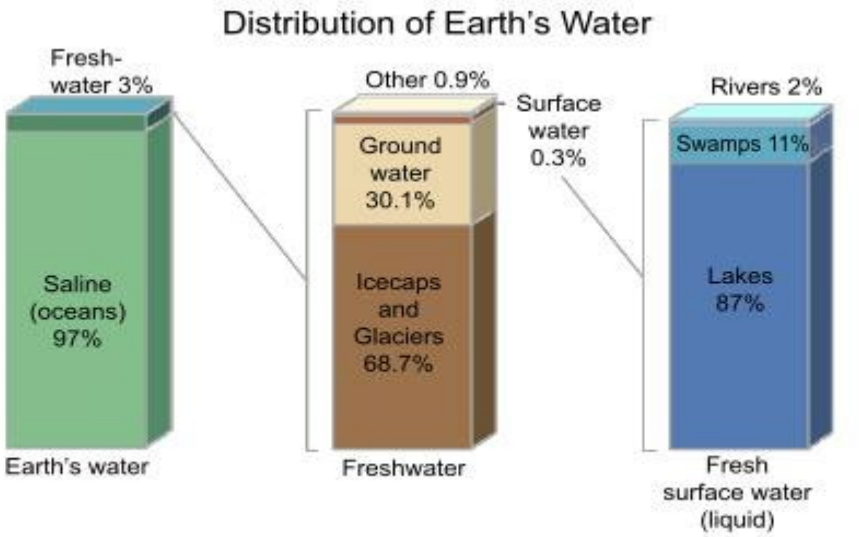
CHAPTER 4

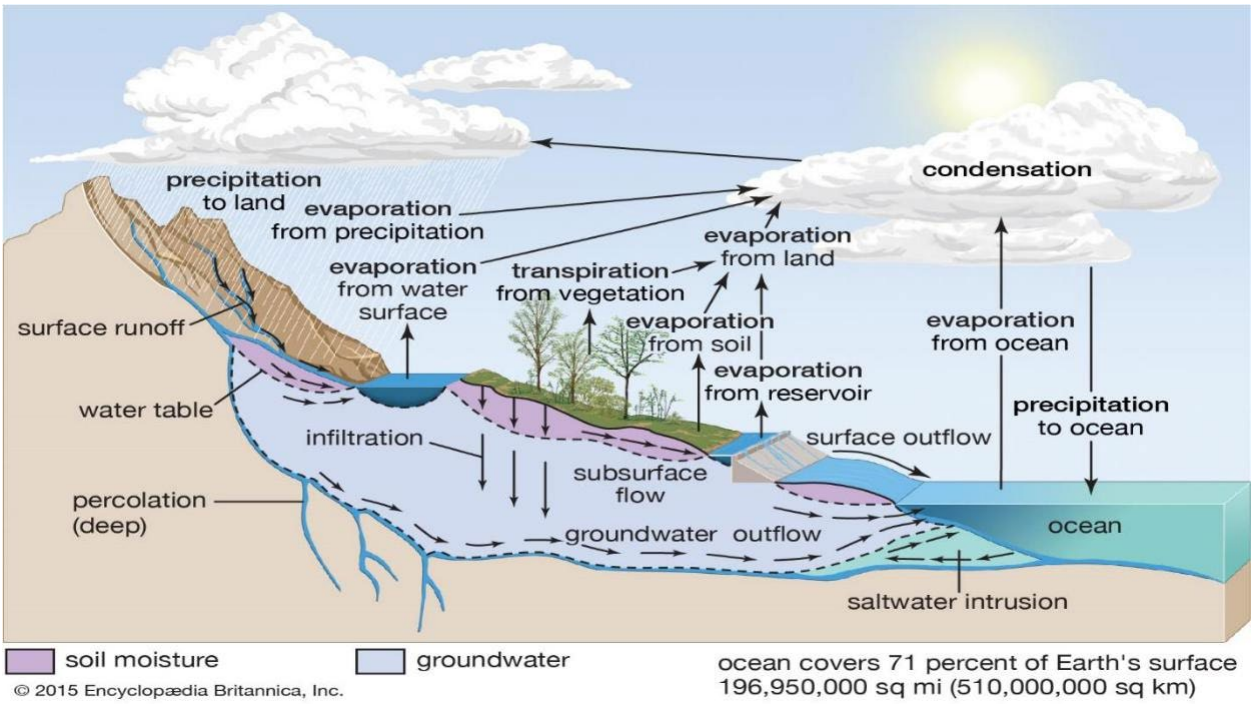
WATER AND ITS MANAGEMENT

- Oceans cover 71% of the Earth's surface.
- Oceans and seas contain 97% of all the Earth's water.
- Only 3% of water on Earth is fresh-water.
- 69% of this 3% fresh-water is in the **'**deep freeze' in the ice sheets.



The Water Cycle:

- **Precipitation**: moisture that reaches the surface in the form of rain, sleet, snow, or hail.
    - Rain is the most common type.
- **Surface run-off**: precipitation that flows over the ground surface, eventually finding its way into streams and rivers.
- **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.
- Through-flow: downslope movement of water through the soil, roughly parallel to the ground surface.
- **Ground water flow:** slow horizontal movement of water through rock.
- **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.
- **Transpiration:** evaporation or diffusion of water from plant leaves.
- **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 main processes in the water cycle

Why human need water:

Domestic needs:

- In the home 3% of domestic water used for drinking and cooking.
- In MEDCs 50% of domestic water is used for washing and flushing the toilet and 20% for washing clothes.
- Much less domestic water is used for washing, flushing the toilets and laundry in LEDCs.

Industrial needs:

- Used for cooling in the production of electricity.
- Used as a solvent.

Agricultural needs:

- Irrigation is the greatest use of water in agriculture.
- For domestic animals.

The main sources of fresh water (water supply)

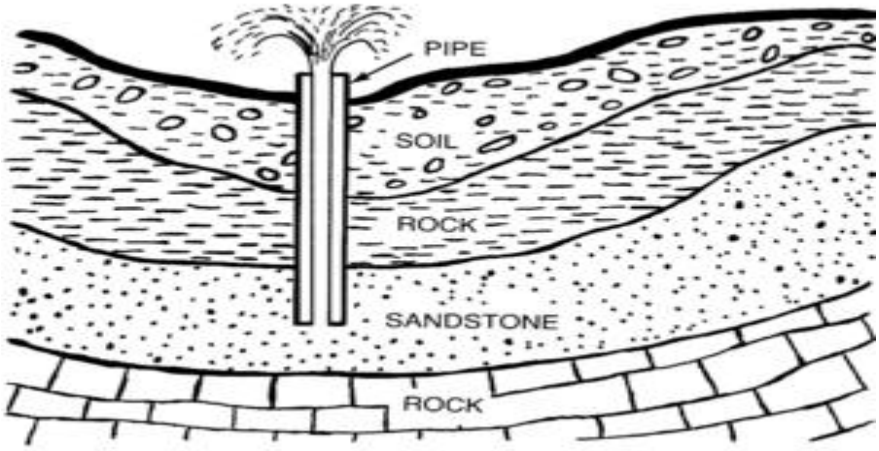
- **Surface water:** water in lakes, rivers and swamps.
- **Ground water:** water in the soil, and in rocks under the surface of the ground which are called **Aquifers**

Water from rivers:

- Water can be taken from rivers by simply dipping a bucket into it.
- Or often involving the construction of a **reservoir** which may be created behind a dam or by the side of the river (**a bank-side reservoir**). This water is not safe but can be treated to make it potable.
- **Service reservoir** is another type of reservoir in which treated and potable water is stored, e.g **water towers** and **cisterns**

Water from the ground:

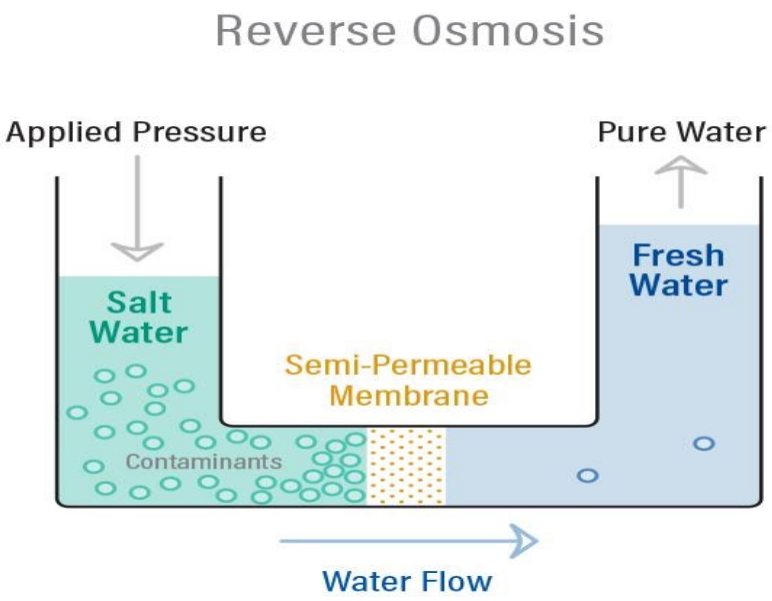
- Alternating layers of permeable and impermeable rocks trap the water in permeable rock;
- **Aquifers:** water stored in porous rocks (limestone or sandstone) under the ground.
- The most common way in which water is obtained from aquifer is to sink **wells** into them.
- If the water in the aquifer is not under pressure, it has to be raised to the top of the well by a bucket (used in LEDCs). In MEDCs motor-driven pump is more likely to be used.
- If the water is stored under pressure the aquifer is called **artesian aquifer.**
- Water from a well sunk into an artesian aquifer will rise to the surface without the need for a pump**.**



Artesian aquifer

Water from the sea:

- To make water suitable for human consumption, salt has to be removed in **desalination** process.
- The first method of desalination is **distillation**, in which water is boiled and released as vapour leaving the salt behind.
- The vapour is then condensed as liquid water and can be used.
- It is 10-30% efficient and uses a lot of energy.
- Provision of energy and salt water (brine) is a source of pollution.
- The second method of desalination process is reverse osmosis, in which salt water is pumped at high pressure through a fine membrane.
- 30-50% efficient and requires lesser energy than distillation.

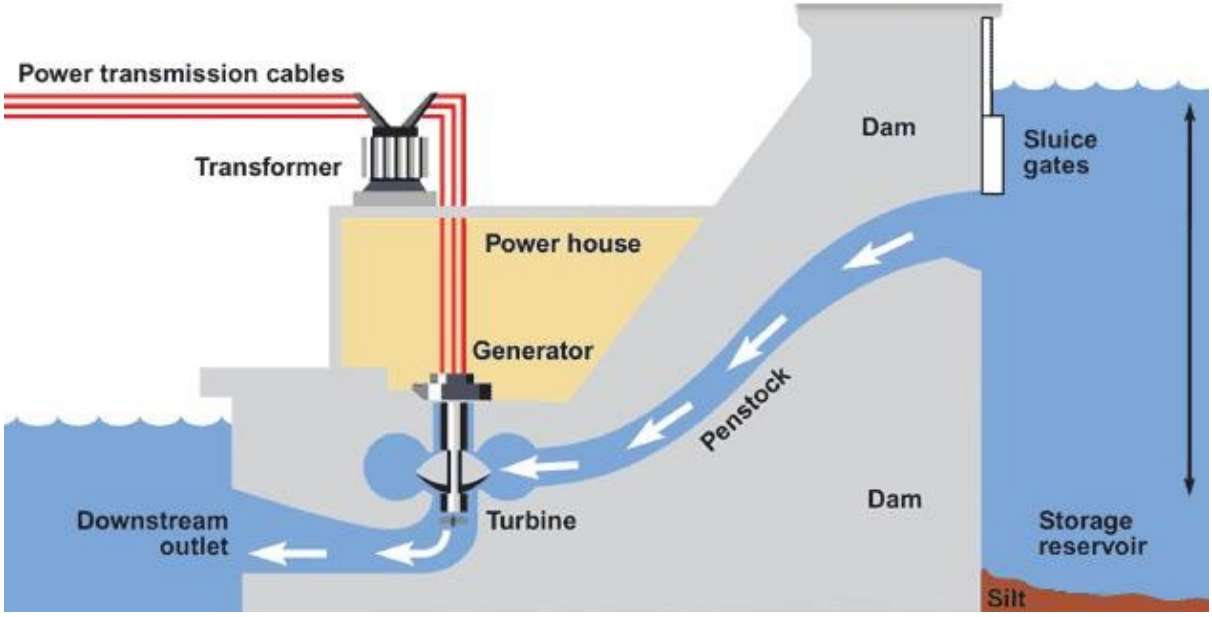


Water quality and availability

- **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:
  - Dominated by desert countries.
  - 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.
- **Water conflict:** conflict between countries, states, or groups over an access to water resources.
- **Physical water scarcity:** not enough water to meet both human demands and those of ecosystems to function effectively. This may be due to low rainfall and/or high level of evaporation.

  - 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.
- Even if water is available, it may not be safe for drinking (potable). Ways of ensuring that water is potable involve two principles:
  - **Sanitation system**: which ensure that dirty water does not mix with water intended for human use.
  - **Water treatment process**: which ensure that the water supplied to people is safe to drink.
- Unlike Rural areas, Urban areas have higher access to safe drinking water because**:**
  - Cities are more wealthy places with factories and offices;
  - On average, people's incomes are higher;
  - Easier to put pressure on the politicians or leaders to make improvements;
  - Wealthy people are more likely to live in cities;
  - Water pipes are easier and cheaper to build when a lot of people live close together.

Multipurpose dam projects



- The construction of dam across a river can be very expensive, but the benefits are great. It helps with:
  - Generation of electricity in hydro-electric power plants;
  - Flood control
  - Irrigation
  - Tourism and leisure
  - The provision of water
  - Creation of habitat for wetland species
  - Access by boat to otherwise inaccessible areas
  - Renewable source of energy;
  - Doesn't produce greenhouse gases;
  - Reduces fossil fuel consumption;
  - Creates more jobs.
- The disadvantages of dam projects include:
  - Relocating people
  - Flooding land
  - Disrupting the life cycles of fish and other aquatic organisms
  - Altering the water supply for people downstream of the dam

- Reducing the enrichment of the soil downstream of the dam
- The dam may become redundant as sediment in the river sink to the bottom of the reservoir (siltation)
- Very expensive to build
- Requires maintenance
- Reduces jobs for farmers if natural fisheries are affected;

Assessment:

Look at the list of the advantages and disadvantages of dam projects given above. Copy and complete the table below by adding each of advantages and disadvantages to the correct cell.

	advantages	**disadvantages**
Environmental		
Economical		

Social		

Where to build a dam

- Deciding where to build a dam requires detailed studies which include;
    - 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 hydro-electric 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.

- **Are dams sustainable:**
    - **Sustainability of dams:**
        - Alternative for burning of fossil fuels as no greenhouse gases are produced.
    - **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.

Key terms

Potable: safe to drink**.**
Reservoirs: an artificial lake used as a source of water supply, usually created behind a dam or by the side of a river (bank-side reservoir).
Service reservoir: a reservoir where potable water is stored e.g. Water tower and Cistern**.**
Wells: a hole bored or dug into rock to reach the water stored in them**.**
Rivers: a large, natural stream of water flowing in a channel to the sea, a lake, or another river.

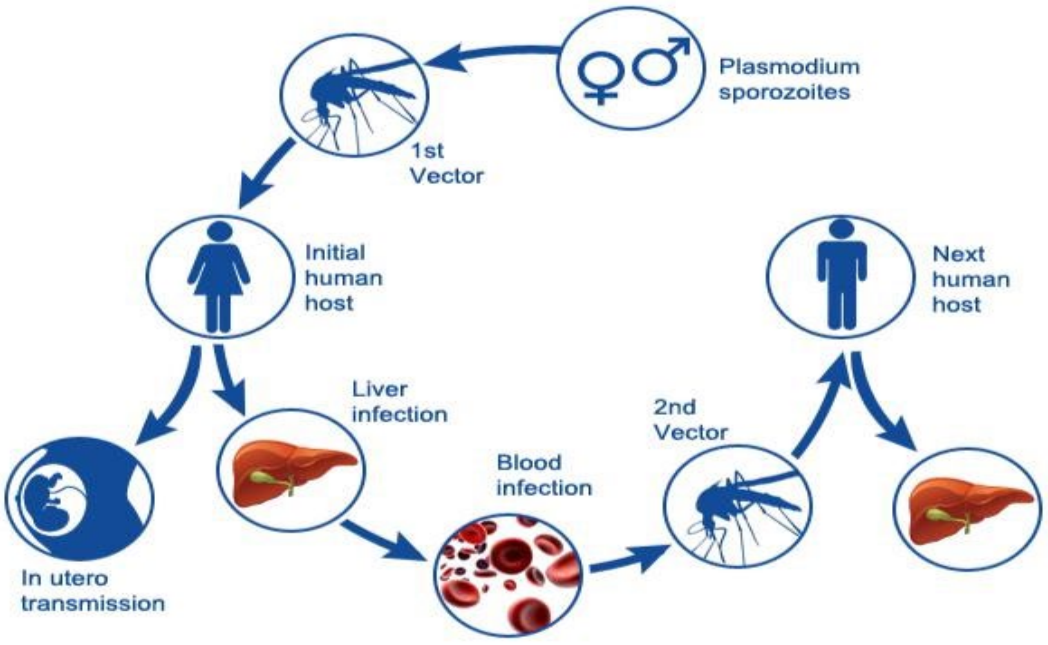
Water related diseases:

- Water provides a very good habitat for living things.
- There is plenty of food in water because of the presence of plants and their ability to photosynthesise.
- Water provides a nutrient rich environment for bacteria.
- Bacteria may enter drinking water from sewage if sanitation is poor. If these bacteria are pathogens, and the water in which they live is drunk untreated, diseases can be spread.
- **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	**Typhoid**
Infective bacterium (pathogen)	*Vibrio cholerae*	*Salmonella typhi* or *Salmonella paratyphi*
Time before onset of symptoms after infection	A few hours up to 5 days	6-30 days
Symptoms	Diarrhoea and vomiting	Fever, abdominal pain with a skin rash Diarrhoea and vomiting
Consequence	Can be mild but can lead to dehydration and death	3-5% of infected people remain as carriers with no symptoms If untreated, fatal complications can arise
Treatment	Rehydration A vaccine exists	Antibiotics A vaccine exists

- **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.

- **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:**



- **Strategies to control malaria:**
- **Individuals can prevent being bitten by mosquitoes by:**
    - Sleeping under mosquito nets treated with an insecticide.
    - Wearing clothing that covers most of the body and treat exposed parts of the body with mosquito-repellent.
    - Spraying insecticide inside building and accommodation.
- **For governments, strategies for malaria control are focused on controlling the vector. This can be achieved by:**
    - Spraying insecticide inside building.
    - Draining wetland areas to eliminate breeding grounds.
    - Put oil over the tops of pools to stop the larvae from breathing and stops adults from laying eggs.
    - Introducing fish which eat the larvae and pupae.
- Eradicating malaria means completely removing of the malaria parasite from the population. Controlling the vector is not enough.

Water pollution and its sources

- **Sewage:** waste matter that is rich in organic matter, thus microbial organisms can thrive in it. It is usually disposed in water bodies, and thus has to be treated.
- **Domestic waste**: sewage from rural and urban settlements carry many pathogenic micro-organisms, increasing the content of nitrates and phosphates in rivers.
- Detergents, metals and other manufactured products contain traces of toxic chemicals.
- **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).
- 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 ground water.
- On farms, animal manure, synthetic fertiliser, and chemical pesticides are main sources.
- **Agrochemicals:** pesticides, herbicides and fertiliser.

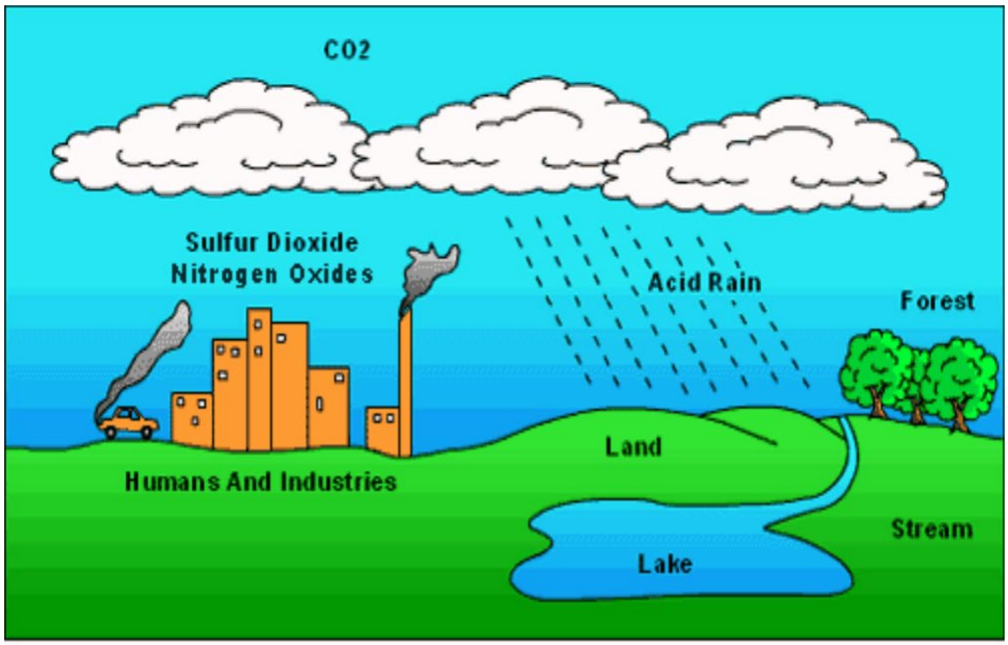
Impact of water pollution

- **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.
- **Accumulation of toxic substances from industrial processes in lakes and rivers:** reduces oxygen in lakes and rivers, causing reduction in photosynthesis and 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.
- **Formation of acid rain:** burning fossil fuels such as coal and oil produce sulfur dioxide (SO2) and oxides of nitrogen (NOx) that are blown long distances and react with water in the atmosphere.
- SO2 dissolves in water to form sulfuric acid, and NOx dissolves to form nitric acid that fall in the form of rain.

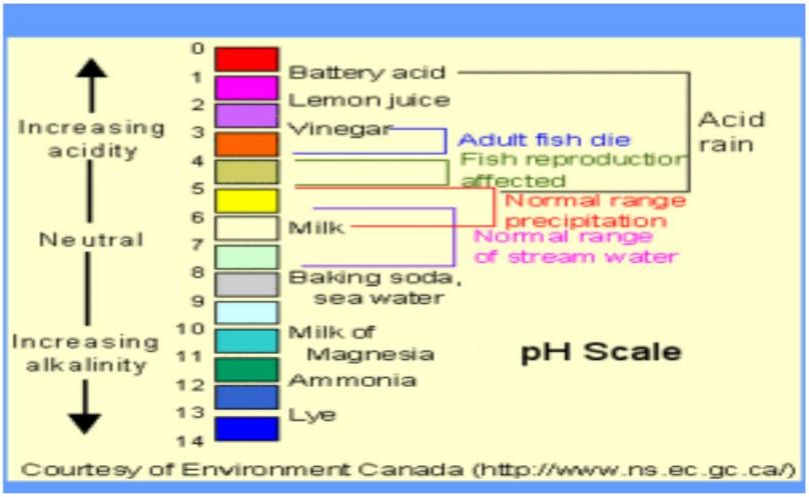
The effect of acid rain on organisms in rivers and lakes:

- Lower pH makes the environment intolerable for aquatic life;
- Fish egg-laying is reduced, and young fish are malformed;

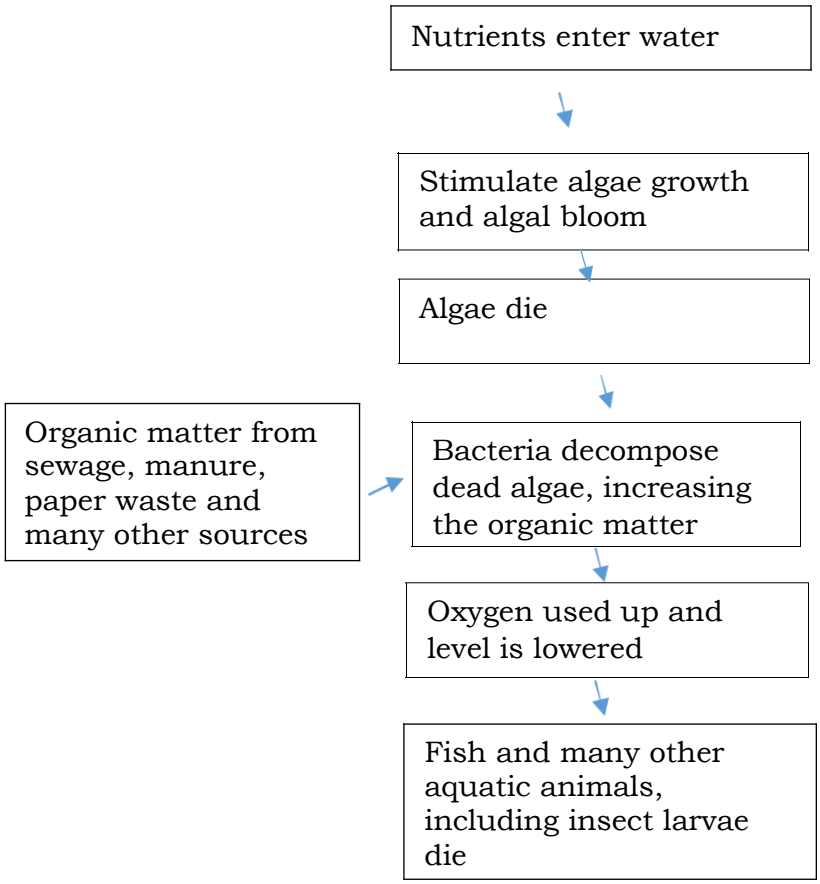
- Leaching of heavy metals such as aluminum, lead and mercury from the soil into the water;
- Aluminum clogs fish gills and causes suffocation;
- Minerals essential for life, notably calcium and potassium, are washed out of the lake or river, reducing algae growth and leaving less food for fish and other animals.



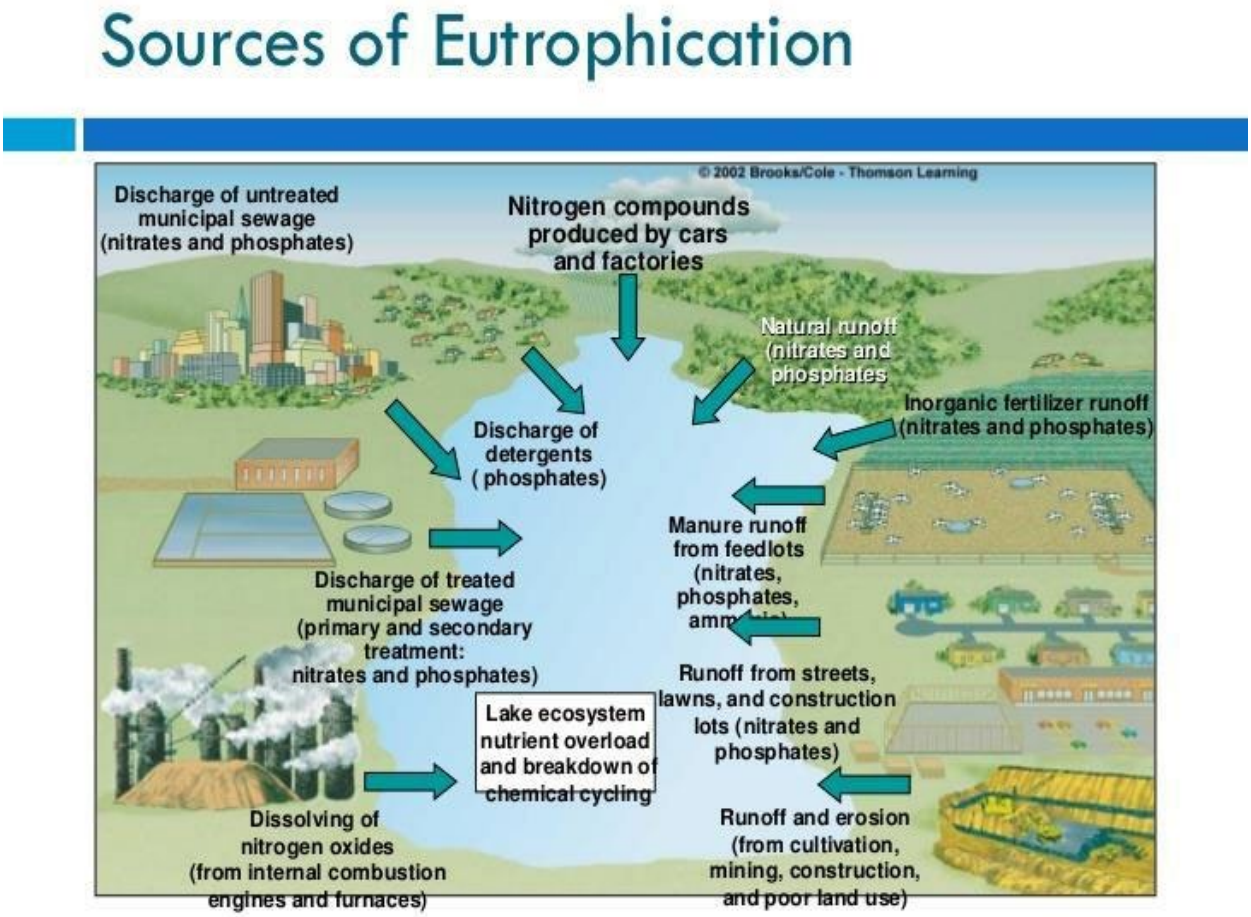
Acid Rain



- **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.



A flowchart showing how eutrophication occurs



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

- **Sewage outfall:** waste water from homes and industries is taken to a sewage treatment plant in sewers.
- **Screening tank:** large objects are removed from the waste using a coarse grid.
- **Primary treatment, first settling tank:** solid organic matter, mainly human waste, settles at the bottom of the tank (sludge), which is treated in a sludge-digester.
- Clean water then overflows the sides of the tank and is taken to the next stage.
- **Secondary treatment, oxidation**: water is pumped into a tank where oxygen is bubbled through it. This encourages the growth of bacteria and other microbes that break down organic matter, which cause BOD.
- **Secondary treatment, second settling tank**: water enters, where bacteria settle to the bottom, forming more sludge. This cleaner water overflows the sides of the tank as effluent, usually discharged into a river.
- **Sludge digester:** oxygen-free conditions 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.

- **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.

- **Coagulation:** Particles in the water are stuck together and settle to the bottom of the container. Water is then filtered through sand.
- **Chlorination:** to kill remaining pathogens, chlorine is as a disinfectant.

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 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.

Key terms

Sewage: waste matter that is carried a way in sewers or drains from domestic or industrial establishments.
Pathogen: an organism including bacteria and virus that cause diseases.
Vector: an organism that carries disease-producing organism.
Effluent: a discharge of liquid waste.
Chlorination: adding chlorine-based substances to water.

CHAPTER 5

OCEAN AND FISHERIES

Oceans are very important part of life on Earth. They are sources of:

- **Food:** fish that includes true fish, finfish, shellfish and other sea animals that can be eaten.
- The main fisheries are located on the continental shelves because the water is shallow there, so light can penetrate and there is more oxygen as well as nutrients are abundant on the shelf.
- **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.
- Some substances can be extracted directly e.g. salt, magnesium, tin, gold, titanium, diamonds.
    - **Salt**: seawater that is left behind over many weeks in the hot sun.
    - **Diamonds**: found in greater numbers in ocean floor than on land.
        ▪ Much harder to mine ocean floor as it must be dredged, then the sediment silted.
    - **Sand, gravel and crushed rock:** mined for the construction industry.
        ▪ Physical damage can be caused to seabed and associated habitats if care is not taken.
        ▪ Fine particle clouds that are produced resettle and interfere with photosynthesis, they also act as a source of heavy metals that can enter food chains.
    - **Oil:** chemical that is extracted by offshore drilling rigs.
- **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 varying gravitational pull of the sun and moon, water in the sea moves up and down on a twice-daily basis. This causes it to come onto land and later recede, which can be harnessed to generate electricity.
- **Tourism:** seaside is a major tourist attraction. People of MEDCs are attracted to marine sites of great natural beauty, especially coral reefs.
- Diving, snorkeling, windsurfing, jet skiing and deep-sea fishing or simply sunbathing on the beach are some adventurous activities.
- There's business in boat trips to view sea creatures, especially whales and dolphins.
- Transport: ships are important 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.
- Types of merchant (goods carrying) ships:

SHIP TYPE	**LOAD OR PURPOSE**
Bulk carriers	Transport of food such as rice and wheat.
Container ships	Entire load is carried in lorry-sized containers, known as containerisation.
Tankers	•Transport of fluids, especially liquefied petroleum gas and liquefied natural gas. • Transport of vegetable oils and wine.
Refrigerated ships	Transport of perishable items such as vegetables, fruits, fish and dairy products.
Roll-on/roll-off ships	Transport of vehicles, together with their loads, that can be driven on and off the ship.

Coastal trading vessels	Used for trade between places that are close together, especially in island groups.
Ferries	Used for mainly for the movement of foot passengers, sometimes with their cars, mainly between islands or between mainland and islands.
Cruise ships	Used for pleasure voyages where the facilities on the ship are a crucial part of the trip.
Ocean liner	Used to transport people from one port to another.

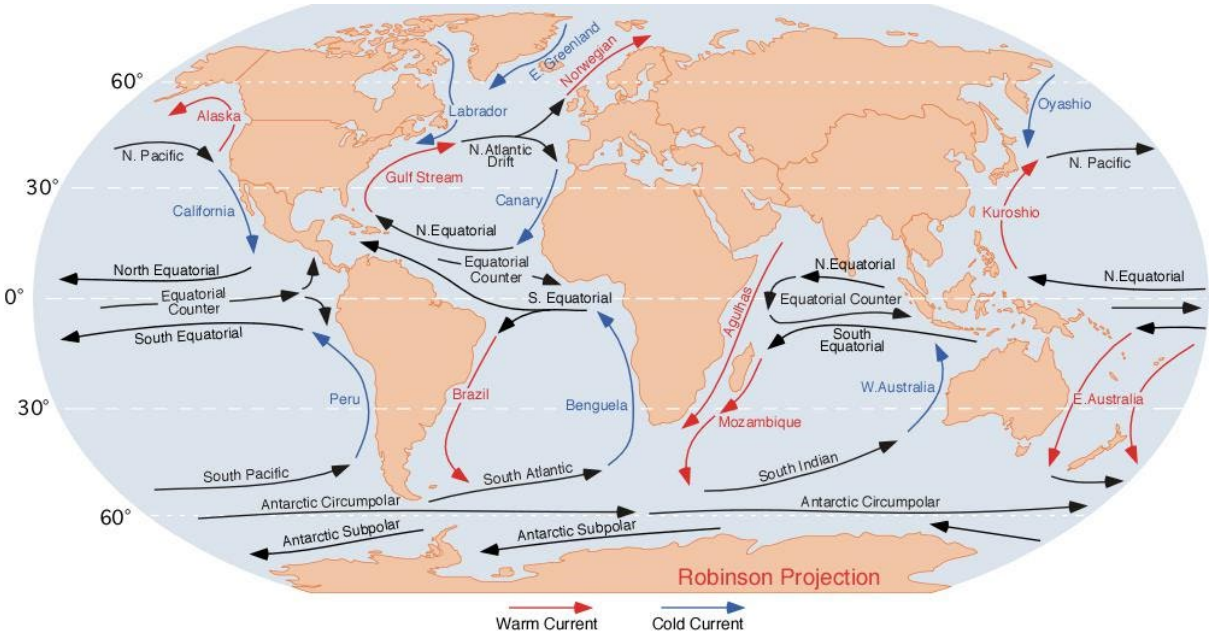
- **Potential for safe drinking water:** only small proportion of water is safe to drink.
- Salty water is unsafe as your body must remove the salt, requiring more water.
- Purification of water is possible by desalination.

Assessment: text book p. 116 qu. 5.1-5.3

World fisheries

Major ocean currents:

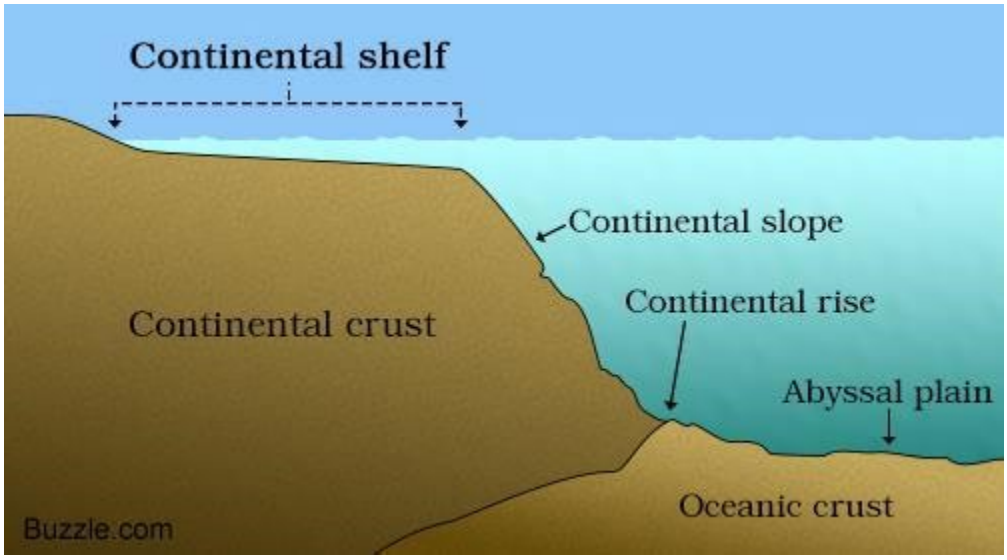
- **Surface currents**: movement of the surface water of the sea in a constant direction.
- **Prevailing wind**: the direction from which the wind nearly always blows in a particular area.
- Currents in the southern hemisphere are generally anticlockwise as the winds blow from the south-east and force the western Australian, Benguela, and Peruvian current northwards.
  - **Cold currents**: come from the poles.
  - **Warm currents**: come from the tropics or either side of the equator.



Currents of the world

Finding fish

- Main fisheries are located on continental shelves where water is shallow (<150m below sea level), allowing light to penetrate with plentiful oxygen than further below.



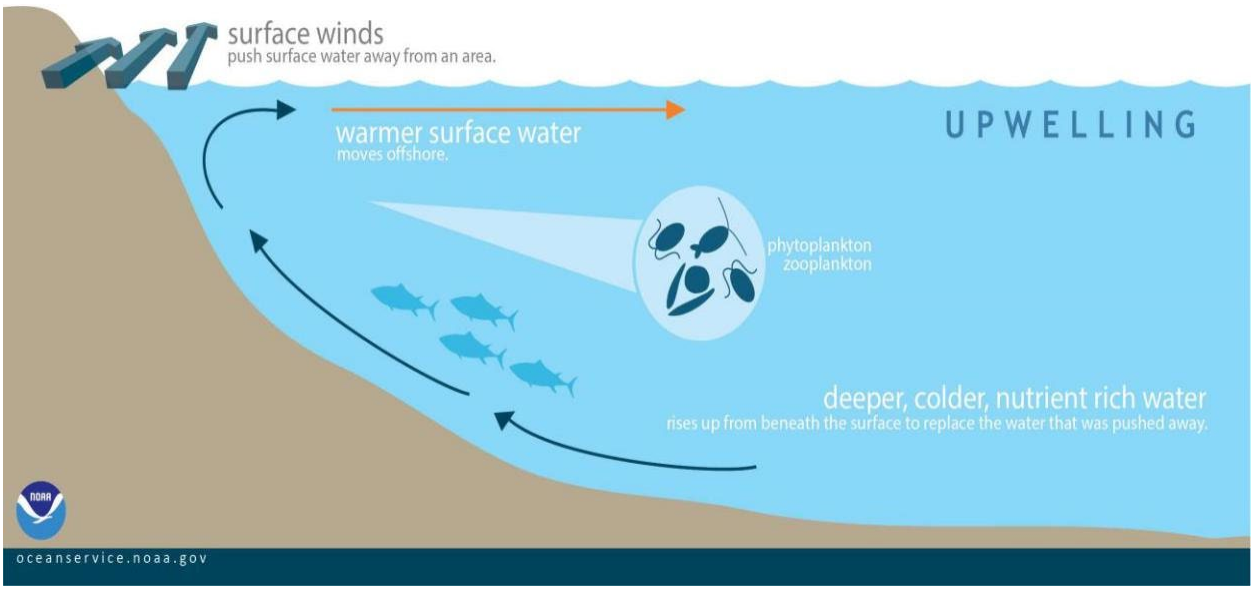
The continental shelf

- Herbivorous fish rely on primary producers, mainly green algae called phytoplankton. Carnivorous fish eat the herbivorous ones or other carnivores.
- There're parts of the food web, starting with the phytoplankton. Thus, fish are found where there are plentiful phytoplankton.
- Phytoplankton produce their own 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.

- Most ocean water has absorbed all the sunlight by a depth of only 200m. This 200m deep zone is called the **euphotic zone**, below which photosynthesis will not take place.

Not all areas with continental shelves have significant fisheries because:

- Phytoplankton need not just light, CO2 and water, which allow it to make carbohydrates such as sugars, but they also require mineral nutrients to make proteins.
- Making proteins requires a source of nitrogen and sulfur.
- Nucleic acids, which form the genes of living things, also require phosphorus.
- The green pigment chlorophyll, which is essential for photosynthesis, requires magnesium.
- The most important fisheries of the world are where the current system stirs up decaying material from the seabed, which is rich in nutrients.
- **Upwelling**: areas where minerals at the ocean floor are brought up to the surface by currents.
- An example is the Peruvian anchovy off the west coast of South America.



This graphic shows how displaced surface waters are replaced by cold, nutrient-rich water that "wells up" from below. Conditions are optimal for upwelling along the coast when winds blow along the shore.

- This upwelling is distured once every 10-15 years by an event called **El Nino Southern Oscillation (ENSO).**
- **El Niño Southern Oscillation (ENSO):** the change in the prevailing winds that leads to change in the pattern of currents in the oceans of the South Pacific.
- Warm nutrient-poor water comes into the region from the equator.
- Results in no upwelling of the cold, nutrient rich water that supports the anchovy fishery.
- No nutrients mean the phytoplankton do not grow well, so there's less food for the fish.
- Much of the production of the anchovy fishery was used for fishmeal which is used to feed farmed fish, thus countries where this is important, are affected by a crash in the anchovy fishery.

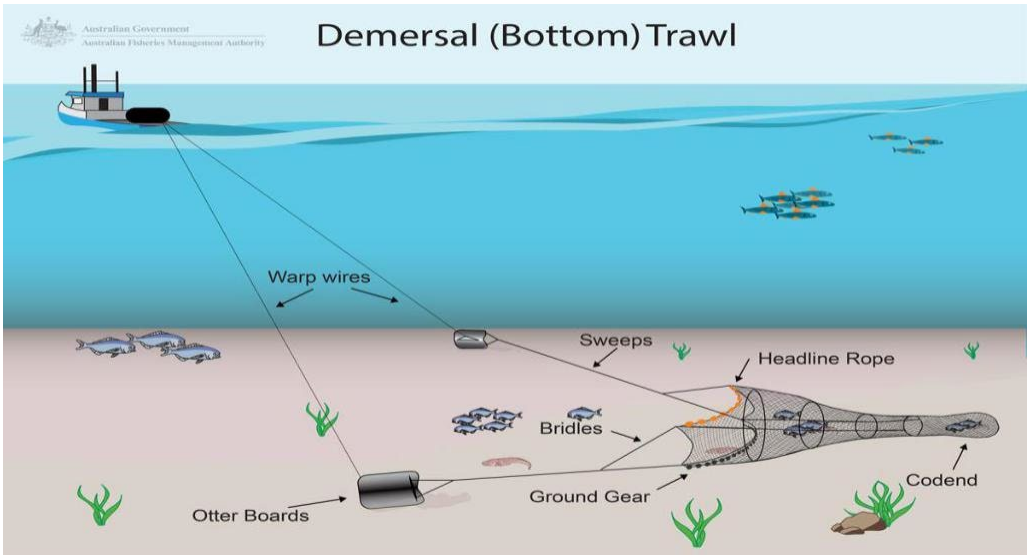
Assessment: text book, page 121, qu. 5.4 -

5.6 **Impact of exploitation of the oceans**

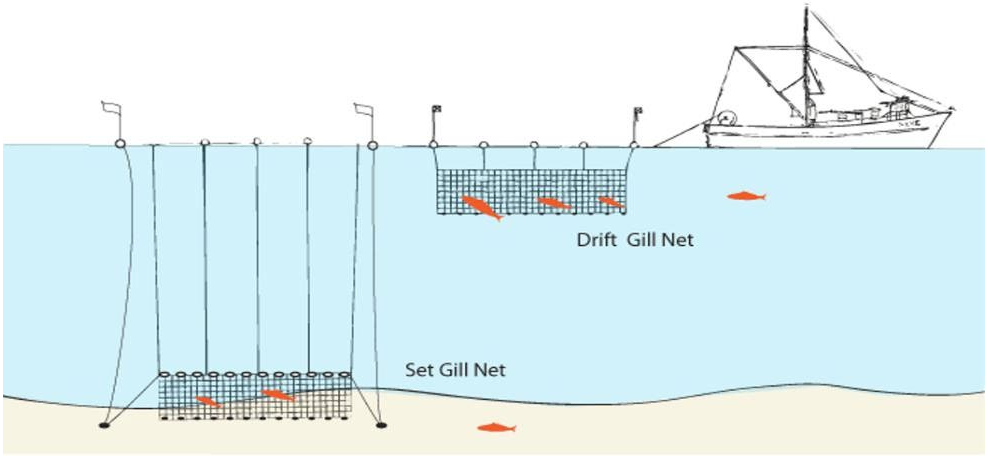
• **Causes of overfishing of marine fish species**:

- **Demand for fish as food due to increasing world population**;
- Much bigger boats, which can work a long way from a port for many weeks;
- Finding fish easily by using SONAR and detailed weather data;
- Creation of huge nets that scoop up everything in an area, often half of which is discarded as bycatch (animals caught by fishers that are not the intended target of their fishing effort).

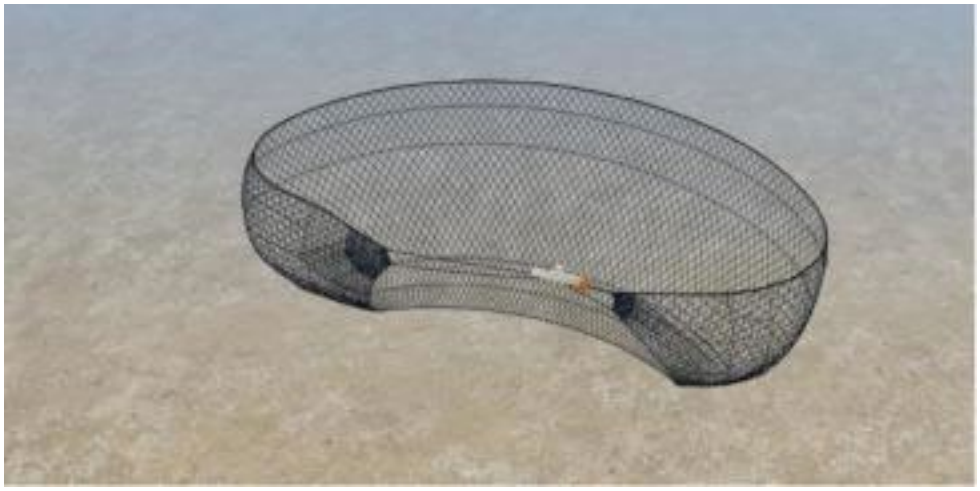
- **Impact of overfishing of marine fish species:**
  - Lack of growth in fish caught globally since 1990s, leading to loss of job and reduction in food supply;
  - Size of fish gets progressively smaller, increasing demand for food;
  - Harvest of untargeted/protected/endangered marine species that are discarded at the sea or shore;
  - Reduction in marine biodiversity, causing a disruption in food chain.
  - Nets;
  - **TRAWL NET** (INCLUDING BOTTOM TRAWL NETS): Catch all types of unwanted species and damage the seabed during their use.



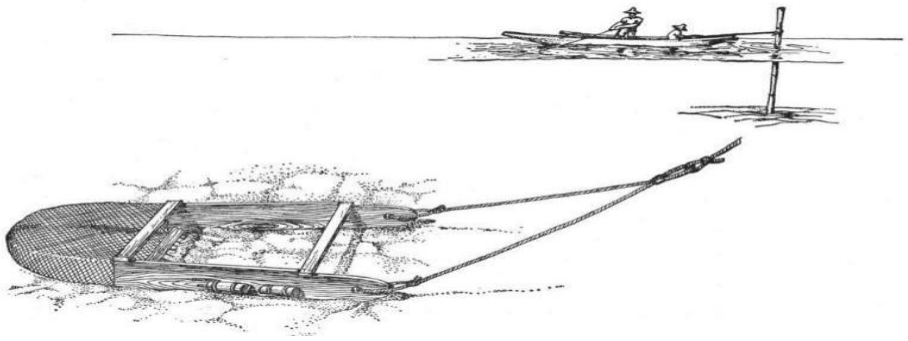
- **DRIFT NET:** Drift with the current and are not anchored. Often used in coastal waters.



- **SEINE NET (INCLUDING PURSE SEINE):** Hang like a curtain in the water. A variant called the surrounding net is often used.



- **DREDGE NET:** Dragged along the seabed, mainly to catch shellfish and other types of fish living in the mud. Thus, they dig into the seabed with teeth or water jets.



- **Farming marine species (Mariculture) reduces the exploitation of fisheries**:
  - Due to the increasing human population, the increase in 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;
  - So, fish are farmed in controlled environments.
  - **Aquaculture:** farming fresh water fish.

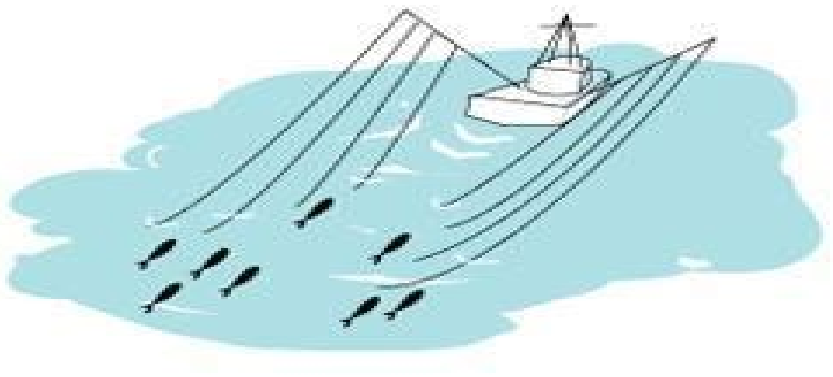
- **Mariculture**: aquaculture practised in marine environments e.g. closed section of an ocean, tanks, ponds and raceways filled with seawater.
  - ▪ It reduces the pressure on wild population, allowing their population to increase;
  - ▪ Production is constant;
  - ▪ No bycatch, as non-interest species are unlikely to be present in the farm;
  - ▪ No erosion of seabed, that is usually caused by trawl nets.

Strategies for managing the harvesting of marine species

Every country with coastline has a zone of 200 nautical miles designed by UN convention on the law of the sea as **economic exclusion zone.** A variety of strategies to do this are:

- **Net types and mesh size and shape:**
  - If mesh size is too small, juvenile fish will be caught, reduces the number of fish that grow to maturity and reproduce.
  - 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:**
  - Many fish species naturally congregate near objects floating in the ocean.
  - Many fishers use fish aggregation devices (FADs) for tuna fisheries.
    - ▪ includes the usage of a log suspended below the surface of the sea
    - ▪ this attracts the tuna together with other species, including tuna predators.
    - ▪ once a good aggregation of fish is collected, they are gathered in a giant net.
    - ▪ this will take all other species and younger tuna fish with it, leading to a large bycatch.

- **Solution:** Use pole and line method for catching the tuna. Done right, this method is highly selective with very little or no bycatch.



Pole and line method for catching the tuna

- **Quotas**:
  - Legislators e.g. 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 across the world about fish populations;
  - These limits ensure enough fish are left to reproduce and replenish the fishery for the following season.
- **Closed seasons:**
  - Governments and other legislation bodies can pass laws that can close fisheries down for part of the year, most commonly in 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.
- **International agreements (implementing and monitoring):**

Some fisheries are protected by conservation laws, e.g:

- **Magnuson-Stevens Fishery Conservation and Management Act:**
  ▪ Main law governing marine fisheries in the USA; It aims to control the country's terrestrial waters, conserve fishery resources, enforce international fishing agreements, develop underused fisheries and protect fish habitats.
- **Economic exclusion zone:**
  ▪ Every country with a coastline has a zone of 200 nautical miles around it inside which the country responsible must attempt to manage its fisheries so that they're sustainable.
- **International agreements**: needed to regulate fisheries in international waters, leading to the UN Convention on the Law of the Sea (UNCLOS).
- ▪ Such an agreement is needed in the Mediterranean where a 200 nautical mile exclusion zone has no meaning.
- **Monitoring:** a model system is operated by the African country of Namibia.
  ▪ Larger vessels in its waters have onboard observers and air patrols detect and deter unlicensed vessels;
  ▪ All landings are monitored at the country's two fishing ports;
  ▪ In addition, all vessels in the exclusion zone must keep daily logs of their catches.

Effectiveness of these strategies:

▪ Because of the vastness of the oceans, it is difficult to monitor fishery laws and agreements. Monitoring organisations based in ports have more success;
▪ Due to fishing being important for both income and food for many people, 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 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.

Key Terms

Surface currents: movement of the surface water pf the sea in a constant direction.
Prevailing wind: the direction from which the wind nearly always blows in a particular area.
Limiting factor: of all the factors that might affect a process, the one that is in shortest supply.
Euphotic zone: the top 200 m or so of seawater through which light can penetrate and in which photosynthesis can happen.
Upwelling: areas where minerals at the ocean floor are brought to the surface by currents.
Overfishing: when the number of fish that caught is greater than the rate at which the fish reproduce, leading to a fall in fish number in an area.