NATIONAL CENTRE FOR RISK ANALYSIS AND OPTIONS APPRAISAL

RISK PROFILE Nº 2

Air Quality and the Environment

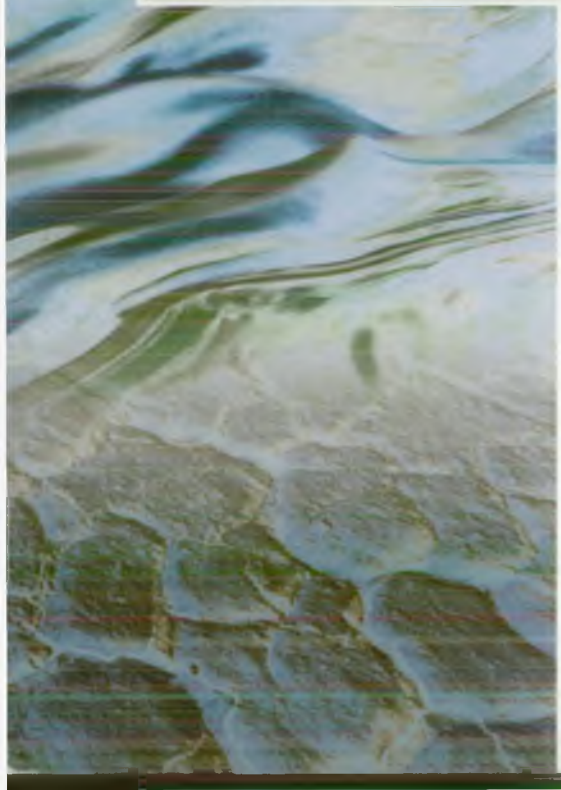
Clean air is essential for human health and the wellbeing of the wider environment. There is growing concern that human activities are posing increasing risks to air quality and that these are a threat to progress towards sustainable development. Air quality is one of the themes in the Environment Agency's *'An Environmental Strategy for the Millennium and Beyond'*. This Risk Profile is the second to be produced by the Agency's National Centre for Risk Analysis and Options Appraisal and complements a more in-depth account of air quality problems and trends, and the options available to address them.

Under Integrated Pollution Control (IPC), the Agency has direct responsibility for regulating emissions to the atmosphere from the most complex and potentially polluting industrial processes. The Agency also has a duty to contribute to sustainable development and in this respect needs to develop a balanced perspective on emissions of pollutants, the relative risks they pose to the environment, and the potential costs and benefits of various preventative and control options. There are limits to what the Agency can achieve by itself and it is working with the Government, local authorities, industry and others to achieve a more sustainable approach to environmental management.

The Agency does not seek to duplicate the efforts of others in addressing the issues of air quality but will develop a risk analysis framework to ensure that its response is properly targeted and appropriate to the issues at hand.

This Risk Profile appears at a time when air quality is a major public concern and at the centre of Government initiatives on transport, energy efficiency in industry and the home, controlling the transport of pollutants across national boundaries and global warming. The application of IPC will continue to reduce industrial emissions and implementation of the Government's National Air Quality Strategy (NAQS) is gathering momentum. The implications for the Agency, and other bodies, of the European Community Directive on Integrated Pollution Prevention and Control are being assessed.

All of these activities will ultimately have an impact on society and the lifestyle of individuals. If difficult decisions are to be made, it is important that the reasons for these decisions and how they will be implemented are understood by as many people as possible. As part of its principal aim of protecting the environment, the Agency has an important role to inform and promote the understanding in society of issues and policies designed to protect and improve the environment. This Risk Profile is part of that process.



ENVIRONMENT AGENCY

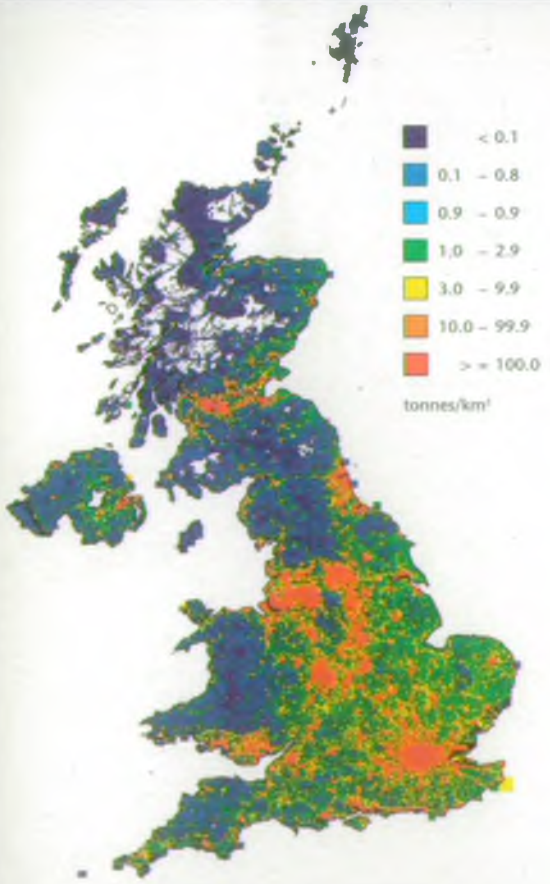
Sources of air pollution

Chemicals causing air pollution are emitted from a wide range of sources, involving both human activities and natural processes. Major sources and examples of such chemicals include:

Natural

Geological and biological sources, which are independent of human activities, are significant sources of a number of potential pollutants. These include volcanoes (eg sulphur dioxide), certain naturally-radioactive rocks (eg radon), marshes (eg methane), vegetation (eg pollen) and marine organisms such as phytoplankton (eg dimethyl sulphide).

1995 UK EMISSIONS OF VOLATILE ORGANIC COMPOUNDS



Acknowledgement: Courtesy of DETR/AEAT

Industrial

In the developed world industrial processes are major sources of emissions to the atmosphere. In the United Kingdom industrial sources account for 90% of sulphur dioxide, 30% of nitrogen oxides and 55% of carbon dioxide emissions. Examples include coal-fired power stations (eg sulphur dioxide, carbon dioxide), chemical plants (eg hydrocarbons), mineral works (eg small particles) and metal industries (eg lead).

Transport

All forms of transport using fossil fuels give rise to exhaust emissions. Nationally, road transport is the major source of nitrogen oxides (almost half) and diesel vehicles account for a significant fraction of the emission of fine particles. In many parts of the country road transport is the major contributor to episodes of poor local air quality. Other transport emission sources include aircraft (eg hydrocarbons, nitrogen oxides) and shipping (eg sulphur dioxide). As with other emissions, the height of release into the atmosphere is important; aircraft can impact on the stratosphere while the low height of vehicle exhaust emissions increases their impact on local air quality.

Domestic

Domestic emissions of smoke were a major contributor to the smogs of the 1950s. Smoke emissions have decreased by a factor of 10 since that time but domestic sources are still significant and include emissions from gas heating in homes (eg carbon dioxide) and the use of household products (eg volatile organic compounds from paint).

Waste disposal

The disposal of waste may give rise to emissions reflecting the organic and inorganic content of waste streams and the way the waste is managed and treated. Examples include landfill of biodegradable waste (eg methane and carbon dioxide) and waste incineration (eg dioxins and metals).

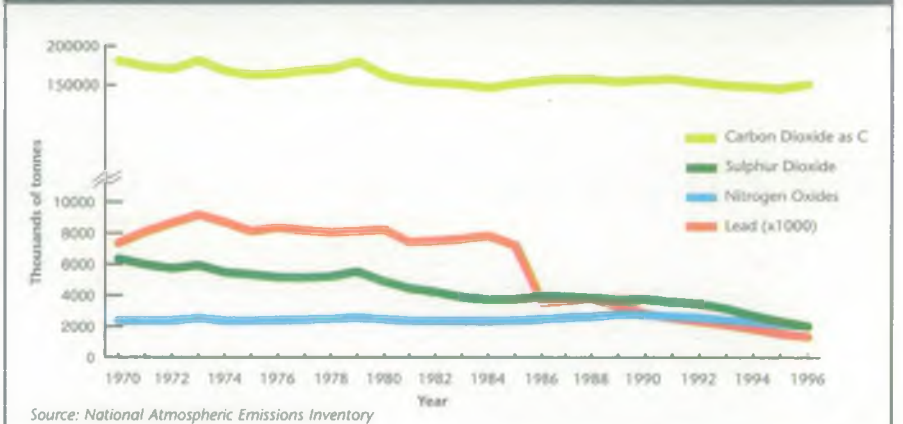
Commercial premises

Emissions from shops, offices and buildings such as hospitals and schools are broadly similar to domestic emissions, but on a larger scale, and include chemicals more associated with small industries (eg sulphur dioxide from small boilers).

Responsibility for air quality

Responsibility for improving air quality is shared across a range of organisations who have varying roles and degrees of responsibility, and who collaborate on particular problems. The Environment Agency has a major role in regulating the most complex and potentially-polluting industrial processes. It collaborates with local authorities, who are responsible for regulating emissions from small industry and for local air quality management. Other organisations with key responsibilities for air quality are the Government (mainly the Department of the Environment, Transport and the Regions), the Health and Safety Executive, the European Union, the World Health Organisation and the United Nations.

TRENDS IN UK EMISSIONS



Source: National Atmospheric Emissions Inventory

Roles of organisations

Regulation

The operations, emissions and environmental impacts of particular types and sizes of industrial processes are regulated by the Environment Agency and local authorities. This is aided by the availability of guidance on industrial technologies including possible emission control, and on the response of environmental receptors to changes in emissions. Organisations responsible for regulation are also tasked with the associated enforcement.

Measurement

Measuring the rates at which pollutants are emitted by sources and the concentrations of pollutants occurring in the ambient atmosphere, is an important role played by the regulators and others. In this way it is possible to form a view of the state of the environment, to identify trends and determine the environmental response to policy initiatives. To underpin such a view it is necessary to have a sound understanding of the atmospheric processes which control the often complex relationships between emissions and impacts.

Standards and objectives

Setting standards and objectives for permissible concentrations and depositions of air pollutants to protect humans and the environment, based on toxicological data, is the role of Government. Similarly it is for the Government to set UK emission reduction objectives to address global issues such as the proposed 20% cut in carbon dioxide emissions. Ideally standards should take account of the risk to the environment and, wherever possible, be based on environmental endpoints.

PRIMARY ROLES IN AIR QUALITY ISSUES

ORGANISATION	SCALE OF PROBLEM				INFLUENCE ON PROBLEMS					
	Indoor	Local	National	International	Human health	Quality of life	Soil/water quality	Ecological quality	Property	Climate change
Local Authority	■	■			■	■			■	
Environment Agency		■	■		■	■	■	■	■	■
Health & Safety Executive	■				■					
Central Government	■	■	■	■	■	■	■	■	■	■
European Union			■	■	■	■	■	■	■	■
United Nations/WHO		■	■	■	■		■	■	■	■

Advice and Guidance ■ Policy setting ■ Regulation ■

The table shows the roles of various organisations and their relative influences over the major air quality problems. Responsibility for air quality is shared between several organisations and improvements will be the result of careful collaboration and co-ordination. The Environment Agency has a range of responsibilities and is seeking to play a major part in the improvement process. Progress on improving air quality does not rest solely with local, national or international organisations, but on choices by individuals towards reducing emissions and minimising the impacts of air pollution.

Uncertainties

Ecological quality

Ecological quality can be adversely affected by pollutants in the air and by deposition to soil, water and vegetation. Ozone and sulphur dioxide alone, and in combination, may cause damage to naturally occurring plants and trees, a reduction in crop yield and a weakening of the resistance of plants to disease and attack by insects. Deposition of sulphur and nitrogen on soil and water can cause acidification with damage to vegetation and to populations of fish and other aquatic species.

Property

Building damage is caused by chemical reactions resulting from exposure to gases such as sulphur dioxide, by the deposition of particles and by acid rain. Exposure to ozone contributes to damage to materials such as rubber and textiles.

Climate change

Some pollutants are known to contribute to climate change and are part of international agreements for their control. Examples of these pollutants are carbon dioxide and methane, which promote global warming, and sulphate aerosols which cause regional cooling of the climate. Climate change poses risks of changes in sea level, patterns of rainfall, temperature distribution and agricultural productivity.

Air quality issues are complex. The problems of long range acidification of forests and lakes, stratospheric ozone depletion and in particular global warming are occupying the attention of several thousand scientists internationally and involve satellite surveillance, solar space probes, worldwide monitoring and some of the most complex mathematical modelling ever undertaken. Even with this large deployment of resources many problems are barely understood and uncertainties remain.

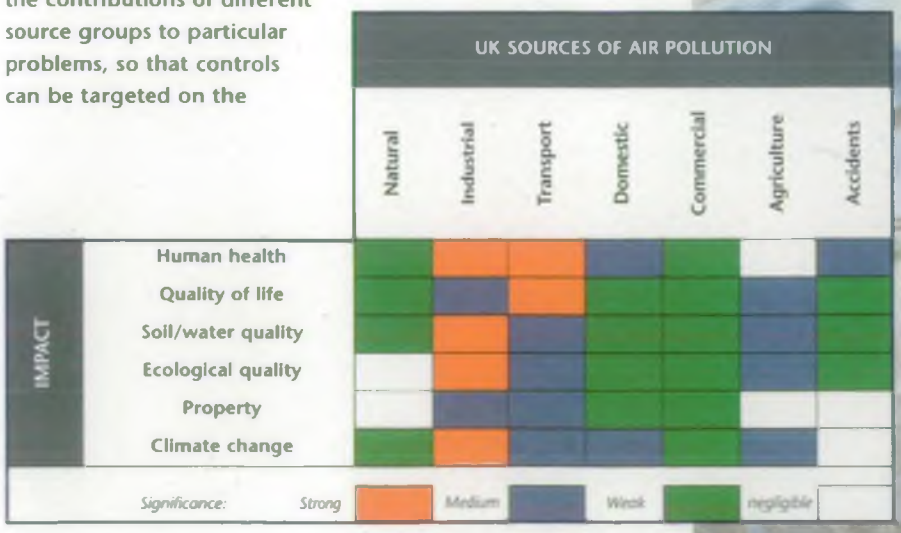
Against this background of technical complexity and scientific uncertainty, risk analysis and determining priorities for action are difficult tasks. This is further complicated by the need to place a value on avoiding environmental damage. In even the most straightforward cases of odour control, the cost of abatement has to be balanced against the inconvenience of the odour.

Putting a monetary value on biodiversity, good visibility, clean buildings, prevention of asthma in children and premature deaths in the elderly and infirm is a complex exercise. These costs are large and such valuations are important in risk analysis and options appraisal. Valuations have to be made to inform decisions on issues including vehicle use, energy efficiency and the emission of acid and greenhouse gases.

Linking of impacts to emission sources

Many air quality problems are due to impacts from several different types of sources. The problem of acidification, for example, is due to emissions from industry, transport, domestic and commercial activities, as well as a small contribution from natural sources. A major task is therefore to identify the contributions of different source groups to particular problems, so that controls can be targeted on the most appropriate sources. This is important in working towards sustainable development.

It is important to recognise that the precise mechanisms linking each source with an impact are not always fully understood.



Environmental impacts

The impacts of poor air quality vary considerably. They extend from odours which may last for only a few seconds and be offensive over a range of only a few metres, to potentially large climate changes which may last for centuries or more and affect the whole planet.

Risks to the environment from the emission of air pollutants and poor air quality can be summarised under the following headings.

Human health

Emission of toxic pollutants

Risks to human health include possible cancer from carcinogenic emissions such as benzene in vehicle exhausts, heart and lung disease from particles, dioxins and metals in the food chain and increased incidence of asthma attacks.

Photo-oxidants

These are formed by chemical reactions between emissions from combustion processes, including vehicles, and naturally occurring chemicals in the atmosphere. Their formation requires sunlight, and high concentrations are associated with hot, calm, sunny days. Ozone is the most prominent of the photo-oxidants but others such as peroxyacetylnitrate (PAN) are important. Risks associated with photo-oxidants include asthma attacks; impaired lung function; eye, nose and throat irritation; coughs and headaches.

Radioactivity

Airborne radioactivity and deposited radioactive material from industrial and other sources can potentially increase the risk of cancer and cause hereditary damage if there is a pathway to humans. The main source of population exposure to radiation, however, is the radioactive decay products of naturally occurring radon gas. The populations most at risk are miners and residents of areas where radon is emitted naturally from the soil. These impacts are potentially very long-term, but may be masked by other factors such as smoking.

Increased UV radiation

Man-made emissions of halocarbons have depleted ozone in the stratosphere in both the southern and northern hemispheres. This region of the atmosphere is high above the surface of the earth, roughly 15-50km, where ozone plays a protective role in absorbing incoming solar radiation. Its depletion is likely to cause increased ground-level UV with increased risks of cataracts and skin cancer.

Quality of life

Poor air quality can also be simply annoying. It can have an impact on human senses, cultural objects and on the general quality of life. Examples are odours, adverse visual impact of plumes from chimneys and cooling towers, and reduced visibility resulting from photochemical activity and the formation of aerosols. It also discolours stone work and even dissolves the stone of our historic monuments, buildings and town centres.

Soil and water quality

Acidification of soils and water is caused by the deposition of pollutants such as sulphur and nitrogen oxides and ammonia. It can occur close to large sources but also at considerable distances and involves complex reactions between pollutants in the air and in clouds. Emissions from the UK have been implicated in the acidification of parts of Scandinavia and other European countries. At present in the UK critical loads for soil acidification are exceeded in many sensitive ecosystems, particularly in northern and western upland areas. Nitrogen oxides can also affect biodiversity (eg a shift from moorland to grassland with increasing atmospheric nitrogen input) and contribute to problems of eutrophication in water courses. Soil can also be contaminated by the fall-out of airborne radioactivity which can subsequently enter the food chain (eg impact of Chernobyl on UK hill farming).

Scale of problems

Indoor

The indoor environment includes air quality in the home, workplace, other buildings (eg schools and leisure centres), motor vehicles and public transport; some elements of which are regulated by local authorities and the Health and Safety Executive.

Local

National policies are expected to deliver significant improvements in air quality throughout the country. However, in some locations, local factors such as traffic density, the presence of industry or topography can give rise to problems. Within the NAQS, local authorities have a responsibility to review air quality in their area and consider future air quality to 2005. If the objectives of the NAQS are unlikely to be met an Air Quality Management Area must be declared and plans drawn up to deliver the objectives. In areas with a contribution from IPC processes the Agency has an important role to play.

NATIONAL AIR QUALITY STRATEGY OBJECTIVES

CHEMICAL	MEASURED AS	OBJECTIVE
Benzene	running annual mean	5 ppb
1,3-Butadiene	running annual mean	1 ppb
Carbon monoxide	running 8-hour mean	10 ppm
Lead	annual mean	0.5 µg/m³
Nitrogen dioxide	1-hour mean annual mean	150 ppb 21 ppb
Ozone	running 8-hour mean	50 ppb as the 97th percentile
Fine particles (PM_{10})	running 24-hour mean	50 µg/m³ as the 99th percentile
Sulphur dioxide	15-minute mean	100 ppb as the 99.9th percentile

ppm = parts per million; ppb = parts ber billion; µg/m³ = micrograms per cubic metre

National

At a national level the Government is responsible for air quality policy, strategy and legislation. These are developed to take account of medical evidence on the possible effects of poor air quality on human health and studies of the effects of air pollutants on the natural and built environment.

International

In addition to global issues such as climate change and stratospheric ozone depletion, many air quality issues have a transfrontier dimension, for example acidification, tropospheric ozone and fine particles. Co-ordinated international action is essential and, increasingly, air quality is the subject of European Directives and United Nations Protocols.

Risk perception and communication

Public concern about environmental problems in general, and global environmental change in particular, has increased since the late 1960s. Before then, air quality issues had revolved around black smoke pollution, mainly from domestic coal fires. Surveys in recent years suggest that while concern for global issues remains high there is evidence of a trend towards greater concern about national and local issues, notably exhaust emissions, urban smog, UV radiation and high pollen counts. This is associated with growing concern over increased incidence of asthma attacks, other respiratory illness and skin cancers.

Public perception of the risks associated with air quality is influenced by many factors. These include personal familiarity and control, degree of irreversibility, potential for large scale effects, perceived fairness in the distribution of risks and benefits, the extent to which risk managers are trusted, local history of air quality issues and the extent to which risks may affect future generations.

Communicating information on air quality is important and will be evaluated by the recipients with respect to their social, economic and environmental situation. In the UK, the Department of the Environment, Transport and the Regions makes air quality data available through a Freephone telephone service, CEEFAX and the Internet. In addition, many national and regional TV stations and newspapers carry forecasts of air quality, pollen count and sunburn risk, especially when the risk is high. Public demand for such services is likely to increase and it is important that information is communicated in a timely and understandable way.

Atmospheric processes

Agriculture

Both arable and livestock farming cause emissions to air (ammonia, methane and odours). Agriculture is the major source of emissions of ammonia to the atmosphere in the United Kingdom, accounting for about 90% of the national total, with around 50% from cattle. Livestock are also a major source of methane, accounting for about 30% of the national total. In addition to methane, agriculture is also a source of another greenhouse gas, nitrous oxide. Both farming and related industries have also been the subject of complaints about odours.

Accidents

Releases of a wide variety of chemicals into the air can occur following accidents such as the failure of safety systems (eg particles, radioactive substances) and the fracturing of containers and pipelines (eg chlorine, hydrocarbons).

Atmospheric processes control the transport and reaction of emissions between their point of release and potentially sensitive receptors in the environment. These processes control not only where emissions may impact on the environment but also their chemical and physical form. Impacts on the environment can be made worse by adverse meteorological conditions. In general, the most important atmospheric processes for air quality at a given location are:

Wind speed

This affects the rate at which emitted chemicals are transported, the rate of dilution with clean air, and factors such as the height to which a plume rises in the atmosphere.

Wind direction

This determines which locations are exposed to a given atmospheric release, and the frequency of such exposures.

Turbulence

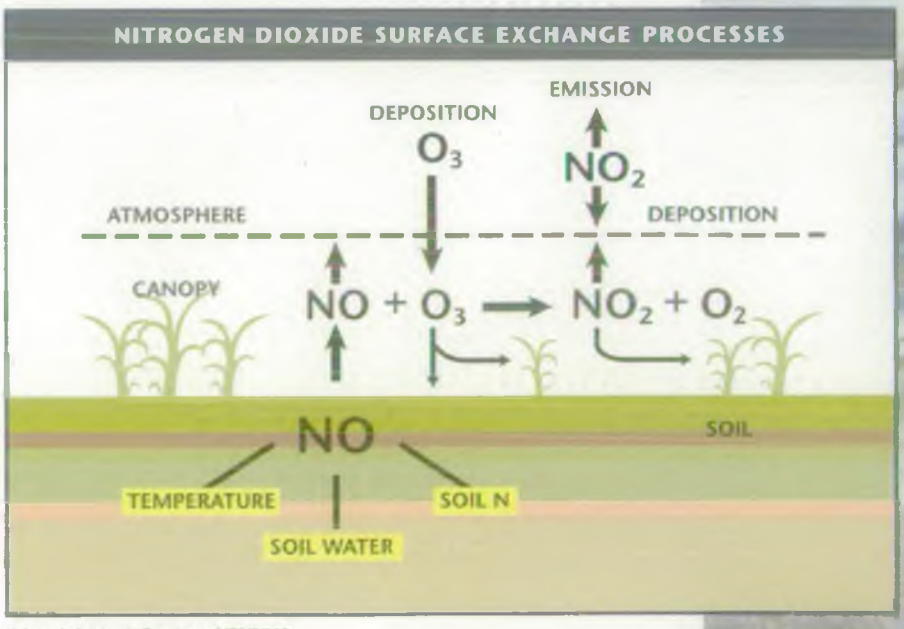
This refers to natural mixing processes in the atmosphere, which dilute chemicals as a result of either wind flow over obstacles or convection.

Conversion

Chemicals can be converted while travelling in the atmosphere, and this may involve either chemical processes (eg oxidation of SO_2 to sulphate aerosol) or physical processes (eg radioactive decay). In the case of chemical reactions, these may occur either in cloud or in dry air.

Deposition

Chemicals are removed from the atmosphere through deposition processes. These may either occur directly (dry deposition) or in precipitation (wet deposition). A further, locally significant, process occurs when upland vegetation is shrouded in cloud. While wet deposition is independent of the underlying surface, dry deposition can be largely determined by surface properties; sulphur dioxide will deposit more quickly on to a forest than on to moorland, for example.



Acknowledgement: Courtesy of ITE/RGAR

MANAGEMENT AND CONTACTS:

The Environment Agency delivers a service to its customers, with the emphasis on authority and accountability at the most local level possible. It aims to be cost-effective and efficient and to offer the best service and value for money.

Head Office is responsible for overall policy and relationships with national bodies including Government.

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The 24-hour emergency hotline number for reporting all environmental incidents relating to air, land and water.

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