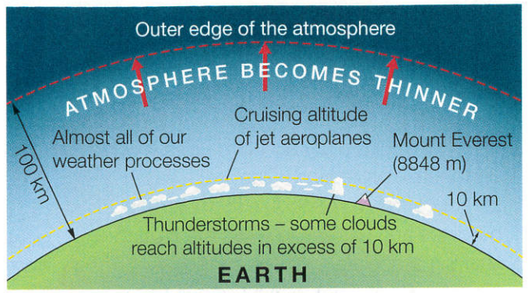
3 Weather hazards

3.1 Global atmospheric circulation

On this spread you will find out how global atmospheric circulation affects global weather and climate

What is global atmospheric circulation?

The cruising altitude (height) of an aeroplane is about 10 km above the ground surface. At this altitude the vast majority of the atmosphere's mass is below you (diagram **A**). The atmosphere – the air above our heads – is a highly complex swirling mass of gases, liquids and solids. These include water droplets, water vapour, ash, carbon dioxide and oxygen – just to mention a few!

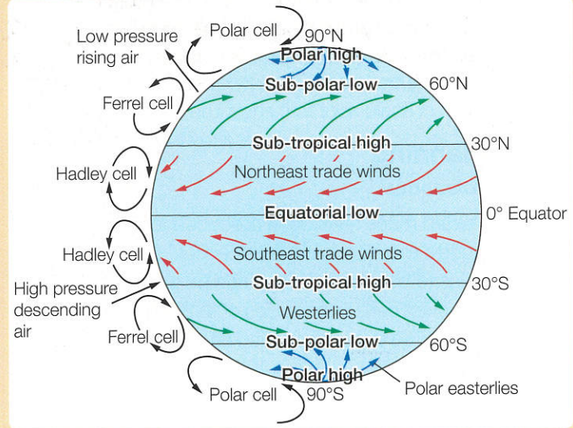


A *The atmosphere*

How does global atmospheric circulation work?

Diagram **B** shows global atmospheric circulation. This involves a number of circular air movements called cells. These cells all join together to form the overall circulation of the Earth's atmosphere.

- Air that is *sinking* towards the ground surface forms areas of *high pressure* (for example, at the North Pole). Winds on the ground move outwards from these areas.
- Air that is *rising* from the ground surface forms areas of *low pressure* on the ground, for example at the Equator. Winds on the ground move towards these areas of low pressure.
- Winds on the ground are distorted by the Earth's rotation. They curve as they move from areas of high pressure to areas of low pressure.
- Surface winds are very important in transferring heat and moisture from one place to another.
- The patterns of pressure belts and winds are affected by seasonal changes. The tilt and rotation of the Earth causes relative changes in the position of the overhead Sun. These seasonal changes cause pressure belts and winds to move north during our summer and then south during our winter.



B *Global atmospheric circulation*

Did you know?

The prevailing wind for the UK comes from the south-west over the Atlantic Ocean. This is why we have a moist and mild climate.

How does global circulation affect the world's weather?

Global atmospheric circulation is what drives the world's weather. The circulation cells, pressure belts and surface winds (diagram **B**) affect the weather around the world. For example, the trade winds in the tropics are responsible for driving tropical storms (hurricanes) across these regions bringing chaos and destruction to coastal regions in their path.

Cloudy and wet in the UK

The UK is located at about 55° North just below the 60° N line of latitude. This puts the UK close to the boundary of cold polar air moving down from the north and warm sub-tropical air moving up from the south.

The boundary between these two air masses is unstable. Here there is rising air and low-pressure belts (the *sub-polar low*) on the ground. Rising air cools, condenses and forms cloud and rain. This is why it is often cloudy and wet in the UK.

Surface winds in these mid-latitudes come from the south-west. These winds bring warm and wet conditions to the UK. But sometimes the cold polar air from the north moves down over the UK bringing snow and very cold winter weather.

C *Wet weather in the UK*

Hot and dry in the desert

Most of the world's hot deserts are found at about 30° north and south of the Equator. Here the air is sinking (diagram **B**), making a belt of high pressure (the sub-tropical high). Air isn't rising here, so there are few clouds forming and little rainfall. The lack of cloud makes it very hot during the day very cold at night, as heat is quickly lost from the ground.

D *Hot, dry weather in the desert*

Hot and sweaty at the Equator

At the Equator the air is rising (diagram **B**) and there is another low pressure belt (the *equatorial low*). This part of the world is very much hotter than the UK, with the sun directly overhead. Equatorial regions, such as central Africa and south-east Asia, experience hot, humid conditions. It is often cloudy with high rainfall. This is the region where tropical rainforests are found.

E *Hot, humid weather at the Equator*

ACTIVITIES

1. Copy diagram **B**. Draw the lines of latitude and label the Equator. Add the winds and circulation cells to your diagram. Use different colours to show the high and low pressure belts.
2. What do you notice about patterns of surface winds in relation to high and low pressure belts?
3. Explain why the patterns of pressure belts and surface winds move north and south during the year.
4. How does the atmospheric circulation system explain the UK's mild, cloudy and wet weather?
5. Draw a sketch to show how atmospheric circulation accounts for the high rainfall at the Equator.

Stretch yourself

Find a map to show the tracks followed by tropical storms. Use diagram **B** to add the Equator and the tropics. Draw on the trade winds to show how they are responsible for the east-west movement of the storms.

Practice question

Explain how the global atmospheric system affects the weather and climate of the tropics. *(6 marks)*

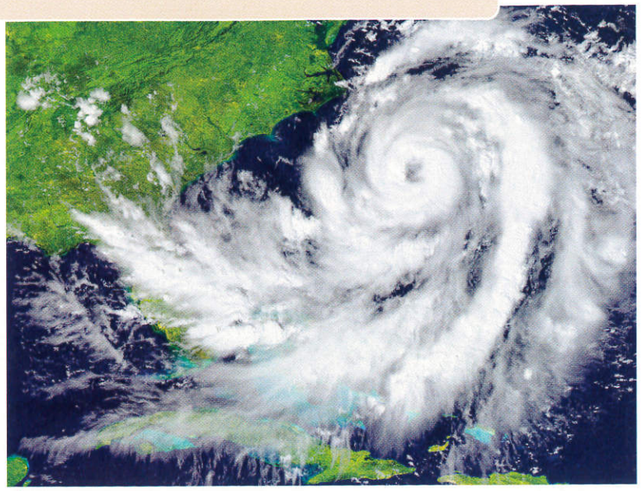
3.2 Where and how are tropical storms formed?

On this spread you will find out about the distribution and formation of tropical storms

What is a tropical storm?

A tropical storm is a huge storm that develops in the Tropics (image **A**). In the USA and the Caribbean these are called **hurricanes**. In south-east Asia and Australia they are called **cyclones**, but in Japan and the Philippines they are called **typhoons**.

Tropical storms are incredibly powerful and can cause devastation to small islands and coastal regions. Photo **B** shows some of the damage caused by Hurricane Sandy on the east coast of the USA in 2012. It was the costliest and most deadly Atlantic storm of the year, killing 285 people.



A *Satellite image of Hurricane Sandy off the coast of Florida, USA, 2012*

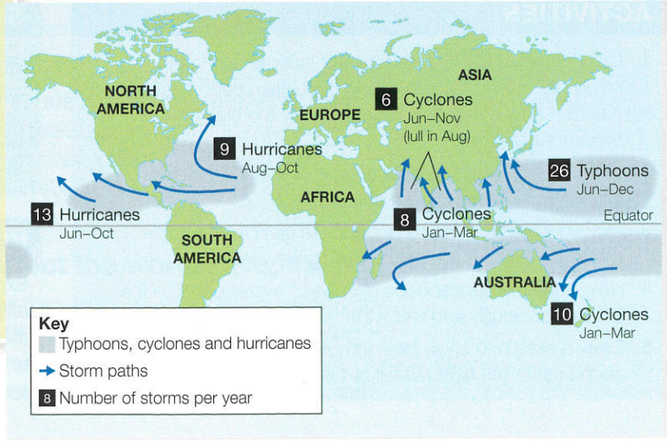
B *The impact of Hurricane Sandy in Queens, New York*

Where do tropical storms form?

Map **C** shows the distribution of tropical storms. It also provides some useful clues about the formation of tropical storms.

- Tropical storms form over warm oceans (above 27 °C), which explains why they are found in the Tropics.
- They form in the summer and autumn when sea temperatures are at their highest.
- Most tropical storms form 5–15° north and south of the Equator. This is because at the Equator there is not enough 'spin' from the rotation of the Earth. The effect of the Earth's rotation is called the *Coriolis effect*. A tropical storm is a spinning mass of clouds (photo **A**).
- In tropical regions the intense heat makes the air unstable causing it to rise rapidly. These unstable conditions are important in the formation of hurricanes.

C *The distribution of tropical storms*



How do tropical storms form?

Scientists are not certain what causes the formation of a hurricane, but it involves the sequence of events shown below.

On reaching land the storm's energy supply (evaporated water) is cut off. Friction with the land slows it down and it begins to weaken. If the storm reaches warm seas after crossing the land, it may pick up strength again.

As the storm is carried across the ocean by the prevailing winds, it continues to gather strength.

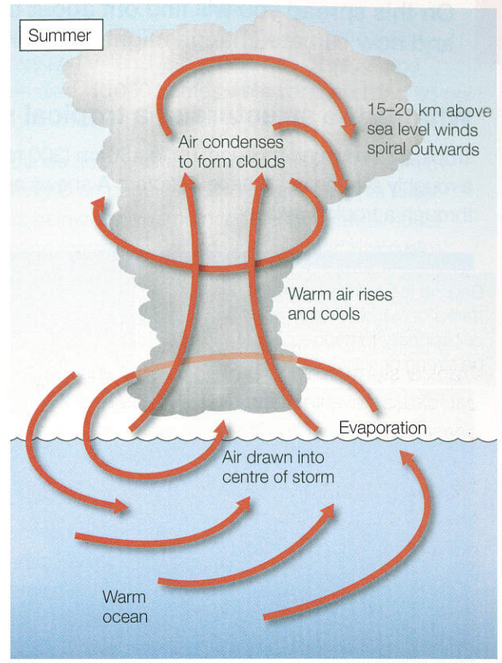
The storm now develops an eye at its centre where air descends rapidly. The outer edge of the eye is the eyewall where the most intense weather conditions (strong winds and heavy rain) are felt.

Several smaller thunderstorms join together to form a giant spinning storm. When surface winds reach an average of 120 km per hour (75 miles per hour) the storm officially becomes a tropical storm.

As the air condenses it releases heat which powers the storm and draws up more and more water from the ocean.

This evaporated air cools as it rises and condenses to form towering thunderstorm clouds.

A strong upward movement of air draws water vapour up from the warm ocean surface.



D *Formation of a tropical storm*

ACTIVITIES

1 **a** In which part of the world are tropical storms called cyclones?
  b During which months are hurricanes most likely to affect the east coast of the USA?
  c On average how many cyclones affect Australia each year?
  d Which countries are most likely to experience tropical storms during the year?
2 Why do tropical storms not form at the Equator?

Stretch yourself

Make a copy of diagram **D** showing how a tropical storm forms. Add detailed labels in the form of a sequence (1, 2, 3, etc.). Describe the formation of a tropical storm.

Practice question

Using map **C** and your own knowledge, describe the global distribution of tropical storms. *(4 marks)*

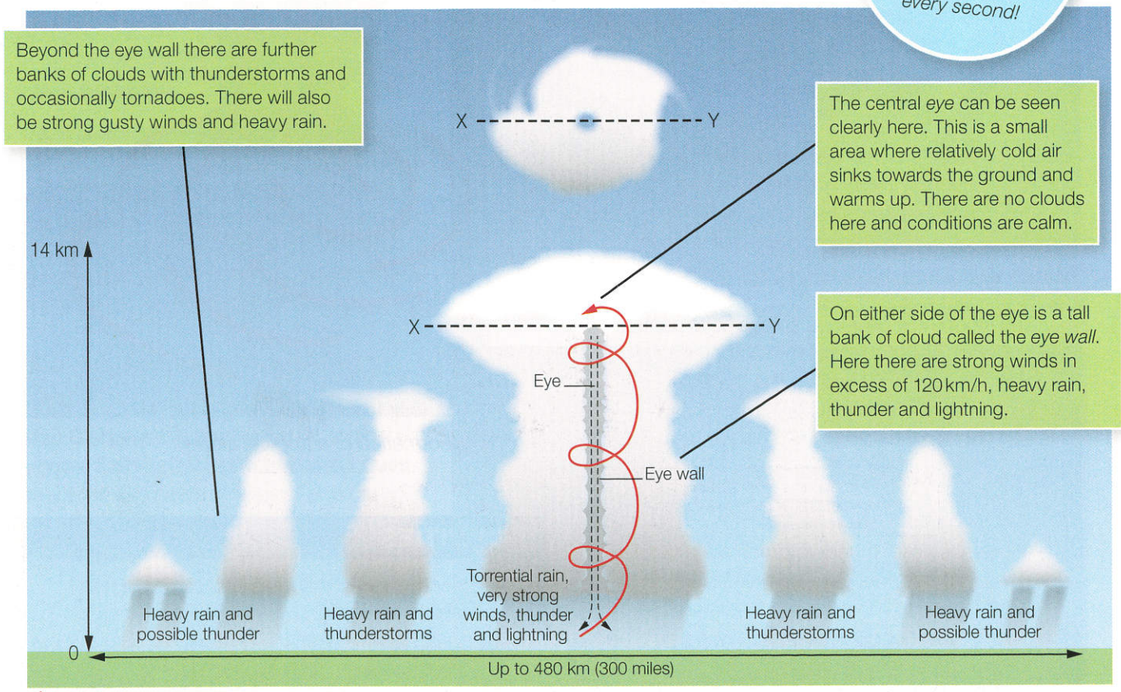
3.3 The structure and features of tropical storms

On this spread you will find out about the structure and features of tropical storms, and how climate change might affect tropical storms in the future.

What is the structure of a tropical storm?

Tropical storms can be huge, up to 480 km (300 miles) across. A tropical storm has a roughly symmetrical shape. Diagram **A** shows an imaginary cross-section (X–Y) through a tropical cyclone.

Did you know?
A tropical storm can release the energy of 10 atom bombs every second!



A *Structure of a tropical storm*

Will climate change affect tropical storms?

There is strong scientific evidence that global temperatures have risen over the last few decades. These rises may be impacting on the world's natural systems. But what impact will they have on tropical storms?

Tropical storm facts

- Tropical storms are the most destructive storms on Earth.
- They are given names for identification. Hurricanes, for example, are given alternating male and female names each 'season'. The first hurricane starts with 'A', the second 'B', and so on. In 2016, the first hurricane will be Alex, then Bonnie, then Colin...
- Hurricane Camille in 1969 had the highest recorded wind speed, estimated at 304 km/h (190mph).

How strong is a hurricane?

Hurricanes are measured using the Saffir-Simpson scale.

Category	Wind speeds
5	> 252 km/h
4	209–251 km/h
3	178–208 km/h
2	154–177 km/h
1	119–153 km/h

Distribution

Over the last few decades sea surface temperatures in the Tropics have increased by 0.25–0.5 °C. As patterns of sea surface temperatures change, they may affect the distribution of tropical storms.

In the future, tropical storms may affect areas outside the current hazard zone, such as the South Atlantic and parts of the sub-tropics. Hurricanes may also become more powerful.

Hurricane Catarina (2004)

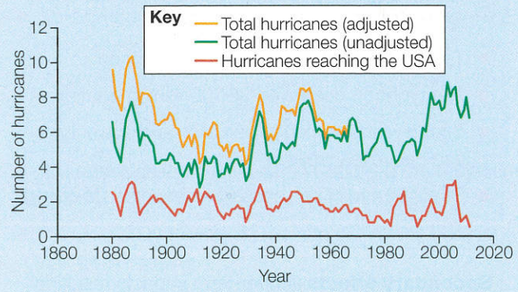
In March 2004, the south-east coast of Brazil was struck by a Category 2 hurricane, the first ever recorded here. Coastal communities were taken by surprise and extensive damage was done. Some people died, 40 000 homes were damaged and 85 per cent of the region's banana plants were destroyed.

Hurricanes do not usually form in the South Atlantic (see map **C** on page 24). Cold ocean currents keep waters below the minimum temperature required for hurricane formation. Strong winds 'shear' rising air preventing storms from forming.

In March 2004, sea surface temperatures were unusually high. Conditions were right for a hurricane to form. Such events might become more common as sea surface temperatures change.

Frequency

Graph **B** shows the number of hurricanes recorded in the North Atlantic since 1878. Six of the ten most active years since 1950 have happened since the mid-1990s. Some computer models indicate that the frequency of tropical storms may decrease in the future – but, their *intensity* might increase.

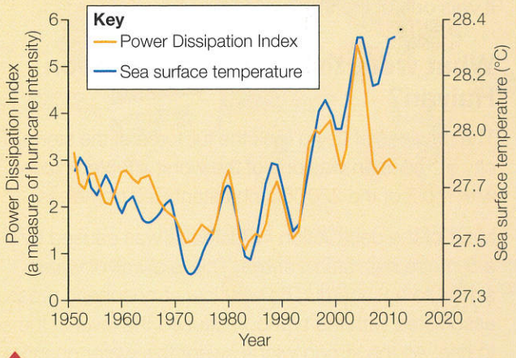


Adjusted figures (orange line) account for the lack of aircraft and satellite observations in the early years

B *Hurricanes in the North Atlantic, 1878–2013*

Intensity

Graph **C** shows hurricane intensity in the North Atlantic has risen in the last 20 years. This appears to be linked to increases in sea surface temperatures. But comparisons with the past may not be completely reliable. More data will be needed over a longer period of time.



C *Hurricane intensity in the North Atlantic, 1951–2011*

ACTIVITIES

1 Make a copy of diagram **A**. Add labels to describe the main features of a tropical storm.

2 **a** What is the orange line on graph **B** and why is it important?

b Describe the pattern of hurricanes reaching the USA since 1980.

c Is there evidence of an overall trend since 1878?

3 Describe and explain the pattern of the Power Dissipation Index between 1950 and 2011 (graph **C**).

Stretch yourself

Carry out some research on Hurricane Catarina. Why did the formation of the storm make it so unusual?

Practice question

Study graph **C**. Has there been an increase in hurricane intensity in recent decades? Support your answer with evidence. *(4 marks)*

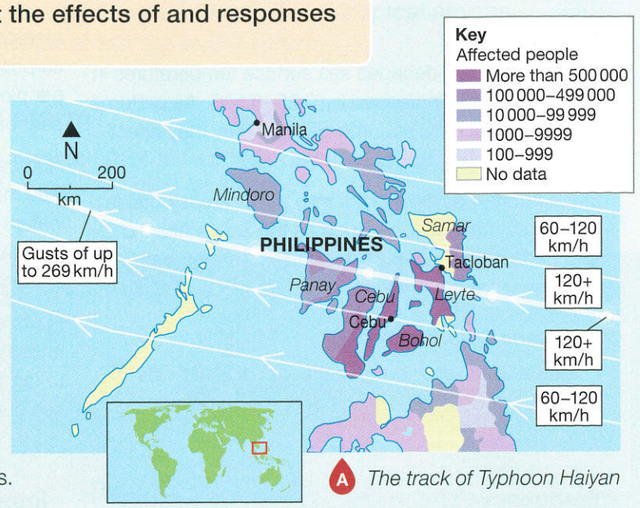
3.4 Typhoon Haiyan – a tropical storm

On this spread you will find out about the effects of and responses to Typhoon Haiyan

Example

Tropical storms can have devastating effects on people and property. The strong winds can tear off roofs, overturn cars and make large objects fly. Torrential rain can lead to flooding. Strong winds and low atmospheric pressure may cause the sea level to rise by several metres to form a destructive storm surge. These storm surges cause the most loss of life.

Tropical storms can be tracked and warnings given for people to evacuate coastal areas. In the aftermath, people need emergency support. Reconstruction may take many months.



A *The track of Typhoon Haiyan*

What happened?

In November 2013 'Super' Typhoon Haiyan – a category 5 storm on the Saffir-Simpson scale – hit the Philippines (map **A**). Huge areas of coastline and several towns were devastated by winds of up to 275 km/h (170 mph) and waves as high as 15 m (45 ft). It was one of the strongest storms ever recorded.

What were the effects of Typhoon Haiyan?

The province of Leyte took the full force of the storm. The city of Tacloban was one of the worst affected places, with most of the 220 000 inhabitants left homeless.

Most of the destruction in Tacloban was caused by a 5-metre high *storm surge*. This is a wall of water similar to a tsunami. The very low atmospheric pressure associated with the typhoon caused the level of the sea to rise. As the strong winds swept this water onshore, it formed a wall of water several metres high.

B *The destruction at Tacloban*

Primary effects (impacts of strong winds, heavy rain and storm surge)

- About 6300 people killed – most drowned by the storm surge.
- Over 600 000 people displaced and 40 000 homes damaged or flattened – 90% of Tacloban city destroyed.
- Tacloban airport terminal badly damaged.
- The typhoon destroyed 30 000 fishing boats.
- Strong winds damaged buildings and power lines and destroyed crops.
- Over 400 mm of rain caused widespread **flooding**.

Secondary effects (longer-term impacts resulting from primary effects)

- 14 million people affected, many left homeless and 6 million people lost their source of income.
- Flooding caused landslides and blocked roads, cutting off aid to remote communities.
- Power supplies in some areas cut off for a month.
- Ferry services and airline flights disrupted for weeks, slowing down aid efforts.
- Shortages of water, food and shelter affected many people, leading to outbreaks of disease.
- Many jobs lost, hospitals were damaged, shops and schools were destroyed, affecting people's livelihoods and education.
- Looting and violence broke out in Tacloban.

What were the responses to Typhoon Haiyan?

Immediate responses

- International government and aid agencies responded quickly with food aid, water and temporary shelters.
- US aircraft carrier *George Washington* and helicopters assisted with search and rescue and delivery of aid.
- Over 1200 evacuation centres were set up to help the homeless.
- UK government sent shelter kits (photo **D**), each one able to provide emergency shelter for a family.
- French, Belgian and Israeli field hospitals set up to help the injured.
- The Philippines Red Cross delivered basic food aid, which included rice, canned food, sugar, salt and cooking oil.

C *A survivor in Tacloban*

Long-term responses

- The UN and countries including the UK, Australia, Japan and the US donated financial aid, supplies and medical support.
- Rebuilding of roads, bridges and airport facilities.
- 'Cash for work' programmes – people paid to help clear debris and rebuild the city.
- Foreign donors, including the US, Australia and the EU, supported new livelihood opportunities.
- Rice farming and fishing quickly re-established. Coconut production – where trees may take five years to bear fruit – will take longer.
- Aid agencies such as Oxfam supported the replacement of fishing boats – a vital source of income.
- Thousands of homes have been built away from areas at risk from flooding.
- More cyclone shelters built to accommodate people evacuated from coastal areas.

D *The contents of a Shelter Box*

ACTIVITIES

1 Describe the track of the typhoon (map **A**).

2 **a** Why do you think so many buildings were destroyed (photo **B**)?

b What are the challenges facing the authorities in rebuilding this area?

3 **a** Why do you think the man in photo **C** appears happy despite all the destruction around him?

b What are his immediate needs and what are the challenges facing him in the future?

4 Describe the purpose of each of the items in the Shelter Box (photo **D**).

Stretch yourself

How has the city of Tacloban been rebuilt since the disaster struck? What is the situation like now? Is the city in a better position to cope with a future typhoon?

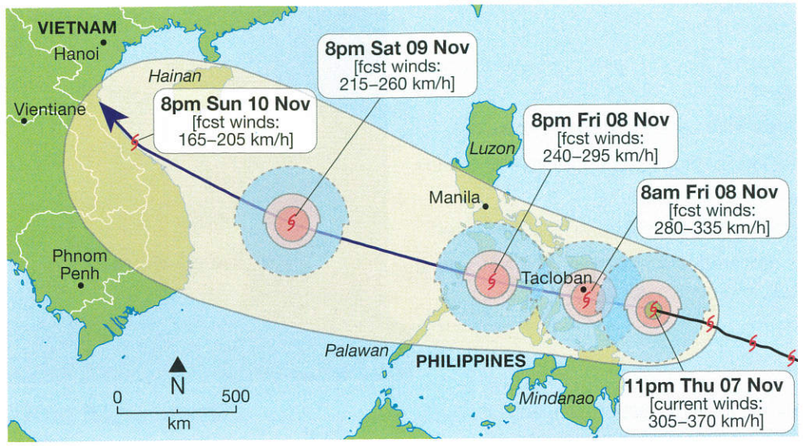
Practice question

Describe the primary and secondary effects of a tropical storm. Use a named example and your own knowledge. *(9 marks)*

3.5 Reducing the effects of tropical storms

On this spread you will find out how the effects of tropical storms can be reduced

Monitoring and prediction



Key
- Forecast track
- Previous track
- Potential track area
- Typhoon or super typhoon
- Area of 120 km/h winds
- Area of 95 km/h winds
- Area of 65 km/h winds
- Rain area

A *The predicted track of Typhoon Haiyan*

Map **A** shows the location of Typhoon Haiyan at 11 pm local time on Thursday 7 November 2013. This was just 9 hours before it struck Leyte and flattened most of the city of Tacloban. The map shows the predicted course (track) of the tropical storm across the Philippines. Notice that the area showing the predicted track becomes wider with time. This is because the future track of the tropical storm is uncertain.

Developments in technology have made it possible to predict and monitor tropical storms more accurately and effectively.

In the North Atlantic, there are two levels of warning issued by the National Hurricane Center in Miami:

- Hurricane Watch – advises that hurricane conditions are possible.
- Hurricane Warning – advises that hurricane conditions are expected and that people should take immediate action (e.g. evacuate to high ground or take shelter).

Think about it

Storm surges are often the greatest threat to life and property from a tropical storm. Why do you think this is?

Protection

There are a number of options available to protect people from the hazards associated with tropical storms.

- Windows, doors and roofs reinforced to strengthen buildings to withstand strong winds.
- Storm drains constructed in urban areas to take away excessive amounts of rainfall and prevent flooding.
- Sea walls built to protect key properties from storm surges.
- Houses close to the coast constructed on stilts so that a storm surge will pass beneath.
- In Bangladesh nearly 2000 cyclone shelters have been built (photo **B**).

B *Cyclone shelter in Bangladesh*

Planning

It is unrealistic to stop the tens of millions of people living and working in coastal areas that are at risk from tropical storms. Many people rely upon fishing or tourism to make a living. Even in rich countries like the USA, vast urban developments have been allowed to take place on vulnerable barrier islands off the coast of Florida, for example Miami Beach. South Miami was hit by a powerful hurricane in 1992. However, building developments have still taken place on land at risk from flooding. It's only a matter of time before Miami gets hit again.

C *National Hurricane Preparedness Week (USA)*

Planning to reduce the tropical storm hazard is mostly about raising individual and community awareness. People need to understand the potential dangers and be able to respond. In the USA there is a National Hurricane Preparedness Week (image **C**) which focuses on educating people about potential dangers ahead of the next hurricane season. Families are encouraged to devise their own plan of action should a warning be issued.

Bangladesh – a success story

Early warning systems, cyclone shelters (photo **B**) and greater awareness have helped reduce the death toll from tropical cyclones in Bangladesh. The number of deaths has decreased 100-fold over the past 40 years from 500 000 deaths in 1970 to 4234 in 2007.

Tropical cyclones are tracked by the Bangladesh Meteorological Department. Warnings are issued in several languages by radio, television and via social media. In rural areas, even the most remote communities are reached – sometimes by bike (photo **D**)!

D *Bikes carry cyclone warnings to rural communities in Bangladesh*

ACTIVITIES

1 **a** Use map **A** to describe the characteristics of Typhoon Haiyan at 11 pm on Thursday 7 November.

b Describe the direction of the predicted track of the typhoon.

c How many hours was the typhoon expected to take to cross the Philippines?

d Where was the typhoon expected to make landfall after the Philippines?

2 What are the special design features of the cyclone shelter in photo **B** to reduce the impacts of a storm surge?

Stretch yourself

Do some further research about the work of the National Hurricane Center in Miami.

- How are hurricanes forecast and predictions made?
- What advice is given to people who live in vulnerable areas to help them prepare?

Practice question

Explain why planning and being prepared is the best option for reducing the effects of tropical storms. *(4 marks)*

3.6 Weather hazards in the UK

On this spread you will find out how the UK is affected by a variety of weather hazards

What are the UK's weather hazards?

The *weather* is a description of the day-to-day conditions of the atmosphere. We might talk about the temperature, amount of cloud, the strength and direction of the wind or whether it is raining. When we talk about *climate*, this is the average weather over a long period of time. Data are used over a 30-year period to describe the climate of a place.

Weather hazards are extreme weather events. Even though the UK has a moderate climate, it experiences its share of **extreme weather**. Weather is driven towards the UK by south-westerly prevailing winds. Fuelled by the warm and moist conditions of the Atlantic Ocean, strong winds and heavy rain batter the exposed western areas.

Did you know?
Between 30 and 60 people are struck by lightning in the UK each year. Most people survive!

Thunderstorms

In July 2014 dramatic electrical storms resulted in 3000 lightning strikes across southern Britain following a period of hot weather (photo **A**). Torrential rainfall associated with thunderstorms can result in sudden 'flash' flooding as happened in Boscastle in Cornwall in 2004 (photo **B**).

A *Lightning above Canary Wharf, London, July 2014*

Prolonged rainfall

Persistent rainfall over a long period can lead to river floods. This is common in the UK especially during the late winter and early spring when snowmelt makes the problem worse. During the very wet winter of 2014 flooding was widespread across much of southern England.

Drought and extreme heat

The UK has experienced long spells of dry, hot weather resulting in drought. Rivers can dry up and reservoirs become dangerously low, which affects water supplies and wildlife. Very high temperatures – heatwaves – can be dangerous to frail and elderly people. In 2003 much of Europe suffered the most extreme heatwave for 500 years (photo **C**). Over 20 000 people died, and several countries, including the UK, recorded their highest ever temperatures.

B *Boscastle flash flood, 2004*

Heavy snow and extreme cold

Long periods of severe winter weather have become less common in recent years, but there are occasions when heavy snow and severe cold can cause great hardship to people particularly in the north of the UK.

Strong winds

The UK does occasionally get battered by strong winds. Sometimes the remnants of hurricanes travel over the Atlantic from the USA and Caribbean. These can cause disruption to power supplies and damage from fallen trees. Read about the strong winds that hit the UK in February 2014 (extract **D**).

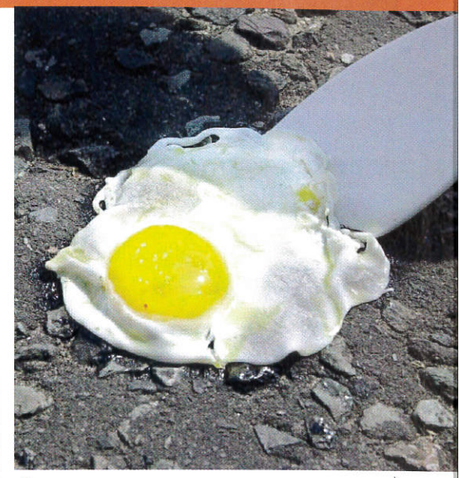
Strong winds bring chaos to UK

There was widespread disruption to road and rail networks, leaving 21 000 people without power, as strong winds continued to batter the UK this week.

Electricity supplies were affected in South Wales, the south-west and the West Midlands. Wind speeds of up to 105 mph were recorded in Aberdaron in north-west Wales, with gusts of 92 mph recorded on the Gower Peninsula, south-west Wales.

The Met Office has warned that coastal areas of the UK could be battered by large waves. Clifton suspension bridge in Bristol was closed briefly for the first time ever because of high winds, and storms have brought down many trees.

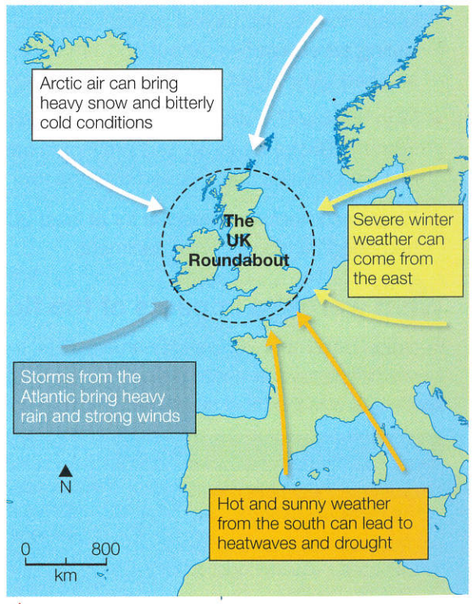
D *News report, February 2014*



C *'Hot enough to fry an egg' – heatwave in 2003*

Why does extreme weather occur in the UK?

The UK is rather like a roundabout (map **E**) because it is at the meeting point of several different types of weather from different directions. This explains why we experience such varied weather from week to week and how occasionally we can be affected by extreme weather events.



E *The UK's weather roundabout*

ACTIVITIES

1. What is the difference between weather and climate?
2. What are the hazards associated with thunderstorms?
3. Use evidence from photo **B** to describe the impacts of the flash flood on the lives of local residents in Boscastle.
4. What is a drought and what impact does it have on the natural world?
5. Read extract **D**. What were the effects of the strong winds in February 2014?

Stretch yourself

The European heatwave of 2003 was a truly extreme weather event.

- How long did the heatwave last and what was the highest temperature?
- What were the impacts of the heatwave on people and the natural world?

Practice question

Describe two types of weather hazard that could affect the UK. *(4 marks)*

3.7 The Somerset Levels floods, 2014 (1)

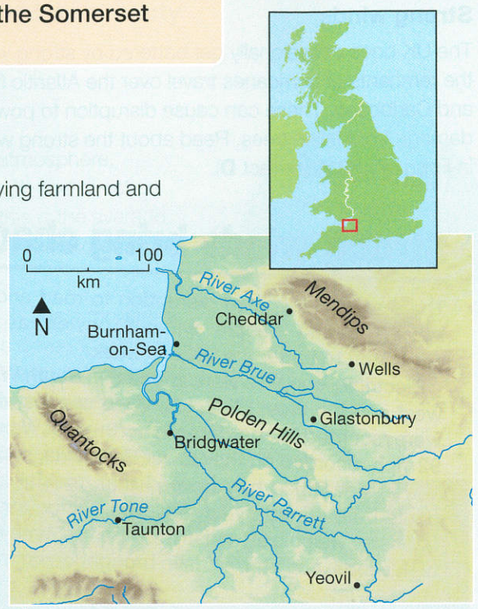
On this spread you will find out about flooding on the Somerset Levels in 2014

Example

Where are the Somerset Levels?

Somerset is a county in south-west England. The Somerset Levels and the Somerset Moors form an extensive area of low-lying farmland and wetlands bordered by the Bristol Channel and Quantock Hills to the west and the Mendip Hills to the north (map **A**).

The area is drained by several rivers, most notably the Tone and the Parrett, which flow to the Severn Estuary via Bridgwater. Flooding has occurred naturally here for centuries. As the area has been developed for farming and settlement, many people are now at risk from extreme flood events.



A *The Somerset Levels*

What caused the floods in 2014?

There were several factors that led to extensive flooding of the Somerset Levels.

- It was the wettest January since records began in 1910. A succession of depressions (areas of low pressure) driven across the Atlantic Ocean brought a period of wet weather lasting several weeks. About 350 mm of rain fell in January and February, about 100 mm above average.
- High tides and storm surges swept water up the rivers from the Bristol Channel. This prevented fresh water reaching the sea and it spilled over the river banks.
- Rivers had not been dredged for at least 20 years, and had become clogged with sediment.

B *Rescuing a resident from Moorland*

What were the impacts of the flood?

Between December 2013 and February 2014, the Somerset Levels hit the national headlines as the area suffered extensive flooding. It was the most severe flooding ever known in the area.

Social	Economic	Environmental
• Over 600 houses flooded • 16 farms evacuated • Residents evacuated to temporary accommodation for several months • Villages such as Moorland and Muchelney cut off. This affected people's daily lives, e.g. attending school, shopping, etc. • Many people had power supplies cut off	• Somerset County Council estimated the cost of flood damage to be more than £10 million • Over 14 000 ha of agricultural land under water for 3–4 weeks • Over 1000 livestock evacuated • Local roads cut off by floods • Bristol to Taunton railway line closed at Bridgwater	• Floodwaters were heavily contaminated with sewage and other pollutants including oil and chemicals • A huge amount of debris had to be cleared • Stagnant water that had collected for months had to be reoxygenated before being pumped back into the rivers

C *The impacts of the Somerset Levels floods*

Managing the floods

Immediate responses

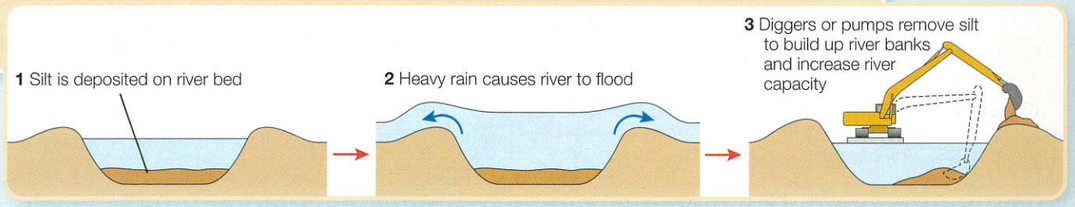
As the floodwaters spread out over the Somerset Levels, homeowners coped as best they could. Villagers cut off by the floods used boats to go shopping or attend school. Local community groups and volunteers gave invaluable support.

The village of Burrowbridge almost cut off by the floods D

Longer-term responses

A £20 million Flood Action Plan has been launched by Somerset County Council who will work together with agencies such as the Environment Agency to reduce the risk of future flooding.

- In March 2014, 8 km of the Rivers Tone and Parratt were dredged to increase the capacity of the river channel (diagram **E**).
- Road levels have been raised in places to maintain communications and enable businesses to continue during future flood events.
- Vulnerable communities will have flood defences.
- River banks are being raised and strengthened and more pumping stations will be built.
- In the longer term – by 2024 – consideration will be given to a tidal barrage at Bridgwater.



E *How dredging works*

ACTIVITIES

1 Why do you think the Somerset Levels are prone to flooding (map **A**)?

2 What were the factors contributing to the floods in 2014?

3 **a** Describe the extent of the flooding (photo **D**).

b Several roads were flooded. What impact did this have on local people?

c Suggest the impact of the flooding on farmers in the area.

4 Make a copy of diagram **E**. Add labels to describe how dredging can help reduce the flood risk.

Stretch yourself

Imagine you are a local councillor in Somerset. Analyse research plans to construct a tidal barrage at Bridgwater (they can be found on the internet).

What would this scheme involve and how would it reduce the risk of flooding?

Practice question

Using table **C**, evaluate the main impacts of the flooding of the Somerset Levels. *(6 marks)*

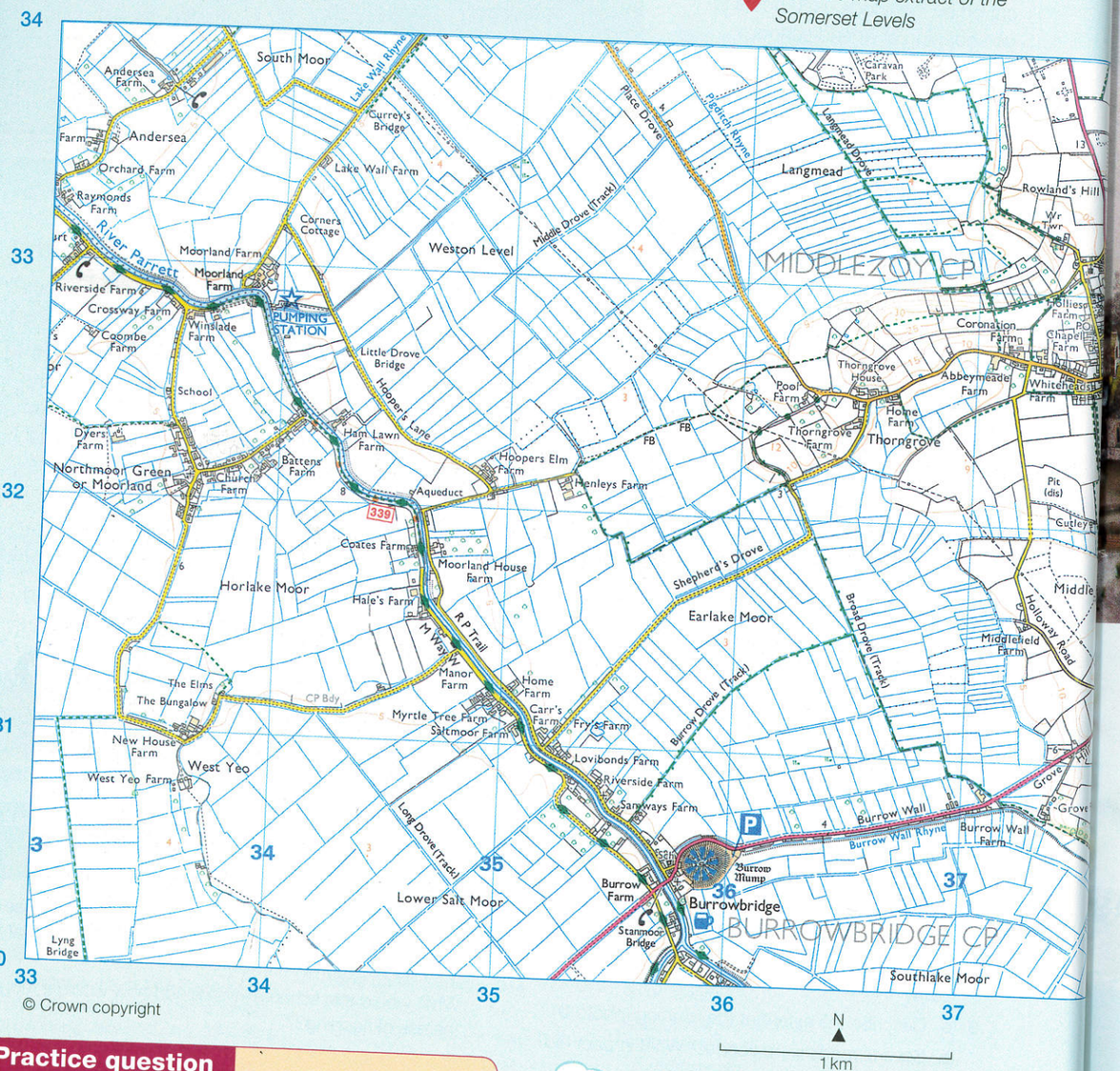
3.8 The Somerset Levels Floods, 2014 (2)

On this spread you will use a 1:25 000 map to find out about flooding on the Somerset Levels in 2014

Example

Map **A** is a 1:25 000 map extract of the Somerset Levels a few kilometres south-east of the town of Bridgwater. Photo **B** shows flooding in the village of Moorland (also called Northmoor Green: grid reference 3332). The key for OS maps can be found on page 352.

A *1:25 000 map extract of the Somerset Levels*



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Practice question

Suggest the likely social, economic and environmental impacts of the flooding. Use evidence from photo **B** to support your answer. *(4 marks)*

Think about it

How can maps help you to interpret aerial photographs?

B *Flooding in Moorland, Somerset (2014)*

ACTIVITIES

1 Use map **A** to answer the following questions.

- **a** What is the evidence from the map that this area is very flat and low-lying?
- **b** What is the name of the main river?
- **c** Why do you think the area has hundreds of drainage ditches?
- **d** What is the six-figure grid reference of the pumping station?
- **e** Why do you think there is a pumping station at this location?
- **f** In what direction is Burrowbridge from the pumping station?
- **g** To the nearest 100 m, what is the straight line distance from the pumping station to the bridge over the river at Burrowbridge (grid reference 357304)?
- **h** What is the evidence that most of this area is farmland?
- **i** Use evidence from the map to suggest why Moorland is at risk from flooding.

2 Photo **B** shows part of the flooded village of Moorland. Locate the church at the bottom left of the photo. Now locate the church on map **A**. It is at the road junction in the centre of the village.

- **a** What is the six-figure grid reference of the church?
- **b** In what direction is the photo looking?
- **c** What is the name of the farm at the top left of the photo?
- **d** What has been done to try to stop this property from flooding?
- **e** Describe the extent of flooding in the photo.

3.9 Extreme weather in the UK

On this spread you will find out if the UK's weather is becoming more extreme

What is the evidence?

There have been many extreme weather events in the UK throughout history. However, scientists have noticed that these events seem to be occurring more frequently than in the past. Look at the diagram below to read about extreme weather events in the UK since 2000.

2003 – Heatwave
The UK recorded its highest ever temperature of 38.5°C in Kent. Over 2000 people died due to the heat, railway tracks buckled and in places the roads melted!

2007 – Floods
Several people died and many were left homeless by summer floods affecting Hull, Sheffield and Gloucestershire.

2008 – Floods
Severe flooding occurred in south-west and north-east England with Somerset, Worcestershire and Northumberland badly hit.

2009 – Heavy snow
Parts of south-west and south-east England were affected by heavy snow with 20 cm falling in the capital.

2009 – Floods
The town of Cockermouth in Cumbria was devastated by floods. Record rainfall amounts fell in November in the Lake District.

2010 – Heavy snow
Much of the UK was hit by heavy snowfalls in December. Northern Ireland recorded a record low temperature of –18.7°C at Castlederg.

2013/14 – Floods
Severe flooding occurred across southern England causing the River Thames to burst its banks and vast areas of the Somerset Levels to become inundated. It was England's wettest winter in 250 years.

2015/16 – Floods
Severe storms and exceptionally heavy rainfall caused devastating floods to many areas, especially the north of England. Yorkshire and Cumbria (photo **C**) were badly affected. December 2015 was the wettest and warmest month ever recorded in the UK.

A *Trafalgar Square during the heatwave of 2003*

B *Snow causes traffic chaos in 2010*

Why might extreme weather events be on the increase?

Recent extreme weather events have also occurred elsewhere in the world. There have been devastating floods in Pakistan (2010), intense heatwaves in Russia (2010) and severe droughts in western USA (2014).

No single extreme weather event can be blamed on climate change. However, scientists believe that a trend over many years could be linked to a warming world.

- More energy in the atmosphere could lead to more intense storms.
- The atmospheric circulation (see page 22) may be affected, bringing floods to normally dry regions and heatwaves to normally cooler areas.

In 2011 the Intergovernmental Panel on Climate Change concluded that extreme weather would become more common as global warming heats the planet.

Could our weather patterns be getting 'stuck'?

Weather systems cross the UK mainly from west to east, driven by winds from the *jet stream*. The jet stream moves north and south but can 'stick' in one position, resulting in a long period of the same type of weather, such as heavy rain or drought. A large area of high pressure over Northern Europe can block the easterly movement of weather systems and have a similar effect on UK weather.

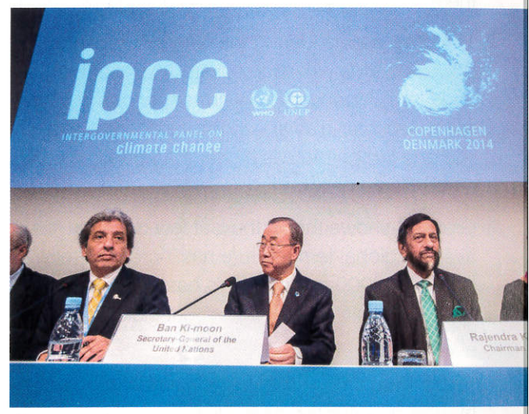
In 2014 scientists in Germany published a report. It suggested that in recent years weather patterns have become 'stuck' for long periods of time. This has resulted in prolonged periods of high temperatures (heatwaves and droughts) and heavy rain (floods).

These periods seem to have become more frequent in recent years and this could be due to climate change. A warming Arctic, for example, may slow down the atmospheric circulation in the northern hemisphere mid-latitudes resulting in the weather 'sticking' for long periods of time. This could explain the recent heatwaves and floods.

ACTIVITIES

1. Draw a timeline to describe the extreme weather events in the UK since 2000. Use text boxes to describe the impacts of the events and illustrate your timeline using photos. Add any recent events.
2. What UK weather records have been broken by extreme weather events since 2000?
3. Newspapers sometimes blame an individual extreme weather event on climate change. Why is this misleading?

C *Floods in Carlisle, 2015*



D *The Intergovernmental Panel on Climate Change, 2014*

Stretch yourself

Imagine you're a journalist writing an article about extreme weather in the UK since January 2014.

- What happened and what were the impacts?
- How have these events – along with the others since 2000 – been linked with climate change?

Practice question

Suggest why the UK's weather might be becoming more extreme. *(4 marks)*