Volcanic eruption impacts & human response
3.1.5.3 Hazards

What you need to know
The primary and secondary impacts of volcanic hazards including environmental, social, economic and political impacts.
Short and long-term responses: risk management designed to reduce the impacts of the hazard through preparedness, mitigation, prevention and adaptation.
Impacts and human responses as evidenced by a recent volcanic event.

The impacts of volcanic hazards

A volcanic eruption can impact people and property on a range of scales from local to global. Impacts can be divided into primary and secondary impacts.

- **Primary impacts** occur as a direct result of, and immediately after, a volcanic eruption. Lava and pyroclastic flows cause damage and destruction to buildings and infrastructure including communications, roads and railway networks. Falling ash, tephra and volcanic rocks cause further damage to buildings and roads, pollute rivers and lakes, and destruction of forests, vegetation and crops over large areas. It can also turn day to night as the ash blocks out sunlight.

- **Secondary impacts** are less direct impacts and occur in the days, weeks or even months following an eruption. Lava and pyroclastic flows often melt glacier-clad volcanoes and the resulting fast-flowing mudflows or lahars can kill or injure people. After the eruption of Mount St. Helens in May 1980, lahars transported over 3 000 000 m^3 of material over 17 miles south into the Columbia River, destroying 200 homes, many of the roads and eight bridged along the Toutle and Cowlitz Rivers in the process. These cost $145 million to replace. Economic consequences arose as unemployment in the area increased tenfold and the overall cost of the eruption was $1.1 billion. The destruction of road and railway networks can slow access for emergency services, meaning people are more likely to die, as they cannot reach local hospitals for treatment. Volcanic landslides are gravity-driven slides of volcanic rocks; ground deformations that occur during eruptions can increase the angle of the volcano's flanks and triggers dangerous slides and debris avalanches.

  Tsunami are giant 'harbour waves' (Japanese) that are common after large caldera-forming eruptions. The most famous example being the 35-metre high tsunami triggered in Indonesia by the eruption of Krakatoa in 1883 which killed more than 30,000 people.

  Social impacts from an eruption can be anything from psychological problems caused by the loss of family, friends and homes to the collapse of schools and public facilities necessary for education and community activities.

  After the eruption of Mount Merapi in Central Java in November 2010, 320 000 people were made homeless and nine villages close to the volcano were formally abandoned as the government considered them to be unsafe. Much of the exclusion zone is now a National Park. However, some locals have taken the

government to court about losing their land rights. In future eruptions, local people may not evacuate, choosing to stay and protect their homes and land, risking death, but securing their homes.

Short-term responses to volcanic hazards
The first responses any country makes when a volcano erupts, is the deployment of the emergency services to search for and take the injured to hospital for medical treatment. Often first-responders from neighbouring countries and international medical charities such as Medicines Sans Frontier and the Red Cross will supply trained medical staff to help if the scale of the disaster is big or the local population is vulnerable. The first 24 hours are the most critical for the injured. In the following days, governments and charities start to transport shelter, food, water and medical supplies to help make homeless victims more comfortable. Umbrella organisations such as Disaster Emergency Committee (DEC) in the UK co-ordinate the efforts of leading aid charities to save lives and help communities in poorer countries.

Long-term responses to volcanic hazards
There are a number of long-term responses a country can take to reduce the impacts of future eruptions. These involve environmental control, modifying vulnerability, prevention and adaptation.

- **Environmental control.** It is impossible to control a volcanic eruption. However, the path taken by lava flows and mudflows can sometimes be diverted. Seawater was sprayed onto lava flows during the eruption of Eldafell on Heimaey, Iceland in 1973 to slow the lava and protect the harbour of Vestmannaeyjar. When Mount Etna erupted in 1983, scientists took the unusual step of using explosives to divert the lava flow away from the towns of Rocca and Ragalna. Lava and pyroclastic flows tend to follow well-defined routes; therefore it is more plausible to move people away from hazardous areas than to move the volcanic hazard itself.

  If people do not want to move away from living near to a volcano, little can be done to resist lava, mud or pyroclastic flows, since they are so powerful that they will destroy anything in their path. Buildings can be constructed on areas of high ground away from valleys avoiding the paths of lava, mud or pyroclastic flows. Buildings can also be built to resist ash fallout. Roofs can be built with a steep pitch (> 45 degrees) to allow ash to slide off and with strong materials such as reinforced concrete rather than tiles or corrugated iron to prevent collapse. In areas where lahars are common, homes can be built on stilts so that flows can travel underneath rather than through buildings. These measures can all keep residents safe until the eruption is over.

- **Modifying vulnerability.** People are vulnerable to natural hazards if they are unable to prepare for eruptions ahead of time. The most vulnerable populations tend to be those living in poverty and less well educated. They are less likely to be able to manage the volcanic hazard effectively. Evacuation is the best way to save lives, but the community needs to know that a volcano is about to erupt, in order to evacuate in time. Most active volcanoes are now monitored, but the advance preparation and community management to organise the evacuation can be expensive.

In January 2002 over 400 000 residents from the city of Goma in the Democratic Republic of the Congo were evacuated over three days across the Rwandan border in anticipation of the eruption of the Mount Nyiragongo. This was impressive since there are few functioning institutions in the country set up to organise such a mass movement of people. In the end only 147 people died in the eruption, even though thousands of buildings were destroyed and 120 000 people were left homeless.

When Calbuco volcano in Chile violently erupted in April 2015, 6 500 people were evacuated and as a result of this successful hazard management there were no casualties. Evacuations can be expensive and it was decided in Montserrat to move the population to the north of the island permanently to a safe zone instead of implementing regular evacuations when the Soufriere Hills Volcano threatens to erupt.

- **Predicting volcanic eruptions.** Effective volcanic monitoring can help to forecast eruptions. At present there are around 600 active volcanoes that have erupted in historical time and another 900 are thought to be active. The cost of monitoring is high, so not all active volcanoes are monitored. Monitoring is more common in richer countries that can afford the technology and have the experts available. Japan has 118 active volcanoes, more than almost any other country and a volcanic alert level is available for each volcano. Even so, Mount Ontake erupted in September 2014 without warning, killing 57 people. The Japanese are pushing the frontiers of volcano monitoring. At Mount Unzen as well as measuring gas and water samples, using digital cameras, tiltmeters, GPS and satellite measurements, they are also drilling deep inside the volcano to sample magma and shed light on the nature of magma and the resulting eruptions.

With developments in technology, the results from remote sensing of land and air composition are continually improving and can help with the accuracy of eruption forecasting. After the Eyjafjallajökull eruption in March 2010, over 107 000 flights were cancelled over eight days due to airport visibility issues and the threat to jet engine intakes. More disruptions could have occurred had test flights by Lufthansa and KLM not taken place and revealed no problems with the aircraft engines becoming damaged by high-altitude volcanic ash.

The perception of hazards

People react to hazards in a number of different ways. Perception is affected by who we are and where we live and factors such as our socio-economic status, wealth, education, culture, religion and past experiences. Perceptions about hazards can include:

- Fatalism (acceptance) – hazards are natural events that are part of life. Losses are inevitable, so people carry on living in an area and take direct action to rebuild when disaster strikes.
- Adaptation – planning zoning can give assurance to people by prohibiting building in known lava/lahar-flow valleys and only permitting it where there is no history of flow, as takes place on the flanks of Mt Etna in Sicily.
- Mitigation - people think that the impact of hazards can be reduced by prediction, protection and preparation that is appropriate to the degree of risk. If they have

faith in the efficiency of warning and evacuation planning, then they may accept the hazard risk with consideration that there is little personal risk.
- Fear – people move away from a hazardous area due to feeling vulnerable because of the potential disaster that might occur there.

Impacts and human responses as evidenced by a recent volcanic event.
In March 2010, rising magma broke through the crust under the Eyjafjallajökull glacier and lava eruptions began. On 14 April, the lava eruptions became more intense and more explosive; water mixed with the silica to form fine glassy ash, which rose high into the atmosphere and blew south over the European continent. The glacier continued to melt and a huge amount of meltwater flowed down to the sea, destroying sections of the main highway on the south coast of Iceland. The eruption of Eyjafjallajökull in March 2010 had both local and international impacts.

Icelandic impacts
- Just under a thousand local people were evacuated out of the danger zone.
- Communication and transport infrastructure was disrupted which limited access for local people travelling to the capital Reykjavik and cost the country £12 million to reconstruct.
- Tourism was affected, as planes could not fly.
- The growing season in Iceland is short, so a whole year's worth of crops were damaged resulting in food shortages, particularly of fodder crops to feed animals through the long winter.
- Homes directly to the south of the volcano were destroyed.

International impacts
- 48% of all air traffic was grounded for eight days across Europe, as the ash cloud was thought to be unsafe for the aircraft. Total losses were in the region of £80m.
- Following just-in-time inventory strategy, many industries were affected by a lack of imported parts and raw materials, this included Nissan in the UK and Apple in Japan. Nissan halted production of 2 000 vehicles in the UK.
- Fresh produce could not be imported to northern Europe, this affected supermarkets and producers worldwide. Cut flower, fruit and vegetable producers from Kenya and other African nations were particularly affected as their economy relies on international trade. Kenya is reported to have destroyed 3,000 tonnes of flowers that could not be transported to the UK.
- Residents living under the Heathrow Airport flight path enjoyed the peace.

Responses to the Eyjafjallajökull eruption
- People stranded across the world as a result of the airspace closure struggled to make their way back home.
- Schools were particularly hard hit as the eruption occurred at the end of the Easter holidays; teachers and students were stranded in locations worldwide.
- Total loses for airline companies and airport operators were around £1.1 billion due to grounded flights.
- In the United Kingdom alone thirteen travel firms collapsed during the summer of 2010.

