AQA Geography A-level

3.1.5: Hazards

Essential Notes

The Concept of Hazard

A **hazard** is a potential threat to **human life** and **property** caused by an event.

There are three major types of geographical hazard:

Geophysical	Atmospheric	Hydrological
hazards caused by **land processes**, majorly tectonic plates (e.g. volcanoes)	hazards caused by **atmospheric processes** and the conditions created because of these, such as weather systems (e.g. wildfires)	hazards caused by **water bodies** and **movement** (e.g. floods)

Aspects of Hazards

Incidence: **frequency** of a hazard

Intensity: the **power** of a hazard i.e. how strong it is

Magnitude: the size of the hazard, usually this is how a hazard's **intensity is measured**

Distribution: where hazards **occur**

Level of development: economic development will affect how a place can **respond** to a hazard, so a hazard of the same magnitude may have very different **effects** in two places of contrasting levels of development

Human Responses to Hazards

Perception

People have different **viewpoints** of how **dangerous** hazards are and what **risk** they pose. These perceptions are dependent on **lifestyle factors** such as **economic** and **cultural** factors. For example, a person who is wealthy is perhaps less likely to view a hazard as dangerous as they may have the money to respond to it.

Response

Fatalism: The viewpoint that hazards are **uncontrollable** natural events, and any losses should be **accepted** as there is nothing that can be done to stop them.

Prediction: Using **scientific research** and **past events** in order to know when a hazard will take place, so that **warnings** may be **delivered** and **impacts** of the hazard can be **reduced**. In some cases, hazards may also be **prevented** when predicted early enough. (e.g. predicting wildfires from climatic red flags)

Adaptation: Attempting to **live with hazards** by adjusting **lifestyle choices** so that vulnerability to the hazard is lessened. (e.g. earthquake proof houses.)

Mitigation: Strategies carried out to **lessen the severity of a hazard** (e.g. sandbags to offset impact of flooding)

Management: Coordinated strategies to reduce a hazard's effects. This includes prediction, adaptation, mitigation.

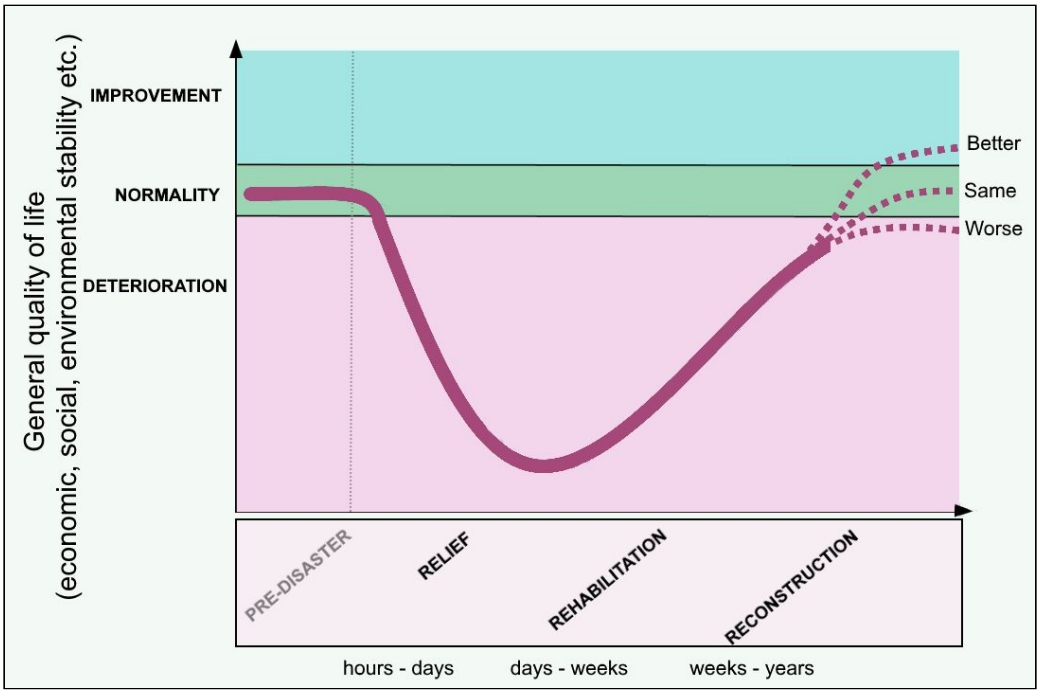
Risk sharing: A form of **community preparedness**, whereby the community **shares the risk** posed by a natural hazard and **invests collectively** to mitigate the impacts of **future hazards**.

These responses are all affected by the **aspects of hazards**. For example, **higher magnitude hazards** will clearly require more **management**. **Low incidence hazards** will be harder to **predict**, etc.

The Park Model

- **Graphical representation** of **steps carried out** in hazard **recovery**
- Rough indication of **time frame**.
- Can be used in **comparing** hazardous events (e.g. a hazardous event that is in a low income country will have a longer recovery time).
- The **steepness** of the curve shows how **quickly** an area **deteriorates** and **recovers**.
- The **depth** of the curve shows the **scale** of the **disaster** (i.e. lower the curve, lower the quality of life).

The Park Model of Human Response to Hazards



Stage 1 - Relief (hours-days)

- **Immediate** local **response** - medical aid, search and rescue
- Immediate appeal for **foreign aid** - the beginnings of global response

Stage 2 - Rehabilitation (days-weeks)

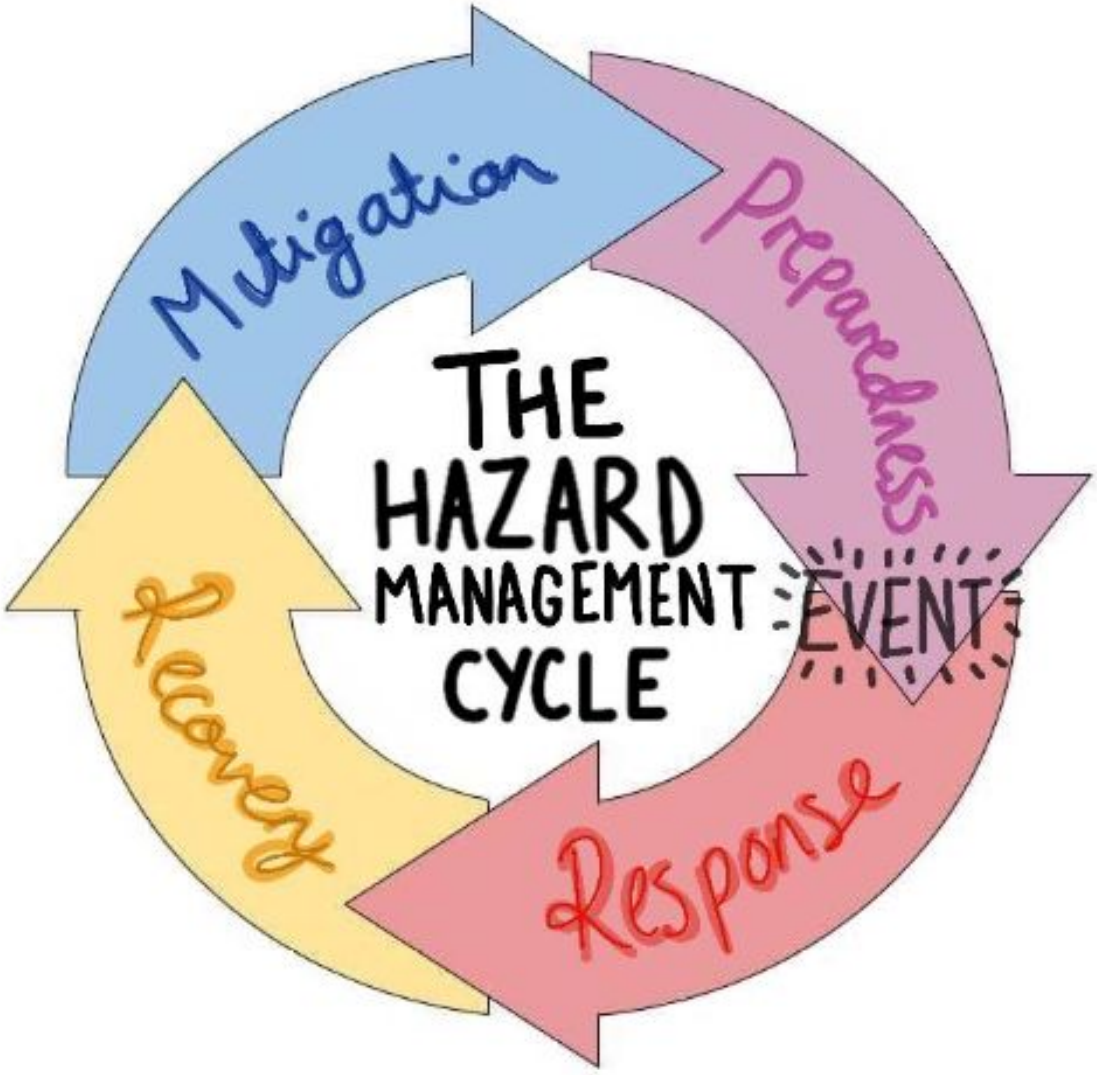
- **Services** begin to be restored
- **Temporary shelters** and **hospitals** set up
- **Food and water** distributed
- **Coordinated foreign aid** - peacekeeping forces etc.

Stage 3 - Reconstruction (weeks-years)

- **Restoring** the area to the same or better quality of life
- Area back to **normal** - ecosystem restored, crops regrown
- **Infrastructure** rebuilt
- Mitigation efforts for **future event**

The Hazard Management Cycle

The Hazard Management Cycle outlines the stages of responding to events, showing how the same stages take place after every hazard.



Preparedness

Being **ready** for an event to occur (public awareness, education, training)

Response

Immediate action taken after event (evacuation, medical assistance, rescue)

Recovery

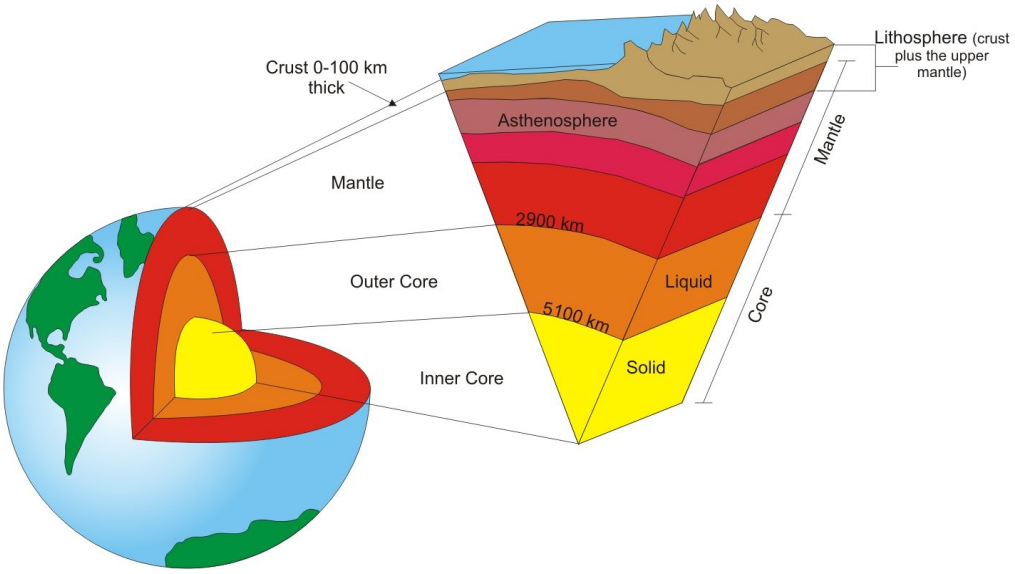
Long-term responses (restoring services, reconstruction)

Mitigation

Strategies to **lessen effects of another hazard** (barriers, warning signals developed, observatories)

Plate Tectonics

Structure of the Earth



(Source:https://www.leeds.ac.uk/ruskinrocks/Earth%20Structure.html

Inner core

- Solid ball of iron/nickel
- Very hot due to **pressure** and **radioactive decay** (contains elements such as uranium)
- This heat is responsible for **Earth's internal energy**, and it spreads throughout

Outer core

- Semi-molten
- Iron/nickel

Mantle

- Mainly solid, rocks high in silicon
- The top of the mantle is the **asthenosphere**

Asthenosphere

- **Semi-molten**
- Moves due to **convection currents**
- powered by **heat from core**
- **Lithosphere** above

Lithosphere

- Broken up into **plates**
- Majority of the lithosphere is within mantle
- The top of the lithosphere is the **crust**

Crust

- The thin top of the lithosphere
- **Oceanic crust** is **dense** and is destroyed by **plate movement, continental crust** is **less dense** and is **not destroyed.**

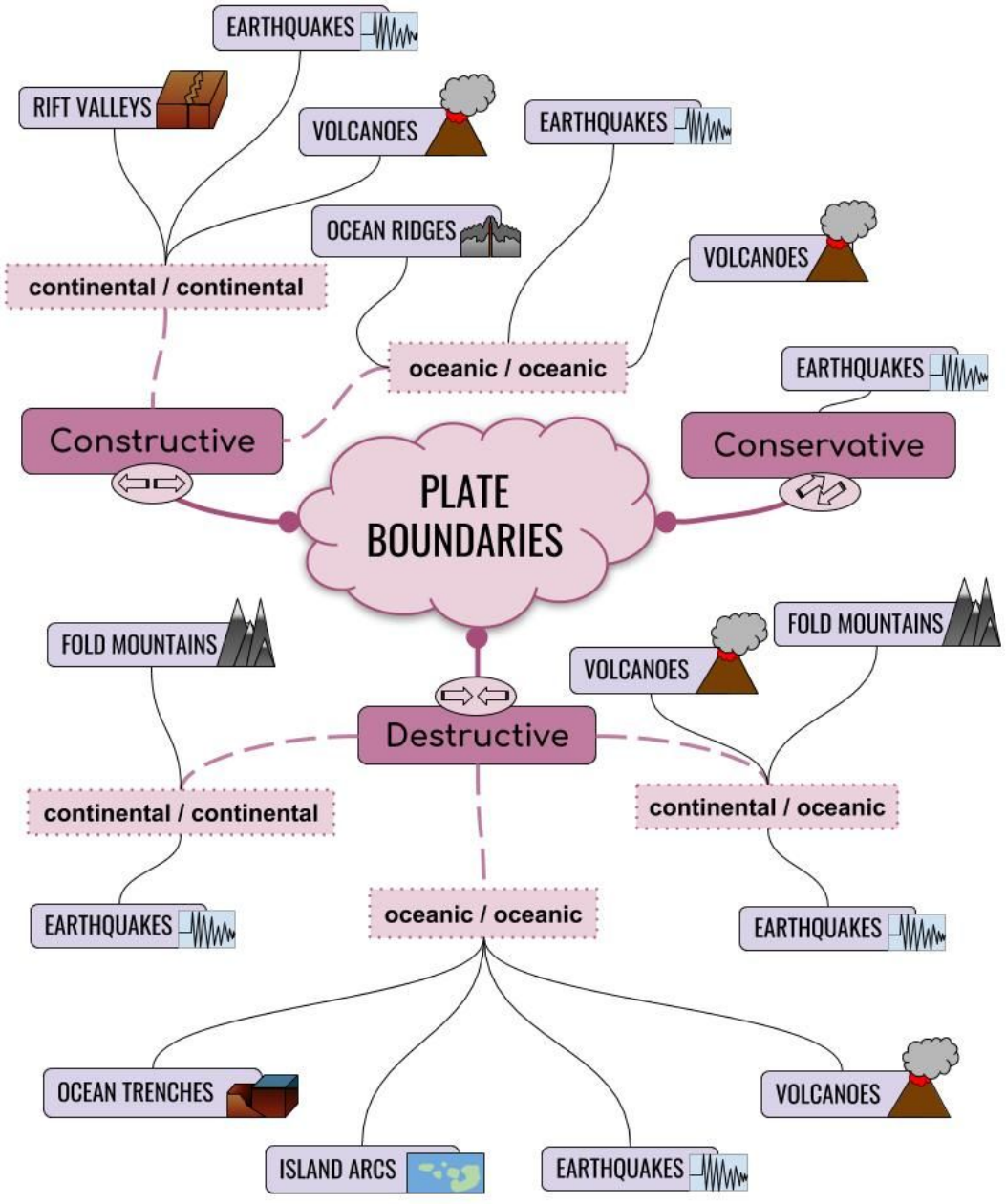
Plate tectonic theory

The lithosphere is broken up into **large slabs of rock** called **tectonic plates**.

These plates **move** due to the **convection currents** in the asthenosphere, which push and pull the plates in different directions. Convection currents are caused when the less dense magma rises, cools, then sinks. The edges of where plates meet are called **plate boundaries** (or plate margins).

Different plate boundaries

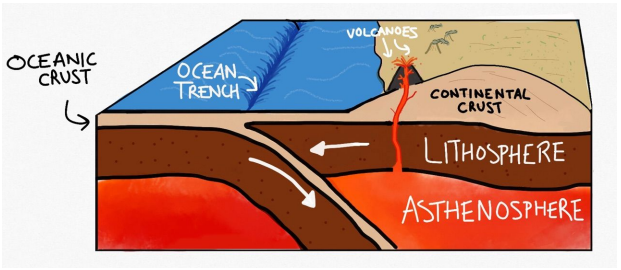
At plate boundaries, different plates can either move **towards each other** (**destructive** plate margin), **away from each other** (**constructive** plate margin), or **parallel** to each other (**conservative** plate margin). Different landforms are created in these different interactions. This spider diagram outlines what landforms and processes occur at the boundaries:



Destructive plate boundaries

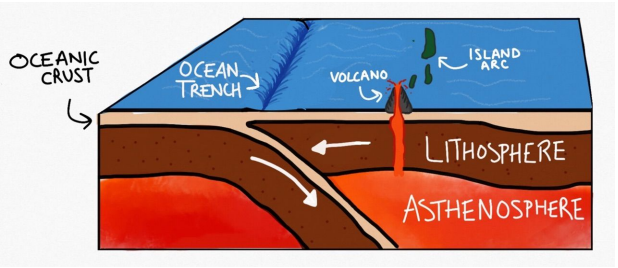
Continental and oceanic:

- Denser oceanic plate **subducts** below the continental.
- The plate subducting leaves a deep **ocean trench**.
- Built up **pressure** from the melting plate cause explosive volcanoes bursting through the **continental plate**.



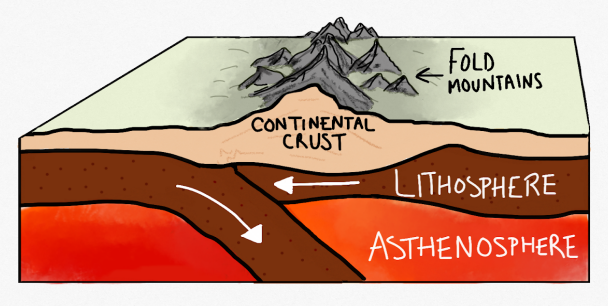
Oceanic and oceanic:

- Heavier plate **subducts** leaving an ocean trench.
- Built up pressure causes **underwater volcanoes** bursting through oceanic plate.
- Lava cools and creates new land called **island arcs**.



Continental and continental:

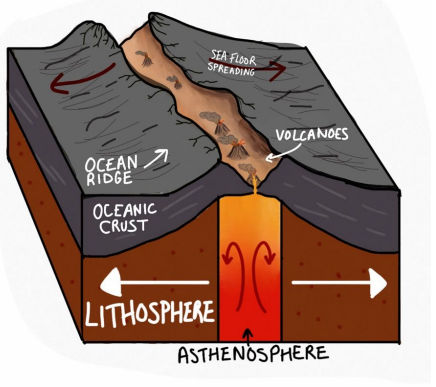
- Both plates are not as dense as oceanic so lots of **pressure builds.**
- Ancient oceanic crust is subducted slightly, but there is **no subduction of continental crust.**
- **Pile up** of continental crust on top of lithosphere due to pressure between plates.
- **Fold mountains** formed from piles of continental crust.



Constructive plate boundaries

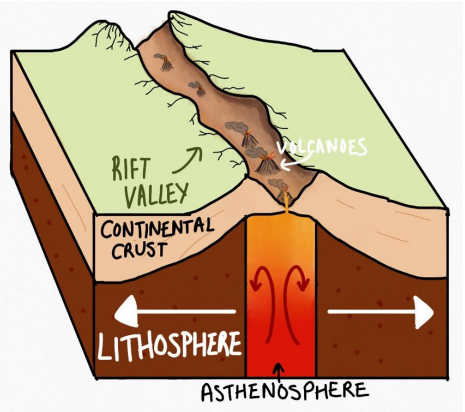
Oceanic and oceanic:

- Magma rises in between the **gap left by the two plates separating**, forming new land when it cools.
- Less explosive underwater volcanoes formed as magma rises.
- **New land** forming on the ocean floor by lava filling the gaps is known as **sea floor spreading** (as the floor spreads and gets wider).



Continental to continental:

- Any land in the middle of the separation is forced apart, causing a **rift valley**.
- Volcanoes form where the magma rises.
- Eventually the gap will most likely fill with water and separate completely from the main island.



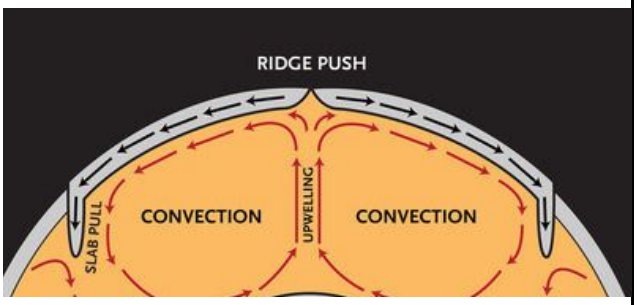
There are further forces influencing how convergent boundaries occur -

Ridge push:

The **slope** created when plates move apart has **gravity acting upon it** as it is at a **higher elevation**. Gravity pushes the plates further away, widening the gap (as this movement is influenced by gravity, it is known as **gravitational sliding**).

Slap pull:

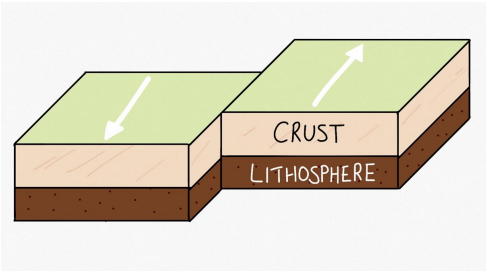
When a plate **subducts**, the plate sinking into the mantle **pulls the rest of the plate** (slab) with it, causing further subduction.



Source:CK-12 Foundation

Conservative plate boundary

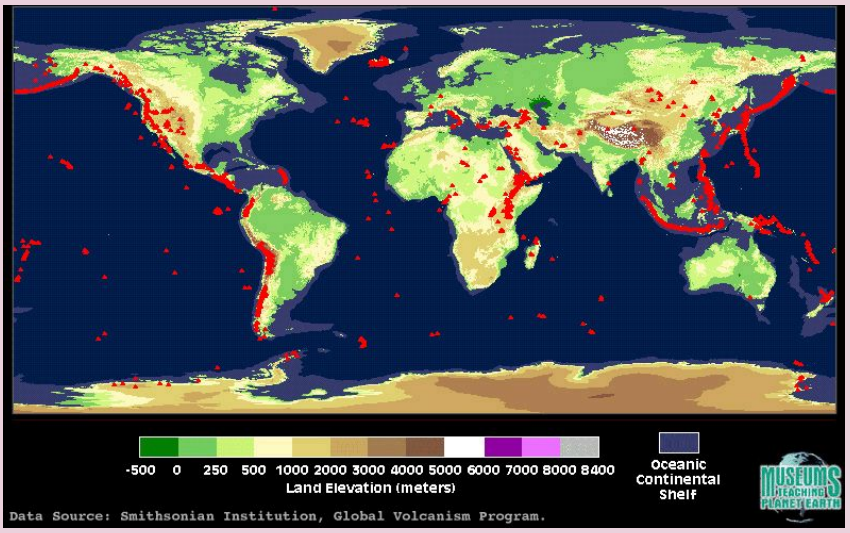
Between any crust, the **parallel plates** move in **different directions** or at **different speeds**. No plates are destroyed so no landforms are created.



Hotspots

Hotspots are areas of volcanic activity that are **not related to plate boundaries**. Hot **magma plumes** from the mantle rise and **burn through** weaker parts of the crust. This can create **volcanoes and islands**. The plume stays in the same place but the **plates continue to move**, which sometimes causes a **chain of islands** (such as Hawaii).

Volcanic Hazards

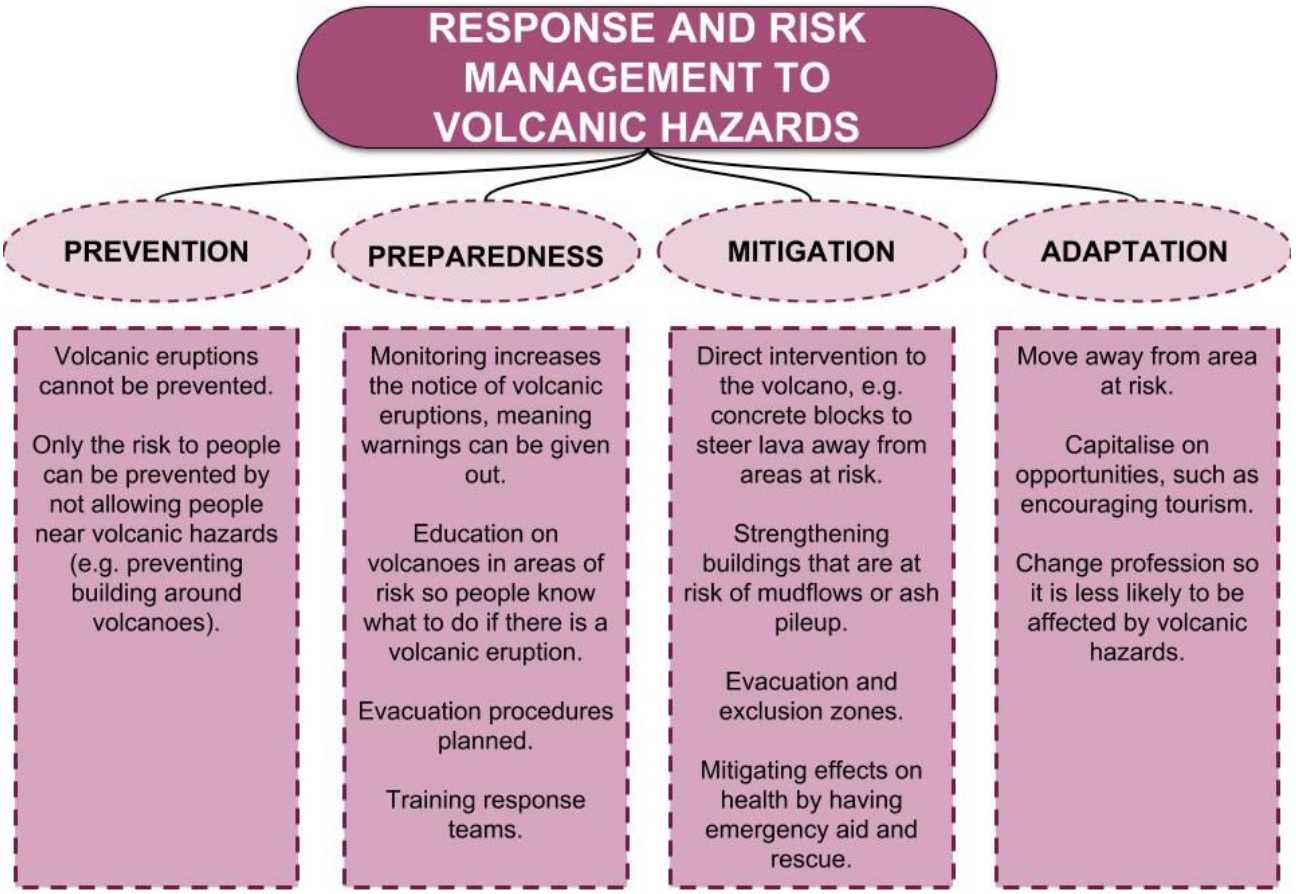
Spatial Distribution	Along **constructive** or **destructive** plate boundaries, or located on **hotspots**. 
Magnitude	**Vulcanicity** is measured using the **Volcanic Explosivity Index**. The more powerful, the more **explosive**.
Frequency	Frequency of eruptions varies per volcano. Volcanoes are classed as either **active, dormant or extinct.** An estimated **50-60 volcanoes erupt each month**, meaning volcanic eruptions are always frequent (and some volcanoes erupt constantly). The frequency of volcanic eruptions hasn't changed much in recent history.
Regularity	Volcanic eruptions are regular in that the eruptions on **each type of boundary** are similar (e.g. eruptions on destructive boundaries will regularly be more explosive than at constructive boundaries). Sometimes eruptions may be irregular and not fit patterns.
Predictability	Regularity of eruptions can help estimate when eruptions will take place (i.e. every 10 years). Seismic activity, gases releasing, elevation etc. can all indicate an imminent eruption, but there is no **definite** predictions to a volcanic eruption.

Hazards caused by volcanoes:

- Lava flows
- **Lahars** (mudflows) - caused by a number of reasons, usually by melting ice at high latitudes
- Floods - from melting ice sheets or glaciers at high latitudes
- **Tephra** - any type of rock that is ejected by a volcano
- Toxic gases - released during some eruptions
- Acid rain - caused when gases such as **sulfur dioxide** are released into the atmosphere
- **Nuées ardentes**/pyroclastic flows - clouds of burning hot ash and gas that collapses down a volcano at **high speeds**

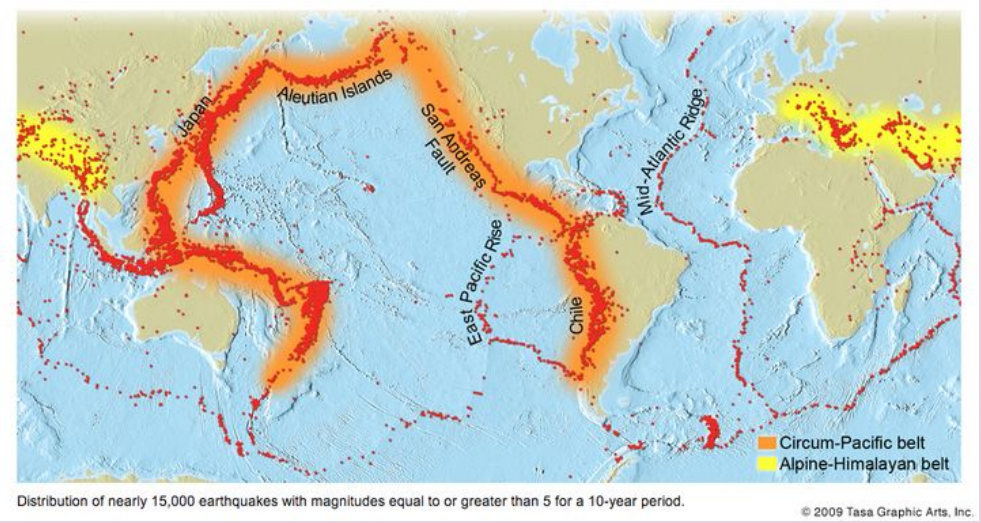
	TYPE OF VOLCANIC HAZARD			
EFFECT	**Environmental**	**Economic**	**Social**	**Political**
Primary	- **Ecosystems damaged** through various volcanic hazards - Wildlife killed	- **Businesses** and industries destroyed or disrupted	- People **killed** - **Homes destroyed** from lava/pyroclastic flows	- **Government buildings** and other important areas destroyed or disrupted
Secondary	- Water acidified by **acid rain** - Volcanic gases contribute to **greenhouse effect** (global warming)	- **Jobs lost** - Profit from **tourism** industry	- **Fires** can start which puts lives at risk - **Mudflows** or **floods** - Trauma - Homelessness	- **Conflicts** concerning government response, food shortages, insurance etc.

Hazards can be responded to by **preventing** them directly, being **prepared** for the next hazard, **mitigating** the effects of the hazard, or completely **adapting** your lifestyle to limit the hazard's effects.



Seismic Hazards

- Plates do not move in **fluid** motions
- At any boundaries, plates become stuck due to the **friction between plates**
- The pressure builds so much that it cannot be sustained and the plates eventually **give way**
- The pressure is released quickly, causing a **jolting motion** in the plates
- This jolt is responsible for **seismic** movement spreading throughout the ground
- The **focus** is the point underground where the earthquake originates from

Spatial Distribution	Along **all boundaries.**  Distribution of nearly 15,000 earthquakes with magnitudes equal to or greater than 5 for a 10-year period.
Magnitude	**Seismicity** is measures using the **logarithmic Richter Scale** which is a measure of the strength of seismic waves. The **Mercalli Scale** is also used, which is a rate of the destruction caused.
Frequency	Earthquakes are frequent around the world and occur **every day** at boundaries. Hundreds of smaller magnitude earthquakes that cannot be felt by humans occur every day, whereas the larger earthquakes are less frequent.
Regularity	Earthquakes follow no pattern and are **random** so there is irregularity between events.
Predictability	Earthquakes are almost impossible to predict. **Microquakes** may give some indication but the magnitude cannot be predicted as how strong they are is **random**.

Hazards caused by seismic events:

- **Shockwaves** (seismic waves) - energy released from the sudden jolt that vibrates through the ground
- **Tsunamis** - caused when water is displaced from plates moving underwater, creating a large wave
- **Liquefaction** - When soil is saturated, the vibrations of an earthquake cause it to act like a liquid. Soil becomes weaker and more likely to **subside** when it has large weight on it
- Landslides and avalanches

	TYPE OF SEISMIC HAZARD			
EFFECT	**Environmental**	**Economic**	**Social**	**Political**
Primary	- Earthquake can cause **fault lines** which destroy the environment - Liquefaction	- Businesses destroyed	- Buildings **collapse**, killing/injuring people and **trapping** them.	- Government buildings destroyed
Secondary	- **Radioactive materials** and other dangerous substances leaked from power plants - Saltwater from tsunamis flood **freshwater** ecosystems -Soil **salinisation**	- **Economic decline** as businesses are destroyed (tax breaks etc.) - High **cost of rebuilding** and insurance payout - Sources of income lost	- Gas pipes **rupture**, starting fires which can kill - Water supplies are contaminated as pipes burst, spreading **disease** and causing floods - Tsunamis which lead to **damaging flooding**	- Political unrest from food shortages or water shortages - Borrowing money for international aid - Can be initial chaos and '**lawlessness**' e.g. looting

RESPONSE AND RISK MANAGEMENT TO SEISMIC HAZARDS

PREVENTION

The majority of seismic hazards cannot be prevented. Earthquakes and tsunamis will occur regardless.

Liquefaction of soils can be prevented through soil stabilisation (gravel columns can be put in the ground).

Avalanches can be prevented through controlled explosions.

PREPAREDNESS

Earthquake prone areas (such as Japan) have extensive awareness strategies and education in place e.g. Drop, Cover, Hold On.

Earthquake warning systems and tsunami warning systems after an earthquake.

Evacuation plans and training.

MITIGATION

Search and rescue, immediate emergency aid, evacuation (short term).

Demolishing older, unsafe buildings.

Tsunami wave breaks and sea walls.

ADAPTATION

Move away from area at risk.

Capitalise on opportunities, such as encouraging tourism.

Insurance if living in places of risk.

Changing lifestyle choices e.g. moving valuable items so they cannot fall.

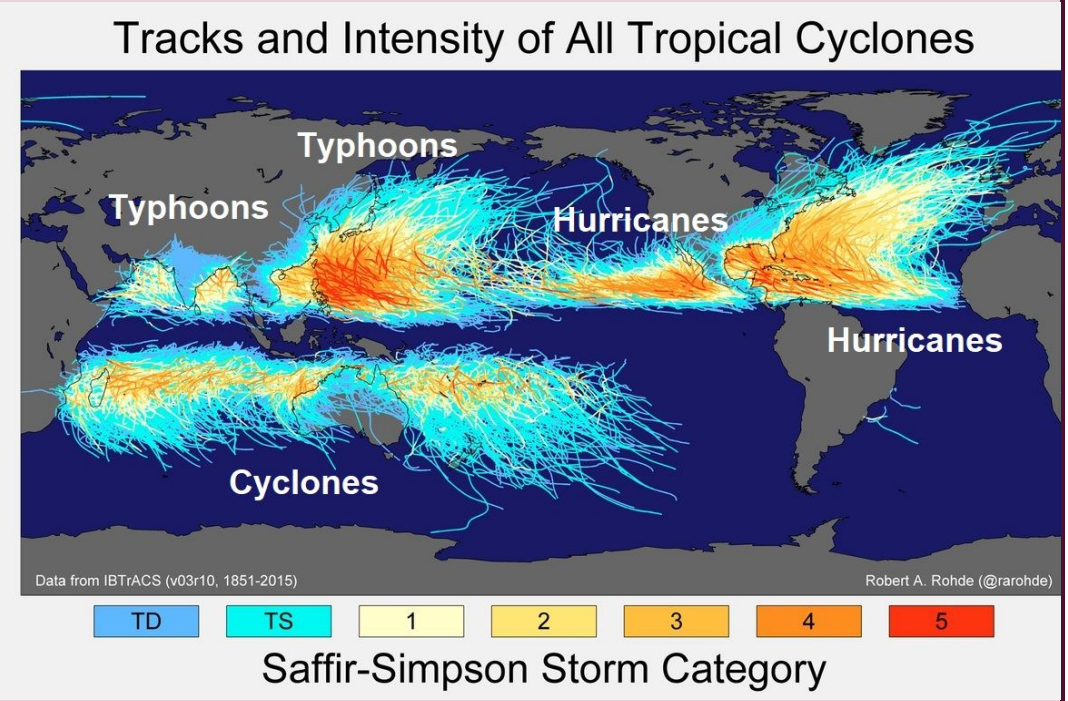
Building specially designed 'earthquake proof' buildings.

Storm Hazards

Tropical storm: a **low pressure**, spinning storm with high winds and torrential rain.

Conditions for a storm to form:

- **Temperature:** Ocean temperatures must be around **26 - 27°C** to at least 50 metres deep.
- **Rotation:** Forms around the equator but no less than **5° on either side**.
- **Air pressure:** Must be in areas of **unstable air pressure** - usually where areas of high pressure and low pressure meet (**convergence**) - so that warm air rises more readily and the clouds can form.

Spatial Distribution	
Magnitude	Measured on the **Saffir-Simpson Scale** (A scale of 1-5) based on wind speed and thus power of the storm.
Frequency	Northern Hemisphere from June-November, Southern Hemisphere from November-April. Tropical storms that are **more powerful** and reaching land are thought to be increasing in frequency.
Regularity	Tropical storms are **irregular** because although they occur in the **same areas**, their path does not follow a set route - the route taken is **dependent on the storm** and the climatic conditions.
Predictability	Tropical storms form **away from land** meaning **satellite tracking** of cloud formations and movement can be tracked and the general route can be predicted.

Hazards caused by tropical storms:

- **High winds** - over **300km/h** and therefore very strong
- **Flooding** - coastal/river flooding from **storm surges** and **heavy rain**
- **Landslides** - due to soil becoming **heavy** when wet with high levels of rain
- **Storm surges** - Large **rise in sea levels** caused by low pressure and high winds, pushing water towards the coast

	TYPE OF STORM HAZARD			
EFFECT	**Environmental**	**Economic**	**Social**	**Political**
Primary	- Beaches **eroded** -Sand displaced - Coastal **habitats** such as coral reefs are destroyed	- Businesses destroyed - **Agricultural land** damaged	- **Drowning** - **Debris** carried by high winds can injure or kill - Buildings destroyed	- Government buildings destroyed
Secondary	- River flooding/ **salt water** contamination - **Animals displaced** from flooding e.g. alligators -Water sources **changing course** from blockages	- High cost of **rebuilding** and **insurance** payout - Sources of income lost - Economic decline from sources of income destroyed	- Homelessness - **Polluted water** supplies spread disease - Food shortages from damaged land	- Issues paying back international aid - Pressure for government to do more about **global warming**

RESPONSE AND RISK MANAGEMENT TO STORM HAZARDS

PREVENTION

In current climates and weather conditions, tropical storms cannot be avoided.

Strategies to mitigate climate change could prevent higher category storms.

PREPAREDNESS

Awareness through education of what to do during a tropical storm.

Evacuation plans and training.

Satellite image tracking to manage the areas that are at risk.

Storm warning systems and television broadcasts tracking the storm.

MITIGATION

Search and rescue, immediate emergency aid, evacuation (short term).

Strengthening the home through door barricades, roof strengthening etc.

Clearing loose debris before storms.

ADAPTATION

Move away from area at risk.

Design buildings to withstand high winds and flood damage.

Flood defenses such as houses on stilts, coastal walls, river levees etc.

Wildfire Hazards

Wildfire: A large, **uncontrolled** fire that quickly spreads through vegetation.

Conditions favouring intense wildfires:

Vegetation Type

Thick, close together vegetation allows fires to spread **quickly** and easily. **Trees and thick bushes** lead to more intense wildfires; grasslands do not burn as intensely. Vegetation with **flammable oils** - like eucalyptus - causes more intense fires also.

Fuel Characteristics

Vegetation should be **dry** to allow it to catch. **Finer** vegetation causes fires to spread **quicker**, but larger, **thicker** forms of vegetation burns for longer and more intensely.

Climate and Recent Weather

Must be in a climate that has **enough rainfall to have sufficient plant growth**, but considerable dry spells and droughts to **dry out the fuel**. Areas with **dry seasons** such as California allow for intense wildfires. **Wind** also causes fires to spread quicker. **Recent temperature increases** have caused an **increase** in the number of **wildfires**.

"Forest fires in the western US have been occurring nearly five times more often since the 1970s and 80s. Such fires are burning more than six times the land area as before, and lasting almost five times longer."

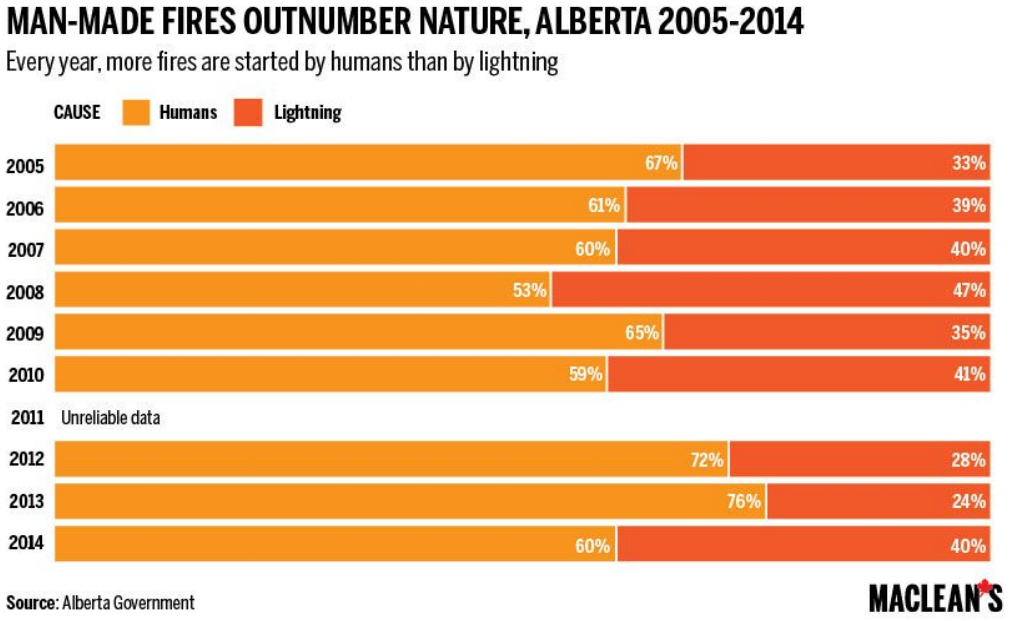
(https://www.dw.com/en/how-climate-change-is-increasing-forest-fires-around-the-world/a-19465490)

Fire Behaviour

Fires spread quickly on **hills** as the heat rises. Fire can also **'jump'** across rivers and into areas due to **lit debris** which causes it to **spread**.

Causes

Wildfires can be caused **naturally** or by **humans**. The majority of the time, wildfires are not naturally started. Humans may start fires **accidentally** or through **arson**.
Natural causes include spontaneous combustion, volcanoes and lightning; **human causes** can be lit cigarettes, BBQ's, agriculture, train lines and more.



	HAZARD			
EFFECT	**Environmental**	**Economic**	**Social**	**Political**
Primary	-**Air pollution** from ash -**Water pollution** -Habitats destroyed in fire -**Toxic gases** released in burning	- Businesses destroyed - Agricultural land damaged - Cost of **fighting fires** (firefighters, helicopters, water)	-People killed or injured in fires - Homes destroyed - People go **missing** during evacuations	- Government buildings destroyed
Secondary	- Removing **invasive species** and stimulating seed **germination** - **Migration** patterns of animals affected -Increased **CO2** from fires could heighten the greenhouse effect	- High cost of rebuilding and insurance payout - Sources of income lost - Discouraging visitors, losing **tourism** sector -**Planes** cancelled	- Homelessness - Food shortages from destroyed agricultural land - **Health problems** such as asthma from **smoke inhalation**	- Borrowing money for international aid - Pressure for government to do more about global warming due to increased frequency