GEOFILE 731

# What makes people vulnerable to natural hazards?

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## Synopsis

Natural hazards are those forces in the natural world that can cause harm to people and their property. They come in many forms – avalanches, landslides, earthquakes, volcanic eruptions, typhoons, floods are just a few.

Studying these hazards, and taking necessary precautions, can help to reduce vulnerability and also the damage or harm caused by extreme events – saving lives, reducing injury and minimising damage to property.

Some parts of the world are 'hazard hotspots', for example the Philippines, but the level of risk in any country is also affected by the economic, social and institutional conditions of its society.

We are now better at forecasting disasters, and our buildings and other structures are better able to withstand physical impacts; this increases our resilience to hazards. All the same, the total dollar amount of damage has been increasing.

There are some trends that suggest that vulnerability to natural hazards could increase in the future. Add to this an ageing population in many parts of the world and increasing urbanisation, often near the coast, and deaths and economic losses from hazards could rise. For example, assessments of long-term earthquake rates in California suggest that there is roughly a 2 in 3 chance that a magnitude 6.7 or larger earthquake will strike within the next 30 years in the greater San Francisco Bay area.

## Key terms

**Vulnerability, forecasting, spatial pattern, poverty, disaster, precautionary measures, food insecurity.**

## Learning objectives

After working through this unit you will:

- have a better appreciation of different spatial, cultural and political contexts
- be able to identify interrelationships between people and the environment
- have an understanding of the possible consequences of extreme conditions and natural disasters, and their detrimental outcomes for human well-being
- have a better appreciation of the wider environmental and social context within which a country is placed
- underrstand the links between the environment and political and economic contexts.

| Exam Board | Link to specification |
|---|---|
| **AQA** | Unit 3, GEOG3 Contemporary Geographical Issues, the Physical Options, Option 1: Plate Tectonics and Associated Hazards; Option 2: Weather and Climate and Associated Hazards, see page 10 http://filestore.aqa.org.uk/subjects/specifications/alevel/AQA-2030-W-SP-14.PDF |
| **Edexcel** | Unit 1, Global Challenges, Topic 1: World at Risk, see pages 19–25 http://www.edexcel.com/migrationdocuments/GCE%20New%20GCE/UA035234_GCE_Lin_Geog_Issue_4.pdf |
| **OCR** | A2 Unit F763: Global Issues, Option A1: Earth Hazards, see page 29–31; Option A3: Climatic Hazrds, see pages 35–7 http://www.ocr.org.uk/Images/69036-specification.pdf |
| **WJEC** | Unit G1, Changing Physical Environments, Section A, Theme 1, Investigating Climate Change, see pages 18–19 http://www.wjec.co.uk/uploads/publications/6312.pdf |
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| **International Baccalaureate** | Geography Diploma Programme, Paper 1, Core Theme, Patterns and Change, Patterns in Environmental Quality and Sustainability http://ibgeog2009.wikispaces.com/Extreme_Environment |

 

# What makes people vulnerable to natural hazards?

Vulnerability is about the potential for people to be harmed. Harm may be caused by many types of hazard, but not all are natural. Natural hazards are those forces in the natural world that can cause harm to people and their property.

A natural event may be rare but there are broad trends to most hazards due to the characteristics of natural and human systems. These trends can help in understanding who is vulnerable, and in what ways. This can help us to reduce vulnerability and also the damage or harm caused by extreme events – saving lives, reducing injury and minimising damage to property.

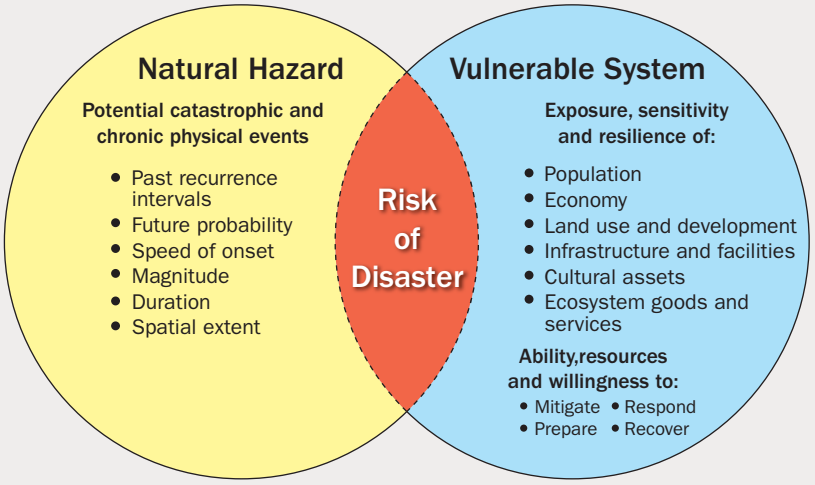


**Figure 1** Understanding Risk

## Why does vulnerability vary?

Vulnerability to a hazard or risk is influenced by numerous factors (Figure 1). According to World Risk Report 2012, prepared by the UN University's Institute for Environment and Human Security (UNU-EHS) the level of risk in any given country depends on the economic, social and institutional conditions of its society.

Of course there is the scale/strength of a disaster like an earthquake to consider, although as we will see this is not always a critical factor. A hazard itself may not be straightforward – an avalanche or landslide for example may be caused by an earthquake, a volcanic eruption may trigger flooding if an ice cap melts. Hazards can be multiple events. Some parts of the world are 'hazard hotspots', prone to different events; for example the Philippines, with its typhoons, volcanoes and earthquakes. Despite such complications it is possible to identify a number of key factors that impact on vulnerability.

## Disaster trends and patterns

We need to recognise that vulnerability can vary both temporally and spatially.

### Over time

Generally disasters are becoming less deadly but more costly. Fewer people are dying (Figure 2) in natural disasters, but they are costing more. Improvement in science and technology is one reason that fewer lives are lost. We are now better at forecasting disasters, and our buildings and other structures are more able to withstand physical impacts; this increases our resilience to hazards. Growth in population and economies are major reasons that more money is lost. Simply put, society now has more of value that is exposed to hazards. Even though much of this is also more resistant

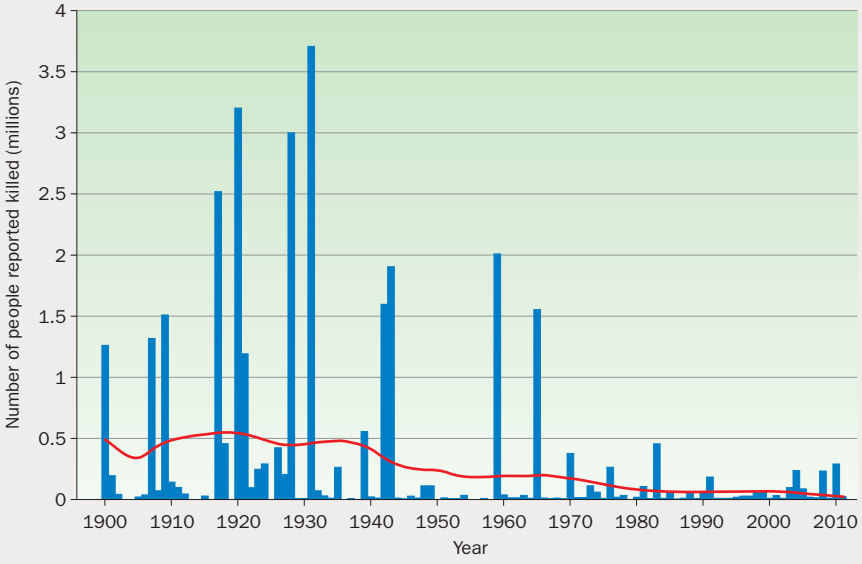


**Figure 2** Number of people reported killed by natural disasters 1900–2011

*Source*: EMDAT The International Disaster Database

 

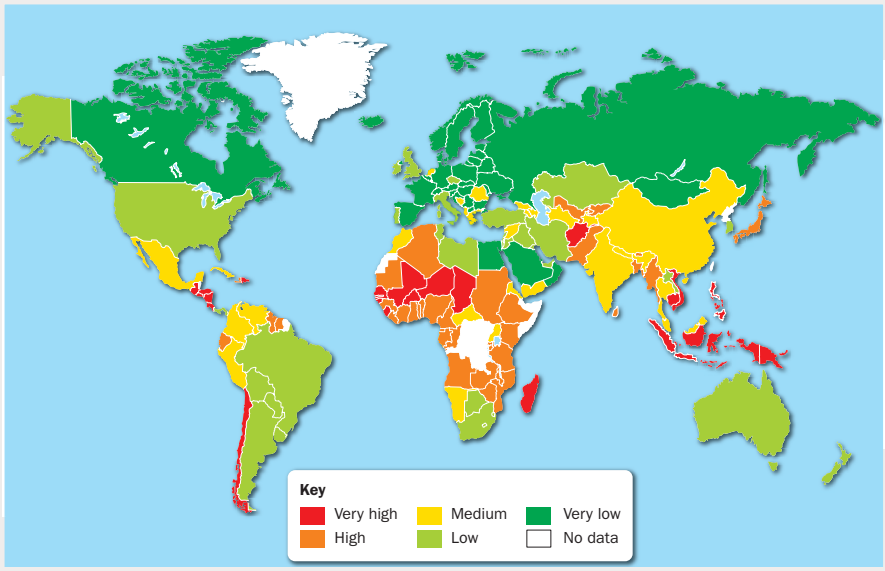


**Figure 3** World Risk Index of vulnerability to natural disasters

to damage, the total dollar amount of damage has been increasing.

### Over space

Figure 3 is one of several attempts to develop a world index of vulnerability and establish a world spatial pattern. You might like to complete Focus Question 1 at this stage.

Earthquakes and volcanic eruptions are associated with tectonic plate boundaries. Large areas near the centres of tectonic plates rarely if ever experience such events. Floods are more severe in certain regions where rainfall is high or intense at certain times of the year, or that are affected by rapidly melting snow. Low-lying areas, like much of Bangladesh, also tend to be more vulnerable to flooding. Drought is a problem in particular parts of the world, often interior locations like central Australia and the mid-west of the USA, and nearer the tropics. You might like to consider the spatial pattern of other natural hazards such as avalanches and tropical cyclones.

### Science and technology

This is the main reason why fewer lives are now lost from natural hazards. The forecasting of disasters has greatly improved.

There is no reliable method for predicting earthquakes in the short term. However, probabilities can be calculated. For example, assessments of long-term earthquake rates in California suggest that there is roughly a 2 in 3 chance that a magnitude 6.7 or larger earthquake will strike within the next 30 years in the greater San Francisco Bay area. Scientists are also studying patterns of earthquake activity, for example the probability of a smaller earthquake after a large one.

Spatial patterns are also important. Since the disastrous 1939 Erzincan earthquake in eastern Turkey, there have been seven earthquakes measuring over 7.0 in magnitude, each happening at a point progressively further west. Seismologists studying this pattern believe that each earthquake may trigger the next. By analysing the stresses along the fault caused by each large earthquake, they were able to predict the shock that hit the town of Izmit with devastating effect in August 1999. It is thought that the chain is not complete, and that an earthquake will soon strike further west along the fault – perhaps near the heavily populated city of Istanbul.

Volcanoes generally show signs of unrest hours, weeks and months before they erupt. Changes in gas emissions, swelling of a volcano, and swarms of small earthquakes are signs that a volcano might erupt. All of these changes can be detected with appropriate monitoring equipment.

The United States Geological Survey (USGS) National Volcano Early Warning System is designed to detect these signs of unrest at the earliest stages. The USGS issues warnings and alerts of potential volcanic hazards—including imminent or ongoing eruptions, ash fall forecasts, and when eruptions have ended—to the emergency-management authorities and those potentially affected.

Many hazards like avalanches and landslides are mapped so that areas most at risk are identified. This often involves correlating the hazard with other factors like slope stability, rainfall patterns, geology, earthquake activity and population distribution.

Technology has also changed architecture and construction. Buildings, bridges and other structures are now more able to withstand the impacts of natural events

## Population/ demographic factors

Population growth and distribution, especially increased population density and urbanisation, increases vulnerability to disasters. Nearly 80% of the US population resides in urban areas, with increasing population concentration in coastal communities and flood-prone areas. Congestion, limited escape routes, dense infrastructure, and poverty add to vulnerability. Cities and countries in other regions of the world face similar problems. For

example, in countries such as China, urban earthquakes are more dangerous because of the density of the infrastructure. The growth of coastal populations, for instance, raises important concerns about increased human exposure to coastal flooding, hurricanes, and tsunamis. The organisation of work and leisure around coastal areas in India was one of the factors that resulted in high rates of injuries and fatalities following the 2004 Indian Ocean tsunami.

Age and gender are also factors, with children and the elderly more vulnerable. They have less physical strength to survive disasters and are often more susceptible to certain diseases. The elderly often also have declining vision and hearing. Both children and the elderly have fewer financial resources and are frequently dependent on others for survival. In order for them to survive a disaster, it is usually necessary for both them and their carers to stay alive and stay together.

An example of the role of age is the 2003 European heatwave. About 40,000 people died in one of the hottest summers ever in Europe. Many of the deaths were elderly people who were less capable of taking care of themselves. These people were unable to adapt to the extreme heat, and had few helping them out.

Women are often more vulnerable to natural hazards than men. This is partly because women are more likely to be poor, less educated, and politically marginalised, often due to sexism in societies around the world. Women often face additional burdens as caretakers of families. When disaster strikes, women are often the ones tasked with protecting children and the elderly. This leaves them less mobile and more likely to experience harm themselves.

## Level of economic development

Growth in population and in economies is the main reasons that more money is lost in disasters. This includes property, roads, railways and other infrastructure. Even though much of this is also more resistant to damage, the total dollar amount of damage has been increasing.

The less developed parts of the world are more vulnerable to disasters. At the beginning of 2010 an earthquake hit the Caribbean island republic of Haiti, hundreds of thousands of people died and more lost their homes. Just a few weeks later, another earthquake shook the central coastal region of Chile. There, jolts reached 8.8 on the Richter scale, compared with the 7.0 earthquake in Haiti. Yet in Chile, far fewer people died – 500, compared with the 200,000 who lost their lives in Haiti (Figures 4 and 5). Chile has an efficient public sector, the government takes measures against corruption, earthquake-proof building codes have been tightened in recent years, and – perhaps most importantly – those regulations were enforced. Furthermore, the population was trained for natural disasters, through drills.

Studies of tropical cyclones have confirmed that poorer populations are more vulnerable. Economies relying on the tertiary sector are less affected than those relying on agriculture, where fields and crops are often devastated. Rural economies are often characterised by more sparsely distributed populations, they may be more isolated and living in less well-built homes. Urban populations can have better access to healthcare and their needs can be more easily met following a disaster.

Studies of drought have shown that the numbers killed decrease as the GDP per capita grows and percentage of arable land grows. The explanation seems to be linked with poverty, poor health and food insecurity. These all increase vulnerability to the hazard.

Housing conditions, nutritional standards and levels of medical care all play an important role in limiting death tolls in the aftermath of a disaster. Recovery and the well-being of the population after a hazard are also affected by insurance. Losses amounted to $16 bn following the 2011 earthquake in New Zealand, compared to $8 bn in Haiti; 80% of New Zealand's losses were insured but only 2.5% were

Chile, as a more developed country than Haiti, has sounder architectural engineering and therefore better-protected structures. The Chileans have recorded the behaviour of their earthquakes over many years and several events, which helps them limit even larger-scale disaster damage.

Roger Musson (British Geological Society) identified two key factors to explain why the 2010 Chilean earthquake caused less damage than the Haitian event:

1. the Chilean earthquake was deeper
2. the buildings were better protected.

As for Haiti, the building quality was very poor; earthquakes were rarely in the equation. Most casualties are caused by bad structural design and poor materials – these lead to collapse, the main cause of death.

**Figure 4** Building quality – Haiti and Chile earthquakes 2010

 

**Figure 5** Port-Au-Price, 28 August 2010: nothing had been done to clear the debris and rubble in most of the places.

*Source*: arindambanerjee/Shutterstock.com

insured in Haiti. In fact, Haiti's losses exceeded its gross national product.

Other variables include a country's leadership and its willingness to invest in precautionary measures. Examples of domestic precautionary measures might include planning regulations that seek to avoid construction of homes and other buildings in areas subject to risk. Policies should encourage urban and rural development that will encourage the quick delivery of post-disaster aid. Aid flows might differ widely in their effectiveness, depending on the policy environment in the country to which they are channelled. This is affected by quality and efficiency of government and levels of corruption.

## Culture and attitudes

The Japanese tsunami of 2011 illustrated well the influence of culture on vulnerability and recovery. The Japanese people and authorities responded very rapidly to the tsunami, and within months some devastated areas had been cleared and life was returning to normal. One year after the disaster, prominent signs stood amongst the remaining devastation sending a one-word message – *Ganbaru*, meaning 'hold out, stand firm, and hang in there'. The resilience of the people helped the recovery and reduced the vulnerability.

## Conclusion

The future in relation to natural hazards is apparently contradictory and complex. Data indicates that loss of life from natural hazards has been declining. We have seen how a number of factors have helped to reduce vulnerability. However, there are trends, some that we have not yet considered, that suggest that vulnerability to natural hazards could increase in the future. One major issue is climate change. We know that this can lead to more intense weather patterns and storms, rising sea levels and more droughts. Add to this an ageing population in many parts of the world and increasing urbanisation, often near the coast, and deaths and economic losses from hazards could rise. Sir John Beddington (UK Government Scientific Advisor) has said in recent report (2012): 'Extreme events will happen every five years instead of every 20. Vulnerability will come from changing climate, demography and most people living in cities.'

The World Risk Report 2012 argues that both politics and science have paid too little attention to disaster risk. The costs of natural disasters continue to rise; annually they cost about $370 bn. Many hazards cannot be prevented, but vulnerability to them can be reduced.

Ongoing research is needed, including vulnerability modelling, better forecasting and the use of tools like GIS to identify, understand and plan for areas most at risk.

Countries and their populations need different attitudes to hazards. On the one hand they should not become complacent when hazard warnings work and impacts are reduced. They should also not be fatalistic and just assume that death, injuries and economic loss are inevitable. 'Resilience is about boosting a country's ability to deal with disasters' (Justine Greening, UK Secretary of State for International Development).

## Websites

http://www.nat-hazards-earth-syst-sci.net/9/1149/2009/nhess-9-1149-2009.pdf

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## Focus questions

1 Describe and suggest reasons for the patterns shown in Figure 3.

2 Summarise the various types of initiatives that can help to reduce vulnerability to natural hazards.

3 You could usefully apply what you have learnt in this unit to a selection of natural disasters – particularly contrasting LEDC and MEDC events.

Consider how the following have impacted on vulnerability:

- scale of the disaster
- demographic factors
- level of economic development
- culture/attitudes.

4 Essay-style question: Natural hazards have a greater impact on LEDCs than MEDCs. Discuss.

## Learning checkpoint

While you're studying the unit, consider the following questions:

Rank the types of hazard covered in this unit in terms of their potential severity.

Why did the Haitian earthquake have much worse consequences than the more powerful Chilean earthquake?

Are natural hazards evenly distributed about the world?

How can a nation's cultural outlook affect its ability to respond to a natural disaster?