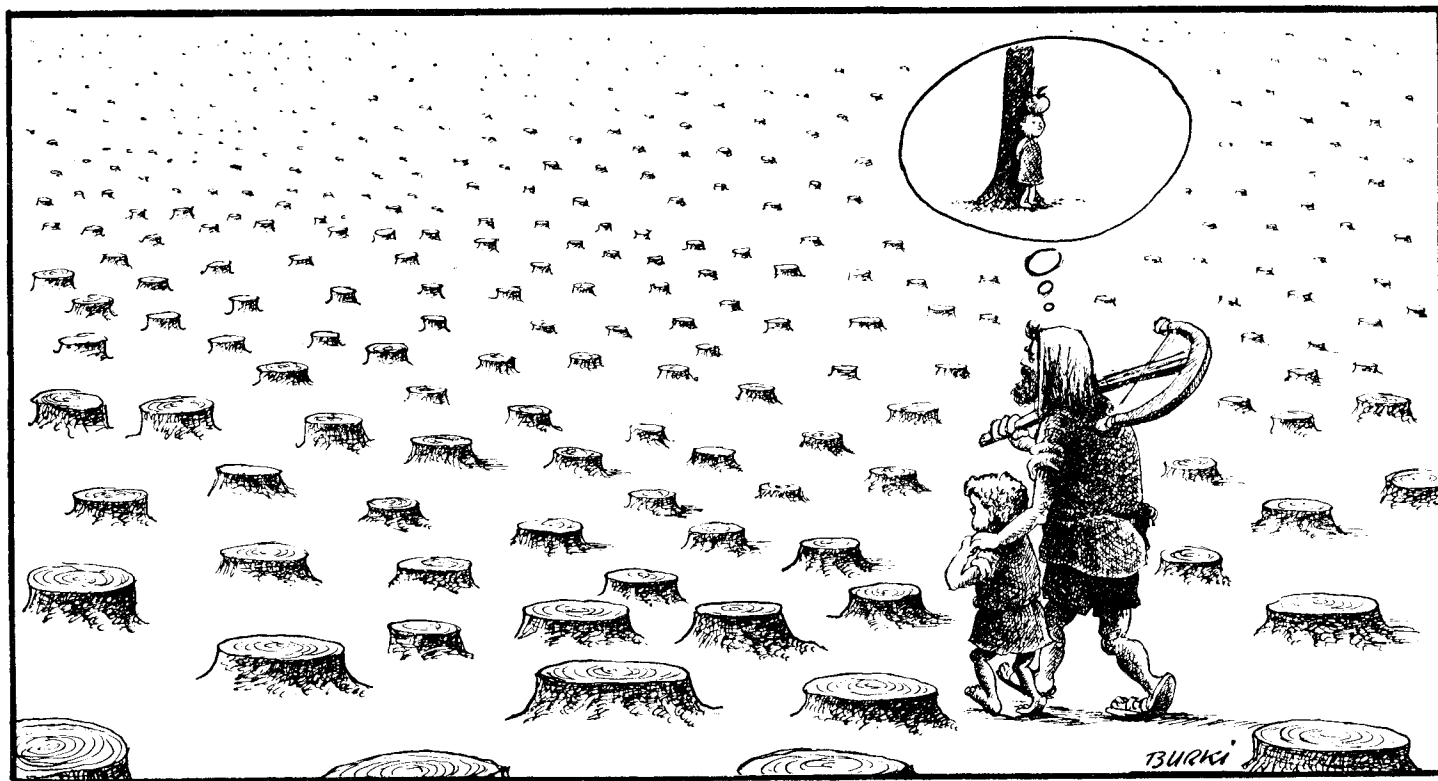


# Acid News

No. 3-4, Dec 1986

A Newsletter from the Swedish and Norwegian NGO Secretariats on Acid Rain



Drawing: Burki, c 24 Heures

## EUROPE

# Trafficking in pollution

The motor car is not only a method of travel, a status symbol, or a demonstration of masculinity. It is also the source of a wide range of pollutants which damage the environment as well as people's health. The number of cars in the world has already increased from 38 million to 350 million in the last forty years, and the pollution from road traf-

fic is continuing to increase with extreme rapidity.

A recent review seminar on pollutants from motor vehicles and their effects, organized by the newly-formed European Association for the Science of Air Pollution (Eurasap) in conjunction with the Transport and Road Research Laboratory in England, has just finished grappling with

the implications of traffic pollution in Europe. The conclusions reached in the seminar were far-reaching and disturbing.

It has long been realised that pollution from traffic is damaging to health and the environment, and measures for its control have been in force in the United States and Japan since the early 1970s. In 1970, the US Congress

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# Acid News

A newsletter from the Swedish and Norwegian NGO secretariats on acid rain.

ACID NEWS is a joint publication of the two secretariats, whose aim is to provide information on the subjects of acid rain and the acidification of the environment.

Anyone interested in these problems is invited to contact the secretariats at either of the addresses below. All requests for information or material will be dealt with to the best of our ability.

In order to fulfill the purpose of Acid News, we need information from everywhere — so if you have read or heard about something that might be of general interest, please write or send a copy to:

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## THE SECRETARIATS

The Swedish NGO Secretariat on Acid Rain is supported by the following environmental organizations:

- The Environmental Federation (Miljöförbundet)
- The Swedish Anglers' National Association (Sportfiskarna)
- The Swedish Society for the Conservation of Nature (Svenska Naturskyddsföreningen)
- The Swedish Youth Association for Environmental Studies and Conservation (Fältbiologerna)

Address and telephone: see above.

The Norwegian secretariat, "The Stop Acid Rain Campaign/Norway," is organized by six non-governmental organizations concerned with the environment:

- Nature and Youth (Natur og Ungdom)
- The Norwegian Forestry Society (Det Norske Skogselskap)
- World Wildlife Fund/Norway (Verdens Villmarksfond)
- The Norwegian Association of Anglers and Hunters (Norges Jeger- og Fiskeforbund)
- The Norwegian Society for Conservation of Nature (Norges Naturvernforbund)
- The Norwegian Mountain Touring Association (Den Norske Turistforening)

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# Now we know

A recommendation to carry the reduction of harmful emissions far beyond the figures of any previous proposals was the outcome of a conference staged by environmental organizations just before the Nordic Council's own conference on air pollution early in September.

Discussion has hitherto centred on a reduction of sulphur by 30 per cent, and nineteen countries have undertaken to reduce their emissions by at least that amount by 1993, calculated from their 1980 levels. But two of the countries whose emissions have most to do with acidification in Sweden — the United Kingdom and Poland — are still not taking part in this international effort.

A reduction of 30 per cent is in any case far from sufficient to counteract acidification. This figure came about mainly for tactical reasons — to get international cooperation in the matter under way, while engaging as many countries as possible. It was never thought of as providing anything like adequate protection for the environment.

To do that, a 90-per-cent reduction of the emissions of sulphur will be required. Only so can the souring of forest soils, surface water, and groundwater in those parts of Europe that are most sensitive to acidification be stopped.

This stepped-up demand is based on figures produced by a group of Scandinavian scientists to show the maximum concentrations and depositions (of sulphur, nitrogen, and ozone) that the environment will tolerate. This group was specially appointed by the Nordic Council, and before presentation their report was put before groups of experts within the UN Economic Commission for Europe (representing in effect some thirty nations) who found it acceptable.

From these figures it could be deduced that in addition to the 90-per-cent reduction for sulphur, the emissions of nitrogen oxides

would have to be brought down by 75 per cent, and ozone concentrations also by 75 per cent.

The findings of the Scandinavian scientists were later explained in addresses to the Nordic Council's conference, at which the resulting demands from the environmentalists were also presented.

That the outcome of that conference should have been a relatively strongly worded communiqué was certainly gratifying. It is felt that this result could be ascribed in considerable part to the environmentalist organizations' presentation of the facts as seen from an ecological viewpoint. It may be noted that the conference communiqué says explicitly that in setting up target figures for the reduction of emissions, account must be taken of what the environment will stand.

In their appeal to the European MPs attending the Nordic Council's conference, the environmentalist organizations made especially three requests.

1. That they should accept the findings of the scientists, and as politicians act accordingly.
2. That they should not allow the big emitter nations to go on trying to hold off action by referring to a need for further research or making similar excuses.
3. That they should go to the root of the matter by addressing the miscredited energy and transportation policies that are responsible for the enormous emissions of pollutants, and thus for the acidification of the environment and for forest dieback.

In the long view the problem can in the main only be solved through determined efforts to reduce the consumption of energy, increase the use of energy from renewable sources, and design transportation systems to save the environment.

It is to be hoped that the MPs will have grasped the seriousness of the message, and will now start translating it into action in their home parliaments.

Christer Ågren

# Trafficking in pollution

continued from page 1

passed a series of sweeping amendments to the Clean Air Act. Perhaps the most controversial of these was the inclusion of a set of standards for the emissions of carbon monoxide, hydrocarbons, and nitrogen oxides which were designed to stimulate improvements in automobile technology.

In spite of the protests of car manufacturers, the new standards proved to be achievable, and a cycle began in which regulations were tightened as new technology became available. In 1975, all new cars had to be equipped with oxidation catalysts, and in 1981, three-way catalytic converters became necessary for meeting the standards (see Table 1). The new US standards were then, and are still, the strictest anywhere.

Table 1.  
US Federal Emission regulations  
(pollution allowed, in g/mile\*)

Model year	CO	HC	NO <sub>x</sub>
1970	34.0	4.1	4.0
1975	15.0	1.5	3.1
1980	7.0	0.41	2.1
1981	7.0	0.41	1.0
1983	3.4	0.41	1.0

\* 1 mile = 1.6 kilometres

In thirteen years, the permitted emissions of carbon monoxide and hydrocarbons were reduced to one-tenth, and those of oxides of nitrogen to a quarter of what they had been previously. The US Environmental Protection Agency estimates that carbon monoxide in the air across the USA was reduced by 33 per cent between 1975 and 1983. Nitrogen dioxide levels decreased by about 6 per cent over the same period, reflecting the fact that NO<sub>x</sub> comes from other sources besides road traffic, while the amount of traffic has also been increasing. In Europe, this kind of pollution is increasing rapidly.

The improvement in environmental quality achieved by the US standards was noted worldwide, and other countries began to follow. Japan adopted similar standards, followed by Australia

and Canada. Austria, Switzerland, Sweden, and Norway will make the US emission standards obligatory in 1988/89 while South Korea and Brazil have announced their intention of adopting them too. Some countries, including West Germany, the Netherlands, Austria, and Sweden are encouraging the sale of catalyzer-equipped cars through financial incentives.

Approximately 130 million cars around the world are equipped with catalyzers, according to Mike Walsh, technical consultant and former head of the traffic emissions section of the US EPA, who was addressing the Eurasap meeting. Nearly half the world market for catalysts is supplied by the British firm Johnson Matthey Ltd, who have to date made 55 million catalyzers and are currently turning them out at the rate of twelve million a year. The technology, it would appear, is well-established and is set to dominate the world market.

This is not the impression one would gain, however, from an examination of the discussions underway within the EEC. Although emission controls were introduced in Europe at about the same time as in the United States, the existing standards are much more lenient. The EEC standard (ECE 15.04), which was agreed in October 1982, and came into force in the EEC in October 1986, in no way approaches the stringency of the US regulations. The proposed Vehicle Emissions Directive (COM/85/288) is the latest Euro-attempt to set limits to vehicle emissions. This is a compromise package that ten out of twelve

EEC-countries have agreed upon. At the moment it is stalled in Brussels because the Danish and the Greek governments are refusing to ratify it, and EEC rules require unanimity before the directive can become Community law.

Greece is holding out for laxer standards, while Denmark wants the much more stringent US standards. Countries in the EEC without large-car manufacturers, such as Denmark, and those which make mainly large cars, such as West Germany, want tough controls on emissions — especially since they believe car emissions to be contributing to large-scale environmental damage, including forest decline. Countries producing small cars, which may be vulnerable to Japanese competition, notably Britain, France and Italy, are hostile to the introduction of tough standards.

Vigorous lobbying by British and French car manufacturers has resulted in a hybrid system of controls designed to protect smaller cars from catalyst technology (see Table 2). The Danes say the directive, as it is drafted, will have virtually no effect on emissions in their country, where most of the cars are small. Denmark wants the right to introduce tougher controls that would be applicable for small cars as well.

It should also be noted that the EEC's proposed emission standards are based on the use of a test cycle that is hardly representative of driving practice in Europe. It is for stop-and-go urban traffic at a maximum speed of 50 kph and an average speed of only 19 kph. At these

Table 2.  
Proposed EEC Directive for Vehicle Emissions

Engine capacity	Date of introduction		Emissions (g per test cycle)		
			CO	(HC + NO <sub>x</sub> )	NO <sub>x</sub>
	New models	All new cars			
Over 2 litres	Oct 1988	Oct 1989	25	6.5	3.5
1.4 to 2 litres	Oct 1991	Oct 1993	30	8	—
Less than 1.4 l					
Stage 1	Oct 1990	Oct 1991	45	15	6
Stage 2	Oct 1992	Oct 1993	to be decided by 1987		

speeds, nitrogen oxide emissions are relatively small. The US test cycle, on the other hand, comprises speeds up to 91 kph, with an average speed of 34 kph, and starting with a cold engine.

In his Eurasap presentation, Mike Walsh gave a rule-of-thumb guide to the proposed EEC standards, compared with the US 83 standards, from the point of view of NO<sub>x</sub> emissions (see Table 3). This showed the emission standards that are to be introduced in Europe to be one-and-a-half to three times more lenient than those that have been in force in the USA since 1983. The large-car standards can only be met by the use of three-way catalytic converters, the medium range should be attainable by using lean-burn engines plus an oxidation catalyst, and the Stage 1 small-car standards will be achievable with lean burn alone.

Table 3.

US 83 standards	1 g per mile for NO <sub>x</sub> .
Proposed EEC limits	
Large cars	1.5 g per mile
Medium cars	2 g per mile
Small cars	3 g per mile

The EEC directive, however, is permissive: if a country does not wish to adopt the emission standards, it need not do so. If, on the other hand, it adopts even stricter standards, then it will paradoxically fall foul of the Treaty of Rome — on the grounds that it is restricting freedom of trade.

The reason for the pressure away from catalysts is their add-on cost and the possible gains from the use of lean-burn technology. Motor manufacturers argue that significant reductions in pollutants can be brought about even without the use of catalysts. This produces strange contradictions. *"The car manufacturers in the USA,"* says Mike Walsh, *"brag about the pollution reductions that they have achieved in the USA through the use of catalysts — and they're quite entitled to. The same car manufacturers come to Brussels, however, and say that catalysts won't work."* Most UK car manufacturers already supply cars fitted with cat-

alyzers for the US market. Jaguar alone buys 100,000 catalyzers a year.

The Eurasap/TRRL meeting provided the first scientific overview of the state of vehicle pollution in the UK. Martin Williams of Warren Spring Laboratory pointed out that NO<sub>x</sub> emissions in Britain have doubled since 1900 and now amount to 1.7 million tons per annum. This has serious implications, as NO<sub>x</sub> in combination with hydrocarbons forms ozone, the pollutant which is regarded as a major contributory factor to widespread forest death in central Europe.

Mike Ashmore of Imperial College examined the role of various pollutants in damaging plants. The total loss of crops in the USA due to ozone damage has been estimated to be 3 billion US dollars per annum. Research in the UK indicates that certain species of plants are already being damaged at current background levels of ozone.

Martin Holdgate, chief scientist at the Department of the Environment, summarized the numerous points on which there had been agreement at the seminar:

- A good system for measuring exposure to different environmental pollutants is necessary, as is reasonable survey data concerning the effects of pollutants on human beings, the environment, and materials; and this has to be backed up with more research into what causes the pollutants.
- In spite of the complexity of the issue, it is apparent that at existing levels of certain pollutants in the air, notably ozone, plants are susceptible and are likely to be exhibiting impaired performance. The interaction of different pollutants is also responsible for damage which could occur before the symptoms are externally visible (for example tree growth could be inhibited before the trees start dying).
- The role of emissions from diesels is becoming increasingly suspect, as new research indicates that they may be carcinogenic.
- The preventive approach, reducing exposures to hydrocarbons, NO<sub>x</sub>, particulates, and

ozone, is wise, and some benefit is likely to come anyway from reducing the levels of ozone.

- Road traffic is an important source of direct pollutants and of the precursors to pollutants such as ozone. But reductions will have to be achieved by limiting emissions of NO<sub>x</sub> from heavy vehicles and power stations as well as cars; and hydrocarbon emissions from the use of solvents, such as certain types of paint, will have to be addressed.

The current position of the UK government does not accord with the scientific analysis summarized by Dr Holdgate. The government is refusing to require any clean-up for large cars, as it has ruled out the use of three-way catalyzers entirely. It may require the introduction of lean burn plus oxidation technology to medium engines, but it has been careful not to commit itself to the implementation of the EEC Vehicle Emissions Directive. As for monitoring, the DoE is setting up eighteen ozone-monitoring stations around the country—not enough to give a complete picture of ozone levels, but maybe enough to indicate trends. The monitoring system in London, which has been measuring pollution since the 1920s, is under threat for lack of finance.

Final words, first from Mike Walsh: *"We are dealing here, not with how much we can reduce pollution, but how we can stop it from getting worse. With regard to Europe as a whole, there is no question that NO<sub>x</sub> emissions will increase for the rest of this century. We're not talking about an actual reduction, we are talking about having in hand, as regards mobile sources, a way to start reducing the increase. I personally would be surprised if Europe will be able to show significant improvements in NO<sub>x</sub> emissions if it adheres to the course that has so far been laid out."*

Martin Holdgate: *"So you would say that the British government's stated aim of policy, to reduce national NO<sub>x</sub> emissions by 30 per cent between 1980 and the end of the century, is unlikely to be attained?"*

Mike Walsh: "Yes."

Steve Elsworth Christer Ågren

## Clean-up technology

### Catalyzers

The three primary pollutants from car exhausts are: unburnt hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides ( $\text{NO}_x$ ). Catalyzers can substantially reduce all emissions of these substances by converting them into carbon dioxide, water, and nitrogen.

The most widely used catalyzer consists of a cylindrical ceramic block with a honeycomb structure which is thinly coated with some metals of the platinum group. This is fitted into the car's exhaust system to clean the exhaust gases from the engine.

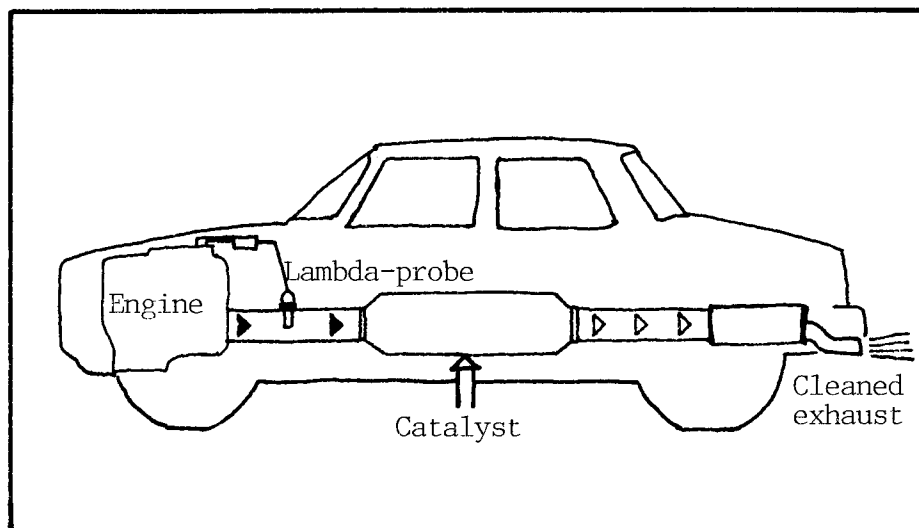
#### Oxidation catalyzers

Reduce HC and CO but not  $\text{NO}_x$ .  $\text{NO}_x$  can be reduced by other means, such as recirculating the exhaust gases or using lean-burn engines. This system could meet some proposed EEC standards but not the stricter American ones.

#### Three-way catalyzers

Simultaneously control HC, CO and  $\text{NO}_x$ . Require an air-fuel ratio of 14.7:1, and sophisticated fuel control. Necessary to meet the US standards, as well as the proposed EEC standards for cars over 2 litres.

Both oxidation and three-way catalyzers require the use of unleaded petrol, as lead can poison the catalyzer and prevent it from



operating effectively. Ambient lead levels have notably decreased in countries where catalyzers have been introduced. Substantial reductions in emissions of carcinogens such as formaldehyde and benzo(a)pyrene have also been achieved.

#### Lean-burn engine

Until about 15 years ago, car engines were calibrated at an air-fuel ratio of 14.7:1, which gave maximum power and best driveability, but produced the maximum amount of  $\text{NO}_x$  emissions. After the fuel crises in the 1970s, the amount of air in the air-fuel ratio was increased to boost the fuel economy. This lowered the combustion temperature, with a

resultant drop in  $\text{NO}_x$  emissions ( $\text{NO}_x$  formation depends very much on temperature).

$\text{NO}_x$  and CO emissions are low at an air-fuel ratio of 22:1, but HC emissions start to climb after 18:1. Lean-burn engines do not significantly reduce emissions of HC, and early research at TRRL indicates that  $\text{NO}_x$  emissions at high speeds from lean-burn engines, with or without oxidation catalyzers, are similar to those of a conventional car. Used in combination with an oxidation catalyzer, lean-burn technology could meet some proposed EEC standards, but not the US standards. Some improvements in fuel economy should be attainable with this method.

Average performance and price of European cars equipped with catalyzers compared with cars not so equipped.

Engine size	Max speed	Acceleration (0-62 mph)	Fuel economy	Price (pounds sterling)	
				USA emissions	Euro
Less than 1.4 l	+0.3 mph	+0.2 sec	-1.3 mpg	+505	+178
1.4 to 2 litres	-3.1 mph	+0.8 sec	+0.4 mpg	+376	+250
Over 2 litres	-2.2 mph	+0.4 sec	-0.4 mpg	+315	+315
Overall averages	-2.2 mph	+0.4 sec	-0.4 mpg	+354	+214

Figures supplied by Johnson Matthey, based on a range of 22 European models currently on sale in West Germany.

# The facts are now clear

Twenty-four delegates from various European conservation and environmental organizations met for two days last September to review the scientific evidence, to set targets and timetables for emission controls based on ecological tolerances, to discuss future strategy and activities, and to produce a statement to be presented at the Nordic Council's International Conference on Air Pollution. The main outcome from the NGO Conference at Lida, near Stockholm on September 6-7, 1986, is here presented.

*Statement from the NGO Conference on Acid Rain to the Nordic Council's International Conference on Air Pollution, Stockholm, September 8, 1986.*

Within the past few months, scientific knowledge of acid rain has crossed a vital threshold. For the first time, there is a broad scientific consensus about the levels to which pollution must be reduced, to allow forests, soils and lakes to survive, or to recover. In other words, the scientific bottom line is becoming clear. This is an historic development.

Up to now, governments have talked about — and tried to achieve — various percentage reductions in air pollution. The best known is the 30 % Sulphur Protocol of the Convention on Long-Range Transboundary Air Pollution, a treaty run by the UN ECE. This Protocol started life as the 30 Per Cent Club and was signed at Helsinki last year.

It should be stressed that figures such as the 30 per cent are *political* target figures.

They were drawn up when countries fighting acid rain were shooting in the dark. It was an understandable pragmatic decision at that time. Some kind of action was needed as a first step, and such reductions were welcome in attacking an environmental disaster that nobody properly understood.

Now, all that has changed.

At the Nordic Council's initiative a special group of scientists was formed last year. This April, at a meeting in Oslo, they reached a scientific agreement on the loads of pollutants, which are critical for nature. As a result we now have figures for

sulphur, as well as for nitrogen and for ozone.

In effect, we entered a scientific dialogue with the environment — and the environment has given us an answer. Nature says:

"I'm still suffering — 30 per cent is not enough."

The data collected at the Nordic Council's initiative show that to avoid further environmental damage over large areas such as Europe and North America, we must achieve a reduction in sulphur emissions of 90 per cent. This is the fall in deposition needed to safeguard significant areas of sensitive soils in countries such as Poland, East and West Germany, Holland, Czechoslovakia, as well as in southern Scandinavia.

Levels of nitrogen compounds and ozone must be cut by 75 per cent. Hydrocarbons will need rapid reduction to achieve this target for ozone.

This is new. It changes the whole debate, the whole basis of action. These are not arbitrary figures or political notions. These are the reductions actually needed to protect nature, safeguard our heritage, our health and our economies.

Our first plea to you as politicians is: Accept this scientific evidence...and act upon it.

These ecological targets were taken from the Nordic expert group, to the expert group which looks at effects for the UN ECE. Here too, they were accepted. The UN ECE group represents the combined scientific expertise of 35 nations. These ecological targets result from an unprecedented exercise in scientific fact-finding. They

give a very high degree of certainty — and deserve to be treated with equal political seriousness.

The sulphur study alone included reviews of more than one thousand separate papers. There is much less published evidence on nitrogen, yet studies based on six different aspects of its chemistry in the environment all produced the same answers. Many different scientific roads have led to the same conclusion. So here is our second plea.

Do not allow politicians in the major polluting countries to cause delay, for the sake of delay, by starting research into these findings. It is neither needed nor justified. There is no need to reinvent the wheel.

The evidence on acidification and oxidant damage is now as good as that on almost any major problem. It is as strong as that on smoking and lung cancer.

We urge you to accept these targets and to act on them. Time is not on our side. The damage is intensifying. It is spreading from one country to the next. Forest damage now affects at least ten million hectares in over seventeen countries, from Japan to the United States of America, from France to Finland.

Twenty years ago, air pollution was considered a local problem. Ten years ago it was seen as a regional problem. We now know that it is a global problem.

Atmospheric pollution involves the transport of chemicals — such as hydrocarbons, heavy metals, nitrogen compounds, sulphur, and radioactive

particles — across oceans and across continents, for thousands of kilometres. Ninety per cent of the sulphur in the skies over Europe is caused by pollution.

What is more, some of the same processes that give rise to acid rain are contributing to the greenhouse effect — and global climatic change. And insidious, cumulative, and permanent damage is being done to soils and forests. It is probably irreversible. So far we have seen only the tip of the iceberg.

Urgent and effective reductions are needed. And they are needed now!

It will be disastrous if another year is allowed to slip by, while we wait for more nations to back the 30 Per Cent Club or other outdated targets. It will be

equally disastrous if we lose another year just talking about a UN ECE Protocol to reduce oxides of nitrogen, instead of bringing one into force, and getting reductions.

So here is our third, and last plea to you.

Instead of more research into research, see that your governments make urgent and effective reductions in emissions, and then go on to tackle the underlying problems of industrial planning which have created the pollution crisis. This means, transforming industry.

Not only must we make each car cleaner: we must not allow an increase in traffic which would then create a higher level of total pollution. In the same way, it is no use turning to coal

or oil-fired power stations as an escape route from nuclear power, if that is going to lead to more acid rain. That is no solution — instead it creates a two-jaw trap.

We must avoid creating that trap at all. We can avoid it by dramatically reducing our total use of energy, and by a massive increase in the use of "alternative" energy sources, and by more use of public transport systems.

For our part, environmental organizations will do all in their power to further these objectives. But our resources are limited. Only governments, and parliaments, can finally solve this problem.

You are parliamentarians, this is your responsibility.

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## AIMS AND OBJECTIVES

# This is what is needed

### Reductions of pollution

#### Sulphur dioxide (SO<sub>2</sub>)

In 1983, the environment movement asked for a 75-per-cent reduction of sulphur dioxide over the next ten years. Current scientific consensus is that an 80-per-cent reduction for Europe generally is necessary for protecting the environment, with a 90-per-cent reduction to protect the most vulnerable areas.

*Our objective: a 90-per-cent reduction of European emissions of SO<sub>2</sub>.*

#### Nitrogen oxides (NO<sub>x</sub>)

The environmental movement asked for a 75-per-cent reduction of the emissions of NO<sub>x</sub> over ten years from 1983. Scientific evidence suggests that this is still a reasonable objective, given the part played by

nitrogen in the processes of acidification and ozone formation, and the threatened large-scale increase in road traffic by the end of the century. Reductions of ammonia deposition should also be brought about by a 75-per-cent reduction of ammonia production in areas of intensive livestock breeding.

*Our objective: at least a 75-per-cent reduction of European emissions of NO<sub>x</sub>.*

#### Ozone

Ozone's part in the pollution process is now well understood, and there is scientific consensus as to the necessary reductions. Ozone formation is to be reduced through the above reductions of NO<sub>x</sub>, combined with a sufficient reduction of the emissions of hydrocarbons.

*Our objective: a 75-per-cent reduction of European-wide ozone formation.*

### Timeschedule

The objectives above are designed to bring acidic pollution down to levels at which the environment will no longer show symptoms of damage. From an environmental point of view, the reductions are required immediately. Below are targets which we consider technically attainable:

#### Sulphur dioxide

A reduction of European emissions of SO<sub>2</sub> by at least 80 per cent before 1993. The 90-per-cent reduction to be achieved as soon as possible thereafter.

#### Nitrogen oxides

A reduction of European emissions of NO<sub>x</sub> by at least 75 per cent, to be achieved not later than 1995.

# How it can be done

## Means by which pollution can be reduced

### Effective planning

Emission reductions can only be achieved by the use of abatement technologies in conjunction with energy and transport policies which themselves lead to the elimination of pollution.

Governments must achieve reductions in air pollution by using existing knowledge and expertise in the areas of:

- Alternative energy sources
- Efficient electrical equipment
- Energy saving through insulation
- Energy efficiency labelling.

They should also invest in less polluting transport systems, improve public transport by making it cheaper and more efficient, and shift freight from road to rail.

### Use of existing technology on large combustion plants

To achieve our pollution reduction objectives for sulphur, we would expect all large combustion plants in use in 1995 to be fitted with FGD (Flue Gas Desulphurization) equipment, or to be achieving similar levels of pollution reduction through the use of other processes. With regard to NO<sub>x</sub>, Flue Gas Denitrification systems and more efficient combustion technologies must be introduced in large combustion plants throughout Europe.

### Tighter control of automobile pollution

Our requirements to counter automobile pollution are:

- The immediate and obligatory introduction of lead-free petrol in all European countries.
- All new cars sold after January 1, 1990, must meet emission standards equivalent to those current in the USA. Car manufacturers should be free to choose the technology (3-way catalysts, lean-burn engines with



Photo: Kjell-Arne Larsson

catalysts, or other new techniques) necessary to meet these standards.

- There should be no distinction made between "new models" and "new cars" for the purpose of meeting these standards.
- There should be significant financial incentives before 1990 to encourage people to buy cars which meet USA standards.
- There should be Europe-wide speed limits of, at most, 100 kph for motorways, and 80 kph for other roads.

### International cooperation

There are a number of initiatives which could lead to the Europe-wide reduction of air pollutants:

- The UN ECE, EEC, and Comecon should establish deposition standards for acidifying substances, designed to give adequate protection to sensitive soils, waters, and forests.
- The same organizations should establish such emission standards for large combustion plants and motor vehicles as are in accordance with the best available technology that is economically feasible.
- They should also agree to standards for SO<sub>2</sub>, NO<sub>2</sub>, and ozone concentrations in the air, designed to adequately protect

forests and crops.

- The western European countries should cooperate with and give financial and technical assistance to eastern European countries so as to secure an abatement of their acidifying emissions.
- Financial incentives and penalties should be re-examined to assess their effectiveness in reducing air pollution, financial penalties such as a pollution levy to be paid by large emitters of SO<sub>2</sub>, NO<sub>x</sub>, ammonia, or hydrocarbons to help finance pollution abatement.
- The UN ECE should adopt a Protocol committing parties to specify how they will achieve percentage reductions in pollutants by particular dates, using avoidance strategies such as energy and transport policy rather than abatement technologies.

### Need for speedy implementation

It must be emphasized that, even if all the measures above were carried out as quickly as possible, there would still be continuing destruction of forests and lakes until the emission reductions achieved a significant level. This is a problem of such widespread and multiplying proportions that immediate, drastic action is essential.



# So much will nature stand

The following is an abridgement of the address by Jan Nilsson to the NGO Conference at Lida.

Before starting I should say that I shall not be giving any figures that have not been accepted in discussions with the UN ECE groups at Geneva. In February they were put before the Group of Designated Experts, in June the Group of Effects, and recently in the Group on  $\text{NO}_x$ -reduction. The following will now be brought to the Executive Body of the ECE Convention via two routes: through the Group of Effects, and the  $\text{NO}_x$  group.

We have come to a decision on critical loads for pollutants. I shall show you what these are, and compare them with actual loads in Sweden. I hope you will then take the figures and compare them with those for your own country, and see how close the latter may be to these critical levels.

It is useful when thinking of this problem to consider the process by which damage occurs. It will be seen from the cup full of stresses (Fig. 1), representing a tree, that if the sum of the stresses is more than the tree can tolerate, damage will occur. In the case of many trees the cup is already full. If there

should be a dry period, say, or strong winds, then the tree can become damaged, even though there should be no increase in the amount of pollutants that it is exposed to. Remember, too, that various stress elements can have a combined effect.

Another thing that should be remembered is that before this situation has been reached, there will have been an accumulation of pollutants. In the case of nitrogen, for example (Fig. 2), there is a delayed response. While there may often be a positive effect during the initial stages of deposition, later there will be a very strong neg-

ative effect, as may happen even if the amount of nitrogen being deposited remains the same—and even if the deposition should decrease.

Taking then the critical levels for sulphur dioxide. In ambient air with a mixture of pollutants, the critical level for causing significant forest damage is about 25 micrograms of  $\text{SO}_2$  per cubic metre. This applies to spruce (*Picea abies*). Other trees can support higher concentrations. For sensitive trees on sensitive soils, however, one may expect damage when concentrations exceed 25  $\mu\text{g}/\text{m}^3$ . Damage is also likely if peak values.

Fig 2. Delayed response to the accumulation of nitrogen.

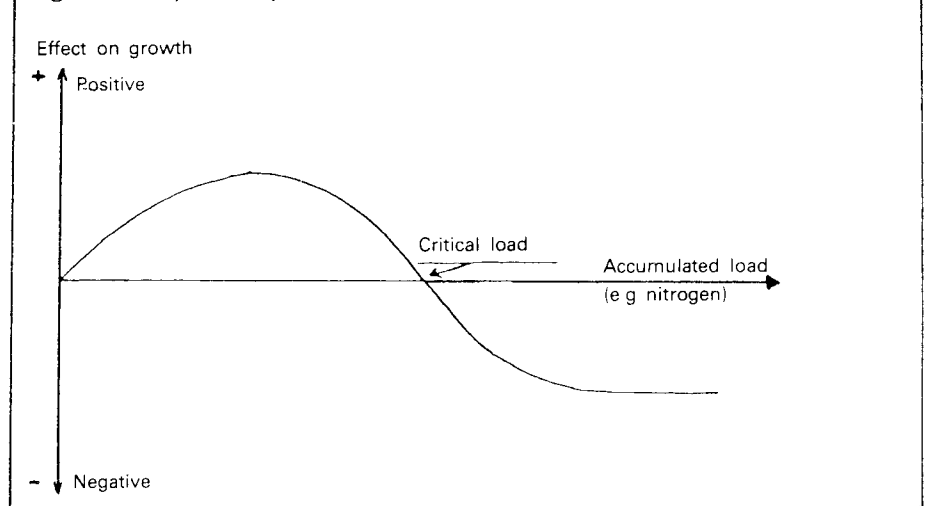
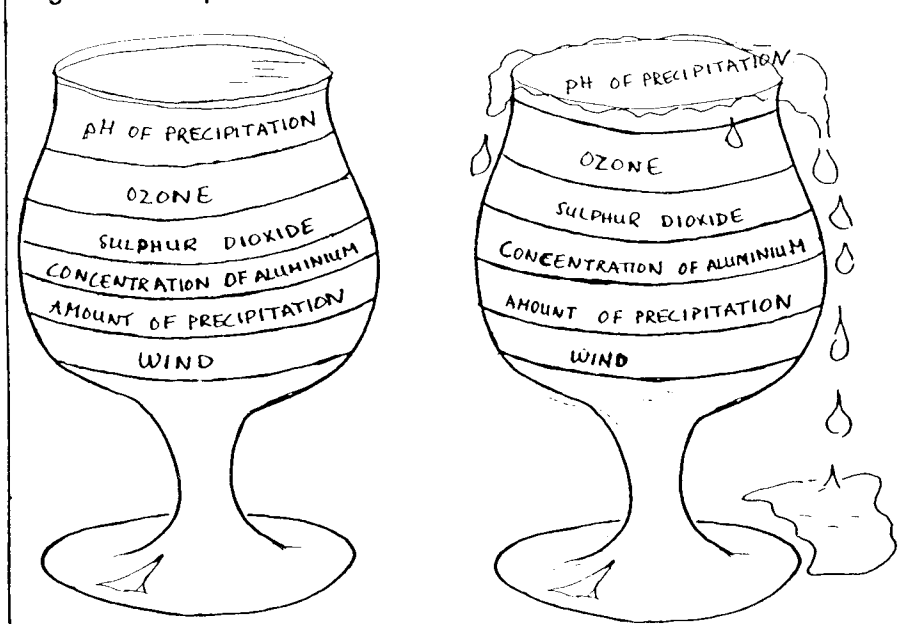


Fig 1. The cup of stresses.



lasting for a few hours during a couple of days, exceed 200  $\mu\text{g}/\text{m}^3$ . The figure of 25  $\mu\text{g}/\text{m}^3$  does not allow for dry deposition. If this is included, then the critical level is about 10  $\mu\text{g}/\text{m}^3$ . By comparison, the annual mean in Sweden varies between 4 and 60  $\mu\text{g}/\text{m}^3$ , while peak values vary between less than 100 and more than 250  $\mu\text{g}/\text{m}^3$  (Fig 3).

It is useful to remember that estimates of critical levels have been falling over the years. Thirty years ago, the official critical levels for sulphur dioxide would have been about 4,000  $\mu\text{g}/\text{m}^3$ . Five years from now I should probably be presenting lower figures than the ones you see here.

Critical levels for nitrogen dioxide (NO<sub>2</sub>) are shown in Fig. 4. It is difficult to explain the damage to forest and crops only in terms of NO<sub>2</sub>, which may however be considered as an element in the cup of stresses.

Critical levels for ozone (O<sub>3</sub>) are determined by looking at the effects on many species of plants. Here "annual mean" would perhaps be better expressed as a summer mean, since ozone is a summer phenomenon. The critical level seems to be about 80 microg/m<sup>3</sup>, but Dutch studies of poplars (*Populus* sp.) have revealed significant reductions of growth at 60 microg/m<sup>3</sup>. Spruce is not, as far as we know, one of the most sensitive species, whereas beech (*Fagus* sp.) seems to be very sensitive. When peak values exceed 120 micrograms for some hours, damage effects may be seen (Fig. 5). In most areas of Sweden the annual mean does not exceed the critical level, although we often have many days with peak values of about 200 microg/m<sup>3</sup>. At high altitudes (more than 600

metres above sea level) in central Europe, you can have peak values as high as 500 micrograms for many days.

It is well known that ozone causes substantial losses in crops. In the USA, the costs of reduced crop yields from ozone damage are estimated to be 2,000 million pounds sterling a year, and in the European Community to be 1,000 million pounds a year.

Those are the three main pollutants that have a direct effect on the trees. There are many others — hydrocarbons, for example, although I cannot give any figures.

Now we come to critical loads, as opposed to critical levels. "Critical levels" refer to the threshold concentrations of pollutants in the air, above which damage will occur. "Critical loads" refer to the threshold amounts of pollutants falling to earth (deposited), above which damage will occur. The information that follows is new. In the literature, you will have seen figures of the critical load of sulphur for surface water.

The figure of 5 kg of sulphur per hectare per year on susceptible surface waters was accepted at the international conference in Stockholm 1982 as the critical load. But there have been no estimates for the critical load for groundwater, for surface water in relation to total acids, or for the critical load for nitrogen.

Eighteen months ago, the Nordic Council set up a working group to establish critical loads in these cases, and the results have now been published. In April this year we had a workshop to which we had invited about 30 experts from various countries. At this meeting, the conclusions of the working group were accepted by the other scientists. The material was then put before the UN ECE groups at Geneva, and the figures were incorporated in the report of the group looking at the effects of acidification, and that of the NO<sub>x</sub> group. The critical loads for soil, surface waters and groundwater are in Fig. 6.

"Poor soils" are those of the type found for example in most

Fig 3. Critical levels of sulphur dioxide for forests

Annual mean	25 microg/m <sup>3</sup>
Peak values	200 microg/m <sup>3</sup>

Ambient air in Sweden

	Rural	Urban
Annual mean	4-7	20-60 microg/m <sup>3</sup>
Peak values	< 100	> 250 microg/m <sup>3</sup>

Fig 4. Critical levels of nitrogen dioxide for forests

Annual mean	30 microg/m <sup>3</sup>
Peak values	250 microg/m <sup>3</sup>

Ambient air in Sweden

	Rural	Urban
Annual mean	4-12	60 microg/m <sup>3</sup>
Peak values	20-50	400 microg/m <sup>3</sup>

Fig 5. Critical levels of ozone (O<sub>3</sub>) for forests

Annual mean	60-80 microg/m <sup>3</sup>
Peak values	120 microg/m <sup>3</sup>

Ambient air in Sweden

Annual mean	40-60 microg/m <sup>3</sup>
Peak values	200 microg/m <sup>3</sup>

Fig 6. Critical loads for acid depositions on forest soils, groundwater and surface waters, expressed as the total annual deposition

Total annual	kg S/ha/yr	keq H <sup>+</sup> /ha/yr
Poor soils	2-7	0.1-0.5
Medium soils	6-18	0.4-1.1
CaCO <sub>3</sub>	>100	> 5
Actual deposition		
SW Sweden	20-30	1.0-1.4
N Sweden	3-5	0.2

Fig 7. Critical load for acid depositions on susceptible surface waters

Total annual deposition	keq H <sup>+</sup> /ha/yr
Sweden: shallow soils	0.1
glacial till	0.3-0.4
Norway	0.2-0.4
North America	0.4
Netherlands	0.25
IIASA-model, Sweden	0.2

parts of Sweden, in the Netherlands, in many places in Canada, and some parts of Germany. The figures show the critical acid load not only for Sweden, but also for countries such as the Netherlands and Germany. Comparison with the actual figures shows it to be quite clear that the depositions in many areas will have to be decreased by at least 80 per cent (Fig. 7).

The figures for nitrogen appear in Fig. 8. These are for total nitrogen and include both ammonia and nitrates.

It should be mentioned here that it is easier to dispute the figures for nitrogen than those for sulphur, as the amount of

scientific knowledge is less than in the case of sulphur.

We have used six different concepts in trying to arrive at the critical load for nitrogen, based on research from several different countries. As may be seen from Fig. 9, all six led to about the same conclusion.

These critical load figures for sulphur and nitrogen are the only figures being forwarded to the Executive Body of the UN ECE from the working groups on effects and  $\text{NO}_x$ . They do not include any margin of safety.

During the last year, scientists in the Netherlands have been doing the same kind of work as we have. It was interesting to find that they had come up with

the same figures, despite the fact that their approaches were not all the same. A draft version of the World Health Organisation's air quality standards includes figures on critical levels.

Our acid loading is based on figures for sulphur, although it is true that nitrogen does play some part in acidification when the soil is saturated with it. There are very few studies examining the role of nitrate in this process. It seems however that it is active in peak acid surges. It should also be mentioned that if sulphur deposition is decreased, while nitrogen depositions remain high on soils that have previously had large inputs of sulphur, there may be a large increase in the outflow of sulphur. Even with a decreased deposition of sulphur, there will thus be a strong acidification effect if nitrogen pollution remains at a high level.

Jan Nilsson  
Deputy head of research  
National Swedish Environmental Protection Board

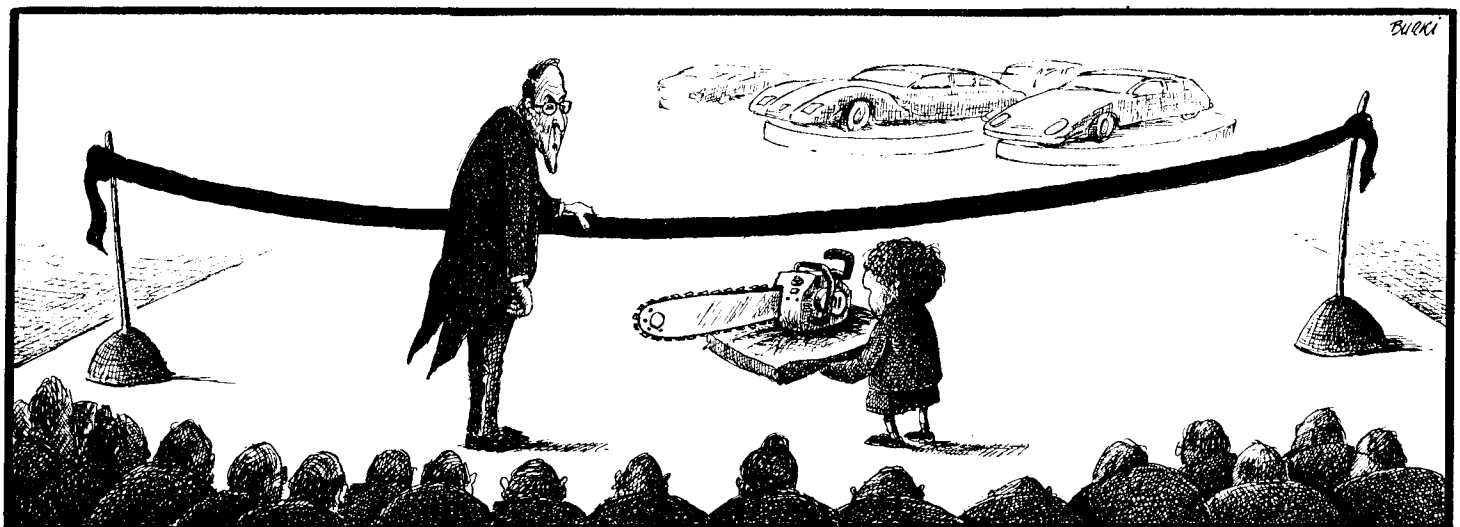
Fig 8. Critical load for the deposition of nitrogen (over a period of 25-50 years)

Annual deposition	10-20 kg N/ha/yr
Actual deposition:	
SW Sweden	20-30 kg N/ha/yr
N Sweden	3 kg N/ha/yr

Fig 9. Estimated critical load for nitrogen deposition, using various approaches

	Critical load kg N/ha/yr
1. Nitrogen productivity concept	15-35
2. Input/output studies	10-15
3. Net uptake in plants	
low-medium productivity	5-15
high productivity	20-45
4. Fertilization experiments	15-25
5. Vegetational changes	10-30
6. Empirical data, surface waters	< 15

A full report from the NGO Conference is available free of charge from the Swedish NGO Secretariat on Acid Rain.



*Inauguration du Salon de l'auto.*

Drawing: Burki, c 24 Heures

# Europe MPs endorse action

Last September some sixty members of the parliaments of sixteen European countries attended a conference on air pollution arranged by the Nordic Council of Ministers of the Scandinavian countries. The principal aim of the conference was to gain a broad parliamentary base for measures for dealing with this particular problem. Unified action in Europe for reducing emissions is clearly necessary, and an important point of the conference was just to produce a common document emphasizing this need.

Evidence of the enthusiasm of many of the MPs for the idea could be seen in the fact that the final communiqué went further than the Nordic Council's original proposal. The final version stated the need for a binding agreement to reduce the emissions of nitrogen oxides and hydrocarbons, similar to the Helsinki protocol on sulphur. But it also said that all nations should start moves to bring about such reductions immediately, without waiting for a final international agreement.

The communiqué also called upon all nations to adhere to the Helsinki agreement to reduce emissions of sulphur by 30 per cent, but it then went further in proposing that consultations should start now with the aim of bringing about still greater reductions in the nineties. It added moreover that when setting the necessary target figures for limits to the emissions of sulphur, the critical load values for particular areas and ecosystems should be taken into account.

This last had been urged by the environment organizations in their statement on the first day of the conference, when they also pointed out that the scientific evidence was already sufficient for setting ecologically viable limits for sulphur, nitrogen, and ozone. Far from all the politicians attending the conference were however prepared to endorse these requirements, which

to environmentalists are so obviously necessary.

The communiqué emphasized the need for reducing emissions through improvements in energy production and manufacturing processes, through recycling and the application of advanced flue-gas cleaning methods as well as the better use of energy. It also pointed to the need for reducing the emissions of pollutants from road vehicles and aircraft, for instance through more effective exhaust controls and changes in the pattern of transportation.

Among the points agreed upon were also the following:

In drawing up national policies for energy, transportation, and industry, all nations should attach greater weight to coordination with environmental policy.

High priority should continue to be given, both in the national and the international sphere, to the development of energy-saving and low-waste industrial processes, and generally those that are less harmful to the environment, as well as to the development of effective control technologies.

More international cooperation is needed in order to save cultur-

al monuments that are now threatened with rapid destruction if air pollution is not reduced.

More research is also needed into the effects of atmospheric pollution on human health.

The communiqué ended by saying: The participants (to the conference) urge their governments to redouble their efforts (in the areas debated) within the framework of existing conventions or in other appropriate forms of cooperation.

Or as Anker Jørgensen, chairman of the Nordic Council as well as of the conference, put it: The arrangers now expect the participants to make efforts to influence their parliaments and governments to act.

Christer Ågren

In preparation for the conference, the Nordic Council issued a booklet entitled "Europe's air — Europe's environment", which is available in English, French, and German translation, as well as in Swedish. Both this and the text of the final communiqué can be obtained from Nordiska Rådet, Box 19506, S-104 32 Stockholm, Sweden.

**Table**  
Estimated area of visible damage to crowns attributable to air pollution. (Data available as of May 1985, 1,000s of hectares.)

	Slight damage	Moderate damage	Dying/dead	Total
Austria	240*	80*	10*	330-
Belgium	17*	2*	1*	20-
Czechoslovakia	514*	123*	54*	691-
France	86*	11*	3*	100*
Germany, Fed. Republic	2,424-	1,163-	111-	3,698-
Hungary	103*	13*	4*	120-
Luxembourg	25*	5*	.*	30-
Netherlands	80*	20*	.*	100-
Poland	419-	199-	36-	654-
Switzerland	295-	76-	13-	384-
Ten countries with known damage	4,203	1,692	232	6,127
Europe (estimate)	—	—	—	6,900

\* Unofficial figure or estimate.

# Can supply be maintained?

One of the addresses at the Nordic Council conference in September that aroused particular interest was that of Lennart Schotte. Mr Schotte is chairman of the ECE group of specialists on the implications on air pollution for the market for timber — in other words, how it will affect the supply and quality of the wood needed for pulp and paper making, as well as sawmilling.

Noting that substantial economic as well as ecological assets were threatened, Mr Schotte emphasized the fact that forest damage was already so obvious as to eliminate any idea that action could be postponed until detailed proof of the causes was forthcoming.

## Widely affected

One difficulty, he said, in assessing the economic consequences of forest damage and in developing strategies, was the lack of comparable annual inventories of growing stock, annual increments, and the area or volume of damaged forest. Techniques were however being developed for monitoring pollutants and collecting data on the damage.

Data from May 1985 indicated, according to Mr Schotte, that air pollutants had affected about 7 million hectares of forest in Europe (see table). This would be 5 per cent of the area of exploitable productive forest. Around 250,000 hectares of forest were then classified as dead or dying, and about 4 per cent of the trees removed had had to be felled prematurely.

## One-fifth lost

Mr Schotte then went on to illustrate the situation with details for one country, Czechoslovakia.

In that country, 27 per cent of the total area of forest is thought to be damaged, with losses amounting to 1.6 million cubic metres of timber a year. This

would correspond to 10 per cent of the average yearly growth. The cost in 1981 was estimated to have been 6.4 billion koruna.

By 1990 it is estimated that 42 per cent of the forested area will be under threat from air pollution, with a consequent annual loss in output of 3.4 million cubic metres, or 21 per cent of the normal increment. Even after the electricity plants have been equipped for flue-gas cleaning, around the end of the century, the situation will still be roughly the same.

## Added expense

The consequence of air pollution is thus reduced forest growth. It is feared, moreover, that the wood from sanitation fellings will be of poorer quality, the conditions for spontaneous forest regeneration will deteriorate, felling and transportation will be more expensive, and there will be heavier costs for conservation. In addition, there will be the ecological consequences to deal with, for which a vigorous conservation program has been initiated, involving investments of Kčs 18,000 million over the period 1986-90.

## Impressive job

In parts of the Erzgebirge extensive damage has been observed, as well as actual forest dieback. The soil itself is seriously acidified. Dead and damaged trees have been removed from large areas, but in 1984 it was considered necessary to give priority to replanting so as to make biological revival possible. The first step has naturally been to treat the soil with lime and fertilizer. An impressive job of replanting is being done, leaving rows of stumps and tree remains, sown with birch and rowan, as windbreaks. So far Colorado spruce (*Picea pungens*) has been the only conifer found capable of surviving and producing

timber. But the costs involved are high. It is estimated that the total cost, from seedlings to closed canopy, will be Kčs 60-90,000 per hectare, compared with a normal cost of Kčs 12,000. Even if this planting program should be successful in the long term, the older type of forest will however never be re-established.

## Ecological priority

In Czechoslovakia the re-creation of ecological systems has been allowed to take precedence over the production of raw timber for the forest-products industries and even over economic considerations. This means that the forest-products industries will eventually have to change their raw material base, moving away from spruce to a mixture of species. Re-creating forest stands is a valuable and necessary endeavour, but the result will not be the homogeneous forest that we have hitherto been used to.

## Safeguard resources

At present, any disturbances of the market are only local in nature. Clear warnings must be however given as to the future. All the forecasts point to an increasing demand for fibre in Europe. We must therefore safeguard existing resources. It is important that our basic approach to air pollution be broad and comprehensive, and that further contacts between different parts of the ECE region be encouraged. No matter whether the emphasis is on reducing emissions, on ecology, or economics, international cooperation will be needed at a variety of levels, concluded Mr Schotte.

# At least making a start

On September 11, 1986 came an announcement that the British government now intends taking steps to bring about a reduction of the country's emissions of sulphur. It was made by the Prime Minister during a visit to Norway, one of the countries that are worst affected by acidification — the cause being in large part emissions from the United Kingdom, about which Norway has been protesting for a long time.

Thus after ten years of being pressured mostly by the Scandinavian countries, the British government has changed its attitude somewhat, and consented at least to a limited program for reducing emissions of sulphur. This will involve fitting three of the largest coal-fired power plants with modern equipment for cleaning the flue gases, which will reduce the amount of sulphur emitted by these power stations by about 90 per cent.

## Doubtful result

Previously the Minister for the Environment, William Waldegrave, had said that the aim was to decrease the emissions of nitrogen as well as sulphur oxides by 30 per cent before the end of the nineties, as usual taking 1980 as the base year. Later estimates of the country's energy requirements have shown however that unless extra measures were taken, the emissions would be just about the same in 2000 as in 1980. It is these new estimates, combined with increasing international pressure as well as ever more scientific evidence of the harmful effects on the environment, that lie behind the change in policy.

Between 1980 and 1984 the UK emissions of sulphur dioxide fell almost by 25 per cent, from 4.7 million tons to 3.5 million. The drop was not due however to any deliberate policy or actual measures, but to a number of other factors, such as switching from coal and oil to natural gas,



Drawing: Chris Rose

changes in the structure of industry, and a recession of business. Unless anything was done, emissions would again start to rise as a result of the increased output of electricity that is now expected.

About 70 per cent of the emissions of sulphur comes from power production, which is in the hands of the Central Electricity Generating Board. It now proposed to retrofit three of the CEGB's largest coal-fired power stations for flue-gas cleaning. One will be the new Drax B, but the other two are not yet announced. Altogether however 6,000 megawatts of the existing generating capacity will be retrofitted between 1988 and 1997, at an estimated cost of 600 million pounds. The increased cost to users is put at 1.5 per cent. The program is on the other hand expected to result in 2-3,000 new jobs per year up to 1997.

The expected effect will be to reduce sulphur emissions by about 14 per cent by 1997. But if power output increases according to forecast, the result may actually be nil.

## Admission of guilt

There is thus a considerable risk that the United Kingdom will still stay outside the 30 Per Cent Club. The country is in any case far from making any attempt to implement the EEC draft directive of 1983, urging the member states to achieve a 60-per-cent cut in emissions of sulphur from large combustors by 1995. To do that it would have had to retrofit twelve of its largest power plants.

There is however a slight gleam of light. The government has announced that it will require all future coal-fired power stations to be equipped for flue-gas desulphurization. This will of course reduce emissions, although the effect will hardly be noticeable until after the turn of the century.

There is moreover a catch in the whole program, as revealed in a press release from the Department of the Environment, saying: *"No final decision will be taken to commence the installation of equipment until next spring's report from the Royal Society and*



Photo: Kjell-Arne Larsson

the Scandinavian Academies of Science, on surface water acidification, has been received and studied."

Lord Marshall, chairman of the CEEB, said the government move followed a CEEB recommendation, based on assessment of new research into the effects of sulphur emissions on Scandinavian lakes and soils. According to Lord Marshall, the soils of Scandinavia have been accumulating acidity and sulphur for many decades, possibly a century and a half. "That acidity", he said, "is accumulating partly from acid emissions in Scandinavia, partly from emissions from ourselves, the remainder of Europe, and America."

He also claimed that "a very important contribution to soil acidification is the rapid afforestation of Scandinavia some decades ago,"

adding: "All this effect on the soil will take a very long time to leach away, possibly decades, even if acid deposition was stopped abruptly overnight."

He considered that two types of action were required to cure the problem: "First a continued reduction in the rate of acid deposition to allow stored acidity to be washed out. This means action in Scandinavia itself, in the UK and elsewhere, and possibly some modification of forestry practice." The second action would be to neutralize the acidity accumulated in the soils by the application of base materials such as limestone.

Adam Markham, Friends of the Earth pollution campaigner in England, described the government's move as too little and too late. "The best we can say about Mrs Thatcher's decision," he said,

"is that it amounts to an admission of guilt. If it is now agreed that flue-gas desulphurization is the best practicable environmental option, then the UK should act on its moral responsibility to the rest of Europe, and fit all large combustion plants with the equipment."

Continuing: "First the government asks for the scientific data before they act, and now, when it is available and points to the need for at least 80-per-cent reductions, they just ignore it. Quite clearly they have no intention of taking any more action than is absolutely necessary to avoid political embarrassment. When will the government realize that our own lakes, rivers, and forests are threatened as well as those of other countries? By helping Scandinavia we could help ourselves."

Christer Ågren



# New summary: Ten million

Growing threats to forests from changes in the chemistry of the atmosphere now pose a set of potentially costly consequences during the coming decades. In the autumn of 1983, the West German Ministry of Food, Agriculture and Forestry galvanized both scientists and the citizenry with an unsettling finding: 34 per cent of the nation's trees were yellowing, losing needles or leaves, or showing other signs of damage. Preliminary evidence pointed to air pollution and acid rain as contributing, if not the leading causes. A more thorough survey in 1984 confirmed that the unusual tree disease was spreading. Foresters found that trees covering half of the nation's 7.37 million hectares of forests were damaged, including two-thirds of those in the southwestern state of Baden Württemberg, home of the fabled Black Forest.

## Worst in Europe

Spurred by West Germany's alarming discovery, other European nations took action to assess the health of their own forests. Different methods of surveying and estimating damage were used in various countries, so the results are not strictly comparable. Nonetheless, the assessments collectively show that trees covering 8 per cent of Europe's 136 million hectares of forest exhibit signs of injury (see table). The key symptoms for the conifer species—the hardest hit—parallel those found in West Germany: yellowing of needles, casting off of older needles, and damage to the fine roots through which trees take up nutrients. Forest injury pervades the band of central Europe bounded by latitudes 46 and 53 degrees North. In at least a half-dozen countries—Austria, Czechoslovakia, Luxembourg, the Netherlands, Switzerland, and West Germany—a quarter to half the forested area is damaged.

National estimates in some cases belie the extent of damage in specific regions. Total damage in Sweden is placed at about 4 per cent, but an estimated 20 per cent of the forested area in the south is affected. In 1984, foresters in France surveyed portions of the French Jura and Alsace-Lorraine, adjacent to West Germany's Black Forest, and found that more than a third of the trees were injured, at least 10 per cent of them severely. Indeed, the alpine region spanning portions of Austria, France, Italy, Switzerland, and West Germany exhibits the worst damage. Swiss officials have warned that avalanches and landslides resulting from the loss of tree cover will damage houses and farms, and may force people to evacuate some areas. Estimates for the Eastern European countries include severely damaged and dead trees, but probably not all those exhibiting early stages of needle loss and yellowing. Unfortunately, no forest damage data are available for Greece, Ireland, Portugal, and Spain.

Unusual tree injury in North America appears much less extensive than in central Europe. In the high elevation forests of the eastern mountain ranges, red spruce trees are undergoing a serious dieback—a progressive thinning from the outer tree crown inward. On a closely studied peak called Camels Hump in Vermont, researchers found that half the spruce trees had died. A 1982 survey indicated that red spruce are declining in a variety of forests throughout the Appalachian Mountains.

## Unsettling parallel

More subtle signs of ill health come from the U.S. Forest Survey's discovery that pine trees in a broad region of the Southeast grew 20 to 30 per cent less between 1972 and 1982 than they did between 1961 and 1972. These pines are important commercially, and sustained growth

declines will reduce the amount of timber available for future harvests. In a November 1985 report, Forest Service analysts state that the net annual growth of softwood timber in the Southeast "has peaked and turned downward after a long upward trend". Though less well documented, unexpected growth declines appear to have occurred throughout the Appalachians, extending north into New England. In written testimony presented to the U.S. Senate in February 1984, soil scientist Arthur H. Johnson draws an unsettling parallel by noting that similar growth reductions preceded the "alarming incidences" of forest damage in Europe.

## A principal cause

Hundreds of scientists in the affected countries continue to search for the cause of this unprecedented forest decline. Collectively they offer a bewildering array of hypotheses, attesting to the difficulty of unraveling a mystery within a complex natural system. Most agree, however, that air pollutants—probably combined with natural factors, such as insects, cold, or drought—are a principal cause. Explanations focus on acid rain, gaseous sulfur dioxide, nitrogen compounds, heavy metals, and ozone, which singly or in combination cause damage variously through the foliage, forest soils, or both.

A key symptom of tree injury, yellowing of the needles, typically results from a deficiency of one or more nutrients. Among the most vital to a tree's health and productivity are calcium, magnesium, and potassium. Any one of these can become deficient in a tree either because the soil is lacking that particular element, so the tree's roots cannot absorb it, or it is being leached from the tree's foliage faster than the tree can take it up from the soil.



# hectares of forest damaged

Table

Estimated Forest Damage in Europe, 1985

Country	Total Forest Area (thousands of hectares)	Estimated Area Damaged (thousands of hectares)	Portion of Total Forest Damaged (per cent)
Austria	3,754	910	24
Belgium	616	111	18
Czechoslovakia	4,600	1,250	27
East Germany	2,900	350	12
France	15,075	— <sup>1</sup>	— <sup>1</sup>
Hungary	1,600	176	11
Italy	6,363	400	6
Luxembourg	82	42	51
Netherlands	309	138	45
Norway	8,330	400	5
Poland	8,677	600	7
Sweden	26,500	1,000	4
Switzerland	1,200	408	34
West Germany	7,371	3,824	52
Yugoslavia	9,500	1,000	11
Other	39,087	—	—
Total	135,964	10,609	8

<sup>1</sup> Surveys covered selected regions; see text.

Sources: *Allgemeine Forstzeitschrift*, No. 46, Munich, West Germany, November 16, 1985; West Germany figures from Federal Ministry of Food, Agriculture and Forestry, "1985 Forest Damage Survey," Bonn, West Germany, October 1985; Italy figure from U.N. Food and Agriculture Organization, Forestry Department, "Long-Range Air Pollution: A Threat to European Forests," *Unasylva*, Vol. 37, 1985.

Both direct attacks to the foliage by air pollutants and acid rain, and indirect damage through changes in forest soils can alter the balance of nutrients and other critical metabolic functions within trees. In combination with natural stresses, both pathways probably contribute to the tree disease and death spreading throughout central Europe. Changes in the soil, however, pose the most troubling prospects for the future. A reduction in pollutant emissions would improve air quality and curb acid rain almost immediately, thus allowing trees suffering from direct attacks on the foliage to recover fairly quickly. Damage to soils from acidification, however, would be irreversible for the near

future, since soils would take decades or centuries to recover.

## Alterations in soil

Evidence from a severely damaged forest in Eastern Europe suggests that alterations in the soil are indeed taking place. Large portions of the Erzgebirge Mountains northwest of Prague, Czechoslovakia, now resemble a wasteland. Near the industrial city of Most, where power plants burn high-sulfur coal, sulfur dioxide concentrations average 112 micrograms per cubic meter, much higher than in most industrial areas, and 13 times higher than in a seemingly undamaged rural forest about 160 kilometres to the southeast. Peak concentra-

tions register several times higher than the average. The numerous dead and dying trees in this industrial region may thus be succumbing to the "classic smoke injury" known to occur near large sources of uncontrolled pollution.

## Threshold effect

Detailed measurements of the chemistry of runoff from the Erzgebirge Mountain forest also suggest, however, that acidification has profoundly altered the soil's ability to support a forest. Czech geochemist Tomas Paces found that losses of the nutrients magnesium and calcium from the damaged forest averaged, respectively, 6.8 and 7.5 times greater than from the undamaged rural forest. Less than half of these increased nutrient losses can be explained by the higher rates of precipitation and thus of atmospheric chemical inputs in the damaged forest. Runoff of aluminium, which normally remains bound up in soil minerals, was 32 times greater than from the undamaged forest. With the loss of calcium and other elements that can buffer incoming acidity, aluminium mobilizes to serve as the buffering agent. Scientists have learned that soluble forms of aluminium can be toxic to trees, damaging their roots and preventing them from picking up vital nutrients from the soil. Finally, outputs of nitrate from the damaged forest exceeded those from the undamaged forest by a factor of 20. Paces believes this reflects the damaged forest's inability to properly recycle nitrogen — a loss of basic ecosystem function.

Forests in the industrial regions of Eastern Europe have borne inordinately heavy pollutant loads over the last few decades. Few forests outside these regions have so drastically collapsed. Yet ecological theory firmly supports the possibility of more widespread destruction as chemical

stress on forests accumulates over time. According to C.S. Holding of the University of British Columbia, natural systems may so successfully absorb stress that for long periods change occurs very slowly. Eventually, however, systems may reach a stress point, and *"a jump event becomes increasingly likely and ultimately inevitable"*. Paces of Czechoslovakia believes such a threshold effect may occur with forests subject to soil acidification. Where and when this "inflection point" will be reached is not known, yet Paces says *"its existence is suggested by the fact that the acidification of soils in Central Europe has proceeded for decades whereas the dieback of forests is a relatively fast phenomenon which takes only a few years"*.

### Economic consequences

Substantial economic losses already are occurring from the existing level of pollution stress on forests, and they will magnify greatly if the prospects of large-scale forest decline become reality. The Czechoslovakian Academy of Sciences estimates the cost of acid pollution at 1.5 billion dollars annually, with forest damage accounting for much of the total. In West Germany, foresters are now harvesting dead and dying trees before their time, which both increases forest management costs and leads to timber surpluses that depress market prices. Professor H. Steinlin of Albert-Ludwigs University in Freiburg sees little potential for West German forest industries to stabilize the market by increasing exports, especially if forest damage simultaneously creates wood surpluses in Austria, Switzerland, and other neighboring countries. With domestic markets saturated and several countries trying to increase exports, lumber prices could drop sharply, causing severe economic losses to forest owners.

Some time in the future, when trees cut prematurely would otherwise have been harvested, a period of shortages and rising

wood prices could occur. Projecting from current trends, one study by researchers at the Technical University of Berlin estimates that German forest industries will suffer monetary losses averaging 1 billion dollars annually through the year 2060. Yet besides supplying timber, healthy forests help protect the quality of streams and groundwater supplies, control the erosion of soils, and provide recreational enjoyment for both Germany's citizens and tourists. Adding in these projected losses, the Berlin researchers estimate that the total cost of forest damage over the next several decades will average 2.4 billion dollars per year.

### Damage may spread

In the United States, field and laboratory experiments, combined with the findings of greatly reduced tree growth, strongly suggest that ozone—already known to be diminishing crop yields—is reducing the productivity of some commercial forest species. Researchers at Cornell University subjected four species—white pine, hybrid poplar, sugar maple, and red oak—to a range of ozone concentrations spanning those typically found in the United States. In all four species, net photosynthesis, which is a measure of a tree's growth, decreased linearly with increasing ozone concentrations. This held true even at ozone levels now typical of rural areas. In no case were the reductions in photosynthesis accompanied by visible damage to the foliage. Thus, even with no outward sign of injury, trees covering large regions are very likely losing vigor and growing slower. As researchers Peter B. Reich and Robert G. Amundson point out, growth reductions of just 1 to 2 per cent per year amount to a substantial loss of timber over a tree's lifetime.

In the Third World, uncontrolled clearing of forests is presently a much greater cause for concern than forest damage from air pollution or acid rain. Yet the

health and productivity of forests in developing countries are bound to diminish in the future if pollution from power plants, industries, and motor vehicles continues to increase. Damage may first appear in the vicinity of large polluted urban centers, as it did, for example, surrounding West Germany's Ruhr Valley during that nation's earlier stages of industrialization. Indeed, trees are reportedly dying along heavily travelled corridors in Mexico City. As in industrial countries, however, damage may spread to rural areas as pollution emissions increase, as trees remain exposed to pollutants for longer periods of time, or as soils acidify.

### Costs mounting

Chronic pollution stress—whether from ozone, acid rain, sulfur dioxide, nitrogen compounds, or metals—now places a substantial share of the industrial world's forests at risk. In just one year, forest damage in West Germany jumped from 34 per cent to 50 per cent. The 1985 damage survey showed just a slight increase, to 52 per cent, perhaps because of weather conditions favorable for the forests. No one knows how much the forest damage in all of Europe—now at least 8 per cent—will increase. Nor does anyone know how many of the injured trees will eventually die, or when thresholds may be reached beyond which forest damage rapidly worsens. Whether the unexplained growth reductions in eastern U.S. forests portend a similar decline there also remains unknown. Meanwhile, with each passing year of continued pollution stress, the costs of lost forest productivity mount, as do the risks of more extreme forest decline and death.

Sandra Postel

From "Altering the Earth's Chemistry: Assessing the Risks", Worldwatch Paper 71.

# Useless proposal for diesels

On June 19, 1986, the European Commission proposed a very weak Directive to the Council of Ministers, to reduce particulate air pollution caused by diesel-powered cars (*COM(86)261 final*).

Specifically, the proposed standards are:

**Type approval** 1.3 g/test

**Production conformity** 1.7 g/test

These standards, which are about three times higher than those which will now go into effect in the US (1987 model year) and which many of the vehicles produced in Europe are already achieving, are intended to be introduced on the same schedule as the tighter standards for gaseous pollutants.

## Hazardous and toxic

This weak proposal is especially unfortunate, since diesel particulate causes or contributes to a wide variety of serious health and environmental problems. For example, a strong correlation exists between suspended particulate and variations in infant mortality and total mortality rates. Further, diesel particles aggravate disease among bronchitis, asthmatics, cardiovascular patients and people with influenza. Diesel particles raise a special health concern because they are very small and are much more likely to be deposited in the deepest recesses of the lung where the critical gas exchange takes place.

Diesel particulate has also been singled out as especially hazardous and toxic because of its composition. It would be prudent, on the basis of wide variety of experiments with animals as well as a series of epidemiological studies, to conclude that diesel particulate contributes significantly to cancer risks in Europe. Since the diesel car population in the Community is projected to grow from today's 5.8 million to about 15 million by 1995, the risk

will increase tremendously, unless substantial controls are instituted.

While health issues have been the cause of most concern, diesel particles can also become a nuisance, impair visibility, and degrade aesthetics and materials through soiling. They may also contribute either directly, or in conjunction with other pollutants, to structural damage by means of corrosion or erosion.

## Weak standards

That the standards proposed by the Commission are weak is shown by the fact that particulate test results collected last year by CCMC member companies (most of world's car makers) revealed that 80 per cent of the vehicles already meet the proposed levels without any controls. The remaining ones could be brought into compliance with only minor engine modifications. But none of the advanced controls already being applied on European cars made for the US market will be required in Europe as a result of these standards.

## Diesels increasing

These modest standards are even more remarkable in view of the explosion of diesel cars sales in Europe. For example, the overall sales of diesel cars in Europe increased by 21.3 per cent from 1984 to 1985. It is especially ironic that West Germany has encouraged the growth of high particulate-emitting diesel cars by allowing them to qualify for "low pollution" tax incentives without any requirement that they meet the same particulate levels as German models exported to the US. In part as a result of these tax incentives, diesel cars sales in Germany have continued to grow in 1986. Fortunately, in adopting its low-pollution tax policies earlier this year, the Netherlands did not provide similar tax reductions for uncontrolled diesels.

A much stronger proposal is warranted than that recently proffered by the commission. It should include the following key elements:

1. The mandatory particulate standard should be 0.6 grams per test, starting with 1987 model year.
2. New truck and bus controls, similar to those recently adopted by the US EPA, should be required.
3. All new government vehicles should be required to meet the lowest possible particulate emissions levels.
4. The Community should do everything possible to encourage the retrofit of urban buses with advanced particulate controls.

In addition, member countries which have adopted tax incentives to encourage customers to purchase low-pollution vehicles should either exclude diesels from any tax reductions or require them at a minimum to achieve 0.6 grams of particulate per test (ECE test) or 0.2 grams per mile (US test) in order to qualify for low-pollution tax credits.

EEB Press release

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1040 Brussels, Belgium  
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# Forest tour of Europe



*Demonstration in the streets of Hamburg, F.R.G.*

*Photo: Urban Nilsson*

Last July the European Youth Forest Action arranged a bus tour of Europe which started in Scandinavia and continued through West Germany, the Netherlands, Belgium, England, France, Yugoslavia (again via Germany), and Austria to Hungary. In one of the final stages the tour was joined by young people from Poland.

About 150 persons from fifteen countries participated in this trip, which included a number of activities and demonstrations along the way. In Denmark there was a visit to a coal-fired power station, street parades were organized as well as a big rock gala—Wood Rock—with an attendance of about 600. In Germany there were street shows and a protest march carrying dead conifers. The devastating effect of air pollution on statues and buildings was demonstrated in Amsterdam; in Holland, too, Europe's

largest opencast coalmining operation was shown, as well as damaged forests.

The singing of a specially composed ditty, addressed to Margaret Thatcher, outside the Houses of Parliament was filmed by the BBC. In London the tour participants also had the opportunity of meeting the environmental spokesmen for the Labour and Liberal parties, David Clarke and Simon Hughes, and a delegation went to the CEEB's headquarters to hand over a message. While the delegation was there, the building was blockaded by other tour members, which caused a certain commotion. Instead of meeting the Minister for the Environment, William Waldegrave, as had been hoped, the EYFA delegation had a short talk with Angela Rumbold, undersecretary of state at the Department of the Environment, during which a question as to what was being

done in the UK to reduce emissions was met with embarrassed silence.

In France, at Nancy, balloons with written messages attached were released. The Austrians had a specially made Wald-Buss, in which stills showing forest damage were screened. Outside was a display of literature, and leaflets were distributed.

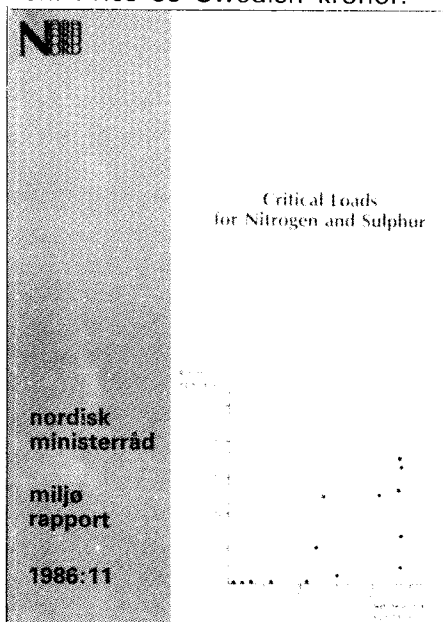
A camp had been set up at Maribor, in Yugoslavia, where the Polish delegates joined the tour. Here exchanges between east and west were discussed. Then in Hungary there were study trips, including one to the country's badly damaged oak forests. Finally at Budapest there was a meeting with Hungarian politicians.

This winter the EYFA intends to hold planning sessions, to decide whether to continue with this form of action, and if it is so decided, what to do next time.

# Literature

## Europe's air — Europe's environment (1986)

94-page report of the Nordic Council of Ministers to the Nordic Council's International Conference on Transboundary Air Pollution, Stockholm, September 1986. Describes the current situation in Europe, emissions and transboundary fluxes of air pollutants, with emphasis on nitrogen. Gives a description of policies and technologies to reduce emissions, and discusses a European plan of action for the 1990s. Available in English, German, French, and Swedish editions from the Nordic Council, Box 19506, S-104 32 Stockholm, Sweden. Price 35 Swedish kronor.



## Critical loads for nitrogen and sulphur (1986)

232-page report from a Nordic working group of scientists, edited by Jan Nilsson. Sets down scientifically defined critical loads for sulphur and nitrogen, especially with regard to their acidifying effects on forest soils, groundwater, and surface water. A critical load is defined as "the highest load that will not cause chemical changes leading to long-term harmful effects in the most sensitive ecological systems." In English. Available from the publisher, the Nordic Council of Ministers, Postboks 6753, St. Olavs Plass, N-0130 Oslo 1, Norway.

## Europe's air



## Europe's environment

## Air pollution and forest damage (1986)

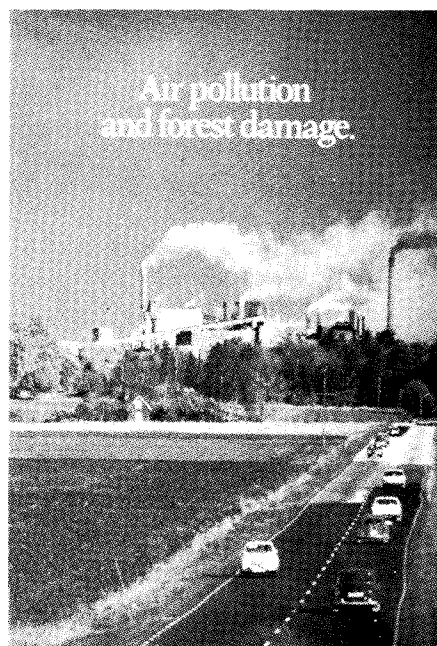
16-page booklet published jointly by the Swedish National Board of Forestry and the National Swedish Environmental Protection Board. Forest damage is illustrated with colour photos, and the causes explained, as well as the measures that can be taken by foresters to curb it. Available from Skogsstyrelsen, Läromedelsbeställningen, S-551 83 Jönköping, Sweden. In English. Price 5-10 Swedish kronor, depending on the number ordered.

## Atmospheric pollutants in forest areas. Their deposition and interception (1986)

287 pages. Edited by H-W Georgii. Proceedings of a symposium held in the Federal Republic of Germany in November 1985. The book reflects the present state of knowledge in regard to the wet deposition of pollutants on forest ecosystems, the interception of acid fog by trees, and new methods for determining deposition and interception. The damaging effects of acid and heavy-metal depositions on forest are also discussed. Published by D. Reidel Publishing Company and available from Kluwer Academic Publishers Group, Box 322, 3300 AH Dordrecht, the Netherlands.

## Transboundary air pollution — Effects and control (1986)

77-page report by the United Nations Economic Commission for Europe, prepared within the framework of the Convention on Long Range Transboundary Air Pollution. Describes the effects of air pollutants on agricultural crops, soil, and groundwater as well as technologies for controlling emissions of nitrogen oxides from mobile sources. Available in English, French, and Russian. For more information, write United Nations ECE, Palais des Nations, CH-1211 Geneve 10, Switzerland.



## Acid rain: Economic assessment (1985)

302 pages. Edited by Paulette Mandelbaum. Presents the scientific understanding of acid deposition and its effects, with an international perspective on the factors involved, New York State's strategy for controlling acid rain, Canada's acid rain policy, and articles on economic and health issues. Proceedings of a conference held in Washington, D.C., in December 1984. Available from the publisher: Plenum Publishing Corporation, 233 Spring Street, New York, N.Y. 10013, USA. Price 55 US dollars (66 dollars outside US and Canada).

# Literature

## **Altering the Earth's chemistry: Assessing the risks (1986)**

68-page report by Sandra Postel, Worldwatch Institute. Tells how human activity has disturbed ecological systems, and describes the consequences such as the changed conditions for world supplies of food, forest health, and human health. Available from Worldwatch Institute, 1776 Massachusetts Avenue, N.W., Washington DC 20036, USA. Price 4 US dollars.

## **Vannkvalitet og helse (1986)**

77 pages. Water quality and health — a study of the possible relationship between aluminium in drinking water and dementia. The results also support the hypothesis of a connection between the concentration of aluminium in drinking water and the frequency of Alzheimer's and similar diseases. Edited by Tiril Vogt. In Norwegian, with summary in English. Published by the Central Bureau of Statistics of Norway in Oslo. Price 30 Norwegian kroner.

## **Waldverwüstende Immissions-schäden in Österreich (1985)**

50-page booklet about forest damage in Austria. In German. Written by Hannes Mayer, and available from the Institut für Waldbau, Universität für Bodenkultur, Peter Jordan Strasse 70, A-1190 Wien, Austria.

## **Som vinden blæser (1986)**

138-page book on the environmental situation in Poland, East Germany and Czechoslovakia. Describes among other things the national energy policies, the situation as regards air and water pollution, and health effects, as well as environmental policies. In Danish. Available from the publisher, the Danish environmental organization NOAH, Studiestraede 24, DK-1455 København, Denmark. Price 130 Danish kroner.



## **Luftvård (1986)**

186 pages. By P. Grennfelt et al. Third revised edition. Covers most aspects of the air pollution problem: emission, transport, deposition, effects and possible measures. In Swedish. Publisher: Bokskogen, Box 7048, S-402 31 Göteborg, Sweden. Price 160 Swedish kroner.

## **Skovdøden (1985)**

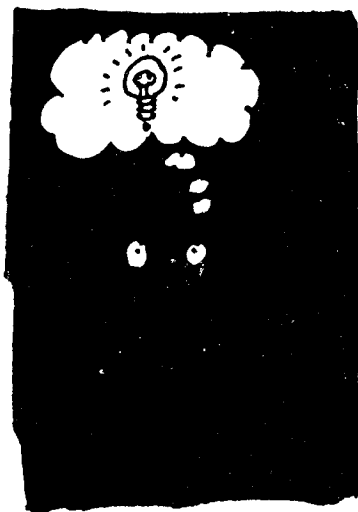
231-page book on forest damage, written by Ingolf Löffler. In Danish. Available from Forlaget Aaløkke, Porskaervej 15, Nim, DK-8700 Horsens, Denmark. Price 98 Danish kroner.

## **Monitor 1986 — Sura och försurade vatten (1986)**

180-page book, profusely illustrated with maps and diagrams in colour. Gives a thorough description of the current acidification situation in Sweden, the number of lakes affected, the chemical processes involved, and a prognosis for the near future. In Swedish. Available from the publisher, the National Environmental Protection Board, Box 1302, S-171 25 Solna, Sweden. Price 85 Swedish kroner.

## **Miljö för miljoner (1986)**

224 pages. Describes some of the main environmental problems in Sweden as they appear in 1985. It shows what has been done and what is now being done nationally and internationally in regard to air pollution, outlines the Swedish laws for the protection of the environment, and the problems connected with the use of various chemicals, etc. In Swedish. Published by the National Environmental Protection Board, Box 1302, S-171 25 Solna, Sweden. Price 110 Swedish kroner.



# International Acid Rain Week 16-24 May 1987

- Forest alerts
- Exhibitions
- Balloon releases
- Postcards
- Articles
- Public debates
- Hearings
- City alerts
- Studies
- Excursions
- Advertisements
- Investigations
- Tree planting
- Spreading information

During International Acid Rain Week, organizations in many countries will be organizing actions and activities on the theme of air pollution and acidification.

Exploit this joint gathering of forces in your massmedia contacts during Acid Rain Week, and point out that this is a unique international action — a mobilization of opinion that cannot be ignored by the decision-makers.

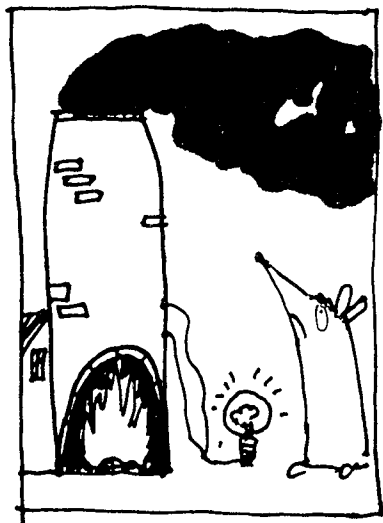
Join up for International Acid Rain Week.

## East-European network

Greenway — a network consisting of environmental NGOs of the European socialist countries was established in 1985. A quarterly newsletter called *Greenway* magazine will be published in order to support the network. It will focus on environmental problems and activities in the European socialist countries, and also try to improve local and international environmental activities.

ELTE Nature Conservation Club, Budapest is responsible for the editing, and the editor-in-chief is Erzsébet Pásztor. *Greenway* will be free of charge, and the editorial board welcome any printed material for exchange, as well as any articles on the above mentioned topics. Address:

Greenway  
ELTE Nature Conservation Club  
Egyetem tér 1-3  
H-1053 Budapest, Hungary  
Phone: (1)350 682, 640 614



Drawing: Chris Rose



# Engaging the young

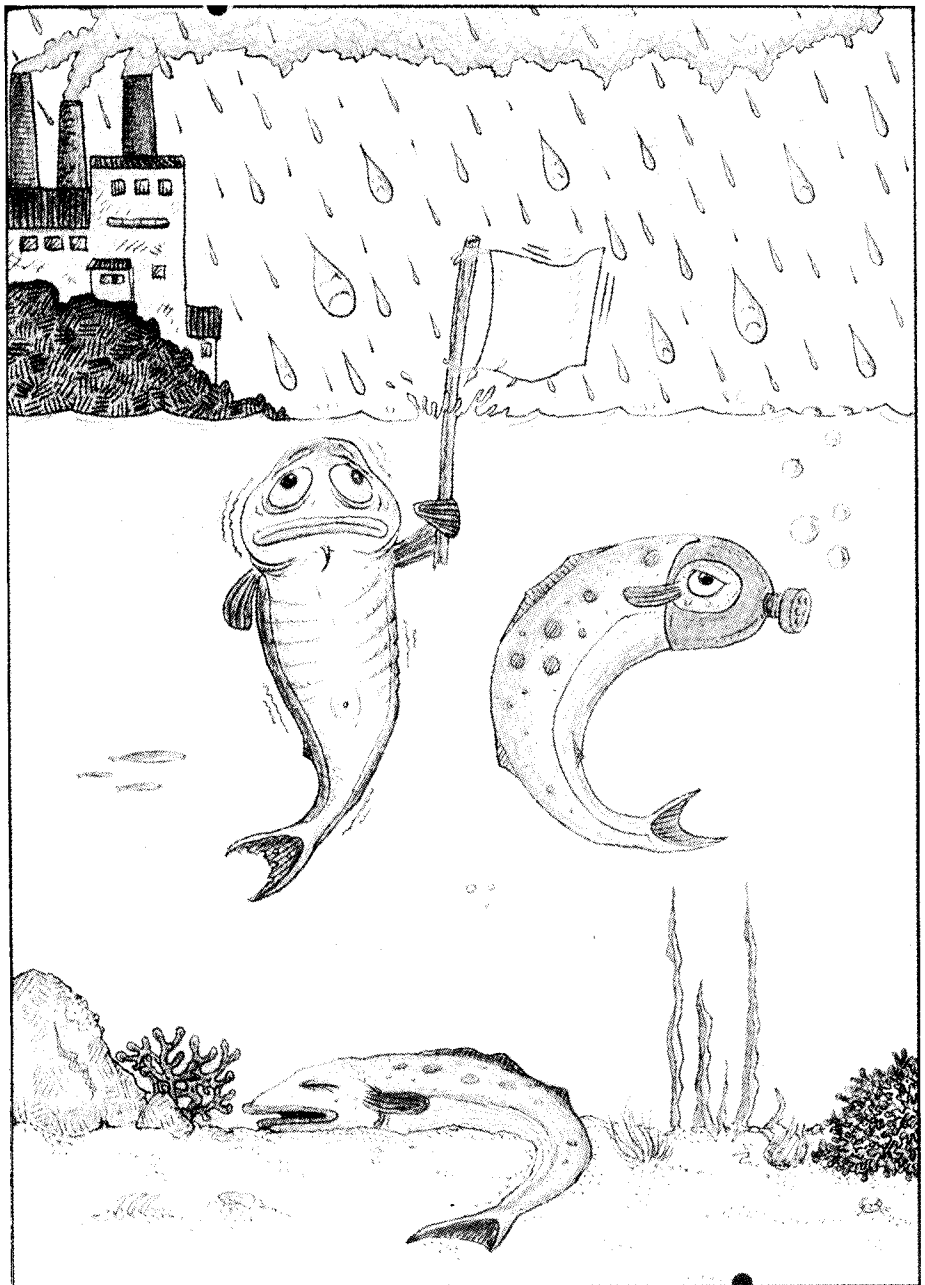
Sad-looking raindrops, dead trees, poisoned animals and people, fish bearing a white flag and a gas mask. Such were among the motifs of 10,000 drawings submitted in a competition for schoolchildren organized by the Stop Acid Rain Campaign Norway last year.

"We were overwhelmed by the response", says Svein Langvad, campaign secretary. "Such a number is enormous for a small country like Norway, but even more surprising is what the competition revealed. Norwegian kids evidently know a lot about acid rain and air pollution, and are indignant at the nonchalance shown by those countries that permit uncontrolled emissions. This can be seen not only from their drawings, but also from their interest in collaborating in the British WATCH project."

## Risk of forgetting

Norwegian schoolchildren have been measuring lake water and precipitation, and each class has a "sister" in the UK with which it exchanges correspondence and coordinates its investigations. The WATCH project is called rather amusingly "Acid Drops" (which normally are sweets) and is organized by the Royal Society for Nature Conservation, and its companion in Norway by the Norwegian Society for the Conservation of Nature, in cooperation with the Stop Acid Rain Campaign.

"An important element in our campaign is to give the young an increased knowledge of nature conservancy and the dangers of air pollution and acid rain. While the response to our drawing competition shows that our efforts must have had effect, there is still much to be done. Acid rain has been a problem in Norway for twenty years, and there is always a risk of it being forgotten. Adults seem to think that the politicians have it



One of the winning drawings, by Thomas Grønbukt, 16-year-old.

under control, so young people must be kept continually informed.

"Reactions to the Chernobyl accident show that it is easier to arouse the media and the public with sudden and frightening environmental problems. Acid rain, on the other hand, is a creeping danger and is nothing new, making it difficult to keep it alive in the media and the general conscious-

ness — despite evidence that acidification is both increasing and spreading geographically.

"These 10,000 drawings have been put to good use. They have been shown all over Norway, and in September most of them were handed in to the British embassy in Oslo, for transmission to Margaret Thatcher. We hope she will be as impressed as we have been."