

Acid News

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



Drawing: Ellen Auensen

NO_x Depression over Europe

Environmental groups reacted angrily in November to the collapse of the UN ECE negotiations for controlling emissions of nitrogen oxides. In Geneva the delegations of western and eastern European countries, the United States, and Canada were negotiating within the framework of the Geneva Convention on Long-Range Transboundary Air Pollution for a protocol on these oxides. It quickly became clear however during the fifth session of the UN ECE Executive Body, November 17-20, that there was too much disagreement to enable a protocol to be ready for signing.

Only five countries — West Germany, Switzerland, Austria, the Netherlands and Sweden had explicitly supported a proposal for a 30-per-cent reduction.

In an address to the delegates a representative of the environmental observer groups said:

"We are gravely disappointed that these countries should not have received more support and should have backed down from the outset. They now appear to be accepting a freeze, with no increase in emission levels, or perhaps even to be accepting an increase in emissions."

"In fact even a 30-per-cent reduction falls short of what is

needed to ensure the protection of forest and aquatic ecosystems. The best and most recent scientific data indicate that reductions of the order of 50-80 per cent is required. Still, the 30-per-cent reduction scheme, originally put forward by West Germany, represented the only serious proposal and a compromise that held out some hope for improvement."

"That hope has now evaporated. It is apparent that (1) a reduction is not going to be seriously considered by the delegations; (2) no immediate action will be required of the member governments to control NO_x emissions

continued on page 2

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:

The Swedish NGO Secretariat on Acid Rain

Miljövard
Vallgatan 22
S-411 16 GÖTEBORG, Sweden
Telephone: 031-13 12 97

Editor: Christer Agren
Published by: The Swedish Society for the Conservation of Nature
Printed by: Williamssons Offset, Solna
ISSN 0281-5087

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)

The Stop Acid Rain Campaign/Norway
Det Norske Skogselskap
Wergelandsv. 23 B,
N-0167 OSLO 1, Norway
Telephone: 02-46 98 57



NO_x Depression... continued

(discussion is now taking aim at the mid-1990s); and (3) any future limit on NO_x emissions will probably be based on future emissions levels — levels which will most probably be significantly higher than those currently endangering European and North American ecosystems.

"A 30-per-cent reduction was itself a compromise between scientific reality and political will. It was not the moon and the stars. Yet no proposals for less stringent reductions were even discussed before the idea of trying to restore environmental quality was laid to rest. The significance of this shift away from consideration of a freeze or reduction can scarcely be overstated. In a sense it is a breaking of faith. It marks the point at which delegates no longer ask what steps must be taken to protect and restore our ailing environment, but rather how much more harm is to be allowed to take place."

Once the prospects for a reduction of emissions had been lost, the debate moved quickly and predictably to postponing the date for action, and to relaxing the emission standards that ultimately might have to be met.

The eastern European states, the USA and the UK are blocking all immediate action and want to increase their NO_x emissions in the 1990s, maybe coming to a freeze of emissions by 1993-1995 at some post-1990 level. Spain and Italy have also been arguing for a long time against proposals for reduction and freezing. Spain has asked for a later date for a freeze (1998) for those countries with structural problems that would make it difficult to achieve standstill at an earlier date.

Countries with quite a positive environmental attitude, such as Canada, Norway, and Denmark, only favour a freeze by 1990. This means that the meeting has seen the end of Scandinavian solidarity in regard to acid rain. Sweden, true to form, is leading the field with its own environmental initiatives and has been a driving force behind

the call for a 30-per-cent reduction of emissions of NO_x by the mid-1990s.

But the other Scandinavian countries are refusing to follow suit. The decision of Denmark, Norway, and Finland not to support the 30-per-cent proposal has been called — especially in the Norwegian newspapers — a major environmental scandal. In the "Year of the Brundtland Report", the Brundtland government has refused to take effective action over something that is one of the biggest causes of public concern in Scandinavia — damage to the forests. Its defence, of not being able to control emissions from Norwegian merchant ships, seems weak, especially as use of better fuel and improved engine technology could lead to substantial reductions.

The Danish plan to delay the reduction of NO_x emissions from stationary sources by 50 per cent for eighteen years is an indication that they do not take the problem of NO_x very seriously. The emissions are to be reduced by using home-grown technology that has not yet been developed and will not be available until the mid-1990s. Until then, Danish NO_x emissions will probably increase.

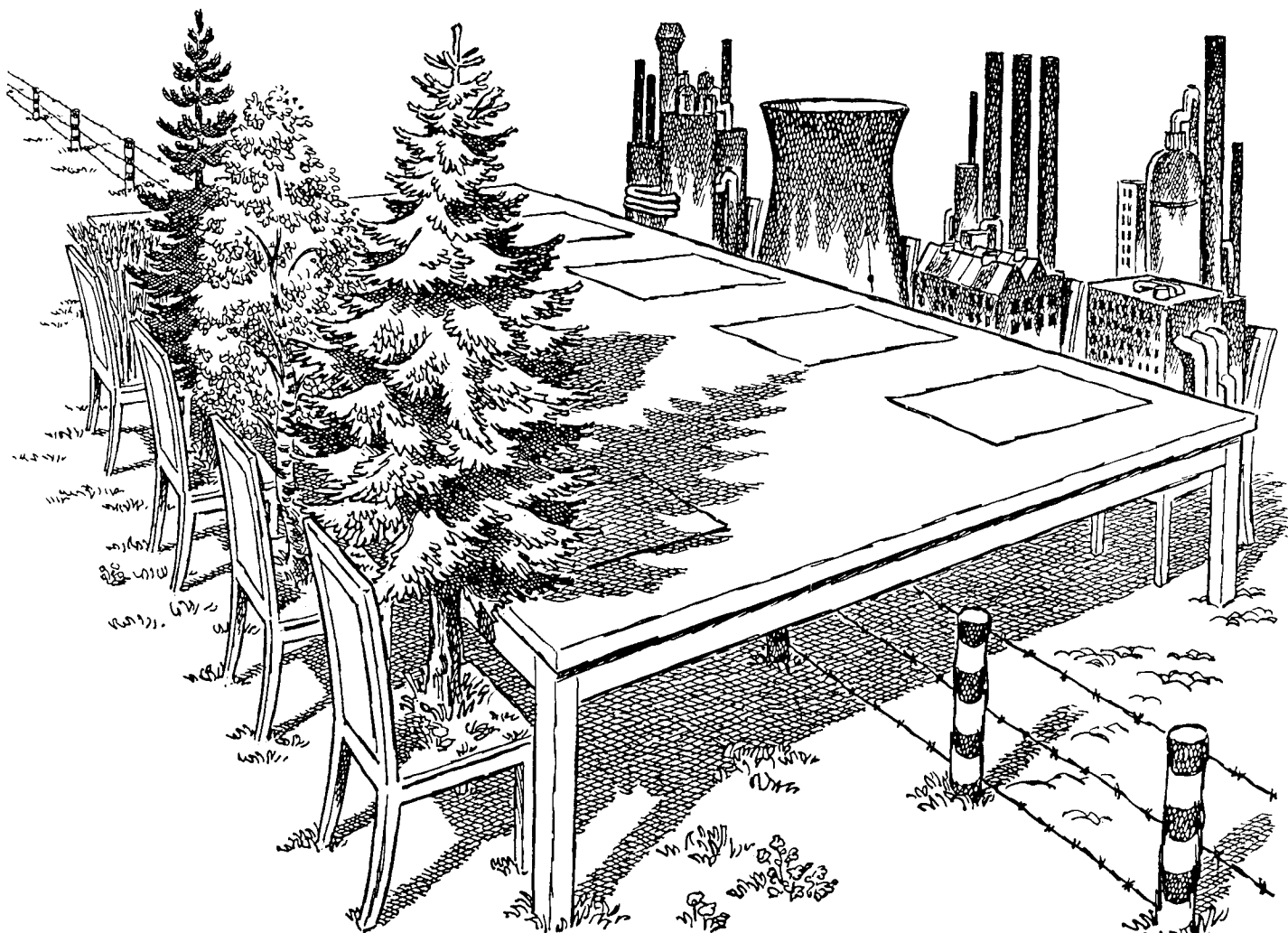
There is a similar attitude in Finland, where they want a standstill of emissions after 1990 and reckon that in the absence of any reduction of pollution from large sources their NO_x emissions will increase by 10 per cent.

The split in the Scandinavian bloc has left the 30-per-cent denitrifiers isolated and unable to exert pressure.

In their daily conference newspaper "ECO" the environmental groups concluded:

"Far from being a cause for celebration and self-congratulation, the result of the NO_x negotiations looks likely to be a source of disappointment to many people. Depression is setting in amongst government delegates and observers alike."

continued on page 3



Drawing: Claus Albrechtsen ©

"Memories of brave promises made during the September '87 session of the NO_x Working Group are rapidly fading. All the rhetoric about a protocol 'with real teeth' has been proven to be as empty as we suspected it might be.

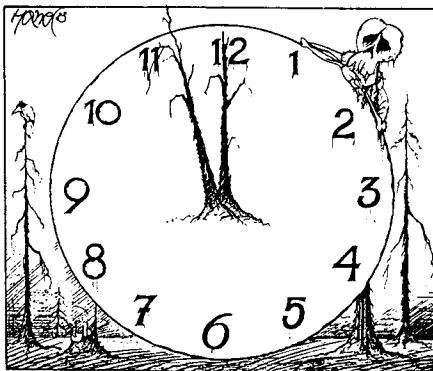
"How is it possible that a group mandated to lay a framework for '...effective NO_x reductions...' can now be discussing increases in emissions? How is it that so many countries seem to be reluctant to admit that NO_x is even a significant problem?

"A rough consensus seems to be emerging that any protocol is better than no protocol. In fact, the signing of an agreement that does no more than legitimize current national pollution strategies may well do more harm than good. A sense of achievement will prevail, and complacency will no doubt set in. Meanwhile, the state of the environment will continue to deteriorate.

"If ever there was a time for international action to protect the

environment, that time is now. If, as seems almost certain, the NO_x protocol is not going to be effective, then it should be bypassed by states wishing to take positive steps.

"Whether they sign it or not, this protocol will have little significance for those countries aiming at substantial reductions of emissions. These countries should break away and form a new group, and perhaps even make a new formalized multi-lateral agreement. The Helsinki Protocol would not have come about unless similar action had been taken by ten governments in 1984."



The next meeting of the NO_x Working Group will take place on February 16-19, 1988. If strong public pressure should not by then have forced the five nations that were for a 30-percent reduction — Sweden, West Germany, the Netherlands, Austria, and Switzerland — to take up their proposal again, and should Norway, Canada, Denmark, Finland, and France not be driven by pressure at home and abroad to associate with them — than the future negotiations will only concern the freezing of emissions between 1990 and 1995.

It is very difficult to imagine the environmental groups lobbying for any such proposals.

Reinhold Pape

Note: Observers at the UN ECE meeting were representatives from Greenpeace International, Friends of the Earth International, IUCN, WWF International, and the Swedish NGO Secretariat on Acid Rain.

Nature's tolerance shown

How much pollution can nature tolerate without becoming damaged? The answer to that question is essential for international discussions as to how much we must reduce emissions. Intensive scientific research has now enabled us to give an answer.

The matter had already been taken up at the 1982 Stockholm Conference on the Acidification of the Environment, where more than a hundred scientists were gathered in the Expert Meeting I to discuss the ecological effects of acid deposition. Some of the main conclusions from that meeting were:

1. The total deposition of sulphur and nitrogen pollutants over a large industrialized region (such as Europe or North America) would decrease approximately in proportion to the reduction in emissions.
2. To avoid acidification of lakes in sensitive areas the annual deposition of sulphur should be less than 5 kg per hectare.
3. Any decrease in the deposition of acidifying substances will bring about a positive improvement in acidified aquatic ecosystems.

Scientific research on air pollution and acidification has subsequently continued and been intensified.

Last year discussion on the amount of pollutant that natural ecosystems can withstand advanced markedly as a result of the presentation by the Nordic Council of Ministers of a report entitled "*Critical loads for nitrogen and sulphur*". In that report, which had been compiled by a group of Scandinavian scientists, critical load is defined as "*the highest load that will not cause chemical changes leading to long-term harmful effects on the most sensitive ecological systems*".

The scientists had mainly considered the deposition of sulphur and nitrogen, and especially as regards the acidifying effect of these pollutants on forest

soils, ground water, and surface water.

One of the first conclusions of the report was that in order to avoid acidification of sensitive forest soils in a very long time perspective, the critical load for acid deposition should not be far from zero. Therefore, one chose to change the criteria so as to give figures on critical loads that would protect *most* soils from *significant* effects of acidification. On this basis it was concluded that for most soils in Scandinavia and for many soil types in central Europe the critical load is 10-20 kiloequivalents of hydrogen ions per square kilometre per year. This could be compared with the natural background deposition, which is estimated to be of the order of 5 keq/km²/yr. It can also be compared with the present deposition of hydrogen ions, which in southwestern Scandinavia is more than 100 keq/km²/yr, and in some areas of Europe exceeds 400 keq/km²/yr.

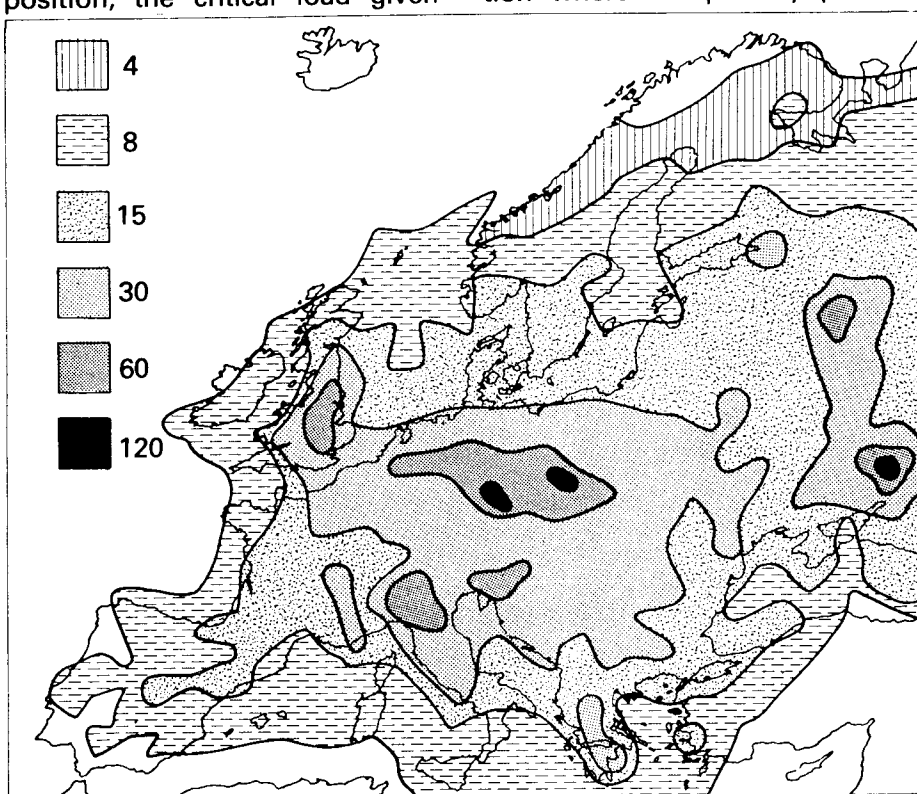
Assuming negligible dry deposition, the critical load given

above means that the pH of the precipitation would have to be higher than 4.7, assuming an amount of 1000 mm per year. This corresponds to an annual sulphur deposition of 2-4 kg per hectare.

The conclusions of the report concerning critical-load figures for acid deposition on forest soils are also indirectly supported by recent evidence in regard to soil acidification in central and northern Europe. Acidification amounting to a decrease of about 0.5-1 pH-units in the last 20-50 years has been recorded, both in the humus layer and in the mineral soil.

Critical loads for acid deposition on ground water and surface water are similar to that for forest soils.

The aim when considering the deposition of nitrogen was to find figures for the maximum deposition that over a period of 20-50 years would prevent forest ecosystems from becoming nitrogen saturated. Nitrogen saturation is defined as a situation where the primary produc-



The total fallout of sulphur, in kg per hectare, over Europe in one year. Drawing: New Scientist

by critical loads



tion of an ecosystem will not be further increased by an increase in the supply of nitrogen. With a total input lower than the critical load, most of the potentially harmful effects of an excess nitrogen input, such as acidification, nutrient imbalances, decreased frost resistance, leak of nitrogen, etc, will be reduced.

According to the report, the critical load is in the range 10-20 kg N/ha/yr for most forest ecosystems. However, for very poor soils with a low productivity, the critical load is put at 5 kg N/ha/yr.

These figures may be compared with the present nitrogen deposition, which over large areas of central Europe is 30-40 kg/ha/yr. In some places, such as in the coniferous forests in the Netherlands, the deposition may even exceed 100 kg N/ha/yr! It should be noted that while the scientific basis for the conclusions on critical loads for acid and sulphur deposition is extremely good, it is not yet so for nitrogen. On the other hand it should also be noted that in 1986 the Working Group on Effects and the Working Group on Nitrogen Oxides (both of which come under the UN ECE LRTAP Convention) adopted this concept of critical loads, and have included such figures on deposition of acids and nitrogen, as well as data on critical concentrations of gaseous air pollutants, in their reports.

On the basis of the data presented in the critical-loads re-

port, and of the available data on critical concentrations of gaseous air pollutants (SO_2 , NO_2 , and O_3) for tree damage, the environmental organizations have agreed on necessary targets for the reduction of European emissions as follows:

- A 90-per-cent reduction of the emissions of sulphur dioxide.

- At least a 75-per-cent reduction of those of nitrogen oxides.

- Furthermore, European-wide ozone formation needs to be reduced by 75 per cent, which is to be attained through the above reduction of NO_x , combined with a reduction of the emissions of hydrocarbons.

- And finally, in areas of intensive livestock breeding, a reduction is needed of ammonia production by 75 per cent, in order to bring about a sufficient reduction of nitrogen deposition.

There are no margins of safety included in these target figures. They express the minimum for safeguarding trees, soils, ground water, and surface water in the most sensitive areas of Europe. It should also be remembered that scientific estimates of the critical level values have been falling over the years, in some part because the methods of monitoring damage have improved. This means that it is not unlikely that compared with the figures now presented, the critical levels will be even lower in the near future. In that case we shall have to revise the targets for emission reductions.

Christer Agren

Literature

Plant extinctions

Many of Britain's rarest and best-loved plants and flowers are under serious threat from acid rain, according to research commissioned by Friends of the Earth. A new report, *Cause for Concern*, highlights lichens, mosses, and insectivorous sundews as being particularly vulnerable.

An analysis of published county floras has revealed the following startling declines:

- 106 vice counties have lost at least one species of moss over the last fifty years.

- 344 moss species have become extinct in at least one vice county.

- 63 moss species have disappeared from between 5 and 22 vice counties.

- A total of 55 vice counties have suffered extinctions of club mosses.

- There have been extinctions of sundew species in 43 counties.

Cause for Concern makes it clear that whilst it is agreed that habitat destruction and land-use changes have had a massive impact on plants in Britain, effects linked to air pollution have been largely ignored. Many of the historical changes due to pollution are related to industrial development, high levels of sulphur dioxide, and smoke. Britain's pollution climate is changing, however, and acidity of rainfall and high ozone and ammonia pollution levels are becoming increasingly important factors in this change.

Cause for Concern - An analysis of air pollution damage and natural habitats. A FoE Research Report written by Nigel Dudley (ERR). Obtainable from Friends of the Earth, 26-28 Underwood Street, London, England N1 J30. Price 5 pounds.

Do vehicles cause cancer?

Apart from lead, the three main pollutants emitted from petrol-driven vehicles are carbon monoxide (CO), oxides of nitrogen (NO_x), and hydrocarbons (HC). In addition a number of secondary pollutants are subsequently formed under the action of sunlight. These are known as photochemical pollutants and the most important are ozone and peroxyacetyl nitrate (PAN). Both primary and secondary pollutants have important health effects (1). Carbon monoxide reduces the oxygen-carrying capacity of the blood and can aggravate chronic respiratory and cardiac disorders in susceptible individuals. In particular patients with coronary artery disease develop angina more quickly when exposed to higher levels of ambient CO (2). The World Health Organization recommends a level of 10 mg/m³ averaged over eight hours. In London eight-hour mean values of between 18 and 24 mg/m³ were recorded over a three-month period, with peak values as high as 60 mg/m³ (3). This is more than seven times the WHO recommended level. In London virtually all CO is derived from petrol-driven vehicles.

Oxides of nitrogen also have adverse effects on human health. Nitrogen dioxide (NO₂) has been linked with increased susceptibility to respiratory infection, and can aggravate asthma even at concentrations as low as 0.1 ppm for periods as short as one hour (3). Such levels are commonly exceeded in London even at monitoring points well above street level. Over the UK as a whole, the contribution to NO_x emissions from motor vehicles and power stations is approximately equal (40-50 per cent each) whereas in urban areas the majority of atmospheric NO_x is vehicle-derived.

Photochemical pollutants, too, exert adverse effects on human health. Whilst it is true that spe-



Photo: Vicky Alhadeff.

cial geographical or climatic factors contributed to the notorious smogs which affected Tokyo and Los Angeles, British cities are not immune from these processes.

Photochemical pollution is visible in London on sunny days as a thick milky haze (due mainly to photochemically generated sulphates and nitrates). Ozone

and PAN exert deleterious effects on the respiratory system as well as causing eye, nose and throat irritation (4). WHO recommends a maximum ozone level of 120 µg/m³, a level which is commonly exceeded in the UK during the summer months, when peak values of 400 have been recorded in London and over 500 µg/m³ down-

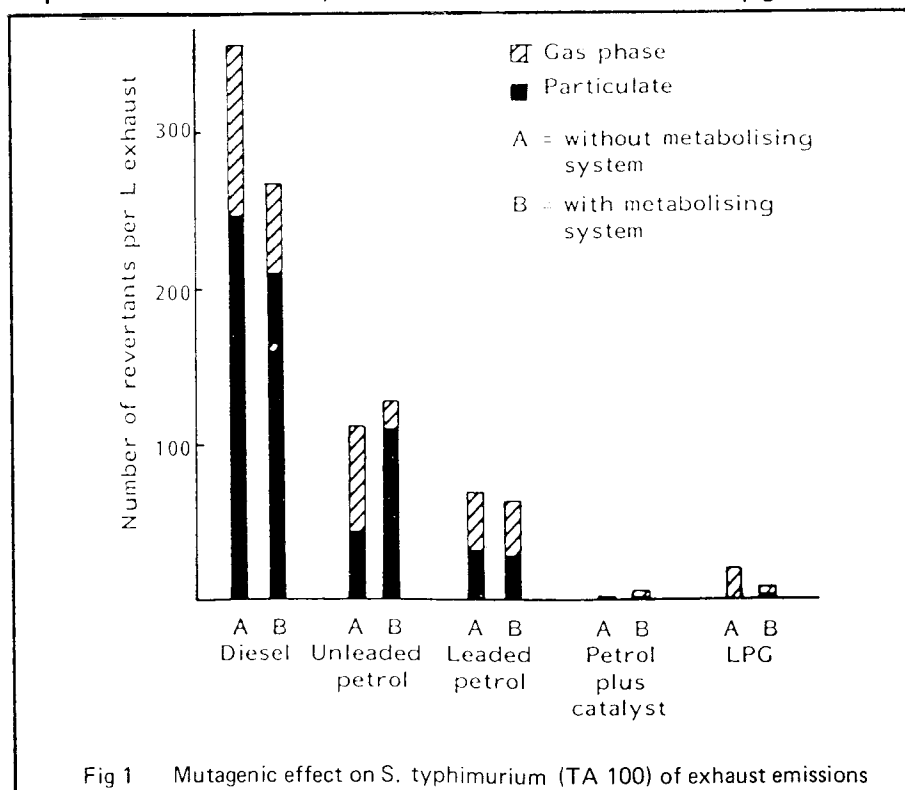


Fig 1 Mutagenic effect on *S. typhimurium* (TA 100) of exhaust emissions

wind of London in Oxfordshire (5).

Of all the pollutants emitted by vehicles, it is the unburnt hydrocarbons, and in particular the polycyclic aromatic hydrocarbons, that pose the greatest risk to health because of their long-term carcinogenic potential. This is particularly true of diesel emissions. The most commonly used test, the AMES test, measures the capacity of pollutants to induce changes in the genetic code of bacteria. These changes, known as revertants, are closely linked to the cancer-inducing potential of the pollutant. AMES testing carried out by the Swedish Environmental Protection Board has shown that diesel emissions are ten times more mutagenic than emissions from petrol-driven engines, which in turn are ten times more mutagenic than emissions from petrol-driven engines equipped with a catalytic converter and running on unleaded fuel (6). Put simply, this means that an untrapped diesel engine carries 100 times the cancer-inducing potential of a catalyst-equipped car (Fig.1). Even more significant from the public health point of view is that 80 per cent of the mutagenic effect resides in the particulate fraction of diesel exhaust, so that an effective trapping or filtering system

will virtually eliminate the health risk. Of course it is not enough to show that a substance or substances are mutagenic. But animal experimentation has confirmed that many of the substances in exhaust gases are also carcinogenic, so it is not unreasonable in this instance to equate mutagenicity and carcinogenicity.

These findings are of more than academic significance, for whilst it is widely realized that smoking is the most important cause of lung cancer, it is also realized that lung-cancer rates are higher in urban areas, and that this increase cannot be explained simply by the different occupations of rural and urban residents. The question of whether atmospheric pollution is implicated in the aetiology of cancer has been raised by a number of studies. A recent UK study demonstrated an increased incidence of bladder cancer in drivers of London taxis and other diesel-powered vehicles (7). However the main concern has focused on the increased incidence of lung cancer. Fig.2 represents geographical data from a large prospective US study involving twenty-five states and over one million persons. The data is for men only and is adjusted for age and smoking. The two lines repre-

sented the relative risk of developing lung cancer according to place of residence (city, town, or country) and occupational risk (exposure to fumes, gases, ionizing radiation etc). It can be seen that lung-cancer risk is higher in occupationally exposed men but also that the risk increases according to population density in both the occupational and non-occupationally exposed groups. Thus lung-cancer rates are higher in large cities (population greater than one million) than in small towns, and higher in towns than in rural areas. Statistical analysis of these data reveal that approximately 12 per cent of lung-cancer deaths are associated with urban residence and could therefore be attributable at least in part to atmospheric pollution (8). Other analyses have produced higher percentages. For example comparing farmers with non-farmers in the United States produces a figure of 23 per cent for the percentage of lung-cancer deaths not related either to smoking or to occupation (8). In the UK 12 per cent of male lung cancer represents approximately 3,000 extra deaths per annum. Clearly not all of these deaths will be the direct result of vehicle emissions, but it is equally clear that the victims of road traffic accidents are not the only people to be killed by motor vehicles in this country.

R. Russel Jones, MRCP

Extract from a paper read at the International Conference on Vehicle Emissions and their Impact on European Air Quality, November 3-5, 1987, in London.

References

1. Motor vehicles and cleaner air (1983). Report of the Swedish Government Committee on Automotive Air Pollution.
2. Aronow et al (1977). American Journal of Medicine 63:904-908.
3. Schwarz M., Bali D. (1983). Air Pollution in London. A Review of past, present and possible future controls. Pub. by GLC Scientific Branch.
4. US E.P.A. April, 1978. Air quality criteria for ozone and other photochemical oxidants. Office of Research and Development.
5. Bali D.J. (1978). Nature 271:733-734.
6. Chemical and Biological Characterization of Exhaust.
7. Baxter P., McDowall M. (1986). Occupation and Cancer in London: An investigation into nasal and bladder cancer using the Cancer Atlas. British Journal of Industrial Medicine 43:44-49.
8. Karch N., Schneiderman M. (1981). Explaining the Urban Factor in Lung Cancer Mortality. Report to the National Resources Defence Council.

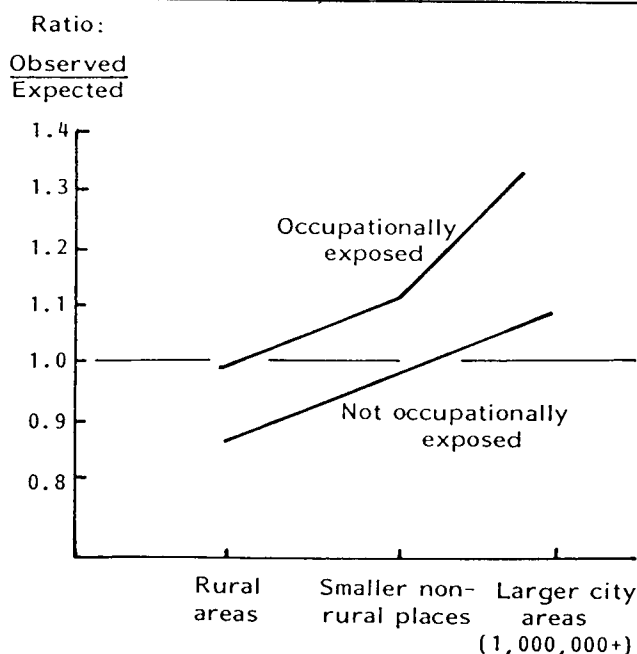


Fig 2 Lung cancer deaths — US data 1959–1965 (adjusted for age and smoking)

Delaying NO_x action

As international discussions move from controls over sulphur dioxide to cutting nitrogen-oxide emissions, the United States has adopted a weak and obstructive position that is contrary to its own interests. The US favours only a stabilization or reduction in growth of NO_x emissions. It rejects the idea of cuts. And its claim that a 1995 deadline for retrofitting major stationary sources would violate the "gradual control approach", might make anyone think that the US is unaffected by damage from acid rain and tropospheric ozone.

The "critical load" concept is generally welcomed as a nonarbitrary means of judging what deposition levels should be avoided if the environment is to be protected. Yet the US and others, such as Great Britain, seem to be using the critical-load concept as a means of postponing action. They argue that this approach for nitrogen oxides is a prerequisite for any efforts to control NO_x emissions. This ignores the conclusions of the critical-load studies, that emission reductions must be initiated as soon as possible in order to avoid serious harm to the environment. To wait for some hypothetical point of "scientific

certainty" is to allow the damage to continue indefinitely.

The real reason for US reluctance to act may be the widespread and culturally ingrained use of private vehicles in North America. The politically influential lobbies both of the auto industry and the coal industry are exerting a stranglehold over US acid rain policy. Allowing industry to guide policy is to follow a disastrous course of increasing destruction on the international as well as the domestic level.

The US attitude should be viewed in the international context as well. For although it may be defended on the basis of domestic concerns, it also has international consequences. In 1950, for instance, 85 per cent of the world's cars were in North America. The number of motor vehicles in North America is still disproportionately high, setting a cultural pattern of accelerated vehicle growth in other parts of the world as urbanization, industrialization and population rapidly increase in less-developed countries.

Air pollution problems caused by NO_x transcend national boundaries — as do the solutions. It is in large measure due to US motor-vehicle standards

that other countries have been able to adopt tighter emission controls as the use of vehicles has expanded. Continuing progress in developing cleaner vehicles in North America has the potential to significantly reduce damage to the environment and human health elsewhere. Technology for light-duty vehicles has advanced beyond the levels needed to achieve today's US standards. The slower development of heavy-duty vehicle controls reflects less stringent legal requirements. Similarly, by delaying stringent NO_x and particulate controls the US Environmental Protection Agency is largely responsible for the absence, until recently, of serious domestic NO_x control efforts.

The same implication holds for the slowness in controlling NO_x on the international level. The will must be there to require and encourage technological improvements before there will be any adequate response from industry and the public. The US is in the position to attain lasting international distinction by leading other nations in the effort to ensure a sustainable global future.

Karen Coulter
Greenpeace US

NO_x emissions

NO_x emissions have approximately tripled in the US since 1950. A 1981 National Academy of Sciences report concluded that NO_x emissions could exceed those of sulphur by the end of the century. In certain circumstances, such as during the spring snowmelt, nitric acid is already disproportionately responsible for the reproductive failure of freshwater aquatic species. Nitric acid was found to be the major source of increased acid deposition and continued acidification in the Hubbard Brook ecosystem. Recognizing the threat to public health, both the World Health

Organization and the State of California have adopted one-hour exposure standards for nitrogen dioxide.

Health effects

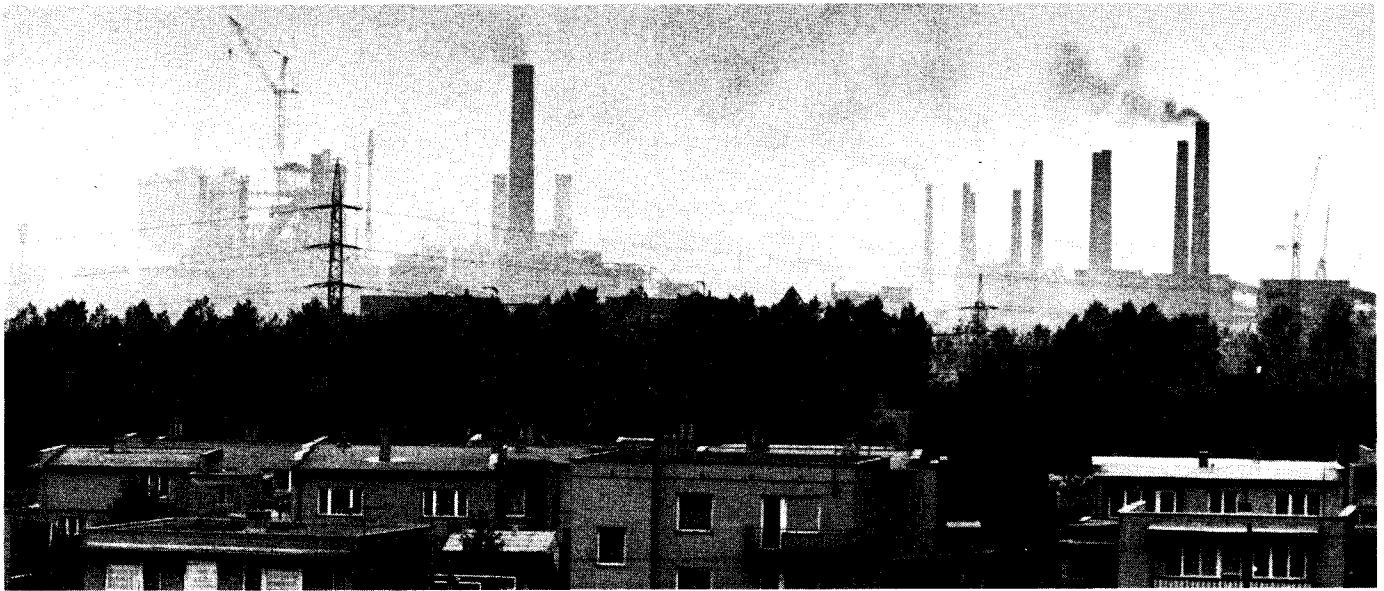
Ozone, from NO_x photochemistry, contributes to ill-health. Almost 80 million Americans currently reside in areas in which the current air-quality standard for ozone is exceeded. Many suffer from irritation, respiratory illness, and reduced pulmonary function as a consequence.

Damage to forests and crops

The contribution of NO_x to the formation of low-level ozone makes NO_x a leading cause of damage to forests and crops

through air pollution. Forest damage is spreading across eastern North America. The Library of Congress found that in the US alone, "the short-run or immediate impacts of ozone are evident in annual crop yield decreases estimated at 1.9 to 4.3 billion dollars". In the long-term, the US Congressional Research Service points out that "ozone damage has resulted in disappearance of high yielding crops from localities and even from the genetic base". Yield reductions attributed to ozone include a 10-22 per cent reduction in field corn, and up to 33 per cent reduction in wheat, and from 24-50 per cent reduction in soy beans.

Living in a smog



Ostrava, Czechoslovakia. Photo: Hans Östbom.

"Coal — The Blood of the Republic!" The sign stands in front of the massive power station at Bilina in Czechoslovakia. Situated between the two northern Bohemian cities of Most and Teplice, Bilina is a vast complex of metal piping and smoke. For many old Communists, it is a sight to be proud of — a living monument to Lenin's slogan: "Socialism equals the Soviets plus electrification".

For many years, Soviet and Eastern European theoreticians entrusted with the task of interpreting science and its development shared this opinion. They were united in a belief that pollution was a problem peculiar to capitalist societies, and not one encountered in the socialist camp. Socialists lived in harmony both with their fellow human beings and with nature. Socialist sulphur dioxide, produced by the toil of workers in control of their destiny, would not harm the soil or leaf on which it fell.

In these days of *glasnost*, this assessment may seem unfair. But such nonsense can still be heard in Romania, for example, and as late as 1983, senior Soviet academics proclaimed it in all seriousness.

Most central European governments now admit that they

are among the world's most prodigious emitters of sulphur dioxide, the principal pollutant from burning coal and a prime cause of acid rain. Three areas stand out. One is the "golden triangle" of Leipzig, Karl-Marx-Stadt and Dresden in East Germany, a country with the highest emissions of sulphur dioxide per head in the world. A second area is the coal-mining and steel complex of Katowice/Nova Huta in southern Poland, whose corrosive fumes are responsible for the destruction of one of the country's architectural shrines, the nearby town of Krakow. Finally, there is Czechoslovakia's black belt of northern Bohemia, stretching along 60 kilometres from Chomutov in the west to Usti nad Labem and Litomerice in the east.

Czechoslovakia has several heavily polluted regions. The government calls its capital, Prague, "a disaster zone". In winter, emissions of sulphur dioxide are often 20 times the permitted limit. "Black Plzen", the home of the beer called Pils and of Skoda, central Europe's largest armaments factory, is no better. Last year, the city council at Ostrava in Moravia gave the old town square a face-lift for May Day. Within six weeks, the bright colours had disappeared

under a blanket of grime. Pardubice, Hradec Kralove, Brno, Melnik were all transformed during the 1950s from centres of light industry, to the home of the country's heavy industry, as Stalin determined that Czechoslovakia should become "the smithy of Eastern Europe".

Northern Bohemia is by far the worst, however. "At the moment, half a dozen main power stations in northern Bohemia produce about 60 per cent of Czechoslovakia's electricity", says Pavel Patzel, the head of the State Commission for the Environment.

The fuel burnt in the stations is lignite, or brown coal. Lignite is heavily laden with sulphur, which is released as sulphur dioxide when the fuel is burnt. It has a low calorific value. Huge quantities must be burnt to provide power. Czechoslovakia burns more coal to create each unit of electricity than any other country in Europe. Extensive opencast mining of brown coal gives northern Bohemia its local name, "the lunar country". Vladimir Vanicky of the Forestry Commission in Chomutov says: "Within about 35 square kilometres, we have 3,170 megawatts of coal-burning power stations, and the mines take up 6,000 hectares."

The opencast mines are insatiable monsters destroying everything in their path. *"They encroach on residential areas, villages and the like, so we then have to construct new housing in non-mining areas,"* says Vanicky. *"The whole district is forever moving house."* Slowly, the mines are becoming exhausted, but the government intends to mine coal for another 30 to 50 years.

Because lignite produces so little energy per tonne, it has to be burnt close to where it is mined. In Chomutov, 18 million tons of brown coal go up in smoke each year. With a population of just 14.5 million, Czechoslovakia pumps out an astonishing 3.5 million tons of sulphur dioxide annually—or twice the output of West Germany, which has a population of over 60 million. Almost three-quarters of these emissions come from the chimneys of northern Bohemia.

All the area's industry lies in a valley overshadowed by the once-beautiful Ore mountains. *"The fallout of sulphur dioxide is heaviest in the forested areas on the Ore mountains. All trees here have been affected,"* says Vanicky. The authorities first identified the problem in the early 1970s. Today, the area has one of the busiest bands of foresters in Europe. Most forest districts in Czechoslovakia replant 250 hectares of trees every year. Here, as pollution acidifies the soils and chokes the trees by coating their leaves, the rate of replanting is 1,500 hectares per year. A recent international survey of damage to Europe's trees from air pollution found about half of Czechoslovakia's trees in some way damaged. This put the country's trees on a par with the much more heavily publicized sick forest of West Germany.

Vanicky looks on the bright side: *"We now feel a mild optimism that there is a real chance to renew the Ore Mountains' forestry."* He is importing pointed spruces from Canada because they are more resistant to sulphur dioxide than indigenous trees. But even these trees find

it hard to survive on the mountain tops. A view of Klinovec, a peak of the Ore Mountains, provides the most numbing sight for the visitor: fields of dead, dry trees stretching beyond the horizon.

Pollution is not, of course, the only hazard for trees. Severe weather can cause havoc. In Prague, Jiri Nechvatal of the Environmental Commission says that the destruction of forests can be explained largely *"by six violent climatic changes, the last on New Year's Day 1980, when overnight the temperature plunged to about -25°C "*.

His colleagues in northern Bohemia insist, however, that sulphur dioxide is to blame and dismiss the weather theory. The truth is that sulphur dioxide is well known to make trees much more vulnerable to frost damage.

The industrial towns of northern Bohemia, nestled at the bottom of a valley, suffer from Eu-

rope's most debilitating example of a phenomenon known as "temperature inversion". Cold, polluted air is trapped in the valley by warm air aloft, which prevents normal daytime air currents from dispersing the pollution. Such an event killed 4,000 people during a black smog in London in December 1952, before the government introduced smoke controls there.

Eduard Vacek, an electrical engineer from Teplice, described a typical morning during an inversion: *"It was one of those nasty autumn days when you wake up with a dull headache. A quick glance through the window tells you the dark blanket, suspended over the town for more than a week, has not lifted. Out again into that muck. You think, God, what a stench! What have they been releasing into the air now? They're waging chemical war against their own people!"*

Karel Mrazek, one of Czechoslovakia's band of ecological activists, says: *"The fog rests on the hill, closing in the whole city. All the hot waste product from the power stations, from VTZ Chomutov (the city's giant steel factory) and every other enterprise rise until they come up against the fog, at which point they return to the ground, turning the whole of northern Bohemia into a sick, black prison."*

At weekends, everyone jumps into cars and drives to the mountains. There it is sunny, with people running about in T-shirts. The towns, just 200 metres below, are blacked out. *"Temperatures on the mountains are then usually well above freezing point, whereas down below it is foggy and -10°C ,"* says Miroslav Duchon, the head of Chomutov's Planning Commission.

The Czechoslovak government is committed to reducing pollution. But many people are sceptical about the readiness of the Communist Party to make the sacrifices in industrial output that could improve the air. There is already a "smog drill". The drill is implemented 24 hours after the level of sulphur dioxide in the air exceeds the



Dead spruce in Giant Mountain in Czechoslovakia. Photo: H. Biebelriether.

prescribed limit at 13 stations between Chomutov to Litomerice. Mrazek claims that during inversions which affect only part of the region, the measures are not taken.

Officials say that the purpose of the drill is to *"cut the factory and power station emissions. So they are ordered to limit output. Special reserves of high-quality coal are kept for periods of inversion. Various government bodies then pass on information to the health and school systems. Schools are forbidden to take children outside. In the hospitals and health centres, extra vitamins are handed out. Sporting organizations are told to cancel all outdoor competitions."*

No warning

A nurse from Most says that officials never warn her health centre when there is a smog alert. *"They give us absolutely no idea whatsoever. Nonetheless, we find out pretty quickly, because the clinic fills up to bursting point with sick people, most of them unable to breathe."* Workers in the understaffed health service are able only to offer temporary relief. Many patients, particularly children, old people and asthmatics, return to clinics two or three times a day and visit casualty wards at night.

In a country where people think very carefully before making any political protest, more than 300 citizens of Chomutov signed a petition recently, complaining about the absence of information concerning the smog drill. They have received a reply from a Politburo member, Ladislav Adamec, in which he says he is studying the problem. Adamec's interest indicates the Party's increasingly serious approach to the problem.

Despite a growing openness, the government refuses to publish detailed figures about life expectancy in northern Bohemia. Even an internal Party bulletin, leaked three years ago, could only hazard a guess. It suggested that life expectancy in northern Bohemia was between three and four years less than the average for the rest of the country.

It was more specific about the incidence of particular diseases in the area. Infant mortality is 12 per cent above the country's average. A third more infants suffer serious illnesses in their first year than in the rest of Bohemia and Moravia. Bronchial disease is twice as common; disorders of the digestive system three times more frequent, skin diseases four times as frequent. *"It is impossible for the Party to publish these figures, because if they did people would just start leaving in droves,"* maintains Mrazek.

Doctors have already voted with their feet. The drain of qualified medical staff from northern Bohemia has been severe enough for the Party's daily newspaper, *Rude Pravo*, to discuss the problem. Three years ago, the government introduced a regulation called *The Stabilization of Doctors and Pharmacists in the North Bohemia Region*. The word "stabilization" crops up frequently in the area. It triggers the offering of incentives. However, as *Rude Pravo* admits, the lure of extra pay and large flats is still not working. During the seventh five-year-plan, the most recent, *"the ratio of children to doctors in Prague was reduced from 971:1 to 919:1, in north Bohemia it rose from 950:1 to 1,077:1"*.

The government works hard to entice people to the area. Anybody who works in the area for 10 years receives a "stabilizing payment" of 2,000 Czech crowns a year, worth about 150 pounds, or half of a monthly salary. *"A special law for the Development of the Northern Bohemia Region was passed both for the seventh and now the eighth five-year plan"*, says Duhon. *"We receive an extra 3.5 billion crowns (270 million pounds) for these measures"*.

Officials are proud of the extra money they are able to offer citizens. However, ordinary Czechs are sceptical. They call the payments "burial money" Those who have lived in the area for a long time claim that "burial money" has resulted in a serious social dislocation.

"Families from the region leave. Families from elsewhere come instead, tempted by the money. They all get put in high-rise buildings and the community collapses," said one old man in Teplice.

In his keynote speech to the Party congress last March, president Gustav Husak announced the investment of 100 million pounds in environmental protection during the eighth five-year plan. This doubled the investment of the previous five years. It is an impressive increase. But estimates of the annual damage caused by sulphur dioxide in Czechoslovakia range from 770 million pounds to 1.9 billion pounds.

Much of the money will go towards installing equipment to reduce emissions of sulphur dioxide. Unable to afford superior American or Japanese technology, the Czechs have turned to the USSR. A 200-megawatt power unit at one of northern Bohemia's largest power stations, Tusemice II, is now being fitted with Soviet equipment. It should be working by the end of this year. Over several years, the investment in this project has been 100 million pounds. If the system works, the Czechs intend to expand its use. The area is committed to reducing its emissions by half before 1993.

So far, the area's record on filtration systems to remove sulphur dioxide has been poor. In a recent issue of the *The Steelworker*, VTZ Chomutov's in-house magazine, Jana Salanova wrote in despair about a filtration system purchased in 1974, but never installed. She complains that the system is now too old to be worth fitting.

By the year 2000, Czechoslovakia plans to produce 50 per cent of its electricity in nuclear power stations. The last coal-fired station in northern Bohemia should be closed in 2020. Will the region survive till then? A stoker from Usti replied: *"With luck I will have died long before, because frankly I wouldn't want to see it."*

Misha Glennly

New Scientist, 24 September, 1987.
Reproduced by permission.

Making the public aware

Lately the facade of the Museum of National Antiquities in Stockholm has been draped in dirty grey shrouding. Out in front is a copy, somewhat sagging and deformed, of the statue of Charles XII that stands by the water opposite the royal palace. But instead of pointing eastward to the traditional enemy, Russia, the king's left arm is raised in desperation towards the sky.

This time the enemy is polluted air, and the dismal arrangements outside the museum are intended to give a foretaste of what is being revealed inside.

Probably most people, including many Swedes, have imagined that this is a clean place, with pure fresh air blowing off the glaciers and the surrounding seas. Although environmentalists in Sweden have been pointing to the threat from polluted air for over two decades, to the majority it has somehow not seemed real. In any case the talk has been mostly about lifeless acidified lakes and dying trees. Only recently has attention turned to the damage that is being done to the country's visible past — its buildings and other monuments — something of which people have been largely unaware.

In the view of the director of the museum, Olov Isaksson, it is not the fault of the politicians that people in Sweden, and Scandinavia generally, have thought that their buildings and monuments would be spared the destruction that is threatening relics of the past all over the continent.

"The fault", he says, "is ours, whose business it is to protect the country's antiquities. Lulled in the belief that this was not really a problem for Sweden, we have been slow in reacting. Now we realize how serious the situation is even in this out-of-the-way part of the world."

Olov Isaksson says that its seriousness only came home to him in the autumn of 1985, after

he had been requested by the Department of Education to discuss the effects of air pollution on monuments and works of art in a paper that he was to read at an ESK Cultural Forum in Budapest. Facts that he then obtained from Tord Andersson, conservator of stone materials in the agency for national antiquities, convinced him that the museum would have to do its part in arousing public opinion. Hence the present exhibition, which the director describes as *"the most important the museum has ever put on"*. Which with the museum's record, is saying a good deal.

This exhibition is a mixture of selected facts, warnings, and exhortations. Its aim, in the words of the catalogue, is *"both to inform and serve as an alarm clock... to bring about a more general awareness of the way our cultural heritage is being destroyed by air pollution and coincident factors"*.

The visitor is first led through a succession of portals — or rather of the same portal in increasing stages of disintegration — of a type typical of some of the churches on the island of

Gotland that date from about 1300. The first shows how it would have looked, only slightly weathered, around 1400. The second its probable appearance in 2000, and the third in 2050, with the effects of air pollution becoming steadily more marked. In the fourth stage it is practically unrecognizable.

The way then goes through a forest of dead trees, with sounds of creaking dry branches, to a church interior, where there are samples of stained-glass windows that have been damaged by pollution. These are also from Gotland, as is a badly eroded 12th-century relief depicting Christ descending into the underworld. Here too a head of Christ, fictitious as in the case of the portals, is used to show the process of decomposition, based on what is known to be going on all around us.

In the next section is a funeral procession with about forty stylized mourners grouped around a collection of sculptured figures from Swedish churches in various stages of disintegration. Entitled *The Valley of the Shadow of Death*, this section is intended to evoke a

Photo: Gabriel Hildebrand ©



Writing on the wall

THE OBTUSE

It'll be all right. People have always been able to adapt themselves. We must put our trust in technology and increase economic growth, so that we can maintain our living standards.

THE INDECISIVE ONE

The situation is serious, that we can't deny. But we must be careful not to overreact, and bind ourselves too far ahead. Let us wait and see what the results of research will be.

THE REALIST

Sometimes I shudder when I think of the future. What will happen to us? It will be difficult, immensely difficult, to check the ravaging. But have we really any choice?

Texts in a section setting forth the alternative courses open to us.



Like the head of Christ opposite, portals show the likely decay if pollution is allowed to continue. Photo: Statens Historiska Museum ©

vision of the end of the country's cultural heritage. Here is also a showcase with two Bronze-Age shields, which would have been buried in a sacrificial rite about 2,300 years ago. One was unearthed in 1865, the other in 1986. While the earlier find is well preserved, the other is almost pulverized.

"If disintegration has taken place so quickly in the last hundred years, one wonders if there will be anything to dig up a hundred years from now. We may only find powdered material and marks in the soil, or perhaps only stone axe heads," says Hans-Åke Nordström, one of the exhibition commissioners.

Acidification of the soil through airborne fallout may be one of the causes, besides lowering of the groundwater and

the spread of chemicals from agriculture.

More eroded stone figures, mostly from buildings in Stockholm, are displayed in lighted niches in a long, dark gallery, along with photographs of Scandinavia and on the European continent.

Naturally in an exhibition of this kind, which is intended primarily to be suggestive, facts have to be presented sparingly and, as may be gathered from the description so far, mainly in visual form. This is made up for in a series of well-informed articles in a 24-page "newspaper", in tabloid format, which every visitor receives together with his entrance ticket.

Articles by Tord Andersson for instance report on the situation in Europe and describe the

processes through which stone is broken down by pollutants in the air. Stonework is having to be replaced at the Acropolis and on Cologne Cathedral, restoration is going on continuously at St Mark's in Venice, and in Rome, where they have already decided to replace many sculptures with copies and bring the originals indoors, they are even considering putting a glass case around some monuments.

The causes of the decay differ. In Rome there is one car to almost every other inhabitant, on the mainland near Venice is one of Italy's largest petrochemical complexes, Cologne is close to the Ruhr. Although attempts at restoration are being made all the time, experts are sceptical of the possibility of achieving anything permanent as long as pollution is allowed to con-



*Funeral procession of decaying sculptures, accompanied by "shades", suggesting the demise of our cultural heritage.
Photo: Bengt A. Lundberg ©*

tinue. Last October Jan Rosvall, who heads a new department for conservation at the University of Gothenburg, arranged an international symposium on the problems caused by air pollution at the Swedish Institute in Rome. There it was noted that while present conservation methods may arrest decay for a time, it soon starts again, and the result may be worse than if the material had not been treated at all.

This is also brought out by Tord Andersson in an article explaining how stone is broken down by airborne pollutants. Limestone, sandstone, and marble are all composed of small mineral particles that are held together by a binder. Reac-

tion with substances such as sulphur dioxide causes the binder to fail, and the stone disintegrates into powder.

Most stones are full of small hollows and cracks, in which there is always some water. Pollutants settling on the surface of the stone become dissolved in the water and attack the stone. Disintegration that may take place inside the stone will go undetected — until quarter-inch pieces suddenly flake off from an apparently undamaged surface.

Sometimes attempts are made to preserve stone by applying paint or other protective coatings. This may make sense when the stone is new, and in 18th-century Sweden new stone-

work used to be preserved in this manner.

But nowadays, as Tord Andersson points out, it may do more harm than good. A certain amount of moisture and pollutant always remains encapsulated in the stone, and if the protective coating is too hard, even larger pieces may spall off.

"Soft" types of rock such as sandstone, limestone, and marble are not the only ones to get damaged. Even hard materials such as granite and gneiss undergo accelerated weathering as acidification of the environment increases.

Sulphur used to be thought to be the chief culprit, but lately attention has been turning to nitrogen as well. Nitrogen oxides in the air may become converted to nitric acid, which can corrode most materials. Moreover scientists at Chalmers University of Technology in Gothenburg have found that sulphur dioxide forms gypsum in stone containing lime ten times as fast if nitrogen oxides are also present in the air. The greater part of the nitrogen oxides in the air comes from road traffic.

It may seem curious that damage to buildings on Gotland should be especially mentioned, since there is little industry there and there are relatively few cars. Yet extensive damage is reported to the stone fabric of many of Gotland's innumerable mediaeval churches, as well as to stained-glass windows — for the same reasons. It has been found necessary to reduce heating in the churches in order to hold back condensation on the glass, which aids disintegration. To save the windows, they are sent to Munich for restoration, and then reinstalled behind a plain glass shield.

Monitoring of the air over the island has shown it to be just as contaminated as that over Stockholm and other urban concentrations on the Swedish mainland. In consequence of its position out in the Baltic, and the prevailing weather patterns, Gotland is exposed to great amounts of pollutants emanating from eastern Europe. The

problem is in other words international, which makes it difficult for Sweden generally. The country has for instance managed to reduce its own emissions of sulphur dioxide from over 900,000 tons a year in 1970 to 272,000 tons in 1985. But in the especially exposed southern part some 80-90 per cent of the fall-out comes from abroad.

In connection with the exhibition, damage to buildings in Stockholm has been demonstrated in guided tours, especially in the Old Town, where numerous carved stone portals, mostly dating from the 17th century, can be seen in various stages of decay. Even the 18th-century royal palace is quite badly affected.

Another part of the effort to arouse public opinion has been a series of lectures by experts in various fields, extending all through the period of the exhibition. Study visits and lessons for schoolchildren have been considered especially important.

Running through the "newspaper" are boxes with rather surprisingly radical exhortations to the public as to how to act if they want to bring about an improvement.

- Get a smaller car, preferably with a catalyzer, and use it as

little as possible. Use public transportation instead.

- Avoid cars with metallic paint. Avoid poisonous chemicals in the garden. Boycott the products of firms that are openly careless of the environment. Try not to take a job with such firms. Don't imagine you will be able to convert them when once inside.

- Lower the temperature indoors. Do all you can to reduce the need for energy.

- Don't wait for the establishment to move. If anything is to be accomplished, we shall have to start it ourselves.

The seriousness with which the arrangers of this exhibition regard the situation may be gauged from the title of a panel debate that was on the program: Is there any future for mankind?

Quite a lot of eminent thinkers have lately been pondering that one.

G Howard Smith

This summer the exhibition will be shown on Gotland, during the tourist season. Negotiations are also proceeding for later showings in Trondheim (Norway) and Åbo (Finland). The address of the Museum of National Antiquities is Box 5405, S-114 84 Stockholm, Sweden.

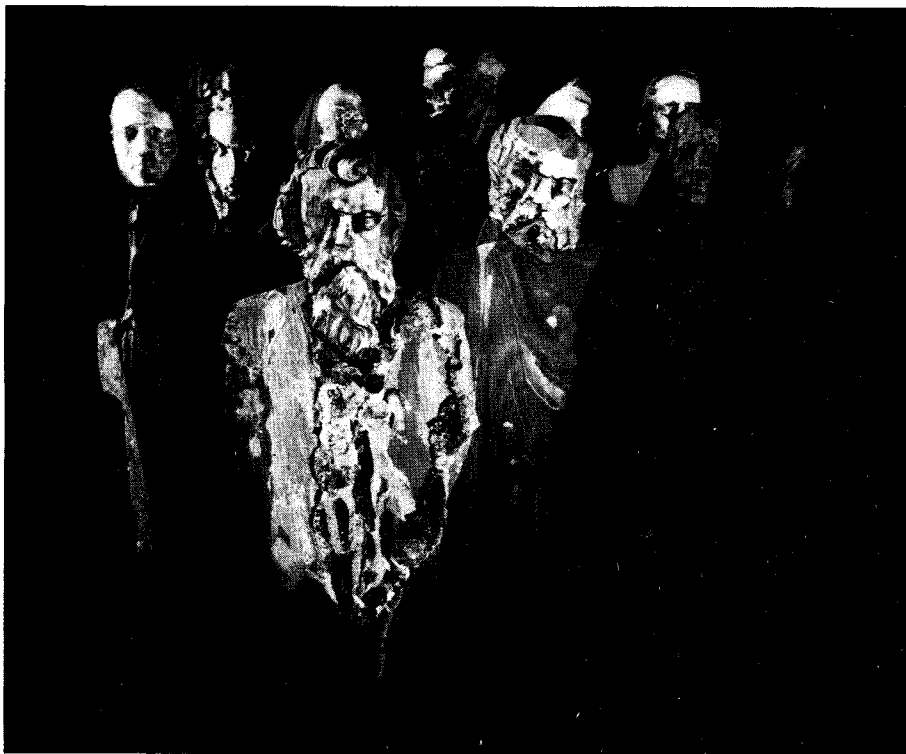
Seen from on high

During the last summer Greenpeace has flown over power stations and lakes, forests, and historic buildings in its hot-air balloon "Trinity", filming acid rain damage in the United Kingdom. Britain's lakes and rivers are already showing signs of acidification, and recently released UN figures indicate that Britain's trees are the most damaged in Europe.

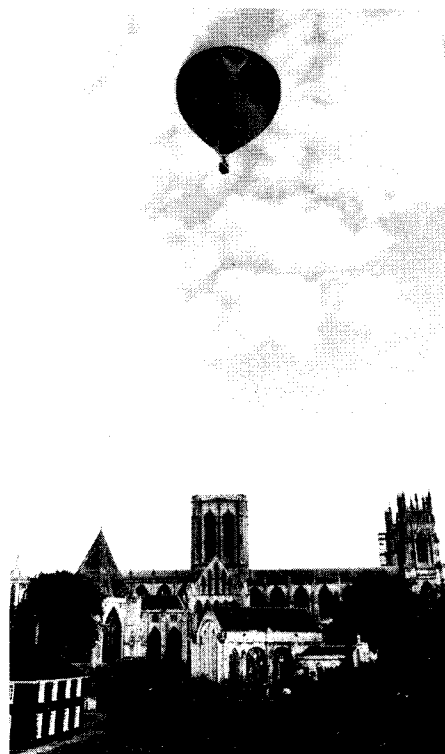
In York the Very Reverend John Southgate, Dean of York, took a ride in the balloon to publicize the horrendous effects on the Minster of the pollution from power stations and road traffic. York Minster is in particular danger. The stone of which it is built is especially vulnerable to acid rain, and the Minster lies within 50 miles of seven enormous coal-fired power stations.

Later Greenpeace flew with the balloon a giant bathroom plug over Eggborough power station in Yorkshire, to encourage the UK government to plug emissions which cause acid rain.

Photo: Bengt A. Lundberg ©



Over York Minster. Photo: Andrew Kerr.



CEGB claims are hot air

The UK is emitting a new kind of pollution. Propaganda.

The Central Electricity Generating Board (CEGB) in its press advertising claims to be "mounting an extensive program of counter measures" and to be reducing the risks from air pollution as much as possible. Greenpeace has provided the Advertising Standards Authority with information which, it believes, firmly contradicts the CEGB claims.

Could the clean-up of only three of the CEGB's 41 fossil-fuel power stations over the next ten years be called "extensive"? Compare this with West Germany where ten power stations had been fitted with flue-gas desulphurization by the end of 1983. By 1988, 80 per cent of their power stations will have the technology. This five year program alone will cost the equivalent of 9.85 billion pounds. Compare this with the CEGB's expenditure of 600 million between now and 1997.



Action outside CEGB headquarters in London. Photo: Greenpeace UK.

The CEGB, it seems, would also like to transfer the problem to the land — since they are opting for a system of flue-gas cleaning which uses ten times as much limestone as a comparable and much more efficient system, and the CEGB system

would leave huge quantities of waste to be landfilled.

In trying to skimp on the job of cutting air pollution, Greenpeace says, the government is allowing damage to spread and storing up problems for the future.

Forestry Commission wavering

In a report on air pollution issued last July (1) the Forestry Commission made major concessions to the claims of environmental organizations. After three years of acrimonious debate with Friends of the Earth on the state of Britain's trees, it says:

- In Great Britain, it now appears that the condition of the trees examined in the survey can only be classed as moderate.
- The acidity of fog and mist may be sufficiently high to cause direct injury to trees.
- Some agents, including air pollution, are thought to be capable of causing "latent injury". In such cases, damage exists, but it is not readily apparent.
- Periods of drought are likely to coincide with the occurrence of high concentrations of pollutants, particularly ozone.
- The forest decline on the continent has continued throughout

the 1980s, and is now affecting both conifers and broadleaves... it seems probable that this decline would not have occurred if the trees had not already been weakened by air pollution or some other stress.

Commenting on the report, Friends of the Earth said:



Drawing: Burki, © 24 Heures

"We are encouraged to see the Forestry Commission beginning to change it's mind on forest damage. Only three years ago, they were accusing FoE of scaremongering and German scientists of hysteria.

"Now their own research (2) has demonstrated that air pollution affects tree health and their surveys show that needle loss in conifers is as bad as anywhere else in Europe. Additionally, they admit that damage can be present before visible symptoms are seen. Surely they must now press the government for stronger action to curb air pollution."

Friends of the Earth — Pressrelease

Notes

(1) Air Pollution and Forestry. J.L. Innes. HMSO, Forestry Commission Bulletin 70. Price 2.60 pounds.

(2) Experimental Work on Air Pollution. A. Willson, D.A. Waddell and D.W.H. Durrant. Forestry Commission Research Division. This document details damage to poplar and scots pine due to pollution in ambient air.