Acid Rain

This atmospheric pollution issue first came to prominence in the 1960s, when forest damage and acidified lakes were observed in northern Europe, Canada and the USA. Action to tackle to the problem was taken in the late 1970s and 1980s. To some extent, the problem fell from the public gaze as ozone depletion, and more recently, global warming became major environmental issues. So, is it 'problem solved' for acid rain or simply that other environmental issues take centre stage?

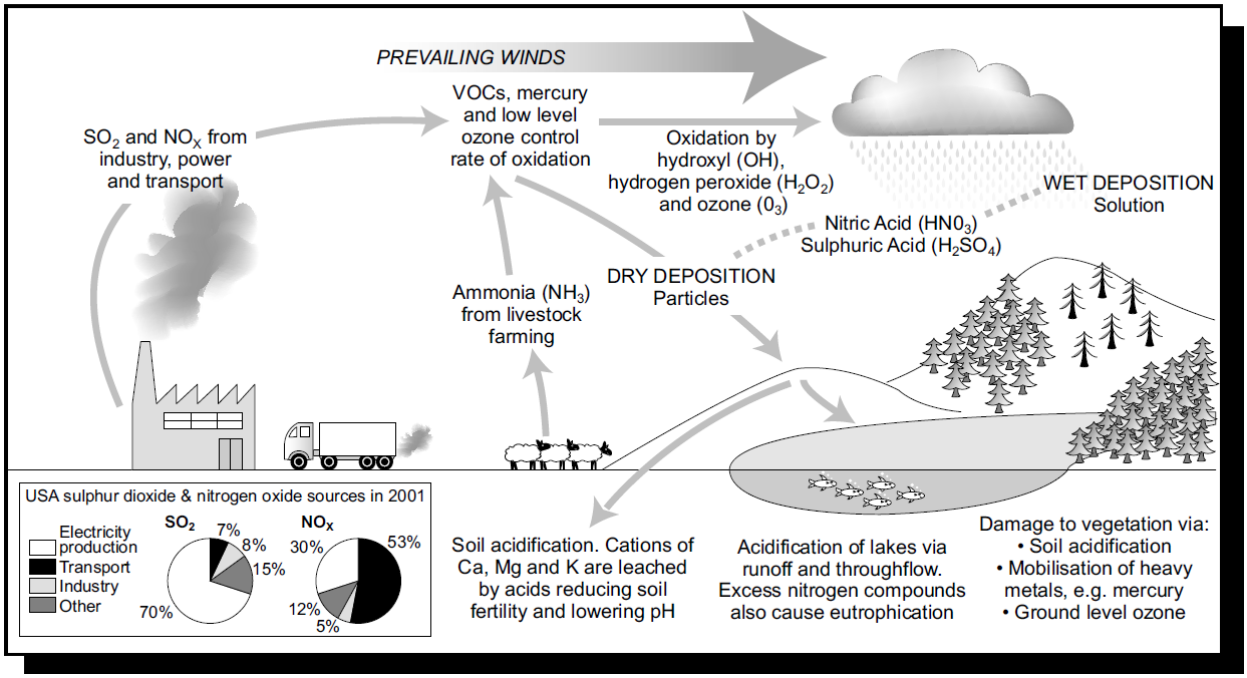
"Dad, what's acid rain?"

What is acid rain?

'Acid Rain' is a general term used to describe the ways in which acids fall out of the atmosphere. Acid deposition is a more accurate term, as acids can be deposited 'dry' as particulate matter and gas, or 'wet' as any form of precipitation (rain, mist, snow). *Fig. 1* summarises the processes and atmospheric chemistry of wet and dry deposition for the USA.

Exam Hint: Practice drawing a simplified, annotated version of Fig. 1. You may find this quicker and easier to repeat in an exam. Explaining complex processes such as acid deposition can eat up a lot of writing time in exams.

Fig. 1 Acid deposition processes



Why is acid deposition a threat?

Acid deposition generates a range of environmental threats, both to ecosystems and humans. Nitrogen oxides and sulphur dioxide have direct impacts, additionally nitrogen oxides and volatile organic compounds (VOCs) can react to increase levels of harmful ground level ozone. The threats are summarised in *Fig. 2.*

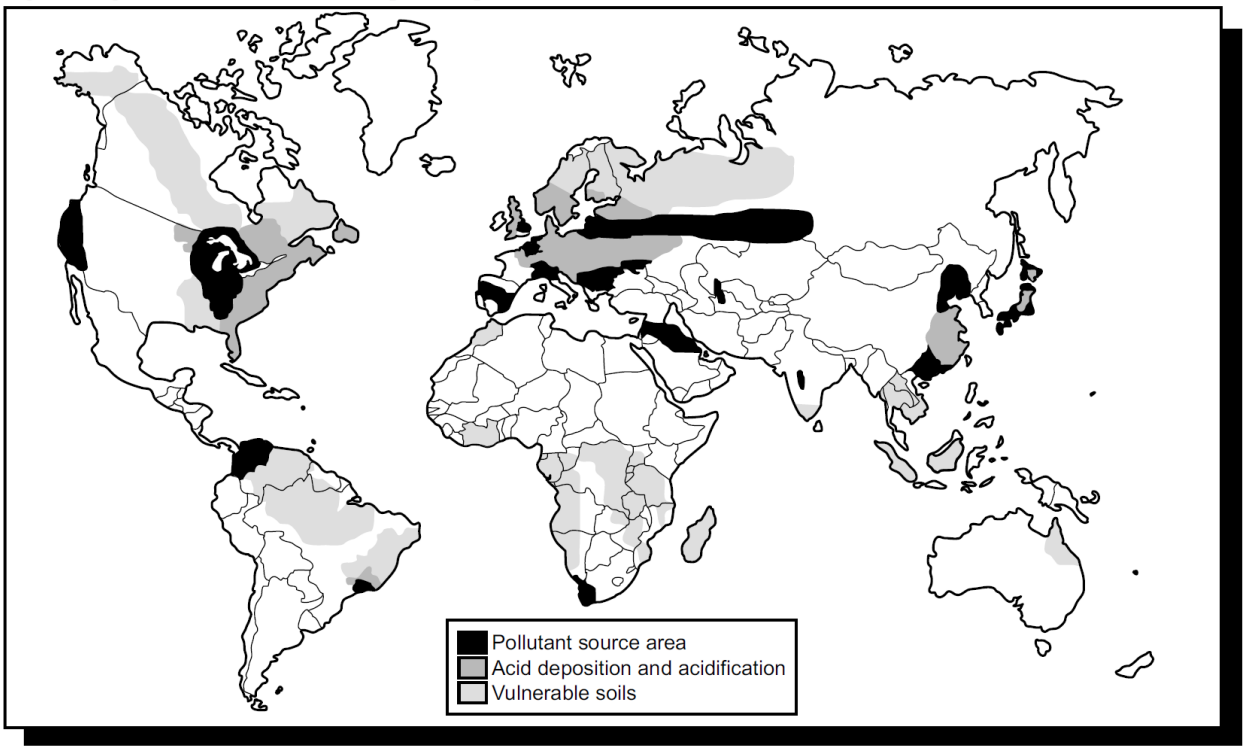
Fig. 2 Summary of acid rain threats.

Lakes	*Acidification of lake water killing fish and disrupting food webs.*
Soil fertility	*Direct acidification reduces nutrient levels and fertility; mobilisation of heavy metals such as mercury.*
Species diversity	*Vulnerable terrestrial and aquatic species lose their habitats. Eutrophication due to nitrogen excess.*
Forest damage	*Reduction in foliage and canopy density, as tree health declines.*
Human health	*Effects on airways and lung function.*
Cultural heritage	*Increased acid weathering of buildings, especially limestone masonry.*

Effects of Geology on Acidification

Not all ecosystems are equally sensitive to acidification. Ecosystems on limestone, chalk and some clay soils are **buffered** against acidification as they have alkali or neutral pH. This means they have a higher **acid neutralisation capacity** than acidic soils. The concept of **critical loads** measures how much acid deposition an area could tolerate before lasting damage occurs. Where acid deposition exceeds critical load, damage to ecosystems occurs.

Fig. 7 The global acid emissions and deposition pattern.



Task:

1. Describe the global patterns that the map depicts. In your answer, make sure to refer directly to named regional areas and locations as 'hot spots' for Acid. [6 marks]

2. Using online research (an atlas or world thematic maps), fully test and analyse the following 4 hypothesis for areas affected by acid rain. Your sources should help to support reasons explain the Global pattern in the map.

a) They are all in MEDCs of the Northern Hemisphere
b) They are all downwind of major industrial areas
c) They are all upland areas with high amounts of precipitation (rain or snow)
d) All these areas have many lakes, rivers and forests [12 marks]

3. Read "Overcoming Acidity" on the next two pages. It provides a case study on the Loch Fleet in Scotland. Answer all the questions.

13.3 OVERCOMING ACIDITY

Loch Fleet, Scotland

Can the damage caused by acid rain and pollution in the atmosphere be repaired? This case study shows how some researchers are trying to do this by restoring balance and richness to an ecosystem.

1 Look at the photograph in Source A. Describe the land and vegetation of the loch's CATCHMENT AREA.
2 Look at the diagram (Source B). Follow the arrows through the diagram and explain why Loch Fleet's ecosystem is poorer today than in the past.
3 Why do you think the water in the loch is crystal clear? What effect does acid rain have on plant and animal life?

A

Restoring a lake in south-west Scotland

Loch Fleet in the Galloway region of south-west Scotland, the site of a major acid lake restoration project

The photograph above is an aerial view of Loch Fleet and the catchment area which supplies it with water in the Galloway region of Scotland. The loch is clear, and the bed has a rich carpet of algae and moss. But there are no fish or other animals. The loch has become more acid, probably from air pollution and acid rain.

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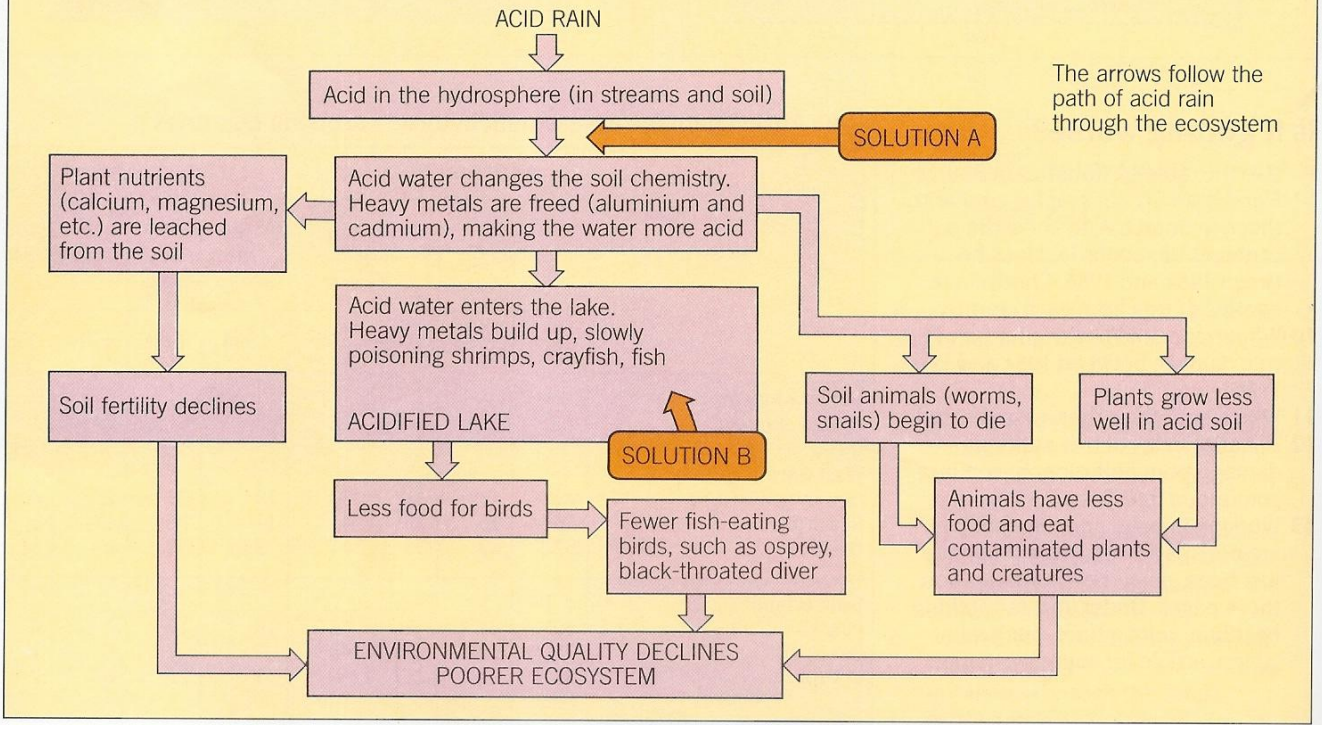
B

The path of acid rain through the Loch Fleet ecosystem



The Loch Fleet project

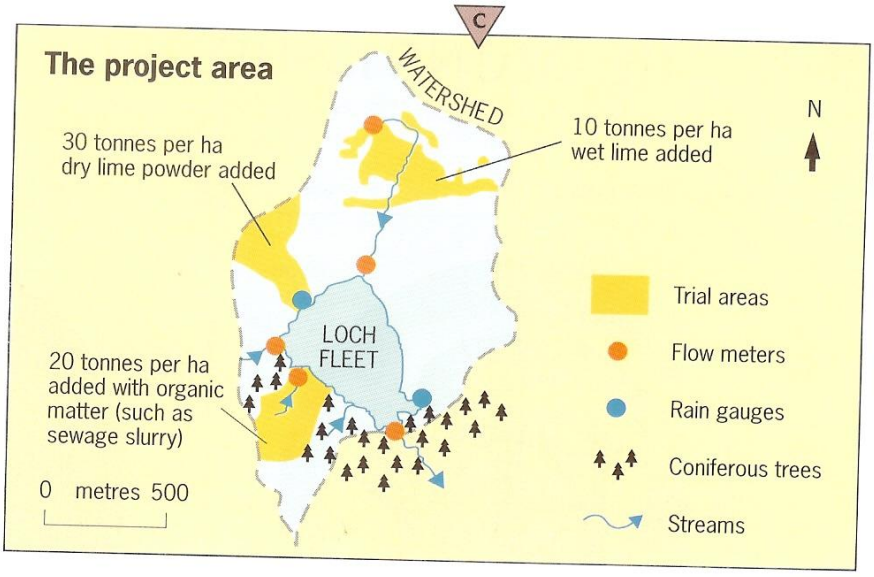
The aim of the Loch Fleet project is to restore the lake so that it will support fish once more. The money for the research is coming from British Coal, the Central Electricity Generating Board, the South of Scotland Electricity Board and the North of Scotland Hydro-Electric Board.

4 Why is dropping lime directly into the lake (solution B in Sources B and D) only a short-term solution?

5 **a)** Why does adding lime to the catchment area (Solution A in Sources B and D) have a wider impact on the ecosystem.
b) Why is this solution more likely to last longer?

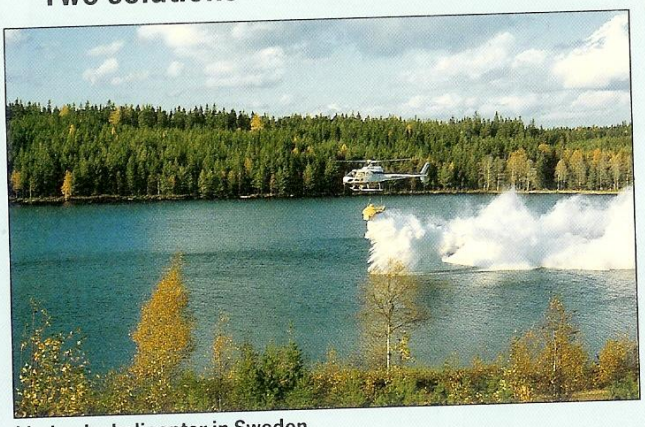
6 **a)** Look carefully at the map (Source C) and list what methods the scientists are using to collect information.
b) Why are they using different methods?

C



D

Two solutions



Liming by helicopter in Sweden

In Sweden, where thousands of lakes have suffered from acid rain, scientists have used lime (calcium carbonate) to repair the damage. Lime is alkaline and helps to neutralise the acid. There are two ways of doing this:

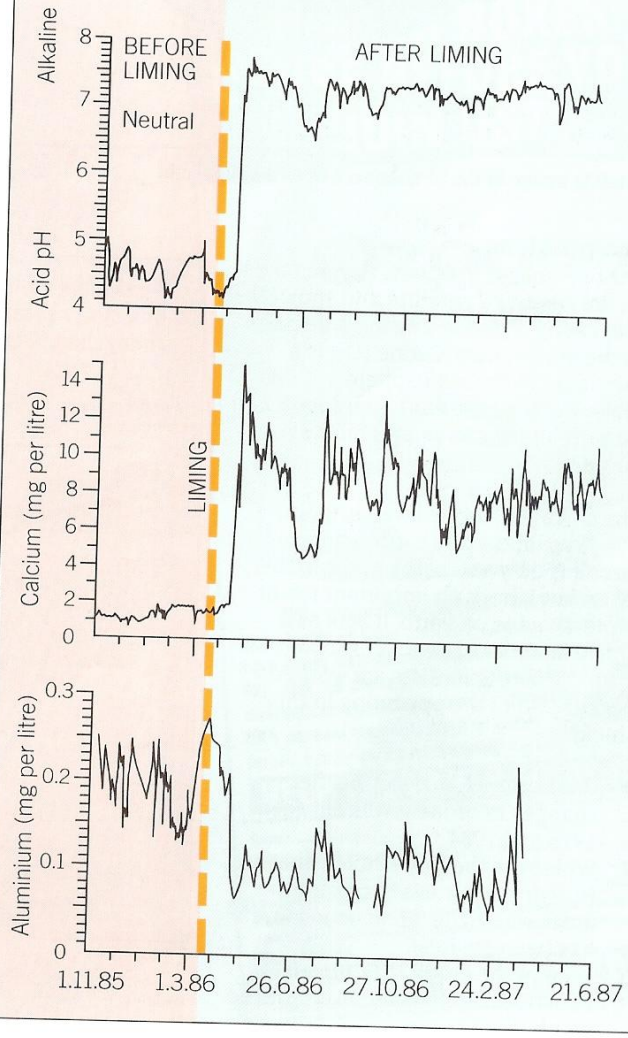
Solution B:
The simplest method is to drop lime directly into the lake (as in the photograph). Look at Source B.

This method enters the flow diagram of the ecosystem where the Solution B arrow is marked.

Solution A:
The Loch Fleet scientists are adding lime to the catchment area. In 1986, 300 tonnes of lime were added to three trial areas, using three different methods. More will have to be added in future years.

E

Loch Fleet water chemistry before and after liming



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7 Use Source E to explain why the scientists are pleased with their first results.

8 The money for this research is coming from the industries which have been blamed for causing acid rain. What else do you think the coal and electricity industries could do to keep Loch Fleet healthy?