eastern North America.[6]

Transboundary transport of acid precipitation is also very significant. About half of the acid precipitation that falls in eastern Canada originates in the United States, while about 6% of acid deposition in the eastern United States originates in Canada.[7]

WET SULPHATE DEPOSITION
(1995) Kilograms per hectare per year



WIND VECTORS AND REGIONS OF INFLUENCE ON HIGH OZONE DAYS



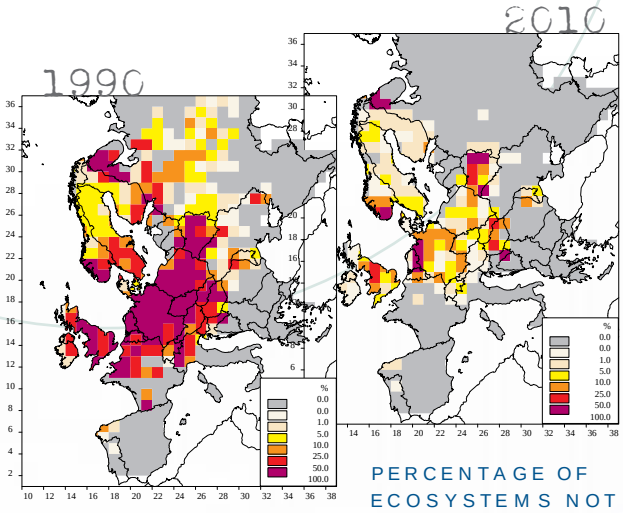
6 http://www.ec.gc.ca/smog/transport/cda_us99.htm *or* http://www.epa.gov/oar/oaqps/publicat.html#uscanaq

7 http://www.ec.gc.ca/special/airqual.htm *or* http://www.epa.gov/acidrain/lawsregs/airus.pdf

Taking Action

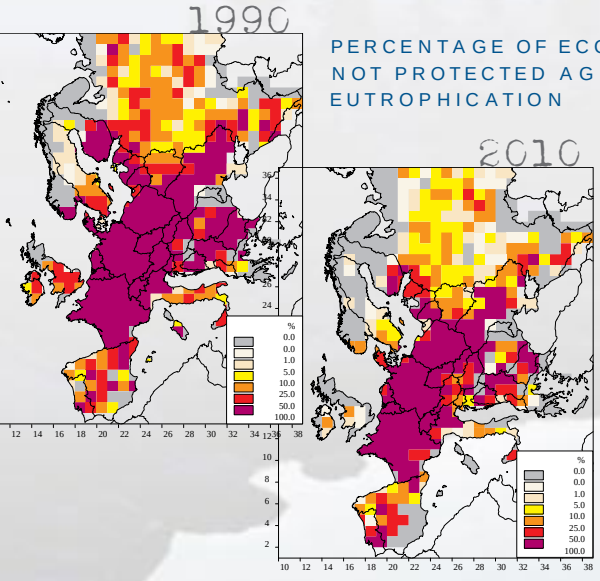
What the Protocol Will Achieve

The Protocol is a major step forward in protecting the quality of the environment and human health in the UN/ECE region. **The major improvements brought about by meeting the Protocol obligations are illustrated in the following maps.**



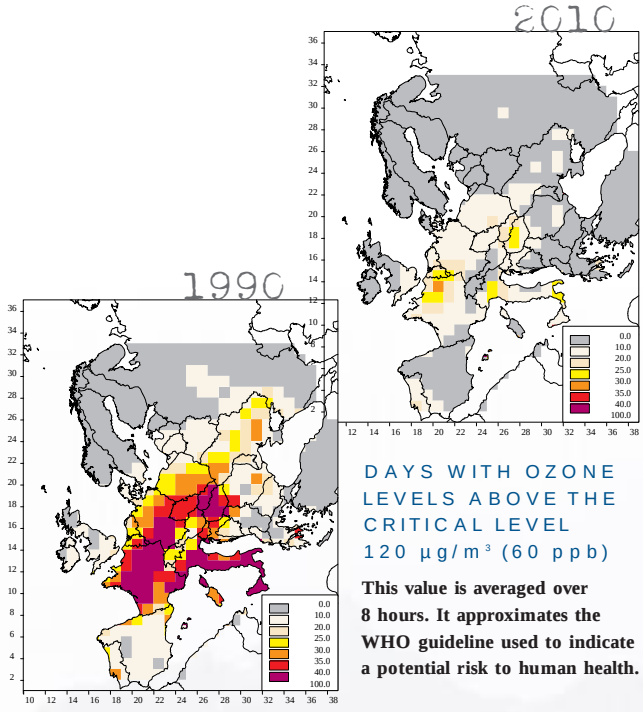
PERCENTAGE OF ECOSYSTEMS NOT PROTECTED AGAINST ACIDIFICATION

The area in Europe where the critical loads for acidification are exceeded will drop from 93 million hectares in 1990 to 15 million hectares in 2010.



PERCENTAGE OF ECOSYSTEMS NOT PROTECTED AGAINST EUTROPHICATION

The area in Europe where the critical loads for eutrophication are exceeded will fall from 165 million hectares in 1990 to 108 million hectares in 2010.



DAYS WITH OZONE LEVELS ABOVE THE CRITICAL LEVEL 120 µg/m³ (60 ppb)

This value is averaged over 8 hours. It approximates the WHO guideline used to indicate a potential risk to human health.

The number of days when ozone exceeds the critical level — the concentration above which human health may be adversely affected — will be reduced by 52%. **Consequently, it is estimated that life-years lost as a result of the chronic effects of ozone exposure will drop by about 2,300,000 between 1990 and 2010, and there will be approximately 47,500 fewer premature deaths resulting from ozone and particulate matter in the air.**

The exposure of vegetation to ozone levels exceeding the critical level will be 44% lower than it was in 1990.

Canada and the United States expect significant health and environmental benefits from the implementation of programmes to reduce SO_2, NO_X and VOC emissions, as well as from the ozone annex being negotiated under the Canada–United States Air Quality Agreement.

Costs and Benefits

The analysis carried out for the Protocol shows that its benefits far outweigh its cost — probably by a factor of three or more.

The total **cost** of reaching the emission ceilings is expected to be about 70 billion euros (US$ 75 billion) a year for Europe as a whole. This includes the cost of several other European initiatives that will contribute to meeting the emission ceilings, such as the European Union directives on emissions from cars and trucks. Although the cost appears high, it amounts to only about 100 euros (US$ 107) per European per year. Furthermore, it is likely overestimated because the calculations focus on the application of technological, "end-of-pipe" control measures, for instance catalytic converters on cars. These not only tend to be more expensive than structural measures, such as energy-efficiency measures, but can also be expected to decrease in cost over time as technology progresses.

The **benefits** of meeting the Protocol's emission ceilings have been estimated at roughly 200 billion euros (US$ 214 billion) a year. These benefits largely result from significant reductions in the negative effects of ozone and particulate matter on human health. Other quantifiable effects include increased agricultural productivity and reduced damage to buildings and materials. In fact, the benefits may be even greater than estimated, as many benefits, such as reduced damage to ecosystems from acidification and eutrophication and to cultural objects such as historic buildings and statues, have not been calculated because of the difficulty in ascribing a monetary value to them.

Costs and Benefits of United States Programmes

The benefits of implementing the Clean Air Act — estimated to be in the trillions of dollars — far exceed the costs, which will be about US$ 25 billion per year by the year 2000. The cost of SO_2 reductions under the Acid Rain Program is estimated at US$ 1 billion to 2 billion a year when fully implemented. The health benefits from SO_2 reductions are estimated at US$ 25 billion to 40 billion a year. The NO_x reduction programme for the eastern United States, stringent motor vehicle standards and gasoline (petrol) sulphur limits related to tighter ozone and particulate matter ambient air quality standards will cost US$ 63 billion a year starting in 2003. The benefits from these initiatives are estimated to reach as high as US$ 161 billion a year.

PROTOCOL	OPEN FOR SIGNATURE	ENTRY INTO FORCE*	ENVIRONMENTAL EFFECT	NUMBER OF SIGNATURES (as of 1 Nov. 99)**	NUMBER OF RATIFICATIONS (as of 1 Nov. 99)**
Acidification, Eutrophication and Ground-level Ozone	1999		Acidification, eutrophication and ground-level ozone		
Persistent Organic Pollutants (POPs)	1998		Accumulation of POPs in the environment	36	1
Heavy Metals	1998		Accumulation of heavy metals in the environment	36	1
Further Reduction of Sulphur Emissions	1994	1998	Acidification	28	22
Volatile Organic Compounds	1991	1997	Summer smog (ground-level ozone)	23	17
Nitrogen Oxides	1988	1991	Acidification Summer smog (ground-level ozone)	25	26
Thirty Per Cent Reduction in Sulphur Emissions	1985	1987	Acidification	19	21
European monitoring and evaluation programme (EMEP)	1984	1988	Long-term financing of EMEP	22	38

** Sixteen ratifications are needed for a protocol to enter into force.*

*** Updated status can be found at http://www.unece.org/env/lrtap/conv/lrtap_s.htm*

Further information on the Convention and its protocols may be obtained from the:

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