GEOHAZARDS (GL1201 and GL1301)

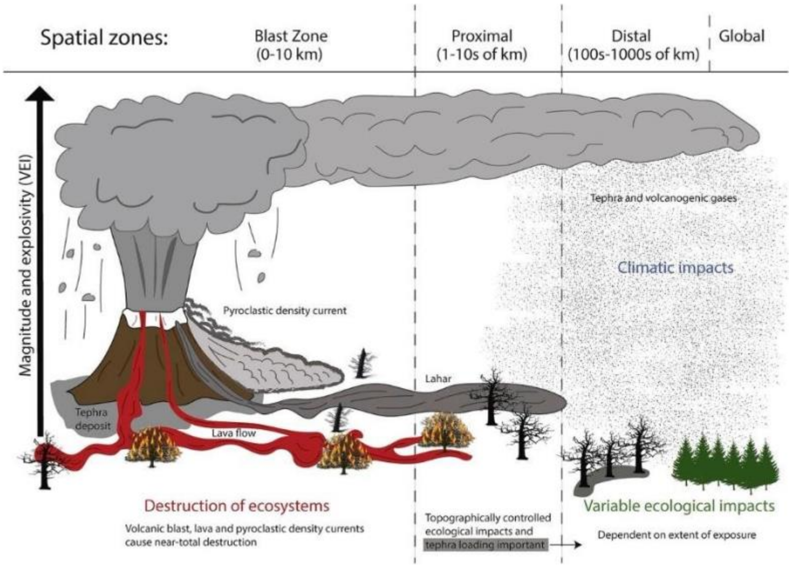
Risk = hazard x vulnerability x exposure

Important definitions

Risk: the likelihood of loss of life, injury, or destruction and damage from a hazard in a given period of time.

(Geo)hazard: natural geological processes that impact adversely on people and the built environment. Related to meteorology (rainfall), tectonics (earthquakes and volcanoes), geochemistry (volcanoes), and geomorphology (mass movements). Climate change exacerbates the magnitude and intensity of these hazards.

Vulnerability: the potential to be harmed by a hazard. Depends on physical (e.g. proximity) and social (e.g. poverty, access to sanitation, structural integrity) factors



Exposure: an assessment of which elements are at risk (e.g. people, buildings, agriculture).

Volcanoes

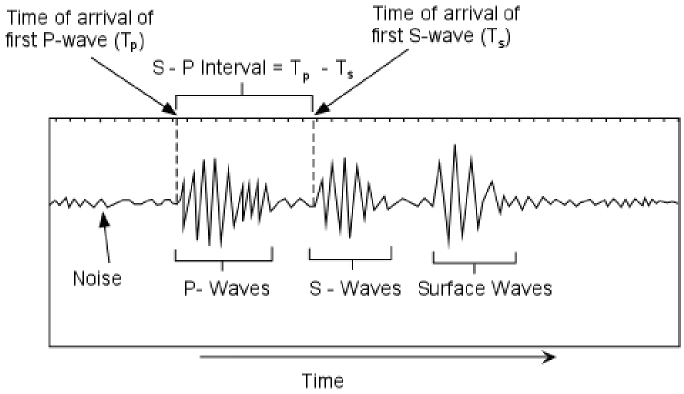
- *Causes*: plate tectonics determine the location of most volcanoes (with the exception of basaltic intraplate volcanoes, which are related to mantle plumes e.g. Hawaii). Immediate

eruptions often due to explosive decompression of gases in the magma mix (similar to the effect of shaking up a can of coke before opening).

- *Categories*: the most explosive volcanoes (e.g. Mt Etna) are due to viscous lava at convergent plate boundaries, due to a high proportion of acidic (i.e. viscous) continental crust and dissolved volatiles in the magma. Basic volcanoes feature runnier lava from basaltic (alkaline) oceanic crust, are less explosive, and form flatter and wider (shield) volcanoes.
- *Effects*: see diagram above. Hazards include lava and pyroclastic flows, ash fall, poisonous gases, blast impact. But there are also benefits e.g. volcanically enriched soil for farming

Earthquakes

Most earthquakes happen when *strain* builds up along a fault, which slips suddenly, releasing huge amounts of seismic energy. They are hard-to-predict, but can be estimated with *recurrence intervals* and by looking for *seismic gaps* on active faults. Measured using e.g. *seismographs* (see right); surface waves are slowest and cause most damage. Compressional P (primary) waves travel fastest and so are recorded first. The most commonly used quantitative scale is known as the *moment magnitude* (M_w) – other qualitative forms like the Mercalli scale exist, based on the amount of damage suffered.

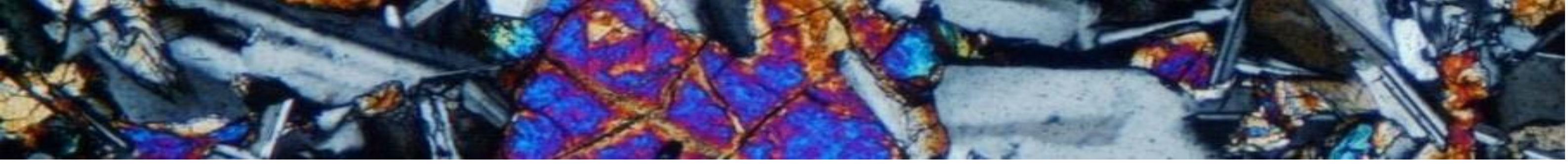


Mass movements

Landslides (photo on left shows a landslide in Nepal that cuts through rice paddies), rock falls, rotational slump, solifluction: these are defined by the timescale at which the processes operate, with the most sudden presenting the greatest risk. Causes can be divided into *antecedents* and *triggers*. The UK contains regions (e.g. the Cotswold Hills) of the greatest landslide density in Europe.

Antecedents: saturated soil, unfavourable geology (e.g. friable and weak schists), unfavourable structure (e.g. 'sandwich' of strong and weak rocks, like clays and limestones), high degrees of freeze-thaw or shink-swell activity in e.g. clays with high montmorillonite content

Triggers: Sudden cloudbursts, over-zealous road building, deforestation, earthquakes



Hydrological hazards

Related to the *unequal distribution* of water around the globe: too much = floods (river, groundwater, pluvial/rain, glacial/snow); too little = drought; the effects of climate change result in increased warming of the oceans, leading in turn to more and more violent hurricanes and tsunami. Also, human activity increasingly causes *quality-related* hazards e.g. arsenic contamination of groundwater in Bangladesh, or neurotoxins polluting the water supply of Flint, Michigan, USA.

Hazard mitigation

The effects of geohazards (and some of their causes) can be mitigated by:

(1) Enhanced measurement campaigns/*more data* (top-left: a low-cost, community-operated river level sensor to feed into a flood early-warning system.
(2) *Better models* (i.e. improved precision and accuracy, validated against real-world evidence)
(3) Community *resilience building* programs (top-right, a workshop on landslide safety and evacuation in a secondary school in Nepal)

Activity

The photograph (right) shows a landslide in the Peruvian Andes.

(1) List five reasons why this region might be susceptible to landslides.
(2) From the photograph, name three factors that might have triggered the slide.
(3) Discuss the interaction between the landslide and the river at the bottom of the valley.
(4) At higher altitudes, rockfalls are the dominant hazard. For a slab of rock to fall, its weight must exceed its shear strength. If an 800 kg, 1 m^3 block of 30% porosity limestone has strength 10 kN, how saturated does it need to be before breaking off from the rock face? (density of water = 1000 kg/m^3).

Want to know more? We recommend ‘Chapters 6, 11 and sections 15.1, 16.8, 17.7 and 20.6; Earth: An Introduction to Physical Geology, Global Edition, Tarbuck et al.’