NEED to KNOW

Edexcel A-LEVEL GEOGRAPHY

Key facts at your fingertips

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HODDER EDUCATION
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Contents

- they travel very quickly, at speeds of up to 700 kph
- when they reach land they rapidly increase in height, up to over 25 m in some cases
- they are often preceded by a localised drop in sea level (drawback) as water is drawn back and then up by the approaching tsunami
- they hit a coastline as a series of waves (a wave-train), more akin to a flood

Exam tip

Despite commonly being called 'tidal waves', tsunamis have nothing to do with tides.

Do you know?

1. State two differences between oceanic and continental plates.
2. Describe the Iceland hot spot.
3. Why is plate tectonics still just a theory?
4. Explain how an earthquake causes a tsunami.

1.2 Why do some hazards develop into disasters?

You need to know

- the relationship between hazards, vulnerability, resilience and disaster
- how hazard profiles can be designed and used
- the importance of development and governance in understanding disaster impact, vulnerability and resilience

Disaster occurrence

Hazard vs disaster

Key points:

- the Degg model illustrates when a hazard becomes a **disaster** (Figure 2)
- one set of community **thresholds** of a hazardous event becoming a disaster is:
  - ten or more deaths
  - one hundred or more people affected
  - one million dollars in economic losses
- the hazard risk equation helps to make clear the relationship between hazards and disasters:

$$\textbf{risk} = \text{hazard} \times \frac{\textbf{vulnerability}}{\text{capacity to cope}}$$

Key terms

Disaster When a hazard has a significant impact on people — a realisation of a hazard.

Threshold The magnitude of a hazard, above which a disaster occurs.

Risk The probability of a hazard occurring and leading to a loss of lives and/or livelihoods.

Vulnerability The risk of exposure to hazards combined with an inability to cope with them.a

- some communities have a high **resilience**. They can reduce the chances of disasters occurring by:
  - having emergency evacuation, rescue and relief systems in place
  - having hazard-resistant design or land-use planning to reduce the numbers at risk

Key term

Resilience The degree to which a society or environment can absorb a hazardous event and yet remain within the same state of organisation — its ability to cope with stress and recover.

The pressure and release model (PAR)

Main features:

- states that risk is a function of vulnerability and hazard
- the socioeconomic context is important — political systems, income levels, economic strength, levels of education, population change, levels of investment
- the nature of the hazard is also key — volcanoes, earthquakes, storms, landslides
- both the context (root causes) and the hazard place **pressure** on a location
- **release** comes with a reduction in the vulnerability of the location affected
- all of these factors are dynamic and hence safety is difficult to manage

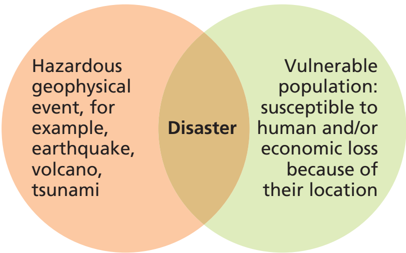


Figure 2 The Degg model

Impacts of tectonic hazards

The impacts of tectonic hazards may be:

- social: deaths, injuries and wider health impacts including psychological
- economic: loss of property, businesses, infrastructure and opportunity
- environmental: damage to, or destruction of, ecosystems

Comparing impacts between countries is difficult, as the PAR model states:

- both the physical nature of the event and the socioeconomic profiles of affected places are different
- the impact of disasters in developed, developing and emerging countries varies

Some other points:

- economic costs in developed and emerging economies can be high
- deaths in developed countries are usually low
- impacts of volcanic eruptions are small compared to earthquakes and tsunamis

Exam tip

Know some facts from case studies to support these statements, as well as evidence to provide a counterargument.

Tectonic hazard profiles

Magnitude/intensity of hazards

Earthquake magnitude:

- energy release is measured by the logarithmic moment magnitude scale (MMS)
- damaging effects are measured by the Mercalli scale (measures intensity of shaking)

Volcano magnitude:

- measured by the volcanic explosivity index (VEI) and based on the volume, duration and column height of ejections
- can be related back to the type of plate boundary the volcano is located on:
    - effusive eruptions of basaltic lavas with low VEI (0 to 3) are associated with constructive boundaries or plumes
    - explosive eruptions with high VEI (4 to 7) of andesitic or rhyolitic lava are associated with destructive boundaries

Comparing hazards

Key points:

- tectonic events can be compared using **hazard profiles**
- hazard profiles indicate variations in magnitude, speed of onset, areal extent, duration, frequency and spatial predictability between different types of hazards (Figure 3)

Key term

Hazard profile A way of summarising the physical processes that all hazards share to help decision makers determine areas most at risk.

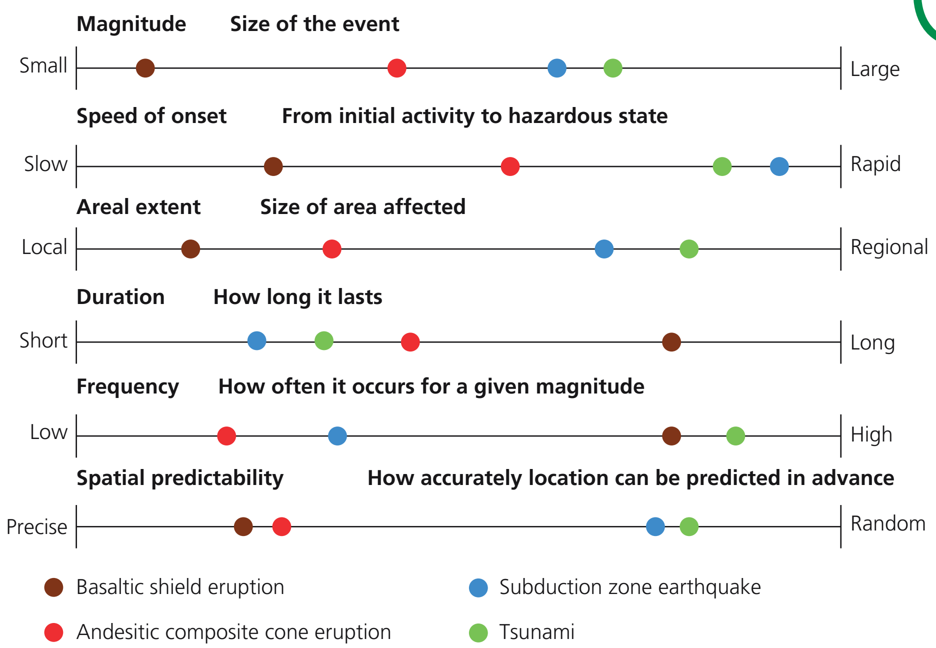


Figure 3 Four selected tectonic hazard profiles

Events that present the highest risk:

- have high magnitudes and low frequencies
- have rapid speeds of onset with low spatial predictability
- have large areal extents
- tend to occur at subduction zones and collision zones

Exam tip

Construct hazard profiles for each of the case studies (in developed, emerging and developing countries) that you examine.

Development and governance

Inequality

Key features:

- inequality of access to education, housing, healthcare and income (measured by **HDI**) is the root cause of hazards as it influences vulnerability and resilience
- locations with a low HDI (<0.55) have a high vulnerability because:
  - many people lack basic needs of sufficient water and food, even in 'normal' times
  - much housing is informally constructed with no regard for hazard resilience
  - access to healthcare is poor, and disease and illness are common
  - education levels are lower, so hazard perception and risk awareness are low
  - low-income groups lack a 'safety net' after a disaster — either a personal one (savings, food stores) or a government one (social security, aid, free healthcare)

Key terms

Human development index (HDI) A measure that ranks countries according to economic criteria (GDP per capita — adjusted for purchasing power parity) and social criteria (life expectancy and literacy).

Governance The processes by which an area, or a country, is run.

Governance

Table 4 Aspects of good **governance** that reduce disaster vulnerability

Governance	Commentary
Meeting basic needs	Providing sufficient food and water is crucial
Planning	Land-use planning/zoning prevents house construction in unsuitable areas
Environmental management	Preventing exacerbating factors such as deforestation Having effective monitoring systems
Preparedness	Providing education and community awareness programmes Having insurance
Tackling corruption	Ensuring aid money is not siphoned off Ensuring correct building codes and standards
Openness	Governments with a free press allow scrutiny of management strategies

Synoptic link

Governance varies significantly around the world — consider the roles of local and national government in a country affected by a hazard.

Geographical factors

Other factors can influence vulnerability and resilience:

- population density: highly populated areas may be hard to evacuate
- isolation and poor accessibility can slow rescue and relief
- degree of urbanisation:
  - death tolls can be high in urban areas because of the concentration of at-risk people
  - urban areas usually have more assets (hospitals, food stores and transport systems) than rural areas, which increases resilience

Different contexts:

- you should be aware of a number of tectonic hazard events that have taken place in a range of locations
- make sure you know of one case study each from a developed, an emerging and a developing country
- use these case studies to show your awareness of the interaction of physical factors, and the significance of their contexts in influencing the scale of disaster

Do you know?

1. What is the term used to describe the outcome of a natural hazard on a vulnerable population?
2. The MMS scale is logarithmic. What does this mean?
3. Apply the concept of hazard profile to one case study you have studied.
4. Why are cities more vulnerable to earthquakes than rural areas?

Exam tips

- Possible volcanic events include: Mount St Helens, Mount Nyiragongo, Mount Etna, Montserrat, Mount Merapi and Eyjafjallajökull.
- Possible earthquake/tsunami events include: Northridge (Los Angeles), Gujarat, Banda Aceh (Indonesia), L'Aquila (Italy), Tōhoku (Japan), Haiti, Christchurch (New Zealand), Ghorka (Nepal), Amatrice (Italy) and Mexico City.

1.3 How successful is the management of hazards and disasters?

You need to know

- how the complex trends and patterns for disasters explain differential impacts
- the theoretical frameworks used to understand the prediction, impact and management of hazards
- the variety of mitigation and adaptation strategies that can be used, and how they vary in their effectiveness

Trends and patterns

Initial points:

- hydro-meteorological hazards (floods, storms, cyclones, drought) have become more common — possibly linked to climate change and deforestation
- the frequency of tectonic hazards has remained static
- the number of people affected by tectonic disasters has increased

Tectonic disaster trends

Key features of earthquakes (since 1980):

- the number of disasters has been between 15 and 40 per year
- deaths have been variable in this time period, with some large events in some years
- **mega-disasters** in 2004 (Banda Aceh) and 2010 (Haiti) resulted in huge numbers of deaths — over 200,000 each
- economic losses have increased — there is more to lose as affluence increases

Key features of volcanoes (since 1980):

- the number of disasters is lower than earthquakes, and deaths are much lower
- only seven eruptions have killed more than a hundred people
- wider impacts can be great as large-scale evacuation is needed

Mega-disaster impacts

Key features:

- some very large tectonic disasters have taken place in the collision zone of the Himalayas — Kashmir (2005), Sichuan (2008) and Nepal (2015) — accounting for 40 per cent of earthquake deaths since 2005
- major earthquake events also took place in Banda Aceh (2004) and Haiti (2010)
- the Tōhoku (Japan) earthquake and tsunami (2011) had worldwide economic impacts
- the Eyjafjallajökull (Iceland) eruption (2010) had a global social and economic impact

Multiple hazard zones

Multiple hazard zones (e.g. California, the Philippines, Japan) are:

- geologically young, with unstable mountain zones prone to landslides
- tectonically active, and earthquakes and eruptions are common
- often on major storm tracks, either in the mid-latitudes or on tropical cyclone tracks
- at risk from global climate perturbations such as **ENSO**

Key terms

Mega-disaster A high magnitude, high impact, infrequent disaster that affects several countries directly or indirectly.

Multiple hazard zones Places where two or more natural hazards occur, and in some cases can interact to produce complex disasters.

ENSO The El Niño Southern Oscillation — a warm ocean current that replaces the usual cold current off the Pacific coast of South America. It brings heavier rain than usual on the coast, and drought inland. It also affects climates further afield, such as California and the Philippines.

Theoretical frameworks

Prediction and forecasting

Table 5 Prediction and forecasting of tectonic hazards

Hazard	Predictability	Comments
Earthquake	Limited	Areas at high risk identified, together with those likely to suffer severe ground shaking and liquefaction Seismic gaps can point to areas of especially high risk
Volcano	Most give some form of warning	Monitoring equipment on volcanoes can measure changes as magma chambers fill and eruption nears Tiltmeters record 'bulging' as magma rises Seismometers record minor earthquakes that indicate magma movement Gas spectrometers analyse gas emissions that can point to increased likelihood of eruption
Tsunami	The earthquake cannot be predicted; the wave can be	Seismometers can tell that an earthquake has occurred and locate it Ocean monitoring equipment can detect tsunamis in the open sea This information can be relayed to coastal areas, which can be evacuated

Key terms

Prediction Knowing when, and where, a natural hazard will strike on a spatial and temporal scale that can be acted on effectively.

Forecasting Provides a 'percentage chance' of a hazard occurring, e.g. a 25 per cent chance of a magnitude 7 earthquake in the next 20 years.

Seismic gaps Areas that have not experienced an earthquake for some time and are 'overdue'.

Synoptic link

Scientists are key players in prediction and forecasting.

The hazard management cycle

Key points:

- illustrates four stages of the management of hazards in attempting to reduce the scale of a disaster (Figure 4)
- the recovery ('returning to normal') stage depends on:
  - the magnitude of the event
  - the level of development and governance of the area affected
  - the external help available

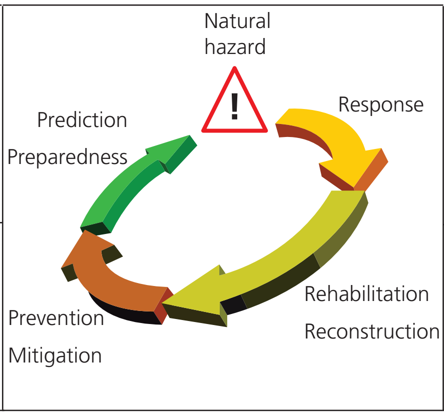
PREPAREDNESS Community education and resilience building including how to act before, during and after a disaster, prediction, warning, and evacuation technology and systems		RESPONSE Immediate help in the form of rescue to save lives and aid to keep people alive, and provide emergency shelter, food and water
MITIGATION Acting to reduce the scale of the next disaster: land-use zoning, hazard-resistant buildings and infrastructure		RECOVERY Rebuilding infrastructure and services, and rehabilitating the injured (physically and mentally)

Figure 4 The hazard management cycle

The Park disaster response model

Key points:

- illustrates how quality of life is impacted by a hazardous event (Figure 5)
- shows how a range of management strategies can be used over time — from before the event to after the event
- highlights the roles of emergency relief agencies and rehabilitation
- shows how different areas affected may have different response curves, depending on their level of preparedness and economic development

Exam tip

Analyse and compare case studies using the hazard management cycle and/or the Park model.

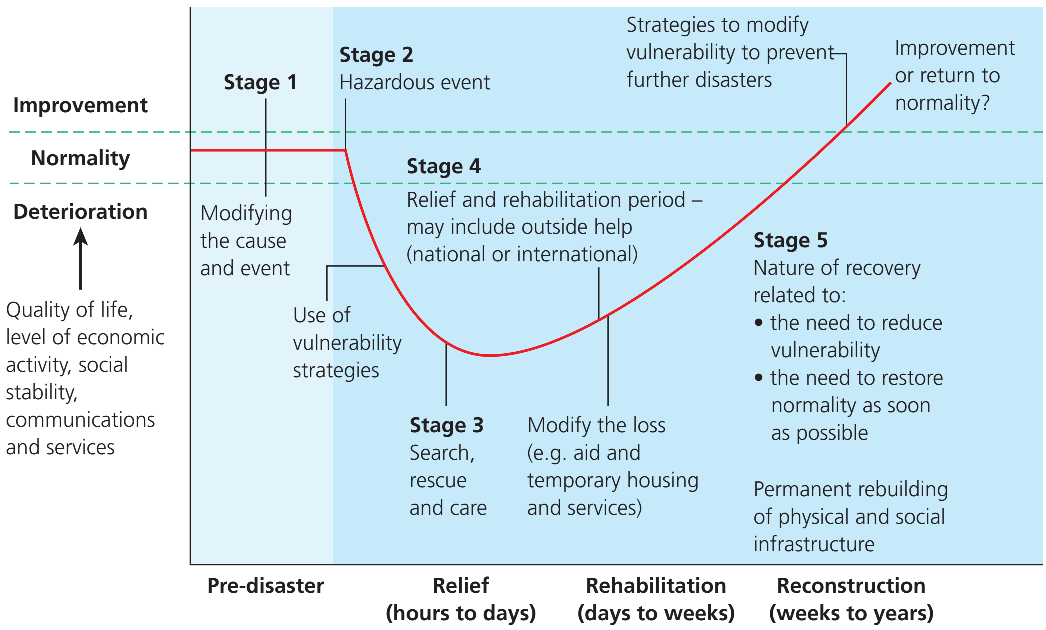


Figure 5 The Park disaster response model

Synoptic link

Note how both of these models highlight the roles played by key players such as scientists, emergency planners and engineers.

Management

Modifying the event

Table 6 Modifying the event

Nature of modification	Benefits	Issues
Land-use zoning: ■ prevention of buildings on low-lying coasts (tsunamis) ■ avoiding areas close to volcanoes ■ avoiding areas where liquefaction is likely	Low cost Relocates people from areas of high risk	Prevents economic development in some coastal areas Requires strict enforcement
Aseismic buildings: ■ cross-bracing ■ using counterweights ■ deep foundations	Protects people and property Financially possible in the developed world Basic design can be replicated in developing world	High costs for tall buildings Older buildings and homes for people on low incomes are too difficult to protect

Nature of modification	Benefits	Issues
Tsunami defences: ■ building sea walls and breakwaters	Reduces damage Provides a sense of security	Can be overtopped Very high cost Unsightly
Lava diversion: ■ channels ■ water cooling	Diverts lava away from people and buildings Relatively low cost	Only works for basaltic lava Not feasible for majority of explosive volcanoes

Modifying vulnerability

Table 7 Modifying vulnerability

Nature of modification	Benefits	Issues
Hi-tech monitoring: ■ used to monitor volcanoes and predict eruptions	Prediction can be reasonably accurate Warnings/evacuation save lives	Costly — only found in developed/emerging countries Possibility of **cry wolf syndrome** Property is still damaged
Community preparedness and education: ■ **earthquake kits** ■ preparation days ■ risk education	Low cost — can be organised by NGOs Can save lives at a local scale	Property is still damaged Harder to implement in isolated rural areas
Adaptation: ■ moving out of danger areas and relocating	Saves lives and property	Difficult in densely populated areas Disrupts people's lives

Modifying loss

Table 8 Modifying loss

Nature of modification	Benefits	Issues
Emergency aid: ■ search and rescue followed by emergency food, water and shelter	Reduces death toll Keeps people alive until government help arrives	Costly — with difficulties reaching isolated areas Emergency services often limited and poorly equipped in developing countries
Long-term aid: ■ reconstruction ■ improvements to resilience	Incorporates land-use planning Establishes better construction methods	Very high cost Initial plans and ambitions not met in time
Insurance: ■ compensation given	Allows economic recovery	Does not save lives Few people in developing countries can afford it

Synoptic link

Note the roles of planners and engineers in these schemes.

Key terms

Cry wolf syndrome Occurs when predictions prove to be wrong, so that people are less likely to believe the next prediction and warning, and therefore fail to evacuate.

Earthquake kits Boxes of essential household supplies (water, food, battery-powered radio, blankets) kept in a safe place at home to be used in the days following an earthquake.

Synoptic link

Forecasting models are key to these strategies — they may not be accurate.

Do you know?

1 Why did the Tōhoku earthquake and tsunami have such a great impact on the world?
2 Why did the Eyjafjallajökull eruption have such a great impact on the world?
3 Can earthquakes be predicted?
4 What is aseismic design?

Exam tip

Note that different types of modification are more applicable to some tectonic hazards than others.

Synoptic link

Decision makers, e.g. NGOs and insurers, play a significant role here.

End of section 1 questions

1 Describe the global distribution of volcanoes.
2 Explain the causes of tsunamis.
3 Explain the development of hazards found at convergent (destructive) plate margins.
4 With reference to examples, outline the ways in which the nature of volcanic hazards can vary.
5 Describe how earthquakes can be measured.
6 Assess the significance of earthquake hazard profiles in relation to the effectiveness of management strategies.
7 Assess the importance of governance in the successful management of tectonic disasters.
8 Evaluate the management of, and response to, one seismic event you have studied.
9 Assess the importance of factors in globalisation in supporting the response to major seismic hazards.
10 'Earthquakes don't kill, buildings do' (McKenna, 2011). In the context of an earthquake, assess the extent to which this statement is valid.