GEOACTIVE Extension 545

Typhoon Haiyan

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A case study about the causes and impacts of tropical storm Haiyan

When tropical storm Haiyan struck southeast Asia in November 2013, it caused havoc in an already economically deprived area. This low-latitude semi-tropical region is prone to extreme weather hazards such as typhoons, and the ability to reduce the impact in such places can be limited by poverty and a lack of development.

As population growth continues, there is increased pressure to use marginal and vulnerable lands that are at risk of the flooding, storm surges and extreme winds generated by tropical storms. In the future, with the influence of climate change and potentially rising sea levels, there could be an increased incidence of tropical storms.

Key vocabulary

tropical storm, typhoon, population density, depression, landfall, Saffir-Simpson scale, storm surge, infrastructure

Learning outcome

In this unit you will:

- learn about the causes, impacts and management of a climatic natural hazard on a region
- consider the potential responses and preparation in future.

Relevance to specifications

Exam board	Link to specification
AQA A	Unit 1: Physical Geography, Section A, Challenge of Weather and Climate, page 11 http://filestore.aqa.org.uk/subjects/AQA-9030-W-SP-14.PDF
AQA B	Unit 2: Hostile World and Investigating the Shrinking World, Section A, Living with Natural Hazards, page 13 http://filestore.aqa.org.uk/subjects/AQA-9035-W-SP-14.PDF
Edexcel A	Unit 1: Geographical Skills and Challenges, Section B, Challenges for the Planet, page 15 http://www.edexcel.com/migrationdocuments/GCSE%20New%20GCSE/9781446911907_GCSE_Lin_Geog_A_Issue_5.pdf
Edexcel B	Unit 1: Dynamic Planet, Section A, Introduction to the Dynamic Planet, Topic 2, Changing climate, page 13 http://www.edexcel.com/migrationdocuments/GCSE%20New%20GCSE/9781446911914_GCSE_Lin_Geog_B_Issue_5.pdf
OCR B	Unit B563: Key Geographical Themes, Theme 3: Natural Hazards, page 16 http://www.ocr.org.uk/Images/82581-specification.pdf
WJEC A	Unit 2: The Options, Physical Options, Theme 8, Weather and Climate, page 19 http://www.wjec.co.uk/qualifications/geography/geography-gcse/16128.pdf?language_id=1
WJEC B	Unit 2: Living in Our World, Theme 2: Physical Processes and Relationships Between People and Environments, 1 Weather and Climate, page 16 http://www.wjec.co.uk/uploads/publications/17213.pdf
CCEA	Unit 1: Understanding Our Natural World, Theme B: Our Changing Weather and Climate, pages 12 and 13; a copy of the specification can be downloaded from: http://www.rewardinglearning.org.uk/microsites/geography/gcse/index.asp
Cambridge IGCSE	Theme 2: The Natural Environment, page 17 http://www.cie.org.uk/images/150857-2016-syllabus.pdf
Edexcel IGCSE	Section A, The Natural Environment and People, Topic 3, Hazardous Environments, page 9 https://www.edexcel.com/migrationdocuments/IGCSE%20New%20IGCSE/IGCSE2009_Geography_(4GE0)_Specification.pdf

Typhoon Haiyan

> "Typhoon Haiyan was one of the strongest tropical storms ever recorded, and the deadliest to hit the Philippines."

In November 2013 a tropical storm began developing in the Pacific Ocean southwest of the Philippines. This developed into a super-typhoon, known locally as Typhoon Yolanda and internationally as Typhoon Haiyan. It was one of the strongest tropical storms ever recorded, and the deadliest to hit the Philippines: it was responsible for over 6300 deaths.

The Philippines is an archipelago of 7107 islands in southeast Asia in the Pacific Ocean, located between the Tropic of Cancer and the equator (Figure 1). It is the seventh most populous nation in Asia, with a population of 98.4 million throughout the islands (according to the CIA Factbook). This population is largely concentrated in the Visayas region, a collection of islands included Samara and Leyte, and is growing at an average rate of 1.7% per year.

Figure 1 The Philippines in southeast Asia

Population density is distributed unevenly across the islands, and is greatest in the cities, particularly the capital city Manila, and Tacloban City on the island of Leyte. The Philippines are known as a less economically developed country (LEDC) with an average GDP per capita of $2765. This can be compared with nearby Malaysia with an average GDP of $10 500, and a world average GDP of $13 100 (Figure 2).

Area	GDP per capita ($)	Population density (people/km²)	Population growth (% year)	Death toll
Tacloban City	2200	1100	+37	5800 (estimated – may be 10 000)
Visayas region (including Tacloban City, Samar and Leyte islands)	2450	278	+6	6200 (estimated)
Philippines (whole)	2765	337	+7	6340+ (Red Cross and locals estimated more than 10 000 deaths; President Aquino estimated just 2500)

Figure 2 The Philippines: some facts and figures
Sources: www.nscb.gov.ph, www.ncca.gov.ph

The Philippines is prone to earthquakes and volcanoes (it is part of the Pacific 'Ring of Fire') and experiences seasonal tropical storms (Figure 3). This type of tropical maritime climate is divided into three seasons:

- *tag-init*: hot, dry summer season, March–May
- *tag-ulan*: rainy monsoon season, June–November
- *tag-lamig*: cool dry season, December–February.

As a result of the climate and its monsoon season, the region receives an average of 19 'typhoon strength' tropical storms each year, with eight or nine making landfall during the season.

What caused Typhoon Haiyan?

The generic term 'tropical storm' refers to an intense low-pressure weather system, or depression, which creates a revolving storm: these are known as hurricanes, cyclones or typhoons in different parts of the world (Figure 4). These depressions can travel great distances,

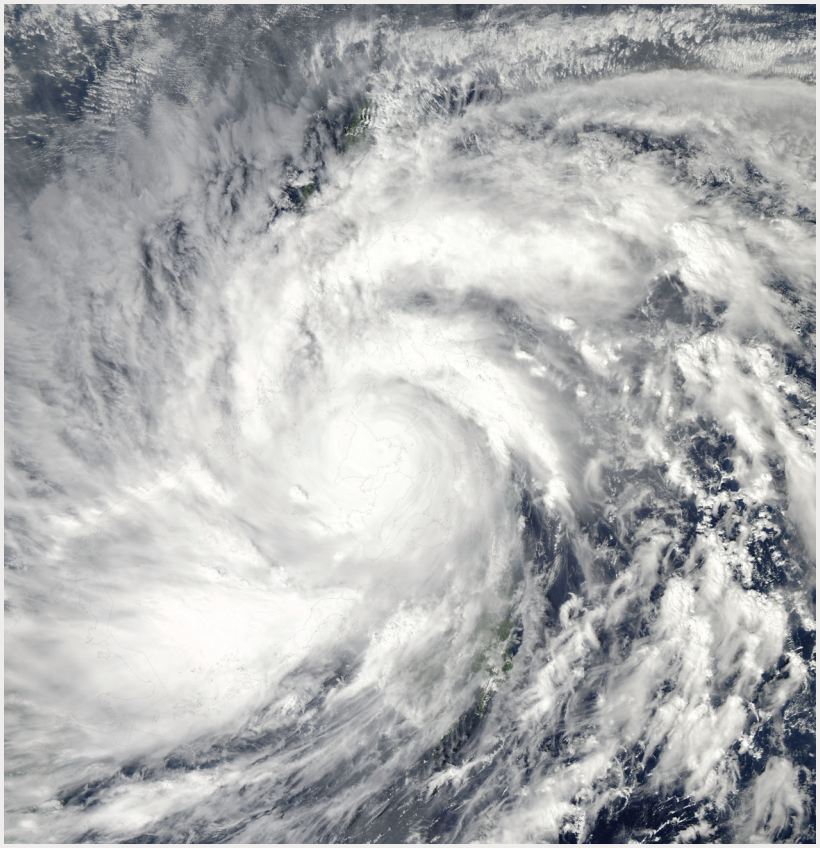

Figure 3 Typhoon Haiyan moves across the Philippines
Source: NASA/Geoff Schmaltz

last days or weeks, and form between the Tropics of Cancer and Capricorn on either side of the equator, where ocean waters are warmer than 27°C and the depth is at least 60 m. This fuels rapid evaporation and moves heat energy from the ocean into the atmosphere, where water vapour condenses to build clouds. High-pressure cold, dense air from the upper atmosphere is drawn down towards the ocean surface, which is now at low pressure, where it mixes with the rising warmer air. This begins to create a swirling movement of air. Additionally trade winds are moving towards the equator from the tropics, and this speeds up the mixing of cool and warm air masses and intensifies the formation of clouds and a spinning movement. The Coriolis force then spins these depressions away from the equator (see Figure 3) and away from ocean towards land. Once the depression reaches speeds of over 119 km/hr it is classed as a tropical storm (or a typhoon/hurricane). Landfall is when the storm hits land, and at this point the storm loses the heat evaporation energy from the ocean and begins to weaken.

Tropical storms are measured on the Saffir-Simpson scale, from Category 1 to 5 according to measurements of air pressure and wind speed (Figure 5). Wind speeds and precipitation are strongest on the edge of the storm, with a calm 'eye' in the centre.

Typhoon Haiyan originated on 2 November in the Pacific Ocean, several hundred kilometres from the Philippines. It then tracked northwest and intensified (Figure 6). The storm was monitored by the Japanese Meteorological Office and Joint Typhoon Warning Centre (JTWC), which made predictions as to where landfall would be made.

Impacts of Typhoon Haiyan

By 7 November the JTWC had upgraded Typhoon Haiyan to Category 5, with estimated wind speeds up to 314 km/hr and air pressure as low as 895 mb. This 'super-typhoon' then made landfall in the Visayas region of the Philippines, crossing between the islands where the warm waters maintained the storm's strength. Haiyan made landfall in five other areas, including southern China, Micronesia and Vietnam, but the Philippines was the worst affected. The storm left scenes of devastation in its wake then gradually weakened as it tracked north, until by 11 November it finally dissipated.

One of the worst impacts of a tropical storm is a storm surge, when the sea level rises unusually high due to the low atmospheric pressure and strong winds blowing onshore (a storm surge should not be confused with a

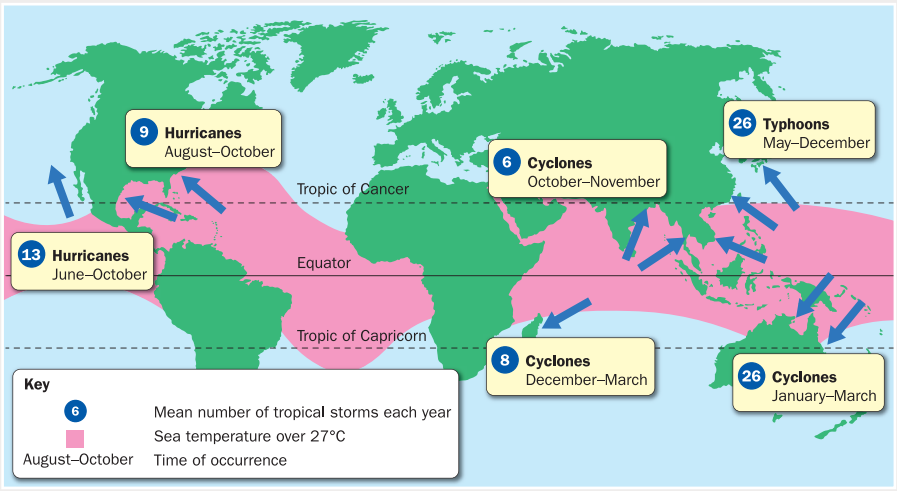

Figure 4 Global distribution of tropical storms, showing their local names

	Wind speed (km/hr)	Air pressure (millibars)
Category 1	119–153	> 980
Category 2	154–177	965–979
Category 3	178–208	945–964
Category 4	209–251	920–944
Category 5	> 251	< 919

Figure 5 The Saffir-Simpson scale

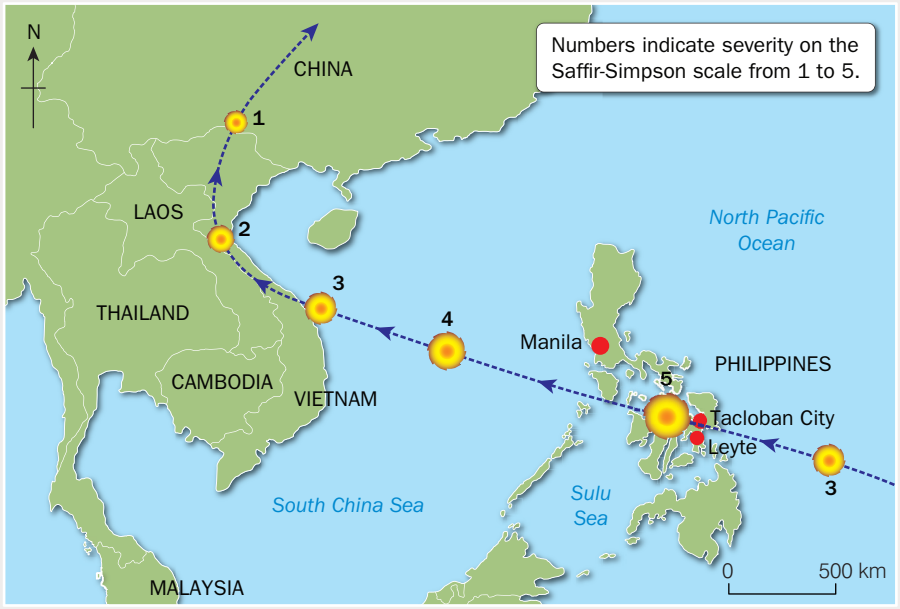

Figure 6 The path taken by Typhoon Haiyan

tidal wave or tsunami). A storm surge of 7.5 m reached the coast across the islands (see Figure 7), and a 5 m surge hit Tacloban City where at least 5800 people were killed. Due to the low-lying ground the surge was able to extend for over a kilometre inland. In rural Hernani town, some 700 m from the sea, the floods were so powerful that bodies were washed out from graves, which caused much grief among a deeply religious community.

Tacloban was by far the worst-hit area. In a town of 220 000 people with a density of 1100 people/km², 90% of all buildings were destroyed, trees were uprooted or flattened, debris covered the land, electricity supplies were cut and infrastructure and communications destroyed. Some 5 million people saw their homes destroyed or become uninhabitable, and the airport was unusable. Of the total 6340 fatalities (estimated), almost all were in Tacloban City or the Visayas region. Local people estimate the death toll to have been around 10 000, although President Aquino suggested a much lower number.

> **"One of the worst impacts of a tropical storm is a storm surge."**

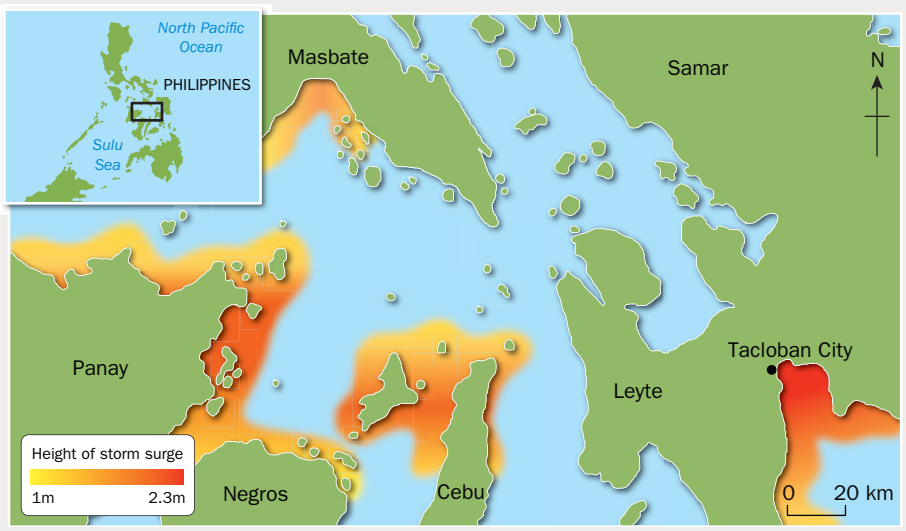

Figure 7 The storm surge brought flooding to low-lying areas

Essential infrastructure, such as the airport, roads, bridges, electricity supplies and communications, were destroyed either by the storm surge, winds, or subsequent landslides. This made it difficult to accurately assess damage and to deploy emergency services, hampering the rescue efforts. By 11 November, seven provinces in the Visayas region, with 14 million people, were affected and a 'state of national calamity' was declared. The international community was called upon for aid.

Emergency response

The emergency response was coordinated by the World Health Organisation and the United Nations, including the UNOCHA (Office for Coordination of Humanitarian Affairs), and other non-governmental organisations (NGOs) such as the Red Cross and the DEC (Disasters Emergency Committee). The DEC launched an international fundraising appeal on 12 November via television, radio, internet and social media – particularly Twitter. This raised millions of pounds worldwide in weeks.

The destruction of infrastructure, particularly the airports, slowed relief efforts as much aid remained halted on entry to the country and could

Figure 8 Damage to infrastructure
Source: www.shutterstock.com; photo by Richard Whitcombe

not be distributed to where it was needed (Figure 8). In mid-November, only 20% of those requiring aid in Tacloban had received it. There were attempts to move thousands of people by military aircraft, but miscommunication and panic slowed this evacuation. There were incidents of looting and assault during these early days – exacerbated by the fact that only 100 police out of 1300 reported for duty. Some United Nations staff were pulled out for safety reasons, and charity agencies were unable to get access to the storm's victims. Tacloban's hospitals, which had also been damaged, ran low on supplies and were shut down either because there were too few staff to operate them, or for safety reasons, leaving the injured without assistance. Despite these difficulties, however, there were no major outbreaks of disease.

In some instances relief trucks were attacked and items stolen, including 33,000 large bags of rice sent in by a charity. Armed police were deployed to protect fuel and aid supplies from looters, a curfew was imposed, and the President declared martial law in some areas, sending in soldiers to maintain order.

The democratic government was criticised for its slow response, with the media claiming that preparation in advance was poorly organised. Five days after the typhoon first struck, residents still lacked basic amenities such as water and safe shelter. With so many displaced people to deal with, and a financial crisis looming, eyes turned to the international community for help. The USA sent in Marines and Navy personnel, and the UK sent in aid via the Royal Air Force and the Royal Navy. The UN fundraising appeal totalled $788 million in aid, and foreign nations donated $500 million (including $131 million from the UK alone through government funds and the Philippines Typhoon Appeal). However, total damage exceeded $8 billion, so the disaster has been a serious setback for the economic development of the Philippines.

The economy is heavily reliant upon agriculture, fishing, tourism and manufacturing – all of which were damaged in the typhoon. Grants were made available for local fishing businesses to buy new boats, Oxfam provided rice seed to farmers, Save the Children helped to build tent schools to ensure that education continued, while tourist resorts along the coast are slowly being rebuilt.

Much of the work in Tacloban was conducted by residents themselves, and in January 2015 was still continuing. Thousands signed up for 'cash for work' schemes in which people are paid by aid agencies such as the Red Cross to help rebuild the city. Businesses are still closed in Tacloban, and many people still live in temporary accommodation.

Following the storm, technology was important. Infrared satellite images were used to locate areas of devastation, and thermal cameras helped to detect bodies buried under the debris. The Humanitarian Open StreetMap Team used crowd-sourced information to keep the global community updated, Google Person Finder enabled people to track friends and family, and social media assisted the relief operations. These all aided search and rescue efforts on the ground.

Future planning?

There are fears that in such a disaster-prone area, and at a time of potential sea level rise and increased sea temperatures, typhoons of this magnitude may become more frequent. It was the unprecedented storm surge that caused the most damage, and so efforts are being made to improve tidal measurements and satellite monitoring to improve the prediction of surges in future.

Some soft engineering schemes such as mangrove plantations are being introduced to reduce surge impact. Afforestation schemes along the coast are also being put in place to create windbreaks and to stabilise the soil.

The UN Development Programme has liaised with the government to improve disaster risk management policies across the region, with evacuation routes, shelters, early warning systems and monitoring schemes being given priority.

The Philippines Weather Service also operates more warnings via the internet and by social media.

Conclusion

The impacts of the storm were so devastating, and the death toll so high, the names 'Yolanda' and 'Haiyan' have been retired from the official typhoon name lists and will never be used again. The Philippines, and southern Asia as a whole, need to pay careful attention to climate change involving changing weather patterns, and to the future risks of increased storm frequency.

Activities

1 Describe the formation of tropical storms. Use a step-by-step flow chart or diagram in your answer.

2 Study Figure 4.
- a Describe the distribution of tropical storms globally.
- b What is the most common storm season for the Philippines?
- c Why are storms in that region most common at this time of year?

3 How many people were displaced as a result of Typhoon Haiyan?

4 Study the information in Figure 2.
- a State the GDP per capita for the Philippines.
- b Suggest how the level of development of a country can influence the impacts of a hazard. Refer to facts relating to the Philippines.

5 Study Figure 7. Describe the pattern of the areas affected by the storm surge.

6 Suggest how a storm surge might have social, economic and environmental impacts. You could present your answer as a Venn diagram.

7 If global sea levels rise by 0.5–2.0 m (as suggested), how might this affect the severity of the impact of tropical storms in future? Refer to Figures 6 and 7.

8 Visit www.dec.org.uk and www.unocha.org to investigate the current situation in the Philippines. How successful has the aid response been?

9 Research the different options for hard and soft engineering to mitigate against tropical storms, including protection against storm surges and winds, for buildings and the environment. Analyse which methods are most effective, and make recommendations for the Philippines.

10 Use the internet to research the humanitarian aid response of NGOs such as the United Nations or Unicef. What was done to help the Philippines?

11 Investigate the role of social media in the response to the disaster, e.g. Twitter #Haiyan or #YolandaPH. How has technology enabled a better response to natural hazards?

12 Research the impact of a tropical storm in a more developed country, e.g. Hurricane Sandy or Hurricane Katrina in the USA. Compare and contrast the primary and secondary impacts, the immediate responses, and the subsequent management of the hazard.

Learning checkpoint

- Typhoon Haiyan made landfall in the Philippines in November 2013.
- It was the deadliest tropical storm to hit the region, killing approximately 6340 people and affecting 14 million people.
- NGOs such as the Disasters Emergency Committee were heavily involved in providing aid to over 900 000 people through an internationally funded Philippines Typhoon Appeal charity drive.

Glossary task

Write glossary definitions for these terms:

depression

infrastructure

landfall

population density

Saffir-Simpson scale

storm surge

tropical storm

typhoon

Remember this case study

To help you remember this case study, make notes under the following headings

What were the causes of Typhoon Haiyan?

What were the primary and secondary impacts?

How did the local and international community respond?

How might this area be protected in future?

Try to make your notes fit a single sheet of A4. You could use a detailed mindmap to help you.