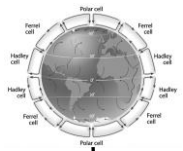
Kemnal Technology College

Paper 1 Topic 2 Weather hazards and climate change

Weather & climate change overview



Global Atmospheric Model

Global Climate

Natural cause: Global Climate Change

Human causes: Global Climate Change

Climate Change impacts

UK climate

Tropical Storms

Impacts of Tropical Storms

Hurrican e Irma

Types of Drought

Natural causes of Drought

Human causes of Drought

Impacts of Drought

Australia

Ethiopia

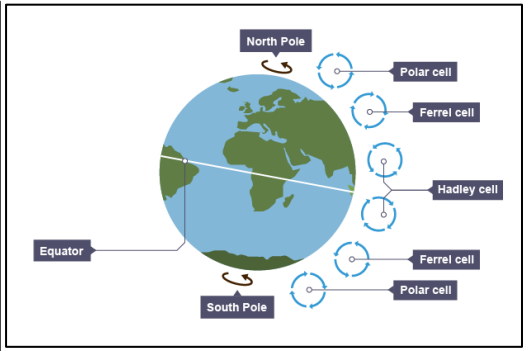
Paper 1 Topic 2 Weather hazards and climate change - GAC

The movement of air across the planet occurs in a specific pattern. The whole system is driven by the equator, which is the hottest part of the Earth. Air rises at the equator, leading to low pressure and rainfall. When the air reaches the edge of the atmosphere, it cannot go any further and so it travels to the north and south. The air becomes colder and denser, and falls, creating high pressure and dry conditions at around 30° north and south of the equator. Large cells of air are created in this way.
Air rises again at around 60° north and south and descends again around 90° north and south. The names of the cells are shown in the diagram.

The Hadley cell
The first cell is called the Hadley cell. At the equator, the ground is intensely heated by the sun. This causes the air to rise which creates a **low-pressure** zone on the Earth's surface. As the air rises, it cools and forms thick cumulonimbus (storm) clouds. The air continues to rise up to the upper atmosphere, and the following then happens:
•The air separates and starts to move both north and south towards the poles.
•When it reaches about 30° north and south, the air cools and sinks towards the ground forming the subtropical **high-pressure** zone.
•As the air sinks, it becomes warmer and drier. This creates an area of little cloud and low rainfall, where deserts are found.
•The Hadley cell is then complete. The air completes the cycle and flows back towards the equator as the **trade winds**.
•In the northern hemisphere, the winds flow to the right and are called northeast trade winds. In the southern hemisphere the winds flow to the left and are called the southeast trade winds. This is down to the **Coriolis force** and friction.

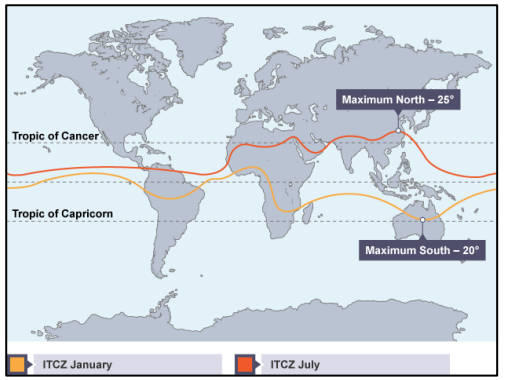
The Ferrel cell
The Ferrel cell occurs at higher latitudes (between 30 degrees and 60 degrees N and 30 degrees and 60 degrees S):
•Air on the surface is pulled **towards** the poles, forming the warm south-westerly winds in the northern hemisphere and north-westerly winds in the southern hemisphere.
•These winds pick up moisture as they travel over the oceans. At around 60 degrees N and 60 degrees S, they meet cold air, which has drifted from the poles.
•The warmer air from the tropics is lighter than the dense, cold polar air and so it rises as the two air masses meet.
•This uplift of air causes low pressure at the surface and the unstable weather conditions that are associated with the **mid-latitude depressions**. Much of our wet and windy weather in the UK is determined by this.

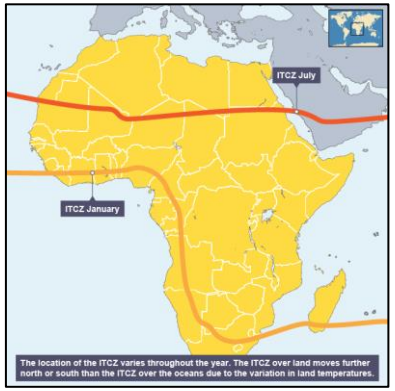
The Polar cell
At the poles, air is cooled and sinks towards the ground forming high pressure, this known as the **Polar high**. It then flows towards the lower latitudes. At about 60 degrees N and S, the cold polar air mixes with warmer tropical air and rises **upwards**, creating a zone of low pressure called the **subpolar low**. The boundary between the warm and cold air is called the **polar front**. It accounts for a great deal of the unstable weather experienced in these latitudes.

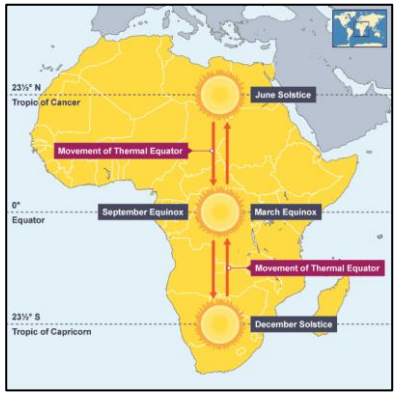


Global atmospheric circulation creates winds across the planet and leads to areas of high rainfall, like the tropical rainforests, and areas of dry air, like deserts.

The **ITCZ** is a zone of convergence at the thermal equator where the trade winds meet. It is a low pressure belt and migrates with the changing position of the thermal equator.
The thermal equator receives the **most intense heat** from the Sun. Around 20th June each year the Sun is overhead at 23½° North, the Tropic of Cancer. Around 20th December the Sun is overhead at 23½° South, the Tropic of Capricorn.

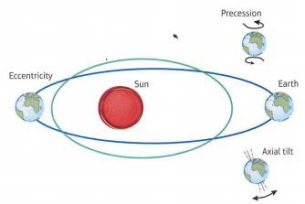






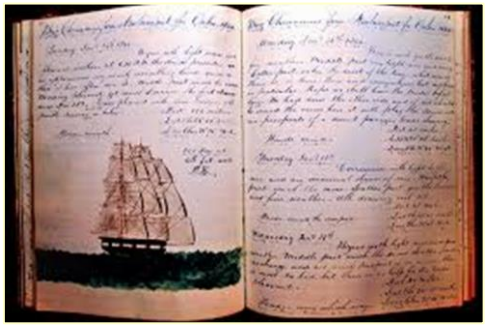
Paper 1 Topic 2 Weather hazards and climate change – Natural causes

Climate change – is the average climate conditions of the planet. They vary over time. The earth has a history of going between warm (interglacial) and cold (glacial) periods. **Climate change can be caused by both natural events and humans**

Factor	Effect
Milankovitch Cycles 	These are natural changes to the earth's orbit and position that affect how much solar radiation we receive from the sun • Eccentricity – The orbit becomes elliptical so at times the earth is further from the sun causing it to be much cooler • Axial tilt – The angle of the earth's tilt changes so summers and winters are more extreme when this happens • Precession – The earth sometimes wobbles on it's axis and it changes seasons slightly.
Solar Variation	The amount of radiation the sun produces varies over time. Lower solar activity are likely to end in glacials.
Volcanism	Large-scale eruptions can lead to lots of ash in the atmosphere, sometimes it's so great it can block out the sunlight reducing global temperatures
Surface impact	Asteroids and comets can impact the earth's surface and cause lots of ash blocking out sunlight and reducing global temperatures

What is the evidence?

Ice Cores
Ice sheets in Greenland or Antarctica has built up over many years. In some places ice can be 3,000m deep. As snow falls and compacts as ice, it traps air bubbles – these contain a sample of what the atmosphere was like at that time.
Water in the ice also contains isotopes – scientists can measure the temperature of the earth at the time



Historical Sources:
Historical documents such as diaries, paintings etc. can describe what the climate is like at the time

Tree rings:
As trees grow they produce growth rings. In warmer climates growth rings are further apart. In cooler climates they are closer together.
These can indicate what the climate was like 100,1000 years ago

Paper 1 Topic 2 Weather hazards and climate change – Human causes

Transport:
As cars are more affordable now than ever – more people are buying and using them. As well as this, flights are now cheaper so people fly more. All modes of transport rely on fossil fuels

Energy:
The demand for electricity is growing because of increasing population, standard of living improves, technology improves and people because richer

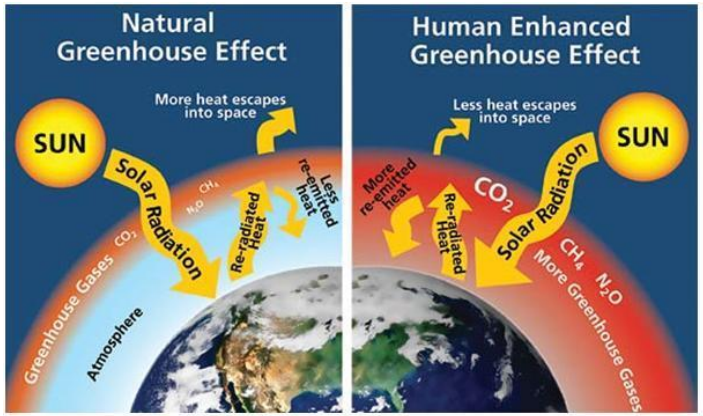
How do humans cause global warming?

Industry:
As people have more disposable income increases, so does the demand for the production of industrial goods. This leads to more fossil fuels being used

Agriculture:
Increased population growth means there is an increased need for food. This then leads to more intensive agricultural practises that require machinery which use fossil fuels

<u>The natural greenhouse Effect:</u>

This is a **natural process**, which keeps the earth warm.
Greenhouse gases (carbon dioxide, methane, nitrogen) trap some of the heat that is radiated from the surface which would have been lost into space.
Without this the temperature of the earth would be a lot cooler

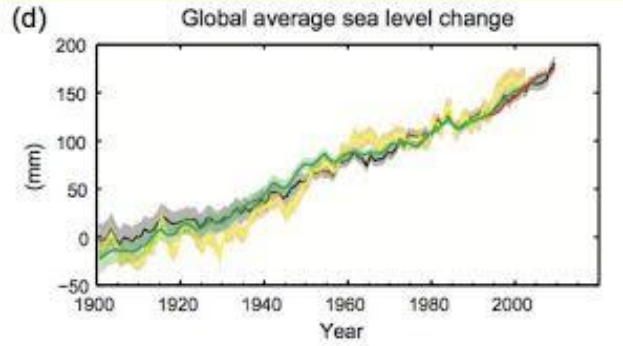


<u>The enhanced greenhouse Effect:</u>

Human activity has resulted in an increased amount of greenhouse gases in the atmosphere.
This means the earth absorbs **more** solar radiation and less radiation is able to escape – this causes an increase in temperatures.

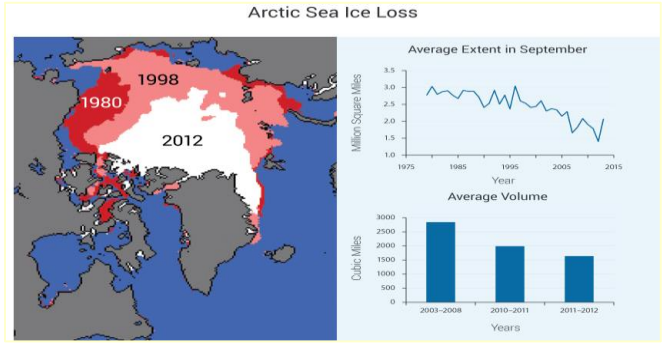
Paper 1 Topic 2 Weather hazards and climate change – Evidence

Evidence of climate change

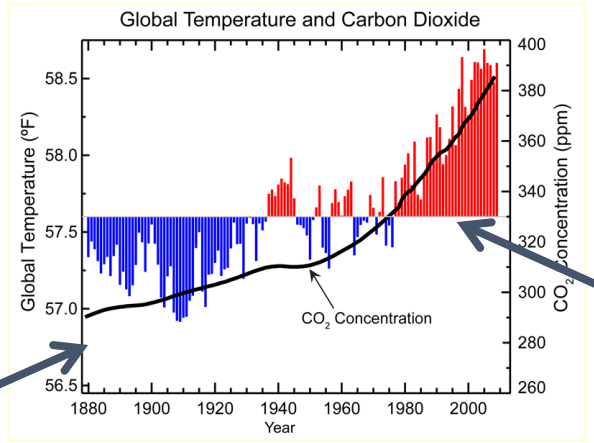


Sea Level Change:
- Long-term measurement of sea levels shows there has been 20cm increase since 1900
- Rises have increased recently to 3.2mm per year and are more in some areas.

Melting Ice Caps:
- Sea level change is caused by **thermal expansion** – when water warms up it expands
- The Arctic Ice Caps have decreased. Warmer temperatures meant that sea ice has declined



Warmer Global temperatures and Carbon Dioxide
- The rise in global temperatures is closely linked to the increase of carbon dioxide.
- The increase in carbon dioxide since 1950 has been much higher and much more rapid than anything recorded for the last 400,000 years.
- Human activity is the reason for much of this increase.



Warmer Global temperatures:
- Measurements of average global atmospheric temperatures show a steep rise from around the 1950s to the present. Although temperatures have risen before it is unusual for the increase to be so rapid

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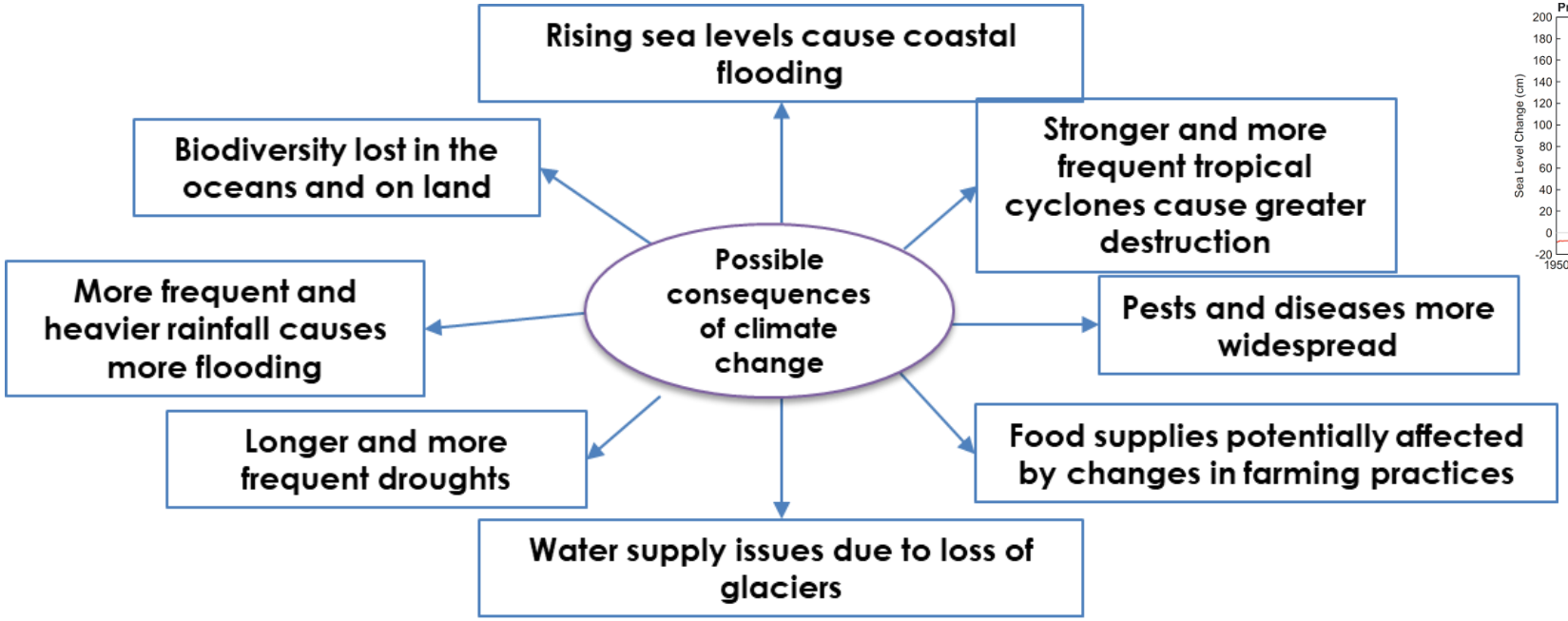
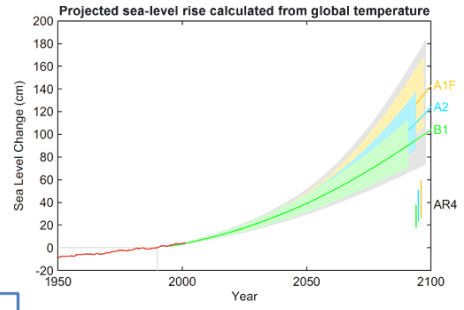
Paper 1 Topic 2 Weather hazards and climate change – Impacts





Sea Level Rises:
Around 23% of the worlds population live within 100km of the coast – this means lots of people are at risk of coastal flooding
The effects of 1m rise in sea level is:

- Low-lying islands will be submerged (e.g. Maldives) – causing land to be abandoned
- New sea defences will need to be built – costing millions!
- Salt water intrusions will contaminate farmland and groundwater supplies (making water unusable)

Future projections:
Future predictions are difficult to predict because it changes (will greenhouse gases continue to rise or will we find ways to reduce emissions?)
Climate change organisations have modelled 4 scenarios:

1. Emissions peak at 2020 then decline
2. Emissions peak at 2040 then decline
3. Emissions peak at 2080 then decline
4. Emissions continue to rise

- The loss of Greenland's ice sheet would raise sea levels by 7m
- The Antarctic ice sheets would add 13m
- Sea level rise will be higher in some areas than others due to prevailing winds and currents. Also where the land is sinking sea level will be higher

Increased Temperatures:
Warmer temperatures can impact on food production as some areas will experience drought conditions.
More pests will spread quicker due to the warmer weather
Ecosystems and habitats suffer as temperatures increase as animals and plants struggle to adapt leading to a loss of biodiversity

Extreme weather events:
Experts believe there will be a rise in extreme weather events: Tropical Cyclones, drought, intense prolonged rainfall and heavy snowfall. This leads to a greater number of people at risk

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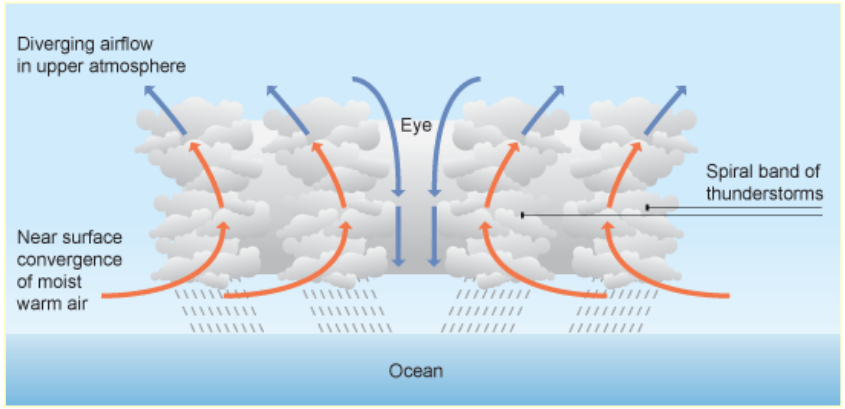
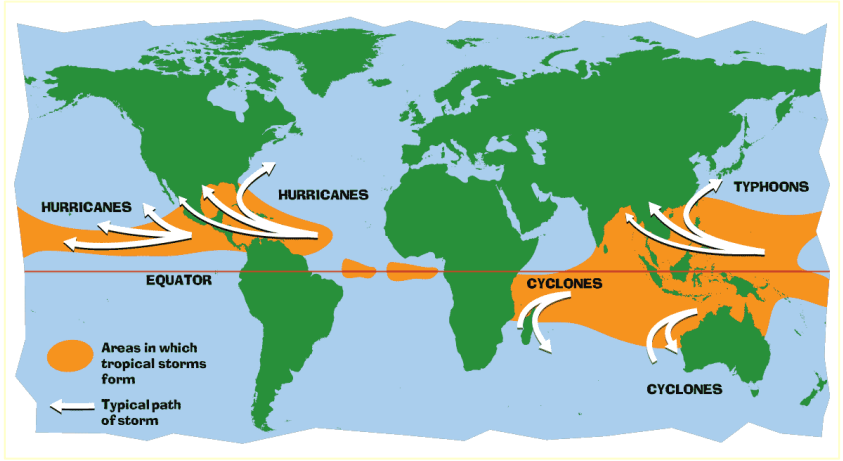
Paper 1 Topic 2 Weather hazards and climate change – Tropical storms

Hurricanes
The strongest tropical storms are called **hurricanes**, **typhoons** or **tropical cyclones**. The different names all mean the same thing, but are used in different parts of the world. If these huge storms start in the Atlantic, off the west coast of Africa, they are called **hurricanes**.
In an average year, over a dozen hurricanes form over the Atlantic Ocean and head westwards towards the Caribbean, the east coast of Central America and the southern USA (Florida in particular). Hurricanes may last as long as a month and although they travel very slowly - usually at about 24 km/h (15 mph) - wind speeds can reach over 120 km/h (75 mph).

How hurricanes form
When this warm and wet air rises, it condenses to form towering clouds, heavy rainfall. It also creates a low pressure zone near the surface of the water.
Rising warm air causes the pressure to decrease at higher altitudes. Warm air is under a higher pressure than cold air, so moves towards the 'space' occupied by the colder, lower pressure, air. So the low pressure 'sucks in' air from the warm surroundings, which then also rises. A continuous upflow of warm and wet air continues to create clouds and rain.
Air that surrounds the low pressure zone at the centre flows in a spiral at very high speeds - anti-clockwise in the northern hemisphere - at speeds of around 120 km/h (75 mph).
Air is ejected at the top of the storm – which can be 15km high – and falls to the outside of the storm, out and over the top, away from the eye of the storm. As this happens, it reduces the mass of air over the 'eye of the storm' - causing the wind speed to increase further. Some ejected air also cools and dries, and sinks through the eye of the storm, adding to the low pressure at the centre.
The faster the winds blow, the lower the air pressure in the centre, and so the cycle continues. The hurricane grows stronger and stronger.
Seen from above, hurricanes are huge circular bodies of thick cloud around 450 km (300 miles) wide. The cloud brings heavy rain, thunder and lightning.
In the centre is the **eye of the hurricane**, about 45 km across (30 miles) across. Often there will be no clouds in the eye. Seen from below it will seem calmer, with a circle of blue sky above. The eye is formed because this is the only part of the hurricane where cold air is descending.
In the northern hemisphere, the prevailing easterly tropical winds tend to steer hurricanes toward land - although their course is unpredictable. As hurricanes move inshore, their power gradually reduces because their energy comes from sucking up moist sea air.





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Paper 1 Topic 2 Weather hazards and climate change – Tropical storms

	Description	Impact on people	Impact on environment
High Winds	Winds from 119 – 250 kmph	• Infrastructure such as power lines damaged • Buildings destroyed • Loss of life/injury	• Trees uprooted
Intense Rainfall	Heavy rainfall causing surface flooding	• Damage property • Injury • Potential loss of life	• Flooding • Pollution of water systems
Storm Surges	Low pressure allows local sea level to rise, the winds help push the water up on land	• Coastal defences destroyed • Flooded inland areas contaminating farmland • Damage to properties	• Beaches and coastal habitats destroyed
Coastal Flooding	Intense rain and storm surges leads to coastal flooding	• Peoples lives and properties at risk of destruction • Farming, tourism and industry at risk of flooding	• Salt water intrusion • Habitats destroyed • Water contamination
Landslides	Intense rain in high relief areas can saturate the soil quickly, making it heavy. This can mean the soil can't hold together	• Settlements destroyed/damaged • Transport routes cut off • Loss of life and injury • Displacement	• River flooding if a channel is blocked • Habitats destroyed • Debris contaminate water

Physical vulnerability:
Coastal areas are more at risk as tropical cyclones form over oceans and seas. Island nations (e.g. Maldives and the Philippines) are more vulnerable as they are surrounded by warm water and are low-lying. They are more likely to suffer flooding, storm surges and high wind speeds. Some areas are also at risk from heavy rain and landslides

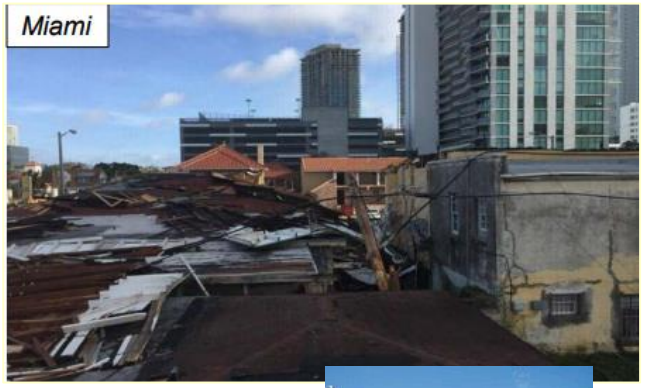
Economic vulnerability:
Countries with higher levels of development are more likely to have better technology to prediction and monitoring systems and are therefore able to prepare for tropical cyclones by evacuating areas and putting up coastal defences and preparing emergency response teams

Social vulnerability:
Areas with high poverty are more vulnerable as infrastructure (buildings etc) are not very stable and will be easily damaged or destroyed. The after effects also worse in poorer areas as there might not be access to food, water, medical supplies etc often resulting in higher losses of life. Age is another social inequality, older and younger people are more vulnerable as they are likely to suffer an injury during evacuation and have more difficulty in evacuation too. Young and old are more likely to catch illnesses and diseases

Paper 1 Topic 2 Weather hazards and climate change – Case Study Hurricane Irma

What: Hurricane Irma, Category 5
When: 8th to 11th September 2017
Where: Gulf of Mexico
Who: Barbuda, Caribbean Islands, Florida, USA

Why/How: **Causes**
Description:
Tropical depression formed in the Atlantic Ocean. Spinning vortex of winds as heat energy is evaporated from the ocean to fill gap of very low air pressure.
Sea temperatures 32˚C in Gulf of Mexico. Air pressure 915mb. Trade winds blowing away from the Equator.



Developing country	Developed country
Caribbean – Barbuda • Up to 185mp winds • 600 students had to go to school on other islands • 90% properties damages • 68 sq. miles covered by Category 5 hurricane • No water or communications – island considered uninhabitable • 3 deaths • Most people evacuated from Barbuda to Antigua • $250 million in damages = 12% of islands GDP • 1,800 residents evacuated • 3m storm surge causing significant flooding • 60 tons of relief supplies sent by USA and British Aid Agencies	**USA – Florida Keys** • 7 direct deaths in USA 85 indirect deaths of which 80 were in Florida • 77,000 people in shelters • 6.5 million ordered to evacuate • 70% buildings built before 1994 • 6.9 million homes left without power • 2 – 3 m storm surge causing significant flooding • 250 to 300mm rainfall an hour • $62.5 million in damages • Loss of tourism trade

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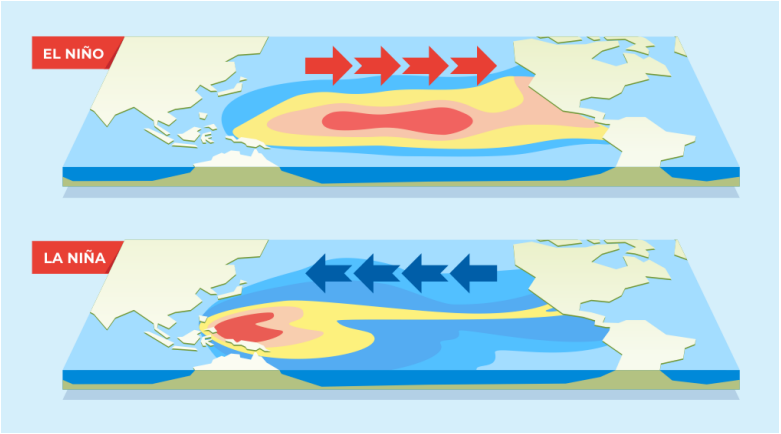
Paper 1 Topic 2 Weather hazards and climate change – Droughts

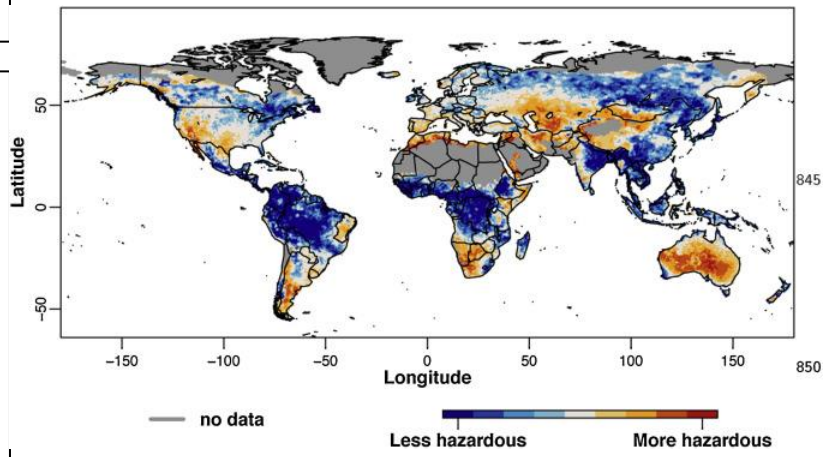
Characteristics and types of droughts
Droughts occur when there is abnormally low rainfall for an extended period of time. This means that a desert would not be considered in drought unless it had less rainfall than normal, for a long period of time. Droughts can last from weeks to months and even years.

Why are some areas more vulnerable to droughts?
Droughts can occur all over the world. However, there is a link between drought and some climate patterns.
•A lack of water vapour in the atmosphere means there is less **precipitation** and more chance of drought. High-pressure systems reduce evaporation and moisture in the atmosphere.
•**El Niño** – as the surface temperature of the Pacific Ocean around the central South American coast **increases**, storm patterns are disrupted. This phenomenon is thought to create droughts in Indonesia and Australia.
•**La Niña** - as the surface temperature of the Pacific Ocean around the central South American coast **decreases**, storms are again disrupted and North and South America are prone to



Types of droughts
There are three main types of drought:
•**Meteorological drought** – when the amount of precipitation received in a specific area is less than the average.
•**Hydrological drought** – when reduced precipitation impacts on **water supply**, eg there is decreased streamflow, soil moisture, reservoir and lake levels, and groundwater.
•**Agricultural drought** – when the above two types of drought impact on agricultural activities, eg reduced soil moisture or reservoir levels required for **irrigation**.

Hazardous impacts of droughts
Droughts, unlike **earthquakes** and **volcanic eruptions**, are not a sudden hazard event. Instead, their beginning and end are hard to gauge and they can last for months and even years.
Approximately 780 million people worldwide lack a reliable and sufficient water supply. This can have many serious impacts:
•A lack of clean and reliable water can cause people in developing countries to drink contaminated water which could cause a range of diseases such as cholera and typhoid.
•Commercial and **subsistence farmers** can experience high crop or livestock losses and a reduction in the land's value. Subsistence farmers may experience **famine**.
•With less moisture and rainfall, wildfires can become common, damaging crops, buildings and even causing death.
•Businesses and services which rely on clean water may be closed, eg hospitals and restaurants.
•Conflicts or war between people and countries can occur when pressure is put on water supplies. It can also lead to people having to migrate away from drought-stricken areas.



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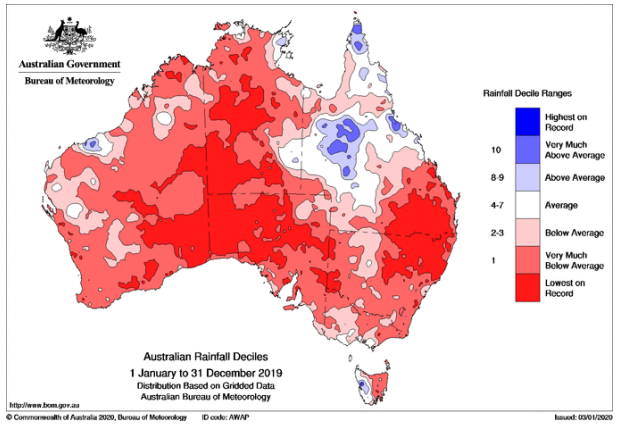
Paper 1 Topic 2 Weather hazards and climate change – Case Study Australia

What: Worst drought in 125 years
When: 2002 to 2009
Where: South-east Australia
Who: Everyone, especially farmers

Why/How: **Causes**
Description:
This was credited to El Niño, where moist trade winds are reversed, so instead of bringing rainfall to Australia they travelled west towards South America, leaving south-east Australia with a lack of rainfall. Some scientists believe climate change exacerbated this drought by also reducing rainfall.

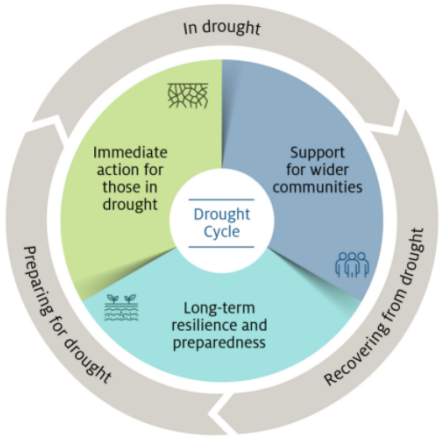
The region most affected was the Murray-Darling River Basin in New South Wales. This area usually provides 75% of Australia's water, 40% of Australia's agricultural produce and is home to nearly 2 million people.

This drought had severe **agricultural impacts**:
•Significant loss of livestock and crops. Some farmers had to sell machinery, land or even move elsewhere and lose their livelihood.
•With fewer crops and livestock, Australia had to import more food. This increased the price of food for the whole country.
•Droughts degrade the quality of the soil, affecting farming for years to come.
This drought had severe impacts on the **natural ecosystem**:
•Wildfires caused by drought destroyed vegetation and animals' habitats.
•Creeks and rivers dried up causing the organisms relying on them to die or migrate.
•Increased soil erosion destroyed vegetation and the creatures which relied on it to survive.



Responses

$11.1 billion in Australian Government funding committed to drought-related programs since 2018-19 (as at 31 December 2021)



Long-term resilience and preparedness

$5 billion Future Drought Fund
8 drought resilience hubs
80 soil and agricultural landscapes projects

Immediate action for those in drought

2,567 drought loans to farmers
124 drought loans to small businesses
11,389 rebates for on-farm emergency water infrastructure
16,800+ farmers received Farm Household Allowance (since 2014)
1,591 small regional businesses accessed rural financial counselling
57 regional climate guides

Support for wider communities affected by drought

57,000+ households assisted to pay urgent expenses
Support for **180** local government areas (infrastructure & other projects)
Support for **250** schools
$10+ million in cash and/or voucher support for farmers

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Paper 1 Topic 2 Weather hazards and climate change – Case Study The Sahel Ethiopia

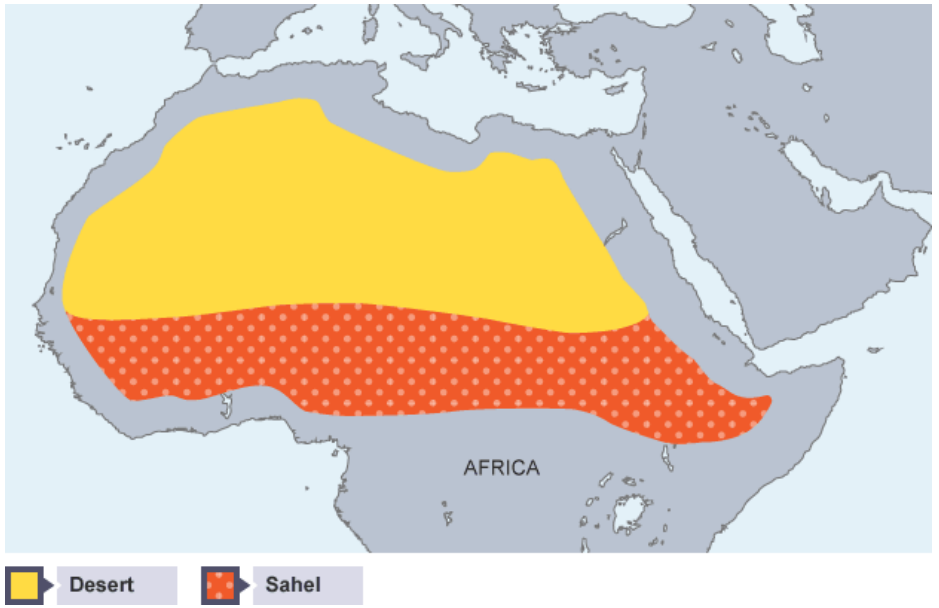
The Sahel is located directly south of the Sahara desert and stretches from the east to the west of Africa. The Sahel is semi-**arid**, receiving between 250 and 450 mm of rainfall in total in an average year, however it only falls in one or two months. This region provides Africa with food and cash crops such as millet and cotton.

Since the 1970s, the Sahel has experienced drought conditions on a regular basis. This is down to physical and human factors:

•**Overgrazing** and **deforestation** on **marginal land** can lead to **desertification**. With less vegetation there is less **transpiration** and **evaporation** from the soil, causing less rainfall.

•Changes in surrounding ocean temperature – the temperatures of the south Atlantic and Indian Oceans increased, with a smaller temperature gap between land and ocean, and **monsoon** rains were reduced.

•Some scientists believe climate change has reduced rainfall or made it less predictable.



The social and economic impacts of drought in the Sahel

Social impacts

•Subsistence farmers' crops fail and livestock dies. This can lead to famine and hunger.

•Commercial farms growing cash crops such as cotton lose income, which may cause unemployment.

•With less food being grown and an increase in demand, food prices increase.

•Increased soil erosion makes the land less fertile, creating a long-term issue for the farming community.

•Clean water is not available for people to drink, increasing the use of contaminated water and diseases such as cholera.

•People (usually women and children) travel further to find water, which means children miss school and the carrying of heavy loads can lead to back problems.

Environmental impacts

•Seasonal rivers and water holes dry up, so organisms which live in them or rely on them for water may die.

•Vegetation dies causing animals depending on it for food or shelter to perish or migrate.

•Increased soil erosion. Eroded material is washed into rivers or water holes resulting in contamination.

Attempted solutions

•Encouraging farmers to grow drought-resistant crops.

•Improving knowledge and understanding of droughts across the region by launching the Africa Climate Exchange

•Use of drip irrigation systems to reduce water usage.

•Lines of rocks are placed across the land to slow flowing rainwater and encourage the **deposition** of sediments (rich in nutrients). This is a cost-effective option.