

## **The Philippines - Hazard Hotspot Case Study**

The Philippines is a group of 7000 islands in the South-China Sea in South-East Asia.

It has a vulnerable population of 98 million people who are at risk from a variety of hazards, including 11 million people in the densely populated coastally situated megacity of Manila, the capital.

### **Hazards**

Geophysical Hazards: Earthquakes, Volcanic Eruptions, Tsunamis and Landslides.

Hydro-meteorological Hazards: Typhoons, Floods, Droughts and Landslides.

### **Volcanic Eruptions: (and subsequent Lahars)**

- The Philippines is near to a destructive plate boundary whereby the dense oceanic crust of the Philippine Plate is being subducted beneath the continental crust of the Eurasian Plate.
- The islands were formed by a combination of folding at the boundary, and volcanos formed from magma that has risen to the surface from the Mantle below from the subducted Philippine plate.
- e.g. The eruption of Mount Pinatubo in June 1991, which killed 500 people, and caused crop failure due to the falling ash (from the eruption).

### **Earthquakes:**

- The Philippine Plate and the Eurasian Plate can become locked together as the Philippine Plate is being subducted, which can cause the buildup and sudden release of pressure.
- Earthquakes can also occur at Fault Lines in the area, where the plate has cracked under pressure.
- e.g. 1990 Earthquake on Luzon Island, magnitude 7.8, killing 1500 people.

### **Landslides:**

- Landslides can be triggered by tectonic activity in the area from Earthquakes
- Landslides can also be caused by heavy levels of rainfall which lead to cliff saturation if they fall in areas with a steep gradient.
- e.g. 2006 Landslide on Leyte Island after 10 days of heavy rain, which buried a village and killed hundreds of people subsequently.

### **Typhoons:**

- The Philippines is situated in the latitudes between 5-20 degrees North of the Equator, so is vulnerable to Typhoons developing in the West of the Pacific Ocean, where Ocean surface temperature is above 26 degrees celsius, the Coriolis effect is strong enough to rotate the low pressure system, and trade winds will move storms Westwards towards the Philippines.
- The Philippines experiences between 7-10 typhoons annually.
- e.g.1 Typhoon Xangsane in 2006, which swept across Manila and the surrounding densely populated area, destroying homes with torrential rain and subsequent flooding/landslides

- e.g.2 Typhoon Haiyan in November 2013, which had maximum one-minute wind speeds recorded at 315km/h before reaching land, the most powerful tropical cyclone to ever hit land, causing 6,500 human fatalities and affecting 11 million people.

### Tsunamis:

- Submarine Earthquakes in any of the surrounding plate boundaries or fault lines can cause a tsunami local enough to be devastating to the Philippines.
- e.g. in 1976 a submarine earthquake of magnitude 7.9 caused a Tsunami of 4-5m high which hit the coastline of the Moro Gulf on the Southern Island of Mindanao, damaging 14 buildings in Zamboanga City.

### Droughts:

- Drought can occur when the wet season (which is distinct in some areas e.g. Manila) hasn't brought enough rain to last through the dry season, or when the dry season is particularly harsh.
- e.g. Luzon Island drought of 2005, whereby a reduction in rainfall decreased river discharge, which decreased economic activity in the area due to a lack of hydroelectric power.

### Flooding:

- During the wet season, coastal floods can be caused by typhoon storm surges or rising ocean levels, and river flooding can be caused by heavy rainfall, even in areas subject to drought (where the soil is sun-dried and infiltration is significantly reduced).
- e.g. the December 2010 floods in Eastern Philippines following heavy rainfall, which resulted in displacing 450,000 people in 19 provinces, killing 25.

### Vulnerability

The population of the Philippines is largely vulnerable to the natural hazards, partially due to having a low capacity to cope.

- **The capital of Manila and the island of Luzon are very densely populated, hence increasing disaster risk** by increasing the impact of a hazard on people and their property when it hits those areas.
- **Coastally distributed population**, hence increasing vulnerability to hydro-meteorological hazards.
- **Landslide disaster risk has increased as the pressures of an increasing population have led to deforestation of upland areas for agriculture**, which reduces interception (increased lag-time) and water table capacity (decreasing potential levels of infiltration).
- **Settlements have been built in vulnerable areas** e.g. Angeles near Mount Pinatubo when it was classified as dormant (not erupted since 1830) before eruption in 1991.
- **Widespread economic deprivation/poverty** means the Philippines have a low capacity to cope, as they can't afford to build stable hazard-proof infrastructure, provide special educational programmes to citizens, provide mitigation disaster kits to all the population or respond quickly to disasters in the quantity needed. GDP per capita is \$3300 in the Philippines compared to \$53 000 in the USA.

## **California - Hazard Hotspot Case Study**

California is a rich member state of the USA on the South-West coast of North America.

It's population of 38 million people, predominantly coastally situated especially in the densely populated megacity of Los Angeles and millionaire cities of San Francisco and San Diego, is vulnerable to many geophysical and hydro-meteorological hazards.

### **Hazards**

Geophysical Hazards: Earthquakes, Volcanic Activity, Landslides.

Hydro-meteorological Hazards: Droughts (La Niña), Wildfires (La Niña), Tsunamis, Flooding (El Niño), Landslides (El Niño).

### **Earthquakes:**

- The conservative San Andreas Fault runs through California, with the oceanic Pacific Plate and continental North American Plate moving past each other (due to mantle convection currents), parallel to the plate boundary but at different speeds.
- Earthquakes occur along the San Andreas Fault when pressure between the plates builds up (when they lock while moving), and is suddenly released causing violent surface movement.
- California experiences 2 to 3 Earthquakes powerful to damage buildings (5.5+ magnitude) each year. Historical data analysis indicates a strong chance California will have a 7.0+ magnitude earthquake in the San Francisco Bay area by 2025.
- e.g. Loma Prieta Earthquake in San Francisco in October 1989, measured at magnitude 7.1 with an epicentre just 60 miles South-East of San Francisco's CBD, which killed 63 people and caused \$10billion in economic damages.

### **Volcanic Eruptions:**

- No Volcanic eruptions in California since Lassen Peak in 1915.
- However, there are multiple volcanos being scientifically monitored for future eruptions e.g. Lassen Peak and Mount Shasta (both North-East California).

### **Landslides:**

- Landslides occur on unstable land with a steep gradient.
- Land can be made unstable by coastal erosion or extreme weather (rainstorms), or indeed tectonic activity (minor earthquakes).
- The risk of landslide disasters in California is high because of building on and around steep slopes (e.g. The Rockies), building on coastal land overlooking the ocean (e.g. La Conchita), and land that has previously been burnt and eroded by Wildfires (e.g. from La Niña cycle high pressure).

### Tsunamis:

- Tsunamis are a series of large waves that can flood coastal area, caused by submarine earthquakes on the seabed/plate boundaries or landslides into the sea.
- Earthquakes under the Pacific Ocean could cause a tsunami along the Californian coast.
- e.g. in 1964 a submarine earthquake off the coast of Alaska hit Crescent City in Northern California, killing 12 people.

### Droughts/Wildfires:

- Droughts in California can be caused by **anticyclones**, which are long-lasting periods of high air pressure with a sinking dry airmass which brings with it no rainfall.
- Drought can also be caused by **La Niña events**, periods when the ocean currents in the eastern Pacific Ocean is cooler, which means less evaporation and therefore less precipitation.
- Furthermore, **increased wind blowing westward** from the desert areas East of California e.g. Arizona, bring air with no moisture to cause precipitation.
- **Wildfires** can be caused by droughts in California, as the dry vegetation from drought is extremely flammable, so fires can be started and spread very easily and quickly respectively.
- e.g. 2007 Wildfires which killed 22 people and destroyed 1300 homes in Southern California.

### Vulnerability

California is wealthy, so has a high capacity to cope (through prevention and reaction to natural disasters) but parts of the population are vulnerable due to the scope of the hazards and vulnerability:

- **Proximity to hazards** - over 70% of California's population live within 50km of a fault line.
- **Building on unstable land** - the risk of landslides and disaster is increased by the construction of buildings on unstable land, which can become a major problem (e.g. during the 1989 Loma Prieta Earthquake) because of the possibility of soil liquefaction.
- **Coastal distribution of population and infrastructure** makes the populations and buildings/infrastructure vulnerable to coastal hazards e.g tsunamis.
- **Some people live in Poverty with a low capacity to cope.** 20% of Los Angeles residents live below the official poverty line.
- California has a massive economy and is very developed, so **huge economic losses** occur from natural disasters, even at low magnitudes.

## The Arctic - Climate Change Case Study

The Arctic is the area within the Arctic Circle around the North Pole. The Arctic includes areas of Asia, North America and Europe.

Global Warming is affecting the Arctic directly:

- **The area of the Arctic sea ice is shrinking**, to the point whereby it will be eliminated by 2030.
- **The Greenland ice sheet is melting**, with the rate increasing in recent years.
- **The permafrost boundary is moving North** as the area covered by permafrost is decreasing (extension of the tree line).
- **The treeline is moving North** and the area where trees can't grow is shrinking

These effects have indirect impacts on the environmental and ecology of the Arctic.

### Impacts of Global Warming on the Arctic

#### Environmental impacts

- **The injection of fresh water into the sea (from melting of ice sheets) will cause changes to the density of the water, disrupting ocean currents**, which could lead to the loss of the North Atlantic Drift for the UK.
- **Thawing of permafrost releases CO<sub>2</sub> and Methane emissions** as permafrost is a natural sink of greenhouse gasses.

#### Ecological impacts

- **Changing climatic regions means that the habitats of some species are being reduced or lost.** e.g. Polar bears use areas of sea ice to hunt for food. As these are being lost polar bears may become endangered in the wild.
- **The Arctic has sensitive ecosystems which can be easily disrupted by the loss of a few species.** Other species can be devastated by the loss of another in their fragile food chain.
- **Biodiversity may increase in some Arctic areas** due to climatic changes.

#### Socio-economic impacts

- **New shipping routes could be created in the Arctic Ocean** in the summer, which could boost trade routes and local ports in Siberia.
- **Facilitates exploitation of natural resources in the Arctic** such as unexplored oil reserves below permafrost, although this could lead to **conflicts over international ownership of the resources.**
- **Extension of the treeline may open up areas for agriculture and forestry.**
- **Thawing of permafrost would destroy buildings and infrastructure with reliant foundations** where the melting makes the ground less stable.

### Consequences of Arctic Warming for the Rest of the World

- **Melting ice sheets** e.g. Greenland **will contribute to global sea level rises**, and the reduction of the albedo effect will accelerate this warming further.
- **Ocean currents can be disrupted by salinity changes** as this affects local ocean currents which operate in a globally interlinked system.
- **Changing temperatures, sea ice and landscapes affect air currents in the Arctic. This also affects global weather patterns** because the atmosphere operates as an interlinked system.

## Africa - Climate Change Case Study

Due to its range in latitudes, Africa experiences a range of different climates ranging from dry deserts to tropical rainforests.

Global warming is having different impacts in different areas:

- Arid and semi-arid environments are getting **drier**. e.g. The Sahel Region
- Tropical and sub-tropical environments are getting **wetter**. e.g. Congo Basin
- The entire African continent is getting **warmer**, by 0.5 celsius in the last century.

The economic impacts of global warming in Africa are complex and the relative financial costs are gigantic as Africa's population is vulnerable:

- **The poor population has a low capacity to cope** e.g. subsistence farmers, who will have no income if droughts intensified by artificial climate change cause crop failure.
- **Poorer countries are less able to prepare for, predict and respond** to the impacts of climate changes.
- **Political turmoil and government/business corruption ensure that appropriate disaster responses aren't made** by large organisations, making the impacts of climate change worse.

Impacts of climate change on Africa:

- **Global warming has caused desertification**, the process by which fertile land has become unusable for agriculture. e.g. In the Sahel Region of sub-saharan Africa desertification has occurred which has caused a decrease in agricultural productivity, leading to more poverty, unemployment, malnourishment and starvation.
- **Warming in Africa has engendered the presence of malaria as mosquitoes prefer warmer climates**. Malaria has huge impacts on poorer communities who cannot afford nets etc. to combat the mosquitoes, subsequently killing over 1 million people in Africa annually. Malaria puts economies under strain and prevents growth due to the costs of health care, the reduction in productivity and decreased tourism and foreign investment.
- **Global warming is causing a more erratic climate with more natural hazards/disasters**. Africa is not more susceptible to drought and heavy rainfall than ever before, ensuring that the climate has a regular human impact in areas where people have a low ability to rebuild damaged infrastructure and recover. e.g. in Mozambique, crop failure was caused by drought in 1995 and then in 2000 flooding displaced much of the population.
- **Global warming has caused a reduced growing period** across Africa, decreasing agricultural production. e.g. in the Sahel Region, agriculture forms 70% of employment, so a reduction in agricultural employment seasons leads to unemployment, poverty, malnourishment and starvation.
- **Global warming means tropical areas of Africa are experiencing longer growing periods, potentially financially benefiting as a result**. e.g. In North-East Tanzania the growing season has extended by more than 50 days a year.