

The Challenge of Natural Hazards: Tectonic Hazards

What is a natural hazard?

An extreme event that occurs naturally and can cause loss of life, extreme damage to property and disrupt human activities. It can be tectonic (earthquakes, tsunamis and volcanic activity), geomorphological (avalanches and floods) biological (extreme temperatures, drought and wildfires), atmospheric (hurricanes) or biological (forest fire disease epidemics).

What factors affect hazard risk?

Hazard risk is the probability of being affected by a natural event and may be affected by factors such as: geographical location, magnitude, duration, frequency, level of economic development, education and population density/distribution.

Key Term	Definition
Conservative plate margin	Tectonic plate margin where two tectonic plates slide past each other.
Constructive Plate Margin	Tectonic plate margin where rising magma adds new material to plates that are diverging or moving apart.
Destructive plate margin	Tectonic plate margin where two plates are converging or coming together and oceanic plate is subducted. It can be associated with violent earthquakes and explosive volcanoes.
Earthquake	A sudden or violent movement within the Earth's crust followed by a series of shocks.
Immediate responses	The reaction of people as the disaster happens and in the immediate aftermath.
Long-term responses	Later reactions that occur in the weeks, months and years after the event.
Monitoring	Recording physical changes, such as earthquake tremors around a volcano, to help forecast when and where a natural hazard might strike.
Plate margin	The margin or boundary between two tectonic plates.
Planning	Actions taken to enable communities to respond to, and recover from, natural disasters, through measures such as emergency evacuation plans, information management, communications and warning systems.
Prediction	Attempts to forecast when and where a natural hazard will strike, based on current knowledge. This can be done to some extent for volcanic eruptions (and tropical storms), but less reliably for earthquakes.
Primary effects	The initial impact of a natural event on people and property, caused directly by it, for instance buildings collapsing following an earthquake.
Protection	Actions taken before a hazard strikes to reduce its impact, such as educating people or improving building design.
Secondary effects	The after-effects that occur as indirect impacts of a natural event, sometimes on a longer timescale, for instance fires due to ruptured gas mains resulting from the ground shaking.
Tectonic hazard	A natural hazard caused by movement of tectonic plates (including volcanoes and earthquakes).
Tectonic plate	A rigid segment of the Earth's crust which can 'float' across the heavier, semi-molten rock below. Continental plates are less dense, but thicker than oceanic plates.
Volcano	An opening in the Earth's crust from which lava, ash and gases erupt.

Structure of the Earth

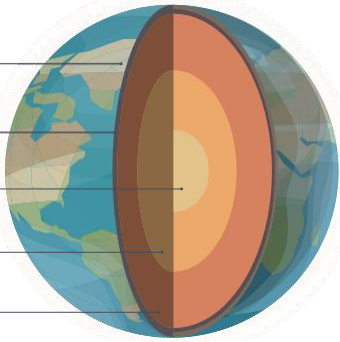
Crust

Lithosphere

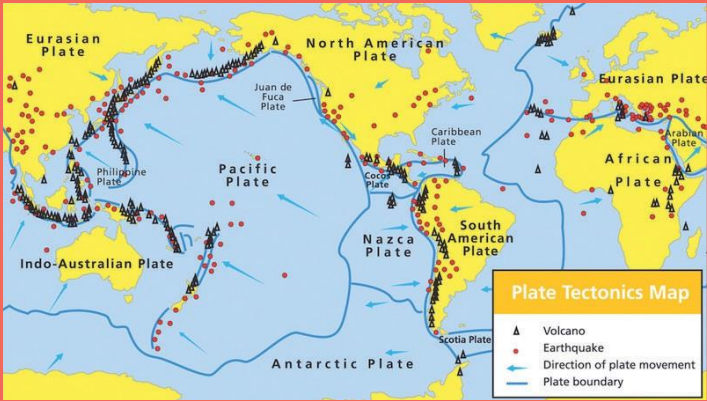
Inner core

Outer core

Mantle

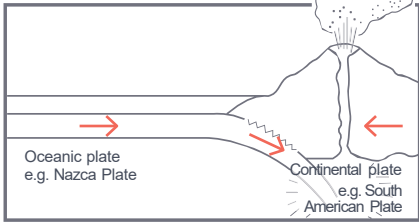


Distribution of Earthquakes & Volcanoes



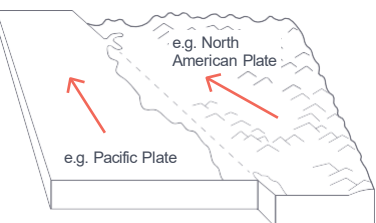
Types of Plate Margin

Destructive margin



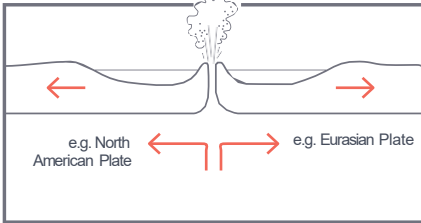
Activity: **Earthquakes and volcanoes**

Conservative margin



Activity: **Earthquakes**

Constructive margin



Activity: **Earthquakes and volcanoes**

Plate Movement

The lithosphere is broken into tectonic plates which move very slowly. Three of the forces proposed as the main drivers of tectonic plate movement are: **Convection currents**; **Ridge push**; **Slab pull**

Effects of Tectonic Hazards

Volcanic Eruptions		Earthquakes	
Primary Effects • People and animals may be injured or killed. • Buildings and roads may be destroyed. • Crops are damaged and water supplies contaminated. • Harmful gas emissions	Secondary Effects • Respiratory problems • Roads are blocked – aid and emergency services can't get through • Possible flooding if ice melts • Air travel may be halted due to volcanic ash • Economy slows down. • Tourism can increase as people come to watch. • Ash breaks down leading to fertile farm land.	Primary Effects • Property and buildings destroyed. • People injured or killed. • Ports, roads, railways damaged. • Pipes (water and gas) and electricity cables broken.	Secondary Effects • Business reduced as money spent repairing property. • Blocked transport routes hinder emergency services. • Broken gas pipes cause fire. • Broken water pipes lead to a lack of fresh water.

Responses to Tectonic Hazards

Volcanic Eruptions		Earthquakes	
Immediate • Issue warnings if possible. • Restrict access to areas and/or evacuate areas • Rescue teams search for survivors. • Treat injured. • Provide shelter, food and drink. • Recover bodies. • Extinguish fires.	Long Term • Restore utilities. • Repair and re-build properties & infrastructure. • Resettle locals elsewhere. • Develop opportunities for recovery of economy. • Install monitoring technology. • Improve building design to reduce the risks from ash weight on buildings. • Educate locals	Immediate • Search for survivors • Provide shelter and emergency supplies • Treat injured • Recover bodies • Extinguish fires	Long Term • Improve building regulations. • Use appropriate technology to design earthquake resistant buildings. • Monitor through use of seismographs.

Case Study: Volcanic Eruption

High Income Country: Iceland

Name: Eyjafjallajokull

Date: 20th Mar - 17th Jun 2010

VEI: 3



Low Income Country: Guatemala

Name: Fuego

Date: 3rd - 5th June 2018

VEI: 3



Effects	Responses	Effects	Responses
- Sub-glacial eruption led to jokulhlaups (glacial meltwater floods). - Heavy ash fallout created dangerous driving conditions and plunged areas into total darkness. - Water and crops were contaminated with ash. - Some locals experienced sore eyes and throats and respiratory problems. - Ash was carried by jet stream towards northern Europe.	- Automated warning messages sent to phones and alerts displayed on TV. 700 people evacuated - Rescue workers helped 70 tourists trapped near the volcano - Community meetings were held to bring locals up to date information. - Farmers advised to keep livestock indoors to avoid contaminated water and hay. - Diggers used to remove sections of the main road in 4 places to divert flood water and relieve pressure on the road bridge. - Face masks distributed to residents in the worst affected areas. - Air space was closed in much of Europe. In total 107,000 flights were cancelled, impacting over 10 million passengers and air cargo delivery. - Assistance was given to residents to clean ash from infrastructure. - Some compensation and financial support available for damage to houses and cultivated land due to flooding and ash - Farms around Iceland harvested more hay than normal to form a “hay bank” for farmers in ash affected areas.	- More than 190 people killed but official figures are disputed. - Villages on the slopes were buried in volcanic ash and mud following pyroclastic flows and lahars. - More than 1.7 million people were affected. - Ash rained down on towns and cities across a far wider area and the airport in Guatemala City was temporarily closed by debris on the runway. - Estimated that 12,823 people were evacuated and 3,613 people placed in shelters. - Crops and livestock were destroyed and damaged, affecting population’s livelihoods and impacting their food security and household economic security.	- Seismologists warned of the eruption eight hours before the main eruption. - Government faced criticism for not acting sooner to start forced evacuations. - The eruption moved quickly and communities around the volcano had very little time to flee. - Locals living on the slopes are used to smaller eruptions and were caught by surprise. - Almost 4,000 people were housed in temporary shelters. - Search and rescue teams push through ash and debris to reach villages buried under pyroclastic flow and debris to search for missing people. - Survivors were being treated for burns and breathing difficulties. - Local residents had received training in emergency procedures but were not able to implement them because the initial volcanic activity happened too fast. - Volunteers have been handing out food and other essentials to those affected, as well as to rescue workers.

Comparing high and low income countries

Effects and responses are often influenced by the level of economic development and may be dependent upon resources and finance, population density, building density, distance from the eruption, type of volcanic hazard, medical facilities, transport infrastructure, monitoring and prediction, emergency services and training

Why people live in hazardous areas

Geothermal Energy. Fertile Soils. Mineral Resources. Tourism

Reducing the Risk of Tectonic Hazards: Volcanoes		
Monitoring and Prediction	Protection	Planning
Equipment to monitor advance warning signals	- Attempt to divert lava flows away from settlements - Set up exclusion zones - Supply gas masks	- Prepare an evacuation plan - Provide details of plan to locals

Reducing the Risk of Tectonic Hazards: Earthquakes		
Monitoring and Prediction	Protection	Planning
- Seismometers measure earth tremors - Mapping earthquake locations to look for patterns - Animal behaviour	Designing earthquake resistant buildings and infrastructure	- Prepare emergency supplies and plan location of emergency shelters. - Training of emergency personnel - Education of local population

Case Study: Earthquake

High Income Country: New Zealand

Date: 22nd Feb 2011

Time: 12.51pm

Magnitude: 7.3

Epicentre: 10km SE of Christchurch

Depth: 5km



Low Income Country: Haiti

Date: 12th Jan 2010

Time: 4.53pm

Magnitude: 7

Epicentre: 25km west of Port au Prince

Depth: 13km



Effects	Responses	Effects	Responses
185 people were killed 164 people were seriously injured - Cost \$18 billion - Water pipes, roads, bridges, power lines, cell phone towers and ordinary phone lines were broken or damaged. - Liquefaction caused buildings and other structures to sink into the ground. - Up to 100,000 buildings were damaged and about 10,000 buildings needed to be demolished. - Many people needed to use portable or chemical toilets, and got their water from tankers for months after the quake.	- The government declared a national state of emergency the day after the quake. - Authorities quickly cordoned off Christchurch’s central business district. The cordon remained in place in some areas until June 2013. - Power companies restored electricity to 75% of the city within three days, but re-establishing water supplies and sewerage systems took much longer. - Over a quarter of the buildings in the central business district were demolished - The population for the greater Christchurch area declined by 9,200 (2%) - A number of schools found they couldn’t follow the emergency procedures they had practised because many students were outside the classroom having lunch.	- Over 220,000 people were killed. - At least 300,000 people were seriously injured - Cost \$14 billion - About 1.5 million were made homeless - Many of Port-au-Prince’s multi-story concrete buildings collapsed 3,978 schools were damaged or destroyed - An outbreak of cholera in October 2010 resulted in 5,899 deaths with 216,000 people infected.	- Over 600,000 people left their homes in Port-au-Prince. - People were living in makeshift internally displaced persons (IDP) camps. - Neighbouring Dominican Republic provided emergency water and medical supplies as well as heavy machinery to help with search and rescue but most people were left to dig through the rubble by hand. - Emergency rescue teams arrived from a number of countries e.g. Iceland. - Temporary field hospitals were set up by organisations like the International Red Cross to treat the injured. - GIS was used to provide satellite images and maps of the area, to assist aid organisations. - United Nations troops and police were sent to help distribute aid and keep order. \$13.34 billion of aid was allocated by international agencies to assist in rebuilding. ‘Cash for work’ programmes paid Haitians to clear rubble. - Small farmers were being supported to grow crops. - Schools were rebuilt.

Comparing high and low income countries

Effects and responses are often influenced by the level of economic development and may be dependent upon resources and finance, population density, building density, distance from the epicentre, depth of focus, medical facilities, transport infrastructure, monitoring and prediction, emergency services and training, time and day of week, time of year, construction standards.

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rayburntours AQA