Acid rain

Acid rain damages soils, vegetation, rivers and lakes and buildings. The problem has been tackled for over a decade with some success.

Sources

Acid rain is the name commonly given to the deposition of a mixture of acidifying compounds to soils, surface waters and buildings from the atmosphere. These compounds are initially released to the atmosphere as gases, mainly sulphur dioxide and nitrogen oxides but also hydrogen chloride. They are derived from:

- power stations
- industrial combustion processes
- road transport
- waste incineration

Once the acidic gases have been emitted to the atmosphere they can be transported over large distances. Hydrogen chloride is highly soluble and is deposited close to source areas, whereas sulphur dioxide and nitrogen oxides are relatively insoluble (at atmospheric concentrations) and are therefore usually transported much further from the source before being deposited. For example, around 90% of sulphur deposited in Sweden is due to emissions from neighbouring countries.

Types

The deposition of acidic pollutants can occur via one of three pathways:

- wet deposition - the deposition of pollutants in rain and snow, commonly termed "acid rain". This is the main pathway for most upland areas.
- dry deposition - the deposition of gases and particles directly onto terrestrial surfaces. In many parts of the UK dry deposition is larger than wet deposition.
- cloud deposition - the capture of cloud droplets by terrestrial surfaces. Pollutants are generally more concentrated in cloud than in rain, therefore, over high ground this pathway can provide a significant input of acidic pollutants.

Ammonia, which is derived mainly from agriculture (from farm animal waste), also contributes to acidification, even though it is not acidic. This occurs in several ways:

- ammonia increases the efficiency of sulphur dioxide wet deposition and therefore increases the local impact of sulphur dioxide emissions;
- sulphuric and nitric acids react with ammonia to produce ammonium sulphate and nitrate particles, which are deposited more slowly than the parent acids and are therefore transported further;
- when ammonia is deposited to soils it is converted to nitrate by soil
micro-organisms and releases hydrogen ions, therefore potentially increasing the acidity of the soil.

Distribution

The patterns of deposition of sulphur and nitrogen compounds over England and Wales are shown in Figures 1 and 2. Figure 1 also gives the predicted distribution for sulphur in 2010. The sources of the sulphur are both anthropogenic and natural, the amount deposited from each source is shown in Figure 3.

The highest deposition of sulphur compounds occurs close to the area of highest anthropogenic emission - the Midlands. The highest areas of nitrogen deposition are more widespread as a large proportion of the nitrogen oxides is from a diffuse source - traffic. Also, the amount of deposition of both compounds often corresponds with the regions of highest rainfall: in Scotland, along the high ground of northern England and on the Welsh hills.

Trends

Acidification is being tackled. The deposition of sulphur has decreased significantly over recent years and is predicted to decrease further by 2010 (Indicator: Sulphur deposition). This reflects a fall of 58% in sulphur dioxide emissions from 1986 to 1997, which led to a fall of 60% in dry deposition and 43% in wet deposition. The reductions in sulphur reflect investment made at power stations to reduce their emissions, by using flue gas desulphurisation technology and alternative fuel sources. Reductions in emissions of transboundary air pollutants are agreed at International level. Further progress is expected by 2010.

Effects

Lakes on rocks sensitive to acidification have become more acidic since the onset of industrialisation (Indicator: Lake acidification). Despite the recent reductions in sulphur deposition, there is no evidence of recovery in these lakes yet. Acidified water releases aluminium from soils, which can be toxic to fish and insects. This has led to the loss of species at all levels of the food chain. For example, the fisheries (young salmon and trout) in small headwater rivers in Wales have been affected, natterjack toads in the south of England may have been lost due to the acidification of their spawning ponds, and dippers (a riverine bird) have lost some of their food supply.

Different parts of the environment respond differently to acid deposition. Soils on chalk and limestone, for example, are naturally alkaline and neutralise acid deposition. Soils which are naturally acidic, like those found in much of Cumbria and Snowdonia, are more sensitive to acid deposition. These differences are reflected in their ‘critical loads’ – a measure of how much pollution that part of the environment can tolerate without harmful effects.

Critical loads

Maps showing where acid deposition damage occurs have been made by setting current levels of deposition against critical loads. Damage is most likely where the critical loads are small and the excess deposition is high. The maps show significant areas of the UK under pressure from current levels of acid deposition. For soils, there is a clear regional pattern, with the highest exceedence occurring in the most sensitive regions, notably Wales, the Pennines, and the Scottish Highlands, but also in certain parts of East Anglia and the south of England. The exceedence of critical loads for fresh waters gives a different regional picture, with the local high exceedences in particular parts of the Pennines, western Scotland and north and south Wales.

Excessive deposition of nitrogen has the effect of acting as a fertiliser. This changes the species composition of plant communities, affecting the animals that live on them. Figure 4 shows where the 5-percentile critical load of nutrient nitrogen is exceeded for natural vegetation. A 5-percentile critical load is the value that will protect 95% of the total ecosystem area. The map demonstrates that...
nutrient critical loads are widely exceeded and therefore damage to vegetation is probably occurring across much of the country.

Find out more

Use the right hand column to link to:

- **Centre for Ecology and Hydrology (CEH)** - critical load mapping
- **Convention on Long-Range Transboundary Air Pollution, United Nations Economic Commission for Europe.**