Geo Factsheet

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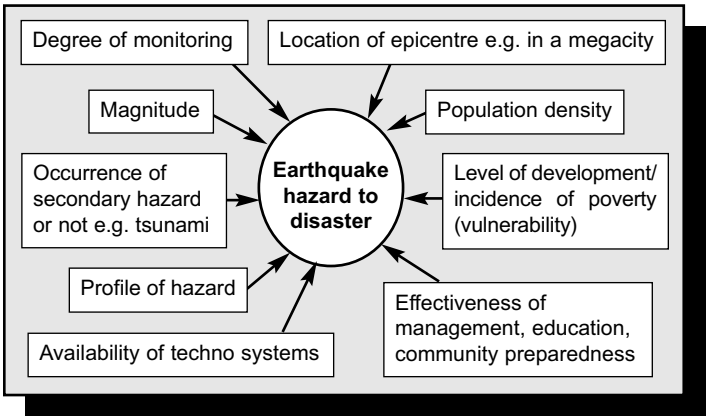
INDONESIA – a tectonic hazard 'hot spot'

Introduction – Why is Indonesia currently so dangerous?

Indonesia lies on the edge of the Pacific Ring of Fire and is currently subject to a **time-concentrated** range of tectonic activity which makes it a tectonic hazard hotspot (a hotspot can be defined as an area where two or more hazard types occur **frequently**). This enormous country, with the exception of the large island of Borneo, consists almost entirely of **island arcs** raised by tectonic movements and volcanic activity during the long term collision of two plates at a very active destructive plate boundary. The Indo-Australia plate is being dragged down (**subducted**) beneath the Indo-China/Burma plate at a rate of around 6cms per year. Vast bursts of energy are released as earthquakes when the sea floor crust shudders, jerks and cracks on its downward journey. This is a major source of subduction related seismicity especially in **Sumatra** and the very densely populated island of Java *(Fig. 1)*. The **Sunda fault** has been likened by geologists to a zipper which is gradually coming undone as each earthquake transfers stress along its length.

On 26th December 2004 the earthquake (Richter scale 9.0) which generated the Boxing Day Tsunami, was followed in April 2005 by a further high magnitude earthquake (Richter scale 8.7) and since then the area has seen a concentrated outburst of earthquakes, hazards and associated volcanic activity.

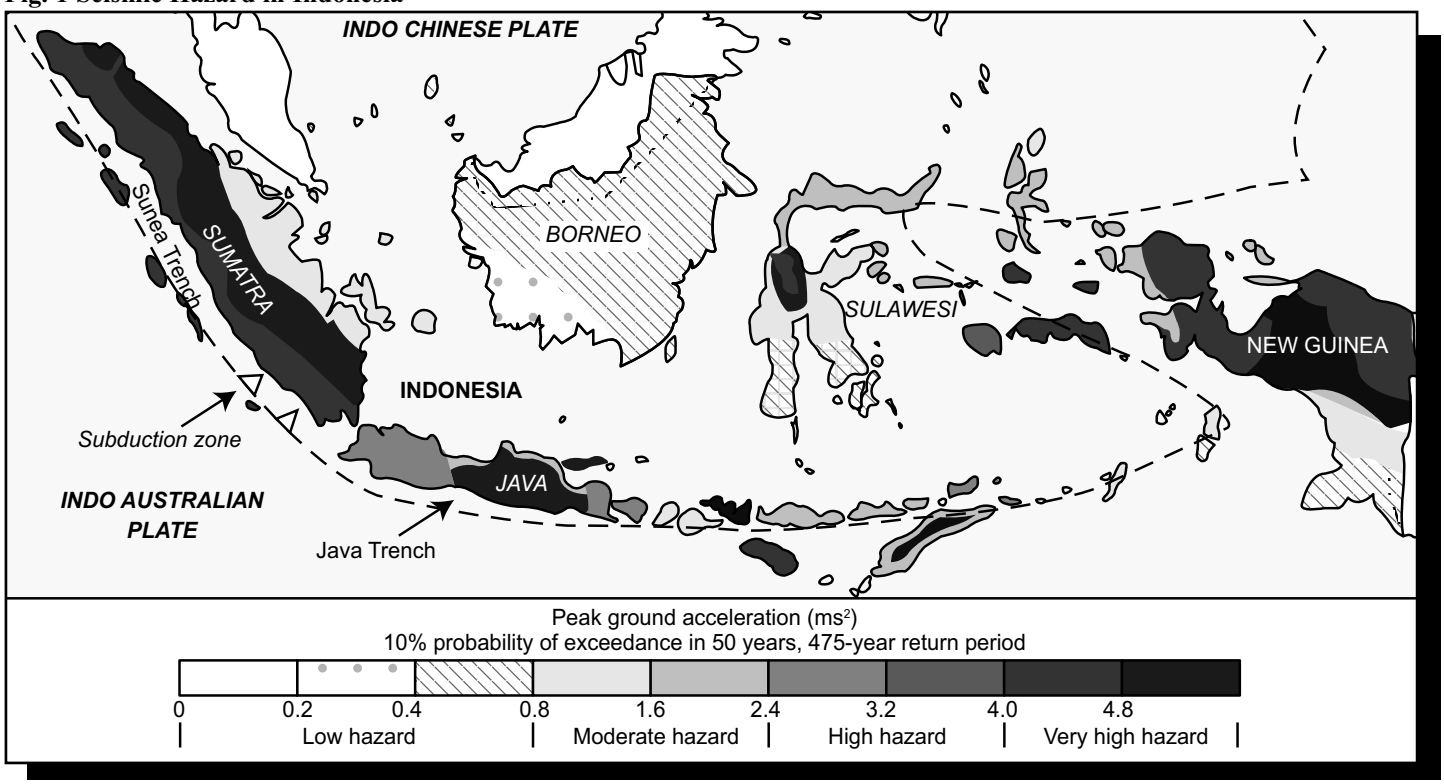
Fig. 2 Factors influencing the risk of a disaster developing.



A study of events in the main body shows how the **social costs** of mortality and injury, and the **economic costs** of damage to buildings, crops and infrastructure, are only partially related to the magnitude of the event.

Exam hint: *Make a table to profile each hazard event and then correlate magnitude with social and economic impacts.)*

Fig. 1 Seismic Hazard in Indonesia



In 2006 a cluster of hazard events took place on Java:

1 Earthquake: Yogyakarta, Java, Indonesia - May

On 27th May 2006 a 6.3 magnitude earthquake struck about 25km southwest of the Indonesian city of Yogyakarta. There were two aftershocks measured at 4.8 and 4.6 occurring between 4 and 6 hours after.

The earthquake caused a significant number of number of deaths estimated to be about 6,000 together with 46,000 injuries. There were 135,000 houses damaged and 1.5 million people were left homeless.

Coastal residents fled inland in fear of a tsunami, but fortunately one did not occur due to the location of the earthquake epicentre.

2 Catastrophic mudflow: Lusi, East Java: A quasi-natural hazard?

The mud started flowing on 29th May 2006, a couple of hundred metres from where the gas company PT Lapindo Brantas was drilling an exploratory well nearly 3km deep. Mud has been gushing up at nearly 50,000 cubic metres a day which is equivalent to 20 large bathfulls every 10 seconds.

Thousands were forced to flee homes and villages. The mud gobbled up thousands of acres of farmland, roads, schools and factories – *see Fig. 2*. The costs related to this disaster now stand at $500 million and counting.

Indonesia's Muddy Disaster	
13,000	displaced
41,000	treated in hospitals
65,000	hectares of agricultural land destroyed
10,000	houses inundated
23	schools covered
15	mosques submerged

There is considerable speculation over the exact cause of this hazard although the general consensus is that is it human-induced and related to the drilling operations. One theory states water at high pressure from the 3km borehole has forced its way into the surrounding 'muddy' rocks. This water has then mixed with the mud-material before breaking to the surface to create a mud volcano.

Everyone seems to agree that there is no way of telling when the mud flow might stop. Whenever it does stop there could be grave new danger – the ground surrounding the borehole could collapse catastrophically. There is also the long term environmental issue of what to do with the mud itself. A number of suggestions have been put forward including flushing the mud out to sea, spreading it on the land and even making it into building bricks!

3 Volcanic activity: Mount Merapi, Java: 13th May - 6th July 2006

Mount Merapi ('Mountain of Fire') is a conical volcano in Central java. It is the most active volcano in the region and has erupted 68 times since the 16th Century. In April 2006 increased seismicity at more regular intervals and an enlarged bulge in the volcano's cone indicated that fresh eruptions were likely to be imminent (red alert). This posed a particular hazard since the volcano lies close to the city of Yogyakarta and thousand of people inhabit the flanks of Merapi. By early May active lava flows had begun. On 11th May 2006, with lava flow beginning to be constant, 17,000 people were evacuated from the area and the authorities raised the alert status to its highest level. Many villagers, however, still ignored the warnings, saying that they could not leave as they needed to tend their livestock and crops.

By the end of May 2006 volcanic activity had calmed down, despite a 6.2 magnitude earthquake within 50km of Merapi on 27th May. There were fears that this could initiate a 'blow'. It did not.

Some volcanic activity continued in June 2006, which including lava flows and superheated clouds of gas on the upper slopes. The volcano remains a very real threat. In July 2 deaths occurred from pyroclastic flows.

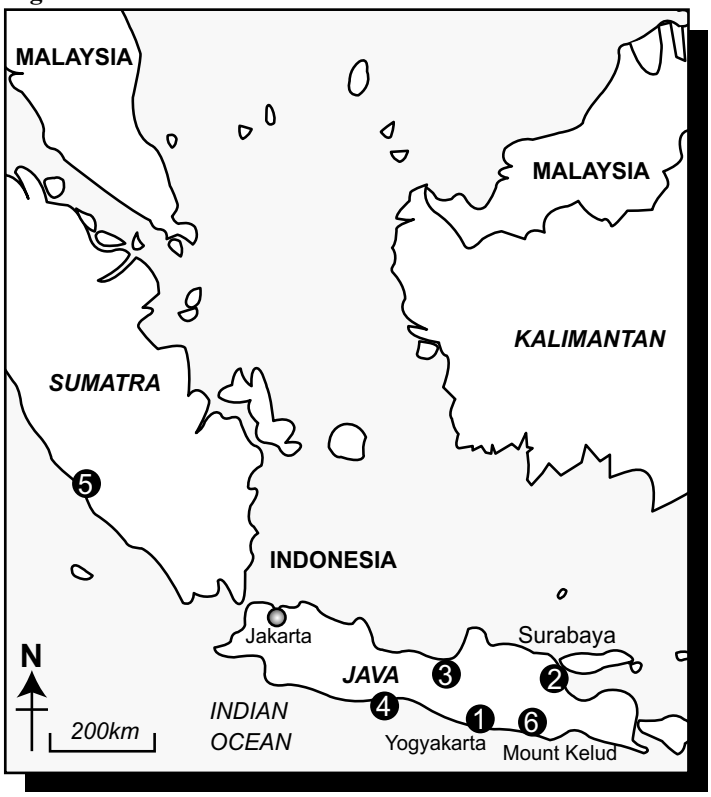
(4) Earthquake and tsunami: Southern Java – 17th July 2006

On 17 July a large magnitude 7.7 magnitude earthquake occurred off the south coast of Indonesia – *refer to Fig. 3*. There were approximately 500 deaths and more than 50,000 displaced.

A difference between this event and the one in May is that the July earthquake caused a 3m high tsunami which destroyed houses on the south coast of Java killing another 550 people. The water reached 200 metres inland and destroyed a number of houses, restaurants and hotels. There was also extensive damage at the west Java beach resort of Pangandaran.

The Pacific Warning Centre in Hawaii issued notice of the tsunami wave, but the Indonesian government were criticised for not alerting local communities in sufficient time (7 minutes before impact via test messaging). In the absence of official notice some residents were more reluctant to leave homes and businesses due to reports of looting in the wake of May earthquake.

Fig. 3 The main events in 2006 in Java.



5 Earthquake and tsunami: Sumatra – August 2007

In 2007 the action shifted back to Sumatra, location of the Boxing Day Tsunami. In August 2007 three earthquakes jolted Indonesia in less then 24 hours, sending a 3 metre tsunami crashing to shore, damaging hundreds of homes. At least 10 people were killed by earthquakes. The first earthquake was 8.4 magnitude in Southern Sumatra and the tsunami could have been as damaging as the Boxing Day one, but the waves were pushed seaward by a freak of nature. Two other quakes, 7.8 and 6.2, followed in Padang (Southern Sumatra).

6 Postscript

The instability continues: November 5th 2007 – several volcanoes in Java including the deadly Mount Kelud erupted. Evacuation orders were issued but 25,000 people defied them to tend their crops and livestock and remained in the danger zone. Previous eruptions have led to many deaths…..

Table 1 Historical disaster data for Indonesia 1907-2005.

Disaster	# of Events	Total Killed	Avg # Killed	Total Affected	Avg # Affected
Cyclone	10	1,992	199	19,698	1,872
Drought	11	9,329	848	4,894,220	444,929
Earthquake	78	21,856	280	1,723,756	18,180
Flood	93	4,298	46	5,069,306	49,643
Volcano	43	17,945	417	981,853	22,351

El Niño related

Major killer

Widespread occurrence
Largely La Niña linked

In conclusion it must be emphasised that these tectonic events are not part of a rising trend, unlike for hydro-meteorological hazards. It is also worth pointing out that Indonesia also experiences hydro-meteorological hazards too as a result of the El Niño – La Niña cycle. For example heavy flooding hit both Indonesia and Malaysia, caused by the heaviest rainfall in a century as a result of a La Niña event. As many of the hillsides have been deforested heavy flooding can lead to land slipping, and mudflows. In El Niño years such as 1997 Indonesia experiences major droughts, which led to extensive wildfires. Northern Indonesia can also experience tropical storms. *Table 1* summarises the occurrence of disasters in Indonesia for the last century.

Questions

(1) Produce a chronological matrix of hazard events in Indonesia 2006 which also classifies according to type and scale, i.e. large, medium and small.

(2) Are the **types** hazards experienced in 2006-07 similar to the overall hazard trends reported in the 20th century *(Table 1)*?

Answer hints

(1) Below is an idea of how you might begin to construct such a matrix. Note how this technique is really useful if you were going to create your own hazard diary for a year. Its also a useful way of summarising and reworking notes for revision.

Jan 2006			Landslide
March 2006			
June 2006	Mudflow+		Volcano+
Oct 2006			EQ & tsunami++
Dec 2006		Flooding+	
	Human induced	Hydro-meteorological	Geological & tectonic

Key: + = medium scale ++ large scale - smaller scale

(2) Geological and tectonic events dominate the 2006 hazard record. *Fig. 2* confirms that Indonesia is very susceptible to tectonic activity and its causes the most **deaths** over historical times. However, the droughts of the 20th C caused more impact in terms of the number of people affected. If predictions about the impacts of global warming are accurate, then this region may well experience and increase in the incidence of droughts and the intensity of rainfall leading to flooding.

Further reading

Catastrophic mudslide could last 100 years, say scientists. The Guardian, 26 September 2006
Indonesia earthquake, The Independent 29 May 2006
This week: mud volcano, New Scientist, 3 February 2007
Two bodies found on Mount Merapi, BBC News 16 June 2006
Heavy flooding uproots thousands in Asia. Mail & Guardian online. December 2006.

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