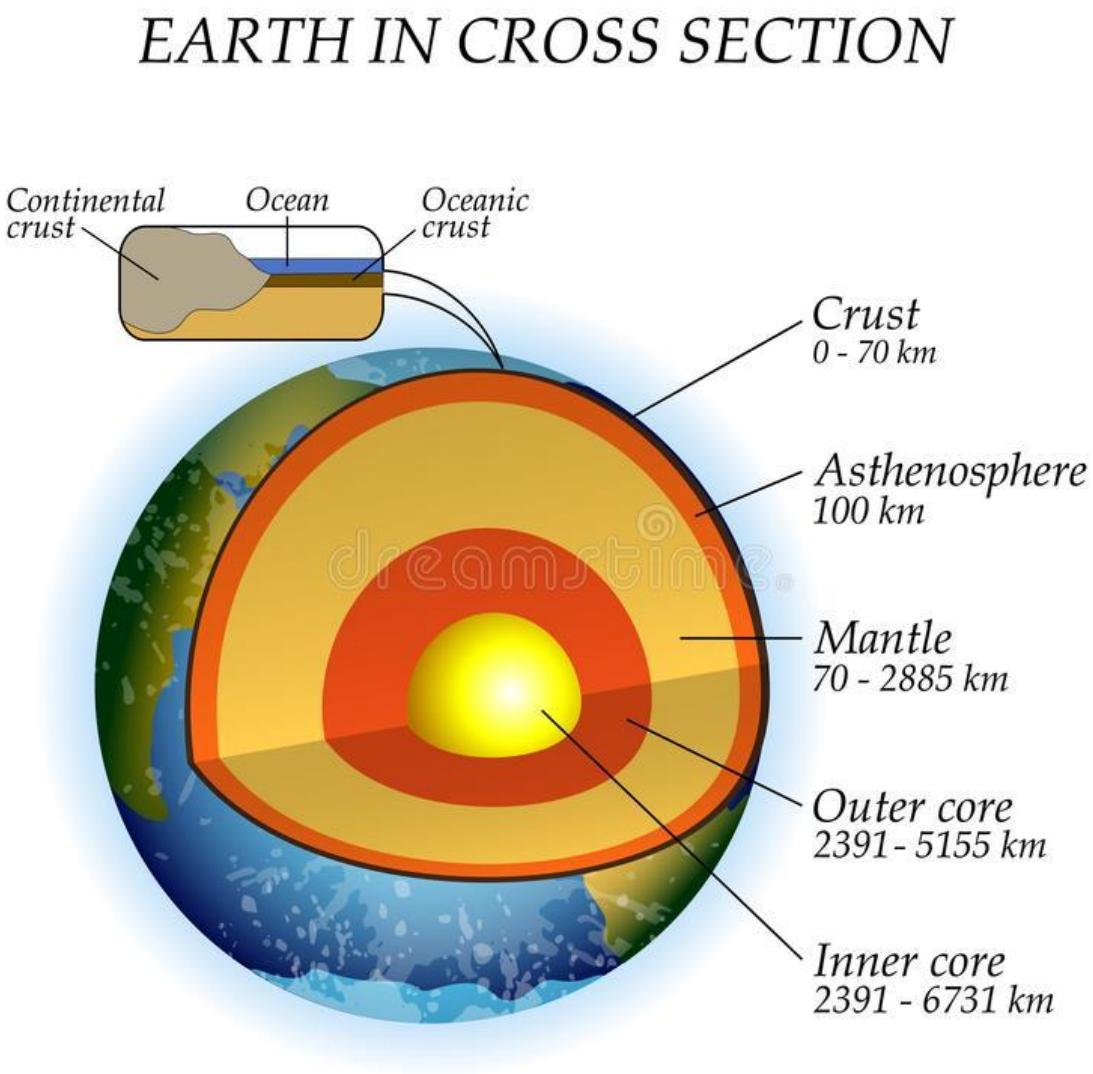
Managing Natural Hazards

Earthquakes and Volcanoes

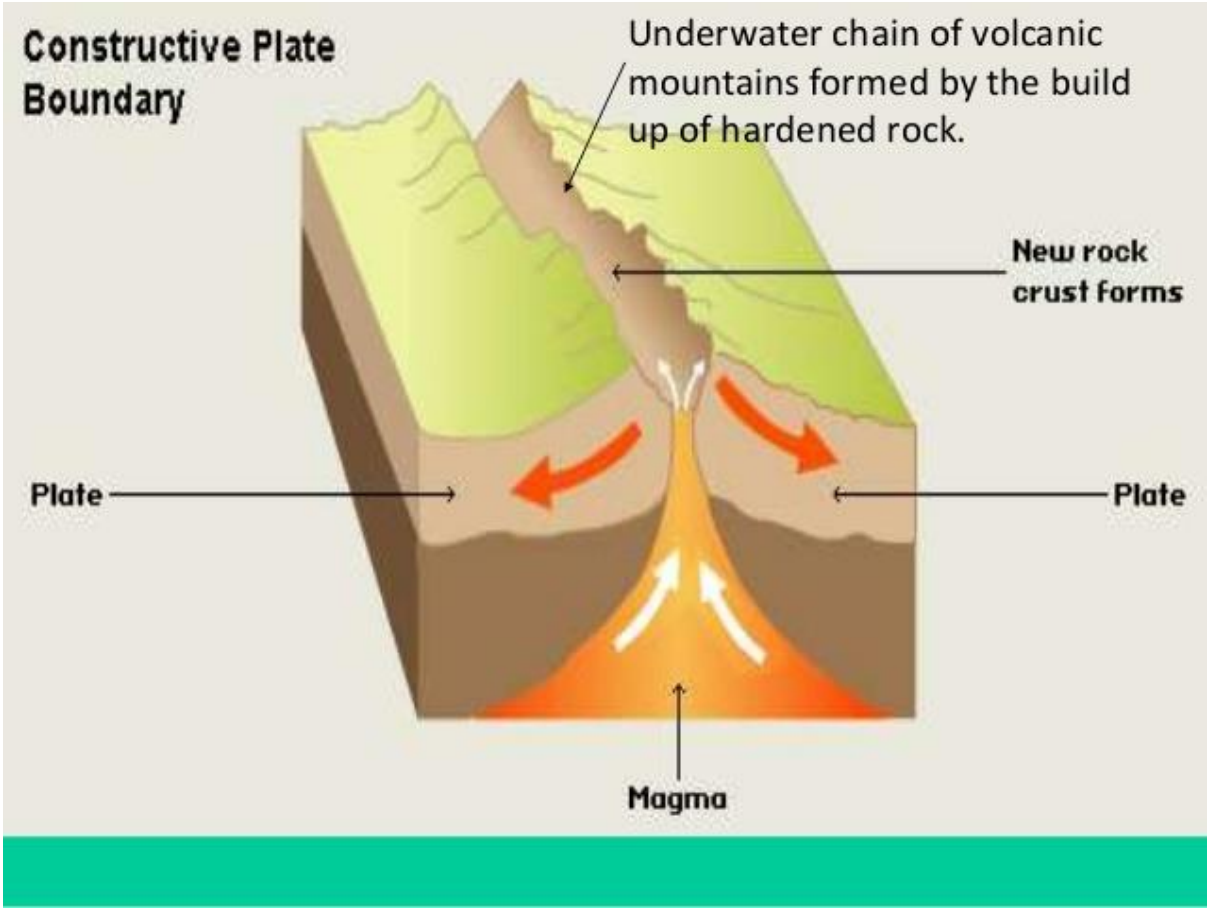
- **The structure of the Earth:**



Layer	Temp (ºC)	State	Material
INNER CORE	5000 – 6000	Solid (intense pressure from overlying rocks).	Iron and nickel.

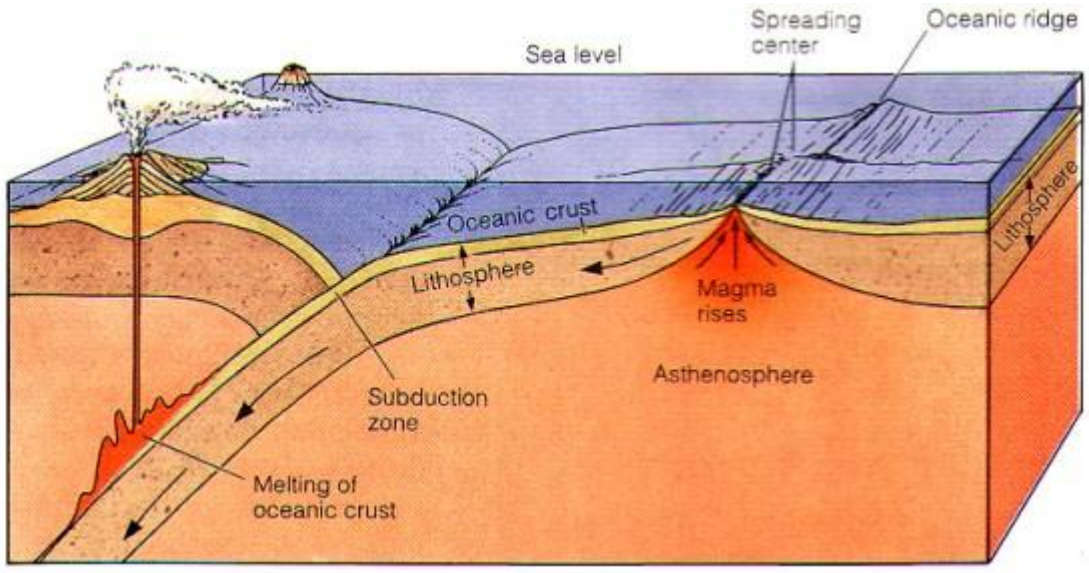
Layer	Temp (ºC)	State	Material
OUTER CORE	4000 – 5000	Liquid.	Iron and nickel.
MANTLE	1000 – 1200	Liquid (flows slowly due to convectional currents from the core).	Mainly silicate minerals.

- **Tectonic plate:** a piece of lithosphere that moves slowly. It is made of crust and upper mantle.
- Where the convention currents rise to the surface, the plates move away from each other (and vice-versa).
- **Plate boundaries:** where two or more plates meet.
- **Constructive (divergent) plate boundary:**



- Two plates move **away** from each other.
- When **two oceanic plates** move away, magma rises to the surface (convection current) and solidifies when it comes in contact with cold ocean water.
- The magma turns to lava and forms a new basaltic ocean crust.
- They can also form shields or basic volcanoes (submarines) and have non-explosive eruptions.
- This is known as sea-floor spreading or ridge push.
- Small Earthquakes are triggered.
- If **two continental plates** move away from each other, a rift valley may form.

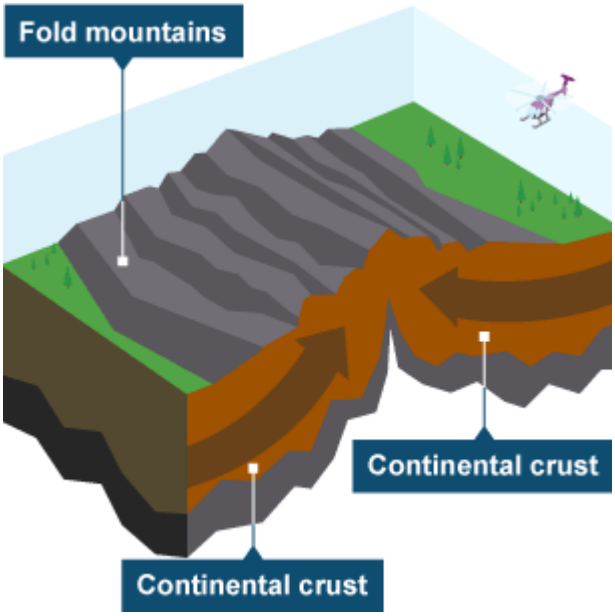
- **Destructive (converging) plate boundary:**



- Two plates move **towards** each other.

- When **an oceanic plate and continental plate** move towards each other, the denser (oceanic) plate is forced down (subducted) under the lighter (continental) plate.
- This happens in the subduction zone, and an ocean trench is formed.
- The friction between the plates triggers Earthquakes.
- The heat produced due to friction turns the descending plate into magma.
- The magma starts to rise and erupt (due to pressure) through a weakness in the crust as an explosive composite volcano.
- Fold mountains are also formed.
- The magma that erupts at the surface forms a chain of volcanic islands called an island arc.
- If **two continental plates** move toward each other, the sediments between the two plates are compressed (collision zone) and pushed

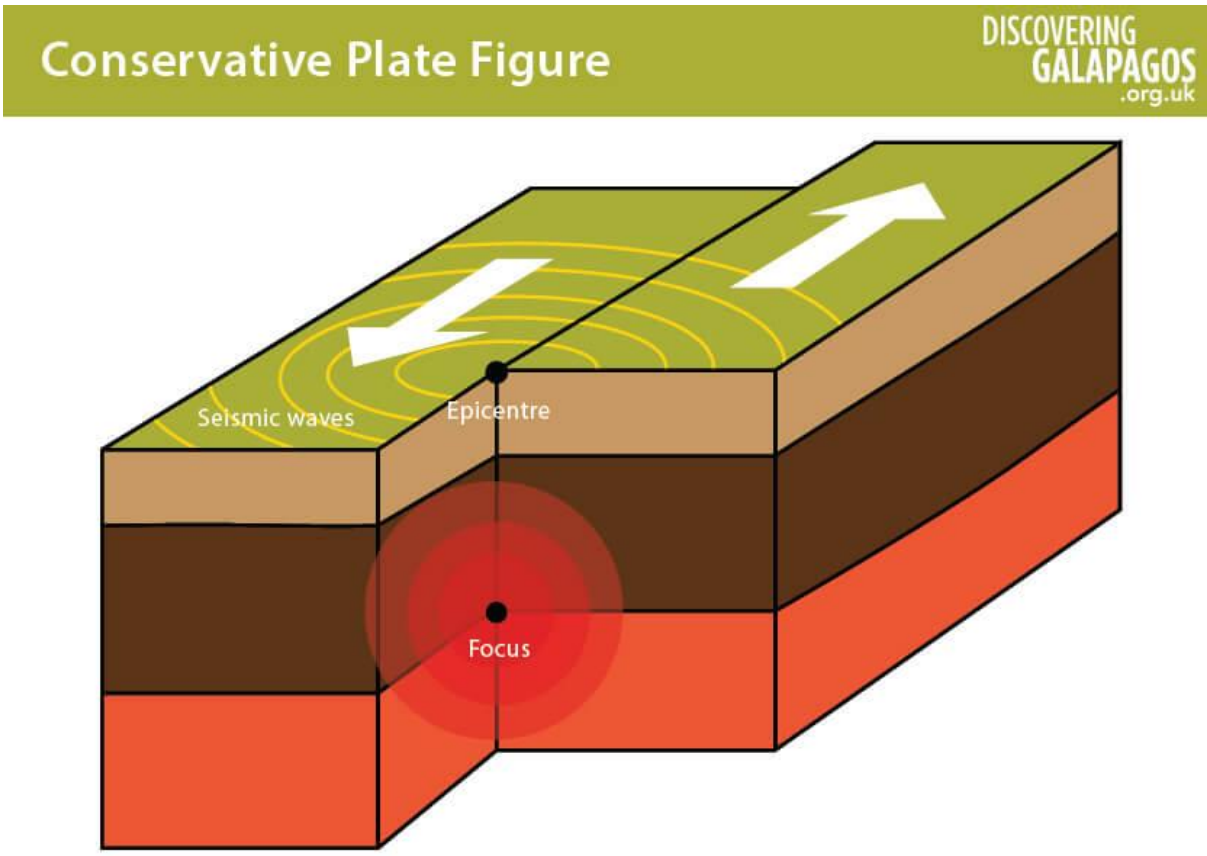
upwards to form fold mountains.



- Earthquakes occur, but no volcanic activity as there's no subduction of oceanic plates.

- **Conservative plate boundary:**
  - Two plates **slide past** each other.
  - They move at different speeds.

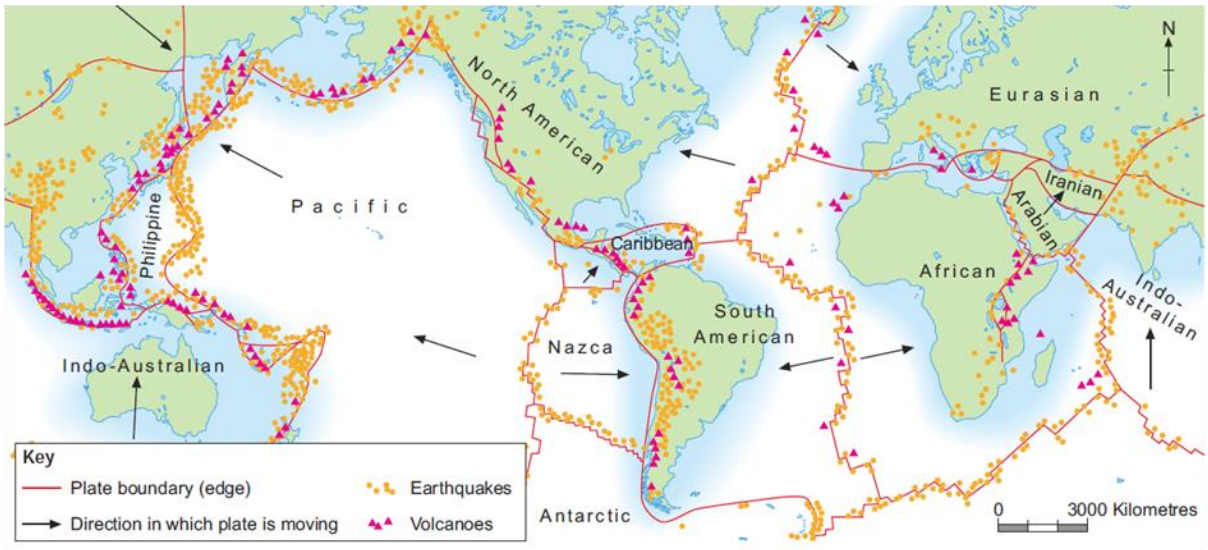
- The plates get locked together, and pressure builds up until it is released as an Earthquake.



- The magnitude (strength) of an Earthquake is measured using a seismometer on the Richter scale.

Richter Magnitude	Earthquake effects
0-2	Not felt by people
2-3	Felt little by people
3-4	Ceiling lights swing
4-5	Walls crack
5-6	Furniture moves
6-7	Some buildings collapse
7-8	Many buildings destroyed
8-Up	Total destruction of buildings, bridges and roads

- **Distribution and causes of volcanoes:**



- Caused due to the tectonic activity (refer to 6.1; Plate boundaries).
- Found on constructive and destructive plate boundaries and hotspots.

Distribution and causes of Earthquakes:

- Caused due to the tectonic activity (refer to 6.1; Plate boundaries).
- Occur mostly on the destructive and conservative plate boundaries (and sometimes on the constructive plate boundaries).
- **Earthquakes**:
- **Focus**: where the Earthquake begins underground.
- **Epicenter**: point on the surface above the focus.
- **Seismometer**: an instrument used to measure the magnitude of an Earthquake (on the Richter scale).

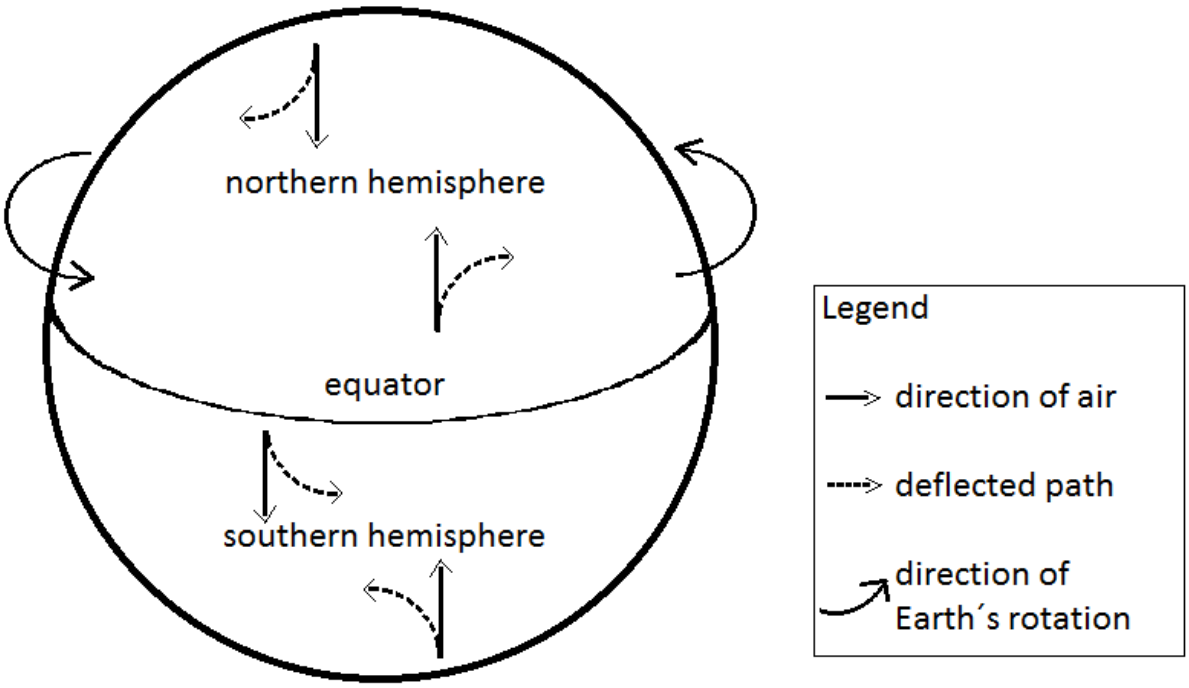
Factors that affect the impact of an Earthquake:

- Location of the epicenter;
- Time of the Earthquake;
- Geology of the area;
- Relief of the area;
- Severity of aftershocks;
- Level of development of human settlement;
- Population density;
- Building density and strength.

Tropical Cyclones

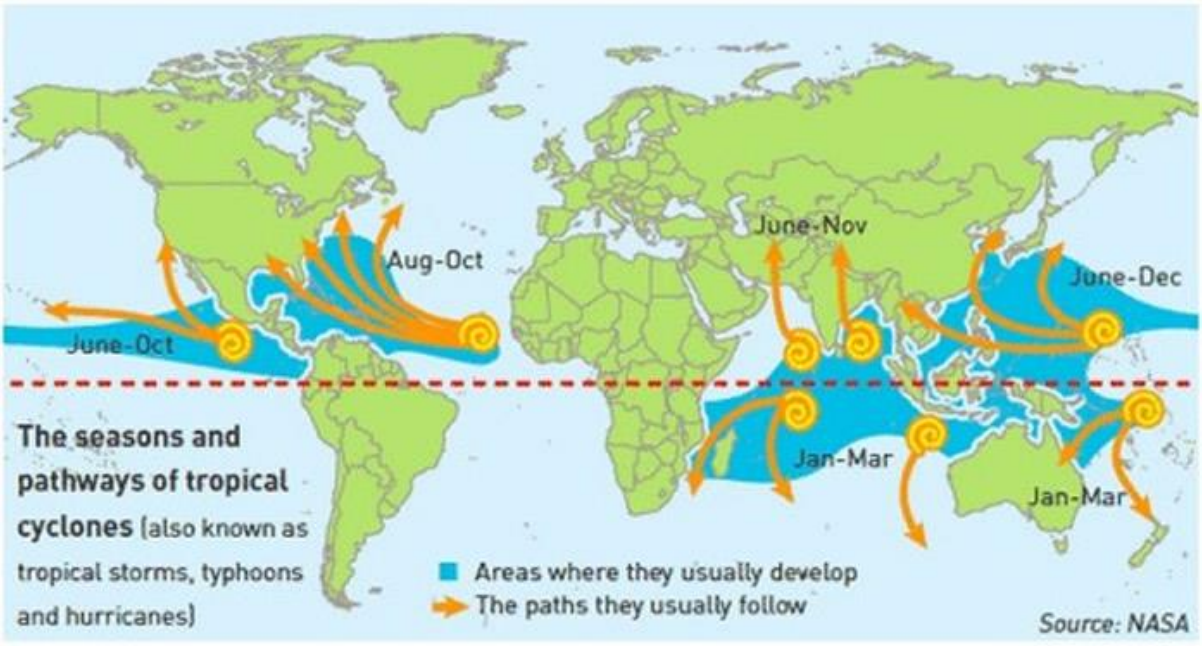
- **Causes of tropical cyclones:**
- Ocean surface temperature of at least 27°C.
    - Warm water provides the energy to evaporate more water that rises, and condenses, releasing huge amounts of energy.

- Ocean depth of at least 60m deep.



- These conditions occurring between 5° and 20° north and south to have sufficient Coriolis effect, making the air spin.
- Very little wind shear (change in wind speed or direction).
    - Allows the vertical development of the storm.

- **Distribution of tropical cyclones:**



- Between 5° and 20° north and south.
- They do not form on the equator because the Coriolis effect there is 0.
    - The air at the equator tends to flow straight from high pressure to low pressure, without any rotation.

Flooding

Physical cause	impact
heavy rainfall	Reduces the infiltration capacity of the soil;
	Increase in overland flow.
prolonged rainfall	Saturates the soil;
	Causes the water table to rise, reducing infiltration capacity.
snowmelt	Overland flow occurs due to rapid snowmelt.
land relief	Steeper slopes lead to faster overland flow has little time to infiltrate.

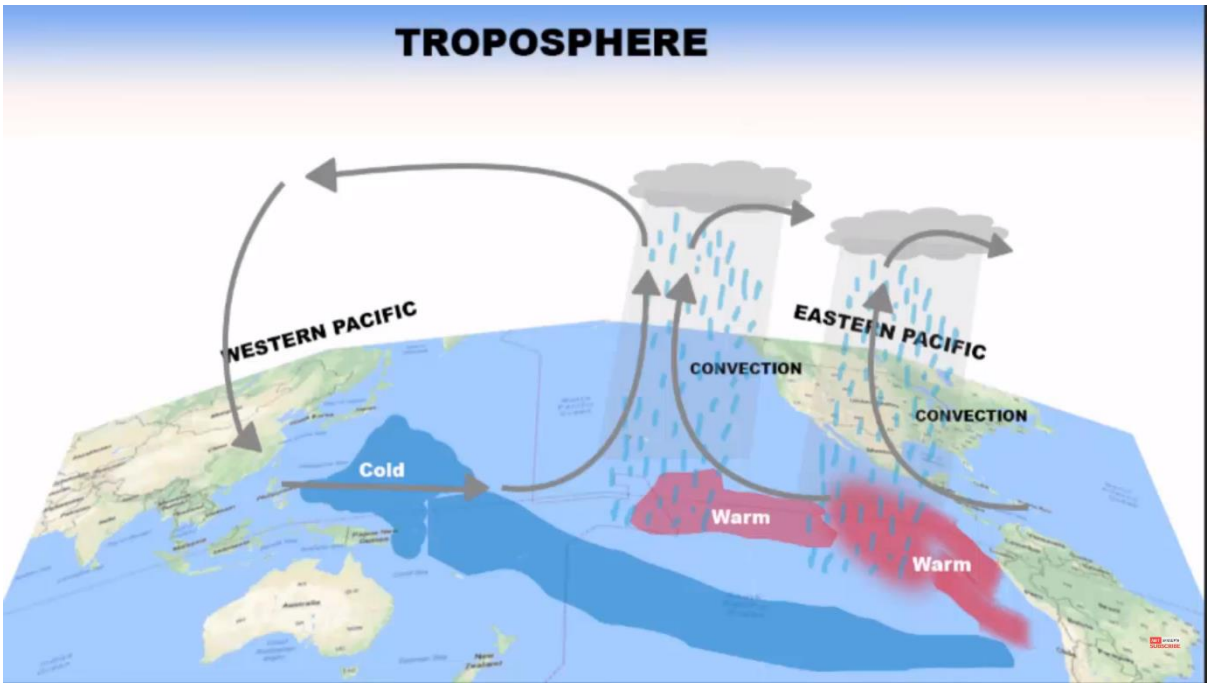
Physical cause	impact
saturated soil	The more saturated the soil is (before the rainfall), lesser infiltration and more overland flow.
storm surges, tsunamis	Flooding of low-lying coastal areas.

Human cause	IMPACT
Deforestation	Reduces interception and infiltration.
Cultivation	Ploughing down rather than across slopes increases the water flow.
Urbanisation	Concrete and tarmac are impermeable surfaces (no infiltration /><spanhigh overland flow.(
Climate change	Global warming may lead to rise in sea levels and more rainfall in some areas.

Drought

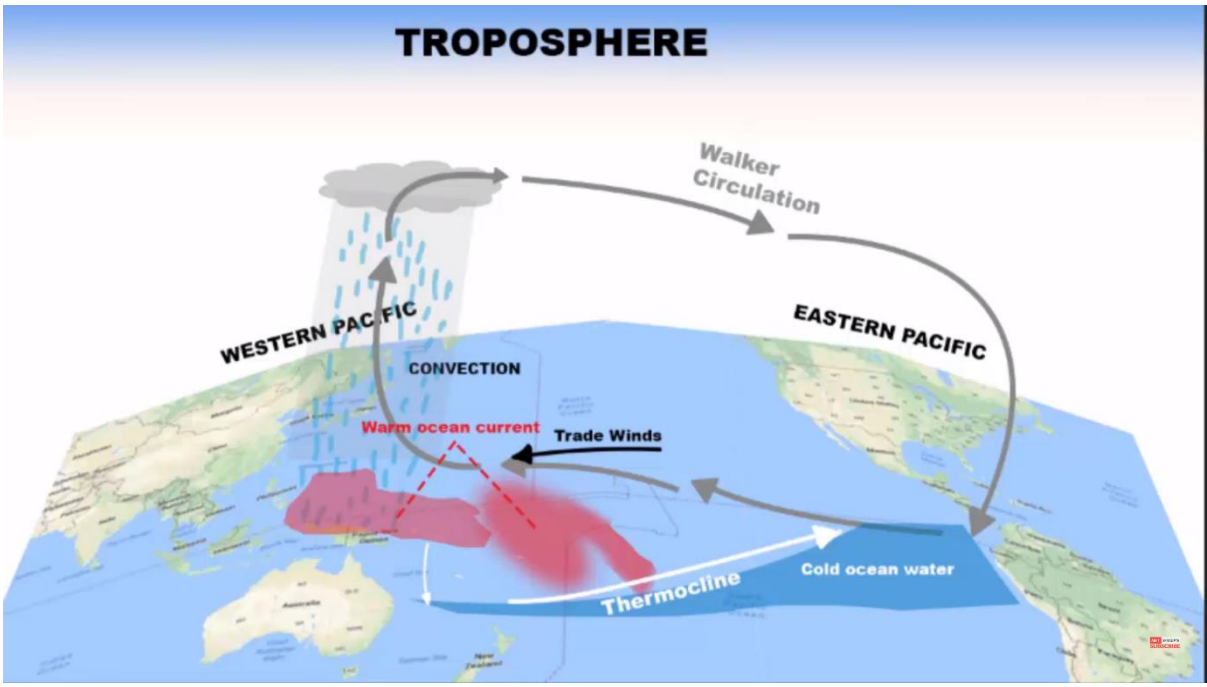
- **Causes of drought:**
- Lack of rain caused by prolonged high pressure:
    - Air in a high-pressure system sinks and doesn't form rain clouds.
- Effect of El Niño Southern Oscillation and La Niña:

- El Niño causes the surface water in the Pacific Ocean along South America to be warmer.



- These warmer waters alter storm patterns and can cause droughts in Australia.
- Whereas, La Niña causes the temperature of the water along South America to

- decrease.



- The cooler conditions cause drought in parts of North and South America.
- (refer to Section 5.2 World Fisheries; **El Niño Southern Oscillation (ENSO)**)

- Effect of climate change:
  - Warmer worldwide temperatures cause the rainfall to decrease in some parts of the world, leading to drought.

The Impacts of Natural Hazards

Impacts of tectonic events:

- Damage to buildings and infrastructure;
- Fires from ruptures of gas pipes;
- Tsunamis hit coastlines;

- Landslides cover buildings and roads;
- Destruction of farmland, leading to starvation;
- Loss of wildlife habitats;
- Water-related diseases because victims are in temporary accommodation with no sanitation or clean water;
    - Water is also contaminated by broken sewage pipes or untreated sewage.
- Loss of life;
- Trauma, poor mental health;
- Financial losses when repairing the damage.

Impacts of tropical cyclones:

- Flooding from storm surges and heavy rainfall;
- Loss of life;
- Damage to buildings and infrastructure;
- Disruption of electricity, transport and water supply;
- Water-borne diseases;
- Economic loss as production is halted;
- Damage to crops, food shortages and loss of export earnings;
- Loss of wildlife habitats.

Impacts of flooding:

- Loss of life;

- Damage to buildings and infrastructure;
- Contamination of water supplies leading to disease;
- Loss of crops and livestock leading to food shortages;
- Deposition of silt from the flood waters;
- Recharge of groundwater stores;
- Rivers may change course;
- Financial losses when repairing the damage.

Impacts of droughts:

- Water sources dry up, forcing people to travel long distances to fetch water;
- Decline in crop yields;
- Loss of crops, livestock, plants and wildlife;
- Decrease in land prices as production declines and farmers lose money;
- Migration from rural to urban areas;
- Unemployment;
- Increase in food prices;
- Health problems due to malnutrition;
- Soil erosion, leading to desertification;
- Increased risk of wildfires and poor air quality;
- Conflicts over water usage and food.

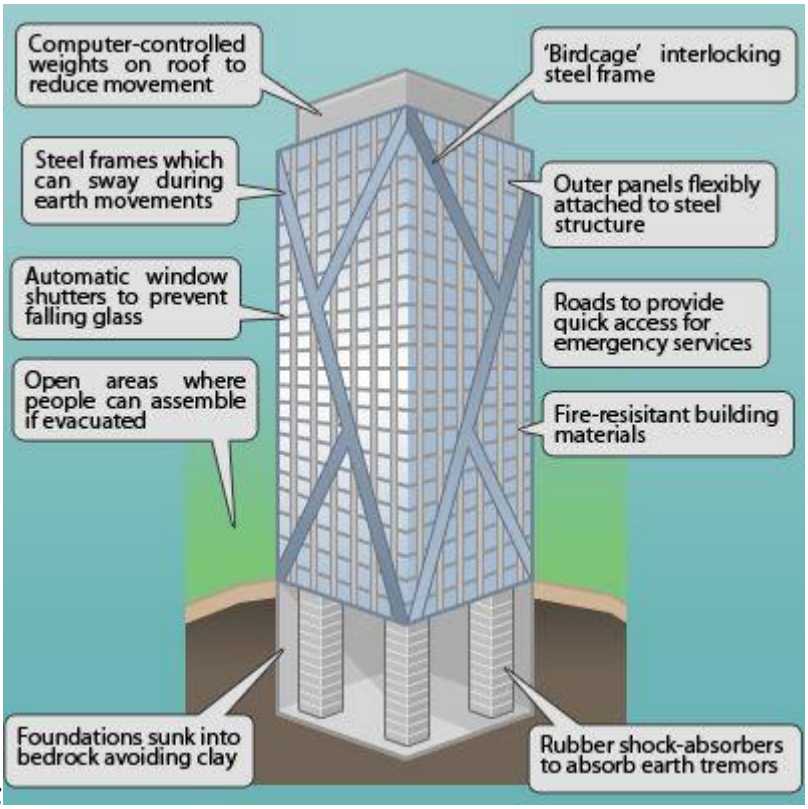
Managing the Impacts of Natural Hazards

- **Volcanoes:**

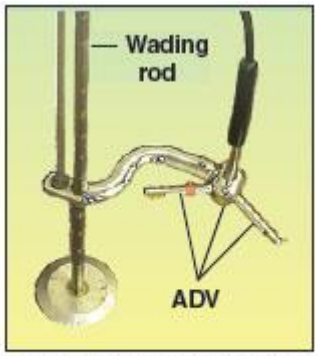
- **Prediction:**
    - Seismometers can be used to monitor tremors caused by rising magma;
    - Satellites using heat-seeking cameras can be used to monitor increasing ground temperatures;

    - Tiltmeters (measure very subtle changes in the surface of the Earth as magma accumulates) and GPS can be used to monitor changes in volcano shape;
    - Emissions of steam and gas (sulfur dioxide) can be monitored.
- **Preparation and protection:**
    - Volcano hazard map (study past eruptions);
    - Lava diversion channels and lava barriers ;
    - Spraying lava with water;
    - Halting lava advance by dropping concrete slabs into the flow;
    - Building reinforcements (sloping roofs to protect against ashfall).

- **Earthquakes:**
- **Prediction:**
    - Monitor tremors (using seismometers), groundwater levels, and radon gas;
    - Epicentres and frequencies of past events can be mapped to check if a pattern is developing;
    - Measurement of local magnetic fields;
    - A hazard zone map can be drawn (geological info and ground stability);
    - Unusual animal behaviour.
- **Preparation and protection:**
    - Earthquake-proof or aseismic buildings. Older buildings can be modernised;



    - Smart meters to switch off gas supplies, preventing fires;
    - Land-use planning: important services (schools, hospitals) must be built in low-risk areas.
- **Tropical cyclones:**
- **Prediction:**
    - Tracked using satellites.
- Preparation and protection:
    - Cyclone shelters;
    - Embankments along the coast;
    - Preserve mangrove swamps to absorb the energy of storm surges.
- **Flooding:**
- Prediction:



Acoustic Doppler Velocimeter (ADV) mounted on a rod.

    - Monitoring the amount of rainfall and river discharge using an ADV;
    - Using the features of the drainage basin and type of storm to determine the severity of the flood.

- Preparation and protection: 
    - Complex engineering projects (levees, flood barriers and dams);
    - Soft engineering projects (afforestation and storage basins);
    - Increasing the river channel (clearing vegetation);
    - Land-use planning to restrict development on floodplains;
    - Use of sandbags and pumps;
    - Adapt houses to position power sockets 1.5 m above ground level to prevent electrocution.
- **Droughts:**
- **Prediction:**
    - Monitoring precipitation and temperature.
- **Preparation and protection:**

- Increase water supplies (dams, reservoirs, wells, percolation ponds, aquifers, pumps, water transfer by pipeline, and desalination);

- Water conservation (storage tanks, spray irrigation, drought-tolerant crops, recycling water and reducing deforestation);
- Agricultural improvements (shelterbelts to decrease wind and evaporation, bunds to increase infiltration and fencing to control overgrazing);
- The government stockpiling supplies of water, food and medicine.

Opportunities Presented by Natural Hazards

- Individuals may want to be near family and friends.
- Confidence in prediction, preparation and protection.
- Employment opportunities e.g. tourism.
- No choice in moving if there is pressure on land or if it is too expensive to move.
- After a volcanic eruption, fertile soils are created that produce high crop yields.
- The scenery can be spectacular;

- Geothermal energy can be obtained easily;
- Possibility of mining minerals such as sulfur, diamonds and gold.
- Living near rivers may provide a source of food, water for drinking and irrigation.
- Communication may be easier;
- Flat land on either side is available for building on.