MOJZA

O Levels

Environmental Management Notes

5014

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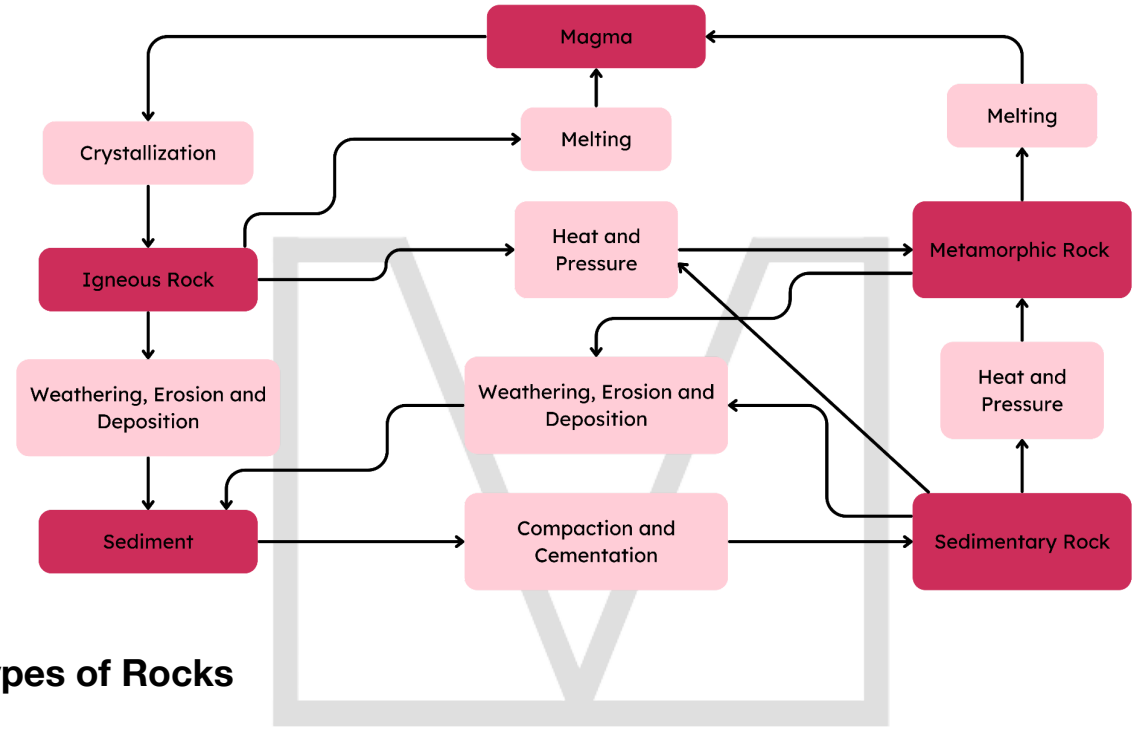
CONTENTS

Rocks and Minerals and their Exploitation

Formation of rocks

The Rock Cycle



Types of Rocks

- **Igneous Rocks**
  - ➔ Igneous rocks are formed by fire and are associated with volcanic activity
  - ➔ When magma from the mantle rises upwards the surface, it forms solid igneous rock when it cools down
  - ➔ **Examples:** Granite and basalt

- **Sedimentary Rocks**
  - ➔ Sedimentary rocks are made up of sediments
  - ➔ Sediments are small particles that are broken off from larger rocks
  - ➔ After breaking, they eventually reach the seabed
  - ➔ The weight of the new sediments compresses the layers below
  - ➔ The sediments are then transported/eroded by water and wind
  - ➔ **Examples:** Limestone, sandstone, shale
  - ➔ **Limestone:** Formed from the remains of plants and animals at the seabed
  - ➔ **Sandstone:** Grains are concentrated in a rock
  - ➔ **Clay:** Accumulation and compression of mud

- **Metamorphic Rocks**
  - ➔ These are rocks that have physically or chemically been changed by heat (contact metamorphism) and pressure (regional metamorphism) in the Earth's crust
  - ➔ Rocks in contact with new magma flow are changed by heat
  - ➔ Rocks on plate boundaries are changed by pressure and stress which accompanies great Earth movement
  - ➔ **Examples:** Marble and slate
  - ➔ Limestone is changed to marble and clay is changed to slate

Extraction of Rocks & Minerals from the Earth

Types of Mining

- **Surface Mining**
  - ➔ This type of mining involves an open pit/open cast on the surface
  - ➔ The stages involved in this mining are:
    - ◆ Clear the vegetation and remove the top soil
    - ◆ Break up and loosen the rock by using explosives
    - ◆ Use diggers to remove the loose rock
    - ◆ Load the rock or mineral into trucks or wagons
    - ◆ It is used to extract sand, gravel, stone and coal

- **Subsurface Mining**
  - ➔ This type of mining involves deep mining methods
  - ➔ The stages involved in this mining are:
    - ◆ Drill a vertical shaft to reach the layer where the rocks and minerals are located
    - ◆ Create a horizontal tunnel along the mineral deposit
    - ◆ Extract the minerals by digging using miners and machines
    - ◆ Transport the loose rock to surface waste heaps
    - ◆ Transport the minerals to the surface for further transportation via trucks or trains

Factors that Affect the Decision to Extract Rocks and Minerals

- **Geological factors**
  - ➔ Either near the surface or deep underground
  - ➔ Small deposits of high-grade ore are economically viable for mining
  - ➔ Small deposits of low-grade ore that are not economically viable to mine are preserved as reserves

- **Accessibility and Feasibility**
  - ➔ Sensitive local environmental issues can hinder the mining process
  - ➔ Transportation (either in remote areas, or close to the industries with dense road network)
  - ➔ Costs are involved for transportation of ores, and building of roads and railway networks
  - ➔ Transportation costs can be reduced by carrying out some processing at the mine

- **Climate and Environmental Impact Assessment**
  - ➔ **Climate:** Either extreme weather conditions like intense heat, cold and heavy rainfall, or no extreme weather conditions
  - ➔ Mining companies should choose appropriate sites of mining with suitable weather conditions
  - ➔ Mining companies should also have a strategic plan to minimise habitat loss during mining and restore the land after completing the mining activities

- **Supply and Demand**
  - ➔ Supply depends on known reserves
  - ➔ Demand depends on the need of the people
  - ➔ When demand increases, world market price increases
  - ➔ When demand decreases, mines may be closed or shut down
  - ➔ For example, when cold winter hits Europe and North America, the demand for oil and gas increases, so the world market price also increases
  - ➔ **Price fluctuation:** High demand, low supply, high prices OR low demand, high supply, low prices

Impact of Rock and Mineral Extraction

Environmental Impacts

- **Land Pollution**
  - ➔ Surface heaps of mining waste (worse after heavy rain)
  - ➔ Open cast mining leaves big scars on the land
  - ➔ **Deforestation:** Trees are cut off to construct roads and railway networks
  - ➔ Habitat loss due to clearance of vegetation
  - ➔ Tall chimneys destroy the scenic beauty of the area

- **Air Pollution**
  - ➔ Deposition of mining waste releases toxic gases
  - ➔ Dust and fumes are released from chimneys while crushing mineral ores
  - ➔ This can engender lung diseases like asthma

- **Water Pollution**
  - ➔ **Water Pollution:** Due to leaks from oil wells and pipelines
  - ➔ Water pollution gives rise to bioaccumulation and biomagnification
  - ➔ Polluted water can also become unsafe to drink and kill aquatic organisms

- **Economic Impacts**
  - ➔ Mining provides employment opportunities in primary, secondary and tertiary sectors, e.g. extraction, transportation, refinery
  - ➔ Foreign exchange is gained by exporting minerals
  - ➔ This income can be used to improve infrastructure, transportation, healthcare, education
  - ➔ This would contribute to the growth and welfare of the country

- Problems Associated with Deep Mining

- ➔ Flooding
- ➔ Ventilation issues
- ➔ The roof of the tunnel may collapse - this can trap, injure or kill miners
- ➔ Dangerous gases in mines increase the risk of fires and explosions

- Uses of Rocks and Minerals

Mineral	Use
Chalk	Used to make cement
Gravel	Used to make concrete
Limestone	Used to make cement and concrete
Clay	Used to make bricks and pottery
Sand	Used to make glass
Copper	Used to make electrical wires
Lead	Used to make cables and batteries
Bauxite	Used to make aluminiums, and transport and domestic equipment
Sulphur, Salt and Potassium	Used in the chemical industry
Gold, Silver and Diamond	Used to make jewellery

Managing the Impact of Rock and Mineral Extraction

- Landscaping/Restoration

- ➔ Reclamation should be done by filling the dug hole, and vegetation cover should be grown so the land can be used again
- ➔ Removal of waste heaps
- ➔ Removal of sediment from streams
- ➔ Replacement of overburden
- ➔ Sealing contaminated areas with clay so water cannot take toxins into groundwater/streams
- ➔ **Replacement of soil:** A new layer of fertile topsoil should be added
- ➔ Fertilisers should be added to the soil, along with acids/alkalis to neutralise the soil
- ➔ **Bioremediation:** A process that uses living organisms, like microbes and plants, to remove pollutants from the environment

- **Afforestation and Reforestation**
  - ➔ Planting trees on the land can stabilise the soil, prevent erosion, improve air quality and recover local ecosystems by providing wildlife habitats and promoting biodiversity

- **Landfilling**
  - ➔ Old quarries and large holes left after mining are often cheap & convenient places for waste disposal
  - ➔ Mining waste must be securely stored to prevent structural collapse

- **Making Lakes and Natural Reserves**
  - ➔ Creating lakes and natural reserves from mined land promotes biodiversity by providing habitats for numerous species
  - ➔ They also offer green spaces for recreation
  - ➔ Non-toxic, waterproof pits can be converted into reservoirs for irrigation or drinking water

Sustainable Use of Rocks and Minerals

- **Sustainable Resource**
  - ➔ A natural resource that is renewable and can be replenished at a rate equal to or faster than its rate of consumption
  - ➔ **Examples:** Agriculture and biofuels

- **Sustainable Development**
  - ➔ Development that fulfils the current needs in a way that does not hinder future generations from satisfying their own needs

Enhancing Extraction Efficiency

- **Reprocessing Mining Waste**
  - ➔ Processing mine waste a second time recovers valuable minerals and minimises pollution risks

- **Chemical and Biological Treatment**
  - ➔ Utilising chemical treatments and microorganisms can extract remaining valuable minerals from waste

- **Improved Machinery Performance**
  - ➔ Enhancing the efficiency of mining and processing machines

- **Data Analysis**
  - ➔ Using computer-driven data analysis to predict geological conditions more accurately

Improving Utilisation Efficiency

- Engineering Solutions

➔ Designing steel beams with the same strength but using less steel to optimise material use

Recycling

- Energy Efficiency

➔ Recycling rocks and minerals requires less energy compared to processing raw ores

- Waste Reduction

➔ Recycling generates less waste, thereby lowering pollution risks

Legislative Measures

- Government Regulations

➔ Governments can enact laws to ensure manufacturers are responsible for recycling and reusing materials

Energy and the Environment

Fossil Fuel Formation

- Fossil Fuel

- ➔ A natural fuel such as coal, oil, or natural gas, formed from the remains of ancient plants and animals over millions of years

- Formation of Coal

- ➔ Vast forests grew across the Earth millions of years ago
- ➔ Dead vegetation accumulated and formed peat
- ➔ Peat was compressed between layers of sediment, creating lignite (a low-grade coal)
- ➔ Continued compression transformed lignite into coal

- Formation of Oil and Gas

- ➔ Small animals and plants die and settle at the seabed
- ➔ Their remains become buried under layers of sediment
- ➔ As these sediments accumulate, they transform into sandstone under increasing temperature and pressure
- ➔ The heat and pressure convert the organic remains into crude oil and natural gas
- ➔ These hydrocarbons then separate and migrate upward through the sandstone, occupying its pores
- ➔ An impermeable (non-porous) rock layer above prevents the oil and gas from escaping, trapping them beneath it
- ➔ A drilling rig is used to extract oil and gas

Energy Resources and the Generation of Electricity

- Renewable Energy Resource

- ➔ An energy resource that can be reused and replenished naturally at a sustainable rate; it does not deplete or diminish

- Non-renewable Energy Resource

- ➔ A limited energy resource that cannot be reused or replenished naturally at a sustainable rate; it depletes or diminishes quickly

- Examples

Non-renewable Energy	Renewable Energy
	Solar Power

Nuclear Power	Hydro-electric Power
	Geothermal power
Fossil Fuels (coal, oil, natural gas)	Wind Power
	Wave Power
	Tidal Power
	Biofuels (bioethanol, biogas & wood)

- Solar Power

- ➔ Solar panels absorb heat energy from sunlight to produce electricity
- ➔ Photovoltaic cells generate a small electrical charge when exposed to light
- ➔ When arranged into solar panels, a collection of these cells can produce a substantial amount of electricity

Advantages	Disadvantages
Renewable	High installation cost
Environmental friendly (no pollution)	Not effective on cloudy days
Low fuel costs and maintenance	

- Hydro-electric Power

- ➔ Fast running water, such as from a waterfall or below a lake is used to drive turbines
- ➔ Which turn on the generator to produce electricity
- ➔ Water is stored in a reservoir and then released from the reservoir
- ➔ Water flows through the turbine, revolves it and then activates the generator to generate electricity
- ➔ Suitable places for HEP are narrow, deep valleys where a dam and a reservoir can be built

Advantages	Disadvantages
Renewable	High installation cost
Environmental friendly (no pollution)	Risk of floods
Clean	Building of dams disrupts ecosystems and displaces people
Reliable as water flow is concentrated and can easily be controlled	

- Geothermal Power

- ➔ Geothermal power involves heat from the ground in areas of volcanic activity which is used to generate electricity

- ➔ A layer of heated rocks is pumped with cold water while under pressure
- ➔ The water is heated by the rocks
- ➔ Using a heat exchanger, the hot water returns under pressure to the surface and warms the second water supply
- ➔ The turbine is moved by the steam created in the second supply, which produces energy

Advantages	Disadvantages
Renewable	High installation cost
Environmental friendly (no pollution)	Needs large amounts of water
Reliable	Location-specific (limited to areas with suitable geological conditions)
Low operating costs	
Requires less land	

- Wind Power

- ➔ Wind turbines have blades which are blown by wind
- ➔ In extremely windy situations, brakes slow down or stop the rotor to protect the blades
- ➔ The turbine rotates and activates the generator to produce electricity
- ➔ Many turbines are set up in areas where strong winds blow such as on hill tops, along the coast lines on land and offshore close to the coast

Advantages	Disadvantages
Renewable	High installation cost
Environmental friendly (no pollution)	Unpredictable (depends largely on wind flow)
Clean	Spinning of turbines produces noise pollution
Low operating costs	Unsightly
	Spinning blades can inflict harm on birds - hence disturbing wildlife

- Wave Power

- ➔ Wave power involves forces of the sea waves
- ➔ It utilises the minute variations in water levels brought on by wind
- ➔ The turbine revolves which turns on the generator to generate power

Advantages	Disadvantages
Renewable	High installation cost
Environmental friendly (no pollution)	Negative impact on marine life and coastal

	environments
Predictable	Location-specific (limited to certain coastal areas with suitable wave conditions)
Produces significant amounts of energy	

- Tidal Power

- ➔ Makes use of the water's natural rise and fall in a certain area
- ➔ **Tidal Barrage:** A tiny dam that discharges water back through a turbine, holds back water when the levels drop

Advantages	Disadvantages
Renewable	High installation cost
Environmental friendly (no pollution)	Disrupts local marine ecosystems
Predictable	Location-specific (limited to certain coastal areas with significant tidal currents)
Low operating costs	

- Biofuels

- ➔ Uses fuel woods, crop wastes, animal dung and fuel
- ➔ Abundant supply is available, and growing plants removes carbon dioxide from the atmosphere
- ➔ However, an extensive area is needed for plant growth, and natural ecosystems are also disturbed
- ➔ Burning biofuels releases harmful gases like methane and carbon dioxide

Advantages	Disadvantages
Renewable	Requires large areas of land
Environmental friendly (no pollution)	Requires significant amounts of water
Biodegradable	Limited availability
Can be produced locally	Using crops for biofuels can compete with energy production

- Nuclear Power

- ➔ During nuclear fission reaction, a heavier nucleus splits into two or more lighter nuclei
- ➔ Uranium (radioactive element) releases a large amount of heat energy in nuclear fission
- ➔ A gas takes the produced heat to the reactor to the boiler, where water turns into steam
- ➔ This drives the turbine, which in return drive the generator to produce electricity

Advantages	Disadvantages

Reliable	High installation cost
Environmental friendly (no greenhouse gas emissions)	Produces toxic radioactive waste
Very efficient (a small amount of uranium is sufficient to produce a large amount of energy)	Non-renewable
	Risk of nuclear accidents
Reduces dependence on fossil fuels	Security threats

Energy Demand

- Domestic Demand

- ➔ Affordability, availability, and social status drive many purchases now considered necessities
- ➔ These purchases have increased the demand for energy supplies, especially electricity
- ➔ For example, fruits and vegetables not naturally available locally in a given season are produced in greenhouses or grown in areas with a favourable climate and then transported
- ➔ In both scenarios - greenhouse operation and transportation - the energy costs are substantial

- Industrial Demand

- ➔ Manufacturing requires significant amounts of energy throughout the production process, such as in iron and steel production
- ➔ Advanced manufacturing techniques have made products that were once luxury items more affordable
- ➔ As more people want to buy these products, the demand for them increases, leading to a higher demand for the energy needed for their production

- Transport

- ➔ Manufacturers supply customers worldwide
- ➔ This lowers production costs in importing countries but raises transportation costs due to the large amounts of fossil fuels needed for operation

- Personal and National Wealth

- ➔ **If Economic Conditions are Good:**
  - ◆ Higher employment leads to more disposable income for luxury items
  - ◆ This results in an increase in demand for these products
  - ◆ Consequently, the demand for energy required for production also rises

- ➔ **If Economic Conditions are Poor:**
  - ◆ Families have less money to spend on luxury items, necessitating savings
  - ◆ They reduce the use of fuel and the purchase and use of electrical items
  - ◆ This leads to a decrease in the demand for energy
  - ◆ Decline in the economy of one country can have a global impact

- Climate

- ➔ The demand for energy related to climate varies by country
- ➔ People in temperate climates experience colder winters, leading to a much higher demand for heating
- ➔ They also have fewer daylight hours, increasing the usage of electrical lighting
- ➔ Climate change, with excessive heat or cold, has increased energy consumption, particularly in urban areas
- ➔ There is a greater need for additional heating and the installation and operation of air-conditioning units

Conservation and Management of Energy Sources

Strategies for the Efficient Management of Energy Resources

- Reducing Consumption

- ➔ Reducing the amount of energy used to heat a building
- ➔ Electrical devices should be turned off when not in use to save energy
- ➔ Devices left in 'standby' mode consume energy but can be accessed quickly
- ➔ Investing in more energy-efficient devices is crucial, as well as developing alternative fuels for vehicles and advancing engine technology
- ➔ **Insulation:** Using materials with good insulation properties in construction helps prevent heat loss

Insulation Method	Description
Loft Insulation	Adding an insulation layer to the roof space
Underfloor Insulation	Installing an insulation layer on the floor, such as under carpets
Cavity Wall Insulation	Filling the gap between inside and outside walls with insulating material to slow heat transfer
Double Glazing	Using two panes of glass with a sealed gap in between, often filled with air or inert gas like argon, to act as an insulator
Triple Glazing	An option with three panes of glass, but it is typically too expensive for widespread use

- Energy from Waste

- ➔ Reusing existing materials to extract energy from them before they are disposed of

- ➔ **Anaerobic Digestion:** Organic matter like waste food and vegetation is broken down by bacteria in a sealed container, producing methane (a flammable gas) for heating and composted waste for improving soil structure
- ➔ **Incineration:** Household rubbish can be burnt to generate heat and electricity

Advantages	Disadvantages
The resulting ash is small in volume, reducing space requirements.	Combustion can produce poisonous gases.

- ➔ **Vegetable Oils:** Once used, vegetable oils should be disposed of properly
- ➔ These oils can be collected and recycled into biofuels for vehicles, either used exclusively or as an additive

- Education

- ➔ The benefits of the technology should be communicated to others
- ➔ Promote new ways of thinking
- ➔ Emphasise that significant savings on energy bills can be achieved over the long term, leading to reduced energy use
- ➔ Provide energy-efficiency ratings for new products to compare with older ones

- Legislation

- ➔ Stricter building regulations require new constructions to be more energy efficient
- ➔ Prevent the sale of inefficient electrical devices
- ➔ **Offer incentives to encourage the purchase of more efficient technologies, such as:**
  - ◆ Insulating older houses to improve energy efficiency
  - ◆ Replacing older, inefficient electrical devices
  - ◆ Scrapping older cars that emit more pollutants

- Exploiting Existing Energy Resources

- ➔ The choice of energy source is influenced by social, environmental, and economic factors
- ➔ The current approach is to use renewable resources as the primary energy source when possible, with a fossil-fuel or biofuel-powered station as a backup for unsuitable weather conditions
- ➔ This method provides a reliable energy source for industries and households while reducing fossil fuel use

- Transport Policies

- ➔ Regulations on the quality of exhaust gases from vehicles
- ➔ Monitoring fuel efficiency
- ➔ Restrictions on vehicle access to certain areas
- ➔ Taxes on fuels
- ➔ Surcharges for travelling to specific locations during peak times
- ➔ Enhancing public transport to make it more convenient and cost-effective than driving
- ➔ Improving routes for cyclists and pedestrians
- ➔ Encouraging car-sharing

- ➔ Implementing restrictions on car usage, such as the odd-even rule in Delhi
- ➔ Providing incentives for purchasing more fuel-efficient vehicles and those using cleaner technology

- Development of New resources

- ➔ **Fracking:** Extracts oil or gas from shale rock by fracturing it with a mixture of water, sand, and chemicals
- ➔ A vertical well, 2-3 km deep, is drilled to reach the shale rocks
- ➔ Water, sand, and chemicals are injected into the shale layer to fracture the rock, releasing oil and natural gas, which are then collected
- ➔ **Purpose of the Components:**
  - ◆ **Water:** Facilitates the process under high pressure
  - ◆ **Chemicals:** Prevent blockages in pipes
  - ◆ **Sand:** Keeps the fractures open

Advantages	Disadvantages
Provides access to additional oil and gas reserves	Risk of toxic substances contaminating the water table
Results in less pollution compared to burning coal	Chemicals used can be harmful to local residents
Reduces the need for imports	High water usage may lead to water scarcity
Creates many local jobs	Generates noise pollution
	Can damage natural areas
	May induce minor earthquakes

Impact of Oil Pollution

- Causes of Marine Oil Spills

- ➔ Leakage from the rigs during offshore oil extraction
- ➔ **Oil Pipeline Leaks:** Breaks in the pipeline system
- ➔ Risk of collision or damage to oil tankers during shipping

- Impacts of Marine Oil Spills

Organism or Habitat	Impact
Phytoplankton	Oil floats on the water's surface, preventing sunlight from penetrating; since phytoplankton cannot carry out photosynthesis, they die

Fish	Food scarcity causes phytoplankton to decline; gas exchange is hindered by oil floating on the surface; fish that come into direct touch with oil have problems with their gills and eventually run out of oxygen
Birds	There is scarcity of food due to fish and other animal deaths; birds may ingest harmful amounts of oil while eating fish; their feathers become coated with oil while they hunt, which hinders their ability to fly
Mammals	Food supplies are used up; hazardous oil ingestion during feeding; skin irritation from oil coating
Reefs	The reef is completely destroyed, and species die due to lack of oxygen
Beaches	Oil carried by tides coats rocks, affecting organisms and habitats; the toxic effects of the oil can kill organisms in shallow waters and rock pools; the presence of oil impacts animal food sources and negatively affects tourism

Management of Oil Pollution

Reducing Oil Spills in Marine and Coastal Ecosystems

- MARPOL (International Convention for the Prevention of Pollution from Ships)

- ➔ Oversees the transport of oil at sea
- ➔ All tankers must have certification proving they utilise proper systems; otherwise, they may face hefty fines or be denied departure from the port

- Double-hulled Tankers

- ➔ If the outer layer is damaged, the inner plate still protects the contents
- ➔ It reduces the risk of oil spills and marine pollution, as it decreases oil outflow

Minimising the Impacts of Oil Spills in Marine and Coastal Ecosystems

- Floating booms

- ➔ A floating barrier is used to encircle the oil slick and prevent it from spreading
- ➔ This method is effective when the spill is confined to a small area and the sea conditions are calm

- Detergent sprays

- ➔ Detergents assist in breaking down oil slicks into smaller droplets that eventually degrade and disperse

➔ They are effective for smaller spills but can harm coral reefs, which are not tolerant to detergents

- Skimmers

➔ Use a material that easily absorbs oil to clean the water
➔ A skimmer removes oil from the surface of the seawater, which is then scraped into a container
➔ This method is effective when the oil slick is contained within a boom and the sea is calm
➔ If the oil reaches beaches, it must be removed manually, which is both difficult and time-consuming

Agriculture and the Environment

Soil Composition

- Mineral Particles

- ➔ Formed from a combination of rock fragments and other inorganic substances
- ➔ Created through the physical, chemical, and biological weathering of parent rock

- Organic Content

- ➔ A mixture of living plants, animals, microorganisms, and their dead remains

- Air

- ➔ Held within the pore spaces between mineral particles and organic content
- ➔ Air enters the soil through diffusion

- Water

- ➔ Held within the pore spaces, providing water available for plant growth
- ➔ Water enters the soil through precipitation or irrigation

- Proportion of Components

- ➔ **Depends on the following factors:**
  - ◆ Type of soil
  - ◆ Soil management
  - ◆ Local climatic conditions
  - ◆ Size of mineral particles

- Soil Types

Type	Size	Texture
Sand	2.0 - 0.02 mm	Gritty
Silt	0.02 - 0.002 mm	Silky or Soapy
Clay	<0.002 mm	Sticky when wet; hard when dried

Soils for Plant Growth

- ➔ Soil is the most affordable and widely available medium that provides plants with water, mineral nutrients, ions, and oxygen

- Elements required by plants

- ➔ Nitrate ions (NO_3^-)
- ➔ Phosphate ions (PO_4^{3-})
- ➔ Potassium ions (K^+)

- Organic Content

- ➔ Decomposers like bacteria and fungi feed on decaying organic matter, producing rich nutrients
- ➔ Some bacteria convert nitrogen to nitrates in the nitrogen cycle

- Soil pH

- ➔ Soil acidity is measured by the pH scale (5.5 to 8 is ideal for farming)
- ➔ Above 8 is saline soil, and below 5.5 is acidic soil
- ➔ Soil pH affects the availability of nutrients and their uptake by plant roots
- ➔ Farmers can alter soil pH by adding fertilisers (to make it acidic), or by adding limestone (to make it alkaline)

- Drainage

- ➔ The soil's ability to drain water should be moderate, avoiding both water loss and excess water accumulation

- Ease of cultivation

- ➔ The ease of cultivation refers to how easily the soil can be ploughed

Difference between sandy and clay soil

Sandy Soil	Clay Soil
Large air spaces	Small air spaces
Good drainage	Poor drainage
Easy to cultivate	Hard to cultivate

Agriculture types

Arable Farming	Pastoral Farming	Mixed Farming
Growth of crops on a farm, which are used or sold by the farmer according to his needs	Rearing of animals for production of animal-related products	Combination of arable and pastoral farming which means both animals and plants are reared and grown
Examples: Rice, wheat, maize	**Example:** Milk, wool, eggs	

Subsistence Farming	Commercial Farming
Cultivation of food primarily to meet the needs of the farmers and their families	Cultivation of food primarily for sale to generate income
Any surplus is traded for other goods or cash	Some of the food may be used by the farmers themselves
Example: Rice and wheat	**Example:** Sugarcane, cotton, corn, tea, coffee, cocoa, rice, wheat

Increasing Agricultural Yields

- Crop Rotation

- ➔ Growing different types of plants in different plots each year
- ➔ Soil-borne diseases are left behind, reducing plant disease
- ➔ Pests must find new sites, leading to a decrease in their population
- ➔ The new plot is more likely to have essential nutrients for the plants
- ➔ Crops are ready for harvest at different times, resulting in less waste and reduced need for labour and machinery
- ➔ A good rotation system maintains soil fertility and structure, increases crop yield and reduces the risk of soil erosion

- Fertilisers

- ➔ Fertilisers contain all the essential mineral ions and nutrients, e.g. nitrogen, phosphorus, potassium
- ➔ Nitrogen fertilisers, such as ammonium nitrate and ammonium sulphate provide soluble nitrogen to plants
- ➔ **There are 2 types of fertilisers:** Organic and inorganic

Type	Advantages	Disadvantages
Organic	Uses natural resources	Unpleasant to handle
	Supplies organic matter	Harder to transport
		Variable in composition
Inorganic	Meet a particular need	Cost of manufacture
	Easier to store	Transportation costs
Quick acting	Deficiency problems are dealt with swiftly	Easily leach out in heavy rain
Slow acting	No need to reapply	Little immediate impact

- Irrigation

- ➔ Supply of water to the crops from lakes, reservoirs etc

- ➔ Water is essential for photosynthesis, cell activity, and uptake of minerals and nutrients
- ➔ Water that is transferred from areas of storage is used by canals
- ➔ Water is sprayed by sprinklers to provide an equal amount over a wide area
- ➔ **Example:** Hot deserts (Egypt, Middle East etc.), Savanna and Monsoon (a dry season during which temperature is high
- ➔ **Common water application methods:**
  - ◆ Overhead sprinklers

Advantages	Disadvantages
Easy to set up	Large droplets may cap the soil
Can cover large area from one sprinkler	Small droplets may be blown away by wind
No need to attach pipes to each plant separately	Water lands on leaves and soil, which evaporates quickly

  - ◆ Clay pot irrigation system

Advantages	Disadvantages
Simple technology	Only suitable for permanent plants
Easy to check the amount of water	Large labour cost
High efficiency	

  - ◆ Trickle drip system

Advantages	Disadvantages
Water placed directly at the base of the plant	Expensive to install; complex to maintain
Automated and controlled via computer	Grit can block tubes
Water is used very efficiently	Inflexible; cannot be moved easily

  - ◆ Flood irrigation

Advantages	Disadvantages
Inexpensive	Inefficient use of water
Can cover large areas quickly	Damages soil structure

- Insect Control

- ➔ **Pesticides:** Used to control pests

- ➔ **Herbicides:** Used to kill weeds
- ➔ **Insecticides:** Used to control insects
- ➔ **Fungicides:** Used to control fungal diseases
- ➔ **They need to be controlled because they:**
  - ◆ Compete with crops for resources like light, water, and nutrients
  - ◆ Lower the quality of seed or crop
  - ◆ May be toxic
  - ◆ Hinder cultivation
  - ◆ Can obstruct drainage systems due to excessive growth
  - ◆ Can harbour pests and diseases
  - ◆ Can appear untidy, affecting tourism areas

- Mechanisation

- ➔ Allows cultivation of larger areas
- ➔ Reduces labour costs
- ➔ Enables ploughing even when the soil is heavy
- ➔ Facilitates the application of fertilisers and pesticides with additional attachments

- Selective Breeding

- ➔ Selective breeding is a process in which those parents are chosen that have best desirable traits and characteristics of the species
- ➔ Raise the offspring from these selected parents
- ➔ Select the best offspring displaying the desired traits
- ➔ Repeat the process
- ➔ However, it is a slow process and the success rate is low
- ➔ **Examples:** Wheat, rice, beef cattle, dairy cattle

- Genetically Modified Organisms

- ➔ **Genetic engineering:** It is the process of altering the genetic composition of an organism by modifying its own genes or introducing genes from a different species. It involves the transfer of genes from one organism to an unrelated species.
- ➔ **Biotechnology:** It is the use of living organisms or biological processes for industrial, agricultural, or medical purposes.

- Different Types of GM Crops:

- ➔ **Pest resistant crops**: Plants are protected against insect damage by producing a toxin, found in the common soil
- ➔ **Herbicide tolerant crops**: They are not affected by the adverse effects of herbicides
- ➔ **Disease resistant crops**: They are not affected by viral plant diseases
- ➔ **Modifying plant products**: Food could be produced that offered higher level of nutrients and vitamins
- ➔ **Disadvantages:**
  - ◆ Uncertain effects of the new characteristics on human health
  - ◆ Products are not natural
  - ◆ Genes may transfer to wild plants if they crossbreed with genetically modified organisms, potentially reducing biodiversity
  - ◆ Reduction in the gene pool

Controlled Environments

- Greenhouses

- ➔ **Temperature:** Controlled using heating systems (insulation), and roof ventilators
- ➔ **Light:** Controlled using additional lighting and roof shades
- ➔ **Humidity:** Controlled using misting units and roof ventilators
- ➔ **Water Supply:** Controlled using irrigation and drainage

- Hydroponics

- ➔ A method of growing plants without soil, using nutrient-rich water solutions to deliver essential minerals and nutrients directly to the plant roots
- ➔ This technique allows for precise control over the growing environment, leading to faster growth and higher yields

Impact of Agriculture

- Overuse of Insecticides and Herbicides

- ➔ Frequent use of a single insecticide can lead to resistance in the pest population
- ➔ Additionally, unintended environmental harm can occur, as beneficial insects like bees may be affected, disrupting the food web

- Overuse of Fertilisers

- ➔ Adding extra mineral nutrients is a waste of money and resources if the soil has already reached its maximum nutrient capacity
- ➔ Heavy rain can dissolve these nutrients, causing leaching
- ➔ Excess water with dissolved fertilisers can flow into nearby lakes and rivers, leading to eutrophication
- ➔ Large quantities of fertilisers can alter the soil's pH, affecting the availability of minerals
- ➔ Excess trace elements can be toxic to plants, and too much fertiliser can dehydrate and scorch them

- Mismanagement of Irrigation Causing Salinisation and Waterlogging

- ➔ **Soil Compaction:** Damage to soil structure leading to compaction
- ➔ **Root Death:** Waterlogged soils prevent plant roots from getting sufficient oxygen, causing root death
- ➔ **Nutrient Loss:** Nutrients dissolve and wash away with water
- ➔ **Soil Erosion:** High levels of runoff result in soil erosion
- ➔ **Salinisation:**
  - ◆ Irrigation water penetrates deep into the soil, dissolving salts at these depths
  - ◆ As water evaporates from the field, it causes both water and salts to rise to the surface
  - ◆ The remaining salt accumulates at the surface then kills plant roots

- Overproduction and Waste

- ➔ **Unsold Crops**: Excess crops remain unsold, leading to waste

- ➔ **Storage Space**: Longer selling times may require additional storage, and some crops need special storage conditions
- ➔ **Transportation**: Selling crops may involve travelling longer distances, leading to wasted transportation resources
- ➔ **Quality Products**: Lower quality results in less demand, wasting good products
- ➔ **Labour**: Overproduction leads to inefficient use of time and labour

- Exhaustion of Mineral Ion Content

- ➔ Using the same soil repeatedly leads to the depletion of essential nutrients in the soil
- ➔ This occurs when crops continuously absorb mineral ions such as nitrogen, phosphorus, and potassium without adequate replenishment
- ➔ Over time, the soil becomes deficient in these vital nutrients, which can lead to reduced soil fertility, poor plant growth, and lower agricultural yields
- ➔ Replenishing the soil through fertilisation or crop rotation is necessary to restore its mineral ion content

- Soil Erosion

- ➔ Soil erosion is the process by which the top layer of soil is removed and transported by natural forces such as wind, water, or through human activities like agriculture, deforestation, and construction
- ➔ Soils that are regularly cultivated lose their structure and become more vulnerable to erosion, as they break down into smaller particles

- Cash Crops Replacing Food Crops

- ➔ Most commercial farmers tend to grow crops that generate higher profits, leading to a decrease in the availability of staple crops

Causes and Impacts of Soil Erosion

Causes of Soil Erosion

- Deforestation

- ➔ Removing trees and vegetation leaves soil exposed and vulnerable to erosion
- ➔ Removal of natural vegetation eliminates roots that bind the soil and slow down water flow
- ➔ This leads to flash flooding and rainwater runoff, which pick up and carry away the soil

- Overcultivation

- ➔ Overcultivation involves repeatedly growing crops on the same land without allowing time for soil recovery
- ➔ This intensive farming practice depletes soil nutrients, weakens soil structure, and reduces organic matter
- ➔ As a result, the soil breaks into smaller particles, making it more susceptible to wind and water erosion

- Overgrazing

- ➔ Livestock grazing reduces vegetation to nearly ground level, often leaving no roots to hold the soil in place
- ➔ Animals trample the plants, and their hooves compact the ground, further increasing the risk of soil erosion

- Wind Erosion

- ➔ Strong winds can blow loose soil particles away, especially in dry regions
- ➔ This removes the topsoil, which is rich in nutrients and organic matter, leading to decreased soil fertility and agricultural productivity

- Water Erosion

- ➔ **Heavy Rainfall:** Carries soil particles away, leading to soil loss
- ➔ **Excess Runoff:** Water that cannot be absorbed by the soil transports soil from the area
- ➔ **Soil Compaction:** Reduces water infiltration, increasing surface runoff
- ➔ **Gully Erosion:** Large volumes of water erode the soil, forming deeper and deeper crevices

Impacts of Soil Erosion

- Loss of topsoil

- ➔ Topsoil, which is rich in organic matter and nutrients, is crucial for plant growth
- ➔ Its loss leads to decreased soil fertility and reduced agricultural productivity

- Reduced Crop Yields

- ➔ With less fertile soil, crop yields decline, affecting food security and the livelihood of farmers

- Water Pollution

- ➔ Soil particles carried away by erosion often end up in water bodies, causing sedimentation that can pollute water sources, harm aquatic life, and disrupt ecosystems

- Silting & Flooding

- ➔ Erosion can remove soil that absorbs rainfall, leading to increased surface runoff and a higher risk of flooding
- ➔ Due to silting, silt takes up all the space in water bodies, so flooding occurs as water bodies can't hold excess water

- Desertification

- ➔ In severe cases, soil erosion can lead to desertification, turning fertile land into barren, unproductive desert
- ➔ This leads to migration, famine and malnutrition

- Loss of Biodiversity

- ➔ Erosion can destroy habitats for plants and animals, leading to a decline in biodiversity
- ➔ When the fertile topsoil is eroded, the habitat for many plants, microorganisms, and soil-dwelling animals is destroyed

- ➔ This loss of habitat reduces the variety of plant species that can grow, which in turn affects ecosystems

Managing Soil Erosion

- Terracing

- ➔ Prevents soil erosion by rainwater on steep slopes
- ➔ **On a Natural Slope:** Water runs down, increasing in speed and volume, carrying soil in the runoff
- ➔ **On a Terraced Slope:** Water is held in the flat terraced areas, reducing runoff risk and increasing infiltration
- ➔ Often used for rice cultivation

- Contour Ploughing

- ➔ Contour ploughing involves ploughing land along the contour in parallel lines
- ➔ Ridges and troughs (furrows) run along the contour
- ➔ Each furrow holds water, preventing large torrents from running down the slope and stopping the formation of gullies and runoff of topsoil
- ➔ It is useful for all gradients of slopes

- Bunds

- ➔ Artificial banks at the edges of growing spaces to hold back water
- ➔ Useful for crops that require moist soils, such as rice
- ➔ Water is retained on the terrace
- ➔ Increases the quantity and fertility of the soil

- Windbreaks

- ➔ Permeable barriers used to reduce the impact of wind on an area
- ➔ Without windbreaks, the soil is easily eroded by wind
- ➔ Solid structures, like walls, force wind into smaller spaces, increasing wind speed and causing eddy currents
- ➔ Permeable structures, like vegetation, allow some wind to pass through, reducing its speed and the amount of wind erosion
- ➔ **Advantages:** Provide additional habitats for beneficial insects and the roots of the windbreak prevent erosion from runoff

- Maintaining Vegetation Cover

- ➔ Sowing legumes immediately after a crop has been harvested prevents soil erosion
- ➔ Legumes add nitrogen to the soil, increasing its fertility for the next major crop
- ➔ During cultivation, the legumes can be ploughed directly into the soil

- No Dig Method

- ➔ Existing vegetation is left in place until the new crop is grown
- ➔ Herbicides are applied to kill the weeds instead of cultivating the soil
- ➔ The roots of the existing vegetation bind the soil until the main crop is established

- ➔ **Risks:** Herbicide residues can build up, and if the control of the cover vegetation is ineffective, it may compete with the main crop as a weed

- Addition of Organic Matter to Improve Soil Structure

- ➔ Provides additional air gaps in the soil, improving soil structure
- ➔ Increases decomposers in the soil as they feed on the organic matter
- ➔ Adds nutrients to the soil after decomposition
- ➔ Acts like a sponge, holding extra water and preventing soil dehydration
- ➔ Reduces soil erosion as the organic matter acts as a base for smaller particles

- Planting Trees

- ➔ A row of trees acts as a windbreak
- ➔ The tree canopy provides shade for smaller plants that don't thrive in direct sunlight
- ➔ Trees provide a natural habitat for animals that feed on pests
- ➔ Fallen tree leaves add organic matter to the soil

- Cropping Methods

- ➔ **Mixed Cropping:** Growing more than one type of plant in the same area
  - ◆ Resources in the soil, like nutrients, are used more efficiently
- ➔ **Intercropping:** Rows of a different crop are grown between the rows of the main crop
  - ◆ This maximises the use of space and other resources
- ➔ **Crop rotation:** The practice of growing different types of plants in different plots each year

Sustainable Agriculture

- Aims of Sustainable Agriculture

- ➔ Meeting the needs of the population for agricultural products
- ➔ Making efficient use of non-renewable resources
- ➔ Supporting the natural ecosystem by using farming techniques that follow natural processes
- ➔ Sustaining the economic independence of farmers

- Organic Fertilisers

- ➔ Slow-acting, reducing the risk of eutrophication
- ➔ Being a waste product, their use saves on disposal costs
- ➔ Already present on many farms, minimising transport costs
- ➔ Do not require energy for their manufacture
- ➔ Also improve soil structure

- Managed Grazing

- ➔ Prevention of overgrazing
- ➔ Ensures sufficient grazing
- ➔ Maintains appropriate soil fertility through animal waste
- ➔ Maintains good drainage to prevent soil compaction

- Crop Variety

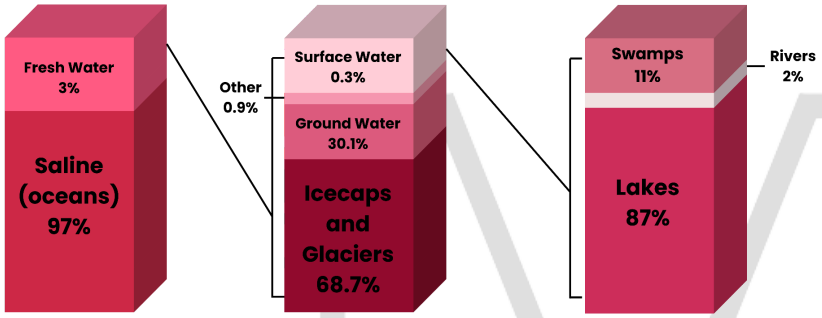
- ➔ Use of pest-resistant crop varieties reduces pesticide use
- ➔ Use of drought-resistant crop varieties reduces water usage for irrigation
- ➔ Use of herbicide-resistant crop varieties reduces herbicide use

- Rainwater Harvesting

- ➔ Rainwater harvesting involves collecting rainwater from surfaces such as rooftops
- ➔ The collected water is stored in tanks or reservoirs for later use

Water and its Management

Global Water Distribution



- ➔ Oceans cover 71% of the Earth's surface
- ➔ Oceans and seas contain 97% of all the Earth's water
- ➔ Only 3% of water on Earth is fresh-water
- ➔ Nearly two-thirds (65%) of this 3% fresh-water is in the deep freeze in the ice sheets

The Water Cycle

- Precipitation

- ➔ Moisture that reaches the surface in the form of rain, sleet, snow, or hail is known as precipitation
- ➔ Rain is the most common type of precipitation, which occurs when droplets of water in clouds combine and fall to the ground
- ➔ Sleet, snow, and hail are other forms of precipitation, each formed under different temperature conditions in the atmosphere

- Surface Run-off

- ➔ Precipitation that flows over the ground surface, eventually finding its way into streams and rivers
- ➔ This runoff can come from rain, melting snow, or other forms of precipitation
- ➔ As it travels over the land, it can collect nutrients, sediment, and pollutants before reaching bodies of water

- Infiltration

- ➔ Precipitation soaks into subsurface soils, replenishing the moisture content in the soil and benefiting plant growth
- ➔ This water then moves deeper into the ground, seeping into rocks through cracks and pore spaces
- ➔ As it infiltrates the ground, it can recharge aquifers, which are underground layers of water-bearing rock that provide fresh water for wells and springs

- Through-flow

- ➔ Downslope movement of water through the soil occurs when water travels roughly parallel to the ground surface
- ➔ This process, known as subsurface flow or interflow, happens after precipitation infiltrates the soil and moves laterally
- ➔ It plays a crucial role in delivering water to lower-lying areas, maintaining soil moisture levels, and replenishing streams and rivers

- Groundwater Flow

- ➔ Slow horizontal movement of water through rock, known as groundwater flow, occurs as water percolates deep into the ground and moves laterally through permeable rock layers
- ➔ This movement is driven by gravity and pressure differences, allowing water to travel through cracks, fractures, and pore spaces in the rock
- ➔ Over time, this groundwater flow can feed into springs, wells, and rivers, providing a sustained source of fresh water for various ecosystems and human use

- Evaporation

- ➔ Water from oceans, seas, and other water bodies is changed from water droplets to water vapour (invisible gas) in the atmosphere due to heat
- ➔ This process, known as evaporation, occurs when the sun's energy heats the surface of the water, causing molecules to move faster and transition into a gaseous state
- ➔ Evaporation plays a crucial role in the water cycle, transferring moisture from the Earth's surface into the atmosphere

- Transpiration

- ➔ Evaporation or diffusion of water from plant leaves is known as transpiration
- ➔ Water absorbed by roots travels up through the plant and is released as water vapour through tiny pores called stomata

- Condensation

- ➔ Water vapour is converted back into liquid (water droplets) or solid (particles of ice) due to a decrease in temperature with increasing height
- ➔ This process occurs by air currents, leading to the formation of clouds

Water Supply

- Surface Water

- ➔ Water is present in lakes, rivers, and swamps

➔ These bodies of water serve as crucial freshwater sources for ecosystems and human use

- Groundwater

➔ Water is present in the soil and in rocks beneath the ground's surface
➔ This groundwater is stored in aquifers and is essential for plant growth and as a freshwater source for wells and springs

- Aquifers

➔ Water stored in porous rocks under the ground

- Water Table

➔ Alternating layers of permeable and impermeable rocks trap water in the permeable rock
➔ Folded layers of rock cause water to accumulate most in the downfold
➔ Permeable rocks outcropping on the surface receive new supplies of rainwater
➔ Water is stored in limestone and sandstone (porous) rocks below the water table
➔ Mechanical pumps or human labour are used to raise water to the surface

Water Storage Methods

- Artesian Aquifer

➔ An aquifer in which the water is under pressure
➔ Water from a well sunk into an artesian aquifer will rise to the surface without the need for a pump

- Reservoirs

➔ An artificial lake used as a source of water supply, usually created behind a dam or by the side of a river (bank-side reservoir)

- Service Reservoir

➔ A reservoir where potable (safe to drink) water is stored, e.g. water tower and cistern

- Wells

➔ A hole bored or dug into rock to reach the water stored in them

- Rivers

➔ A large, natural stream of water flowing in a channel to the sea, a lake, or another river
➔ They provide surface transfers of water to low-land areas where farms, villages, towns, and cities are concentrated

Desalination

➔ Removal of salt from seawater by:

- Distillation

➔ Water is boiled and released as vapour, leaving salt behind
➔ The vapour is then condensed as liquid water and can be used

- ➔ This process is 10-30% efficient and uses a lot of energy
- ➔ Provision of energy and salt water (brine) is a source of pollution

- Reverse Osmosis

- ➔ Pumping water at high pressure through a fine membrane
- ➔ This process is 30-50% efficient and requires less energy than distillation

Water Usage

- Domestic

- ➔ At home, 3% of domestic water is used for drinking and cooking
- ➔ In MEDCs, 50% is used for washing and flushing the toilet
- ➔ 20% is used for washing clothes
- ➔ Additional uses include gardening, washing cars, and some is lost in leaks

- Industrial

- ➔ Water is primarily used in factories for cooling
- ➔ Mixing and making products such as dyes and paints
- ➔ Bottling and canning in food and drink industries
- ➔ Power generation

- Agricultural

- ➔ **Water is primarily used for irrigation, which is crucial for:**
  - ◆ Transporting minerals to plants
  - ◆ Facilitating photosynthesis
  - ◆ Preventing plants from wilting
  - ◆ Supporting domestic animals

Water Quality and Availability

- Water-rich Countries

- ➔ Countries abundant in fresh water often have vast land areas for rainfall, such as Russia, and China, or possess major rivers like the Amazon and Mississippi
- ➔ However, large land areas do not always guarantee water availability, as seen in countries like Australia and Sudan, which contain extensive desert regions

- Water-poor Countries

- ➔ Countries with limited fresh water resources are typically dominated by deserts
- ➔ Water poor countries are the ones most likely to suffer from water stress (worries over present and future water supplies)
- ➔ Exceptions include Singapore and Mauritius, which receive high rainfall but are small island states with limited land area for rain to fall on

- Water Conflict

- ➔ This refers to disputes between countries, states, or groups over access to water resources

- ➔ Water insecurity is greatly present in the Middle East due to the region's dry climate and growing water needs
- ➔ It is an area of political instability with massive population movements and refugee flows between countries
- ➔ For example, during the Indo-Pakistani War of 1947-1948, the water rights on the river system were the focus of an Indo-Pakistan water dispute

- Physical Water Scarcity

- ➔ This occurs when there is insufficient water to meet both human needs and the requirements of ecosystems
- ➔ It is common in arid regions but can also occur in areas where water appears abundant but is overused

- Economic Water Scarcity

- ➔ This is caused by inadequate investment in water infrastructure or a lack of capacity to meet water demand in areas where the population cannot afford sufficient water resources

- Urban vs Rural Access to Safe Drinking Water

- ➔ Urban areas generally have better access to safe drinking water than rural areas because cities are wealthier, with higher average incomes
- ➔ It is also easier to exert pressure on politicians to improve water services in cities
- ➔ Wealthier individuals tend to live in urban areas, and it is more cost-effective to build water infrastructure where populations are dense

Multipurpose Dam Projects

- Favourable Reasons for Choice of Site

- ➔ **Strong Impermeable Rock Foundation**: Prevents water drainage and provides a stable base
- ➔ **High Precipitation**: Ensures a sufficient water supply
- ➔ **Low Temperature**: Minimises evaporation losses
- ➔ **High Elevation**: Maximises potential for hydroelectric power generation
- ➔ **Nearby Rivers and Lakes**: Provide additional water sources
- ➔ **Remote Location**: Reduces pollution risk in reservoirs
- ➔ **Narrow, Steep-Sided Valley**: Economical construction
- ➔ **Easy Accessibility**: Facilitates maintenance and use

- Advantages of Dams

- ➔ Provision of water for irrigation facilities
- ➔ Provision of water for agricultural activities
- ➔ Controlling of floods
- ➔ Fighting droughts
- ➔ Generation of electricity in hydr-electric power plants
- ➔ Creation of recreational land for tourism
- ➔ Creation of habitats for wetland species

- ➔ Renewable source of energy
- ➔ Environmentally friendly - no greenhouse gas emissions
- ➔ Reduction in fossil fuel consumption
- ➔ Generation of employment opportunities

- Disadvantages of Dams

- ➔ **Expensive:** High construction and maintenance costs, places the country in debt, diverts spending away from other areas/projects
- ➔ **Siltation Problems:** Dam may become non-functional due to sediment build up
- ➔ **Displacement of People:** Locals are moved to inferior land, family disruption, loss of communities and traditions
- ➔ Disruption of river flow below the dam
- ➔ Flooding
- ➔ Clearance of forests/vegetation
- ➔ Disruption of ecosystems and animal habitats
- ➔ Increased risk of earthquakes and landslides

- Sustainability of Dams

- ➔ **Alternative Energy Source**: Dams generate power without producing greenhouse gases, offering a cleaner alternative to burning fossil fuels

- Unsustainability of Dams

- ➔ **Siltation**: Reservoirs can accumulate silt from rivers, reducing their capacity and efficiency
- ➔ **Structural Pressure**: Dams are subjected to immense pressure, which can cause deterioration and eventual failure
- ➔ **Environmental Impact**: Dams can negatively affect the environment and fish populations

Water Pollution and its Sources

- Domestic Waste

- ➔ Sewage from both rural and urban areas carries numerous pathogenic microorganisms and increases nitrate and phosphate levels in rivers
- ➔ Detergents, metals, and other manufactured products contribute traces of toxic chemicals

- Sewage

- ➔ Sewage is waste rich in organic material, creating an ideal environment for microbial organisms
- ➔ It is typically disposed of in water bodies and must undergo treatment

- Industrial Waste

- ➔ Industrial activities involve the use of chemicals, processing metal ores, and metals leaching from waste heaps and dumps, leading to the presence of metals such as manganese, mercury, and copper in rivers
- ➔ Emissions from industrial chimneys release toxic gases into the atmosphere, which dissolve in water and form acid rain
- ➔ Waste from nuclear power stations includes toxic radioisotopes

- Agricultural Waste

- ➔ Excess phosphorus and nitrogen not absorbed by plants are washed off the land or seep into groundwater
- ➔ On farms, animal manure, synthetic fertilisers, and chemical pesticides are primary sources of pollution
- ➔ Agrochemicals include pesticides, herbicides, and fertilisers

Impact of Water Pollution

- Global Inequalities in Sewage and Water Treatment

- ➔ Developing countries face challenges in treating water and sewage due to a lack of education and inability to pressure the government effectively

- Risk of Infectious Bacterial Diseases

- ➔ Water-borne diseases like typhoid and cholera are prevalent due to contaminated drinking water

- Accumulation of Toxic Substances

- ➔ Industrial processes lead to toxic substances accumulating in lakes and rivers, reducing oxygen levels and causing the death of fish and insect larvae by hindering photosynthesis

- Bioaccumulation

- ➔ The buildup of toxic chemicals in the tissue of individual organisms

- Biomagnification of Toxic Substances

- ➔ Toxic substances, such as mercury and pesticides, increase in concentration in the tissues of organisms higher up in the food chain, leading to illness

- Acid Rain

- ➔ Burning fossil fuels produces sulphur dioxide (SO_2) and nitrogen oxides (NOx), which travel long distances and react with water in the atmosphere to form sulfuric and nitric acid, resulting in acid rain
- ➔ Acidity or alkalinity is measured on a pH scale from 1 (very acidic) to 14 (very alkaline), with 7 being neutral
- ➔ Lower pH levels make water intolerable for aquatic organisms
- ➔ Fish egg-laying is reduced, young fish become malformed, and heavy metals like aluminium, lead, and mercury leach from soil into water, causing various detrimental effects
- ➔ Aluminium clogs fish gills, leading to suffocation
- ➔ Essential minerals such as calcium and potassium are depleted, reducing algae growth and food availability for fish

- Nutrient Enrichment and Eutrophication

- ➔ An increase in nutrients, such as nitrates and phosphates, in water bodies causes rapid algae growth (algae bloom)

- ➔ When algae die, the increase in organic matter feeds bacteria, which consume oxygen, reducing oxygen levels in the water and causing the death of other organisms

Managing Pollution of Freshwater

- Improve Sanitation

- ➔ Enhancing sanitation involves separating human waste from human contact, typically through toilets and latrines
- ➔ Waste can be managed by connecting to a sewer system that collects faeces, urine, and wastewater
- ➔ Alternatively, it can be connected to a septic system, which uses an underground sealed settling tank

- Use of Toilets

- ➔ **Flush toilet:** Uses a holding tank for flushing water and a water seal to prevent odours
- ➔ **Pour toilet:** Has a water seal but uses water poured by hand for flushing
- ➔ **Pit latrine:** Collects human faeces in a hole in the ground, sometimes ventilated to reduce odours
- ➔ **Composting toilet:** A dry toilet where vegetable waste, straw, grass, sawdust, and ash are added to human waste to produce compost

- Treatment of Sewage

- ➔ Treatment of sewage aims to reduce the Biological Oxygen Demand (BOD) of the sewage
- ➔ **Sewage outfall:** Wastewater from homes and industries is taken to a sewage treatment plant in sewers
- ➔ **Screening tank:** Large objects are removed from the waste using a coarse grid
- ➔ **Primary treatment, first settling tank:** solid organic matter, mainly human waste, settles at the bottom of the tank (sludge), which is treated in a sludge-digester; clean water overflows the sides of the tank and is taken to the next stage
- ➔ **Secondary treatment, oxidation:** Water is pumped into a tank where oxygen is bubbled through it; this encourages the growth of bacteria and other microbes that break down organic matter, reducing BOD
- ➔ **Secondary treatment, second settling tank:** Water enters, where bacteria settle to the bottom, forming more sludge; this cleaner water overflows the sides of the tank as effluent, usually discharged into a river
- ➔ **Sludge digester:** Oxygen-free conditions encourage the growth of bacteria that break down the sludge, releasing methane, which can be burnt; treated sludge can be dried in sludge lagoons and used as organic fertiliser on farmland
- ➔ **Tertiary treatment:** Further filtering of the effluent or chlorination produces even cleaner effluent that protects the habitat in which it is released
- ➔ **Water treatment:** Water is made potable by undergoing coagulation treatment, being filtered, and disinfected
- ➔ **Coagulation:** Particles in the water stick together and settle to the bottom of the container; water is then filtered through sand
- ➔ **Chlorination:** Chlorine is added as a disinfectant to kill remaining pathogens

- Pollution Control and Legislation

- ➔ Pollution control and legislation put pressure on polluters to reduce pollutants
- ➔ Industries are required to monitor the pollution they cause and keep it within set levels
- ➔ Fines are imposed for exceeding set limits
- ➔ Companies may be prosecuted and, in extreme cases, forced to shut down
- ➔ Companies may need government agreement on strategic plans to reduce pollution levels
- ➔ Incentives like grants or tax relief may encourage companies to reduce pollution
- ➔ **Example:** Bi-national Great Lakes Water Quality Agreement (GLWQA) set a loading limit of phosphorus at 11,000 metric tonnes per year in response to eutrophication issues in the Great Lakes of the USA and Canada

Managing Water-related Disease

- Water-borne Disease

- ➔ Water-borne diseases are spread by consuming contaminated water due to poor sanitation and untreated sewage or by washing food, pots, pans, or hands and face in dirty water
- ➔ **Examples:** Cholera and typhoid
- ➔ Cholera is an intestinal infection causing severe diarrhoea that can lead to dehydration and death
- ➔ Causes of cholera include poor sanitation, contaminated water and food, and disruption of piped water supplies after a natural disaster
- ➔ Strategies to control cholera include ensuring that sewage and drinking water are kept separate, removing sewage directly to a treatment works, and treating water before it is delivered to homes
- ➔ Avoid using contaminated water to wash food and always wash hands after contact with any faecal material
- ➔ Boiling water and chlorination are also effective methods to prevent the spread of cholera

- Water-bred Disease

- ➔ Water-bred diseases are transmitted by carriers that breed in water and spread the disease by biting their victims
- ➔ An example is malaria, a life-threatening disease transmitted through the bite of an infected Anopheles mosquito (vector) carrying the Plasmodium parasite
- ➔ Once bitten, the parasite enters the bloodstream
- ➔ Symptoms include high temperature and fever, diarrhoea, dehydration, and weakness
- ➔ Strategies to control malaria include sleeping under mosquito nets and using antimalarial drugs in and around homes
- ➔ Draining marshes and stagnant pools to eliminate breeding grounds and putting kerosene over the tops of pools to choke the larvae
- ➔ Spraying antimalarial drugs on stagnant areas of water to kill the larvae and using vaccinations
- ➔ Educating people on the risks of malaria by setting up campaigns and programs

Oceans and Fisheries

Oceans as a Resource

- Food

- ➔ Food from the sea includes true fish, finfish, shellfish, and other marine animals that can be eaten

- Chemicals and Building Materials

- ➔ Chemicals and building materials in the oceans often come from materials eroded from land, where rain and wind break down rocks and carry these substances into the oceans via rivers
- ➔ Some substances, such as salt, magnesium, tin, gold, titanium, and diamonds, can be extracted directly from the sea

- Salt

- ➔ Seawater that is left behind over many weeks in the sun

- Diamonds

- ➔ Diamonds are found in greater quantities on the ocean floor compared to land
- ➔ Mining the ocean floor is much more challenging as it requires dredging and dealing with sediment silt

- Sand, Gravel and Crushed Rock

- ➔ Sand, gravel, and crushed rock are mined for the construction industry
- ➔ If not managed properly, this can cause physical damage to the seabed and surrounding habitats
- ➔ Fine particle clouds produced during mining can resettle and interfere with photosynthesis and may also introduce heavy metals into food chains

- Energy

- ➔ **Oil:** Extracted by offshore drilling rigs
- ➔ **Wave Energy:** Harnessing the enormous energy in ocean waves could potentially produce twice the current world energy output if fully utilised
- ➔ **Tidal Energy:** The gravitational pull of the sun and moon causes sea water to rise and fall twice daily, creating a flow that can be used to generate electricity

- Tourism

- ➔ Seaside destinations draw significant numbers of visitors, particularly from MEDCs, due to their natural beauty such as coral reefs
- ➔ Activities include diving, snorkelling, windsurfing, jet skiing, deep-sea fishing, and beach sunbathing
- ➔ Boat trips for viewing sea creatures like whales and dolphins also generate business

- Transport

- ➔ Transport: ships play a crucial role in transporting goods and people
- ➔ While aviation has reduced passenger shipping, pleasure cruises remain a significant economic sector
- ➔ Ships are the preferred method for bulk freight transport between countries
- ➔ **Types of merchant (goods carrying) ships:**

Ship Type	Load or Purpose
Bulk Carriers	Transport of food such as rice and wheat
Container Ships	Entire load is carried in lorry-sized containers, known as containerisation
Tankers	Transport of fluids, especially liquified petroleum gas and liquified natural gas, as well as vegetable oils and wine
Refrigerated Ships	Transport of perishable items such as vegetables, fruits, fish and dairy products
Roll-on/Roll-off Ships	Transport of vehicles, together with their loads, that can be driven on and off the ship
Coastal Trading Vessels	Used for trade between places that are close together, especially in island groups
Ferries Ferries	Used mainly for the movement of foot passengers, sometimes with their cars, mainly between islands or between mainland and islands
Cruise Ship	Used for pleasure voyages where the facilities of the ship are a crucial part of the trip
Ocean Liner	Used to transport people for one port to another

World Fisheries

- Distribution of Major Ocean Currents

- ➔ **Surface Currents:** Consistent movement of surface seawater in a specific direction
- ➔ **Prevailing Wind:** Dominant wind direction in an area
- ➔ **Southern Hemisphere Currents:** Generally flow counterclockwise due to southeastern winds pushing the Western Australian, Benguela, and Peruvian currents northward
- ➔ **Cold Currents:** Originate from polar regions
- ➔ **Warm Currents:** Emerge from tropical regions or areas near the equator

- Distribution of Major Marine Fish Populations

- ➔ **Location**: Major fisheries are primarily found on continental shelves where the water is shallow (<150m deep), allowing light penetration and higher oxygen levels
- ➔ **Herbivorous Fish**: Depend on primary producers like phytoplankton (green algae).
- ➔ **Carnivorous Fish**: Feed on herbivorous fish or other carnivores
- ➔ **Food Web**: Fish populations are abundant where phytoplankton are plentiful
- ➔ **Phytoplankton:** Perform photosynthesis, requiring light, water, and carbon dioxide (CO_2)
- ➔ **Light as a Limiting Factor**: Light availability often limits photosynthesis since most sunlight is absorbed by 200m depth, the euphotic zone
- ➔ **Mineral Nutrients**: Phytoplankton also need nitrogen, sulphur, phosphorus, and magnesium for growth and protein synthesis

- Factors Affecting Fisheries

- ➔ **Nutrient-Rich Areas**: Important fisheries are found where ocean currents bring up nutrient-rich decaying material from the seabed (upwelling)
- ➔ **Example**: Peruvian anchovy fishery off South America's west coast

- Issues

- ➔ **Overfishing**: Occurs when fish are caught faster than they can reproduce, reducing fish numbers
- ➔ **El Niño Southern Oscillation (ENSO)**: Alters prevailing winds and ocean currents in the South Pacific, bringing warm, nutrient-poor water that disrupts the anchovy fishery by stopping nutrient-rich upwelling, affecting the entire food chain

Impact of Exploitation of the Oceans

- Causes of Overfishing of Marine Fish Species

- ➔ Demand for fish as food is increasing due to the rising world population
- ➔ Larger boats are capable of fishing far from ports for extended periods
- ➔ SONAR and detailed weather data help locate fish more effectively
- ➔ Huge nets capture large quantities of fish, with a significant portion being bycatch
- ➔ Overfishing has led to stagnation in global fish catches since the 1990s, causing job losses and reduced food supply
- ➔ Fish sizes have decreased, leading to higher demand for food
- ➔ The harvest of untargeted, protected, or endangered species disrupts marine biodiversity and food chains

- Types of Nets

Type of Net	Description
Trawl Net	Trawl nets are cone-shaped and made from two, four, or more panels towed by one or two boats, either on the bottom or in midwater; the cone-shaped body of the net ends in a bag or cod-end; they catch all types of

	unwanted species and can cause damage to the seabed
Drift Net	A drift net consists of a series of rectangular, lightweight nets joined end-to-end to form a very long vertical curtain of netting which hangs loosely in the water; they are often used in coastal waters
Seine Net	A seine net is a very long net, with or without a bag in the centre, which set either from the shore or from a boat for surrounding a certain area
Dredge Net	A device consisting of a net attached to a frame, dragged along the bottom of a river, bay; they have a coarse mesh in order to let organisms smaller than the target species through

Management of the Harvesting of Marine Species

- Net Types and Mesh Size

- ➔ Small mesh sizes catch juvenile fish, reducing the population that reaches maturity and reproduces
- ➔ Diamond-shaped mesh catches more fish; square mesh panels are often included to prevent over-catching

- Species-Specific Methods

- ➔ **Fish Aggregation Devices (FADs):** Used in tuna fisheries, consisting of a log suspended from a buoy
- ➔ **Bycatch Issue:** FADs attract tuna and other species, leading to large bycatch including younger tuna and non-target species
- ➔ **Solution:** Pole and line fishing, a highly selective method with minimal bycatch

- Quotas

- ➔ Governments set limits on the number and type of fish that can be caught based on global fish population data
- ➔ Ensures enough fish are left to reproduce and sustain the fishery for the next season

- Closed Seasons

- ➔ Laws can close fisheries during certain times of the year, usually breeding seasons, to protect fish populations

- Protected Areas and Reserves

- ➔ Fishing is restricted in certain areas where target species breed to protect fish populations

- International Agreements and Monitoring

- ➔ **Magnuson-Stevens Fishery Conservation and Management Act:** Governs US marine fisheries, aims to conserve fishery resources, enforce fishing agreements, develop underused fisheries, and protect habitats
- ➔ **Economic Exclusion Zone (EEZ):** 200 nautical miles around a coastline where the country manages sustainable fisheries
- ➔ **UNCLOS:** Regulates international waters fisheries, essential in areas like the Mediterranean

- Monitoring Systems

- ➔ **Namibia's Model System:** Larger vessels have onboard observers and air patrols to detect illegal fishing
- ➔ All fish landings monitored at ports, and vessels must keep daily logs of catches in the exclusion zone

- Effectiveness and Challenges

- ➔ Oceans' vastness makes monitoring laws and agreements difficult
- ➔ Port-based monitoring organisations are more successful
- ➔ High incentive for illegal fishing due to its importance for income and food
- ➔ Quotas can be avoided by underreporting catches
- ➔ Authorities may not check every boat, risking undeclared catches
- ➔ Illegal use of small mesh sizes and fishing in restricted areas due to inadequate patrols
- ➔ Fishers trespass in restricted areas

Managing Natural Hazards

Earthquakes and Volcanoes

Structure of the Earth

- Crust

- ➔ Outermost layer of the Earth, composed of a variety of rocks and minerals

- Mantle

- ➔ Lies between the crust and makes up about 80% of the Earth's volume
- ➔ Composed of silicate minerals that are rich in magnesium and iron
- ➔ The mantle is solid but behaves plastically, allowing movement of tectonic plates

- Core

- ➔ **Outer Core:** Composed mainly of liquid iron and nickel; it is in a liquid state due to the extremely high temperatures
- ➔ **Inner Core:** Composed primarily of solid iron and nickel; despite the high temperatures, it is solid due to the immense pressures

- Distribution and Causes of Volcanoes

- ➔ Magma from beneath the Earth's crust escapes to the surface, forming volcanoes
- ➔ **Intrusive Volcanic Activity:** Occurs when magma cools underground to form igneous rocks
- ➔ **Extrusive Volcanic Activity:** When magma flows out onto the Earth's surface as lava
- ➔ Eruptions include pyroclastic material and lahars

- Distribution and Causes of Earthquakes

- ➔ It is caused due to sudden release of energy in the Earth's crust due to tectonic plate movements
- ➔ The focus is where the earthquake begins underground, and the point on the Earth's surface, directly above is called the epicentre; the release of tension sends out shock waves that travel towards from the focus
- ➔ Plate boundaries are the edges where two tectonic plates meet

- Richter Scale

- ➔ The Richter scale is a logarithmic scale used to measure the magnitude of earthquakes taken with a seismograph
- ➔ It has a scale of 1 to 10, where each whole number increase on the scale represents a tenfold increase in amplitude

Types of Plate Boundaries

- Divergent Boundaries

- ➔ Tectonic plates move away from each other
- ➔ As plates separate, magma rises from below the Earth's surface to fill the gap, creating new crust; this process is called seafloor spreading
- ➔ Most divergent boundaries are found along mid-ocean ridges, which are underwater mountain ranges formed by this upwelling magma
- ➔ On continents, they can create rift valleys, which are large depressions formed by the stretching and thinning of the crust

- Convergent Boundaries

- ➔ Tectonic plates move towards each other
- ➔ **Oceanic-Continental Convergence:** An oceanic plate subducts a continental plate, leading to the formation of volcanic mountain ranges and deep ocean trenches
- ➔ **Oceanic-Oceanic Convergence:** One oceanic plate subducts beneath another, creating deep ocean trenches and volcanic island arcs
- ➔ **Continental-Continental Convergence:** Two continental plates collide, leading to the formation of large mountain ranges

- Transform Boundaries

- ➔ Tectonic plates slide past each other horizontally
- ➔ They are associated with earthquakes as the plates grind against each other and release stress

Tropical cyclones

Distribution and Causes of Tropical Cyclones

- ➔ They are large areas of very low pressure of high wind speeds
- ➔ They rotate in an anticlockwise direction in the Northern hemisphere and in a clockwise direction in the Southern hemisphere

- Conditions for Formation of Tropical Cyclones

- ➔ Ocean surface temperature of at least 27 °C; warm water provides energy for increased evaporation of water which ultimately releases huge amounts of energy
- ➔ Warm ocean water must be at least 60 m deep
- ➔ Conditions must occur between latitudes 5° and 20° north and south
- ➔ Very little wind shear, to enable vertical development of the storm

- Weather Associated with a Tropical Cyclone

- ➔ Sky becomes cloudy, increased wind speed and rain with sunny intervals
- ➔ Approaching the vortex, air pressure falls and wind speed continues to increase as large cumulonimbus clouds form and heavy rain falls
- ➔ In the eye of the storm, temperatures are warm, sky is clear, winds are light and there is little rain
- ➔ When the eye passes, cumulonimbus clouds form again, followed by heavy rain and strong winds

Flooding

Causes of Flooding

- ➔ Flooding is when the discharge of a river exceeds the capacity of the river's channel

- Physical Causes of Flooding

- ➔ Steady, prolonged rainfall which can over saturate the soil, reducing infiltration capacity

- ➔ Previous weather due to which antecedent soil mixture is high , leading to overland flow
- ➔ Impermeable soils and rocks, lowering infiltration capacity and increasing overland flow
- ➔ Steeper gradients leading to faster overland flow
- ➔ Earthquakes, volcanoes and cyclones which produce tsunamis and storms that can cause flooding

- Human Causes of Flooding

- ➔ Deforestation, which reduces interception and infiltration
- ➔ Urbanisation, where presence of impermeable surfaces leads to overland flow
- ➔ Poor agricultural practices and overgrazing leave soil exposed, reducing interception
- ➔ Enhanced global warming due to climate change leads to rise in sea levels

- Storm hydrographs

- ➔ Storm hydrographs show how quickly a river responds to a rainfall event
- ➔ The shorter the lag time and the steeper the rising limb, the quicker the water reaches the river and the greater will be the chance of flooding

Drought

- Causes of Drought

- ➔ It is the lack of rain caused by prolonged high pressure
- ➔ El Niño and La Niña are two opposing phases of the El Niño Southern Oscillation (ENSO), which affect drought conditions
- ➔ El Niño causes increased ocean temperatures and evaporation in the central and Eastern Pacific
- ➔ La Niña results in cooler ocean temperatures and decreased evaporation in the central and Eastern Pacific
- ➔ Due to climate change, warmer worldwide temperatures decrease rainfall events, leading to situations of drought
- ➔ Human activity, such as overcultivation and overgrazing, deforestation, and building of dams can also affect the influence that drought has on a region

The Impact of Natural Hazards

Tectonic Events	Tropical cyclone	Flooding	Drought
Damage to buildings and infrastructure	Flooding	Loss of life	Death of organisms
Loss of habitat	Loss of life	Loss of livestock	Decline in crop yields
Water-related diseases	Financial losses	Loss of crops	Starvation
Loss of life	Damage to buildings and infrastructure	Contamination of drinking water supplies	Desertification

Landslides	Loss of crops	Financial losses	Increased soil erosion
Tsunamis	Water-related diseases	Damage to buildings and infrastructure	Increased risk of wildfires

Measuring the Impact of Natural Hazards

- Earthquakes

Prediction	Preparation and Protection
Seismometers to monitor tremors	Earthquake proof or aseismic buildings
Mapping of epicentres and past events	Smart metres that cut off gas supplies to prevent fires
Designing a hazard zone map	Land-use planning, to build settlements in low risk areas

- Volcanoes

Prediction	Preparation and Protection
Satellites to measure increasing ground temperatures	Create a volcano hazard map
Tiltmeters and GPS monitor changes in volcano shape	Plans such as lava diversion channels, lava barriers, spraying lava with water and halting lava advance by dropping concrete slabs into the flow
Monitoring emissions of gas and steam	Building reinforcements such as sloping roofs to prevents against ashfall

- Tropical Cyclones

Prediction	Preparation and Protection
Satellites for tracking	Cyclone shelters
	Embankments built along coast
	Preserve mangrove swamps to absorb the energy of storm surges

- Flooding

Prediction	Preparation and Protection
Learning about characteristics of drainage basin and type of storm	Hard engineering projects, such as flood barriers, dams and flood control channels
	Soft engineering projects, such as afforestation and storage basins
Monitoring amount of rainfall and change in river discharge	Land use planning to use higher land for settlements

- Drought

Prediction	Preparation and Protection
Monitoring precipitation and temperature	Water conservation through storage tanks and spray irrigation
	Increase water supplies by dams and reservoirs, use of aquifers and desalination
	Agricultural improvements through building bunds
	Government stockpiling supplies of water, food and medicine

Opportunities Presented by Natural Hazards

- Opportunities Presented by Volcanoes

- ➔ Fertile soils are created that produce high crop yields
- ➔ Scenery can be spectacular
- ➔ Geothermal power can supply a cheap form of energy
- ➔ Possibility of mining minerals such as sulfur, diamonds and gold
- ➔ Employment opportunities, such as in tourism

- Opportunities Presented by Flooding

- ➔ Rivers provide a source of food, water for drinking and irrigation
- ➔ Deposition of silt on farmland
- ➔ Flat land either side of the river is available for building on

The Atmosphere and Human Activities

The Atmosphere

- Composition of the Atmosphere

- ➔ Primarily composed of nitrogen (78%), oxygen (21%) and trace gases including carbon dioxide, methane, water vapour and ozone

- Layers of the Atmosphere

- ➔ **Troposphere:** Temperature decreases with height; wind speeds increase with height
- ➔ **Stratosphere:** Contains the ozone layer; pressure continues to fall but temperatures increase steadily with altitude, due to temperature inversion
- ➔ **Mesosphere:** Temperature and pressure decrease with altitude
- ➔ **Thermosphere:** Temperatures rise rapidly with altitude

- Temperature inversion

- ➔ Phenomenon that traps and increases the concentration of smog
- ➔ **Conditions needed for temperature inversion include:**
  - ◆ High air pressure, which causes the upper air to sink
  - ◆ Calm conditions resulting from high pressure
  - ◆ Valleys surrounded by steep-sided hills, which trap the smog

- Natural greenhouse effect

- ➔ It is the process that keeps the Earth's surface and atmosphere warm
- ➔ The Earth receives short-wave radiation from the Sun
  - ◆ About 50% is absorbed by the Earth's surface
  - ◆ 20% is absorbed by the atmosphere
  - ◆ 30% is reflected back into space by clouds and the Earth's surface
- ➔ The Earth's surface warms and emits long-wave radiation back into the atmosphere
- ➔ Greenhouse gases absorb and deflect some of this radiation back to the Earth's surface
- ➔ They trap radiation and warm the Earth, keeping its temperature warmer, allowing life to exist
- ➔ **Greenhouse Gases include:**
  - ◆ Carbon dioxide
  - ◆ Methane
  - ◆ Nitrous Oxide
  - ◆ CFCs
  - ◆ Ozone

Atmospheric Pollution and its causes

Causes of Atmospheric Pollution

- Smog

- ➔ It forms when burning of fossil fuels provide particles that act as condensation nuclei for fog
- ➔ Photochemical smog involves chemical reactions induced by sunlight on certain pollutants that converts them into harmful substances; it is caused by particulate matter and volatile organic compounds
- ➔ Agricultural smog forms when ammonium nitrate from fertilisers and manure is carried in the air

- Acid Rain

- ➔ It results from the emissions of sulfur dioxide and nitrogen oxides from burning fossil fuels
- ➔ These gases react with water vapour to form sulfuric acid and nitric acid
- ➔ Acidic compounds precipitate as acid rain

- Ozone Depletion

- ➔ Ozone is found in the troposphere but is concentrated in the stratosphere

- ➔ Oxygen filtering from the top of troposphere reacts under the influence of ultraviolet radiation to form ozone
- ➔ The ozone layer protects the Earth from the Sun's harmful radiations and is continually being produced, destroyed and replaced
- ➔ Chlorine, released from CFCs, reacts with oxygen such that when it reaches the stratosphere, ultraviolet radiation breaks them down to release chlorine
- ➔ The release of chlorine allows harmful ultraviolet radiations to enter the atmosphere

- Enhanced Greenhouse Effect

- ➔ Higher concentrations of greenhouse gases lead to more infrared radiation being trapped, resulting in overall warming of the Earth's atmosphere

Impact of atmospheric pollution

- Impact of atmospheric pollution

Pollutant	Impact on people	Impact on environment
Smog	Irritation of eyes and throat	Reduced ability of plants to photosynthesize
	Respiratory diseases	
	Strokes and heart attacks	Growth, reproduction and general health of plants decline
	Breathing difficulties	
Acid rain	Acidification of groundwater makes water undrinkable	Foliage dies
		Damage to tree roots
	Crop yields decline	Nutrients leached out of soil
	Buildings are chemically weathered	Aquatic and animal life poisoned
Ozone depletion	Sunburn, skin cancers, retina damage and cataracts	Inhibits reproductive cycle of phytoplankton, affecting food webs
		Changes in biochemical composition of plant leaves
	Suppressed immune system	Rising sea levels
Climate change	Flooding and loss of land	Melting of ice sheets, glaciers and permafrost
	Forced immigration	Rise of sea level

Managing atmospheric pollution

Strategies Used to Reduce the Effects of Atmospheric Pollution

- Individuals

- ➔ Awareness and reduction of carbon footprints

- Governments

- ➔ Reduction and replacement of CFCs
- ➔ Flue gas desulfurization to reduce sulfur dioxide emissions
- ➔ Increased use of renewable energy and nuclear energy
- ➔ Carbon capture and storage
- ➔ Passing laws to reduce emissions from industries

- International Community

- ➔ Controlling and reducing air pollution across borders by international corporations
- ➔ Ban and control use of CFCs to slow down ozone depletion
- ➔ Conserve resources and wildlife habitat

Human Population

Human population distribution and density

- Human population and distribution density

- ➔ The density of a population is worked out by dividing the number of people in a place by the area of that place
- ➔ The population distribution of an area is how the population is spread over that area

Changes in population size

- Growth curve of populations

- ➔ Exponential growth occurs when the growth rate of a population increases rapidly over time
- ➔ Birth rate refers to the total number of live births over time
- ➔ Death rate refers to the total number of deaths over time

- Stages of Population Growth

- ➔ **Lag Phase:** The initial period of slow growth; the population is adjusting to a new environment
- ➔ **Exponential (log) Phase:** A period of rapid population growth where the population size doubles at a constant rate; resources are abundant and population grows exponentially
- ➔ **Carrying Capacity:** The maximum population size that an environment can sustainably support; it is determined by the availability of resources such as food, water and shelter

Changes in Human Populations

- Factors Affecting Birth Rate

- ➔ Higher income levels, which lower birth rate as families may prioritise career and lifestyle over having many children
- ➔ Availability and use of contraceptives and birth control
- ➔ In countries with high death rate for the very young, birth rates are also very high
- ➔ Cultural beliefs and traditions can influence family size and birth rates

- Factors Affecting Migration

Push from rural to urban	Pull from urban to rural
Drought/famine	Good supplies of food
Poverty	Well paid jobs
Poor links with outside world	Good roads
Poor services	Hospitals, schools, water and electricity
Work on the land only, subsistence	Factory, shop, office work for a wage
Desertification	No comparable pull factors
Sea-level rise	
Seasonal weather events, such as monsoons, cyclones etc.	

Population Structure

Population Structure in MEDCs and LEDCs

- ➔ Population pyramids display how the population is made up in terms of age and sex
- ➔ They fall into three main categories

- Expanding

- ➔ Indicates a young population with potential for rapid population growth
- ➔ Common in developing countries (LEDCs) with limited access to healthcare and family planning

- Stationary

- ➔ Indicates stable population growth
- ➔ Common in countries with good healthcare, low infant mortality rates and consistent birth rates

- Declining

- ➔ Indicates a declining population growth rate
- ➔ Common in developed countries (MEDCs) with good healthcare, low fertility rates and high life expectancy

Managing Human Population Size

Strategies

- Family Planning

- ➔ Family planning is a strategy a couple uses to plan how many and when to have children
- ➔ Includes contraception, sterilisation, abortion and assisted reproductive techniques, such as in vitro fertilisation (IVF)

- Improve Health and Education

- ➔ Improved health and education would lead to a rise in the population because it will lower the death rate
- ➔ Education makes people more aware of methods that can be used to limit family size; it can also lead to tendency for later marriage and child bearing
- ➔ Better healthcare and sanitation improves infant mortality rate and encourages people to have children

- Policies and Laws

- ➔ National and regional population policies are used by governments to remedy the situation in their countries
- ➔ Pronatalist policies encourage couples to have children, through subsidised day-care, tax-reductions and subsidised train fares
- ➔ Antinatalist policies discourage couples from having children through certain laws and measures towards family planning, contraceptives and education

Natural Ecosystem and Human Activities

Ecosystems

- Ecosystems

➔ All the living things (biotic components) together with all the non-living things (abiotic components) in an area

- Population

➔ All the organisms of one species living in a defined area

- Community

➔ A group of populations of different species that live together in an area and interact with each other

- Habitat

➔ The place within an ecosystem where an organism lives

- Niche

➔ The role of a species within an ecosystem

- Biotic Components

- ➔ **Producers:** Organisms that produce their own food through photosynthesis (e.g., plants, algae).
- ➔ **Primary Consumers:** Herbivores that eat producers
- ➔ **Secondary Consumers:** Carnivores that eat primary consumers
- ➔ **Tertiary Consumers:** Top predators that eat secondary consumers
- ➔ **Decomposers:** Organisms that break down dead material and recycle nutrients

- Abiotic Components

- ➔ **Temperature:** Affects metabolic rates of organisms
- ➔ **Humidity:** Influences water availability
- ➔ **Water:** Essential for all living organisms
- ➔ **Oxygen:** Necessary for respiration in most organisms
- ➔ **Salinity:** Affects osmoregulation in aquatic organisms
- ➔ **Light:** Essential for photosynthesis in producers
- ➔ **pH:** Influences the chemical reactions in soil and water

- Biotic Interactions

- ➔ **Competition:** When organisms vie for the same resource (e.g., food, habitat)
- ➔ **Predation:** When one organism (predator) hunts and eats another (prey)
- ➔ **Pollination:** Transfer of pollen from one flower to another, often facilitated by animals like bees

- Photosynthesis

- ➔ **Process:** Plants convert light energy, water, and carbon dioxide into glucose and oxygen
- ➔ **Word Equation:** Carbon dioxide + Water → Glucose + Oxygen
- ➔ **Importance of Chlorophyll:** It absorbs light energy, which drives the photosynthesis process

- Energy Flow using Food Chains, Food Webs, and Trophic Levels

- ➔ **Food Chains:** A linear sequence of organisms where each is eaten by the next.
- ➔ **Food Webs:** A complex network of interconnected food chains.
- ➔ **Trophic levels are the hierarchical levels in an ecosystem, each representing a step in the flow of energy:**
  - ◆ Producers (First trophic level)
  - ◆ Primary Consumers (Second trophic level)
  - ◆ Secondary Consumers (Third trophic level)
  - ◆ Tertiary Consumers (Fourth trophic level)
- ➔ Only about 10% of the energy at one trophic level is passed on to the next level, the rest of the energy is lost primarily through metabolic processes as heat, as well as respiration and movement
- ➔ Due to this inefficient transfer, the energy available decreases up the food chain, so by the time you reach the fourth or fifth trophic level, the energy available is too low to support another level

- Ecological Pyramids

- ➔ **Pyramids of Numbers:** shows the number of organisms at each trophic level

- ➔ **Pyramids of Energy:** Illustrates the amount of energy available at each trophic level, decreasing as you move up

- Respiration

- ➔ **Process:** Organisms convert glucose and oxygen into energy, carbon dioxide, and water
- ➔ **Word Equation:** Glucose + Oxygen → Carbon dioxide + Water + Energy

- The Carbon Cycle

- ➔ The continuous movement of carbon among the atmosphere, organisms, and the Earth
- ➔ **Photosynthesis:** Plants take in carbon dioxide and convert it into glucose
- ➔ **Respiration:** Organisms release carbon dioxide back into the atmosphere
- ➔ **Decomposition:** Decomposers break down dead matter, returning carbon to the soil and atmosphere
- ➔ **Combustion:** Burning fossil fuels releases carbon dioxide into the atmosphere

Ecosystems Under Threat

Causes of Habitat Loss

- Drainage of Wetlands

- ➔ Wetlands offer environmental services, such as: shoreline protection, maintenance of water quality, flood control, recharging of aquifers and biological productivity
- ➔ They are drained for agricultural expansion, urban development, provision of tourism facilities and infrastructure projects
- ➔ Other causes of wetland loss include: removal of groundwater, peat removal, discharge of pollutants and dredging for flood control
- ➔ This leads to destruction of critical ecosystems that support diverse species

- Intensive Agricultural Practices

- ➔ Large-scale monoculture farming, excessive use of pesticides and fertilisers, and conversion of natural landscapes into farmland
- ➔ It disrupts soil quality, water cycles and reduces natural habitats

- Deforestation

- ➔ Large-scale logging, clear-cutting for agriculture, urbanisation and infrastructure development
- ➔ Loss of forest cover leads to destruction of habitats for many species, disrupting entire ecosystems

Impacts of Habitat Loss

- Loss of biodiversity and genetic depletion

- ➔ Habitat loss causes organisms to lose their homes and food sources, reducing diversity in species
- ➔ Genetic diversity within populations decreases due to disruption of food chains and food webs, making species more vulnerable to diseases and environmental changes

- Extinction

- ➔ Loss of species can lower rates of reproduction as well sustenance through food webs, until a species no longer exists

Deforestation

- Causes

- ➔ Trees are cut down for their wood, which is used for construction, paper production and fuel
- ➔ Forests are cleared to create agricultural land
- ➔ Construction of infrastructure and urban expansion lead to deforestation
- ➔ Mining for minerals and other resources leads to forest clearance

- Impacts

- ➔ Destruction of habitats for a vast array of plant and animal species
- ➔ Lack of trees and soil to stabilise the soil and prevent erosion
- ➔ Disruption of carbon cycle as it releases stored carbon back into the atmosphere, contributing to climate change
- ➔ Loss of habitat leading to loss of biodiversity and genetic depletion

Managing forests

- Need for Sustainable Management of Forests

- ➔ Growing forests act as carbon sinks by absorbing carbon dioxide during photosynthesis and mature forests store large amounts of carbon in their biomass, mitigating climate change
- ➔ Forests contribute to the water cycle when they add water to the atmosphere during transpiration and generate moisture which can affect rainfall
- ➔ Forests prevent soil erosion, since the trees hold the soil in place with their root systems and intercept rain
- ➔ They are home to a vast array of plant and animal species which provide valuable genetic resources
- ➔ Forests provide food, medicine and industrial raw materials
- ➔ They encourage ecotourism by inviting tourists for their natural beauty, wildlife and recreational opportunities

Measuring and Managing Biodiversity

- Methods for Estimating Biodiversity

Method	Description	Advantages and Disadvantages
Pitfall traps		**Advantages:** Inexpensive, easy to set up and use

	Containers are buried with their rims at ground level to capture small, ground-dwelling animals	**Disadvantages:** Often kill the organisms captured, may oversample or undersample
Pooters	Small devices used to suck up small invertebrates into a container for identification	**Advantages:** Quick, minimal harm to organisms
Quadrats	Square frames of known area used to define sample plots for studying plant and immobile animal populations	**Advantages:** Quick, easy to use, cost-effective **Disadvantages:** Unless many quadrats are placed, the sample can be unintentionally biased
Transects	A line laid out in a habitat along which organisms are sampled at regular intervals	**Advantages:** Quick, inexpensive, portable **Disadvantages:** Often used in inappropriate situations, so care must be taken when deciding whether or not to use a transect

- Random and Systematic Sampling

➔ Random sampling: sampling locations are chosen randomly within the study area to avoid bias

Advantages	Disadvantages
Reduces sampling bias	Can be less efficient if the study area is large or difficult to access

➔ Systematic sampling: sampling locations are chosen at regular intervals along a grid or transect

Advantages	Disadvantages
Simple to implement	May miss rare or clustered species
Comprehensive coverage of the area	

National and International Strategies for Conserving the Biodiversity

- Harvesting

➔ Implementing stability by harvesting natural resources at a sustainable rate
➔ **Examples:** Fisheries, forestry and medicinal plants

- Agroforestry

➔ Sustainable forestry/agroforestry, to integrate cultivation of trees with crops or livestock

- ➔ Selective logging is a process which involves removing only the mature trees of the species that are of value
- ➔ In agroforestry, crops are grown around trees, which enrich the soil when their leaves fall and aid in mineral recycling

- National Parks, Ecological Reserves and Corridors

- ➔ Specially protected regions covered by certain laws are dedicated to protect wildlife
- ➔ National parks provide facilities for tourism, and the money can be for construction work
- ➔ Ecological reserves are areas where the focus is on management of the area for wildlife
- ➔ Wildlife corridors are areas of land that link protected areas that otherwise would become isolated from one another

- Extractive Reserves

- ➔ Areas where sustainable extraction of natural resources is allowed, benefiting local communities

- World Biosphere Reserves

- ➔ Areas which protect the environment and benefit local people
- ➔ **Main areas of biosphere include:**
  - ◆ **Core:** Strict protection and monitoring, no development allowed
  - ◆ **Buffer:** Local community involvement in management, recreation and research
  - ◆ **Transition:** Sustainable development and agriculture allowed

- Seed Banks

- ➔ Facilities that store seeds from various plant species to preserve genetic diversity
- ➔ Seeds take up less space, so more species can be held in the available space

- Role of Zoos and Captive Breeding

- ➔ Provide education about the illegal trade in animals and products and the need to maintain biodiversity
- ➔ Involved in scientific research on control of diseases and techniques to improve breeding success
- ➔ Encourage captive-breeding programmes to increase species numbers, preventing extinction

- Sustainable Tourism and Ecotourism

- ➔ Tourism that focuses on conservation and benefits local communities

A Note from Mojza

These notes for Environmental Management (5014) have been prepared by Team Mojza, covering the content for O Level 2025-26 syllabus. The content of these notes has been prepared with utmost care. We apologise for any issues overlooked; factual, grammatical or otherwise. We hope that you benefit from these and find them useful towards achieving your goals for your Cambridge examinations.

If you find any issues within these notes or have any feedback, please contact us at support@mojza.org.

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