UPDATED TO 2023-2025 SYLLABUS

CAIE IGCSE

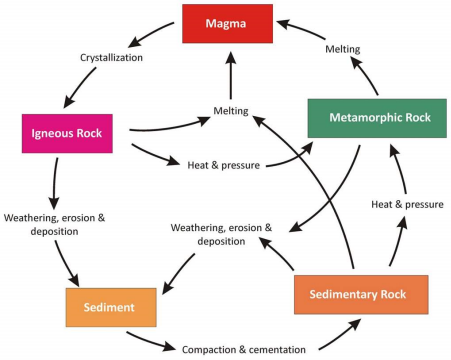
ENVIRONMENTAL MANAGEMENT

SUMMARIZED NOTES ON THE THEORY SYLLABUS

1. Rocks and Minerals and their Exploitation

1.1. Formation of Rocks

- **The Rock Cycle** represents the changes between the three rock types and the processes causing them.



Types of Rocks

- **Igneous rocks:**
  - Made when liquid magma cools to form solid rock.
  - Molten rock below the surface is called magma, and lava when it reaches the surface.
  - **Extrusive igneous rock:** if the rock cools quickly, small crystals, e.g., basalt, are formed.
  - **Intrusive igneous rock:** if the rock cools slowly, large crystals, e.g., granite, are formed.
  - **Examples:** Granite and Basalt
- **Sedimentary rocks:**
  - Formed by the weathering of existing rocks at the Earth's surface.
  - Fossils may be present.
  - Sediments (small particles of rocks) accumulate into layers and get pressurized due to the newer deposits above them.
  - The sediments are transported by water and wind (erosion).
  - Particles like clays, silts, sands, gravels, and small boulders are found in sediments.
  - **Examples:** limestone, sandstone, and shale.
- **Metamorphic rocks:**
  - Formed from the existing rock when heat and/or pressure causes changes in the rock crystals without melting it.
  - The changes can be physical, chemical, or both.
  - **Examples:** marble and slate.

1.2. Extraction of Rocks and Minerals from the Earth

Exploring for Minerals

- **Prospecting:** a process of searching for minerals by examining the surface of the rocks
- **Ore**: A rock with enough important minerals to make it worth mining

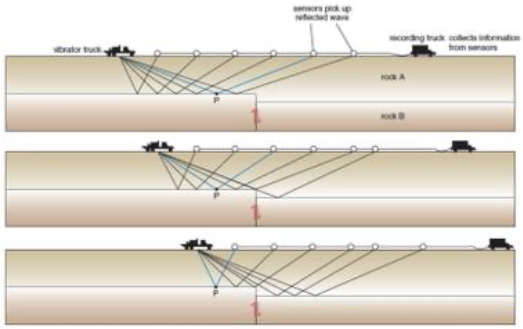
Methods of Exploration

- **Remote Sensing:** a process in which information is gathered about the Earth's surface from above.
  - Photographs of the area are taken from the air.
  - The images are carefully analysed for mineral presence.
  - Aerial photography can cover more ground than a person on the surface.
- **Satellite Signals:**
  - Some satellites send signals to the Earth's surface and collect the reflected signals, indicating the presence of minerals.
  - The unique radiation pattern is processed and analyzed by computers
  - The system works in all weather conditions.
  - The GPS gives the exact location.
  - Large area covered in low-cost
  - Most efficient method

Geochemical Analysis and Field Surveys

- **Geochemical analysis**: analyzing the chemical properties of rocks (by taking samples).
- The samples can be taken from stream sediments, soil or rocks (using shallow drilling).
- The location of the sample points can be accurately found using the Global Positioning System (GPS).

- **Geophysics:** method to identify mineral ores in rocks using their physical properties.
  - A series of vibrations (seismic waves) are sent through the Earth's surface.
  - Several sensors are placed at different distances from the source of vibrations on the surface.
  - The vibrations create shock waves that travel down into the rock layers.
  - They are reflected to the sensors on the surface.
  - The shock waves record different patterns depending on the minerals present in the rock layers.



Methods of Extraction

There are two methods of extraction

- Surface mining
- Sub-surface mining

Surface Mining

- Open-pit mining is used when a valuable deposit is located near the surface.

- The vegetation is cleared, and the topsoil is removed.

- The rocks are broken up and loosened with explosives.
- The loose rock is removed using diggers.
- The rock or mineral is tipped into trucks or railway wagons.
  - Building materials such as sand, gravel, and stone are removed from open pits called quarries.
- Strip mining is used to mine a seam of mineral.
- The overburden (the unwanted overlying rock and soil) is removed as a thin strip.

- It is mainly used to mine coal and lignite

Deep and Shaft Mining

- A vertical shaft is sunk into the rock layer containing minerals.
- A horizontal tunnel is made, following the mineral layer.

- The minerals are extracted by digging (by machines and miners).
- The loose rock is brought from the mine and piled up on waste heaps on the surface.
- The minerals are brought to the surface and transported in trucks or trains
- **Resources:** Gold and Diamonds

Factors that affect the decision to extract rocks and minerals:

- **Geology:**
  - High-grade ores yield more of the required chemical elements than low-grade ores.
  - Small deposits of high-grade ore are worth mining.
  - Small deposits of low-grade ore that cannot be mined at a profit are left as reserves.
- **Accessibility:**
  - Transporting the ore from the mine to processing plants can be difficult and expensive.
  - The cost of building road or rail links to the processing plant or the nearest export port must be considered.
  - Carrying out some processing at the mine reduces transport costs.
  - The mining company must be given a licence before extracting a deposit.
  - A long-term agreement between the government and mining companies must be reached to avoid rapid rises in the tax, which makes mining unprofitable.
- **Environmental Impact Assessment**
  - For the licence application to be approved, the company must have a plan to keep the loss of habitat minimal, followed by the restoration of land and the completion of mining.
  - The choice of site for mine waste should also be considered.
- **Supply and demand:** the relation between how much of a commodity is available and how much is needed or wanted by the consumers.
  - An increase in world demand for any mineral ore will elevate the prices.
  - The profit from a working mine depends on changes in supply and demand.
  - If the demand is too high, mines that were not profitable before becoming worth mining.
  - If the demand falls, working mines may lose due to the transport and extraction expenses.

1.3. Impact of Rock and Mineral Extraction

Environmental Impacts

- **Ecological impacts:**
  - Loss of habitat as the vegetation is cleared ∴ plants do not have a place to grow, so the animals depending on them for food and shelter are affected.

Pollution:

- **Noise pollution:** due to machinery and explosives ∴ disturbs the behaviour of animal species and causes hearing problems for people.
- **Water pollution:** water supplies may also be polluted, making it unsafe for people to drink.
  - The water may become acidic and dissolve toxic metal ions- this combination kills many aquatic organisms.
  - **Bioaccumulation:** organisms absorb and retain the ions in their body, reaching a concentration higher than that in water.
  - **Biomagnification:** the concentrations increase higher up in the food chain and cause the death of top consumers.
- **Land pollution:** The toxic nature of the waste doesn't allow plant growth even years after the mining is stopped.
- **Air pollution:** dust particles settle on the vegetation, not allowing sunlight to reach the leaves and thus reducing the rate of photosynthesis.
  - Breathing in dust that remains in the lungs can cause serious lung diseases.
- **Visual pollution:** the landscape is damaged.

Economic Impacts

- Jobs are created in the extraction and transporting of minerals
- Increase in the Country's economy
- Earn foreign exchange.
- The income earned can be used for buying goods and services and investing in infrastructure projects.
  - Improvements to transport

Social Impacts

- **Positive:**
  - Better standard of life due to economic gain
  - Improvements to services, like healthcare and education
  - Investing in infrastructure projects can help the country in building more well-designed communities.
- **Negative:**
  - It affects the health of the labour workers
  - Affects the health of civilians due to pollution
  - Lack of safety

1.4. Managing the Impact of Rock and Mineral Extraction

Safe Disposal of Mining Waste

- Mine waste must be stored to prevent collapse.
- The mine site must prevent the chances of water pollution.
- The waste must be monitored to detect any movement or further pollution.

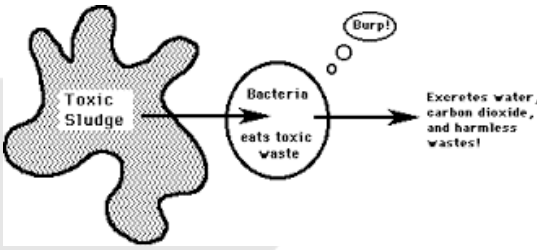
Land Restoration

- **Soil improvement:**
  - After (sanitary) landfilling, mine waste can be covered by a layer of soil that can be enriched with fertilizers.

  - **Landfilling:** the waste is tipped into a hole; from time to time, it is levelled off and compacted.
  - **Sanitary landfilling:** As in landfilling, the waste is used to fill the hole, but alternating layers of waste and sand are used.
- **Tree planting:**
  - After improving soil fertility, plants and trees can be grown in that area, helping an ecosystem to be reborn.

Bioremediation:

- It is a process of removing pollutants from waste using living organisms.
- **In situ treatment:** treatment of contaminated waste where it's left.
- **Ex-situ treatment:** removal of contaminated waste from a site to a treatment plant.
  - Often happens slowly (can be sped up by providing oxygen and nitrogen).



  - Microorganisms, like bacteria, can absorb pollutants and metabolize them into less harmful substances.
  - Some plants can bioaccumulate toxic metals.
  - After these plants grow for a while, the parts of the plants aboveground are removed so the waste in the ground becomes less toxic.

Making Lakes and Natural Reserves

- Several tree and herb species are introduced. This will help maintain the biodiversity
- As their populations grow, they create habitats for many species.
- These nature reserves become valuable green spaces for human recreation and help maintain biodiversity.
- If the rock lining the hole (created by the extraction) is non-toxic and impervious to water, it can be filled with water to form a reservoir or lake.
  - It is used to irrigate farmland or process and provide clean, safe drinking water for humans.

1.5. Sustainable Use of Rocks and Minerals

- **Sustainable resource:** a resource that can be continuously replenished e.g. agriculture, forestry, etc.
- **Sustainable development:** development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.

Strategies for the sustainable use of rocks and minerals:

Increasing the efficiency of the extraction of rocks and minerals:

- Mine wastes must be processed for the second time.
  - This allows the valuable minerals to be recovered and reduces the risk of pollution due to mine waste.
- Chemical treatment of the waste and biological treatment (using microorganisms) still extract much of the valuable minerals within it.
- Improvements in the performance of the machines used in mining and processing.
- Greater use of data analysis by computers (to predict geological conditions).

Increasing the efficiency of the use of rocks and minerals:

- Engineering solutions e.g. design of steel beams with the same strength but using less steel.

The Need to Recycle Rocks and Minerals:

- Recycling uses less energy than processing the ores.
- Recycling also produces less waste and, thus, reduces the risk of pollution.

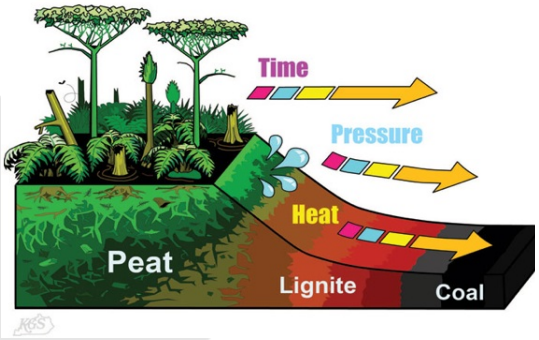
Legislation:

- Governments pass laws that require manufacturers to become responsible for recycling and reusing.

2. Energy and the Environment

2.1. Fossil Fuel Formation

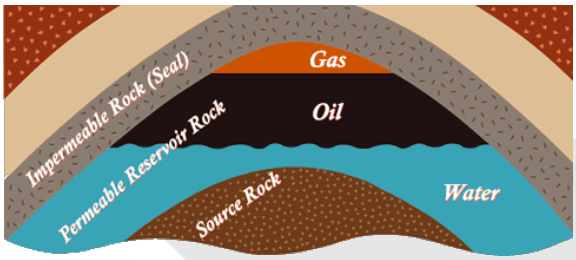
- **Fossil fuels:** carbon-based fuels formed millions of years ago from the decay of living matter.
- **Coal:** formed from plants.
- **Oil and natural gas:** formed from sea creatures.
- **Formation of coal:**
  - Huge forests grew millions of years ago, covering most of the Earth.



  - The vegetation died and formed peat.
  - The peat was compressed between layers of sediments to form lignite (low-grade coal).
  - Further compression formed coal.

Formation of oil and natural gas:

- Small animals and plants die and fall to the bottom of the sea.
- Sediments cover their remains.
- As the sediments start forming layers, they start to change into sandstone as the temperature and pressure increase.



- The heat and pressure turn the remains into crude oil and natural gas.
- They separate and rise through the sandstone, filling in the pores.
- The rock above the oil and gas is **impervious** (non-porous).
- So, they get trapped underneath it.

2.2. Energy Resources and the Generation of Electricity

The demand for energy is increasing worldwide due to:

- Increasing population size.
- Increasing industrialisation and urbanisation.
- Improvements in standards of living and expectations.

Types of Energy Sources:

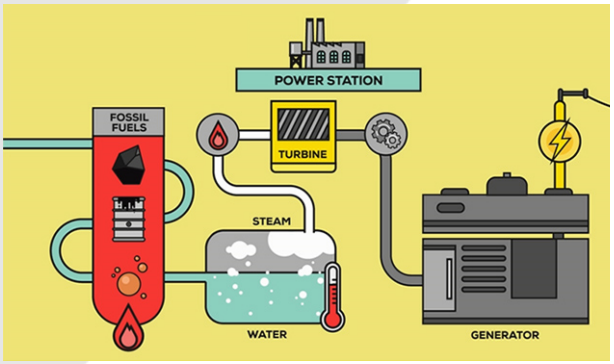
Non-renewable	Renewable
Oil	Geothermal power
Coal	Hydro-electric power
Natural gas	Tidal power
Nuclear power (using uranium)	Wave power
	Wind power
	Solar power
	Biofuels e.g. bioethanol, biogas and wood

- Nuclear fuels last for centuries and are a good replacement for fossil fuels, but the source material (uranium) is limited.
- Biofuels may become limited, but it can be renewed by replacing the cut-down trees with new ones to obtain bioethanol and wood.
  - Biogas can be obtained by recycling waste products.

How energy sources are used to generate electricity:

- **Electromagnetic induction**: a process used for generating electricity that uses the movement of a metal coil and a magnet. Transforms Kinetic energy to electrical energy through a turbine connected to a generator.
- **Turbine**: a machine, often containing fins, that is made to revolve by gas, steam or air (it is connected to a generator).
- **Generator**: a machine that converts mechanical energy into electrical energy.

Fossil fuels and Biofuels:

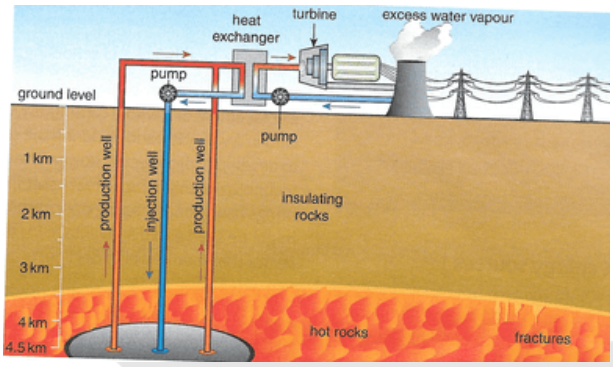


- These produce a massive amount of energy during combustion that is used to heat water and convert it into steam, which thereby drives the turbines.

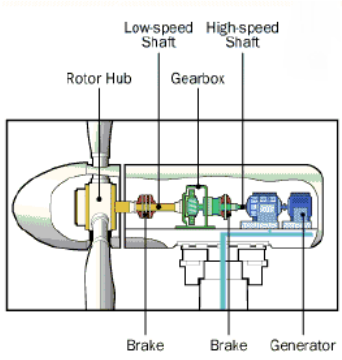
Nuclear power:

- Uranium, a radioactive element, releases huge amounts of energy when nuclear fission (splitting of the atom) occurs.
- This energy is used to heat the water, produce steam, and rotate the turbines.

Geothermal power:



- Cold water is pumped under pressure into a layer of hot rocks.
- The rocks heat the water.
- The hot water returns to the surface under pressure and heats the second supply of water using a heat exchanger.
- The steam produced in the second supply moves the turbine, generating electricity.

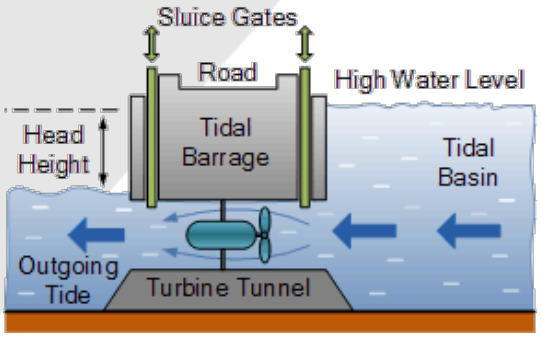


Wind power:

- Wind turbines have shafts (blades) that rotate due to wind.
- Gearbox maximises the rotation of the shaft.
- Brakes slow down or stop the rotor in very windy conditions, preventing damage to the blade.
- As the turbine rotates, the generator produces electricity.

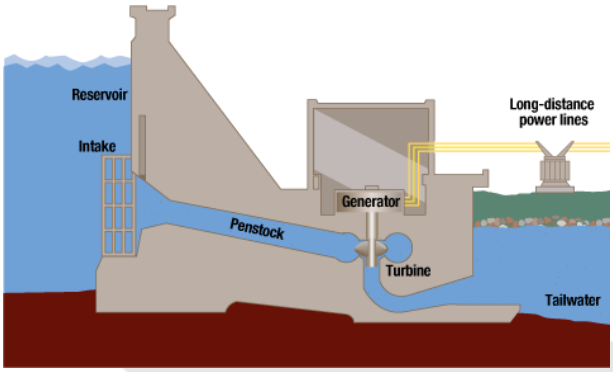
Solar power:

- Uses photovoltaic cells that produce a small electric charge when exposed to light.
- A bank of cells organised into solar panels produce a significant amount of electricity.



Tidal power:

- Uses the natural rise and fall in the level of water in an area.
- When the levels drop, water is held back by a tidal barrage (a small dam that releases water back through a turbine).
- Wave power:
- Also uses turbine and generator.
- Uses the smaller differences in water levels that are caused by wind.



Hydro-electric power:

- Uses a dam on a river to store water in a reservoir.
- Water is released from the reservoir that flows through the turbine, rotating it.
- The turbine then activates a generator that generates electricity.

Using Different Energy Resources

Economic Factors

- Countries use their own fuel supply, as it is cheaper than importing. Depending on their local fuel supply, e.g. Middle East and its Oil, while others take advantage of natural occurring sources e.g. Iceland and geothermal energy.
- The usage of alternative renewable energy depends on the cost of investing in these technologies

Social Factors

- Depending on local areas and the industries they support, the impact of energy sources may differ.
- Areas for mining or oil drilling, make it unsuitable for agriculture, but it with emerging industries more, more jobs are created.
- The development of new technologies might affect existing workers in sectors that start to decline.
- Development of new technology may affect the political relationships and trading patterns between two nations, e.g. less dependency on oil supplying trade partner.

Environmental Factors

- **Pollution** from oil spills or burning of fuels, harms wildlife and the atmosphere.
- **Changes to the ecosystems** through installation of renewable sources or extraction procedures, can destroy/alter habitats and life structures for ecosystems.
- **Visual impact** of changes to natural landscapes

3. |

| |
Fuel Type
|
Advantages
|
Disadvantages
| | | |
Fossil fuels (oil, coal, natural gas)
|

- Provides job opportunities (mining and processing)
- The technology used is well-known and the methods of extraction are well-practised.

|

- Carbon dioxide and toxic gases are released when burnt contributes to global warming
- Damages local area
- Limited supply (non-renewable). Causes prices to rise if supply decreases

| | | |
Nuclear power (using uranium)
|

- Does not produce carbon dioxide (impact on climate change)
- Small amount of fuel produces large amounts of energy
- Power plants employ lots of people

|

- Risk of radiation leakage (impact on human health and environment)
- Waste products cannot be recycled as radiation active for centuries
- Limited supply

| | | |
Biofuels (bioethanol, biogas, wood)
|

- A renewable source: bioethanol and wood are both obtained from growing plants, biogas from the recycling of waste products
- Growing more plants uses carbon dioxide
- Potentially a plentiful supply

|

- Carbon dioxide and other toxic gases produced when burnt
- A lot of land is needed to grow crops for fuel
- Potential removal of natural ecosystems to grow fuel crops

|| ||
Geothermal power
|

- Does not produce carbon dioxide
- Unlimited supply as uses the heat from the Earth as the power source

|

- Can be expensive to install
- Only certain areas have suitable conditions

|| ||
Hydroelectric power
|

- Does not produce carbon dioxide
- Water can be reused for other purposes

|

- Building of dams impacts the natural flow of water
- Villages and ecosystems may be destroyed when dams and reservoirs are built

|| ||
Tidal power
|

- Does not produce carbon dioxide
- Tidal movements not dependent on weather conditions

|

- Limited to specific coastal areas
- Impacts on the tourist industry and local fishers

|| ||
Wave power
|

- Does not produce carbon dioxide
- A renewable source of power

|

- Limited to specific areas
- Currently not very efficient, so large amounts of resources needed

|| ||
Solar power
|

- Does not produce carbon dioxide
- Sunlight is not a limited resource

|

- Only efficient under certain weather conditions
- Generation only occurs in daylight hours
- Visual impact and potential damage to local ecosystems

|| ||
Wind power
|

- Does not produce carbon dioxide
- Uses a renewable resource

|

- Not all locations are suitable
- Generation only occurs in certain conditions (at certain wind speeds)
- Visual impact
- Uses a large area

|| |#

3.1. Energy Demand

Domestic demand:

- Created by affordability, availability and social status.
- Most of the purchases that are considered as necessities now increase the demand for energy supplies, notably electricity.
- **Example:**
  - Fruits and vegetables, that aren't naturally available in the season locally, are produced in glasshouse or in areas with a favourable climate and are then transported.
  - In both the scenarios (glasshouse operation and transport), the energy cost is significant.

Industrial demand:

- Manufacturing requires the use of large amounts of energy throughout the production e.g. iron and steel production.
- Advanced manufacturing techniques made the products, that were once luxury items, cheaper.
  - So, more people want to buy them.
  - The demand for the product increases.
  - The demand for energy (needed for production) also increases.

Transport:

- Manufacturers supply customers across the globe.
- This decreases production costs in countries that import, but increases the transport costs as they require large amounts of fossil fuels to operate.

Personal and national wealth:

- **If economic conditions are good:**
  - Higher employment;
  - More money to spend on luxury items;
  - Increase in demand for the product;
  - Increase in demand for energy (for production).
- **If economic conditions are poor:**
  - Families have less money to spend on luxury items;
  - Need to make savings;
  - Reduce the use of fuel;
  - Reduce the purchase and use of electrical items;
  - Decrease in the demand for energy.
- **Decline in the economy of one country can have a global impact.**
- **Reduction in the economy of China meant a worldwide:**
  - Reduction in production of steel.
  - Decrease in the amount of manufactured goods (transported by ships).
  - Decrease in the price of oil (energy source).

Climate:

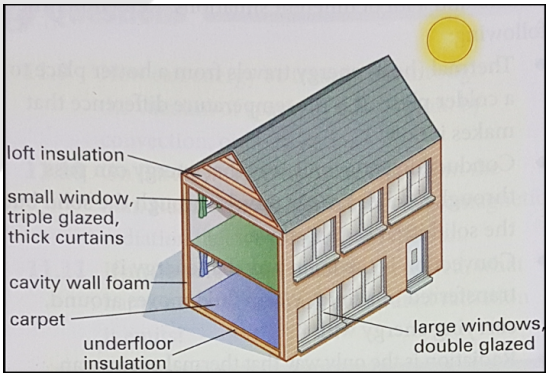
- The demand for energy with regard to climate depends on the country.
- People living in a temperate climate are likely to experience colder winters, so the energy demand for heating would be far higher.
  - They also experience fewer hours of daylight.
  - This increases the usage of electrical lighting.
- Climate change (excessive heat or cold) increased the energy consumption (particularly in urban areas).
  - Need for additional heating.
  - Installation and operation of air-conditioning units.

3.2. 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.



- **Insulation:** constructing using material with good insulation properties prevents loss of heat.
- **Loft insulation:** adding an insulation layer into the roof space.
- **Underfloor insulation:** adding an insulation layer on the floor e.g. carpet.
- **Cavity wall insulation:** a gap between inside and outside walls is filled with an insulating material, causing the heat to pass through more slowly.
- **Double glazing:** two panes of glass with a gap in the middle to act as an insulator.
- This sealed gap is usually filled with air or an inert gas e.g. argon.
- Triple glazing can also be used, but it is too expensive.
- Electrical devices must be turned off when not in use.
- Devices can be left in 'standby' mode and can be accessed rapidly.
- More energy-efficient devices must be bought.
- Developing alternative fuels for vehicles and further development in engine technology.
- **'Scrappage' schemes:** remove inefficient machines from use (electrical appliances or vehicles).

Energy from waste:

- Reusing existing materials to extract energy from them before they are disposed.
- **Anaerobic digestion:** breaking down of organic matter (waste food and vegetation) using bacteria.
- This process takes place in a sealed container and releases methane (a flammable gas) that can be used for heating purposes.
- The composted waste can be used as organic matter to improve soil structure.
- Household rubbish can be incinerated (burnt) to produce heat, that can be used to generate electricity;

Advantages	Disadvantages
Waste from burning (ash) is small in volume. Thus, it doesn't take up much space.	Produces poisonous gases during combustion.

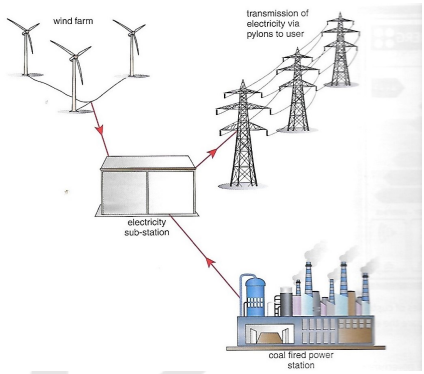
- Vegetable oils, once used, should be disposed;
- These oils can be collected and recycled into biofuels suitable for running vehicles;
- It can be used exclusively or as an additive.

Education:

- Benefits of the technology must be communicated to others;
- Promote new ways of thinking;
- The message must be that significant savings in energy bills can be made over the longer term, reducing energy use;
- Energy-efficiency ratings must be provided for new products to compare with the old ones.
- **Laws passed by the government to make changes rapidly:**
- **Stricter building regulations:** new constructions must be more energy efficient.
- Preventing the sales of inefficient types of electrical devices.
- **Incentives to encourage the purchase of more efficient technologies:**
- Insulating older houses that are energy efficient;
- Replacing older, inefficient electrical devices;
- Scrapping older, inefficient cars, that emit more pollutants.

Exploiting existing energy resources:

- The type of energy source used depends on social, environmental and economic factors.
- The current solution is to use a renewable resource as a primary energy source when possible and have a fossil-fuel (or biofuel) powered station available as a backup when weather conditions are not suitable.



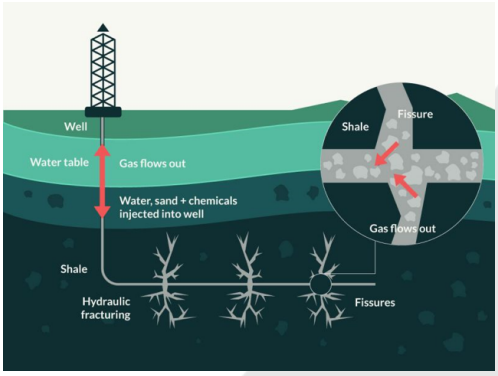
- This is a reliable source for industry and households and reduces the amount of fossil fuels used.

Transport policies:

- Regulations regarding the quality of exhaust gases from vehicles;
- Check on the fuel efficiency;
- Restrictions on where vehicles may go;
- Taxation on fuels;
- Surcharges for travelling to certain places at peak times;
- Improving public transport so it is easier and cheaper than using cars;
- Improving routes for cyclists and pedestrians;
- Encouraging car-sharing;
- Restricting when cars can be used e.g. odd even rule in Delhi;
- Providing incentives to buy more fuel-efficient vehicles and for vehicles using cleaner technology.

Development of new resources:

- **Fracking:** obtaining oil or gas from shale rock by splitting them open using water, sand and chemicals.
- A vertical hole (2-3 km deep) is drilled to reach the fuel-rich rocks (shale rocks).



- A specialized perforating gun is lowered through the hole and fired, to create small inch long fractures.
- Water, sand and chemicals are pumped down into the shale rock layer.
- This causes the rock to fracture, releasing oil and natural gas, which are forced back to the surface and collected.
- **Purpose of the three components:**
  - **Water:** easy to handle (in high pressure).
  - **Chemicals:** stop the blockage of pipes.
  - **Sand:** keeps the cracks in the rock open.

4. |

||
Advantages
|
Disadvantages
|| ||
Access to more oil and gas
|
Risk of toxins entering the water table
|| ||
Less pollution than burning coal
|
Chemicals are toxic and may affect local residents
|| ||
Reduces the need for imports
|
Uses a lot of water; may cause water scarcity
|| ||
Provide many jobs locally
|
Noise pollution, Natural areas damaged and may cause additional earth tremors
|| |#

4.1. Impact of Oil Pollution

Main causes of marine oil spills:

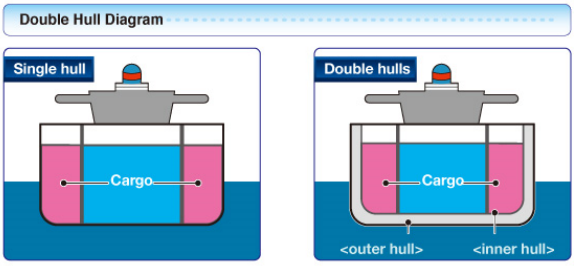
- **Offshore oil extraction:** leakage from the rigs.
- **Oil pipelines:** leaks in the oil pipework.
- **Shipping:** risk of collision or damage to oil tankers.
- **Effects of an oil spill:**

Organism or habitat	Impact of oil
Phytoplankton	Oil floats on the surface of the water and blocks the sunlight from entering. The phytoplankton can't photosynthesise, so they die.
Fish	Shortage of food; reduction in phytoplankton.
	Oil floating on the surface prevents gas exchange. Fish become short of oxygen and die; Direct contact of the fish with oil affects their gills.
Birds	Shortage of food as fish and other creatures die;
	May consume oil when eating fish (toxic);
	When hunting for food, feathers get covered with oil, affecting their ability to fly.
Mammals	Food sources are depleted;
	Mammals may also swallow oil while feeding (toxic);
	The coating of oil will affect their skin.
Reefs	Complete devastation of the reef due to lack of oxygen (species die);
	Areas may be covered in oil.
Beaches	Oil (washed by tides) coats rocks;
	Organisms in shallow water and rock pools may die due to toxic effects of the oil;
	Animal food sources and tourism are affected.

4.2. Management of Oil Pollution

Reducing oil spills in marine environments:

- **MARPOL (Marine Pollution):** International Convention for the Prevention of Pollution from Ships.
- **Regulations of the MARPOL:**
  - Supervise the transport of oil at sea;
  - All tankers must be certificated to show they have appropriate systems in use;
  - Else, it can result in a heavy fine or the ship may not be permitted to leave port.
- **Tanker design:**
  - Oil spill can be caused by damage to the hull (a hole in the hull of the boat causes its contents to leak).
  - **Increase in the number of compartments within the hull of the ship:** if one of the compartment's damaged, the contents of the whole ship aren't lost.
  - **Double-hulled tankers:** if the outer layer's damaged, the contents are still secure by the inner plate.
  - Though double-hulled tankers cost more than single-hulled, the risks of oil spill are far less.



Minimising the impact of oil spills:

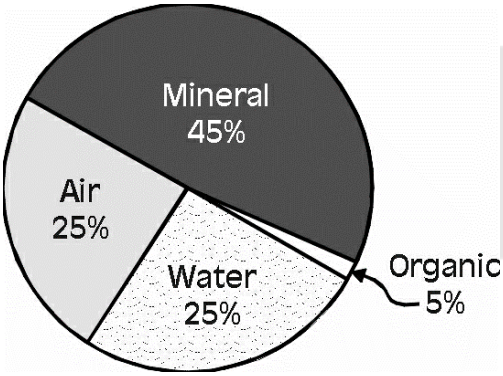
- **Floating booms:** a floating barrier is used to surround the oil slick, preventing it from spreading.
- This process works well when the spill covers a relatively small area and the sea is calm.
- Detergent sprays: detergents help break down the oil slick into smaller droplets, that eventually degrade, and disperse it.
- They are effective on smaller spills, but cause damage to the coral reefs themselves as they're not tolerant to detergents.
- **Skimmers:** clean the water using a material that oil easily attaches to.

- The skimmer drags oil off the seawater surface, that is then scrapped off into a container.
- This system is used when oil slick is contained within a boom and the sea is calm.
- When the oil reaches beaches, it can only be removed by hand (difficult and time-consuming).

5. Agriculture and the Environment

5.1. Soil Composition

- **Mineral particles**: combination of rock fragments and other inorganic substances.
- They are formed due to physical, chemical and biological weathering of the parent rock.
- **Organic content**: mixture of living plants, animals, microorganisms and their dead remains.
- **Air**: held within the pore spaces (between the mineral particles and organic content).
- Air enters the soil by diffusion.



- **Water**: held within the pore spaces (water that is available for plant growth).
- Water enters the soil when there's precipitation or when the soil is irrigated.
- **The proportion of these components depends on:**
- Type of soil;
- Way it has been managed;
- Local climatic conditions;
- Size of the mineral particles.

Soil can be classified into three groups:

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 and Hard when dried

5.2. Soils for Plant Growth

- Soil is the cheapest and most abundant medium in which water, mineral nutrients, anchorage and oxygen can be supplied to a plant.
- Plants require a supply of nitrogen, phosphorus, potassium and a range of other mineral nutrients to construct proteins and carry out life processes.

Element	Supplied as
Nitrogen	Nitrate ions (NO_3^-)
Phosphorus	Phosphate ions (PO_4^{3-})
Potassium	Potassium ions (K^+)

- **Organic content:** decomposers that produce humus (rich in nutrients):
- **Earthworms**: break down vegetation; mix the soil; aerate the soil; spread organic matter through the soil.
- **Fungi**: feed directly on dead matter; digest hard woody items; aid plants to take up nutrients through their roots.
- **Bacteria**: work on organic matter; convert waste products to simple chemicals; some convert nitrogen to nitrates ˢ important in nitrogen cycle.
- **High levels of organic matter:**
  - Increase the water-holding capacity (like a sponge);
  - Increase air spaces in the soil;
  - Increase no. of decomposers, tunnels and burrows in the soil, providing additional drainage and less compaction;
  - Prevent the loss of mineral nutrients (humus holds on to mineral nutrients).
- **Soil pH:**
  - Depends on the type of parent rock and pH of water that flows into the area;
  - Affects the uptake of nutrients by plant roots;
  - Affects the availability of nutrients;
  - Farmers can try changing the pH of the soil either to acidify it (using fertilisers that have an acidic effect) or make it alkaline (adding ground limestone).

Sandy Soils	Clay Soils
Larger air spaces	Poor air spaces
low water-holding capacity	High water-holding capacity
Drains well	Poor drainage
Poor retention of humus	Retains humus
Easier to cultivate	Hard to cultivate
Quick to warm up	Slow to warm up
High risk of erosion (particles dont stick to each other well)	Retains nutrients well

- **Drainage**: capacity of the soil to drain water, depends on how far/close the particles are to each other.
- **Ease of cultivation**: how easily the soil can be ploughed, depends on how sticky the particles are to each other.
- **Water-holding capacity**: water clings to surface to particles, more particles, the more surface area, the more capacity to hold water.

5.3. Agriculture Types

- **Agriculture**: the cultivation of animals, plants and fungi for food and other products used to sustain human life.
- The type of agriculture used in different countries differs due to factors such as:
  - Climate
  - Culture
  - Technology
  - Economics

Subsistence vs Commercial farming

Subsistence	Commercial
Cultivation of food to meet the needs of the farmers and their families;	Cultivation of food with the main aim of selling them for cash;
Little surplus, may be bartered for other goods (or cash).	Some food may be used by the farmers.
Aim to grow everything they need	Main aim is to make money, uses technology to increase yield and reduce costs.
Examples: wheat and rice.	**Examples:** tea, coffee, cocoa, sugarcane, cotton, rice, wheat and corn.

While it's possible to obtain money from both farming ways, the proportion of food that is used for each purpose that is important.

Arable vs Pastoral farming

Arable	Pastoral
Production of plants for consumption by humans.	Production of animals or animal-related products.Also known as livestock farming or grazing
Scale of production varies due to Subsistence Arable or Commerical Arable farming	Plants/grains may be grown, but for the purpose of feeding animals.
Examples: rice, wheat, maize and soybeans.	Examples: grass/grain (to feed the animals), milk, wool and eggs.

Mixed farming:

- Farming that practises both rearing livestock and growing crops.

Extensive versus intensive

- **Extensive production**: when there is a relatively small amount of production (either crops or animals) from a large area of land.
- **Intensive production:** when large amounts are produced from small areas of land. The inputs, e.g. labour, fertilisers or machinery, are usually high in quantity.

5.4. Increasing Agricultural Yields

- Increase in the populations of people, increases the pressure on food production by:
  - The need for more resources for growing populations
  - Climate change effecting fertile land availability
  - Decrease in available farming land due to the increase in settlement building.
  - Availability of water reduced for irrigation because of growing population.

Techniques for improving crop yield

Crop rotation:

- the principle of growing different types of plants in different plots each year.
- Growing the same kind of plants in the same plot, may cause:
  - Build up in diseases, effects future plant growth
  - Increase in pest
  - Depletion of soil nutrients, as the plants use up the same ratio of nutrients each year.
- **Advantages of crop rotation:**
  - Diseases in the soil affecting the plant are left behind;
  - Pests need to find a new site, their population is reduced;
  - The soil in the new plot is likely to have the essential nutrients;
  - Crops ready to harvest at different times, less potential waste, less labour and machinery needed.
- Examples of simple crop rotation:
  - **Legumes**: plants in the pea and bean family, that contain nitrogen-fixing bacteria in their roots to produce a source of nitrates.
  - **Leafy crops**: vegetables that are required for their leaves, requires a lot of nitrogen fertilizer (left in the soil by legume roots). Planted after legumes,
  - **Root crops**: have deep root systems. Helps break up soil, because of soil cultivation. Legumes can be planted afterwards, as it needs well cultivated soils.
  - **Fallow**: the land is ploughed but left barren for a period to restore soil fertility and to avoid surplus production.

Fertilisers:

- Contain minerals such as nitrogen, potassium and phosphorus. All essential for plant growth
- When used correctly, adds to the nutrients in the soil, which increases crops.
- When used incorrectly, causes environmental damage, as they get washed into rivers and lakes by rainfall.

Ranges of fertilisers are classified into 2 groups:

- **Organic:**
  - Derived from natural sources
  - Examples: animal manure, composted plant materials, bone meal (ground-up animal bones), hoof and horn (these parts of the animal ground up) or dried blood.
  - Manure and compost are quite bulky, but they make **good soil improvers**, **increasing water-holding capacity** of sandy soils and **increasing air spaces** in compacted, clay soils.
- **Inorganic**
  - Manufactured in a factory
  - Typically more uniformed from batch to batch, **formulated** to provide precise amounts of each nutrient.
  - **Cleaner and less unpleasant** to handle than compost and manure, less bulky so **storage and transport easier**.
- **Quick acting fertilisers**: fast acting, deficiency problems are dealt with swiftly, but can easily leach out in heavy rain.
- **Slow acting fertilisers**: Long lasting, no need to reapply, but Little immediate impact if plants may already have a deficiency problem
- Farmers use different fertilisers for different needs of plants, and the soil conditions.

Irrigation:

- the method of supplying water to the crops.
- Large percentage of a plant is made up of water, it is essential for cell activity and photosynthesis.
- Mineral nutrient uptake requires water in the soil, hence the water must be free from pollution and low in salt, or else it may damage crop plants.

Common water application methods:

- **Overhead Sprinklers**

Advantages	Disadvantages
Easy to set up	Large droplets may cap the soil
Can cover a large area from one sprinkler	Small droplets may be blown away by wind
No need to attach pipes to each plant	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.

Control of competing organisms

- Growth of a crop can also be reduced by attacks from other organisms that can feed on it, weaken it and in extreme cases kill it.
- **Weed**: a plant growing in an inappropriate place
- **They must be controlled because they:**
  - Compete with crops for light, water and nutrients;
  - Reduce the quality of a seed or grain crop;
  - Might be poisonous;
  - Make cultivation difficult;
  - Can block drainage systems with excessive growth;
  - Can be a source of pests and diseases;
  - Can look untidy (impact on tourism areas).
- **Weed control**: weed-killing chemicals are known as **herbicides**.
- **Advantages of herbicides**:
  - Easier to manage
  - Alternatives may be less effective
  - Cheaper
  - Results are more predictable
  - Less labour needed
  - Effect is more rapid
- **Alternatives to herbicides are cultural controls:**
  - **Cultural controls**: hand weeding and hoeing are useful methods for removing individual weeds but require a lot of labour.
  - **Weed barriers**: using black plastic sheeting over the ground or a deep layer of composted organic matter (mulches) helps smother weeds. Mulches **prevents growth of weeds**, but also prevents evaporation of water from soil, leads to **waterlogged soils**.
  - **Flame guns**: paraffin (kerosene) is a highly flammable liquid that can be used in a flame gun to **scorch off the tops of weeds and kill weed seeds** at the soil surface, but it has **risks**.

Controlling pests and diseases

- **Pest**: an animal that attacks or feeds upon a crop plant.
- **Pesticide**: used to control pests.
- **Insect control**: insect-controlling chemicals are called **insecticides**.
- **Crop disease** is caused by fungi, bacteria or viruses (pathogens)**.** The most common are fungal diseases and are controlled by **fungicides**
- **Biological Control:** alternative to insect control, through finding natural predators, that feed on pests and thus control the infestation.

ADVANTAGES	DISADVANTAGES
No chemical residues	Not as instant as chemical control
No impact of sprays	Pests may breed faster than the predator
No need of reapplication	Predator may feed on an unintended plant
The predators will die naturally when the pests are controlled	

Mechanisation:

- Larger area can be cultivated
- Reduces labour cost
- Ploughing can be done even when soil is heavy
- Additional attachments can be done to apply fertilisers and pesticides
- Tractors can carry heavy loads, useful at harvest times.
- Large fields are needed for large machinery, which changes the landscape by the removal of natural vegetation to smooth the operation.

Selective breeding:

- The traditional method used for improving the performance of crops and livestock.
- The process of selective breeding:
  - Choose parents that exhibit the desired characteristics of the species
  - Raise the offspring from these parents
  - Select the best offspring that shows the desired characteristics
  - Repeat the process.
- **Examples:** beef cattle, dairy cattle, wheat and rice.
- **Drawbacks:** slow process; less success rate.

Genetically Modified Organisms (GMO):

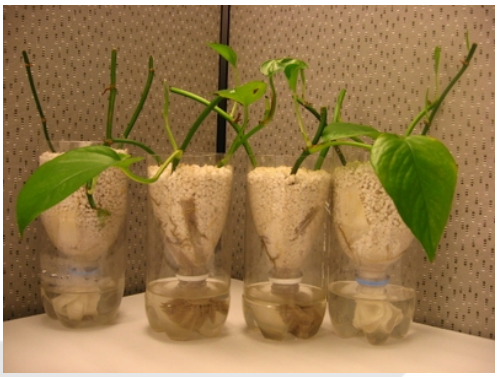
- **Gene**: a sequence of DNA that is responsible for a characteristic of a living organism.
- **Genetically modified organism (GMO)**: an organism whose genetic material has been altered by genetic engineering.
- Different reasons for genetically modifying plant species:
  - Disease and pest-resistance: genes can be cut from a resistant plant and added to a crop plan.
  - Nutritional value: plants can be developed that are more nourishing.
  - Crops can be grown in inhospitable areas
  - Herbicide resistance
  - Crops with longer storage lives, less food wastage.
- Concerns about the development of GMOs:
  - Unknown impact of the new characteristics on human health
  - Products are not natural
  - Genes might get into wild plants if they interbreed with GMOs, reducing biodiversity
  - Reduction in the gene pool
  - issues for other insects caused by insect-resistant varieties

Controlling the crop environments:

- **Greenhouse:** a building made of glass or similar transparent material that is used to manage the environment for plant growth.
- Helps control environments for specific plants, that may need special growth factors to be able to grow.

Growth factor	How to increase	How to Decrease
temperature	Operate heating system (e.g. insulation).	Open roof ventilators.
Light	Supplementary lighting.	Shading material in the roof.
Humidity	Misting units.	Open roof ventilators.
Day length	Supplementary lighting.	Shading material and curtains.
Water	Sprinkler or irrigation.	Drainage material underneath.

- Investment in additional equipment for a greenhouse system is expensive and require a lot of additional labour, only cost-effective for an expensive crop.
- Most modern greenhouses employee sensors to monitor the environmental conditions, when linked with a computer it is able to operate the equipment automatically.
- **Hydroponics:** growing plants without soil, with the nutrients the plant needs, dissolved in water; this technique is often used in conjunction with a growing blueprint.



- **Growing blueprint:** the growing requirements of a crop throughout its life, which a grower can use to maximise the yield.
- The most common method is to float plants on polystyrene rafts on a reservoir of moving water.
- Sensors measure the amount of key minerals nutrients, and add more as needed.
- Air is bubbled through to ensure roots have enough oxygen to respire.

6. |

||
Advantages of hydroponics
|
Disadvantages of hydroponics
|| ||
No need for soil.
|
Expensive to set up

|| ||
Portable, can be set up anywhere.
|
Restricted to small prodcution scales
|| ||
Intensive system that can provide high yield
|
Techincal knowledge requirments
|| ||
Easy to harvest
|
disease, if present, spreads rapidly through the water
|| ||
Exact nutrients are given to plants in the irrigation water
|
Conditions need to be maintained at optimum levels, or else plants die quickly
|| ||
No weeds or pests and diseases in the 'soil'
|
|| ||
Pollutants are not released into the environment
|
|| |#

6.1. Impact of Agriculture

Overuse of herbicides and insecticides:

- Regular use of one insecticide can cause resistance within the pest population.
- **Solution**: use a range of different pesticides.
- **Unintended environmental damage**: beneficial insects like bees are also affected, and food web is disturbed.
- **Spray drift**: herbicides stay longer in the soil and may affect the next crop.
- Heavy rainfall can cause leaching of the chemicals into nearby lakes.

Overuse of fertilisers:

- Addition of extra mineral nutrients is waste of money and resources if the soil has reached its maximum level.
- Heavy rain can dissolve the nutrients and cause **leaching**, the loss or extraction of certain materials from a carrier into a liquid.
- Excess water containing dissolved fertilisers drain into nearby lakes and rivers, leading to eutrophication.
- **Eutrophication**: a sequence of events starting with enrichment of water by mineral nutrients or organic matter that leads to a reduction in oxygen levels in the water and the death of fish and other animals.
- Nitrates from fertilisers if consumed can cause diseases such as blue-baby syndrome
- Large quantities can affect the pH of the soil and in turn, the availability of minerals.
- Too much of trace elements can be toxic to the plant.
- Too much fertiliser dehydrates the plant (scorching).
- Imbalance of nutrient makes the plant produce lots of foliage, but no flower.
- **Solution**: strict limits on where, when and how the fertilisers must be applied; can replace with organic fertilisers.

Mismanagement of irrigation causing salinization and water logging:

- Damage to soil structure, air pockets are lost, when wet and soil becomes compacted.
- Death of plant roots as waterlogged soils prevent plant roots from getting enough oxygen to respire and cells start to die.
- Loss of nutrients as they are dissolved and washed away with water.
- High levels of run off, **soil erosion**.
- **Soil capping**: surface of the soil becomes hard.
- **Salinization**: salt content of the soil can increase. Over irrigation causes soil to be waterlogged, allowing salts from below the soil to rise above, and once soil dries up, salt content is left behind.
  - High salt content, make it hard for plants to take up water (by osmosis), it also makes water supply undrinkable.
  - **Osmosis**: the process by which mineral molecules pass through a semi-permeable membrane from a weaker solution to a more concentrated solution to make the concentration of the mineral the same on both sides of the membrane
- **Prevents soil cultivatio**n as it's difficult to cultivate soil with a high-water content. Soil structure cannot hold machines' weight, causing it to get stuck.

Overproduction and waste:

- **Waste from overproduction**: the unsold proportion of the crop.
- **Waste of storage space**: may take longer to sell a crop, storage may be needed, and some crops need special conditions.
- **Waste of transportation**: to sell a crop, a farmer may need to travel longer distances.
- **Waste of quality products**: low quality means less demand.
- **Waste of labour**: not an efficient use of time and labour if too much is produced.

Exhaustion of mineral ion content:

- The farmers use the soil over and over again with little to no rest which leaves the soil depleted of nutrients and minerals.
- **Solution:** crop rotation, mixed cropping and leaving the land fallow.

Soil erosion:

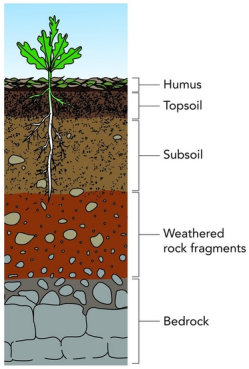
- **Overcultivation:** soils that are cultivated regularly lose soil structure and are more vulnerable to erosion as they break down to smaller particles.

Cash crops replacing food crops:

- Most commercial farmers prefer to grow crops that generate more cash. This causes a decline in the staple food available.

6.2. Causes and Impacts of Soil Erosion

- The topsoil's structure, holds water and supports airspace, makes it a perfect layer for root growth. The loss of this layer, can affect the fertility of the soils



Causes of soil erosion:

- **Removal of natural vegetation**: no more roots to bind the soil together or slow down the torrents of water, so flash flooding and rainwater run-off pick the soil and carry it away.
- **Overcultivation:** Ploughing breaks the soil into smaller and lighter particles. These are more easily carried away by wind.
- **Overgrazing:** Livestock reduces the vegetation to nearly ground level, sometimes leaving no roots to hold the soil.
  - Animals trample down the plants and their hoofs compact the ground.
- **Wind erosion:** Deforestation (due to the need for space, excessive grazing, increase in the development of arable crops) increases the chance of soil getting eroded by wind.
- **Water erosion:**
  - **Heavy rain fall**, dislodges soil particles, loosening them to be eroded in other ways.
  - **Rainwater run-off**, excess water that cant be absorbed by soil, carries it away to another area.
  - **Gully erosion**: gullies and streams contain a volume of water moving at speed that erodes the local soil even further, forming deeper and deeper crevices.

Impacts of soil erosion:

- **Topsoil is removed:** the most productive layer is absent (subsoil lacks nutrients and air spaces).
- **Organisms living in the topsoil lose their habitat:** impact on the entire ecosystem.
- **Silting up of watercourses:** Flooding occurs as water bodies can't hold excess water (space taken up by silt).
- **Silt deposits can form lagoons:** providing breeding grounds for mosquitoes.
  - Silt affects the quality and availability of water for drinking.
- **Aquatic organisms are buried under the silty layer**: preventing light from reaching the underwater plants (low oxygen levels in the ecosystem no photosynthesis).
- **Desertification:** the process by which fertile land becomes desert.
  - Severe droughts lead to migration of the whole community.
  - Risk of famine and malnutrition, due to fewer food sources.

6.3. Managing Soil Erosion

Terracing

- **Terracing:** the artificial development of flat areas (for growing crops) in a sloping terrain.

- **In a natural slope**, water runs down, increasing in speed and volume, carrying soil in the run-off.
- **In a terraced slope**, water is held in the flat terraced areas, causing less risk of run-off and more chance of infiltration.
- Very labour-intensive, the long term effect, reduces the water erosion of soil, instead of running off, it will infiltrate (soak into) the soil.
- Crops like rice benefit from standing water, the pools of water and used to grow plants in.

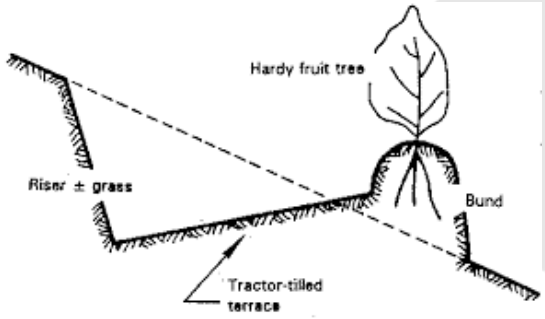
Contour ploughing

- **Contour ploughing:** a technique where the furrows caused by ploughing follow the contours of the land.

- Ridges and troughs (furrows) run along the contour. Each furrow holds water and prevents large torrents of water from running down the slope, preventing the formation of run-off soil.
- Useful for when seeds start to emerge, to protect the root system from erosion, until it is able to bind well with the soil.

Bunds

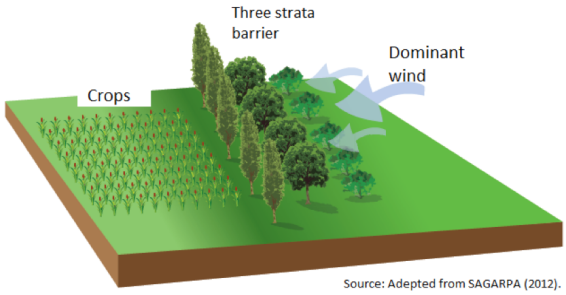
- **Bund**: an embankment constructed around the edge of an area to reduce the loss of a liquid (such as water).



- Useful for crops that require moist soils, e.g. rice.
- The water is retained on the terrace.
- Increases the quantity and fertility of the soil.

Windbreaks

- **Windbreaks**: a permeable barrier, made of either living vegetation or artificial material, used to reduce the impact of the wind on an area.



- Windbreaks helps prevent wind erosion.
- **Solid structures**, like walls, force the wind into smaller spaces, increasing wind speed and causing eddy currents.
- **Permeable structures**, like vegetation, allow wind to pass through, decreasing its speed and, thus, the amount of wind erosion.
- **Advantages**: additional habitats for beneficial insects; roots of the windbreak prevent erosion (run-off).

Maintaining vegetation cover:

- Cultivated soil is most prone to erosion, as there is no vegetation to hold it together. To reduce the risk, farmers usually maintain a vegetative cover on the land for as long as possible
- In some cases it may mean planting an additional cover crop, for example sowing legumes immediately after a crop has been harvested, prevents soil erosion.
- It also provides more nitrogen to the soil, increasing its fertility for the next major crop. When cultivating, the legumes can be ploughed.
- Other methods include the **"no dig" method**, where existing vegetation is left until the moment a new crop is ready to be sown, but rather than cultivate the soil the farmer applies a herbicide to kill off existing weeds.
  - This method is not without risk, as residue of the herbicide can build up and affect crop.

Addition of organic matter to improve soil structure:

- Soil can be replenished by adding of more compost/manure, to reduce the risk of it being uncovered, especially if it has been **broken into small particles** and is **lightweight**.
- Effects of additional organic matter:
  - It provides additional air gaps in heavy soil
  - Increases the number of soil organisms in the soil (because they are feeding on the organic matter)
  - Adds nutrients to the soil, increasing the fertility
  - Regarding soil erosion, improves the general soil structure.
- It acts like a sponge, holding the extra water and preventing soil dehydration and erosion of soil particles.
- Reduces soil erosion as the organic matter acts like a base for smaller particles.

A multi-layered approach to cropping

Tree planting:

- A row of trees acts as a windbreak;
- Tree canopy can provide shade for smaller plants that don't thrive in direct sunlight;
- Provide a natural habitat for animals that feed on pests;
- Tree leaves fall to the ground and add to the organic matter.

Mixed cropping

- Growing more than one type of plant in the same area.

Mixed Cropping

- Resources in the soil, like nutrients, are used more efficiently.
- **Intercropping:** the technique of growing other crops between the rows of a main crop, maximising the use of nutrients and water
- **Crop rotation:** (refer to section 3.4 Increasing agricultural yields; Crop Rotation).

6.4. 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 following natural processes with farming techniques
- Sustaining the economic independence of farmers

Organic fertilisers:

- Nutrients released slowly, reduces the risk of eutrophication.
- Waste products, using them saves on disposal costs
- Already present on many farms, hence minimal transport costs
- Do not require energy for their manufacture
- Improve soil structure

Managed grazing:

- A managed grazing approach looks at the stocking density in an area and evaluates an appropriate timescale for allowing the animals to graze before moving them on to another area.
- Prevention of overgrazing and reducing the ability of grazed plants to regrow
- Ensure sufficient grazing by preventing scrubland plants from establishing because they are eaten as young seedlings
- Maintaining appropriate soil fertility by animal waste
- Maintaining good drainage prevents compaction of the soil.

Crop Rotation: (refer to section 3.4 Increasing agricultural yields; Crop rotation).

Choice of varieties

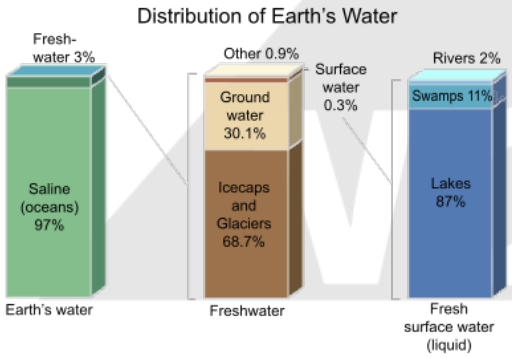
- Plant breeding as let to advancement in quality of crops, in yield and in reliability. These new varieties are able to withstand situations better than older crops.
- The choice of crop varieties now available offers farmers:
  - Reduced pesticide use, due to pest resistant varieties
  - Reduced water usage for irrigation, due to drought resistance.
  - Ability to combat certain plant diseases
  - Reduced herbicide use, due to herbicide resistance.
  - Shorter cropping cycles, more crops per year.
  - Extended harvest seasons, providing extended ranges of food varieties.

Irrigation

- **Trickle Drip Irrigation:** delivering water to the base of plants using small pipes. Provides following sustainable benefits:
  - Minimising water usage
  - Targeted water delivery to plants
  - Precise amounts of water supplied to plants
  - Reduced labour due to automations
  - Reduced risk of salinisation of the water
- **Rainwater Harvesting:** the collection of rainwater, for example, from the roofs of buildings and its storage in a tank or reservoir for later use.

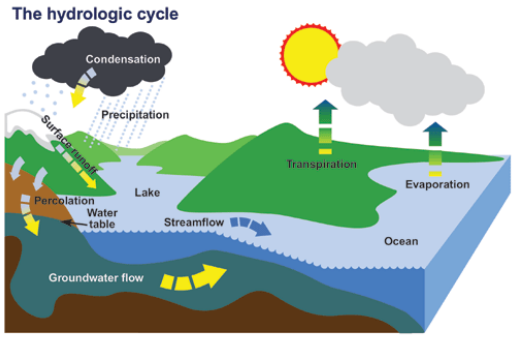
7. Water and its Management

7.1. Global Water Distribution

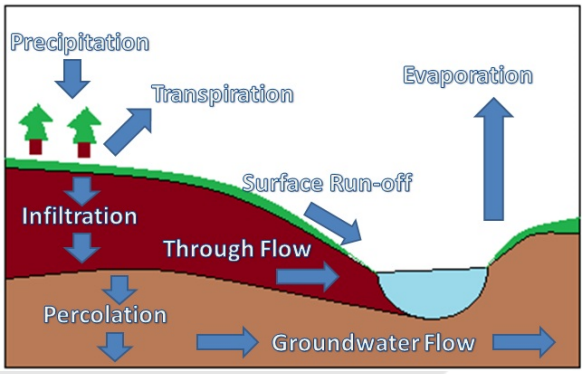


- Oceans cover **75%** of the Earth's surface.
- Oceans and seas contain **97%** of all the Earth's water.
- Only **3%** of the water on Earth is **fresh water**.
- Nearly **two-thirds (65%) of this 3% fresh water** is in the **'deep freeze'** in the ice sheets.

7.2. The Water Cycle

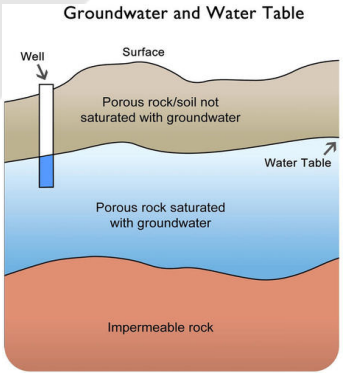


- The state of water changes the location of it, if water in ice is solid, the melting of this ice turns it in to liquid, that may run into a stream of water. The movement of water can be:
  - **Surface run-off:** precipitation that flows over the ground surface, eventually finding its way into streams and rivers.
  - **Through-flow:** down slope movement of water through the soil, roughly parallel to the ground surface.
  - **Ground water flow:** slow horizontal movement of water through rock.
- Once water flow gets collected to form a body of water or joins another body of water (e.g. pond, lake), the warmth of the sun or the heat of the earth below (magma) causes the water to evaporate.
  - **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.
  - Water vapour can also evaporate/diffuse from leaves of a plant, through **transpiration.**
- **Condensation:** water vapour converted back into liquid (water droplets) or solid (particles of ice) due to a decrease in temperature with increasing height by air currents, e.g. clouds.
- The clouds that were formed from the condensed vapours, start growing heavy from the water droplets/particles of ice, the water will fall from these clouds in form of rain or ice.
  - **Precipitation:** the process in which liquid water (as rain) or ice particles (as snow or hail) fall to Earth due to gravity.
  - **Interception:** precipitation that doesn't reach the Earth's surface due to being obstructed by trees and plants.
  - **Infiltration:** precipitation soaks into sub-surface soils and moves into rocks through cracks and pore spaces.
  - **Percolation:** Movement and filtration of fluids through porous materials



7.3. Water Supply

- **Surface water:** water in lakes, rivers and swamps.
- **Ground water:** water in the soil, and in rocks under the surface of the ground.
- **Aquifers:** water stored in porous rocks under the ground.

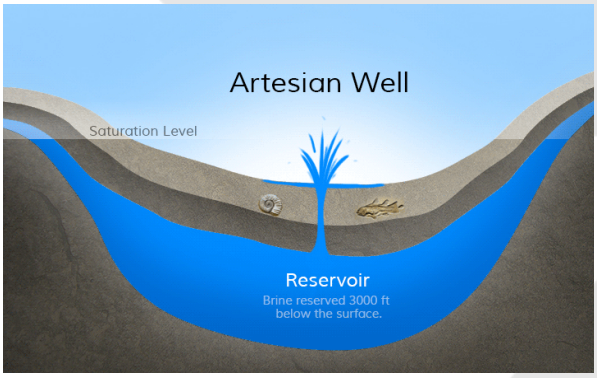


- Alternating layers of permeable and impermeable rocks trap the water in permeable rock, creating folded layers of rock. Water accumulates the most in the down fold.
- Permeable rocks outcropping on the surface receive new supplies of rainwater
- Water that is stored in limestone and sandstone (porous) rocks below the water table, need mechanical pumps or human labour to raise water to the surface.

Main sources of fresh water for human use

Aquifers

- The global quantity of water in aquifer, is about 30% of all fresh water supply.
- Most common ways to obtain water in aquifers is through wells.
  - **Wells:** a hole bored or dug into rock to reach the water stored in them.
  - Water does not raise to the surface, needs either hand lifting through buckets, or the use of pumps to bring water to the surface.
- **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.



Rivers

- **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.

Reservoirs

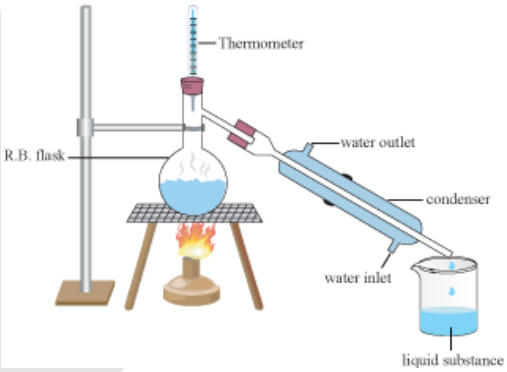
- **Reservoirs:** an artificial lake used as a source of water supply, usually created behind a dam or by the side of a river (bank-side reservoir).
- The water is usually not portable (safe to drink), needs to be treated.
- **Service reservoir:** a reservoir where potable water is stored for use e.g. Water tower and Cistern.

Desalination

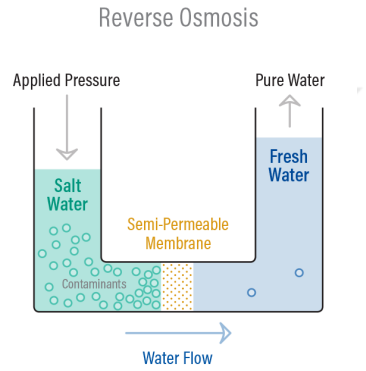
- **Desalination:** removal of salt from seawater. Over 97% of all the world's water is in the ocean and salty.

2 methods of desalination that can be used to make water potable:

- **Distillation:** water is boiled and released as vapour, leaving salt behind.
  - The vapour is then condensed as liquid water and can be used.
  - 10-30% efficient and uses a lot of energy. This and the addition of transporting the potable water, add to the cost.
  - The leftover salt (brine), would need to be disposed off, and the provision of the energy used for distillation are sources of pollution.



- **Reverse osmosis:** pumping of salt water at high pressure through a fine membrane.
  - 30-50% efficient and requires lesser energy than distillation.
  - Brine also needs disposing off, but the energy required for reverse osmosis is less the distillation.
  - Most desalination plants use the reverse osmosis method.



7.4. Water Usage

Domestic

- At home for drinking and cooking (3% of domestic water)
- Water for domestic use, needs to be especially safe.
- MEDCs
  - Washing and flushing the toilet (50%)
  - Washing clothes (20%)
  - Gardening
  - Washing cars
  - Lost in leaks.

Industrial

In factories for:

- Cooling in the production of electricity (Power generation)
- Water is a universal solvent, can be used for wide range of substances and processes:
  - Mixing and making products such as dyes and paints
  - Bottling and canning in food and drink industries

Agricultural

- Mainly for irrigation (plants need water for transporting minerals, for photosynthesis, and for the prevention of wilting)
- For domestic animals

7.5. Water Quality and Availability

Water-rich countries: countries with plentiful fresh water supplies:

- Some are large countries with plenty of land for rain to fall on e.g. Russia, Canada, China, and some with the world's greatest rivers flowing through them e.g. Amazon, Yangtze, Mississippi.
- However, big areas do not ensure water availability e.g. Australia, Argentina, Sudan, due to containing substantial areas of desert within its borders.

Water-poor countries: countries with scarce fresh water supplies:

- Countries dominated by desert.
- Except Singapore and Mauritius since they receive high precipitation totals, but are tiny island states that have only small areas for rain to fall on.

Even if water is available, it may not be potable, there are ways to ensure water potability:

- **Sanitation systems**, which ensure water intended for human use does not mix with dirty water.
- **Water-treatment processes**, which ensures that the water supplied to people is safe to drink.

Water Conflict

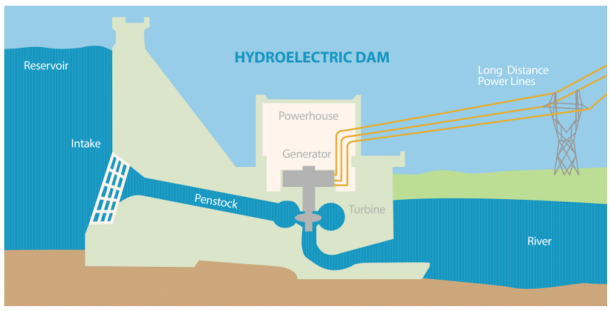
- **Water conflict:** conflict between countries, states, or groups over access to water resources.
- **Physical water scarcity:** not enough water to meet both human demands and those of ecosystems to function effectively.
  - Arid regions frequently suffer from physical water scarcity.
  - It also occurs where water seems abundant, but resources are over-committed.
- **Economic water scarcity:** caused by a lack of investment in water infrastructure or insufficient human capacity to satisfy the demand of water in areas where the population cannot afford to use an adequate source of water.
- **Unlike Rural areas, Urban areas have higher access to safe drinking water because:**
- Cities are more wealthy places with factories and offices, with wealthier people.
- Easier to put pressure on the politicians or leaders to make improvements
- Water pipes are easier and cheaper to build when a lot of people live close together

7.6. Multipurpose Dam Projects

- The construction of dam maybe expensive and controversial, which has its disadvantages but also advantages:

Advantages	Disadvantages
Generation of electricity in hydro-electric power plants;	Relocating people;
Flood control;	Flooding land;
Irrigation	Disrupting the life cycles of fish and other aquatic organisms
Creates recreational land for tourism and leisure	Dam may become redundant due to sediment build up
Provision of water	Very expensive to build
Creation of habitat for wetland species	Requires maintenance
Access by boat to otherwise inaccessible areas	Reduces jobs for farmers if natural fisheries are affected
Renewable source of energy	Altering water supply for people downstream the dam
Doesn't produce greenhouse gases	Reducing soil enrichment downstream of the dam
Reduces fossil fuel consumption	
Creates more jobs	

- **Example:** the Ramganga Dam, Uttarakhand, India.



Choice of site
The optimum site choice needs to have:

- High precipitation to provide sufficient water
- Low temperature to prevent evaporation
- Built on strong impermeable rock, so water doesn't drain and has a good foundation;
- Built high up in order to have good potential for hydroelectric power
- Narrow, steep sided valley for economic reasons
- Rivers and lakes nearby to provide water
- Away from developed areas to reduce the risk of pollution in reservoirs
- Easily accessible
- Maximises water storage capacity

Sustainability of dams:

- Alternative for burning of fossil fuels as no greenhouse gases are produced.

The unsustainability of dams:

- Reservoir can become silted due to material carried into it by rivers
- Dam structure under a lot of pressure can deteriorate and eventually fail
- Have negative effects on the environment and fish population

7.7. Water Pollution and its Sources

Sewage: waste matter that is carried away in sewers or drains from domestic (or industrial) establishments.

- It is usually disposed in water bodies, and thus has to be treated.
- **Domestic waste:** sewage from rural and urban settlements carry many pathogenic microorganisms, increasing the content of nitrates and phosphates in rivers, since they are able to convert ammonia.
- **Pathogen:** an organism, including bacteria and viruses, that can cause disease

Industrial processes: use of chemicals, the processing of metal ores, and the leaching of metals from waste heaps and dumps cause the presence of metals in rivers (e.g. manganese, mercury, copper).

- Detergents, metals and other manufactured products contain traces of toxic chemicals
- Gases from industrial chimneys enter the atmosphere, where they dissolve in water and form acid rain.

Agricultural practices: surpluses of phosphorous and nitrogen not absorbed by the plants are washed from the land or percolate into the groundwater.

- On farms, animal manure, synthetic fertiliser, and chemical pesticides are main sources.
- **Agrochemicals:** pesticides, herbicides and fertiliser.

7.8. Impact of Water Pollution

Global inequalities in sewage and water treatment:

- Developing countries have difficulty treating water and sewage compared to developed countries as people aren't educated and can't put pressure on the government.

Risk of infectious bacterial diseases, typhoid and cholera:

- Water-borne diseases are caused by drinking contaminated water.

8. |

||
Bacterial diseases
|
Cholera
|
Typhoid
|| ||
Infective bacterium (pathogen)

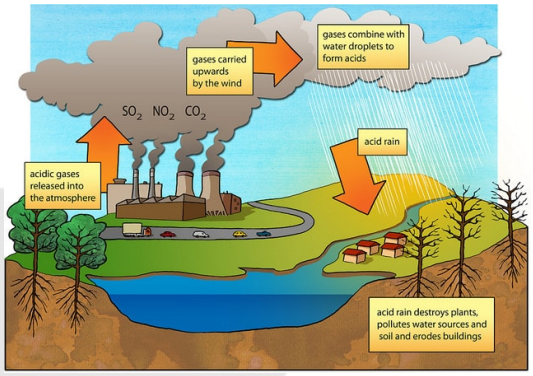
|
Vibrio cholerae
|
Salmonella typhi or Salmonella paratyphi, which causes a less severe illness
|| ||
Time before onset of symptoms after infection
|
A few hours up to 5 days
|
6–6 days
|| ||
Symptoms
|
Diarrhoea and vomiting
|
Fever, abdominal pain with a skin rash, Diarrhoea and vomiting are not uncommon
|| ||
Consequence
|
Can be mild but can lead to dehydration and death
|
3–3% of infected people remain as carriers with no symptoms, If untreated, fatal complications can arise
|| ||
Treatment
|
Rehydration, a vaccine exists
|
Antibiotics, a vaccine exists
|| |#

Accumulation of toxic substances from industrial processes in lakes and rivers:

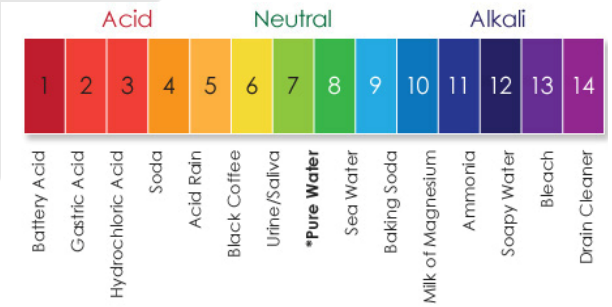
- Reduces oxygen in lakes and rivers, less oxygen available for respiration increasing death of fish and insect larvae.
- **Biomagnification of toxic substances in food chains:** increases concentration of a toxic substance (e.g. mercury and pesticides) in the tissues of organisms at successively higher levels in a food chain, causing illness.
- **Bioaccumulation:** accumulation of a toxic chemical in the tissue of a particular organism.

Acid rain

- **Formation of acid rain:** burning fossil fuels such as coal and oil produce sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) that are blown long distances and react with water in the atmosphere.



- SO_2 dissolves in water to form sulfuric acid, and NO_x dissolves to form nitric acid that fall in the form of rain.
- **pH:** measured by acidity or alkalinity.
  - Ranges from very acidic, 1, to very alkaline, 14.
  - 7 is neutral.



The effect of acid rain on organisms in rivers and lakes:

- Lower pH makes the environment intolerable for aquatic life
- Fish egg-laying is reduced, and young fish are malformed
- Leaching of heavy metals such as aluminum, lead and mercury from the soil into the water
- **Leaching**: the movement of a soluble chemical or mineral away from soil, usually caused by the action of rainwater.
- Aluminum clogs fish gills and causes suffocation
- Minerals essential for life, notably calcium and potassium, are washed out of the lake or river, reducing algae growth and leaving less food for fish and other animals

Nutrient enrichment leading to eutrophication:

- Increase in nutrients, such as nitrates and phosphates, in a water body causes algae bloom (rapid growth of algae).
- Death of algae causes an increase in organic matter that acts as food for bacteria as they decompose the dead algae.
- Bacteria use up oxygen, reducing oxygen content in the water and causing the death of organisms.

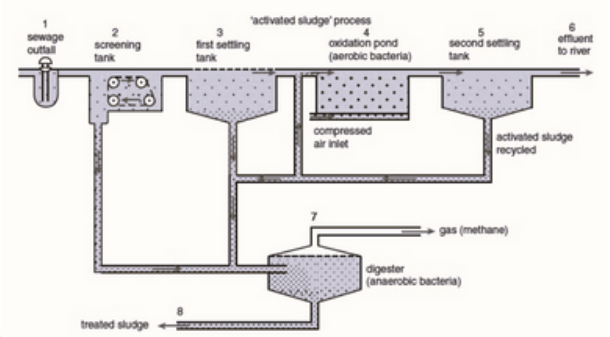
8.1. Managing Pollution of Fresh Water

Improve sanitation: separates human excreta from contact with humans, achieved by toilets and latrines. **Waste can be removed by:**

- Connection to a system of sewer pipes or sewerage, that collects human faeces, urine and waste water.
- Connection to a septic system, which consists of an underground, sealed settling tank.
- **Flush toilet:** uses a holding tank for flushing water, and a water seal that prevents smells.
- **Pour toilet:** has a water seal but uses water poured by hand for flushing.
- **Pit latrine:** type of toilet that collects human faeces in a hole in the ground that is sometimes ventilated to take away smells.
- **Composting toilet:** dry toilet in which vegetable waste, straw, grass, sawdust, and ash are added to the human waste to produce compost.

Treatment of Sewage

- **Treatment of sewage:** aims to reduce the Biological Oxygen Demand (BOD) of the sewage.



1. **Sewage outfall:** waste water from homes and industries is taken to a sewage treatment plant in sewers.
2. **Screening tank:** large objects are removed from the waste using a coarse grid.
3. **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 then overflows the sides of the tank and is taken to the next stage.
4. **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, which cause BOD.
5. **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.
6. **Sludge digester:** oxygen-free conditions are created that encourage the growth of bacteria which can break down the sludge, releasing methane, that can be burnt.
   - Treated sludge can be dried in sludge lagoons and used as organic fertiliser on farmland.
7. **Tertiary treatment:** further filtering out of its effluent or its chlorination which 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.

1. Raw water (non-potable), is carried through the system. Mixing and coagulation causes particles to clump together. **Coagulation:** Particles in the water are stuck together and settle to the bottom of the container.
2. Sedimentation causes clumped particles to settle out.
3. Filtration through sand, removes particles
4. disinfection with chlorine (chlorination), kills bacteria. **Chlorination:** to kill remaining pathogens, chlorine is added as a disinfectant.
5. Water is then taken to a storage/reservoir, and then out to distribution

Pollution control and legislation

- **Pollution control and legislation:** puts pressure on polluters to find ways to reduce pollutants.
- Industries are required to monitor the pollution they cause and keep it within set level.
- **Bi-national Great lakes water quality agreement (GLWQA):** a loading limit of phosphorus was set at 11000 metric tonnes year^{-1} (per year) in response to eutrophication issues in the Great Lakes of USA and Canada.
- Fines 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 may be used to encourage companies to take part, such as grants or tax relief, for those that do achieve a reduction in pollution.

8.2. Managing Water-Related Disease

Water-borne disease: spread by consuming contaminated water due to poor sanitation and untreated sewage, or by washing food, pots and pans, or hands and face in dirty water. **Examples**: cholera and typhoid.

- **Cholera:** intestinal infection that causes severe diarrhoea that may lead to dehydration and eventually death.
- **Causes:** poor sanitation, contamination of water and food, disruption of piped water supplies after a natural disaster occurrence.

Water-bred disease: the carrier breeds in water and spreads the disease by biting its victims. **Example**: malaria.

- **Malaria:** a life-threatening disease which is transmitted through the bite of an infected Anopheles mosquito (vector) that carries the Plasmodium parasite. Once bitten, the parasite reaches your bloodstream.
- **Symptoms:** high temperature and fever, diarrhoea, dehydration and feeling weak.

Life cycle of the malaria parasite:

- Infected anopheles mosquito, transmits plasmodium to human, via bite.
- Plasmodium enters liver cells and multiplies through cell division.
- Liver cells burst, plasmodium is then released into human's blood.
- Transmitted to mosquito, via bite, plasmodium multiplies inside mosquito, if it bites a human, transmission of plasmodium occurs, and the cycle repeats.

Strategies to control malaria:

- Sleeping under mosquito nets and using antimalarial drugs in and spray around homes
- Draining marshes and stagnant pools to eliminate breeding grounds
- Put kerosene over the tops of pools to choke the larvae
- Spray antimalarial drugs on stagnant areas of water to kill the larvae
- Use vaccinations
- Educate people on the risks of malaria by setting up campaigns and programmes.

Strategies to control cholera:

- Ensure that sewage and drinking water are kept separate;
- Sewage removed directly into a treatment works;
- Water being treated before it's delivered into homes;
- Do not use contaminated water to wash food;
- Hands should be washed after contact with any faecal material;
- Boiling water and chlorination

9. Oceans and Fisheries

9.1. Oceans as a Resource

Food

- Fish that includes true fish, finfish, shellfish and other sea animals that can be eaten.
- Fishes are the primary resources of the ocean.
- They are located on the continental shelves where the water is shallow; this means that light can penetrate, leading to a more oxygen-rich habitat
- It's a good area for plants to grow as well

Chemicals and building materials

- Many materials in the oceans have been eroded from the land, where rain and wind break down rocks, and are carried into the oceans via rivers.
- Salt from seawater
- Diamonds are mined from the bottom of the ocean; this can be a complex process though, as the ocean floor needs to be dredged
- Sand and gravel are also mined for construction, though it should be done carefully as there might be some physical damage to the seabed
- Oil is a chemical that is extracted by offshore drilling rigs.
- Delicate particle clouds that are produced resettle and interfere with photosynthesis; they also act as a source of heavy metals that can enter food chains.

Wave energy

- An enormous amount of energy in the waves is estimated to produce twice the present world energy production if harnessed.
- **Tidal energy:** due to the varying gravitational pull of the sun and moon, water in the sea moves up and down twice daily.
- This causes it to come onto land and later recede, which can be harnessed to generate electricity.

Tourism

- The seaside is a significant tourist attraction. People of MEDCs are attracted to marine sites of outstanding natural beauty, especially coral reefs.
- Some adventurous activities include diving, snorkelling, windsurfing, jet skiing, deep-sea fishing, or simply sunbathing on the beach.
- There's a business in boat trips to view sea creatures, especially whales and dolphins.

Transport

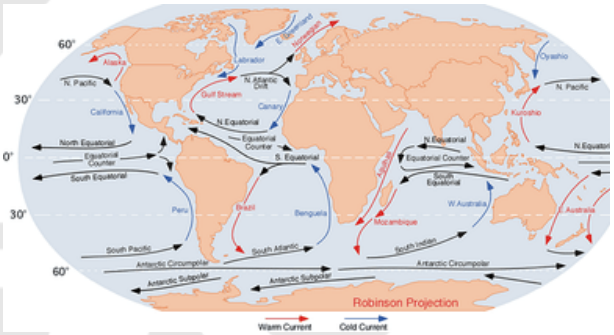
- Ships are essential to transport people and goods; however, shipping is less common to transport people now due to the advent of aviation.
- Pleasure cruises are still an important economic sector, and bulk freight is best transported from country to country on ships.

Potential for safe drinking water

- All living beings require water to survive, but only 3% of earth's water is considered fresh (with a large majority of it being ice).
- Fresh water can be obtained through rivers and wells.
- It is possible to derive safe drinking water by desalination of salty water from the ocean.

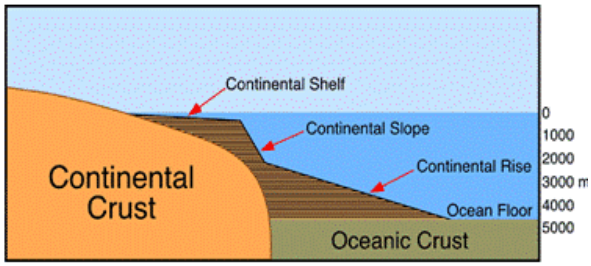
9.2. World Fisheries

- **Surface currents:** movement of the surface water of the sea in a constant direction.
- **Prevailing wind:** the direction from which the wind nearly always blows in a particular area.
- **Currents**
  - Currents in the Southern Hemisphere are usually anti-clockwise
  - Cold currents are near the north and south poles
  - Warm currents are near the equator and the tropics



Distribution of major fish populations:

- They are found in shallow continental shelves due to the large abundance of oxygen and phytoplankton.



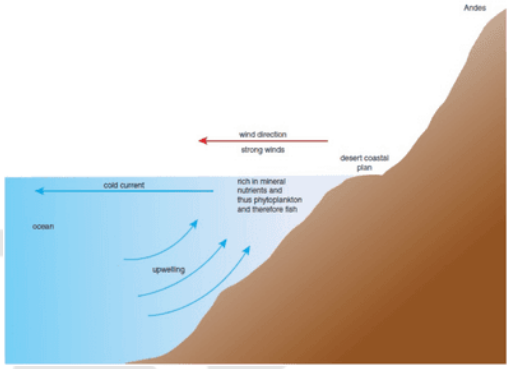
- **Phytoplankton:** small organisms in the sea that can make their own food and upon which almost all other sea creatures depend for their food.
- They're part of the food web, starting with the phytoplankton. Thus, fish are found where there are plentiful phytoplankton.
- Phytoplankton produce their food by photosynthesis which requires light, water, and carbon dioxide (CO_2).
- Water is abundant in the oceans, and CO_2 dissolves in the water from the atmosphere. Therefore, light is likely to be the limiting factor for photosynthesis.
- **Limiting factor:** One is in the shortest supply of all the factors that might affect a process.
- Water absorbs all light by depth of 200m. This zone is called **Euphotic zone,** the top 200 m or so of seawater through which light can penetrate and in which photosynthesis can happen.

Not all areas with continental shelves have significant fisheries because:

- Phytoplankton need light, CO_2, and water, which allow it to make carbohydrates such as sugars but also require mineral nutrients to make proteins.
- Lack of these minerals, even with sunlight, water and CO_2, reduces the production of plankton.
- The most important fisheries of the world are where the current system stirs up decaying material from the seabed, they are rich in mineral nutrients.

El Nino Southern Oscillation ENSO

- The world's largest, most important fishery is the Peruvian anchovy fishery off the west coast of South America.
- In this area, cold water is forced upwards, near Peru's coast, leading to nutrient-rich surface water in this area. This is called upwelling.
  - **Upwelling:** where minerals on the ocean floor are brought up to the surface by currents.
  - This has an effect on plankton growth, supporting large fish populations.
- The fishery yields an excess of 12 million tonnes of fish, however has suffered an enormous collapse due to overfishing.
  - **Overfishing:** when the number of fish caught is greater than the rate at which the fish reproduce, leading to a fall in fish numbers in an area.
- **El Niño Southern Oscillation (ENSO):** the change in the prevailing winds that lead to a change in the pattern of currents in the oceans of the South Pacific.
  - The upwelling of cold, nutrient-rich water is disturbed due to the change of prevailing winds
  - Leading to the upwelling of warm, nutrient-poor water
  - No nutrients mean the phytoplankton does not grow well, so there is less food for the fish.
  - This affects the fishing industry (namely anchovy fishes) negatively



9.3. Impact of Exploitation of the Oceans

Causes of overfishing:

- Demand for fish as food due to increasing world population, however technology and fishing methods that play a major part, as it has made fishing easier with bigger boats and detailed weather data.
- Economic gain, where fisheries catch all fish available, without thinking of the next generation of fishers and their customers.
- Creation of huge nets that scoop up everything in an area, often half of which is discarded as bycatch.
  - **Bycatch**: animals caught by fishers that are not the intended target of their fishing effort.
  - Shrimp fisheries are known to have the biggest bycatch of all, they account for only 2% of the world fishery catch but more than 30% of the world's bycatch.

Impact of overfishing on marine fish species:

- Change the size of fish, as well as their reproduction habits and maturing age.
- Harvest of untargeted/protected/endangered marine species that are discarded at the sea or shore (bycatch), leads to a loss of biodiversity.
- These changes disrupt the marine ecosystem, and create imbalances and erode food webs, which can endanger other marine life.

Farming marine species :

- Due to the increasing human population, the increased demand for fish as food is above the production capacity of oceans and seas.
- Overexploitation of the fisheries leads to a decline in wild fish populations, hence the idea of fish farming in **controlled environments.**
- **Aquaculture:** farming freshwater fish.
- **Mariculture:** aquaculture practiced in marine environments e.g. closed sections of an ocean, tanks, ponds, and raceways filled with seawater.
- **Advantages**
  - It reduces the pressure on the wild population, allowing their population to increase
  - Production is constant
  - No bycatch, as non-interest species are unlikely to be present on the farm
  - No erosion of seabed, which is usually caused by trawl nets.
- **Disadvantages**
  - More suspectible to disease and parasite than wild fish
  - Effects on the local environment; Chemical and antibiotics can leach into the surrounding soil and water. Can poison agriculture land.
  - Expensive to set up and maintain

9.4. Management of the Harvesting of Marine Species

- **Economic exclusion zone:** the zone around a country's coastline that is under the control of that country.
- It is required by the UN, that inside this zone the country must attempt to manage fisheries to make them more sustainable.

Net types and mesh size and shape

- **Trawl nets**, including bottom trawl nets, catch all kinds of unwanted species and damage the seabed during their use.
- **Drift nets**, as their name suggests, drift with the current and are not anchored. These are often used in coastal waters
- Various kinds of **seine net**, including the purse seine, hang like a curtain in the water. A variant called the **surrounding net** is often used.
- **Dredge nets** are dragged along the seabed, mainly to catch shellfish and other types of fish living in the mud. For this reason they dig into the seabed with teeth or water jets.
- If the mesh size is too small, juvenile fish will be caught, which reduces the number of fish that grow to maturity and reproduce. Hence alot off nets with small mesh sizes are banned, e.g. drift net, trawl nets.
- A diamond-shaped mesh catches fish more easily. Thus, a square mesh panel is often included in an otherwise diamond net.

Other Methods of Fishing

- **Fish Aggregation Device (FAD)**
  - These devices bait all the fish together and use a net to collect it
  - Leading to a large bycatch and more younger fishes

- **Pole and line**
  - Very selective method leads to almost no bycatch

Quotas

- Legislators e.g., the government, set limits on how many and what type of fish can be caught;
  - The limits are set according to the information gathered from networks worldwide about fish populations.
  - These limits ensure enough fish can reproduce and replenish the fishery for the following season.

Closed Seasons:

- Governments close down fisheries for a part of the year, usually during the breeding season.
- **Protected areas and reserves:** some fisheries are protected by preventing fishing in certain areas, often where the target species is known to breed.

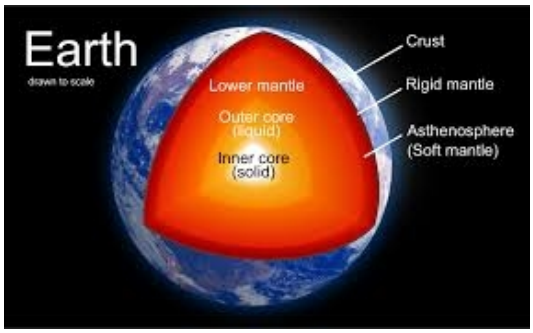
Conservation laws and International Agreements (Implementing and Monitoring):

- **Economic exclusion zone-**:the zone around a country's coastline that is under the control of that country
- **International agreements**: needed to regulate fisheries in international waters, leading to the UN Convention on the Law of the Sea (UNCLOS).
- Countries can monitor varying levels of success
- **Conservation laws aim to:**
  - Conserve fisheries and the territorial waters
  - Conserve fishing resources
  - Protecting fish habitats
  - Enforcing international fishing agreements
- **Effectiveness of these strategies:**
  - Because of the vastness of the oceans, it is difficult to monitor fishery laws and agreements
  - Monitoring organizations based in ports have more success
  - Fishing is important for both income and food for many people, and there is a huge incentive for illegal activities
  - Quotas can easily be avoided by simply not declaring how many fish are being caught
  - Overstretched authorities may not be able to check every boat, and fishers may be willing to risk under-declaring the size of their catch and not being checked
  - Usage of the net with an illegally small mesh size, and in areas where patrols are inadequate
  - Fishers frequently trespass in areas where they are not supposed to fish

10. Managing Natural Hazards

10.1. Earthquakes and Volcanoes

The structure of the Earth:



Layers:

Layer	Temp (°C)	State	Material
INNER CORE	5000 – 6000	Solid (intense pressure from overlying rocks).	Iron and nickel.
OUTER CORE	4000 – 5000	Liquid.	Iron and nickel.
MANTLE	1000 – 1200	Liquid (flows slowly due to convectional currents from the core).	Mainly silicate minerals.

2 Types of Crust

11. |

||
Oceanic crust (sima)
|
Continental crust (sial)
|| ||
Made out of basalt rock
|
Made out of granite rock
|| ||
Thinner, with an average depth of 6m
|
Thicker, average depth 35, but over 100 under mountain ranges
|| ||
Denser, 3 gm^-3
|
Lighter, 2.6 gm^-3
|| ||
Younger
|
Older
|| ||
Sinks, and constantly being renewed and destroyed
|
Cannot sink, neither renews nor destroyed

|| |#

- **The Theory of Plate tectonics**: a theory developed in the 1960s that helps explain the formation of some of the important features on the Earth's surface and how the continents move.
- The earth is not in a continuos layer, but is fractured and in sections called tectonic plates.
  - **Tectonic plate:** a piece of lithosphere that moves slowly. It is made of crust and upper mantle. The Earth is made up of 7 major and 8 minor plates.
  - **Lithosphere:** the outer and rigid layer of the Earth, comprising the crust and the upper part of the mantle
- The plates float like rafts on a mantle, heat from the core creates convention currents in the magma of the mantle, this causes the plates to move.
  - **Convection currents:** transfer heat from place to place, denser colder fluid sinks into warmer areas, heat from the Earth's core causes convection currents in the mantle.
- Plates can move away from, towards or sideways past each other.

Types of plate boundaries:

- **Plate boundaries:** where two or more plates meet.

Constructive (divergent) plate boundary:

- When **two oceanic plates** move away, magma rises to the surface (convection current) and solidifies when it comes in contact with cold ocean water. Magma turns to lava and forms a new basaltic ocean crust. This process if called Sea-floor spreading/Ridge push.
  - **Sea-floor spreading:** the process by which oceans are formed at constructive plate boundaries, new oceanic crust is formed as two oceanic plates move apart.
  - **Ridge push:** a gravitational force that causes an oceanic plate to move away from the crest of a mid-ocean ridge and into a subduction zone, it works together with slab pull.
- They can build up and form mid-ocean ridges and submarine volcanos, which can grow and appear above sea level as volcanic islands.
- These volcanos are non-explosive (due to little pressure build up) and are called shield or basic volcanos
- If **two continental plates** move away from each other, a **Rift valley** may form.