DP IB Environmental Systems & Societies (ESS): SL

Your notes

7.1 Natural Resources Uses & Management

Contents

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Natural Capital & Natural Income

What is natural capital?

- **Natural resources** are the sources of energy and raw materials that society uses and consumes
- In other words, the term natural resources applies to anything that comes from nature that can be used to **benefit humans**
  - Examples include:
    - Sunlight is essential for photosynthesis, solar energy
    - Air: oxygen for breathing, wind energy
    - Water: drinking, irrigation, hydroelectric power
    - Land: soils, agriculture, construction, habitat for wildlife
    - Rocks: minerals, construction materials
    - Ecosystems: forests, wetlands and coral reefs
    - Living things: plants for food and medicine, animals for food and clothing
  - In the environmental sciences, these resources are sometimes referred to as **natural capital**
- **Definition**: natural capital is the **stock** of natural resources available on Earth
- **Types of natural capital**:
  - **Renewable resources** are resources that can be replenished naturally
    - **Examples**: forests (timber), fish populations
  - **Non-renewable resources** are resources that are finite and cannot be replenished
    - **Examples**: fossil fuels (coal, oil), minerals (gold, iron ore)
  - **Ecosystem services** are the benefits provided by ecosystems that support human life and economic activity
    - **Examples**: pollination of crops, water purification, carbon sequestration

What is natural income?

- **Definition**: natural income is the flow of **goods** and **services** produced by natural capital

- **Examples of goods**:
  - **Fish**: harvested from oceans and rivers
  - **Timber**: harvested from forests for building and paper products
- **Examples of services**:
  - **Climate regulation**: forests reduce global warming by absorbing CO_2
  - **Flood prevention**: wetlands reducing flood risk by absorbing excess rainfall, or mangroves buffering against storm surges

Sustainable natural income

- If these natural goods and services are carefully and **sustainably managed**, they can provide even more resources over time
  - This is referred to as **sustainable natural income**
  - For example:
    1. Trees are cut down for timber but forests are also re-planted or left to recover
    2. The rate of new tree growth is **greater** than the rate of timber production
    3. Timber production is a sustainable source of income that can be marketed and used to benefit humans
- In other words, natural income is the term used to describe the sustainable income produced by natural capital
  - Again, using the timber production example:
    - Our forests are the **natural capital**
    - The sustainable timber we can obtain from these forests is our **natural income**
- Non-renewable resources, such as fossil fuels, can be used to generate wealth but can only be used **once** and cannot be **sustainably managed**
  - Therefore, even if they can be considered as natural capital, non-renewable resources cannot produce sustainable natural income


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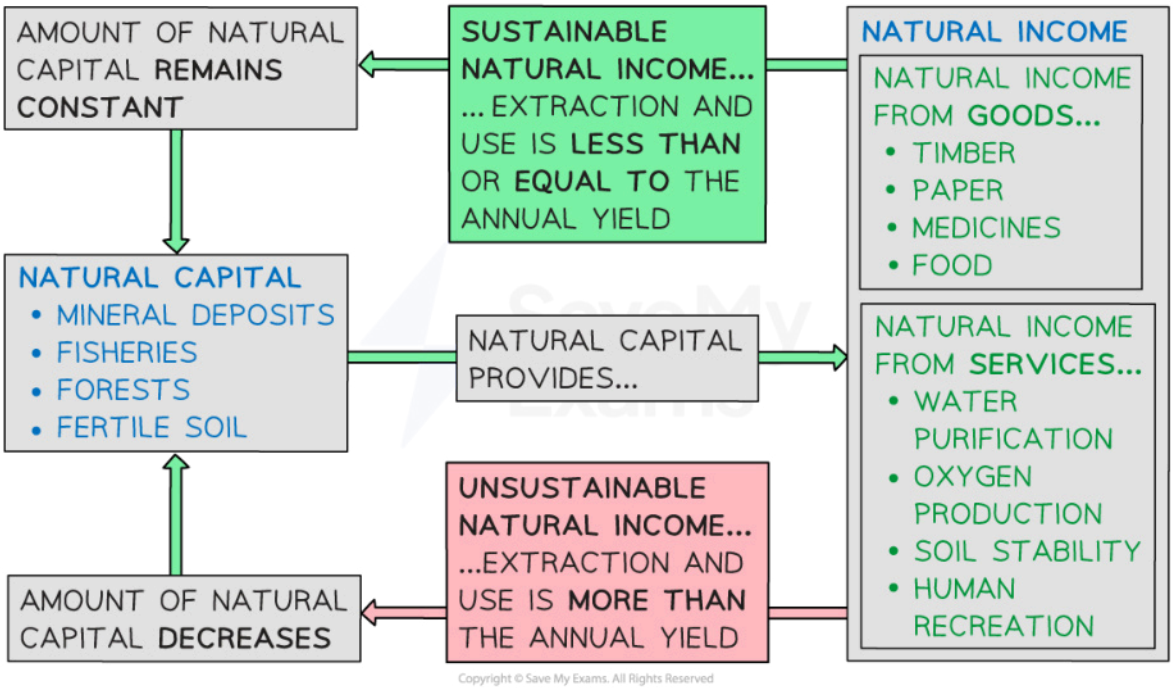

Natural capital can be used to generate natural income, but this can be done in a sustainable or unsustainable way

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Perspectives on nature

- **Economic value**:
  - Viewing nature as natural capital highlights the economic value of resources
  - Encourages investment in their **preservation** and **sustainable use**
  - It helps policymakers and businesses recognise **financial benefits** of maintaining healthy ecosystems
- **Sustainable management**:
  - Emphasising natural capital and natural income encourages sustainable management practices
  - By valuing natural resources as capital, societies are more likely to **invest** in **conservation efforts**
    - Ensures a continuous flow of natural resources, such as clean water, air and fertile soil
- **Anthropocentrism**:
  - This perspective may imply that nature exists solely for human use and exploitation
    - This is an extreme anthropocentric view

- It suggests that the environment's primary purpose is to serve human needs and economic interests
    - Leads to **over-exploitation** and **degradation** of natural resources
- **Intrinsic value**:
    - Some argue that this anthropocentric view reduces nature's intrinsic value
        - I.e. it ignores the inherent worth of ecosystems and species beyond their use to humans

Examiner Tips and Tricks

The terms natural capital and natural income are very easy to confuse. If you are finding this concept tricky, try to remember the following analogy: money in a bank (sometimes referred to as capital) may gain **interest** over time if it is **carefully managed**. Natural income is effectively the interest that humans can live off and benefit from, if natural capital is sustainably managed!

Ecosystem Services

- **Definition**: benefits provided by ecosystems that support life and human well-being
- Ecosystem services usually fall into one of four main categories:
    - Supporting services
    - Regulating services
    - Provisioning services
    - Cultural services

Ecosystem Service	Description	Examples
Supporting	Essential ecological processes for supporting life	Primary productivity (photosynthesis) Soil formation Cycling of nutrients (e.g. carbon cycle, nitrogen cycle)
Regulating	A diverse set of services that shape and stabilise ecosystems	Climate regulation Flood regulation


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		Water quality regulation Air quality regulation Erosion control Disease and pest control
Provisioning	The goods humans obtain from ecosystems	Food Fibres Fuel Fresh water Timber
Cultural	These services derive from humans interacting with nature in a culturally beneficial way	Recreation and tourism Education Health benefits Sense of place, national identity and cultural heritage Employment

Examples of Regulating Ecosystem Services

Ecosystem service	Description	Further information	Examples
Water replenishment	Natural process of replenishing water in aquifers, rivers and lakes	Provides clean drinking water Supports agriculture and industry	Mountain watersheds—snowmelt and rainfall replenish rivers and groundwater, e.g. glacial meltwater
Flood and erosion protection	Ecosystems absorb excess rainfall and prevent soil erosion	Wetlands and floodplains reduce flood risks Coastal mangroves and vegetation protect	Coastal Mangroves in Southeast Asia protect shorelines and support fisheries Forest tree root networks stabilise soil and prevent

		against storm surges	erosion on hillsides
Pollution mitigation	Ecosystems help remove pollutants from the environment	Improves water quality in rivers and lakes	Reed bed buffer zones filter water, removing inorganic nutrients and pollutants Wetlands e.g. saltmarshes, absorb pollution
Carbon sequestration	Process of capturing and storing atmospheric carbon dioxide	Forests and oceans act as carbon sinks Reduces greenhouse gases, mitigating climate change	Tropical rainforests, e.g. Amazon rainforest is a major carbon sink, regulating global climate Seagrass meadows


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The Value of Natural Capital

- Natural capital provides natural income in the form of **goods** (tangible products such as timber and crops) and **services**
- These goods and services have great value to human societies
  - This value may be aesthetic, cultural, economic, environmental, health, intrinsic, social, spiritual, or technological

Natural Capital Value Types

Value type	Description	Example
Aesthetic	Value from the beauty, visual appeal and enjoyment of natural landscapes and biodiversity	Appreciating a stunning sunset over a pristine beach Enjoying the vibrant colours of a diverse coral reef
Cultural	Value in shaping cultural practices, traditions and identities of communities	Indigenous communities relying on forests for their livelihoods and incorporating traditional ecological knowledge in their practices
Economic	Contribution to economic activities through provision of raw materials, fuels, food and other tangible products	Logging industry relying on forests for timber production Agriculture relying on fertile soils for crop cultivation
Environmental	Provision of essential ecosystem services that support the health and functioning of ecosystems	Wetlands purifying water by filtering pollutants Forests sequestering carbon dioxide and mitigating climate change

Health	Supporting physical and mental health through clean air, water and natural spaces	Access to clean air and water and green spaces for exercise and relaxation contributes to overall health and well-being
Intrinsic	Inherent worth of natural capital, independent of its instrumental value to humans	Appreciating untouched wilderness as an essential and irreplaceable part of our planet
Social	Contribution to human well-being, including recreational spaces, opportunities for maintaining physical and mental health and fostering social cohesion	Parks, woodlands and beaches can provide spaces for people to connect with nature and strengthen social bonds
Spiritual	Spiritual significance and connection to nature, essential to some communities	Sacred mountains revered for their spiritual significance Other natural places where people seek solace, reflection and spiritual experiences
Technological	Inspiration and utilisation of natural capital in technological advancements and innovations	Biomimicry, e.g. where the design of a building is inspired by the cooling properties of termite mounds, leading to energy-efficient architecture


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- This diverse range of values associated with natural capital highlights the importance of preserving and sustainably managing these resources
    - This is for the benefit of both **present** and **future** generations

The dynamic nature of natural capital

- The concept of natural capital is highly **dynamic**
    - This is because the value of natural capital can change **regionally** and **over time**
- **Cultural factors** can influence the value of certain natural resources
    - E.g. cork forests in Portugal have been recognised as valuable natural capital due to their importance in the wine industry
    - The cultural heritage associated with this is significant

- **Social factors** can influence value of natural capital
  - E.g. in certain regions, uranium mining is seen as a threat to human health and the environment
  - As a result, uranium may be regarded as negative or harmful natural capital
- **Economic factors** play a significant role in determining the market value of natural capital
  - E.g. lithium, which is essential for battery production in the rapidly growing electric vehicle industry, has seen increased market value and demand
- **Environmental factors**, such as the physical scarcity or abundance of a resource, can influence its value
  - E.g. in areas with significant lithium deposits, such as the lithium triangle in South America, lithium has become highly valuable natural capital due to its critical role in batteries
  - Initially valued for industrial use, coal is now facing scrutiny due to environmental impacts
- **Technological factors**, such as **advancements** in technology, can influence the value of natural capital
  - For example, flint was once an important resource used for hand tools
  - It is now redundant, as it was replaced by the development of metal extraction from ores
- **Political factors**, including regulations and policies, can change the market value of natural capital
  - Governments can impose restrictions or incentives that affect the extraction and use of certain resources, e.g. limiting uranium mining due to environmental concerns


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Resource Sustainability

Renewable natural capital

- **Renewable** natural capital includes natural resources that can be **replaced** or **regenerated** at a rate equal to or faster than they are being used
- **Living species and ecosystems**:
  - These include forests, wetlands, coral reefs and grasslands, which can **regenerate** through natural processes
  - These systems are able to do this as they harness solar energy and use photosynthesis to convert it into biomass
    - E.g. forests provide fuel wood for many communities and are harvested for timber
      - They have the capacity to regenerate through seed dispersal and natural growth
      - This allows new trees to **replace** the ones that have been **harvested**
    - Wetlands play a vital role in maintaining water quality, regulating floods and providing habitat for diverse species
      - They can self-sustain and regenerate, through natural processes like **sedimentation** and **nutrient cycling**
      - They can even regenerate after disturbances such as droughts or human activities like mining or construction
- **Non-living systems**:
  - These include renewable resources such as **groundwater** and the **ozone layer**
  - These can be replenished through natural processes
    - E.g. groundwater is recharged by **precipitation** and **infiltration**
      - This ensures that it can be sustainably used as a freshwater resource
    - The ozone layer can also regenerate itself naturally
      - This can occur if the emissions of ozone-depleting substances are significantly reduced
      - This allows the stratospheric ozone concentration to **recover** over time

Non-renewable natural capital


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- **Non-renewable** natural capital includes natural resources that **cannot** be replaced or regenerated at a rate equal to or faster than they are being used
  - This is because these resources are either **irreplaceable** or can only be replenished over **geological timescales** (i.e. extremely long periods of time)
- **Fossil fuels**:
  - Coal, oil and natural gas are **finite** resources formed over millions of years from the remains of plants and animals
    - Once extracted and burned for energy production, they cannot be replaced within human timescales
  - Although not a fossil fuel, **uranium**, used in nuclear power plants, is also considered as non-renewable natural capital
    - Uranium reserves are also not replenishable within human timescales
- **Soil**:
  - Soil is a renewable resource to some extent
  - However, it can become non-renewable when it is **degraded** or **eroded** at a faster rate than it can be naturally replenished
    - **Unsustainable agricultural practices**, such as excessive tilling and deforestation, can lead to soil erosion and depletion
    - **Urbanisation** and construction activities can result in the permanent loss of fertile soil
    - This effectively removes its ability to regenerate in these areas
- **Minerals**:
  - These include various **elements** and **metals** extracted from the Earth's crust
  - These are **finite** and cannot be replenished within human timescales
    - Rare-earth minerals used in electronics, e.g. lithium, have finite reserves
    - Precious metals, e.g. gold and silver, will have to be **recycled** or obtained from existing stockpiles once natural reserves have been completely extracted

Sustainable and unsustainable use of natural capital

- It is crucial to manage and use renewable natural capital **sustainably** to ensure its **long-term availability**

Sustainable use of renewable natural capital

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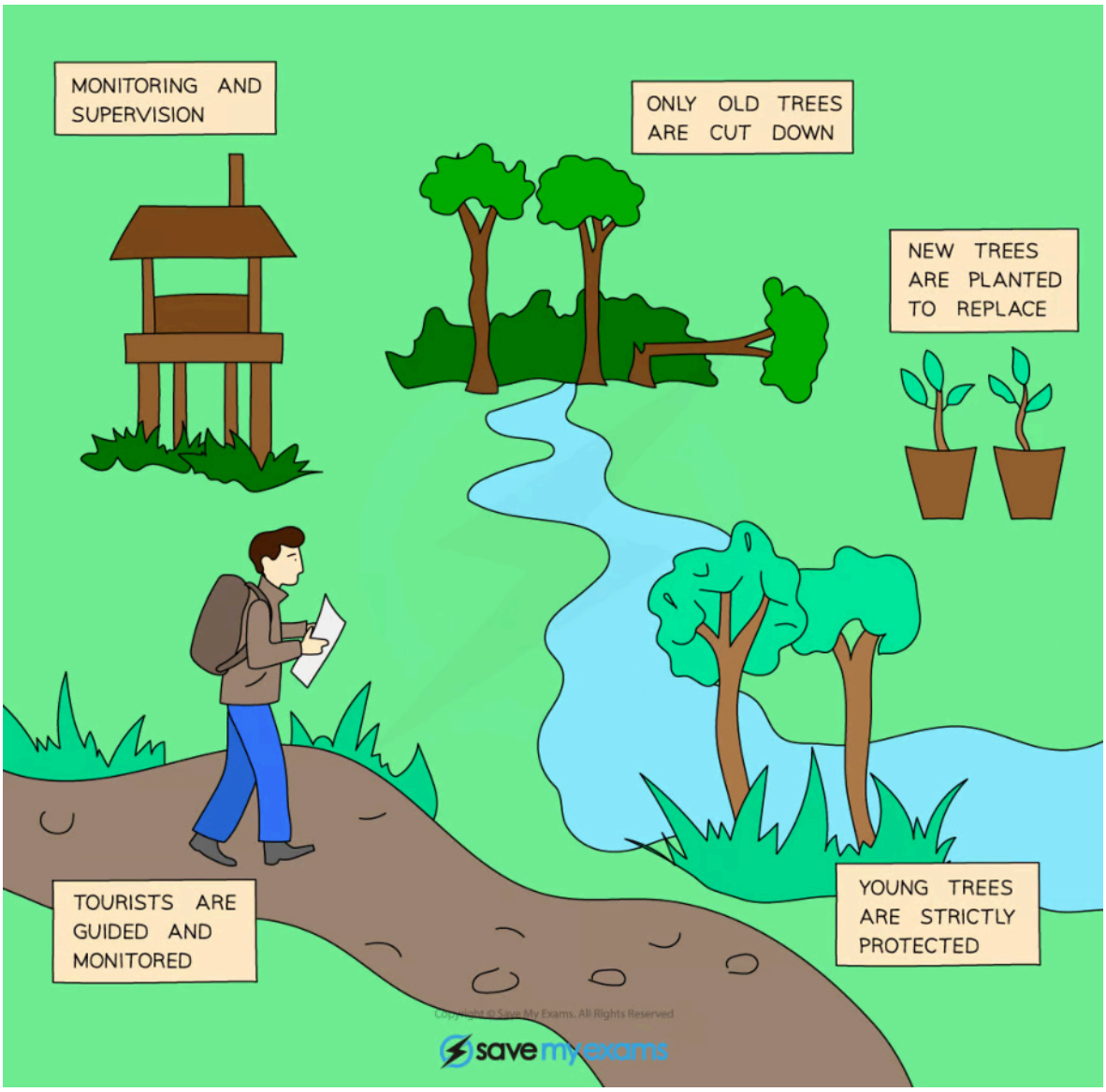
- **Forest management**:
  - Implementing sustainable forestry practices, e.g. selective logging, reforestation and maintaining biodiversity
  - This preserves the integrity of forest ecosystems
  - This ensures continued provision of timber, non-timber forest products and ecosystem services



Sustainable forestry

- **Fisheries management**:

- Strategies can help maintain fish populations at sustainable levels
- This allows for continued fishing activities and the preservation of marine biodiversity
- These include:
  - Setting catch limits
  - Implementing seasonal fishing restrictions
  - Establishing marine protected areas

- **Renewable energy**:
  - Harnessing renewable energy sources such as solar, wind and hydroelectric power
  - This helps reduce reliance on fossil fuels and minimises environmental impacts, providing a sustainable energy alternative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Unsustainable use of renewable natural capital

- **Deforestation**:
  - Examples of unsustainable use include:
    - Unsustainable logging practices
    - Large-scale conversion of forests for agriculture or infrastructure development
  - Clearing forests at a rate faster than their regeneration can contribute to:
    - Habitat loss
    - Soil erosion and desertification
    - Climate change

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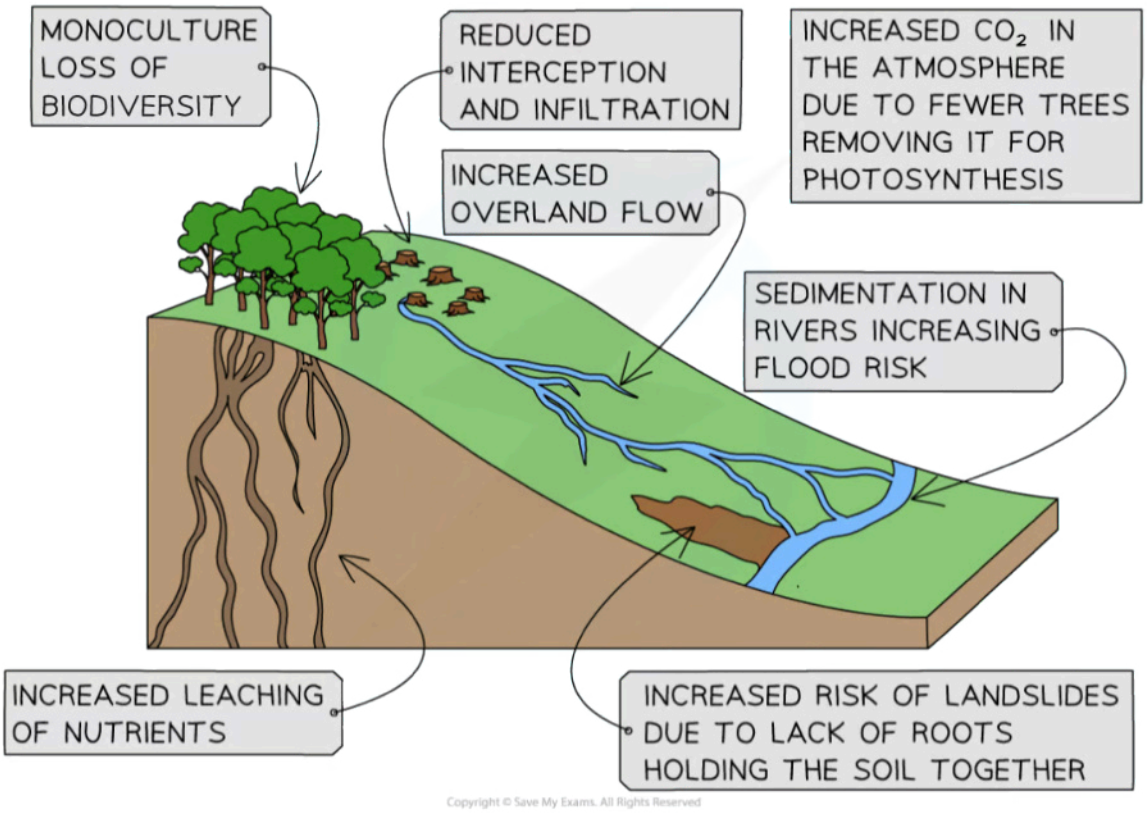

Environmental impacts of deforestation

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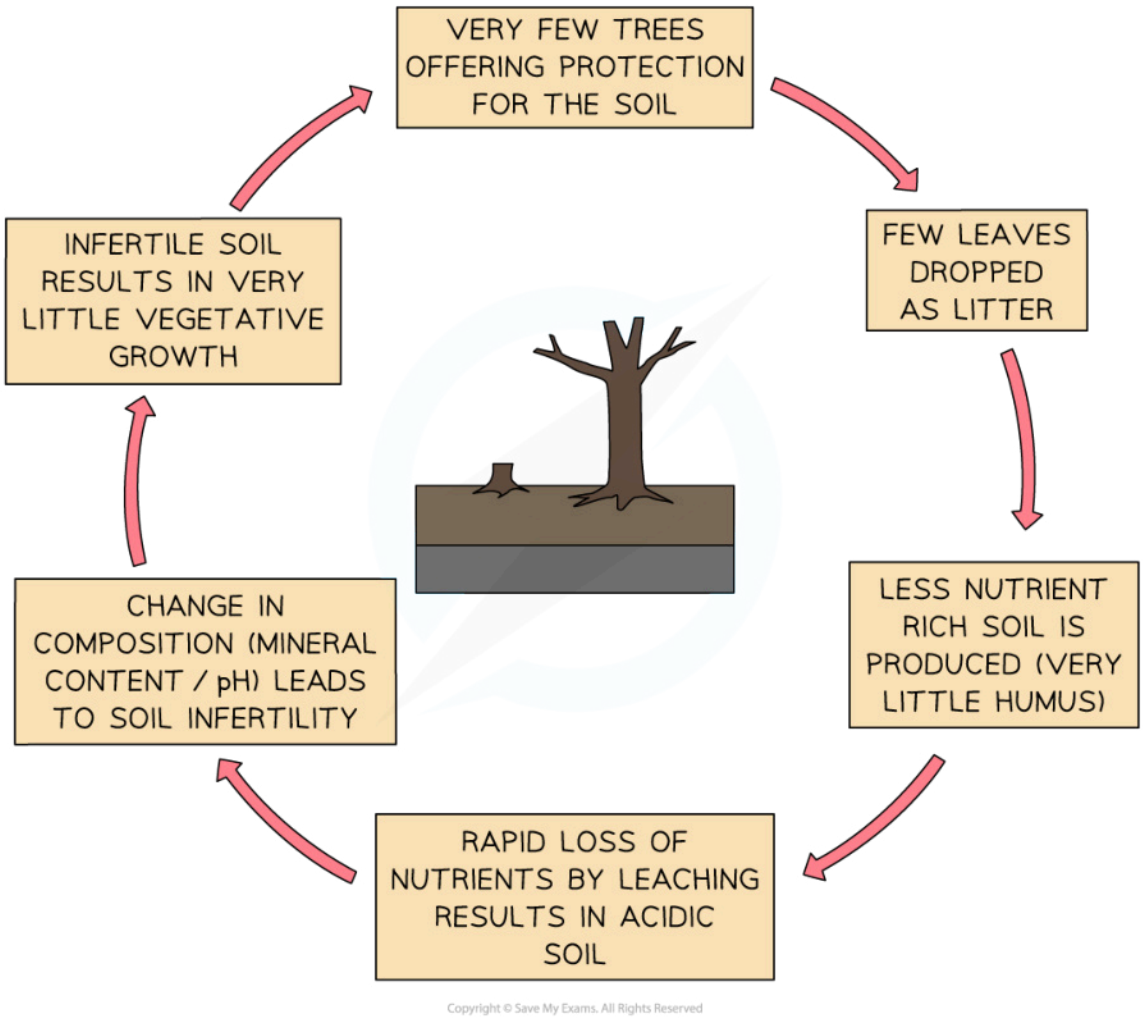

Effects of deforestation on the nutrient cycle

- **Overfishing**:
  - Excessive fishing beyond the natural reproduction rate of fish populations can:
    - Depleted fish stocks
    - Disrupt marine ecosystems
    - Impact the livelihoods of fishing communities
- **Water extraction**:
  - Excessive withdrawal of groundwater from aquifers can result in:

- Freshwater depletion
- Saltwater intrusion
- Long-term water scarcity

- When water is used beyond its natural replenishment rate, it becomes unsustainable


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Resource Security & Choices

Resource security

- Resource security is the ability of societies to ensure long-term availability of sufficient natural resources to meet demand
  - Key natural resources include water, food, energy and raw materials

Importance of resource security

- Ensures stable supply to meet current and future needs
- Prevents resource conflicts
- Supports sustainable development

Case Study

Resource security in contrasting societies

Example 1: Food security in the United States

- The US is a high-income country with advanced agricultural technology
- Factors contributing to food security:
  - **Economic:** high investment in agricultural research and development
  - **Technological:** use of GMOs and advanced irrigation systems
  - **Political:** government subsidies and support for farmers
  - **Environmental:** diverse climate allows a variety of crops

Example 2: Water security in Ethiopia

- Ethiopia is a low-income country with challenges in water accessibility
- Factors affecting water security:
  - **Economic:** limited funds for water infrastructure
  - **Geographical:** arid regions with irregular rainfall
  - **Political:** dependency on upstream countries for water sources
  - **Technological:** lack of advanced water purification and distribution systems

Factors affecting resource choices

- Various factors influence how societies choose to use natural resources
  - These factors include economic, sociocultural, political, environmental, geographical, technological and historical considerations
- Economic factors:
  - **Cost and availability:** resources that are cheaper and readily available are preferred
  - **Market demand:** high demand for certain resources drives their usage
- Sociocultural factors:
  - **Cultural preferences:** traditional foods and materials influence resource choices
  - **Population growth:** increased population raises resource demand
- Political factors:
  - **Government policies:** regulations and subsidies affect resource use
  - **International relations:** trade agreements and conflicts influence resource access
- Environmental factors:
  - **Sustainability:** focus on using resources that do not harm the environment
  - **Climate change:** affects the availability and viability of certain resources
- Geographical factors:
  - **Resource distribution:** proximity to natural resources affects their use
  - **Natural disasters:** areas with more frequent disasters may have limited resource choices
- Technological factors:
  - **Innovation:** advances in technology can create new resources, enable resource extraction or improve resource use efficiency
  - **Infrastructure:** availability of technology and infrastructure influences resource use
- Historical factors:
  - **Historical usage:** long-term use of certain resources can establish dependency
  - **Colonial history:** past exploitation can affect current resource availability and control


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Case Study

Local resource choices

Example: Water conservation in Australia

- Australia has focused on water conservation due to its arid climate and frequent droughts
- Factors influencing this choice:
  - **Economic:** efficient water use reduces costs for agriculture and urban areas
  - **Political:** government initiatives promote water-saving measures and infrastructure
  - **Environmental:** conservation efforts aim to protect water ecosystems and ensure sustainable water supply
  - **Technological:** advances in irrigation technology and water recycling improve water efficiency and availability

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Impact of international agreements on resource choices

- International agreements, like the Paris Agreement, aim to reduce greenhouse gas (GHG) emissions
- Different countries have set varied dates for achieving carbon neutrality (also know as net zero)
  - These targets are crucial for meeting global climate goals
  - They influence the resource choices of countries
- **Net zero emissions goals:**
  - Encourage use of renewable energy over fossil fuels
  - Promote sustainable agricultural practices to reduce carbon footprint
  - Influence local and national policies to align with global sustainability targets

Case Study

Changing resource choices

Example 1: Renewable energy in Germany

- Germany aims to reach net zero greenhouse gas emissions by 2045
- This goal is part of their wider efforts to combat climate change and transition towards a more sustainable energy system
- As a result, Germany is prioritising renewable energy, especially wind and solar
- Factors influencing this choice:
  - **Economic:** investment in renewable infrastructure creates jobs and reduces energy import costs

- **Political:** government policies and subsidies support renewable energy
- **Environmental:** reducing reliance on coal and nuclear power to lower carbon emissions
- **Technological:** advanced technology makes renewable energy more efficient and reliable

Example 2: Electric vehicles in Norway

- Norway has prioritised the adoption of electric vehicles (EVs) to achieve its carbon neutrality goals and align with international climate agreements
- This is directly impacting its choices regarding natural resource use
- Factors influencing this choice:
  - **Economic:** significant incentives and tax exemptions for EV buyers reduce overall costs and encourage adoption, reducing the country's reliance on fossil fuels
  - **Political:** strong government support and policies favour EV infrastructure, such as widespread charging stations, encouraging a shift from oil and gas to renewable energy sources
  - **Environmental:** transitioning to EVs helps reduce greenhouse gas emissions, contributing to Norway's net zero targets
  - **Technological:** advancements in EV technology, including battery life and charging speed, make EVs more practical and attractive

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Examiner Tips and Tricks

Focus on understanding how various factors might influence resource choices across different countries, especially if they are different parts of the world or are at different stages of development.

You don't need to memorise the case studies given here, but be prepared to discuss real-world examples that demonstrate how resource security differs between nations and why certain factors influence resource choices.