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about Swedish policy

# ACID RAIN

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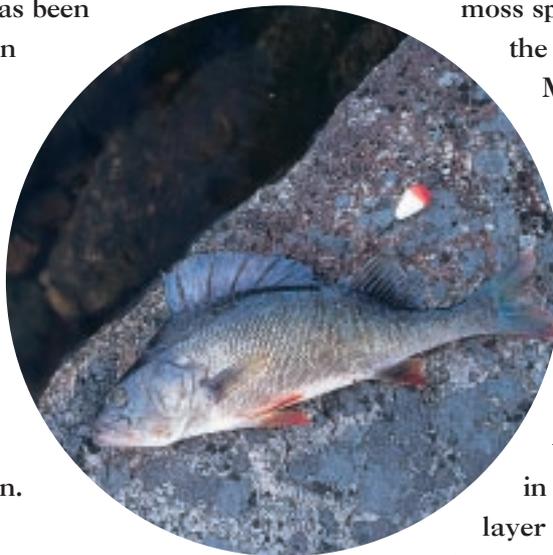
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## SWEDISH ENVIRONMENT POLICY: ACID RAIN

Acid rain harms lakes, watercourses and forest soils in Sweden and many other countries.

In order to hinder such damage European emissions of acidifying substances must be reduced by between 70 and 80 per cent. The commitments hitherto made by European countries are a step in the right direction but will not suffice to eliminate the threat of acidification.

Acidification is an important issue in Sweden and has been so for thirty years. Right from the outset the strategy has been for Sweden to clean up its own "back yard" by reducing Swedish acidifying emissions, to persuade other European countries to do the same, and to alleviate the damage caused by acidification by liming lakes. Since Sweden joined the EU, the Union has become an important forum for Sweden in the struggle to combat acidification.



### THE DAMAGE CAUSED

Deposition of acidifying air pollutants results in acidification of lakes, watercourses and soils, damage to constructions and monuments and also places our health at risk. In Scandinavia most soils are poor in limestone and are therefore more vulnerable to acidification than those in most European countries. However, the most severely acidified area is found in the "black triangle" in Central Europe.

### Lakes

Alarming reports on fish kills in lakes in western Sweden were one of the first indications that acidification was a large-scale environmental problem. A Swedish scientist, Svante Odén, studied measurements of the acidity (pH) in precipitation. He found that the rain had beco-

me eight times more acidic between the years 1962 and 1966. He concluded that the sulphur compounds causing acidification could be dispersed hundreds of kilometres from their sources. At that time it was generally thought that the problem of air pollution was best solved by using tall chimneys.

About 10,000 of Sweden's 85,000 lakes are now so acidified that sensitive organisms cannot survive in them. Worst affected is the south-western part of the country. In the most severely acidified waters, fish, snails, crustaceans, mussels and phytoplankton die out while bog moss spreads across the bottom in the acidic but clear lake water. Moreover, about 7,000 lakes are kept alive by liming.

### Forest soils

Large areas of forest soils in south-west Sweden are acidified. Soil acidification becomes particularly serious when the pH falls below 4.4 in the B-horizon (i.e., the soil layer some decimetres below the soil surface), since this allows the release of potentially toxic metals, such as aluminium.

Soil acidification means that soil chemistry processes are impaired, which eventually affects vegetation and groundwater. In southern Sweden the store of available nutrients such as potassium, calcium and magnesium in forest soils has been halved over the last 50 years. If soil acidification is allowed to continue, there is a risk of forest damage in the future.

Forestry itself has an acidifying effect on soil. Put simply, this arises because when timber is harvested it removes some of the nutrients which the roots have extracted from the soil.

Forestry methods have a great impact on acidification trends in forest soils. Deciduous trees, such as birch, acidify soils less than spruce. As far as Sweden is concerned, it may be advisable to increase the proportion of birch in coniferous forests and replace spruce with deciduous forest on vulnerable soils, although this will not

actually solve the problem of acidification.

Research has shown that it will take many decades for forest soils to return to their natural state even if acid deposition ceases completely.

## Constructions and monuments

Buildings, monuments, metal and concrete constructions, fabrics and glass are all damaged by acid substances in the air and in precipitation; power lines, telecommunication cables and water pipes corrode in acidic soil.

The ongoing erosion of monuments and facades made of limestone and sandstone is nothing less than a disaster for our European cultural heritage. Scientists long believed that granite was not affected by acid rain, but some years ago it was discovered that rock carvings were being eroded. At Tanum, located on the west coast of Sweden, a canopy has been built to protect these monuments, which have received UNESCO world heritage classification.



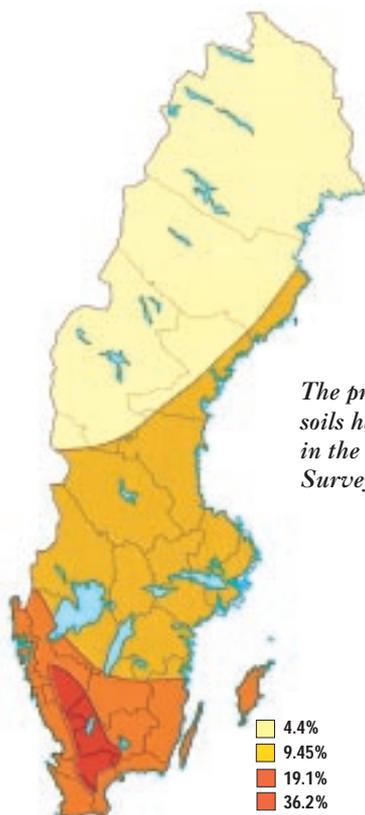
## Sources and dispersal

The burning of oil and coal are by far the main source of emissions of sulphur dioxide, which is carried by winds over long distances. Sulphur dioxide is transformed in the atmosphere and falls as sulphuric acid in rain or is deposited in gaseous or particulate form on the ground, water and on vegetation.

Almost 90 per cent of the sulphur deposition over Sweden comes from other countries, Germany, the United Kingdom and Poland being the main sources.

More than half of the nitrogen oxides originates from traffic exhaust; the remainder comes mainly from stationary combustion plants. Here too, the main sources of deposition over Sweden are in Germany and the United Kingdom.

Ammonia is another nitrogen compound which contributes to acidification of soil and water. Most ammonia derives from livestock farming. It is true that ammonia itself is basic, but when the ammonium ion reaches the soil it is converted by oxidation into nitrate, a process which is acidifying. Approximately 40 per cent of acidification caused by nitrogen compounds comes from ammonia.



*The proportion of forest soils having a pH below 4.4 in the B-horizon. Survey 1983–1987.*

## Health

In urban areas oxides of sulphur and nitrogen lead to health effects, predominantly respiratory diseases. Acidification of soil and water has resulted in the release of mercury into water. As a result, fish in thousands of lakes contain such high concentrations of mercury that they are not fit for human consumption.

Acidification also increases the concentration of aluminium in drinking water supplies. Shallow wells are particularly vulnerable.

## REDUCING EMISSIONS

### Action taken by Sweden

Ever since the late 1960s Sweden has made great efforts to reduce acidification and its effects.

Sweden banned the burning of high-sulphur oils in 1969. This was followed by a series of measures to reduce sulphur emissions, with the result that Swedish emissions of sulphur dioxide fell from 900,000 tonnes in 1970 to 69,000 tonnes in 1997, a drop of more than 90 per cent. Methods to achieve this included:

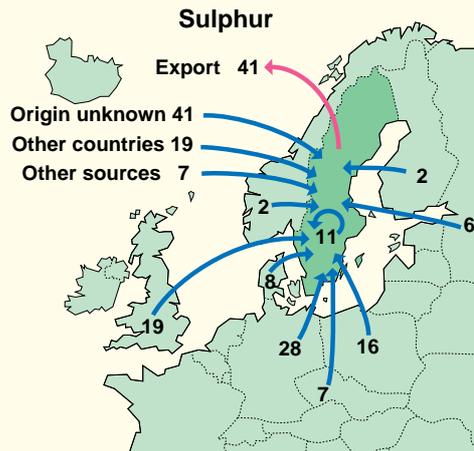
- Reducing the concentration of sulphur in oils
- Reducing the use of oil after the oil crises of 1973 and 1979
- More efficient energy use
- Increasing the use of nuclear energy, which reduced the need to use fossil fuels
- Introducing requirements for flue gas cleaning at combustion plants.

In 1991 a tax of SEK 30,000 per tonne of sulphur emitted was imposed, which has further reduced sulphur emissions.

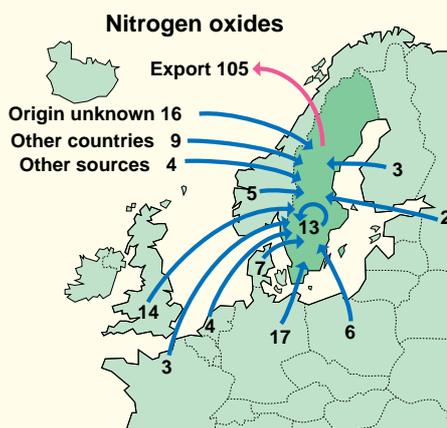
In just a few years a charge on emissions of nitrogen oxides from combustion plants has almost halved NO<sub>x</sub>-emissions from these sources.

Introduced in January 1998, an innovative system of environmentally differentiated fairway and harbour dues is expected to substantially reduce the emissions of sulphur and nitrogen oxides from ships entering Swedish ports.

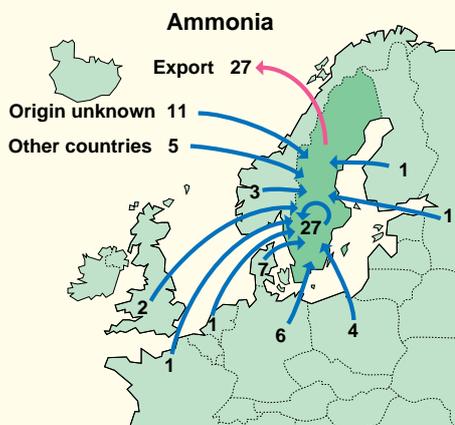
Since 1977 the Swedish Environmental Protection Agency has spent SEK 160 million on research projects intended to examine the effects of acidification on ecosystems. This concerted research programme has yielded an increasingly clear picture of the origin, dispersal and atmospheric conversion of air pollutants as well as their deposition and impact on soil and water. Swedish research into acidification has been of great significance for environmental protection, particularly in the context of the Convention on Long-Range Transboundary Air Pollution.



Sweden receives large quantities of acidifying sulphur dioxide from other countries. Figures for 1997, expressed as thousands of tonnes of sulphur. Source: EMEP Report 1/99.



The origin of deposition of nitrogen oxides over Sweden in thousands of tonnes of nitrogen. Figures for 1997. Source: EMEP Report 1/99.



The origin of deposition of ammonia over Sweden in thousands of tonnes of nitrogen. Figures for 1997. Source: EMEP Report 1/99.

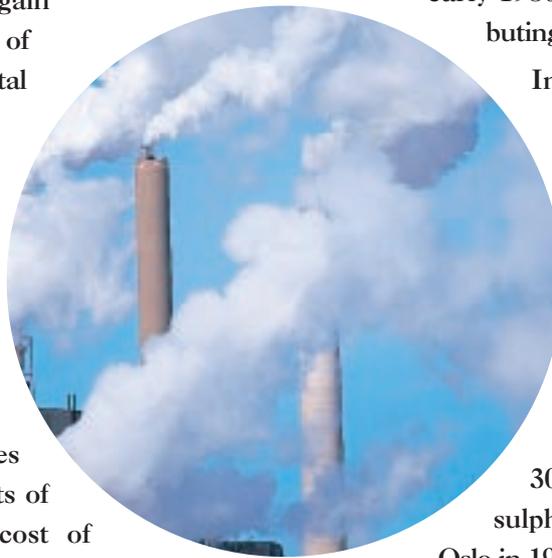
Sweden has drawn attention to the problem in a large number of international fora with a view to encouraging other countries to take action. The UN Environment Conference in Stockholm in 1972 was one important forum. The OECD, ECE, IMO, Nordic Council and, more recently, the European Union, as well as a number of other organisations have received (and are still receiving) Swedish views on acidification.

In addition, for many years the Swedish Government has allocated resources to spread information to citizens and politicians of neighbouring countries in order to gain acceptance of the seriousness of acidification as an environmental threat.

## A temporary line of defence

Since 1977 Sweden has limed some 7,000 lakes and a large number of watercourses in order to alleviate the effects of acidification. By 1998 the cost of these measures had reached approximately SEK 2,000 million.

Liming alleviates the symptoms of acidification in most water bodies and watercourses, although it may take several years before flora and fauna return to "normal".



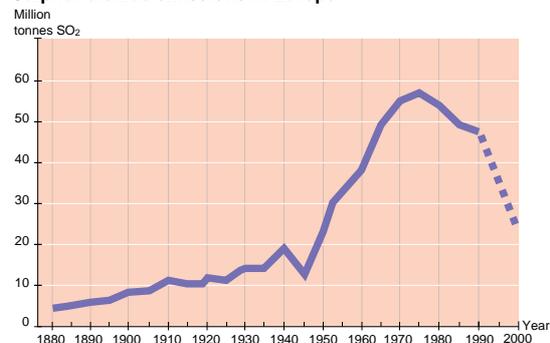
## Europe lagging behind

The time lag between discovery and action was short in Sweden but has been considerably longer in much of Europe. It was not until 1979 that the Convention on Long-Range Transboundary Air Pollution (CLRTAP) was signed. Six years later 21 states agreed on a protocol to the convention in which they made a commitment to reduce their emissions of sulphur by at least 30 per cent between 1980 and 1993. The extensive forest damage which became focus of attention in Germany in the early 1980s was a major factor contributing to agreement on the protocol.

In 1988 a protocol was signed under which the 25 signatory countries agreed to limit their emissions of nitrogen oxides so that they would stabilise at 1987 levels by 1994 at the latest. Some countries, including Sweden, also declared their intention to reduce NO<sub>x</sub>-emissions by 30 per cent by 1998. A second sulphur protocol was signed in Oslo in 1994 by 26 countries and the EU.

This is expected to reduce European emissions by slightly more than 50 per cent by the year 2000 as compared with 1980. The protocol was based on a new principle, that of critical load; in other words, how much acid deposition different types of ecosystems can tolerate.

**Sulphur dioxide emissions in Europe**



*Emissions of sulphur dioxide in Europe 1880–1990 and projected emissions by the year 2000 according to the commitment made in the Oslo Protocol.*

The agreed long-term objective is that deposition of acidifying substances everywhere in Europe should be below the critical load. However, this will necessitate considerably more far-reaching reductions in emissions than have so far been agreed.

Acidification of soil and water is expected to continue in Sweden; only the rate of increase will fall. A certain improvement in the acidification situation in lakes has been noted during the 1990s, but complete recovery will not occur unless further steps are taken to reduce emissions of acidifying sulphur and nitrogen compounds.

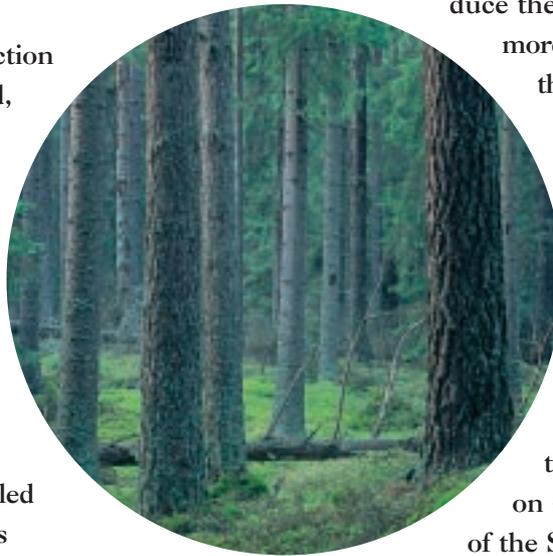
The fact that further action is needed is widely recognised, and has – after several years of preparatory work – led to the finalization of a new protocol aimed at the simultaneous abatement of acidification, eutrophication and ground-level ozone. Scheduled to be signed in Sweden in December 1999, this too is based on the so-called critical loads approach. It sets interim environmental quality targets for the year 2010, which are to be achieved by the establishing of binding national emission ceilings for each of the four pollutants; sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia. The integrated approach of this new protocol leads to improved cost-effectiveness, i.e. more environmental protection is achieved at a lower cost.

## SWEDISH STRATEGY IN THE EU

When Sweden joined the EU the Swedish Government decided that acidification was to be one of four priority environmental issues to be pursued in our EU cooperation. If the EU was to adopt a coherent strategy for combatting air pollution, this would have a decisive impact in determining future measures to

reduce acidifying emissions. At Sweden's instigation the Commission has developed a Community strategy to combat acidification, presented in March 1997. This was followed, in June 1999, by a proposal from the Commission for a Directive on national emission ceilings for acidifying and ozone-forming air pollutants.

One advantage of resolute action at EU level is that it ought to be able to bring about a more rapid and pronounced reduction in acidifying emissions from member states. A further consideration is that it will be able to put greater pressure on other European countries to reduce their emissions by adopting a more active stance in the context of the Convention on Long-Range Transboundary Air Pollution.



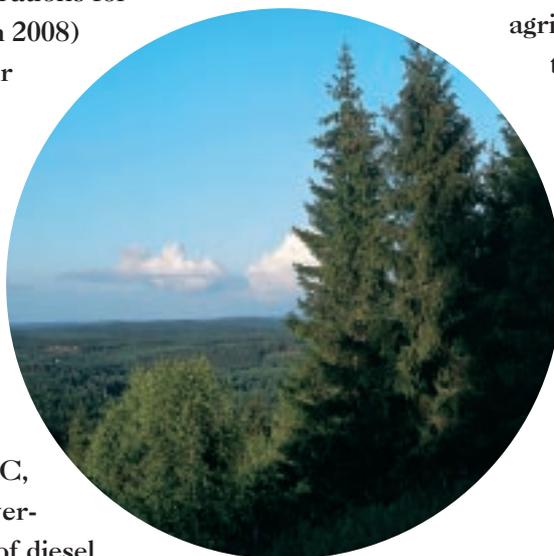
## Many EU issues are related to acidification

There are a number of directives which have a close bearing on acidification. The standpoint of the Swedish Government is that acidification should be treated as a key issue in all these initiatives in order thereby to accelerate EU progress in coming to grips with the problem.

- The proposed Directive on national emission ceilings for acidifying and ozone-forming air pollutants (COM(1999)125) sets binding emission ceilings for each member state for the year 2010. It covers four air pollutants; sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia. Presented by the Commission in June 1999, it will be discussed by the European Parliament and negotiated between the member states in the Council of Ministers, before it can be finally adopted.
- The Directive on large combustion plants (88/609/EEC) contains requirements in respect of emissions of sulphur dioxide and nitrogen oxides. In July 1998, the Commis-

sion presented a proposal for the revision of this directive, including more stringent emission limit values for new plants.

- Under the Directive on sulphur content of certain liquid fuels (93/12/EEC), the maximum permitted concentration of sulphur in diesel oil is 0.05 per cent, and in gas oils 0.2 per cent. These standards will however be strengthened as a result of two new directives. Firstly, the Directive relating to a reduction in the sulphur content of certain liquid fuels (99/32/EC), which prescribes maximum sulphur concentrations for gas oils (0.1 per cent as from 2008) and heavy fuel oils (1.0 per cent as from 2003). Moreover, this directive contains a provision for the Commission that, before the end of 2000, it should make proposals on how to reduce the emissions from bunker fuels used by shipping. Secondly, Directive 98/70/EC, prescribing a stepwise lowering of the sulphur content of diesel fuel, down to 0.005 per cent as from 2005.
- The framework Directive on ambient air quality assessment and management (96/62/EC) will, by means of "daughter directives", set limit values for the concentration of pollutants in air, primarily affecting urban areas. The first daughter directive sets standards for sulphur dioxide, nitrogen dioxide, particulates (PM<sub>10</sub>), and lead.
- The Directives on emissions of air pollutants from passenger cars and from heavy vehicles, respectively, both address nitrogen oxides emissions. New emission standards for cars, to be introduced in two steps from 2000 and 2005, are set in Directive 98/69/EC. A similar stepwise approach is foreseen also for heavy vehicles, but a final agreement is still to be reached. The "Auto-Oil Programme" aims to achieve compliance with air quality stan-



dards in the most cost-effective manner by imposing stricter fuel and exhaust requirements and non-technical measures such as traffic planning and economic instruments.

- The Directive on exhaust standards for non-road mobile machinery (97/68/EC) will bring about a reduction in emissions of nitrogen oxides. Emissions from other non-road motor vehicles, such as tractors and boats are also to be regulated by EU directives.

The Swedish Government has also indicated that it considers EU traffic policy and agricultural policy to be of particular importance for reducing emissions of acidifying nitrogen compounds (nitrogen oxides and ammonia). It has generally been more difficult to reduce acidifying nitrogen emissions than sulphur emissions.

This pamphlet has been produced in cooperation between the Ministry of Environment and the Swedish Environmental Protection Agency, September 1999.

Other pamphlets: Facts about Swedish policy: Biological diversity and Facts about Swedish policy: Waste.

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# SWEDEN AND THE ENVIRONMENT

Sweden is a sparsely populated country which underwent its process of urbanisation late in comparison with continental Europe. 85 per cent of its population of just under 9 million inhabitants now live in towns and cities. The same proportion of the population live in the south of the country, which represents a mere 40 per cent of the land area of Sweden. Sweden has a long tradition of utilising and enjoying the country's varied natural environment. Forest covers 60 per cent of the country and accounts for a significant proportion of exports. There are over 85,000 lakes and the coastline is 2,700 kilometres long. Our intimate relationship with and love of nature explain the widespread commitment to the environment in Sweden.

The Swedish Government realised at an early stage the importance of international co-operation to improve the environment. This insight resulted in the first international environment conference in Stockholm in 1972. Now that Sweden has joined the EU the Union represents an important arena for cooperation on environmental policy.

In 1995, the Swedish Government presented an EU strategy for environmental policy (approved by Parliament), setting out Swedish priorities for environmental cooperation within the

Union. The following areas have been given top priority:

- Acidification and climate change
- Chemicals
- Ecocycles and waste management
- Biological diversity

## THE SWEDISH ADMINISTRATIVE SYSTEM

The ministries of central government have fairly small staffs and concentrate their efforts on preparing government regulations, legislation and budgets to be placed before Parliament. The central authorities, which are independent of government, implement legislation and have regulatory and monitoring functions. The central authorities concerned with environmental issues are the Swedish Environmental Protection Agency, the National Chemicals Inspectorate, the National Licensing Board for Environment Protection and the National Radiation Protection Institute.

The Swedish administrative system dates back to the time of King Gustav II Adolf in the beginning of the seventeenth century. It is a system unique to Sweden, Finland and, to some extent, Norway.



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