



DP IB Environmental Systems & Societies (ESS): SL



Acid Deposition

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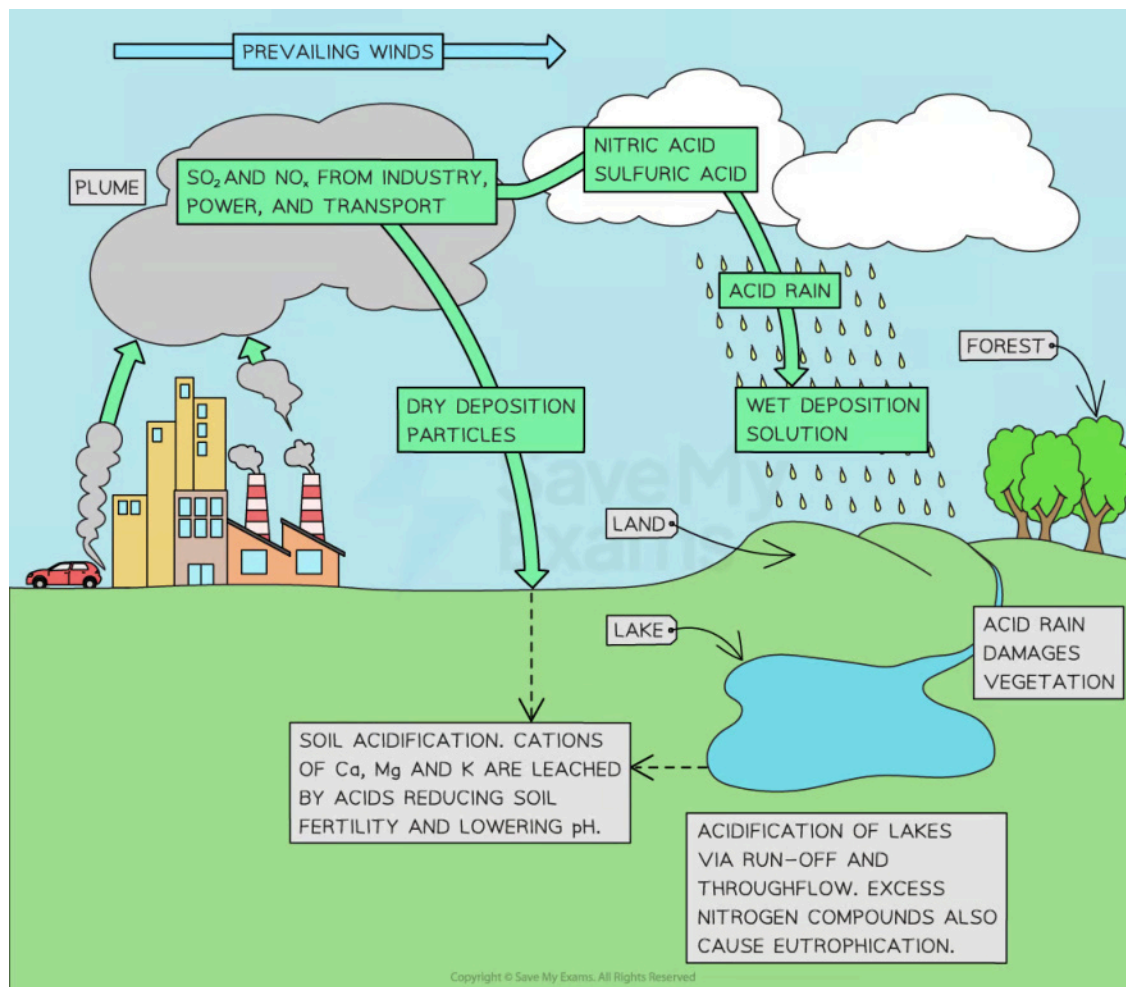
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Acid Deposition: Causes & Effects

Acid Deposition: Causes

Acid Deposition

- Acid deposition is a significant environmental issue caused by **human activities**
- It occurs when **sulfur dioxide** and **nitrogen oxides** are released into the atmosphere primarily from the **combustion of fossil fuels**
- These gases can undergo chemical reactions and transform into secondary pollutants, resulting in both **dry** and **wet** acid deposition



Causes of acid deposition



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Primary Pollutants from the Combustion of Fossil Fuels

- Fossil fuel combustion in power plants, industrial processes, and motor vehicles releases sulfur dioxide (SO_2) and nitrogen oxides (NO_x) into the atmosphere
 - **Power plants** that burn coal, oil, or natural gas are major contributors to SO_2 emissions, while NO_x emissions primarily come from **vehicle exhausts**
 - Sulfur dioxide is released when fossil fuels containing sulfur compounds are burned and contributes to the formation of **acid rain** directly
 - Oxides of nitrogen are produced through high-temperature combustion processes, such as those occurring in vehicle engines and industrial furnaces

Formation of Secondary Pollutants

- SO_2 and NO_x gases can undergo **chemical reactions** with other compounds already present in the **atmosphere**, such as oxygen, water vapor, and various pollutants
 - These reactions lead to the formation of secondary pollutants, including **sulfuric acid** and **nitric acid**

Dry Deposition of Secondary Pollutants

- Sulfuric acid and nitric acid can combine with ash and other particles present in the air, forming **dry particles**
 - Dry deposition occurs when these particles settle on surfaces, including **vegetation, buildings, and soil**, causing damage over time

Wet Deposition of Secondary Pollutants

- Sulfuric acid and nitric acid can dissolve in **rainwater** or **snowflakes**, forming **acidic precipitation**
 - Wet deposition occurs when this acidic precipitation falls to the ground, affecting surface water and soils
- These processes of conversion from primary pollutants to secondary pollutants contribute to the phenomenon of acid deposition
- Understanding the **causes** of acid deposition is crucial in developing effective strategies to reduce emissions, mitigate its environmental impacts, and promote sustainable practices

Acid Deposition: Effects

- Acid deposition has significant environmental effects that can impact various ecosystems and regions

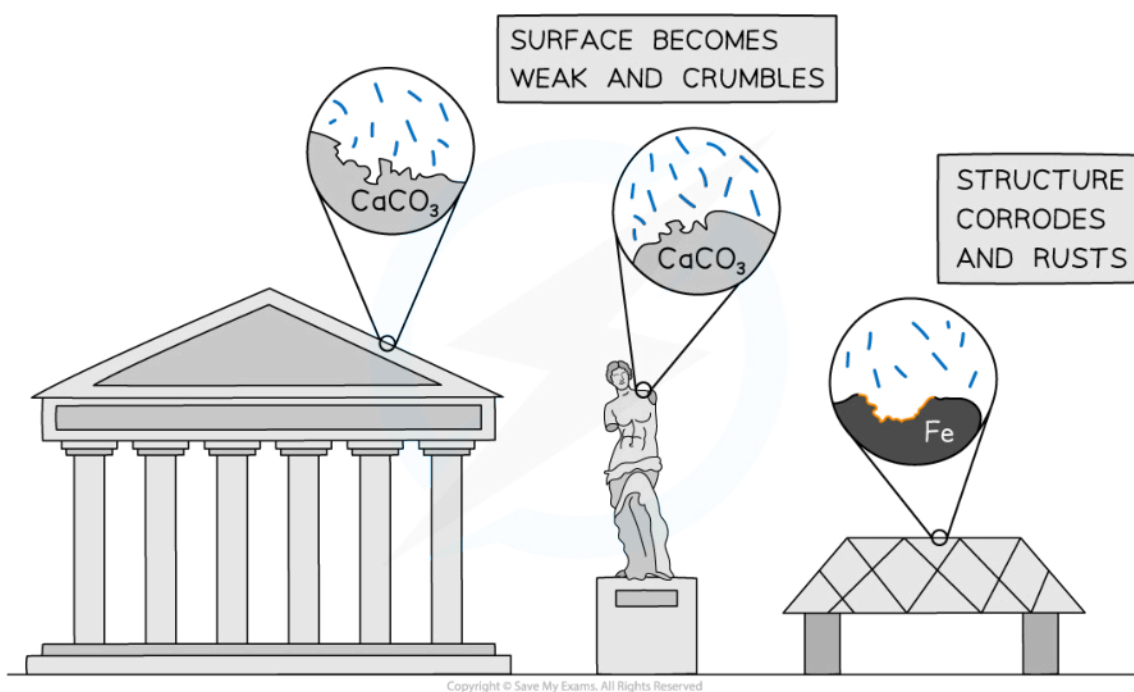


Your notes

- The effects of acid deposition are diverse and can have **direct** and **indirect** consequences on aquatic organisms, forests, and nutrient cycling

Direct Effects

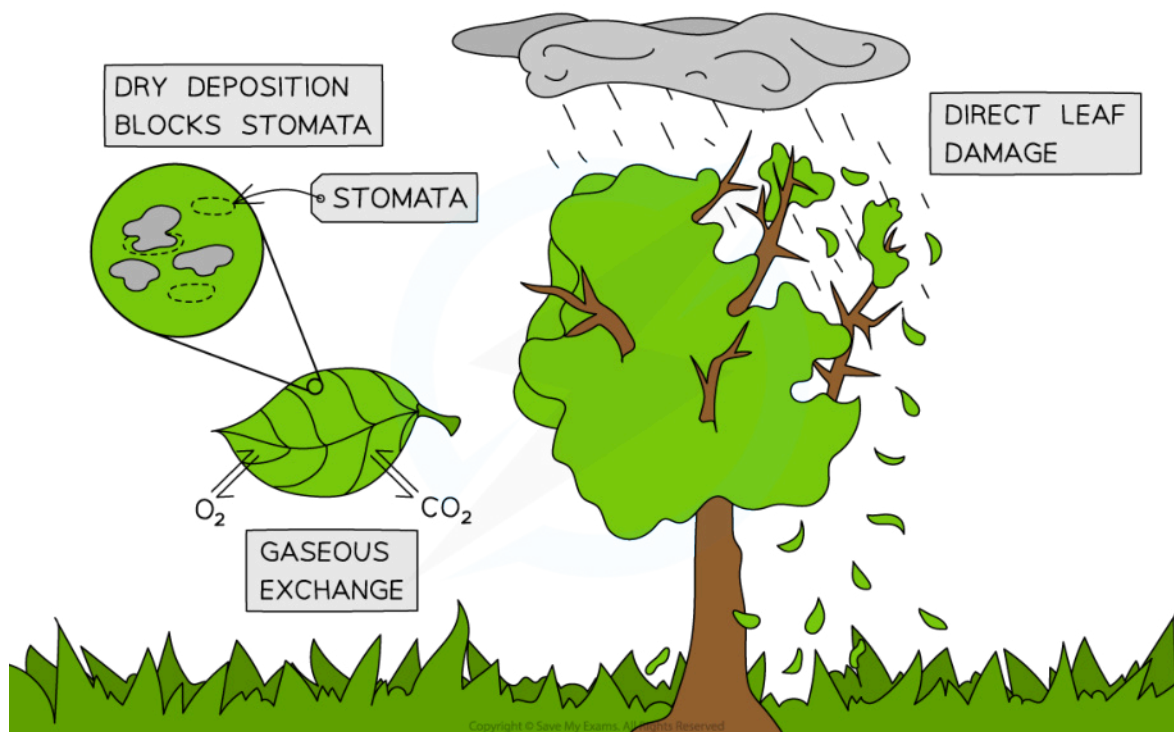
- Acid deposition can react with metals and rocks (such as limestone) damaging buildings and statues
 - Limestone and marble both contain calcium carbonate (CaCO_3)
 - The calcium carbonate reacts with sulfuric acid or nitric acid causing stonework to corrode and weaken



The impact of acid deposition can be seen on buildings, statues and metallic structures, particularly in polluted cities

- Acidic deposition, particularly in bodies of water, directly affects aquatic organisms such as fish, amphibians, and invertebrates
 - Acidic deposition **lowers** the **pH** of the water, making it difficult for some species to survive and reproduce
- As well as acid deposition directly falling on leaves, causing leaf damage and eventually killing plants, acid particulates can also block stomata (plant pores), preventing gaseous exchange
- Coniferous forests, such as those composed of pine or spruce trees, are sensitive to acid deposition due to their shallow root systems and thin bark

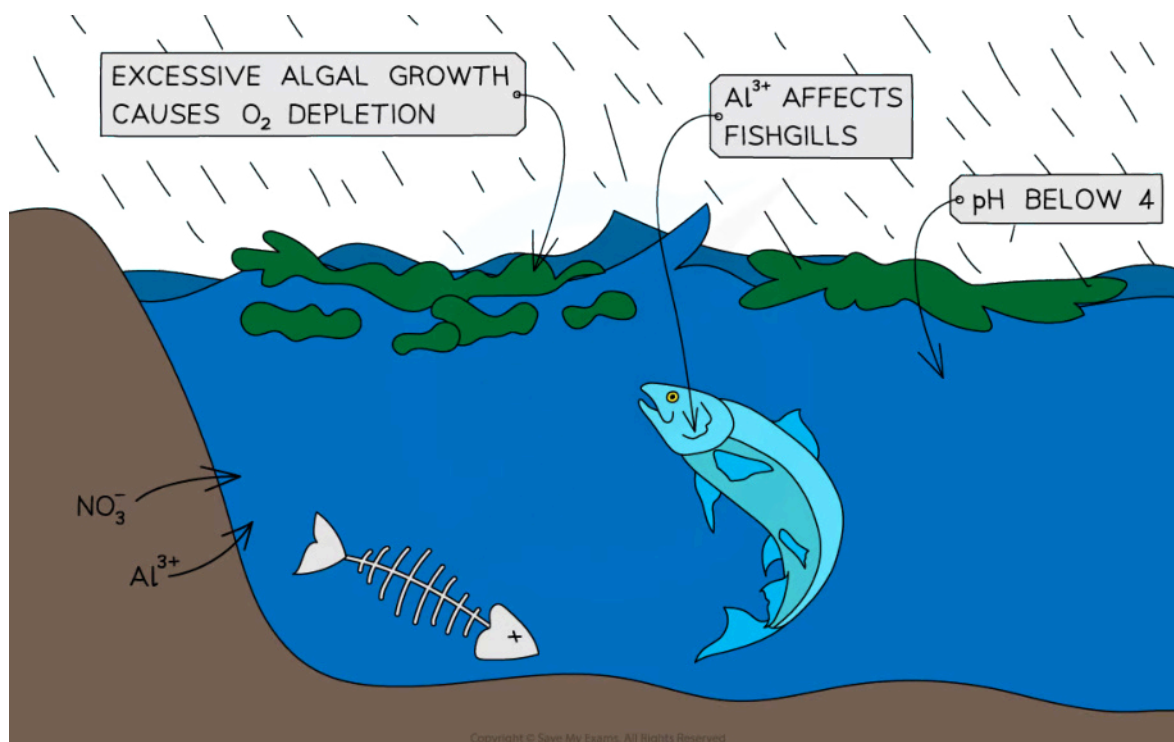
- Acid rain also damages their foliage and inhibits nutrient absorption



The impacts of acid deposition on plant life

Indirect Toxic Effects on Fish

- Acid deposition can **increase the solubility of metals** like aluminium in water bodies
- High levels of **aluminium ions** become toxic to fish, affecting their respiratory systems, impairing growth, and even causing mortality



The impact of acid deposition on waterways

Indirect Nutrient Effects

- Acidic deposition accelerates the **leaching** of essential **nutrients** from soil, such as calcium, magnesium, and potassium
 - Leaching of nutrients reduces their availability for plants, leading to **nutrient deficiencies** and impacting plant growth and overall ecosystem **productivity**

Geographic and Transboundary Impacts

- The impacts of acid deposition are not confined to the immediate vicinity of emission sources
 - Areas **downwind** of major industrial regions are more likely to experience the adverse effects of acid deposition
 - It is also possible for the impacts of acid deposition to extend across **national boundaries**, affecting regions in different countries than the source of emissions
- These effects of acid deposition highlight the environmental risks associated with high levels of sulfur dioxide and nitrogen oxides emissions

- Efforts to reduce acid deposition involve emission control measures, such as the use of cleaner technologies and regulations on industrial and transportation emissions
- **International cooperation** and **agreements** are also necessary to address transboundary impacts



Your notes



Your notes

Pollution Management Strategies for Acid Deposition

Pollution Management Strategies for Acid Deposition

- Acid deposition requires effective pollution management strategies to **mitigate** its harmful effects on the environment and human health
 - These strategies involve altering human activities, regulating pollutant release, and implementing clean-up and restoration measures

Altering Human Activity

- Reducing the consumption of fossil fuels is a key strategy to minimise acid deposition
 - Encouraging the use of alternative energy sources, such as **renewable energy**, can significantly reduce emissions of sulfur dioxide and oxides of nitrogen
- International agreements and national governments play a vital role in promoting sustainable practices, supporting the development of clean technologies, and lobbying for emission reduction

Regulating and Monitoring Pollutant Release

- Government regulations and **monitoring systems** are essential to **control** and **reduce** the release of pollutants that contribute to acid deposition
 - Coal-burning power plants and vehicles are major sources of sulfur dioxide and nitrogen oxides emissions
 - Installing pollution control devices such as **scrubbers** and **catalytic converters** can effectively remove these pollutants from emissions

Clean-up and Restoration Measures

- In areas heavily affected by acid deposition, clean-up and restoration measures may be implemented to mitigate the damage caused
 - For example, **spreading ground limestone** or **lime** in acidified lakes and rivers can **neutralise acidity** and restore the water's pH balance
- Restoring damaged ecosystems can also be achieved through recolonisation efforts, such as **planting acid-tolerant vegetation**
 - This can help to restore some measure of ecological balance to these damaged ecosystems

Limitations

- While clean-up and restoration measures have shown some success, their scope is limited

- Applying ground limestone or recolonising ecosystems can be extremely **expensive** and logistically challenging, making it difficult to address acid deposition on a large scale
- Prevention through **emission reduction** is more effective and sustainable in the long term
- Implementing these pollution management strategies for acid deposition requires a combination of international cooperation, national regulations, technological advancements, and public awareness
- By reducing the emissions of sulfur dioxide and nitrogen oxides, and implementing measures to restore affected ecosystems, the adverse effects of acid deposition can be minimised



Your notes