Geo Factsheet

Number 72

Hazards Case Study: The Philippines

Environmental hazards occur when people and property are at risk. The cause of the hazard may be geophysical or biological but it is because people live in hazardous areas that hazards occur. So why do they live in such places?

The **behavioural** school of thought considers that environmental hazards are the result of natural events. People put themselves at risk by, for example, living in floodplains. By contrast, the **structuralist** school of thought stresses the constraints placed upon the (poor) people by the prevailing social and political system of the country. Hence, poor people live in unsafe areas such as steep slopes or flood plains because they are prevented from living in better areas. This school of thought provides a link between environmental hazards and the underdevelopment and economic dependency of many developing countries.

How do people cope with hazards?
There are three important influences upon an individual's response. For example:

- experience – the more experience of environmental hazards the greater the adjustment to the hazard.
- material well-being – those who are better off have more choice.
- personality – is the person a leader or follower, a risk-taker or risk-minimiser?

Ultimately there are three choices – do nothing and accept the hazard, adjust to the situation of living in a hazardous environment or leave the area.

The level of adjustment will depend, in part, upon the risks caused by the hazard. This includes:

- identification of the hazards
- estimation of the risk (probability) of the environmental hazard
- evaluation of the cost (loss) caused by the environmental hazard

A number of factors influence the perception of risk.

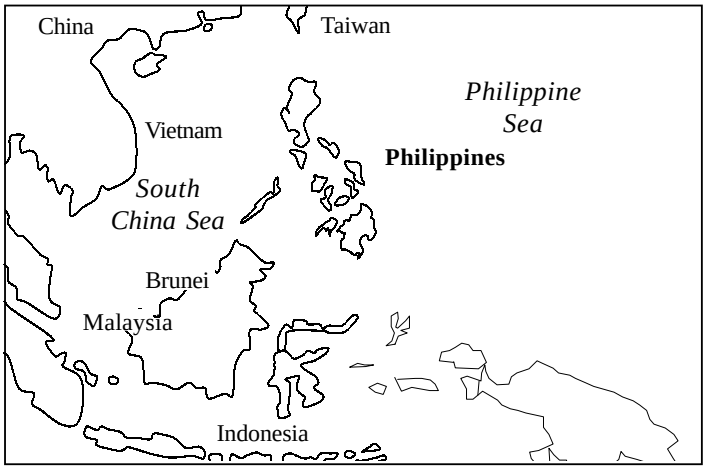
The adjustment to the hazard includes three main options.

1. **Modify the loss burden** – spread the financial burden e.g. insurance, disaster relief
2. **Modify the hazard event** – building design, building location, land-use zoning, emergency procedures - efforts which have been made to control extreme events include flood relief schemes, seawalls, avalanche shelters, etc.
3. **Modify human vulnerability to hazard** – emergency procedures, forecasting, warning.

Hazards in the Philippines

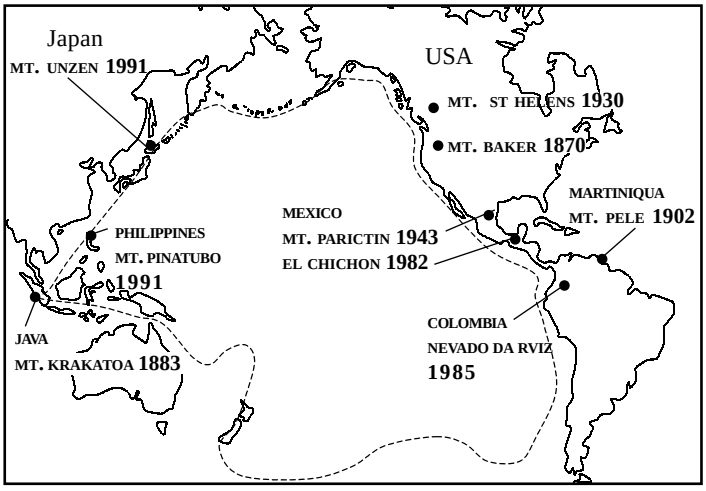
The Philippines consists of over 7000 islands, of which only about 2000 are inhabited. The main islands include Luzon, Mindanao, Palawan and Panay. Only about 500 of the islands are larger than 1 sq km, and about 2500 islands are not even named. (Fig 1.)

Fig 1. The Philippines



The Philippines contains 37 volcanoes, 18 of which are active. These include Mt. Mayon in south Luzon, Mt Pinatubo north-west of Manila in Luzon, and Taal volcano some 600km south of Manila. The reason for all the islands and the volcanoes is due to plate tectonics. The Philippines are located on the infamous Pacific Ring of Fire (Fig 2.).

Fig. 2 The Pacific Ring of Fire



The islands and volcanoes have been formed by the subduction (downthrusting) of the dense, oceanic Philippine plate under the lighter, less dense Eurasian plate. As subduction occurred material trapped between the two converging plates is folded, faulted, warped and uplifted to form lines of islands (called island arcs).

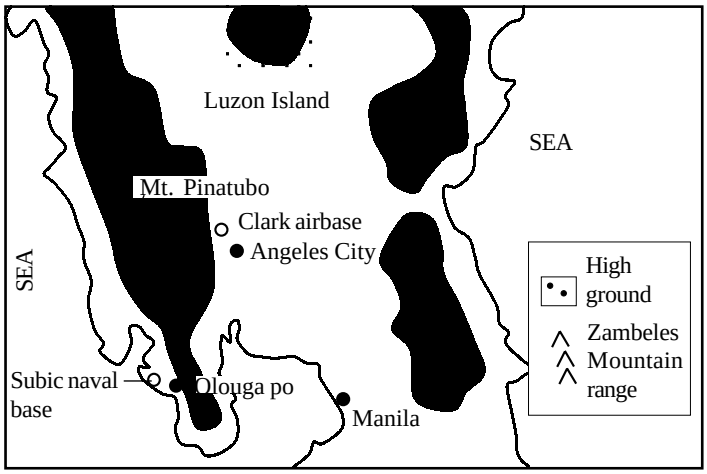
Most tectonic plate boundaries are characterised by intense tectonic activity, and the Philippines are no exception. One of the largest earthquakes this century took place in July 1990. The worst affected area was in northern Luzon, around the cities of Baguio, Cabanataun and Dagupan. The earthquake measured 7.7 on the Richter scale and was responsible for the death of over 1600 people and the destruction of 20 000 buildings.

Volcanoes are a major hazard in the region. Three-quarters of the earth's 550 historically active volcanoes lie along the Pacific Ring of Fire.

This includes most of the world's recent volcanoes, including Pinatubo. Indeed, the Philippines, an arc of islands found at the edge of an ocean, are beset by a variety of environmental hazards, including cyclones, landslides, tsunami, earthquakes and volcanoes. However, without volcanic activity the Philippines would not exist: they comprise the remains of previous eruptions.

Typhoons have a particular impact on the densely populated island of Luzon (Fig 3). For example, during a single week in 1989 the Philippines was hit by typhoons Angela and Dan, resulting in 159 deaths and almost 500,000 people were made homeless. Disasters on this scale occurred annually throughout the 1980s, and the potential for such disasters is increasing. Human activity is implicated in the rising number of hazardous events. For example, the disastrous floods and landslides of November 1991, though triggered by intense rainstorms (typhoons), have been blamed primarily on logging on hillslopes. Deforestation in south east Asia would appear to be out of control. Cutting policies are abused, forestry inspections are inefficient, and there is widespread illegal logging.

Fig. 3 Luzon Island.



One of the main causes of the problem is landlessness (people not owning or having security of tenure over the land). As a result there is a large-scale migration to urban areas in search of work. Many migrants end up living in poorly-constructed squatter settlements on steep slopes or close to the river's edge or on wasteland. These are the **marginal** areas where commercial businesses cannot make use of the land and where urban landlords can make little profit from the land.

In the Philippines about 10% of the population live in self-built housing. In Manila alone there are over 400 slum colonies which are extremely vulnerable to flooding by typhoons. Similarly, many rural dwellers are at increased risk of flooding due to living higher up in the mountains on steeper slopes. Large tracts of the lowland have been taken over for commercial rice farming and the indigenous population have been pushed onto more marginal land. Clearing land and attempting to farm steep slopes makes them vulnerable to the heavy rains and high winds brought by the typhoons. The result is increased siltation of rivers, and increased flood hazard downstream.

Mount Unzen and Mount Pinatubo

Two major volcanic eruptions occurred in June 1991 and attracted worldwide attention. The first, of Mt. Unzen near Nagaski in Japan, had been predicted from scientific monitoring. During a previous eruption in 1792 15, 000 people perished. In 1991, by contrast, an orderly evacuation of the local population took place, and only 39 people died. Mount Unzen and Mount Pinatubo are contrasting cases. Mt. Unzen was known only to be **dormant** and was therefore monitored for signs of impending eruption. Mt. Pinatubo was assumed to be **extinct**.

On June 9th 1991, Mt Pinatubo, a 1460m volcano which had remained dormant for almost 600 years, began to erupt. The most serious eruptions, between the 12th and 15th of June, scattered rock and ash over a 100 km radius and triggered a series of earth tremors of up to 5.34 on the Richter scale. The cause of the eruption was, it was believed, a major earthquake that occurred on the 16th of July 1990, measuring 7.7 on the Richter scale. This rocked Manila and the surrounding region, killing 1 600 and injuring 3 000. It allowed basalt from the upper mantle to squeeze into the magma chamber full of viscous lava. The basalt reactivated the magma and created a fluid gas-charged magma called andesite. This rose towards the surface causing the volcano to bulge. Pressure increased continuously until it was sufficient to blast the dome away, spewing 20 million tonnes of material into the atmosphere. Clouds of hot gas, pumice and ash (known as pyroclastic flows) swept down the slopes at speeds of up to 80 kmph.

The eruption just 80km north of the capital Manila on the Philippines' main island, Luzon, combined with a typhoon on June 15-16, generated devastating mudslides and making up to 200,000 people homeless. The volcano also triggered numerous earthquakes. Many people were killed, mostly by the collapse of buildings under the strain of rain-soaked ash and mud. Indeed, only six confirmed deaths were attributed to the first few days – largely due to advance warning and evacuation procedures.

The mud storms and mudslides covered 50,000 ha of cropland, destroying all crops and over 100,000 homes. Supplies of electricity were cut for over three weeks, water became contaminated, and roads and telecommunications links were destroyed. An epidemic of respiratory and gastric diseases broke out in the temporary housing. The government estimated that 600,000 people lost their jobs.

Evacuation

Over 200,000 people were evacuated as a result of the early warning system. By June 10th 14,500 US Service Personnel and their families were evacuated from Clark air base to Subic Naval Base, 40 km south west of Pinatubo. By the 22nd of June 20,000 dependants of US personnel had been evacuated to the USA. In total, at least 58,000 people were evacuated from the high-risk areas.

Management of the 1991 eruption seems to have been well coordinated and effective

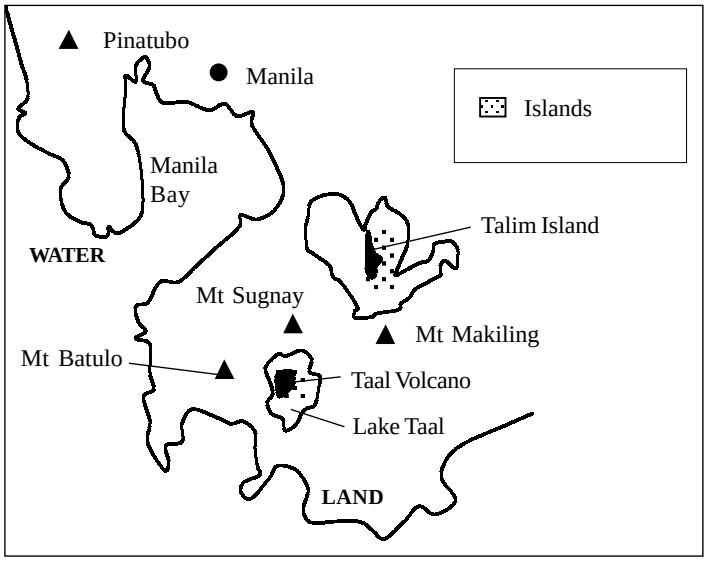
- state-of-the-art volcano monitoring techniques and instruments were applied
- once Pinatubo became reactivated the eruption was accurately predicted
- hazard zonation maps were prepared and circulated a month before the violent explosions
- an alert and warning system was designed and implemented
- the disaster response machinery was mobilised on time

The effects of volcanoes are felt long after the volcanic event. Much of the unconsolidated material, such as ash, soot and debris, that is deposited by the eruption is eroded and transported down hillsides each year by the monsoon rains. For example, in the Zambales mountains immediately west of Pinatubo, there have been mudslides (or lahars as they are locally known) each year since the eruption during the monsoon period.

Hazard assessment: the Taal volcano

An example of the conflicting demands of economic prosperity versus safety is illustrated by the example of Taal volcano in the Philippines. This is one of the world's deadliest volcanoes, and is located on an island in Lake Taal, about 60 km south of Manila. (Fig 4.)

Fig 4. Lake Taal and Taal volcano



Taal has erupted thirty-three times since its earliest recorded explosion in 1572. The 1911 eruption resulted in 1,334 deaths and covered an area of 2,000 sq km with ash and volcanic debris which fell as far away as Manila.

The island is small and the population is less than 4,000 people. However, they are relatively prosperous. The economy is based on fishing, fish-farming, agriculture, mining for scoria (volcanic deposits), and tourism. The location of settlements on the island is closely related to the rich fertile soils that are suitable for sweet potatoes and corn. Alarmingly, population growth is rapid - 9.6 per cent per year - more than three times the national average. Moreover, the island could not cope with a major eruption. It contains only 215 boats which could transport less than 2,000 people. Hence, in the event of a very sudden eruption with limited warning, only about half the population would be able to escape.

A disaster Management Training Workshop in 1988 found that there was very little anxiety on the part of the population over the risks they faced. This was true even among survivors of the 1965 Taal eruption. The lack of escape boats was also of minimal concern. Islanders referred to a building set up by the Philippine Institute of Volcanology (PIV), as a form of 'volcanic eruption insurance policy'. They assumed that the PIV would look after them in the event of a disaster. The very presence of a warning station made some feel that the island was therefore safe for them to live on.

Thus the local resident population took a view in which Taal volcano was just one of many perceived risks that influenced their decision on where to live and work. By contrast, members of the Disaster Management Training Workshop sought to prevent residential occupation of the island. They adopted a narrow view of risk and vulnerability based on physical processes, and failed to acknowledge the advantages that the area offered. Each side has an entirely legitimate and logical response to the same hazard. However, their views differ because of their different needs, priorities, perceptions, and values.

Predicting volcanoes

The rise of magma beneath a volcano may fill a magma chamber and distort the shape of a volcano. Seismometers monitoring earthquakes often pick up large clusters of earthquakes before and immediately after a volcanic eruption. Gases may seep from fissures in the surface known as vents or fumaroles. The temperature of Lake Taal, for example, rose from 33°C in June 1965 to 45°C by the end of July 1965. The water level also rose during this period. In September 1965 the volcano erupted violently.

Managing volcanic eruptions

It is impossible to prevent volcanoes from erupting. In addition, it is virtually impossible to monitor all active volcanoes. However, there are a number of measures that can be taken to limit the damage from volcanoes. Satellites offer the prospect of global coverage from space.

Hazard zonation maps can be used to guide decisions regarding evacuation and other responses. Land-use planning is also important.

Monitoring of active volcanoes provides early warning of likely eruptions. The most reliable forecasts depend on detailed monitoring of microearthquake activity in the vicinity of the volcanic cone, which indicates that magma is working its way upwards. Other measures, including preparation of contingency plans can be used to reduce the effects when vulnerable areas cannot be avoided.

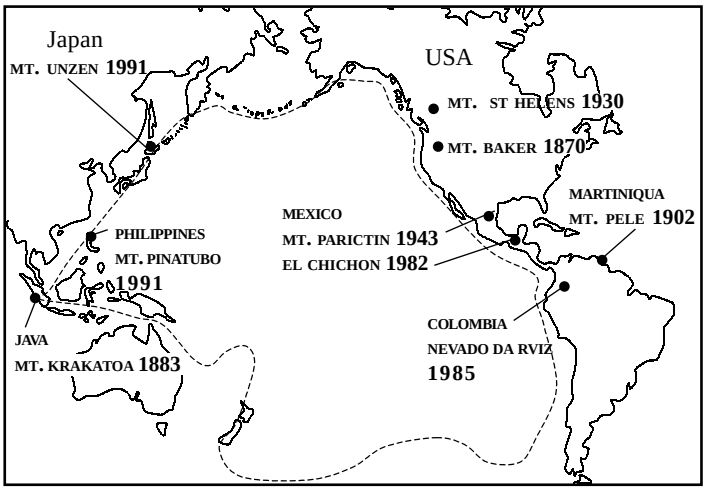
Practice Questions

1. Why do people live in such hazardous areas such as Mt. Pinatubo? Explain how volcanic landforms and/or volcanic activity can be considered a resource.

2. Why is the Philippines prone to volcanic activity?

3. Explain why so few people were killed by the initial blast of the eruption but were killed in the following weeks. Up to a million livestock died as a result of the eruption. How, and why, do you think they died?

4. Study the figure below which shows the Pacific Ring of Fire. Describe the location of the volcanoes shown on the map. Identify any areas where volcanic activity is not associated with margins. How do you account for this?



5. The following data show climate figures for Manila. Plot the data on a climograph and describe the pattern you have drawn. Use the graph to explain why the climate added to the problems after the eruption of Pinatubo.

Month	J	F	M	A	M	J	J	A	S	O	N	D
Rainfall/mm	40	35	20	30	170	260	430	390	320	270	210	120
Max. temp. °C	30	31	33	35	35	34	31	31	31	31	31	30
Min. temp. °C	21	21	23	24	25	25	25	25	25	24	22	21

Suggested answers

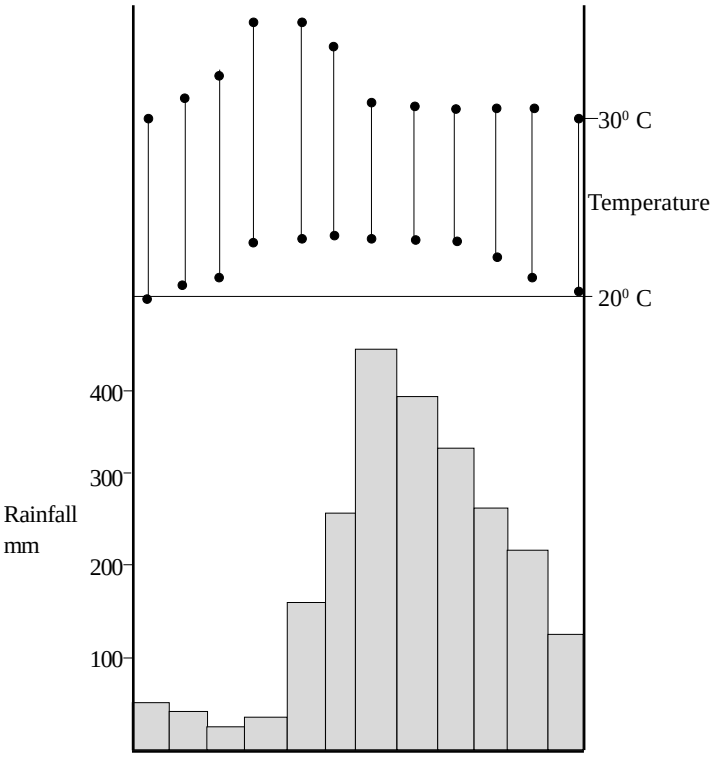
1. People choose to live in hazardous areas because they are also considered to be useful, i.e. they are a resource. For example, volcanic activity has created the Philippines in the first place. In addition, many of the volcanic soils are rich, deep and fertile, and allow intensive agriculture to take place. In recent years, volcanic areas have become important areas for tourism, and there are many opportunities to exploit this growing industry.

2. The Philippines is located at the boundary of the Philippine plate and the Eurasian plate. The cold, dense, oceanic crust of the Philippine plate plunges underneath the less dense, continental crust that forms the Eurasian plate. The rocks of the Philippine plate melt in the high temperatures in the earth's crust, creating liquid magma, which is forced to rise up through cracks in the mantle. At irregular intervals magma is released through volcanic eruptions, creating new landforms and modifying old ones.

3. Very few people were killed in the initial blast because the early warning system was well organised and precautions were taken to evacuate people. However, after the blast, material ejected into the atmosphere combined with the monsoon rains to cause mudslides (lahar). These destroyed large numbers of homes, swept away roads, bridges and other forms of communications, and buried fields and livestock. Most of the livestock were crushed and suffocated.

4. The volcanoes are mostly located around the edge of the Pacific Ocean. For example, in North America Mt. St. Helens and Mount Baker are found, while in Japan Mount Fuji and Mount Unzen are located. The volcanoes are located at plate boundaries. However, an exception are the Hawaiian volcanoes. These are seemingly located in the centre of the Pacific Plate. This is because they are related to hot spot activity. A hot spot is an isolated rising plume of magma. This effectively burns a hole through plate material and allows magma to escape during volcanic eruptions. As a plate moves across a hot spot (as in the case of Hawaii) a linear chain of volcanic islands is formed.

5. The climate of Manila is monsoonal. It is hot throughout the year, but there are two distinct seasons. The hot, dry season lasts from December to April, while the hot wet season lasts from May to November.



The heavy summer rains were responsible for bringing much of the ejected material back down to the land, and thereby causing mudslides. Had the volcanic eruption occurred in the winter there might not have been as many mudslides.

Acknowledgements;

This Geo Factsheet was researched and written by Garrett Nagle

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