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## RECENT LANDSLIDES IN THE PHILIPPINES

**T**HE TERM 'LANDSLIDE' is used as a general term for any downhill movement of earth and rock causing a hazard to the surrounding area. Some areas are obviously more susceptible to landslides than others as there are some necessary conditions without which a landslide cannot occur.

### What are the main contributory factors?

- **Steep slopes:** the steeper the slope the more effective the downward pull of gravity.
- **Rock type and structure:** unconsolidated rocks are those that are loosely bound together so are more likely to collapse. Similarly if there are lots of faults or cracks then rocks are likely to be weaker and more easily weathered so that pieces can fall off or slide away.
- **Water:** water seems to have a major role as it both increases the weight of the slope and reduces the friction between rock or soil particles so that landslides are both more likely and faster.
- **Removing vegetation:** trees are very good at binding loose soils together with their roots, as well as stopping soils from getting too saturated as they intercept rainfall and encourage evapotranspiration.
- **Slope undercutting:** rivers and waves can often undercut slopes so that cliffs overhang, making them weaker and more likely to fall.
- **Extra weight:** people can sometimes add mass to certain vulnerable areas by building or dumping waste material on hillsides so that there is more pressure on the slope to make it move downhill.

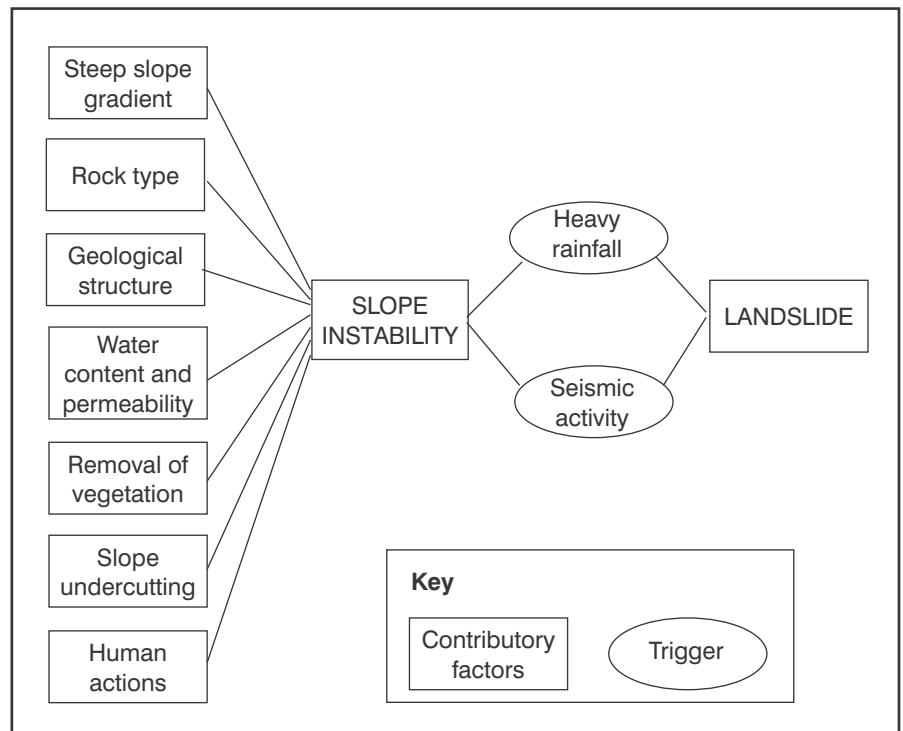


Figure 1: Systems diagram for landslides

When all these combine a landslide is almost inevitable (Figure 1). However, geologists would argue that there still needs to be a **trigger mechanism** that sets the whole thing off – something needs to break the initial inertia that is holding everything in place.

### What are the most common trigger mechanisms?

- **Water:** heavy rainfall or a burst pipe can cause water pressures to become high enough within a slope that the particles of soil or rock no longer come into contact with each other sufficiently for friction to hold them in place.
- **Seismic activity:** tremors in the earth can break the final bonds that hold pieces of rock together.
- **Human activity:** there are very few places on earth where people have not had an impact on the

natural environment. People are often both the victims and the cause of landslides as they may change one of the contributory factors listed above so that the finely kept balance is broken. In some cases people intentionally trigger landslides, for example in quarrying to extract large amounts of rock from a hillside, or in setting off avalanches (both of snow and rock) to remove potentially hazardous slopes.

### Why are the Philippines so susceptible?

The Philippines (Figure 2) seem to have an unfortunately large number of these contributory factors. The three main ones are:

- **Steep slopes:** the Philippines formed as a range of fold mountains with steep sides, which means that gravity can more easily overcome inertia so that material falls or flows downslope. The

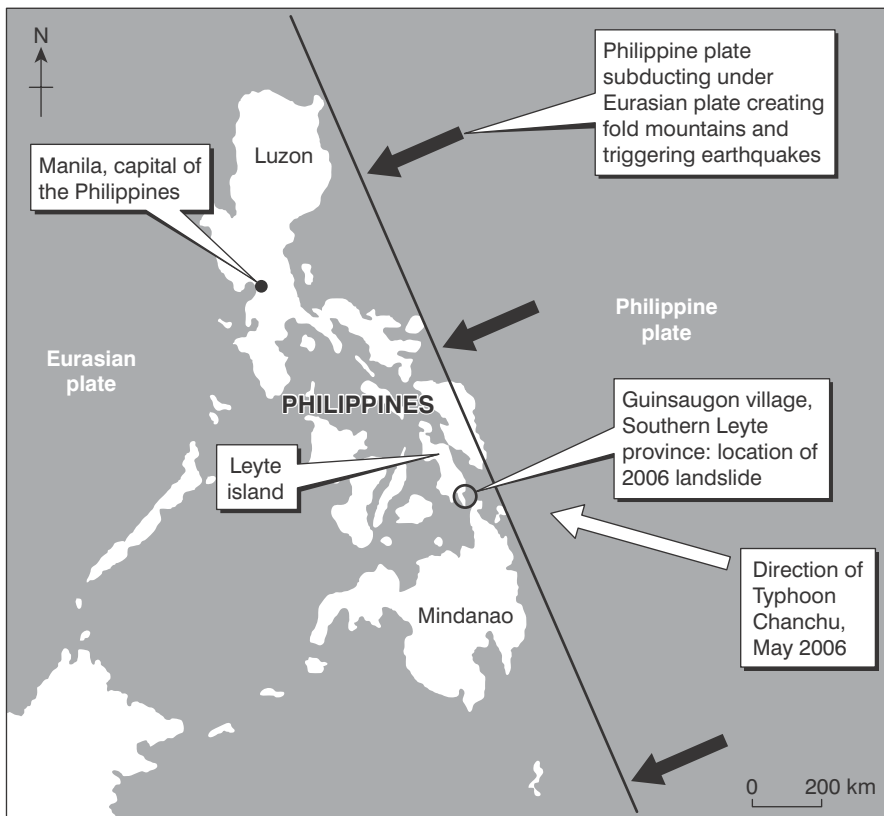


Figure 2: The Philippines and location of the landslide at Guinsaugon

formation of these mountains is the result of tectonic forces that caused rock layers to buckle and fault – so there are many lines of weakness which make these mountainous areas susceptible to rock falls and landslides. Several of the mountains are volcanoes that have built up layers of solidified lava and ash that not only form steep sides but are made of relatively unconsolidated material (unlike most other rocks they have not been formed under intense pressure of overlying layers of material or oceans).

- **Heavy rainfall:** the tropical climate means that there is often convectonal rainfall. This brings regular bursts of heavy rain that can saturate the ground. The high fold mountains encourage relief rainfall, as moist air that is blown in over the tropical seas is forced to rise, cooling and condensing to form rain clouds as it does so. The Philippines also lie in the path of several typhoons a year which can bring torrential rainfall.
- **Removal of vegetation:** people seem to have played a significant role in the recent landslides in the Philippines, particularly with regard to deforestation of the steep slopes. Forests play a vital role in both absorbing the rain that could otherwise cause the hillside to slip, and securing soil and loose sediment to the bedrock with tree roots. Some have even argued that the type of trees in these areas is to blame, as coconut palms (most of which have been planted) do not have the same deep roots as the indigenous trees.

## Case Study

### Southern Leyte mudslide 2006

On 17 February 2006 a major mudslide occurred in the province of Southern Leyte (Figures 2 and 3). It buried the village of Guinsaugon near the town of Saint Bernard, killing 1,126 people and affecting an estimated 8,000 villagers. Guinsaugon is located approximately 675 km south-east of Manila.

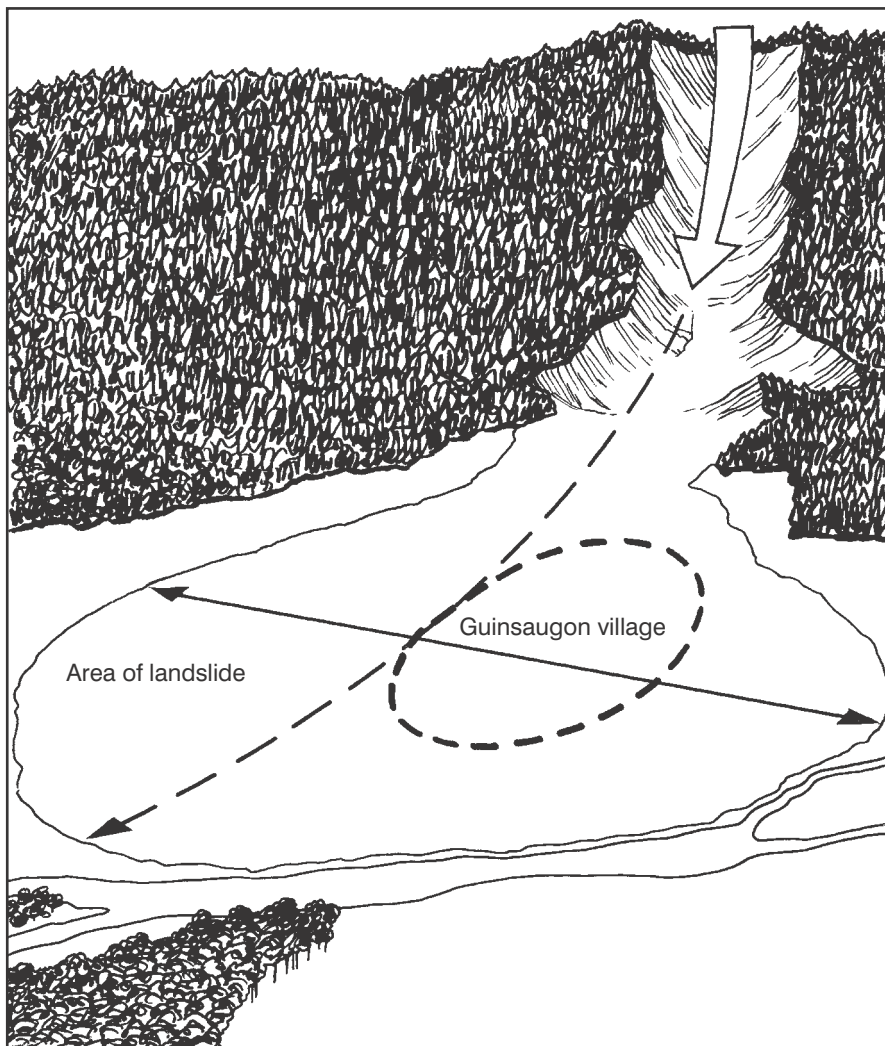


Figure 3: Sketch to show the site and path of the Guinsaugon landslide

## Impact

While several smaller landslides had occurred in the vicinity the previous week, Guinsaigon was by far the worst-hit area. A ridge above the village located on the Philippines Fault collapsed causing a rockslide-debris avalanche event that released an estimated 15 million m<sup>3</sup> of material, burying Guinsaigon's 375 houses to a depth of 10 metres.

Among those buildings destroyed was the village's elementary school. The slide occurred at around 10.30 am on a school day and of the 246 children and 7 teachers at the school, only 1 child and 1 adult were rescued.

## The relief operation

The immediate response was from the Philippines army and air force and the Red Cross. The priority was to find and rescue buried survivors. However, the effort was hindered by a number of factors. Roads and bridges to the village had been blocked or washed away so aid was slow to arrive. There was a lack of heavy equipment necessary to move such a mass of mud and rubble. Furthermore, when heavy equipment did arrive on site the debris was still too soft and unstable to allow it to operate and much of the digging had to be done by hand. Heavy rainfall meant that the environment remained so hazardous for the rescue workers that attempts to dig people out had to be stopped as night fell. Only 53 people had been rescued by this point and the delay reduced the chances of survival for those still alive and buried in the mud.

Following an appeal for assistance from the Philippines government and the Red Cross, the international community responded with financial donations, essential supplies and manpower. Some aid was focused on looking

for survivors; for example, Thailand and Spain sent search-and-rescue teams. However, much of the aid was aimed at helping those injured and made homeless to recover from the aftermath. The United States sent two naval vessels and 6,000 troops to provide assistance; while Australia pledged AUS\$1 million and China \$1 million in immediate relief aid. The Red Cross raised \$1.5 million which was used to purchase necessary supplies including tents, blankets, cooking utensils, water purification tablets and medicines.

## Causes

A number of physical and human contributory factors and trigger mechanisms were considered to be responsible for the landslide.

### *Contributory factors*

- **Heavy rainfall:** approximately 200 cm of rain fell in the province over a two-week period. The unusually heavy rains were blamed on the La Niña weather phenomenon in the Pacific Ocean. The excess water lubricated the fault lines in the steep hills above the village and increased the water pressure between the soil particles, causing instability.
- **Logging:** many people from Southern Leyte blamed deforestation by logging companies as a major cause of the landslide. Logging experts considered this unlikely since a government ban in 2004 has prevented further deforestation in the province. However, tree-cover has continued to be removed due to growing **population pressure** in the area which has forced people to clear and farm land further and further up the steep hillsides.
- **Mining:** civil authorities in Southern Leyte have argued that increased mining operations in the area are to blame. Gold, silver, bauxite, nickel and copper are all found in the uplands and Government legislation in the mid-1990s has led to an increase in activity. These operations may have further destabilised the slopes.

### *Trigger mechanisms*

- **Seismic activity:** while the heavy rainfall may have been primarily responsible for creating the conditions that triggered the event, experts believe that an **earthquake** measuring 2.6 on the Richter scale that occurred just prior to the landslide may have played a role.

# Activities

1 Explain what is meant by:

- a landslide
- contributory factors
- trigger mechanisms.

2 Draw a sketch diagram of a hillside illustrating the main contributory factors and trigger mechanisms that can cause landslides. You should annotate your diagram to explain how these factors can work.

3 Using the table in Figure 4, present the key facts about the Southern Leyte mudslide.

4 Only 53 people were rescued in the immediate aftermath of the landslide.

- (a) Why was it difficult for relief workers to rescue any survivors?  
(b) Why is the loss of life so high after a natural disaster in a low income country (LIC)?

5 The Philippines is an LIC. Why might mining and logging companies argue that they should continue to operate in the area in spite of the potential for landslides as a result of their activities?

6 Rapid population growth in urban areas such as Saint Bernard as a result of people moving out of the surrounding countryside is a common phenomenon throughout LICs. The resulting population pressure forces newcomers to build and farm on less desirable land. Explain how clearing, farming and building on the steep hill slopes around Saint Bernard may have increased the chances of a landslide.

7 Disease is a major hazard following an event such as a landslide. What factors might contribute to the outbreak of disease and what types of aid would be important to help manage and prevent it?

Southern Leyte landslide: some key facts	
Date	
Area affected	
Volume of material	
Depth of mud	
Death toll	
Number of people affected	
Houses destroyed	

Figure 4: Presenting the facts on the Southern Leyte landslide

## 8 Group activity

*How can we protect Guinsaugon village from landslide hazards in the future?*

In your groups, imagine you are members of the village council.

You should discuss ways in which Guinsaugon village could be protected in the future from landslides. You could consider ideas such as:

- managing heavy rainfall
- stabilising the slopes
- protecting the village itself
- the location of buildings
- management of human activities in the area
- methods of coping in the aftermath of another landslide.

You should then put together a report to present to your class, who represent the local government. You could also vote on the best ideas and, as a class, consider the definitive action plan to protect Guinsaugon.