



Section 1: Water Pollution

• What is meant by pollution?

Pollution can be defined as any waste that is released into the environment and causes harm. It is important to understand the concentration level of any pollutant, as this determines whether it causes harm or not. For some types of pollution, even a very small amount of the contaminant can create a problem. Pollution can be visible or invisible, so people are not always aware that there is a problem.

• Suggested Film

- **Pollution: Water**

Extension Questions

Q1. Why are fossil fuels a significant source of pollution?

Coal, crude oil and natural gas are all fossil fuels. They are made from partly decomposed organic matter that, on burning, releases energy in the form of heat (and light). Coal is the most important fuel in terms of global electricity production and emits carbon dioxide and carbon monoxide – both of which are greenhouse gases.

Q2. What is radioactivity?

Some elements are naturally unstable and 'break apart' to form different elements. In doing so, they release energy which we call radiation. Radiation can be both useful and cause problems, for example hospitals use X-rays to improve our healthcare, but exposure to high levels of radiation can cause cancer.

There was a large release of radiation from the Chernobyl nuclear disaster in the Ukraine in 1986 and, more recently, from the Fukushima plant following the Japanese tsunami of March 2011.



Fertilisers can make their way into our waterways

• How can sewage cause water pollution?

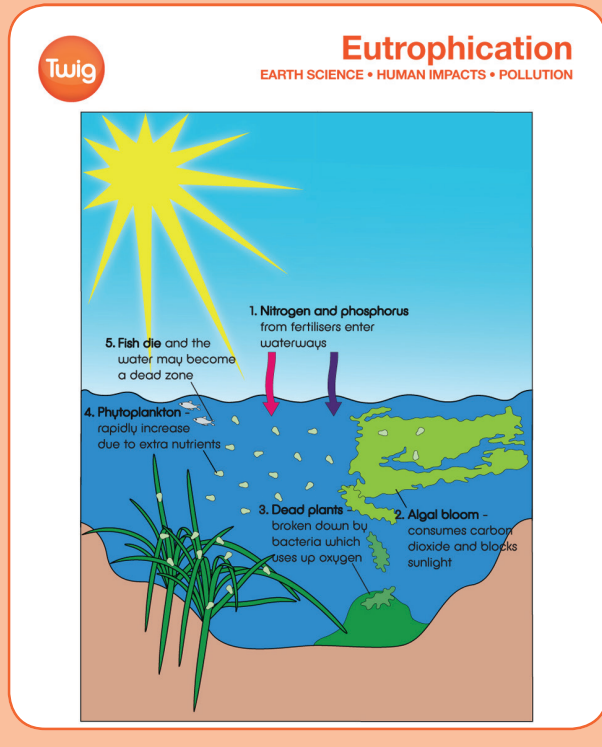


Fish can die in rivers and lakes suffering from eutrophication

Sewage is any waste carried by water that leaves our homes. Toilet waste is usually a component of sewage, and the water that ends up in sewers carries all sorts of pollutants, such as bleach, detergents and oils.

A major problem arises in Less Economically Developed Countries (LEDCs) when sewage-polluted water is used for cooking, drinking and washing. In LEDCs, sewage infrastructure is often inadequate, and safe treated drinking water is often not piped to homes. In some developing countries, groundwater and rivers can be contaminated with sewage as a result of open defecation. This can lead to outbreaks of waterborne diseases, such as cholera and dysentery, as well as eutrophication, which is the uncontrolled growth of aquatic plants. This can use up all the oxygen in the water and destroy animal life.

DIAGRAM 01:



• Suggested Film

- Pollution: Water

• How can industry pollute water?

Industry often relies on rivers as a cheap and easy way to dispose of unwanted waste. Often More Economically Developed Countries (MEDCs) have strict environmental laws to protect their rivers, lakes and groundwater, but LEDCs find it harder to apply such laws as effectively.

Heavy metals, such as mercury, can be very harmful to humans if they make their way into the food chain. In the 1950s, a factory in Japan dumped 27 tons of mercury into the sea at Minamata Bay, which led to over 900 deaths as a result of eating contaminated fish. Thousands of people also suffered health complications, such as nerve disorders, and many children were born with deformities. Gold miners in the Amazon rainforest use mercury to purify the gold, which can pollute rivers in the rainforest. Careful management of this rainforest ecosystem is needed to tackle such problems.

Crude oil spills can be particularly damaging to coastal ecosystems when oil slicks reach the shore. Burning fossil fuels can cause acid rain, resulting in the acidification of many lakes, which can leave them lifeless.

Our modern agricultural systems are very intensive and productive, but they depend on the application of chemicals. Chemicals are needed to fertilise land and control pests, weeds and fungi. Even careful use of these chemicals can't stop excess amounts finding their way into rivers and groundwater. One major problem occurs when fertilisers, which contain nitrates and phosphorus, build up in lakes and cause phytoplankton to 'bloom'. This algae bloom can use up oxygen and block out sunlight, causing the lake ecosystem to die. This is known as eutrophication.



Industrial waste can pollute nearby bodies of water

• Suggested Films

- Pollution: Water

- Oil Spills

- The Oilmen and the Animals

- Ecosystem Management: Tropical Rainforests

• Suggested Activity

- Ask the students to read the local and national newspapers and identify stories that relate to pollution of land, air or water. What are the main sources of pollution, and what is the response to them?

Section 2: Land Pollution

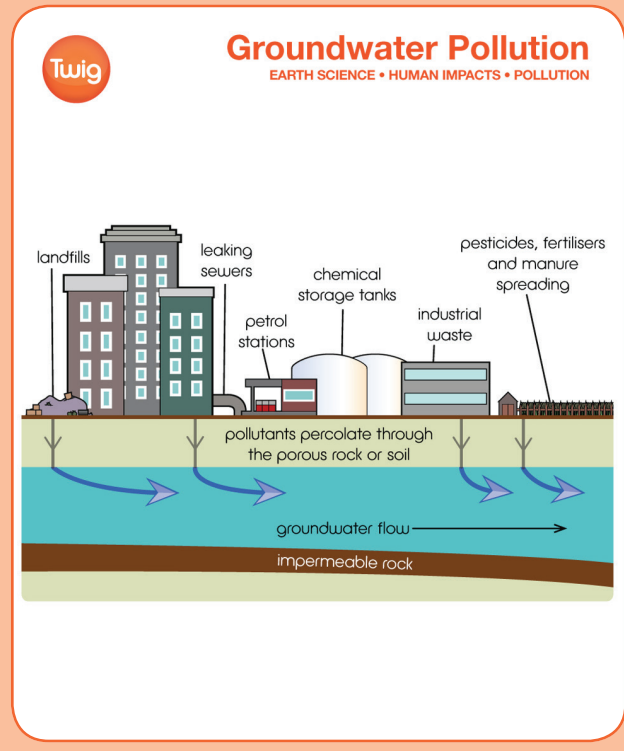
• How can landfill cause land pollution?

A landfill is a site where household waste is dumped. This is sometimes in disused quarries or on open ground in the countryside. Some rubbish can take years to decompose, for example plastic, which can take up to 450 years to degrade. Landfill sites cause visual pollution as they are ugly, but they also release greenhouse gases (carbon dioxide and methane) as the rubbish decomposes. Landfill often contains electronic products and batteries, which release toxic chemicals into the soil and groundwater.

Landfill sites have to be chosen with suitable relief and rock type to minimise pollution. Many landfill sites are full and future waste disposal may be a problem. In some LEDCs, communities develop around landfill sites and people earn their living by sorting through what other people have thrown away. An example is La Chureca in Nicaragua.

- Suggested Film
- Pollution: Land

DIAGRAM 02:



• How can agriculture, industry and energy production cause land pollution?

Modern farming often requires the use of man-made chemical pesticides, herbicides and fungicides, and when concentrated in the soil these chemicals can be harmful to the ecosystem. Heavy industry can cause soil pollution due to the build-up of heavy metals (such as mercury) and other toxic substances (such as arsenic). The nuclear energy industry also produces radioactive waste that requires careful storage and burial, as any leakage of this material has the potential to contaminate soil for hundreds, and even thousands, of years.



Most rubbish is buried in landfill sites

- Suggested Films
- Pollution: Land
- Deforestation
- Ecosystem Management: Tropical Rainforests

• How can land pollution be reduced?

There are both large- and small-scale solutions to the problem. Up to 80% of our household waste can be recycled, which reduces the amount of rubbish going to landfill sites. We can reuse items, such as plastic shopping bags and rechargeable batteries, instead of only using them once. We can also put pressure on our local governments to make recycling facilities available to more people and encourage retailers to prohibit products with unnecessary packaging.

To prevent harm to wildlife, laws can be passed which reduce the pollution and damage caused to ecosystems. Efforts are being made to protect tropical rainforest habitats by forcing cattle farmers to replant trees in the areas cleared for grazing and prohibiting logging. It is worth remembering that 90% of the UK's deciduous forests have been removed over the years, and methods such as pollarding and controlled grazing in the New Forest are helping to protect remaining woodland.

• Suggested Films

- Pollution: Land
- Ecosystem Management: Tropical Rainforest

• Suggested Activity

- Ask the students to keep a written record of what they throw away for one week. Ask the students to identify the items that could be recycled.

Section 3: Air Pollution

• What are the causes of air pollution?

Air pollution can occur naturally, as a result of forest fires or volcanic eruptions, but the majority is caused by human activities – the most harmful being the burning of fossil fuels (coal, oil and natural gas). The burning of coal is a major concern, as in addition to carbon dioxide (the main greenhouse gas) it also releases sulphur dioxide, nitrous oxides and soot particulates. At a local level, cars, lorries and buses (specifically in urban areas) can cause significant air pollution by releasing carbon monoxide, sulphur dioxide and particulates into the atmosphere.

Air travel is responsible for huge carbon emissions. The eruption of the Eyjafjallajökull volcano in Iceland in 2010 led to flights around the world being grounded for several days. Although the volcano emitted a large quantity of ash and gas, the overall result was that less pollution than usual entered the atmosphere during that time because of the reduced number of flights.

Light pollution, caused by artificial light in urban areas, can also seriously impact the surrounding wildlife and ecosystems. The resort of Las Vegas in Nevada's Mojave desert is a prime example of this.

• Suggested Films

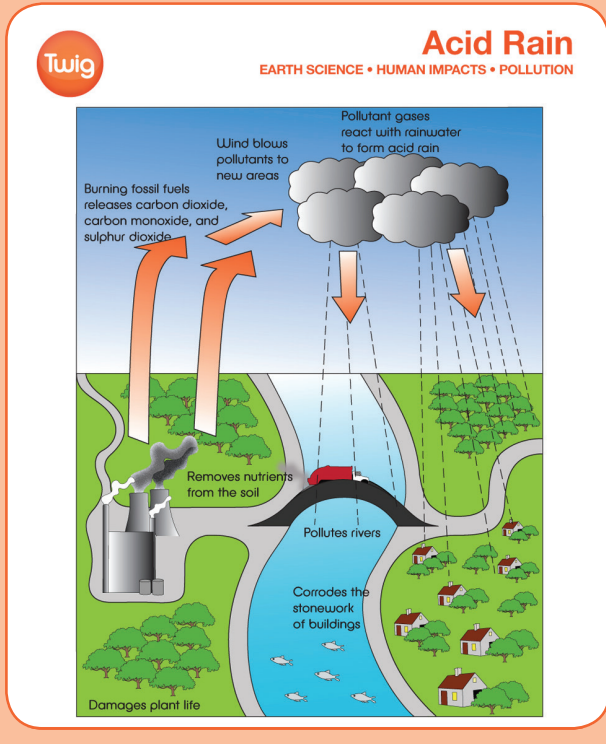
- Pollution: Air
- Ecosystem Management: Deserts



The burning of fossil fuels can cause smog

- What is acid rain?

DIAGRAM 03:



Sulphur dioxide, nitrous oxide and carbon dioxide are all produced when fossil fuels are burned and they dissolve in rainwater to produce acids (sulphuric acid, nitric acid and carbonic acid). Coal and oil power stations release these gases into the atmosphere and they mix with the rainwater in clouds. This makes the rainwater more acidic than normal and it falls back to the Earth's surface as acid rain, snow or even fog.

Acid rain damages habitats and ecosystems, such as forests and lakes. Lake water can become acidified beyond the level that fish and other organisms can live and ultimately the lake 'dies'. Acid rain also makes it hard for trees to uptake nutrients into their root system, so they lose leaves and eventually die.

Acid rain (or dry deposition) in cities can erode stonework. Europe and the USA have had success in reducing the acidity of rainwater, but some developing nations find the necessary technology too expensive. Some power stations install flue-gas desulphurisation technology to 'scrub' the gases as they leave the chimney stacks and reduce sulphur dioxide emissions by 90%.

• Suggested Film
- Pollution: Air

Extension Questions

Q3. What can be done to reduce acid rain?

Countries like the USA and the UK have fitted flue-gas desulphurisation technology or 'scrubbers' to the smoke stacks of coal-fired power stations, which remove the majority of the sulphur dioxide from the waste gases. This sulphur can be disposed of more safely and reduces the acidity of the water vapour downwind of a power station.

Q4. What is smog?

The word 'smog' was first used to describe the mixture of smoke and fog, which often formed as a result of city coal fires polluting the still air on foggy days. Today a common type of smog is 'photochemical smog', which is caused when traffic fumes or burning fossil fuels mix with sunlight. Smog is more likely in warm sunny weather and is common in cities with certain relief features, such as situated in a 'bowl'.

Pollutants react with sunlight to form a dangerous mix of chemicals in the air. One of the photochemical ingredients is ozone. Ozone occurs naturally in the stratosphere and blocks harmful ultraviolet rays, but at ground level it can be toxic to humans if concentrated. Smog can cause health problems, such as asthma and bronchitis.



• How does pollution affect vegetation?

Polluted air often creates visible damage to trees, especially to their leaves. Acid rain also harms vegetation by damaging the protective coating on the leaves of plants and trees. When acid rain seeps into the ground, it dissolves the nutrients in the soil that the vegetation needs in order to stay healthy, replacing them with harmful substances. Acid rain has caused significant damage to forests close to industrial areas in Europe, such as the Black Forest in Germany.

Many tropical rainforests are being cleared to build transport links and settlements, and establish farming and mining, therefore reducing the forests' ability to absorb carbon dioxide from the atmosphere. Afforestation, or tree replacement, can increase the forests' ability to cope with air pollution emitted by industrial activity nearby.

Lichens are known as an indicator species – scientists record the population of different lichen species in areas, over time, and can use information to assess the quality of the atmosphere. Lichens are good indicators because they are formed by two organisms – a fungus and an alga – living mutualistically. They can populate inhospitable habitats, such as bare rocks and barren deserts, because they draw water and minerals directly from the atmosphere. They are very sensitive to atmospheric pollution. Some species of lichen are more tolerant of pollution than others.

• Suggested Films

- **Pollution: Air**
- **Lichen: Indicator Species**
- **Ecosystem Management: Deciduous Forests**
- **Ecosystem Management: Tropical Rainforests**
- **Ecosystem Management: Deserts**

• Suggested Activity

- **Ask the students to research the 'pea-souper' fogs of London in the 1950s. These led to legislation that remains in force today called the 'Clean Air Act'.**
- **Using indicator paper from the Science department at your school, ask the students to test the pH of the rain that falls on the school site.**

• Quizzes

Water Pollution

Basic

• Eutrophication is caused by

- A – land pollution
- B – water pollution
- C – air pollution

• Which term best describes sewage?

- A – toilet waste
- B – any smelly rubbish
- C – water carrying waste from homes and places of work

• Sewage pollution can cause disease if

- A – it is left lying around
- B – it gets into drinking water
- C – there is very warm weather

• Toxins are

- A – pollutants that are poisonous to life
- B – helpful substances found in nature
- C – only dangerous to small animals

Advanced

• Eutrophication is caused by excess leakage of which chemicals into rivers and lakes?

- A – fertilisers
- B – pesticides
- C – herbicides

• Eutrophication kills water life by

- A – acidifying the water
- B – using up oxygen
- C – introducing poisonous toxins to the aquatic environment

• A build-up of toxins in marine food chains

- A – affects small, vulnerable organisms at the bottom of the food chain the most
- B – affects larger animals at the top of the food chain the most
- C – cannot be transferred to humans

• Which statement is most accurate?

- A – poorer nations have no environmental laws
- B – poorer nations don't care about their environment
- C – poorer nations find it much harder to enforce environmental laws

Land Pollution

Basic

• A landfill site is

- A – needed when there is a dangerous hollow
- B – used to bury waste
- C – where sewage is treated

• A plastic bottle can take

- A – 4 years to decompose
- B – 45 years to decompose
- C – 450 years to decompose

• Landfill sites produce

- A – methane and carbon dioxide
- B – carbon and methane
- C – carbon dioxide and ozone

• We could recycle

- A – 8% of our household waste
- B – 80% of our household waste
- C – all of our household waste

Advanced

• Which statement is true?

- A – landfill sites do not contain materials that can be recycled
- B – landfill sites always leak pollution into the groundwater
- C – the impact of landfill sites can be reduced with careful choice and preparation of site

• Decomposition in landfill sites produces

- A – methane and carbon dioxide
- B – methane and toxic chemicals
- C – heavy metals and toxic chemicals

• Which statement is true?

- A – plastics include polystyrene
- B – polystyrene can't be recycled
- C – plastics never decompose

• Radioactive waste is only

- A – produced by the nuclear industry
- B – produced by the nuclear industry and other sources like hospitals
- C – produced only if there is an accident

Air Pollution

Basic

• Which of these is a natural source of atmospheric pollution?

- A – a coal-fired power station
- B – a forest fire
- C – a landfill site

• Acid rain is

- A – natural
- B – man-made
- C – can be both natural and man-made

• Acid rain can

- A – kill trees in forests
- B – kill life in lakes
- C – kill trees in forests and life in lakes

• Smog is usually produced

- A – over cities with heavy traffic
- B – over landfill sites
- C – over cities that suffer sea fog

• A poisonous gas in smog is

- A – methane
- B – ozone
- C – sulphur monoxide

Advanced

• Which source of pollution do humans not encourage?

- A – acid rain
- B – volcanic eruptions
- C – forest fire pollution

• Rain is

- A – naturally slightly acidic
- B – naturally of neutral pH
- C – made acidic by making electricity

• When fossil fuels are burnt they produce

- A – particulates and soot that make rain acidic
- B – photochemical smog that is acidic
- C – sulphur dioxide and nitrous oxides that make rain more acidic

• Acid rain affects forests

- A – by limiting the uptake of nutrients by tree roots
- B – by reducing photosynthesis by coating coniferous leaves
- C – by both the above

• Photochemical smog ingredients include

- A – ozone
- B – methane
- C – both

• Answers

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