OCR (9-1) Geography A specification

GCSE Geography Revision Pack

Unit 2: The world around us

This revision guide is designed to assist you with your revision. The case study sheets contain the minimum amount of information you need – they should supplement your own notes.

If there are any other resources or activities that you would like, please ask. Remember you can also email anyone in the geography department your questions outside of lessons.

In addition to your exercise books and these booklets, the revision guide from the exam board will be available from the school shop from February.

If you complete any of the workbook and would like them marked, please just come and see us.

Good Luck!

The Geography Department

Exam percentage breakdown:
Unit 1 – Living in the UK = 30%
Unit 2 – World around us = 30%
Unit 3 – Geographical skills = 40%

Personal Learning Checklist

Use the following list and colour green, amber, red based on how confident you feel about each area. You should then use this to target your revision to the areas that you feel least confident in.

Topic	RAG rate
Ecosystems of the planet	
I understand what the terms abiotic (weather, climate, soil) and biotic (plants, animals, humans) and I can explain how they are interdependent.	
I can describe the global distribution of the main ecosystems: polar, coral reefs, grasslands, temperate forests, rainforests and deserts.	
I can describe for each of the ecosystems mentioned above the climate, plants and animals found within these ecosystems	
I can describe where the main tropical rainforests of the world are	
Case study: ecosystems under threat - **Peruvian Amazon** • I can describe the nutrient and water cycles • I can describe the location of the Peruvian Amazon. • I can describe and explain why the Peruvian Amazon is valuable to humans and the planet. • I can explain the threats that the Peruvian Amazon suffers from. • I can explain how these threats are being managed.	
I can describe where the main coral reefs of the world are	
Case study: ecosystems under threat – **Andros Barrier Reef** • I can describe the nutrient cycle of the reef • I can describe the location of the Andros Barrier Reef. • I can describe and explain why the AB reef is valuable to humans and the planet. • I can explain the threats that the AB reef suffers from. • I can explain how these threats are being managed.	
People of the planet	
I can define social, economic, environmental and sustainable development.	
I can name different development indicators and can describe the advantages and disadvantages of these.	
I can explain how development indicators can be used to illustrate patterns of development	
I can identify the current patterns of advanced countries (ACs), emerging and developing countries (EDCs) and low income developing countries (LIDCs)	
I can explain the many cause of uneven developing including colonialism, trade and the exploitation of natural resources	
I can describe the different types of aid and their role in promoting and hindering development.	
Case study: Many factors contribute to a country's development – **Ethiopia** • I can describe where Ethiopia is • I can describe what the landscape, climate, ecosystems and natural resources are like in Ethiopia • I can describe the relationship Ethiopia has with other countries – both political and trade relationships.	

• I can describe the imports and exports central to Ethiopia • I can describe the role of international investment including TNCs and aid. • I can describe how education and healthcare provision has changed over time. • I can explain the importance of one aid project – Goat aid and the girl effect. • I can explain the 5 different stages of Rostow's model and identify where Ethiopia is on this.	
I can describe the difference between a world city and a mega city	
I can describe the distribution of megacities and how this has changed	
I can explain what causes rapid urbanization in LIDCs including natural growth and push and pull factors	
I can outline the social, economic and environmental impacts of rapid urbanisation in LIDCs.	
Case study: Cities face distinct challenges – **Rosario** • I can describe the location of the city • I can describe the impact migration (national and international) has had on the city's growth and its character • I can describe the ways of life within the city, such as culture, ethnicity, housing and leisure. • I can explain the challenges created by rapid growth including housing availability, transport and waste management • I can explain the strategies being used to overcome these challenges.	
Environmental threats to our planet	
I can describe how the climate has changed from the quaternary period to present day including key periods of warming and 'mini' ice ages	
I can explain what the evidence is for climate change including global temperature data, tree rings, ice cores and paintings.	
I can explain the natural causes of climate change including sun spots, volcanic activity and orbital changes	
I can explain the role human activity has had on the enhanced greenhouse effect	
I can describe a range of consequences of climate change around the world	
I can describe the distribution of the main climate regions of the world	
I can outline how the global circulation of the atmosphere is controlled by the movement of air between the poles and the equator	
I can explain how the global circulation of the atmosphere leads to extreme weather conditions in different parts of the world.	
I can explain the cause and conditions created by tropical storms and droughts	
I can describe the distribution and frequency of tropical storms and droughts and have these have changed over time.	
Case study: drought can be devastating: **Big Dry - Australia** How the extreme weather of conditions of El Nino/La Nina can lead to drought Effects of the drought on people and the environment The ways people have adapted to drought	

Ecosystems of the planet

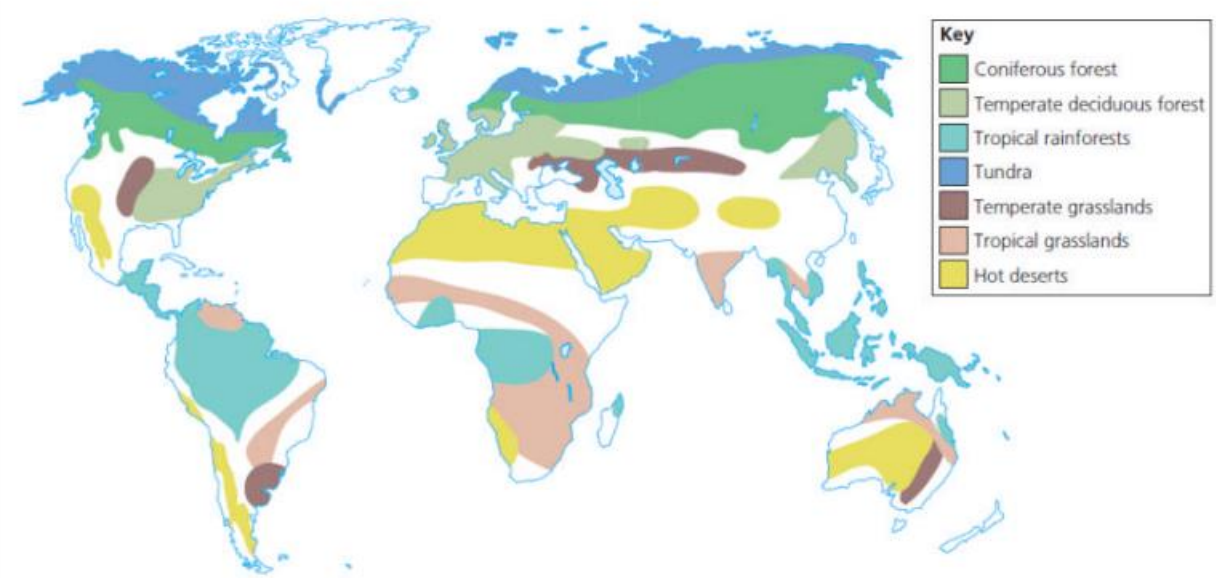
What is an ecosystem and what are abiotic and biotic factors?

An ecosystem is a natural system in which the living parts e.g. plants and animals (biotic) and non-living parts e.g. water, air, sunlight, soil and rock (abiotic) interact.

In an ecosystem, biotic things ***interact*** with each other, and interact with abiotic things.

e.g. a plant (biotic) relies on soil (abiotic) to grow for its nutrients.

What is the distribution of ecosystems and their characteristics?



	Location	Climate	Flora and fauna
Polar: Arctic and Antarctic	Arctic: Located in the north polar region and includes islands such as Greenland and Northern parts of countries such as Canada and Russia Antarctic: A continent in the south pole region. An immense ice shelf covers it.	Both have long, cold winters and short cool summers. They are both covered by snow and ice throughout the year. Arctic: winter = -46C – 26 C Antarctic: winter = -62 - -55 Sea in the Arctic is warmer and does not fall below -2C. The Arctic is also influenced by the Gulf stream, which makes it slightly warmer.	Arctic: tundra (permanently frozen ground) covers 11.5 million km2, which means there are no trees but low shrubs, mosses and grass do grow. 1700 species of plants grow in the tundra. Land mammals include polar bears, wolves, and foxes, whilst sea mammals include walruses and whales. Antarctic: only 1% continent is ice-free. 100 species of moss and 300 – 400 types of lichen as the environment is too harsh for any other plant life to survive. Land mammals include emperor and Adelie penguins as well as fur seals and elephant seals.
Deserts	Cover 1/5 of the earth's surface.	High amounts of sunlight.	Vegetation needs to be resistant to lack of water. They are xerophytic

	Located between 5 – 30 N and S of the equator around the two tropics. Usually on the west coast of continents. Examples: Sahara – 9 million km2 – 37x size of UK.	Daytime temperatures: 36 – 50C. Night-time temperatures can plummet below freezing. Annual precipitation is usually below 40mm and is unreliable. Baked ground means that rainfall does not infiltrate and so evaporates from the surface during the day.	– they have adapted to this. E.g. Cacti and Yucca plants. Cacti have thick waxy leaves to reduce loss of water through transportation and Acacia trees have very long roots (15m) to tap into groundwater supplies. Animals that live in the desert also need to adapt e.g. meerkats have adapted to limited food by eating scorpions and immune to their venom. Camels have humps on their backs to store fat and water. They also have thick hair on their ears and long eyelashes to protect them from the sand.
Tropical rainforests	Found within the Tropics of Cancer and Capricorn, 23.5 N and S of the equator.	Temperatures are consistently high 26 – 28 C and there are no seasons. Annual rainfall totals are high – around 2000mm. Often, there are thunderstorms in the afternoons. Rainforests create much of their own rainfall due to high levels of transpiration.	Climate is perfect for wide variety of species to survive.
Coral reefs	Found 30 N and S of the equator near the tropics.	For coral to grow, water needs to be 18C all year round. The water also needs to be shallow no deeper than 30m.	Less than 1% of earth's surface made of coral reefs yet 25% of all marine life live here. Coral reefs are made of thousands of polyps. They secrete calcium carbonate, which builds up to form a skeleton. They feed on tiny organisms such as plankton. Corals take a long time to grow – averaging between 0.5cm and 2cm per year. Marine life: up to 4000 species of fish can live in coral e.g. parrot fish, starfish, clams, eels
Tropical grasslands	Also known as savannah. Located 5 – 30 N and S of the equator.	Ranges from the fringes of rainforests to the beginnings of deserts. Temperatures are high throughout the year – average daily temp is 25C. Two seasons – a long dry season and a short wet season.	Summer rain causes grasses (e.g. pampas) to grow rapidly – up to 3m high. The baobab tree has adapted to the environment by having a swollen stem, which can store water allowing it to survive in the dry season. Contain the world's greatest diversity of hoofed animals with

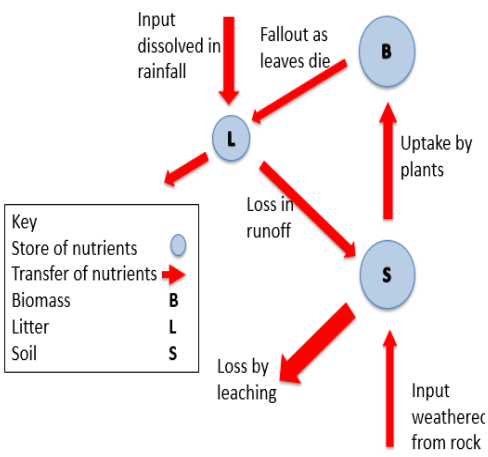
			over 40 species e.g. antelopes and gazelles. Elephants, zebras and lions all live in the savannah.
Temperate grasslands	40 – 60 N and S of the equator e.g. plains of North America and the Pampas of South America.	Summers = v hot → 38C Winters = v cold → can plummet as low as -5. Average rainfall varies but will be somewhere between 250mm - 750mm. 75% of this rainfall falls in the summer.	Vegetation does not grow as rapidly or as tall as in the savannah. Tussock grasses are common and are found in clumps. Willow and oak trees grow in river valleys where there is more water. Gophers, rabbits and kangaroos all succeed in this environment. Carnivores in these areas are coyotes and wolves as well as large birds such as eagles.

Where are the main tropical rainforests and what are the nutrient and water cycles?

Found within the Tropics of Cancer and Capricorn, 23.5 N and S of the equator.

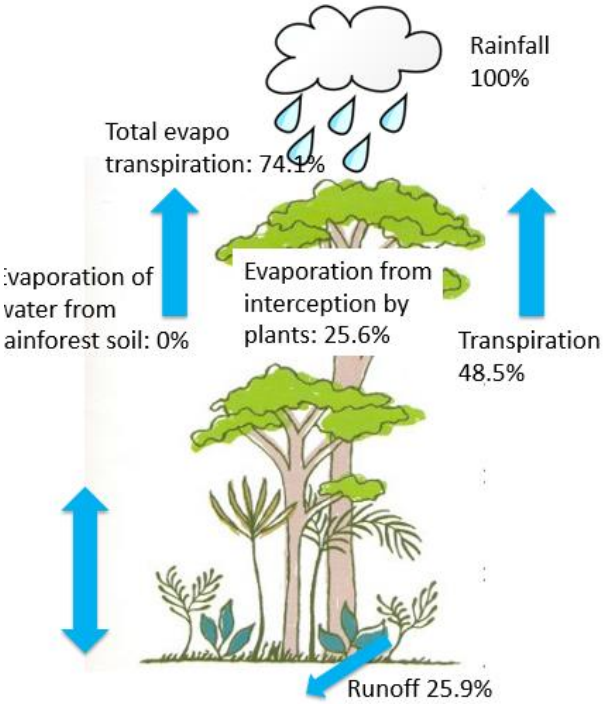
Nutrient cycle:

- The nutrient cycle is rapid in the rainforest. The forest floor is hot and damp which allows dead plants to decompose quickly. This is why there is a small circle for litter. This decomposition takes 3-4 months in rainforest.
- As organic material, such as leaves, decays, it is recycled quickly by the nutrient hungry plants and trees as few nutrients reach the soil. The circle for the soil is even smaller than the litter.



- The greatest store of nutrients is in the biomass, the total mass of plants and animals in the ecosystem.

Water cycle



- Rainforests produce their own rainfall.
- As the rainforest heats up during the morning, the water evaporates into the atmosphere and forms clouds to make rainfall that falls the next day as convectional rainfall.

- Water is lost through pores in the leaves and then evaporated by a process known as evapo-transpiration. The roots of plants take up some moisture through transpiration, but much of the water is evaporated from the canopy later.

- The canopy also intercepts most of the rainfall.

CASE STUDY: Peruvian Amazon

Location:

- Peru, South America.
- Tropical rainforest makes up 60% of Peru.
- 5% of Peruvians actually live in the region.
- Peruvian Amazon is the 3rd largest rainforest in the world.

Characteristics:

- 44% all bird species and 63% mammals live in the Peruvian rainforest.
- Complex interdependence shapes this fragile ecosystem.
- Average temperature is 28C and the annual rainfall is 2600mm.

How is the Peruvian Amazon valuable to humans and the planet?

Value of the rainforest

Biodiversity: 2937 known species of amphibians, birds, mammals and reptiles – 16% don't exist in any other country

Hydroelectricity: there are plans to contribute 15 large dams in the Peruvian amazon – primarily to export electricity to support the Brazilian aluminium industry

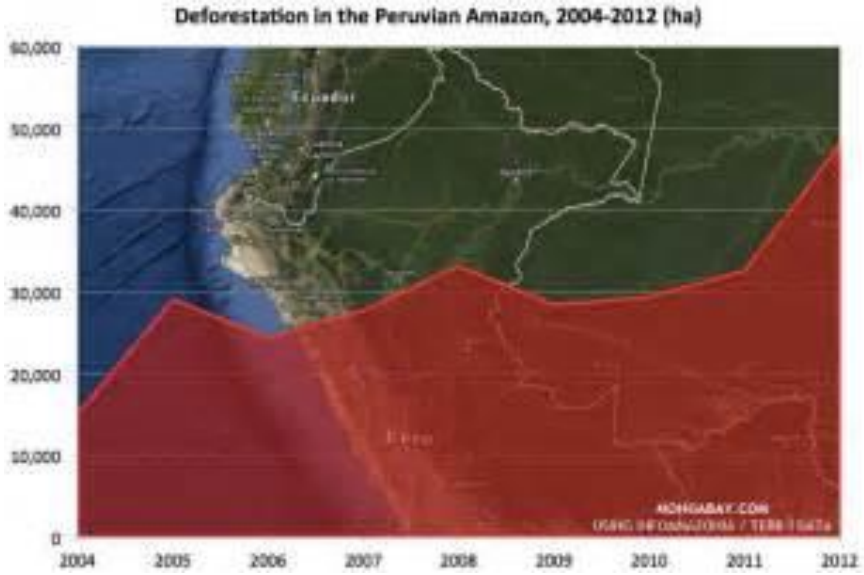
Indigenous tribes: many traditional tribes live in the Peruvian amazon some of which have never been contacted. They live a simple but sustainable life deep in the jungle.

Timber: many valuable hardwood species e.g. Mahogany and logging is widespread (both legal and illegal).

Minerals: oil, natural gas and gold all found in this region. If exploited pose threats to people and the environment.

Medicinal plants: scientists believe that some rainforest plants can help cure diseases such as cancer, aid digestion and even help cure addiction. There is even the possibility that more plants will be discovered.

Threats:



Timber:

- Roughly 1,100 square miles of Peru's forests are cut down every year—around 80% of them illegally
- Mahogany is the most valuable hardwood.
- As one mahogany tree is felled, as many as 20 other trees may be cut down or damaged due to both pulling the tree down and removing the tree from the forest.
- Deforestation also has to occur to provide the infrastructure to remove trees e.g. roads etc.
- Profits are so high for hardwood, that deforestation is also taking place in areas that are supposed to be protected, such as national parks.

Energy

- There are valuable reserves of oil and gas in the Peruvian Amazon.
- China has invested in oil exploration in Madre de Dios region, an area that is home to more than 10% of the world's bird species.
- The extraction of oil can lead to oil leaks and serious pollution of watercourses.

  Camisea natural gas project
  - Designed to exploit a huge gas field in the Peruvian Amazon that could save Peru $4 billion in energy costs and earn it several billion more in exports.
  - Project is located in the most biodiverse part of the rainforest.
  - Home to many indigenous tribes.
  - The Interoceanic Highway—a $2.8 billion, 1,600-mile paved road from the coast of Peru to Brazil—was completed in 2011 and has opened access to once-isolated forest regions. This was done in part to ensure the infrastructure was in place for the pipeline and its workers.

Gold mining

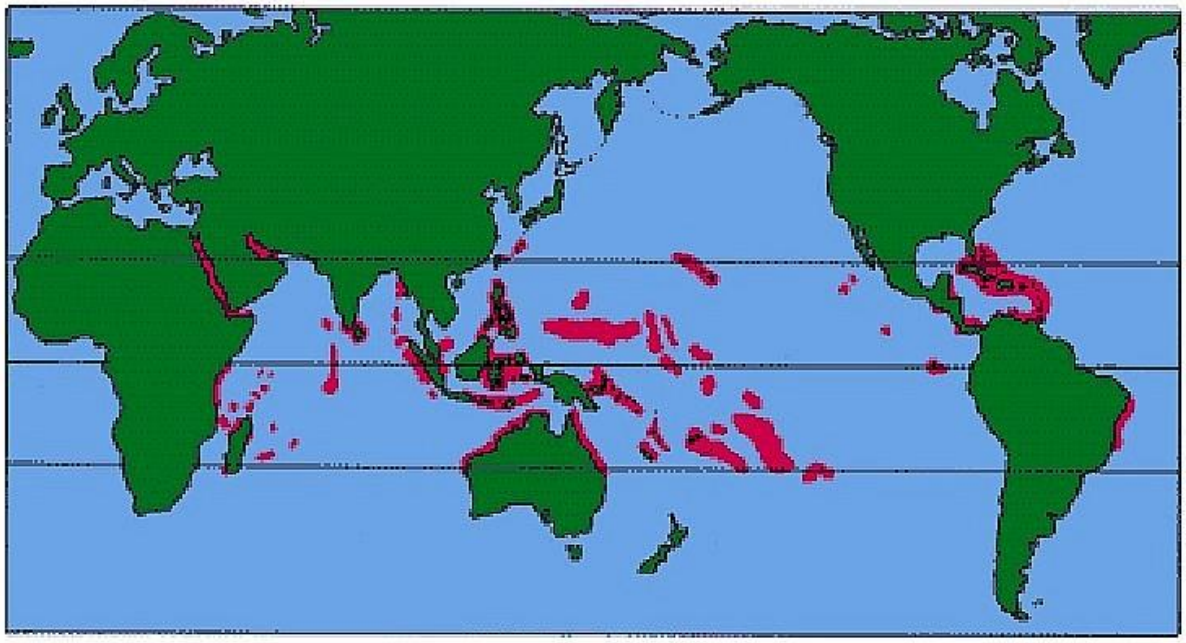
- Gold in found in river deposits.
- Often involves blasting river banks and the removal of rainforest to provide access to areas.
- The new road (mentioned above) has increased the number of people coming into the forest to illegally mine.
- Mercury is used in the operation and this is highly toxic → can cause harm to aquatic ecosystems and it can poison local tribes who depend on the rivers for food and water.

    - 9 of the 15 most consumed fish species for sale in markets have mercury levels exceeding the safe limit set by the US EPA;
    - 78% of residents of the capital of Madre de Dios have dangerously high levels of mercury in their bodies, with women of childbearing age the most affected.
- The worldwide surge in gold prices – a 360% price increase in the last decade- following the financial crisis, draws new miners daily.
- 30,000 miners are estimated to be operating without legal permits.

<u>Management:</u>

- Both the Peruvian government and NGOs (e.g. WWF) have recognised the importance of protecting the Amazon.
    - Since 2000, management plans are required for all forest related harvesting activities and they have to consider how these activities are sustainable. Very difficult to police as area is so large.
    - Indigenous community reserves have been established, giving local communities land ownership and rights over the extraction of material from their land.
    - National Parks and National Reserves have been established to protect certain areas of high biodiversity.

Where are the main coral reefs located and what are is the nutrient cycle?



Found 30 N and S of the equator near the tropics. They need certain conditions to survive:

- » Temperature → only live in seawater 18 and over. The ideal temperature is between 23 – 25 C
- » Light → corals feed on algae, and algae need light to photosynthesis and grow.
- » Clear water → sediment in the water affects the corals ability to feed as well as reducing the amount of light that is able to pass through the water.

Nutrient cycling

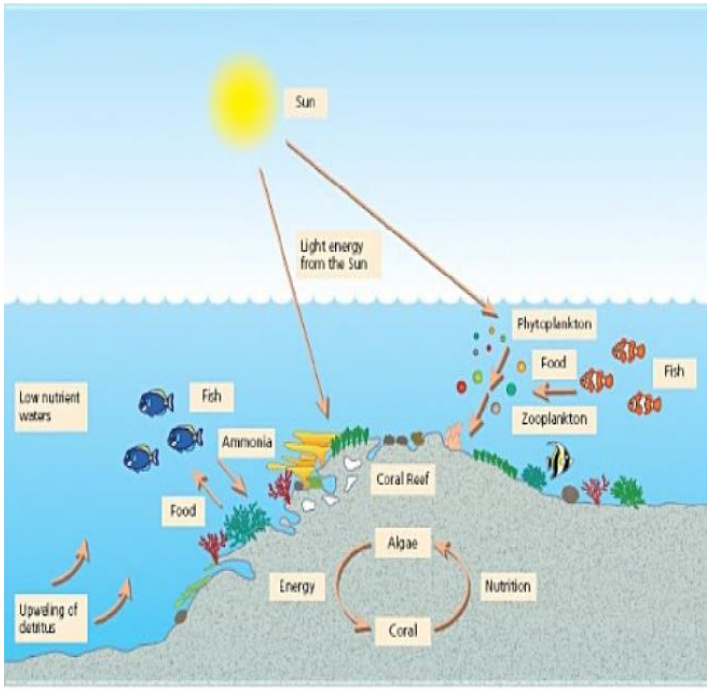


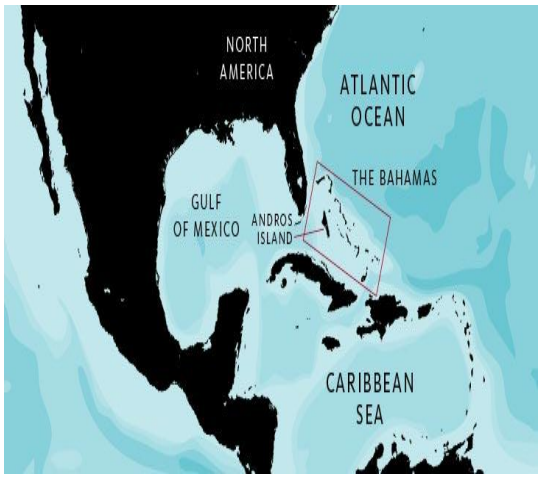
Figure 3 Simplified coral reef nutrient cycle

- Involves to the flows of nutrients within an ecosystem.
- Corals live in nutrient poor waters. It is only through efficient nutrient recycling that the ecosystem is maintained.
- The relationships here are symbiotic - this means that both organisms benefit from each other.

e.g. Zooxanthellae (algae) live in the coral polyps. They are able to photosynthesise and provide nutrients to the coral. In exchange, the zooxanthellae benefit by having exclusive access to the waste nutrients produced by the coral. Tis waste (nitrogen and phosphorus) fertilise the algae.

- Fish constantly excrete ammonia (a dissolved form of nitrogen) into the water and this can be absorbed by corals and algae. Fish also benefit from coral frees, in find both food and shelter.

CASE STUDY: Andros Barrier Reef



Location
In the Bahamas
SE if Florida, USA
Found in the Atlantic Ocean.

Characteristics
- Stretches 200km.
- A shallow lagoon with mangrove forests separates land from the main reef.
- 164 species of fish and coral make up the ecosystem e.g. red snapper, reef shark, rock lobster and the green turtle.

Value to humans and the planet.

Fish breeding grounds
- Corals provide sheltered conditions for the growth of mangrove swamps which are important because they provide shelter for fish to breed.

Treatments for disease
- coral reefs may hold the cures for some of the most serious and common illnesses.

Science
- Andros Barrier Reef recognized as being one of the healthiest coral reefs in the world.
- It is used as a laboratory to find out why it is so healthy so that findings can help support other coral reefs.

Shoreline protection
- coral reefs are a barrier to storm surges and hurricanes, absorbing the impact of waves and wind action for the island.

Tourism
- Coral reefs are spur and groove formations, that means a series of ridges and channels are found in shallow waters. This makes them very attractive and productive.
- Fishermen and tourists alike can easily visit the Andros coral reef.
- Overall, habitats on Andros are thought to generate $260 million a year in net economic benefits, which if sustained, will be worth $4.6 billion over the next 25 years.
- Nature provides income and employment for 80% of Andros; 1,645 full time jobs and 8,000-part time jobs.

Threats:

Overfishing
- Coral reefs can be damaged by contact with anchors, boat hulls and people.
- Though harvesting of sponges is important economically, it can be harmful to the reef.

Pollution

- From agriculture, sewage, and silt from rivers
- Causes water to become cloudy restricting sunlight.
- Marine pollution

Oil and chemical discharge from boats and ships.

- Harmful to both coral and fish

Climate change and global warming

- Higher water temperatures trigger coral to expel the zooxanthellae. This reduces the nutrient flows and cause coral to turn white → Coral bleaching. Eventually the coral dies.
- Projections from climate models suggest that reeds in the Bahamas will annually experience thermal stress severe enough to cause bleaching after 2040.

<u>Management</u>

- In 2006, a team of scientists, researchers and students on a scientific expedition to explore the remote west side of Andros Island.
- Expanded Andros West Side National park from 882,000 acres to nearly 1.3 million acres, ensuring it will remain a safe haven for fish, birds, reptiles and sea monsters alike.
- The area of the Andros Barrier Reef is prone to sports-fisherman from around the world. In order to maintain and increase wildlife populations, proper protection of the park is critical.

People of the planet

Definitions of development

The UNDP defines development as: '*the three essentials of development include the ability to lead a long and healthy life, to acquire knowledge, and to have a decent standard of life*'.

However, we can split development down into four other definitions.

Social development	The improvement that has been made by a country in improving the quality of life of people who live there e.g. literacy, education, housing, healthcare and increasing life expectancy.
Economic development	Improvement the country has made in terms of wealth e.g. value of goods, proportion of population working
Environmental development	Recognises the importance of the natural world and includes looking at how countries are monitoring the emissions of greenhouse gases or what they are doing to improve water quality.
Sustainable development	. That the needs of the present will be met while protecting the needs of the future.

Indicators of development

INDICATOR	Social or economic?	Translation	What does it tell us about a country?
GNP per capita	E	Average earnings per person	Wealth; employment; disposable income; life choices; afford necessities?
Literacy rate	S	People able to read and write	Education; Employment / wages; political awareness
Infant mortality	S	Child deaths	Health care; Nutrition
People per doctor	S		Education; Health care; death rates; life expectancy
Gender development index	S	Inequalities between men and women – health, education and standard of living	Literacy; Disposable income; Political awareness
Internet usage	S		Electricity? Disposable income (luxury item); Political awareness

Life expectancy	S	Average number of years people are expected to live	Health care; Nutrition; GNP
%GDP from agriculture	E		Industry; life choices; afford necessities; reliant on exports

What are the issues related to some of these indicators?

The statistics are averages; therefore hide differences within the population- extremes in wealth, gender differences in education.

Critics argue that such indicators focus too much on the economic, is only money important for a decent life.

Human development index

- Alternate way of measuring human development, a figure is produced between **0-1**.
- This is calculated by using
- **Life expectancy at birth**, as an index of population health and longevity
- **Knowledge and education**, as measured by the adult literacy rate and enrollment in each sector of education.
- **Standard of living**, as indicated by the gross domestic product per capita.

It is a useful indicator because:

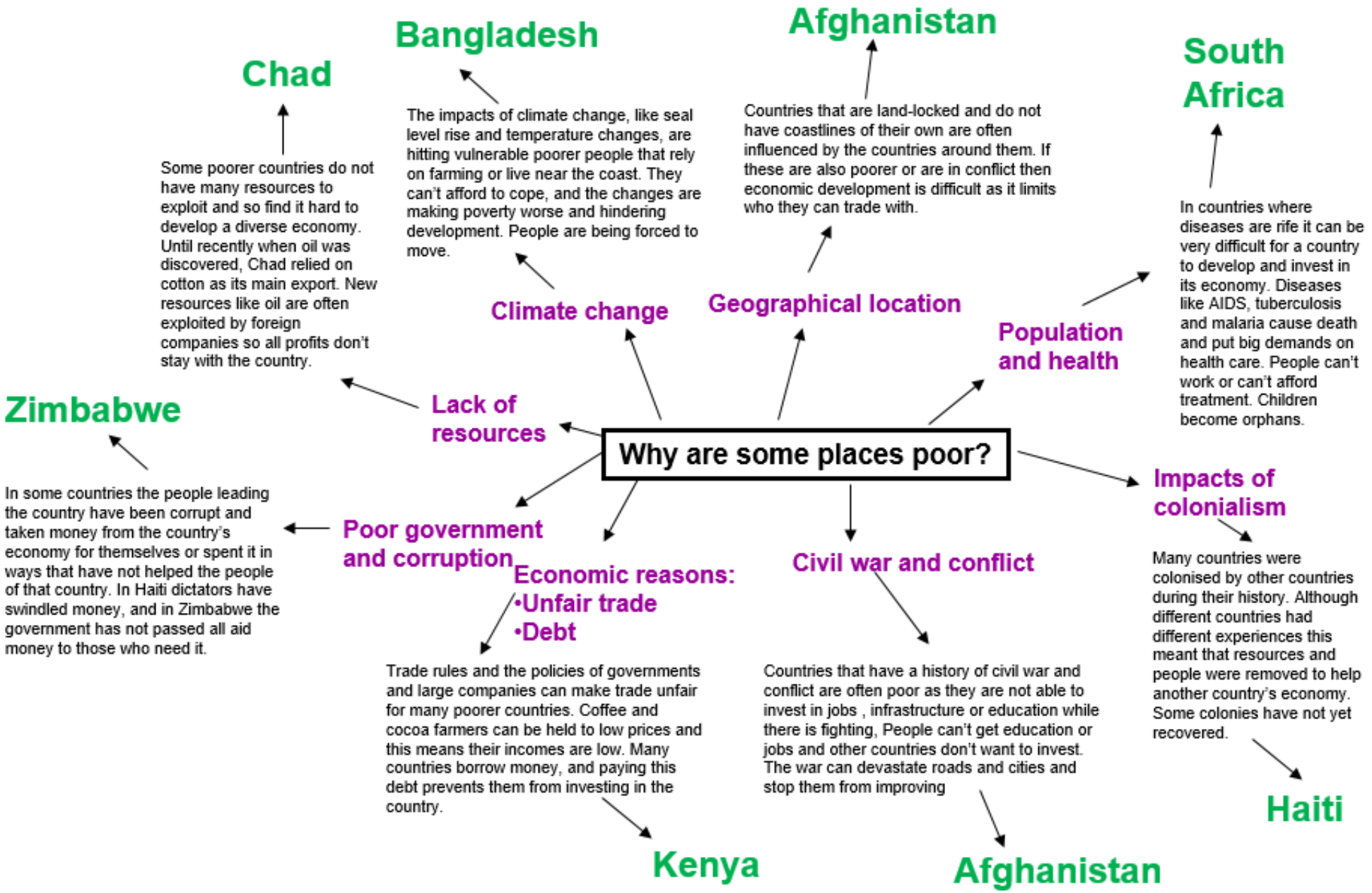
- It does not rely solely on wealth; it gives an indicator of quality of life by including health and education.
- By including education, it gives an indication of the country's future development potential.
- It reveals how a country uses it wealth. For example, if a country has a high GNP, but spends little on education, it will have a low HDI.

<u>How can we classify countries?</u>

- IMF classifies nations into three categories of development
  - Advanced countries (ACs) → 16% of world nations.
  - Emerging developing countries (EDCs) → 45% of world nations.
  - Low-income developing countries (LIDCs) → 38% of world nations.

- Countries are categorized according to wealth per person, trade and links with other nations.

What are the causes of uneven development?



What are the different types of aid available?

Aid is 'the transfer of money, equipment, manpower, to another country, its objective is to benefit the recipient country.'

The World's richest 22 nations have pledged to contribute 0.7% of GNP to overseas development. The United Kingdom currently contributes 0.52%. The highest contributor is Sweden- 1.12%.

There are many different types of aid:

- Short-term aid: Provided after or during a disaster. Also called emergency aid. E.g. *Emergency temporary shelters after an earthquake*.
- Long-term aid: Purpose is to develop the quality of life of individuals and communities over time. Also called development aid. E.g. Wateraid improving water quality in Burkina Faso.
- Voluntary aid: Funded by the public through **NGOs** (Non-Governmental Organisations). E.g. Supporting Oxfam's work by direct debit.
- Bilateral aid: When one country provides resources to another.
- Multilateral aid: Donations are pooled from a number of countries and distributed through an international organisation, such as the *World Bank*. E.g. *This may also be conditional. The World Bank usually requires countries to meet certain conditions in order to receive loans.*

Top down vs Bottom up approaches to aid:

• A bottom up approach to development is one, which looks at helping local communities and local people. An important part of this approach is that the developers (mainly NGOs) ASK the communities what sort of problems they face on a daily basis. The developers then look at long term sustainable solutions to how they can solve these problems. These projects are often more sustainable as the locals are involved. However, they tend to be very small scale and only support/help a small number of people.

• Whereas a top down approach is the type of project that is implemented by either the country's government or by a large institution such as the World Bank. They assume what the country need based on statistics. Often, these are not as sustainable as bottom up approaches as the locals are not involved with the process. However, the positive of these schemes are that more people can be impacted and benefit.

Case study - Ethiopia: changing economic development

Background facts:

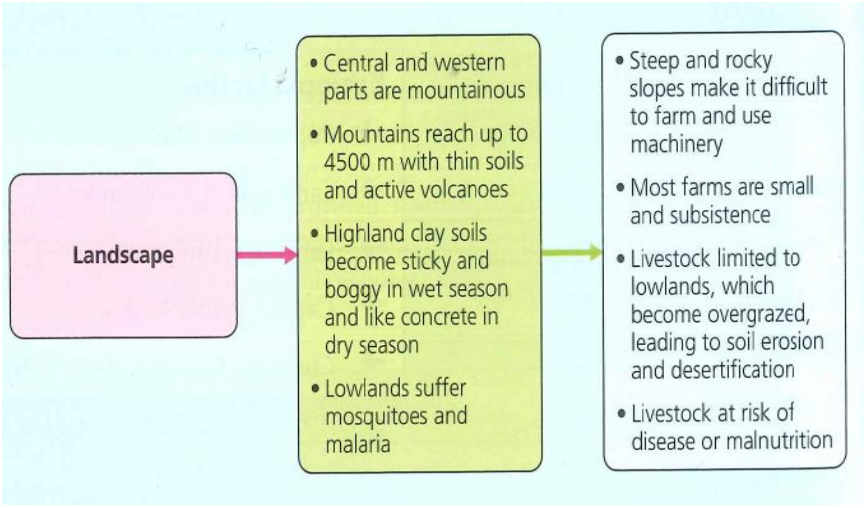
- It's an LIC
- It's GNI/capita is US$505 but the global average is US$10,858
- Even compared to other Sub-Saharan nations, Ethiopia is significantly less wealthy per person and is below the average level of other LIDCs across the world.

Location and environmental context

- In east Africa.
- Landlocked
- Shares a border with 5 countries.

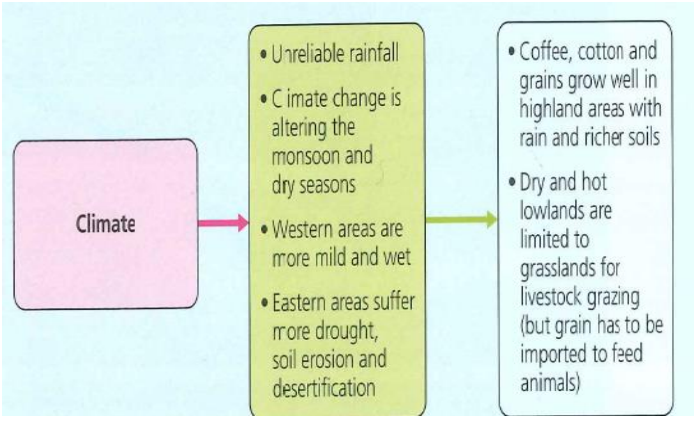
Landscape:

- Varied
- Highlands are over 4500m
- Lowlands where land is fertile
- Semi-arid regions where it is difficult to grow crops.



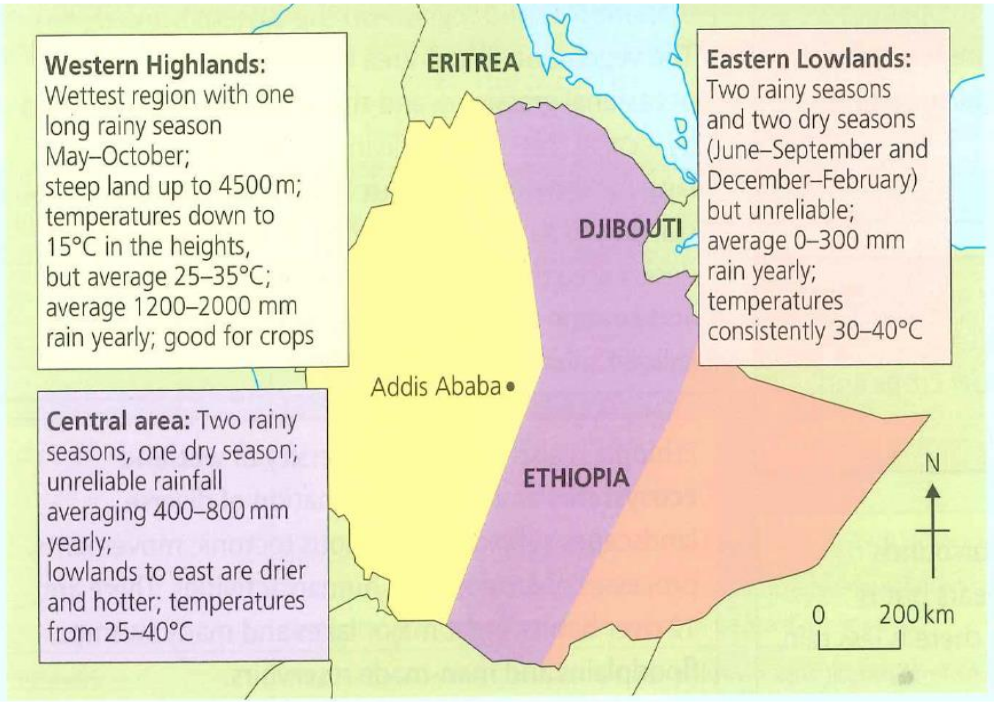
Climate

- Landscapes and climate have a big influence on how successful agriculture is → this has a big influence on Ethiopia's development
- Unpredictable rainfall is a key issue with the climate particularly in the lowlands where monsoon rain often fail.
- Water shortages and infestations of disease carrying insects such as



mosquitoes and tsetse flies; prevent the use of potentially valuable land.

- Eastern areas in particular suffer from drought when rain fails → this has led to farmers over farming or over grazing the remaining land, which leads to soil erosion and desertification.



Ecosystems

Ethiopia has a varied range of ecosystems from forests to wetlands.

Mountainous regions in the northwest and southeast. In the highest areas of the Ethiopian Highlands, there are chains of mountains which have a cold climate near to 0°C all year round, sometimes even with snow cover.

Woodland forests grow on the lower areas of the highlands which have good, fertile soil and are now mostly used for agricultural use to grow crops and graze animals.

Tropical savannahs and **grassland** surrounds the highlands. This is fertile in good years but is vulnerable to drought in years where there is less rain.

Deserts and semi-desert ecosystems in the extreme lowland regions on the eastern border. The vegetation in this area is mainly shrubs, with occasional grassland, and the landscape is dominated by Acacia trees. People living in this area farm the land for their own use, but large-scale agriculture is starting to gain in importance. In the northeast is a desert area that is one of the world's hottest places and contains the world's inhabited location, a place called Dallol.

Ethiopia is also home to a diversity of **wetland ecosystems** as a result of formation of diverse landscapes subjected to various tectonic movements, processes of erosion, and human activities. There are 12 river basins, eight major lakes and many swamps, floodplains and man-made reservoirs.

- 6500 – 7000 species of plants – around 15% can only be found in Ethiopia.
- Large number of vulnerable and endangered species including lions, cheetahs, black rhino and African elephants.

Natural resources

- Ethiopia has small reserves of mineral resources such as gold, platinum and copper as well as reserves of gas.
- Only one large scale gold mine in operation but potential to exploit more oil and gas stocks → only in early stages but already contributes 19% to exports.

Political development

Date	What was happening?
Pre-1935	Ethiopia was once known as Abyssinia and was one of only two African countries (with Liberia) that avoided European control in the colonial era.
1935–41	During the build up to the Second World War, Italy colonised Ethiopia and had control from 1935 until 1941, when rebels and British troops claimed back independence.
1941–74	Although the Italians had invested in highways, rail and power, the nation was set back after the Second World War, due to the conflict and the loss of life and instability that followed. Years of unrest, coupled with drought and famine and the growth of Communism, led to a successful military coup in 1974. The Soviet Union (now known as Russia) and Cuba financed this rebellion, and the military evicted the government leading to many arrests, banishments and deaths.
1974–87	At least 1.4 million people died in the civil war and the Derg government remained in power until 1987. The monarchy was abolished and the land was declared a new republic state. The period 1977–78 became known as the Ethiopian 'Red Terror'. During this time, the government grabbed tracts of land and evicted owners leading to migration, refugees and economic decline. There were up to 50,000 people killed during the Derg era; a further 1.5 million were forcibly relocated.
1984–85	The Derg government pursued a strict policy on agriculture, but productivity declined. From the mid-1980s onwards Ethiopia suffered severe drought and eventual famine. The 1984–85 famine (the inspiration for the original Live Aid *Do They Know It's Christmas* charity song) killed a million people in just one year due to drought and high food prices. International agencies became involved and over US$2000 million in food aid was delivered from NGOs. Ethiopia has remained food deficient since this time, made worse by continued population growth.
1991–2001	With the collapse of the Soviet Union, and the international spotlight on famine, support from other nations helped to stabilise the nation and remove Derg control and from 1991 it became the Federal Democratic Republic. The new government allowed free trade, lifted price controls and provided farmers with cheaper access to imported fertilisers and machinery without paying tax.
2001 to now	Following the events of 11 September 2001 and the Middle East conflicts, the USA gave more support to Ethiopia and agricultural production and the economy have been rising gradually since then. The Growth and Transformation Plan is the government's ambitious plan to end poverty following on from the Millennium Development Goals. Since 2012, new training programmes and investment have enabled farmers to learn new skills (such as mixing crop types with beans to help soils stay fertile) and increase yields. The government is stable, although there are some claims that free speech is limited, but more trust is now being shared with local authorities and the people themselves.

Trade, investment and employment:

- Ethiopia has a trade deficit.
- 80% of exports come from: coffee, vegetables, flowers, livestock and pulses. They contribute 46% to the GDP.
- Ethiopia is one of the world's largest producers of food and flowers → economy is vulnerable to climate change and global price changes.
- The economy has been growing at an average of 11% per year, which is higher than the rest of the world → less people now in poervty and GNI/ capita has improved from US$203 in 1990 to US$505 in 2015.
- Ethiopia is becoming increasingly global. As it does so, international investment is increasing.

- One example, is the increase in TNCs (Trans National Corporations) wishing to locate and invest in Ethiopia.

Advantages	Disadvantages
• Can increase tourism • Workers are often paid a fair wage in hotels and may be offered over time. • Companies may invest in infrastructure such as roads, water, communication (internet) etc.	• Workers may be poorly paid as companies wish to make a profit • Working conditions may be poor • Local workers will not necessarily get management posts – these will be filled by company workers. • TNCs may choose to leave when workers start to demand more money and rights • Tourism may be seasonal and affected by 'trends'

Population and employment structure

- Large population
- High birth rate and falling death rate = natural increase → population is growing by 2.6%
- Famine, drought, poor healthcare, disease and poverty means Ethiopia has one of the lowest level of development. Life expectancy is increasing at 63 still lower than global average.
- Many people still work in the primary industry but secondary industry is starting to take off.

Social factors

Access to education

- A national Education Development Plan has ensured that 96 per cent of children enrol in primary school, which has risen from 50 per cent in 1990.
- The Education gap is closing now, as 93 per cent of girls are in primary schools (compared to 43 per cent in 2000).
- However, the quality of education provision varies, and the adult literacy rate is still just 36 per cent.
- There are more males than females in primary education, and very few females in secondary education.

Healthcare provision

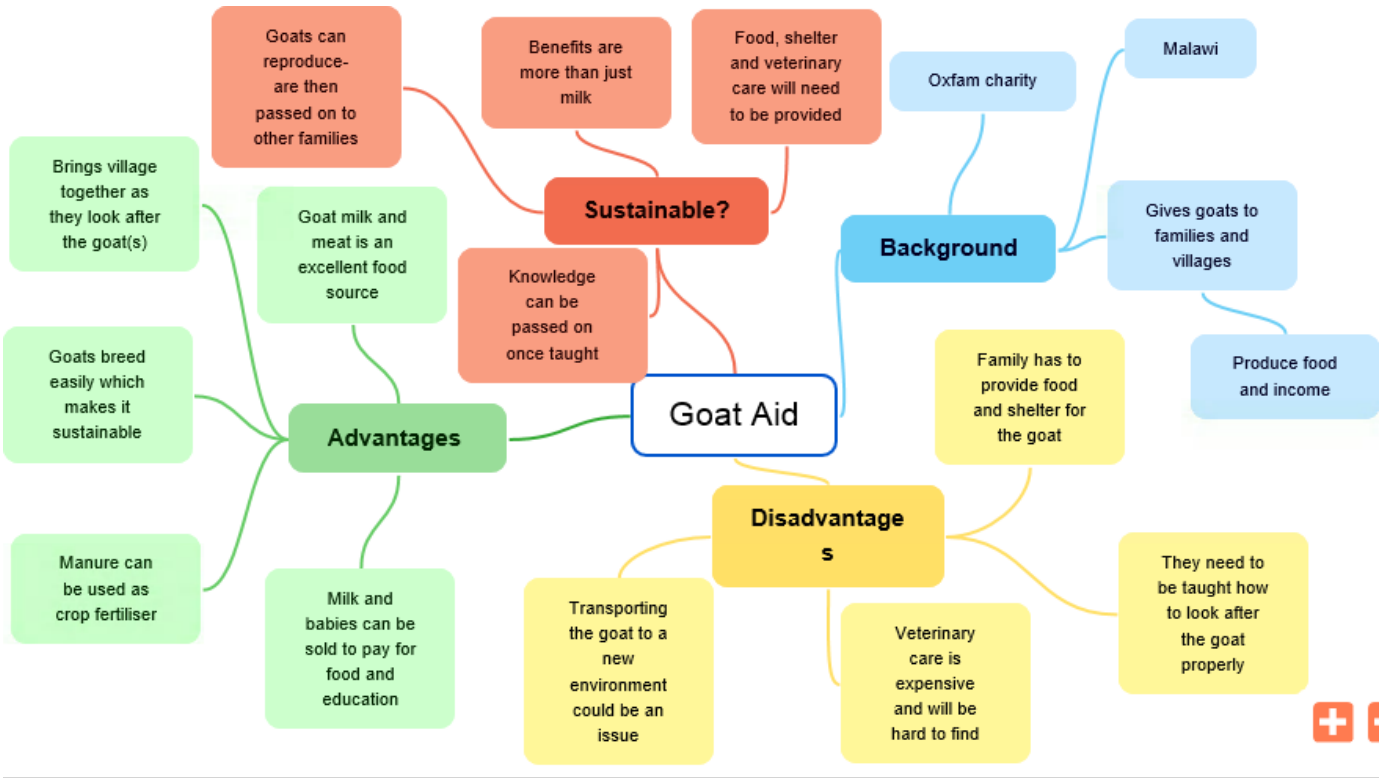
- Maternal mortality has dropped 23 per cent due to better before and after care.
- 55 per cent of women now receive access to contraception.
- Child mortality has been reduced successfully from 97/1000 to 45/1000 since 1900, following investment in maternal health and child health, although rural areas lag behind and there is a rural-urban divide.
- 65 per cent of children now receive vaccinations for preventable illnesses.
- Diarrhoea and malaria are still the biggest killers of children year – diarrhoea accounts for 20 per cent of all child deaths and malaria accounts for another 20 per cent
- The HIV/AIDS pandemic has stabilised and new cases have declined since new treatment centres and education were established. However, there are still 1.1 million adults living with HIV
- Malaria was the leading cause of death among adults but now 100 per cent of the population can access a malaria net.
- Eighty-nine per cent of the population live within 10 km of a doctor, however every doctor is shared by 3333 people.

Aid

- Ethiopia has benefited from international development support thorough aid and debt relief.
- 5 million people receive food aid each year.
- Support from international community meant that in 2006 Ethiopia benefited from debt relief → in 1995 Ethiopia was in debt by US$10 billion. As a result of debt relief, by 2012 the debt had declined to 21% of the national economy (US47 billion).

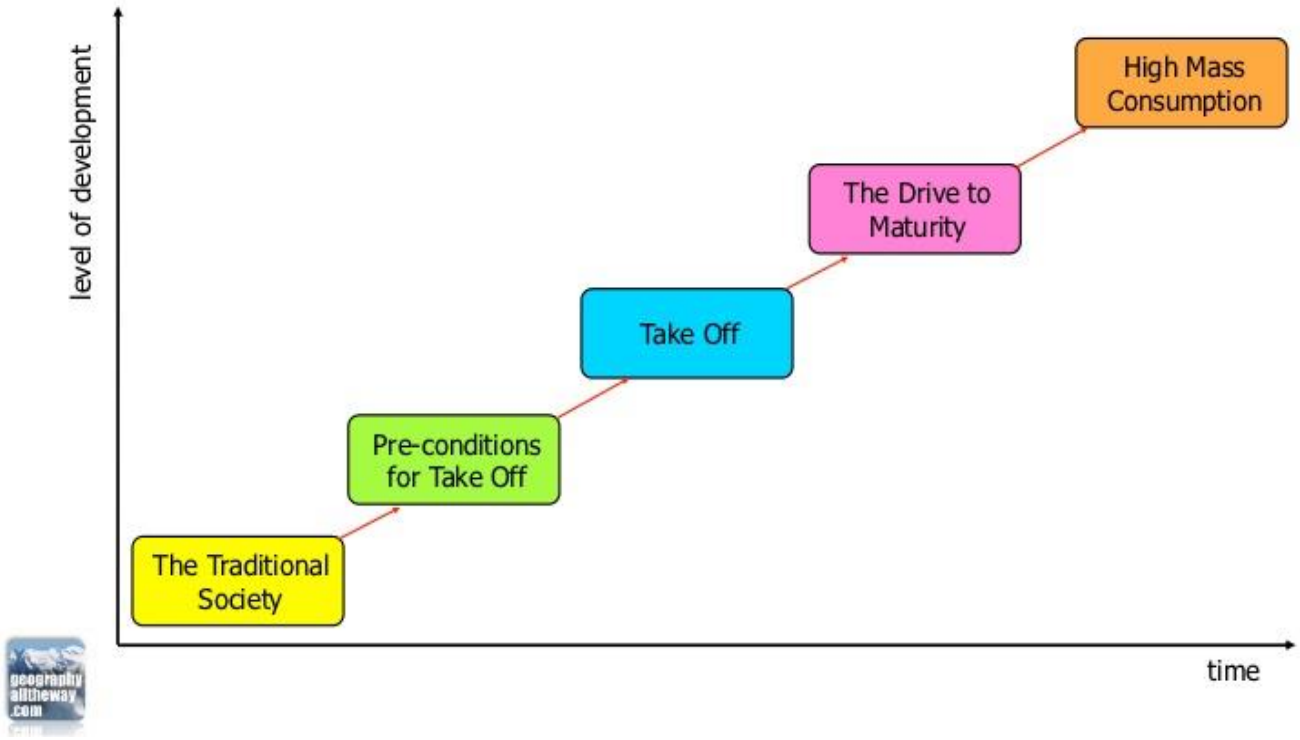
Named project: Goat aid

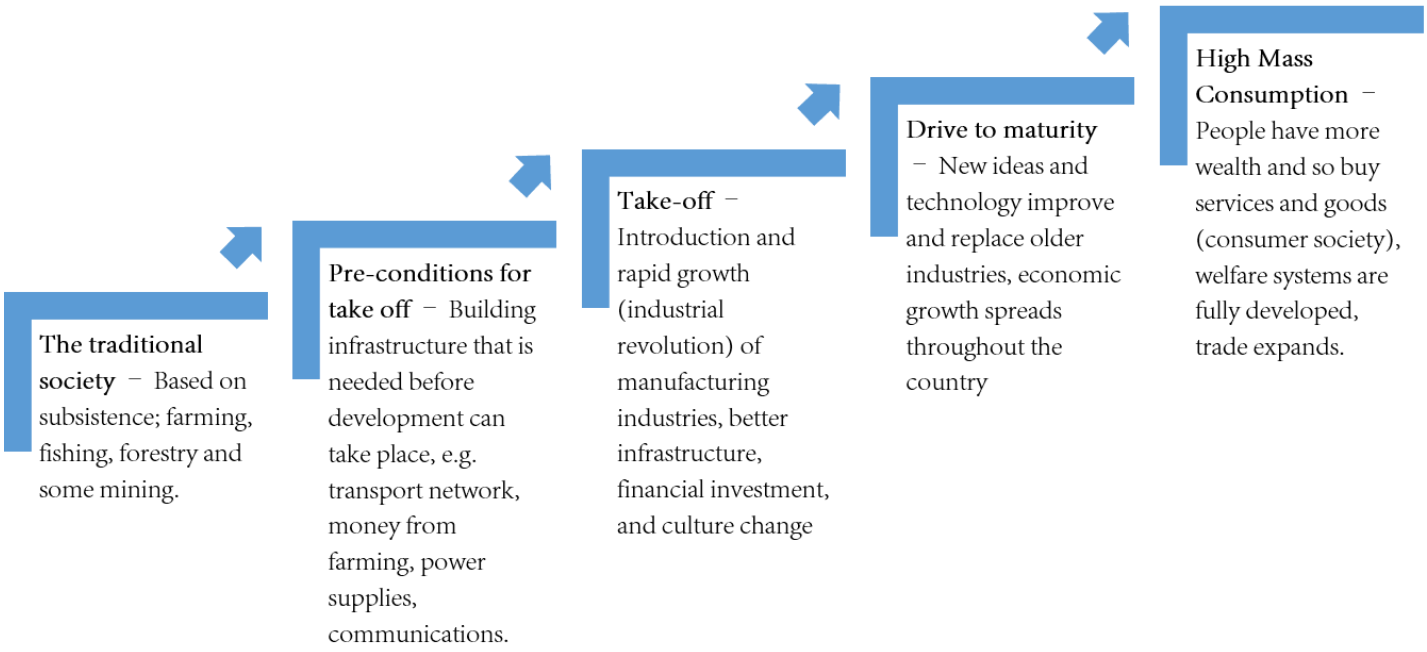
- Oxfam
- £25 gift that people may choose to give each other as part of the 'unwrapped' scheme.
- Really sustainable particularly when targeted at young women.
- Creates the girl effect: pair of goats given to a 12 year old girl → goats are bred to create a flock → milk used to drink or make cheese – meat can be eaten → nutrition improves = better health → surplus sold and money is invested in education, clothing and food → social status and wealth improve, flock is rebred → cycle continues of breeding, selling, investing and educating → leads to sustainable increase in wealth.
- Girl effect avoids potential issues such as early/forced marriage, prostitution, unplanned pregnancies, disease and poverty and empower women.
- This in turn improves development.



Rostow's model of modernisation:

KEY → You must know the order of the stages and roughly what each stage involves.

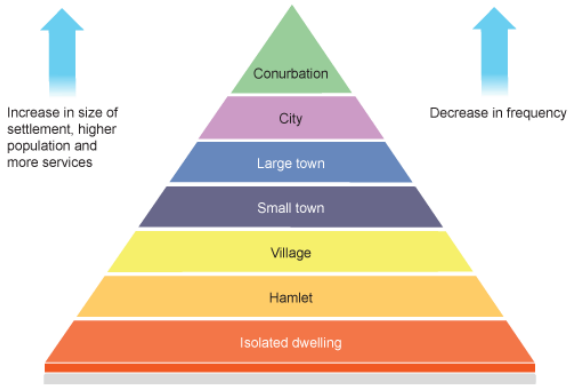




- With a trade deficit and most people employed in the primary sector, it could look like Ethiopia is in stage 1.
- However, government spending has led to improvements in healthcare and education and with the arrival of TNCs and improving infrastructure, it seems that stage 2 is more appropriate.
- While traditional practices such as nomadic livestock farming and water collection still happen, these are now being modified by newer technologies to improve efficiency and quality of life → Pre conditions for take-off are emerging.

Global urbanisation

- 2007: more than 50% world's population lived in urban areas
- The number of urban dwellers rises by 180 000 per day and by 2050, 75% worlds population is set to live in an urban area



The pyramid is called a settlement hierarchy. As settlements grow in size, they develop more functions and offer more services.
The point at which a town becomes a city varies across the world.

A conurbation is made of a major city and its suburban areas, housing tens of millions of people and performing a large number of functions. E.g. Pearl River Delta in China.

Where do cities develop?
By water → first settlers were able to develop through agriculture and then eventually during the industrial revolution water led to more international trade which boosted the importance of port cities such as Liverpool and Southampton.

Today, cities grow for the same reason - industrial development and raw materials still draw people to the major cities, but there are other factors now, such as global outsourcing and cities planned for specific purposes.

Megacities

What are megacities?
- A mega city has a population over 10 million

Where are megacities and how has it changed from 1950s to 2014?
- Mainly in N Hemisphere
- Particularly between tropics
- Generally on coast or on large rivers
- H density of mega-cities in SE Asia.
- Over time cities have moved from MEDCs to LEDCs

Why are they important?
- Demographic pattern changes – younger people. Natural increase occurs as there is greater financial stability
- Urban areas get denser, which could reduce urban sprawl, particularly if the city has been well planned
- Impact of people is concentrated on one area rather than sprawling. There can be a better civic identify with the city, which fosters pride, rather than resentment at those in charge.

What is a world city?
- A world city is one that is an important hub in the global economic system.
- Often grow up as a global hub on account of 'natural' or 'human resources.'

- Serve as core regions for a country's economy, stimulating further economic growth as a result of the wealth circulating in that area i.e. 'Multiplier Effect.'
- Often have the following characteristics

What are the characteristics of a world city?

- HQ of MNCs
- A centre for innovation or business
- A centre for media and communications – broadcasting and technology
- A major centre for manufacturing
- Financial services – home of important stock exchanges or major banks
- Regional importance compared with other cities
- Highly rated universities, often specialisation in research which links to high quality healthcare provision
- Cultural opportunities including opera and ballet as well as film and live music.

What is the global pattern of urban growth?

Advanced countries (ACs) grew most rapidly during the 17th and 18th century during their industrial revolutions. Baby booms during both this time and then in the post war period meant that AC urban areas experienced rapid urban sprawl and the creation of suburbs. Paris and London were the first cities to reach a million people.

EDCs and LIDCs are currently experiencing rapid urbanisation.

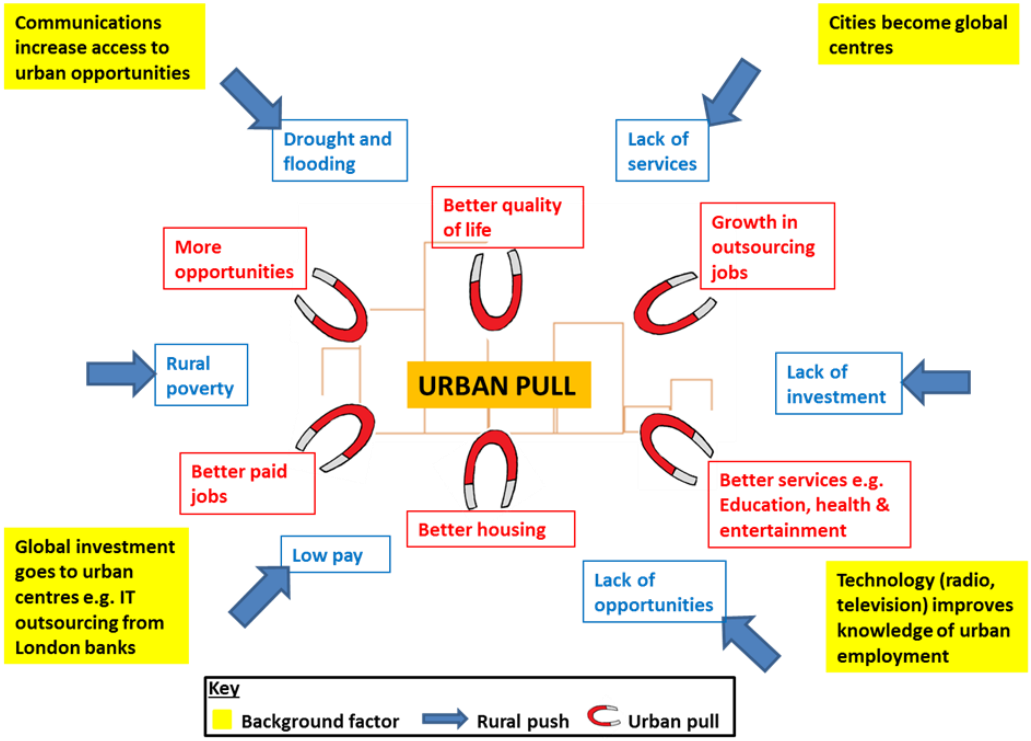
- Growth in Chinese cities has been driven by economic development of urban areas and the need for a large workforce. 200 million people moved to urban areas in East Asia between 2000 and 2010.
- Lagos, Nigeria has experienced rapid growth, In 1950 it had a population of 300 000 now it has a population of 18 million.

<u>Rapid urbanisation in LIDCs</u>

Causes:

- Rural to urban migration
- Natural increase – when those who have moved into cities have lots of children

Rural to urban migration



Problems of rapid development

Housing and sanitation

- 60% of Mumbai's population lives in slums → Many people are forced to use leftover materials to build temporary houses
- The city faces continuous problems of poor water, no electricity, insufficient sewage and garbage disposal
- As the number of people in the cities increase, the problems of space and housing have all intensified
- Unlike MEDC cities, Indian cities are not able to take in more people because of poor urban management and poor funding
- There are very few services in terms of healthcare in the slum area of Dharavi. This combined with poor sanitation and overcrowding means that disease spreads rapidly in the slums.
- As of November 2006 there was only one toilet/1440 residents
- Families rarely earn enough to move out of the slums
- Monsoon rains → causes flooding.

Transport

- Slums tend to grow up around transport hubs. This creates problems for businesses. The slum dwellers are attracted by the amount of jobs that can exist here and the space that is left around the edges of theses hubs.
- The local trains carry 5.5 million passengers per day. Their capacity should be 1700 / day at peak times through there can be more than 4000 / train
- 88% of the population from Mumbai travel by bus and train

- Mumbai metro estimate that western railways operate 923 trains and central rail 1072 trains per day
- In the last 40 years, although the number of train passengers has increased 5 fold, the number of train journeys has only increased 2.5 times
- Smog can be a major problem in Mumbai → leading to health problems in the vulnerable and poor

CASE STUDY: Rosario: a major city in an EDC

Where? NE Argentina – 300km NW of Buenos Aires. Relatively close to the Uruguay border in the east. Largest city in the southern part of the Argentinian province of Santa Fe.

Physical features?

- Lies on the Parana river → flows into Atlantic an is the second longest river in South America.
- Low lying – only 40m above sea level.

Human features?

- Population over 1 million
- Has key rail, river and air transport links
- Major waterway and communication network
- It is an industrial city

How did it develop?

- Small settlement grew around the Parana River with agriculture
- Late 19th Century, became Argentina's first port to export goods → this drew in migrant workers. Grain was particularly important
- Secondary industry such as chemical and steel workers on the docks shut in more recent years. This led to derelict warehouses and contaminated land
- Recently, derelict sites have been renovated with the idea to attract tourists to the area.
- Key milling and meat packing centre for the region for export. → This has led to people from all over Argentina migrating to the area.

How has migration affected the city?

- Rosario has attracted people from all over Argentina.
- Spanish and European migrants moved in the 19th century and more recently there has been an influx from Asian countries. This has changed the characteristics of the city. The early migrants influenced the architecture with French reissuance buildings such as the Stock exchange demonstrate.
- Italian immigration has been a key element in the growth of the city and has influenced hugely the culture and food of the city. Italians formed the majority of immigrants over the last century.
- Population is relatively young – partly due to internal migration from across the country.

What is life like in Rosario?

- Che Guvara was born in the city. It has close links with trade unions because of the level of industry in the city
- There is lots of shopping – has undergone investment and now attracts young people and families alike.
- Meat, particularly beef, is really important to the area. Cattle graze the large grassland areas called pampas and the gauchos (or cowboys) are still important. The asado (or grill) is an important feature of many restaurants.
- Rosario is known as the cradle of the flag as it is where the flag was born and created for the first time.

What are the challenges facing Rosario?

- Unemployment → 2001 onwards there have been riots in the city and looting of supermarkets. There are still crime problems facing the city.
- Crime → slum districts experience high levels of crime and poverty. Drug use has grown among the city's population and spawned violent drug wards in some areas. Sicilian mobsters have been active in the city. Criminals have allegedly infiltrated the police and influence football through violence.
- Social inequality → 100 000 people live in slums, which take up 10% of the city. Available land, even that which is unsuitable for development, is soon used as settlements expand along transport routes – as this is the way that migrants will travel into the city. These slum areas have few services (sanitation and healthcare), high population densities, structural deficiencies and a low quality of life.

What is being done about these challenges?

- Complete replacement – demolition followed by rebuilding to meet the architectural styles of the present day and the ambition of the developers
- Regeneration – improvements to the fabric of the building, which might include changes internally or externally
- Increasing height – the addition of new floors or replacing low rise with high rise development
- Infill – additions to the area which may be out of keeping with the area they are slotted into.
- Gated communities → increasing as people want to feel safe. Rosario has limited these in order to keep community spirit in the city and to prevent the rich from becoming isolated from the poor.
- Empty land → prime for development. High rise developments often locate in these places. Large student population and young migrants want to move to 'trendy' areas.
- Rosario Habitat Programme
    - Set up to reduce inequalities in the city
    - Program led by public housing and started in 2000
    - Scheme has helped over 5000 people.
    - Programme involves:
        - ✓ New urban planning – new roads and sewerage, storm drains and community facilities
        - ✓ Adding toilet facilities to the houses
        - ✓ Legal ownership rather than the previous uncertainty over the status of tenure
        - ✓ Education programme for young people regarding risky behaviour
        - ✓ Money invested into social enterprises
        - ✓ Targeted support for women in the community

Rosario: a green city

- Urban forestry
  - promotes the development of a way of reducing the impacts of climate change in the city.
  - Trees are planted among all new housing developments to reduce the ambient temperature in the area
- Urban agriculture
  - Flood risk zones and peri urban land (land on the edge of the city) have been planted with crops to improve the diet of low income families.
  - Provides an additional income for low income families.
  - Community groups were given tools and seeds and vacant land.
  - The production of food locally also reduces the needs to transport crops into the city from nearby regions – this reduces CO2.
  - Local hotels and restaurants support the campaign by using these vegetables.
  - Now 800 community gardens supporting over 40 000 people.

Environmental threats to the planet

Climate change and its causes

Natural causes of climate change

- Current research estimates that average global temperatures will increase by between 1.8 and 4°C in the next 100 years
- The climate of the Earth exists due to a naturally occurring phenomenon known as the Greenhouse Effect
- Without it, the surface of the planet would be 33°C cooler and life on earth would have not been able to exist or evolve

Variations in the earth' orbit

- The way the Earth moves around the sun affects the way the Earth receives energy from the Sun.
- Earth's movement around the sun gradually changes in three ways, which in turn affect global climate
- These are often referred to as the **'Milankovitch Cycles'** and include: Stretch, Tilt and Wobble.

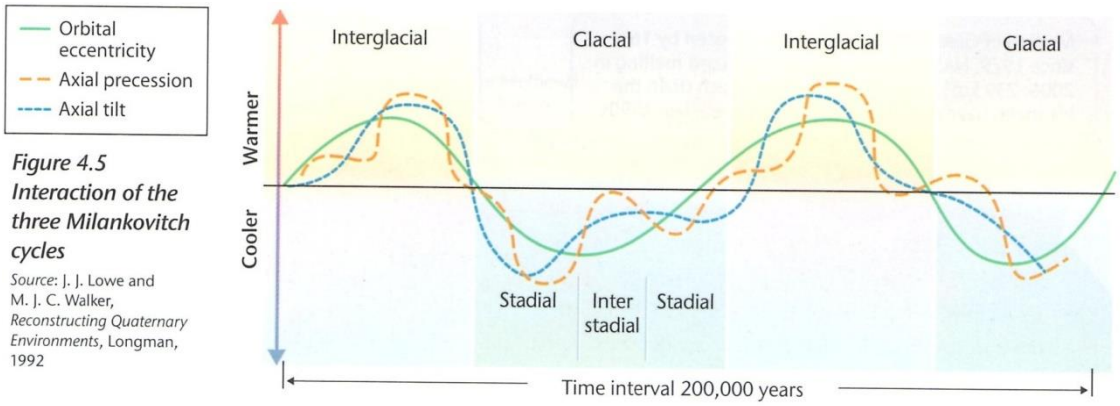
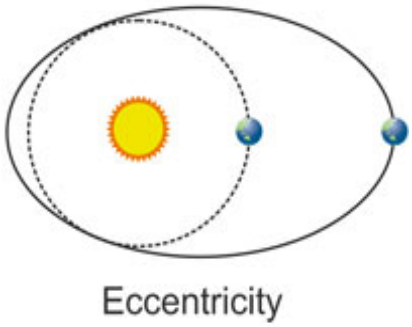


Figure 4.5 Interaction of the three Milankovitch cycles

Source: J. J. Lowe and M. J. C. Walker, *Reconstructing Quaternary Environments*, Longman, 1992

Variation in orbit	What it does	How does it affect climate?	Cycle length
Stretch (eccentricity)	The path of the Earth's orbit around the Sun changes from an almost perfect circle to an ellipse and back again	This changes the distance from the Sun to the Earth, and so the amount of energy the Earth receives from the Sun (at different times of the year) Earth's orbit is elliptical right now – it is closest to the Sun in January and furthest away in July	96 000 years
Tilt (Obliquity)	The Earth is tilted at an angle as it orbits the Sun, called its axis (currently 23.5°)	The change in tilt changes the amount of energy that different latitudes receive, changing global	41 000 years

	This changes between about 21.8° and 24.4°	Climate When the tilt is greater (24.4°) areas that receive lots of energy, such as the tropics, will be larger. Other climate regions, such as the temperate zones beyond the tropics, will be smaller	
Wobble (precession)	Earth does not have a perfect spin about its axis. It wobbles, and this wobble is precession. Precession refers to the direction the Earth tilts in relation to its orbit around the sun and this cycle occurs approx every 21,000 years	The Earth will still be furthest away from the Sun in July, but this will now be winter in the northern hemisphere So in the northern hemisphere, winter would then be colder because it would be at the time when the Earth is further from the sun, and summer would be hotter, because its at the time when the Earth is closer to the sun	21 000 years


Eccentricity

Obliquity

Precession

Variations in Solar Radiation

- The Sun's output of energy isn't constant
- Sunspots are darker areas on the Sun that Increase solar energy output
- They're thought to increase and decrease in number in an 11 year cycle – though there's variation within this cycle
- E.g. A period of cooling in the late 17th century called the little ice age is thought to have coincided with a period when sunspot activity was very low

Volcanic eruptions

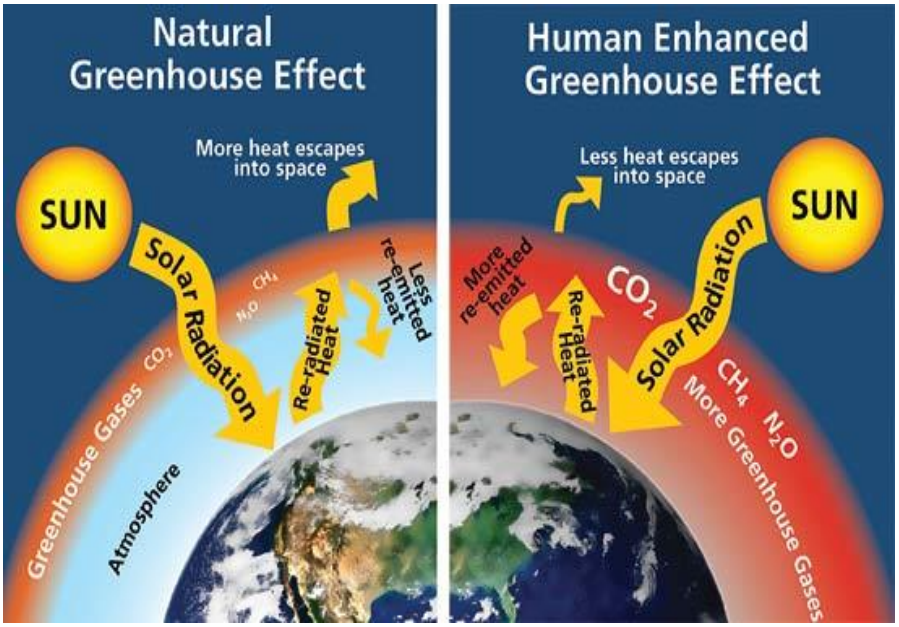
- Major volcanic eruptions also eject large quantities of material into the atmosphere
- This can also block out sunlight (energy), which changes the climate

- E.g. The Eruption of Mount Tambora in Indonesia in 1815 is thought to have lowered global temperatures by about 0.5°C

Human activity

Enhanced Greenhouse effect

- Gases have always been there but since 1750 g/gases up by 25%
- Since 1980's 75% of co2 emissions come from burning fossil fuel
- Also issue of deforesting
- As global temperature rises, so too does the main g/gas. Water vapour- more evap, more condensation, more cloud cover, more heat trapped in atmosphere



Enhanced Greenhouse Gas Emissions

- The recent rise in global temperature (global warming) and the rate of this increase is unheard of in historical terms
- There's a scientific consensus that this temperature rise is caused by human activity (it can't be explained by natural causes, which usually happen more slowly)
- Climate is affected most by two human activities
- Greenhouse gases include CO2, Methane, Ozone and water vapour
- The greenhouse effect is where the greenhouse gases absorb outgoing energy, so less is lost to space. It's essential for keeping the planet warm
- But too much greenhouse gas in the atmosphere means too much energy is trapped and the planet warms up
- CO2 is released into the atmosphere when fossil fuels like coal, oil, natural gas and petrol are burnt
    - E.g. In power stations or in cars

- Since the industrial revolution in the mid-19th century, levels of atmospheric CO2 have increased from 280 ppm (parts per million) to 380 ppm. The level had been broadly stable for the previous 10,000 years

- The increase in CO2 has caused the increase in temperature (global warming) over the same period because of the enhanced greenhouse effect.

Destruction of Carbon Sinks

- CO2 sinks store CO2, keeping it out of the atmosphere – so it's not contributing to the greenhouse effect
- The biggest sinks are the oceans - CO2 dissolves in sea water and gets moved to the deep ocean by natural currents
- Another big sink is plants – plants take in CO2 and convert it into organic matter using photosynthesis. It's also stored in the soil as dead organic matter
- CO2 is released into the atmosphere when trees are burnt by forest fires or to make way for agriculture
- It was thought that a lot of greenhouse gas emissions from humans could be stored in CO2 sinks.
- It's now thought they won't be able to keep pace with increasing emissions, so more CO2 will go directly into the atmosphere

<u>Evidence for Climate change</u>

Ice cores

- Scientists extracted an Antarctic ice core 3000m long
- This represents 740,000 years of snow, with each year preserved like an annual growth ring in a tree.
- By analysing the gases in each year's deposit we can tell how much CO_2 there was in the atmosphere in that year
- Isotopes trapped in the ice can be used to calculate the atmospheric temperature for each year
- By analysing isotopes you can create detailed pictures as to the temperature of the earth and its fluctuations over thousands of years. The climate has always shifted between cold glacial periods that lasted around 100,000 years and warmer interglacial periods that lasted around 10,000 years. We're in an interglacial period now. The graph below demonstrates this:

Tree rings

- A new tree ring is formed each year as a tree grows. If conditions that year were good, the tree ring produced will be thick
- Scientists can take cores and count the rings to find the age of a tree. They then look at the thickness of each ring to see what the climate was like each year
- Tree rings can reliably show and date climate change up to 10,000 years ago

Retreating Glaciers

- Scientists can tell how big a glacier was and how far it extended by looking at the position of rocks deposited by it. These rocks can be dated to show when they were deposited.
- The distance of the rocks from the current glacier indicates climate change
  - E.g. If the front of the glacier is now miles away from the rocks it indicates that temperatures have increased over that period of time.

Weather records

- Details of weather conditions have been constantly collected since 1861

- These can be used to show detailed climate changes over the short time period they've been collected

Change in Polar Ice Melt

- Current research into the behaviour of polar ice shows a reduction in the amount of ice at both poles
- Changes in the extent of polar ice shows changes in the climatic factors affecting them
- E.g. Increased melting shows increased temperatures

Worldwide impacts of climate change

Climate change is having (and will continue to have) significant impacts on people and the environment.

Sea level rise.

The intergovernmental panel on climate change (IPCC) has found that there has been an average sea level rise of 20cm since 1990. It has been suggested that sea level may rise by up to 1m by the end of the century.

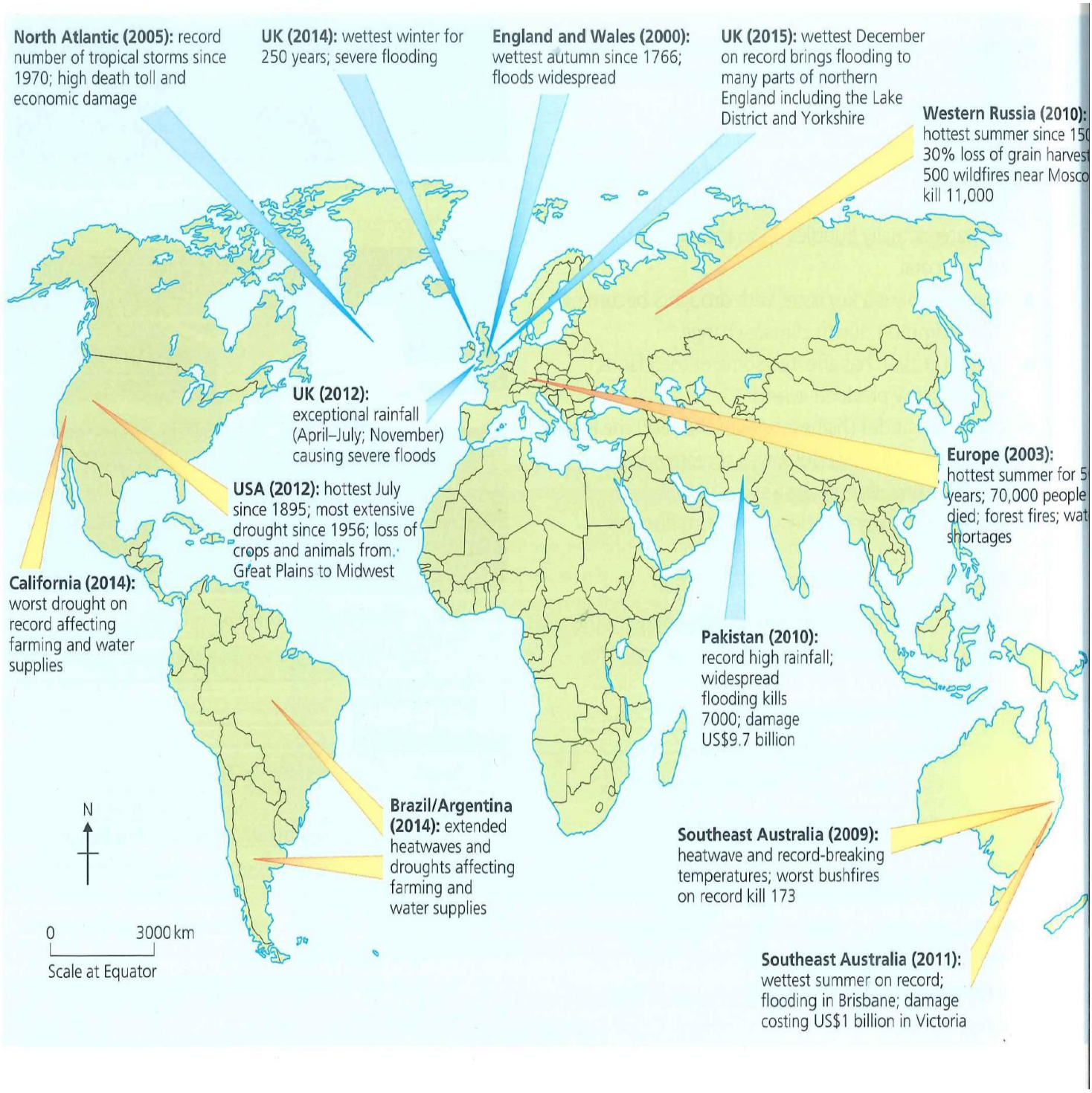
SEE IMPACTS OF SEA LEVEL RISE

Social	Economic	Environmental
600 million people live in coastal areas that are less than 10m above sea level	Many important world cities including New York, Venice and London could be affected.	Fresh water sources such as wells could be polluted by salty seawater. This is called salinization.
People living in vulnerable areas may have to move home or even move to different countries. Some small island states such as Tuvalu are particularly at risk.	Valuable agricultural land (e.g. in Bangladesh and Vietnam) may be lost to the sea or polluted by seawater. Harbours and ports may be affected which will have an impact on trade.	Damage could occur to coastal ecosystems such as mangrove swamps, which form natural barriers to storms.
People may suffer increased frequency of flooding and storm damage	Transport systems (such as railways, roads and airports) may be damaged.	Damage to coral reefs by storms and powerful waves will affect fish breeding grounds and ecosystems.
People may lose jobs, for example in fishing and tourism, and have to learn new skills	Valuable land and property will need more expensive measures of coastal defence	The IPCC estimate that up to 33% of coastal land and wetlands could be lost in the next 100 years.
The numbers of environmental refugees – people who have lost their homes due to flooding – will increase.	Many countries depend on coastal tourism as their main source of income. Beaches may be eroded or flooded forcing hotels to close. People may decide not to visit.	Harbours may become blocked by sediment due to increased rates of coastal erosion.


Case study of low lying islands: Tuvulu
Where?
Tuvalu is an made up of a chain of nine tiny islands in the pacific ocean
It is to the east of both Australia and Indonesia
What is it like?
Low lying - highest point is just 4.5m above sea level.
11000 people live here.
What are the issues?
Increased salinization is affecting the soils, which is having an impact on agricultural productivity.
What are the issues?
Water supply is a key issue, with droughts becoming more common
What are the issues?
There are no rivers on Tuvalu, as rainwater soaks into coral rock. Water comes from wells but these are increasingly becoming polluted by seawater.
What are the issues?
During king tidses (highest tides of the year) the islands are battered by powerful waves which increases erosion and affects homes.
How are people responding?
People are leaving and moving to New Zealand – but NZ will only accept 175 migrants per year.
How are people responding?
Some low sea walls have been built to prevent areas from washing away due to erosion
How are people responding?
Japan is helping to restore the coral reef which will offer some natural proctection.

Can extreme weather events be linked to climate change?

- In 2013 the IPCC reported a clear increase in the number, frequency and intensity of heatwaves and rainfall events – if this trend continues, then the link with long term climate change may become stronger.
- In a warming world, there is more energy in the atmosphere. Greater rates of evaporation from the worlds oceans results in more water vapour which in turn lead to more rainfall or snow. Climate patterns may shift so that some areas become drier while others become wetter.



Global circulation of the atmosphere

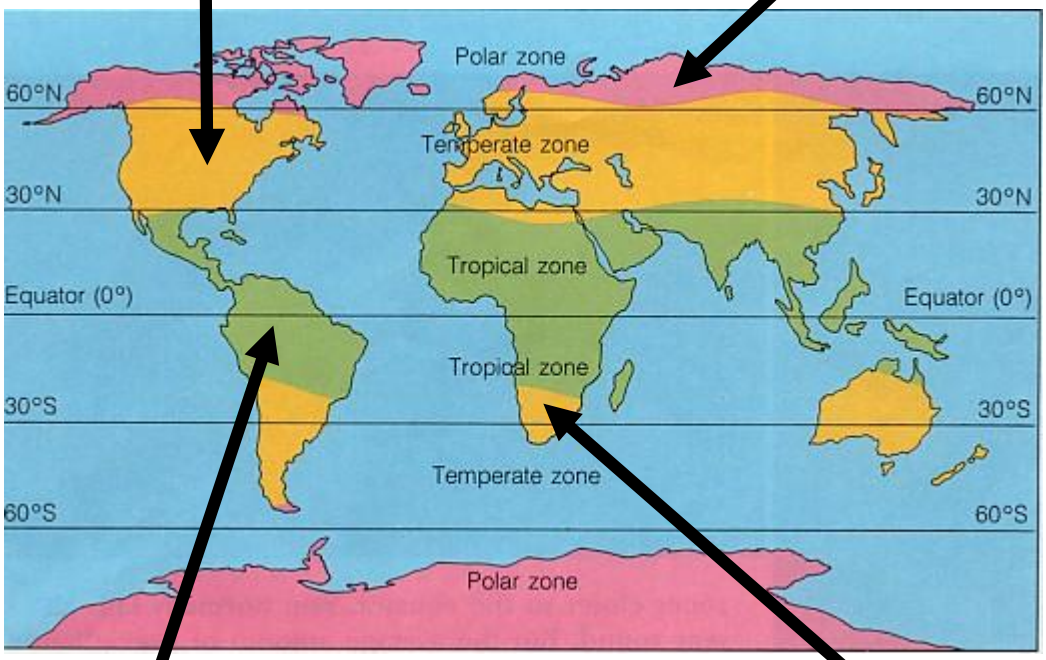
Major climate zones of the world.

Temperate climate:

- mid latitudes – 50 – 60 N and S of the equator, two air types meet, one warm from the Ferrel cell and one cold from the polar cell.
- Low pressure is created from the rising of the war sub-tropical winds over the cold polar winds at a front. As this air rises and cools, it condenses to form clouds and frequent rainfall.
- UK is here.

Polar climate:

- Highest latitudes, cold air from the polar cell sinks, producing high pressure. This is characterized by dry, icy winds caused by the Coriolis effect (spin of the earth).
- In some places, in Antarctica, the average annual wind speed is nearly 50 miles per hour.



Tropical climate:

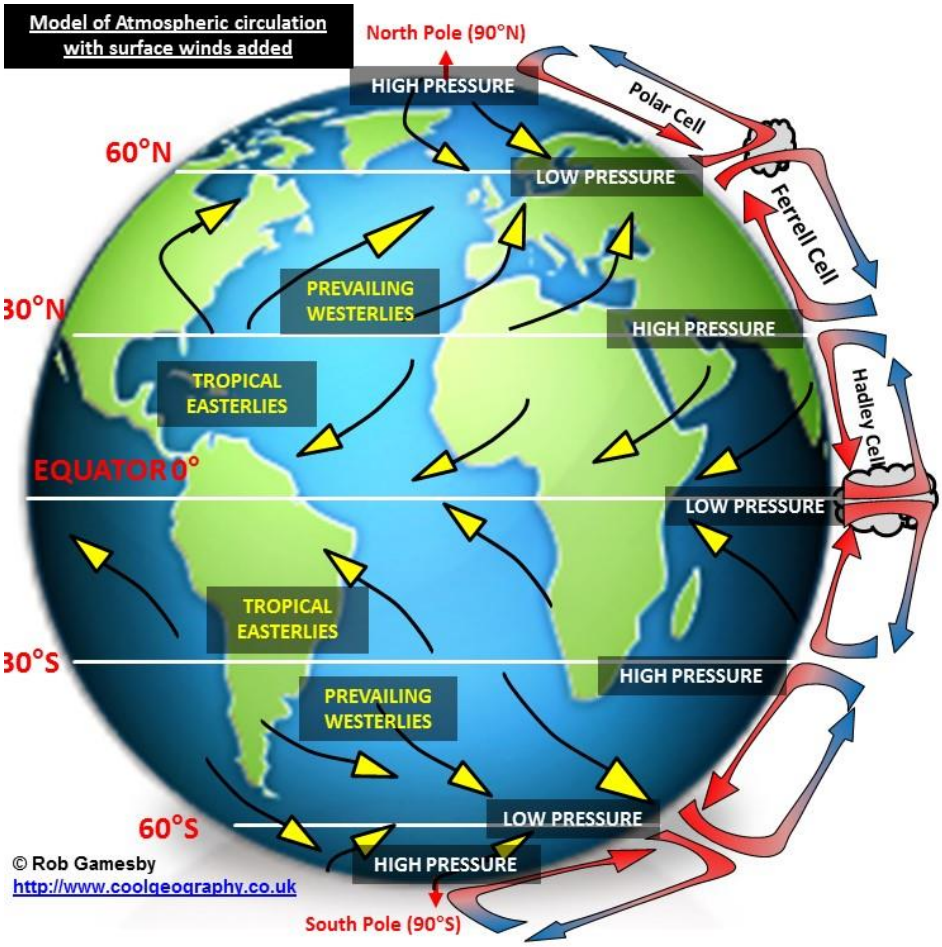
- This is a belt of relatively low pressure, heavy rainfall and thunderstorms as a result of rising air in the Hadley cell.
- Places such as northern Brazil in South America and Malaysia in South East Asia experience this climate.

Sub - Tropical climate:

- At 30 N and S of the equator there is a high pressure as a result of sinking, dry air as the Hadley and Ferrel cells meet.
- This creates a belt of desert regions.
- These include the Sahara in northern Africa and the Namib desert in Namibia, southern Africa.
- Daytime temperatures can exceed 40 C, while at night, due to lack of cloud cover, temperatures can fall to below freezing.

Global atmospheric circulation

The Earth's atmosphere is in constant motion and is driven by the energy we receive from the sun. The air moving around the globe does so because we get more energy in tropical areas and less at the poles. Air movements or winds help to balance this out. They do so according to the model below.



The imaginary lines that surround the earth are known as lines of latitude.

The equator is 0° latitude. The polar regions are 90°N and S of the equator.

The world is divided into two hemispheres – N and S.

In each hemisphere there are three specific cells (seen on diagram).

Within these cells, air circulates within the troposphere, the area of atmosphere that creates the weather and is up to 15km above the earth's surface.

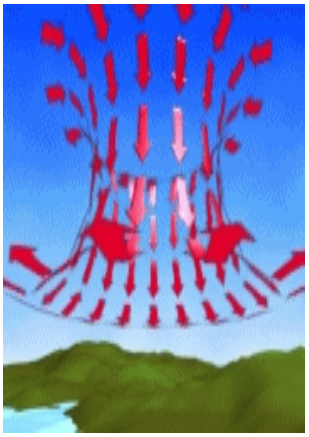
Each of the cells plays an important role in creating the climate zones.

	Where is it?	What happens?
Hadley cell	The largest cell which extends from the Equator to between 30° and 40° north and south.	• Trade winds are winds that blow from the tropical regions towards the Equator. They usually travel from an easterly direction. • Near the Equator, the trade winds meet and the warm air rises and forms thunderstorms. • From the top of these storms air flows towards higher latitudes where it becomes cooler and sinks over sub-tropical regions.
Ferrel cell	The middle cell, which generally occurs from the edge of the Hadley cell to between 60° and 70°.	• This is the most complicated cell as it moves in the opposite direction from the Hadley and Polar cells, similar to a cog in a machine. • Air in this cell joins the sinking air of the Hadley cell and travels at low heights to mid-latitudes where it rises along the border with the cold air of the Polar cell. • This occurs around the latitude of the UK and accounts for the frequently unsettled weather. • Air then flows back towards the low latitudes, in the direction of the Equator.
Polar cell	The smallest and weakest cell, which extends from the edge of the Ferrel cell to the poles at 90°.	• Air in this cell sinks over the highest latitudes, at the poles, and flows out towards the lower latitudes.

Figure 9 Differences between the three circulatory cells

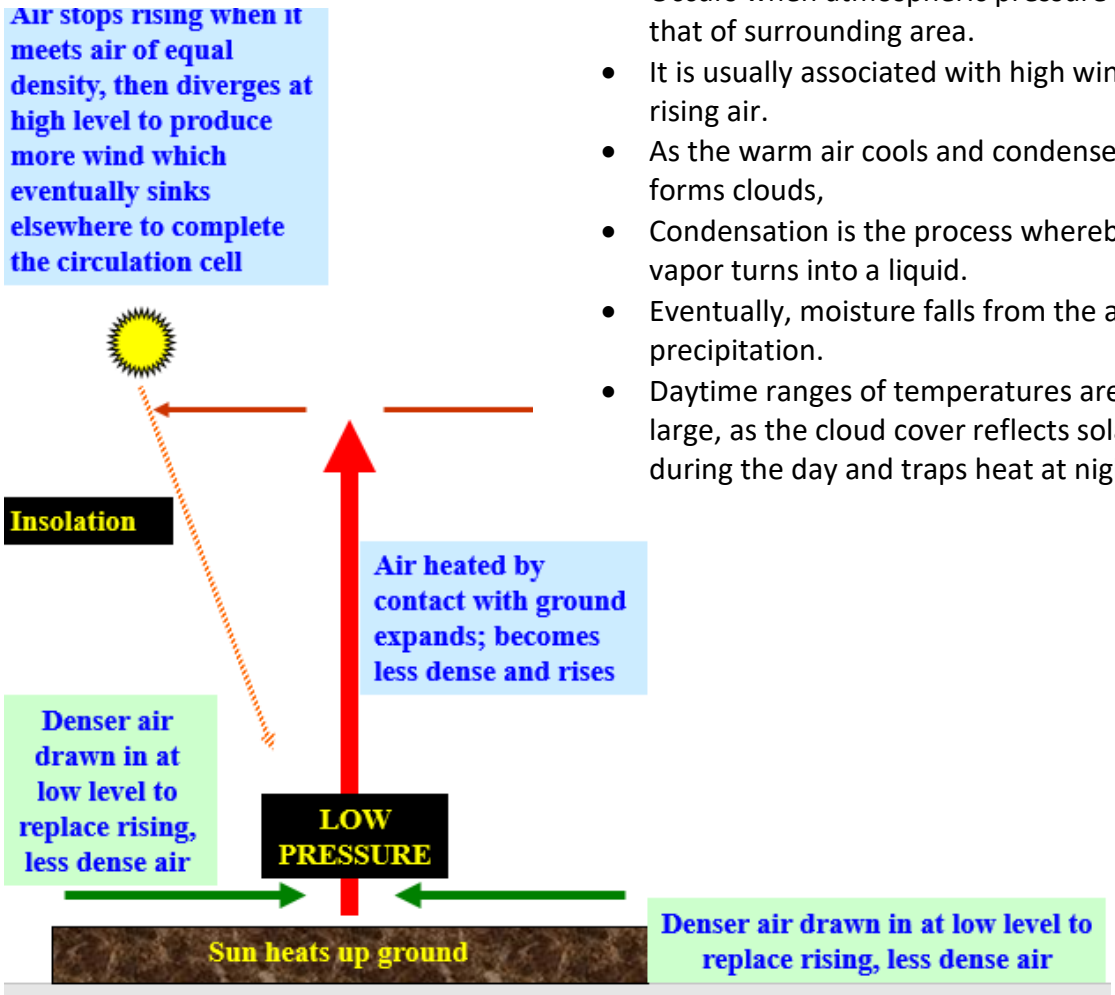
What happens in areas of low pressure and areas of high pressure?

High pressure:



- When air cools, it becomes denser and starts to sink towards the ground.
- As the air is sinking there are few clouds. As the air sinks, it warms and therefore condensation doesn't take place. No condensation means no clouds and therefore no rain.
- Also, heavy rain at the Equator means that most of the moisture in the atmosphere is removed before the air reaches the sub tropics. At 30° N an S of the equator, high pressure weather systems are usually associated with clear skies and dry (through possibly not hot) calm weather.

Low pressure



- Occurs when atmospheric pressure is lower than that of surrounding area.
- It is usually associated with high winds and warm rising air.
- As the warm air cools and condenses as it rises, it forms clouds,
- Condensation is the process whereby this rising vapor turns into a liquid.
- Eventually, moisture falls from the atmosphere as precipitation.
- Daytime ranges of temperatures are unlikely to be large, as the cloud cover reflects solar radiation during the day and traps heat at night.

Weather extremes: where are the coldest, hottest, wettest and windiest places in the world?

Weather extremes: where are the coldest, hottest, driest, wettest and windiest places in the world?

DEATH VALLEY: Driest place in North America with an average rainfall of 500 mm. Storms coming from the Pacific Ocean must travel over a series of mountain ranges on their journey eastwards. This means that many of the clouds have already cooled, condensed and fallen as rain before they reach Death Valley.

MOUNT WAIALEALE: Located on the island of Kauai in Hawaii, this is the wettest place in America with an annual average rainfall of 9763 mm.

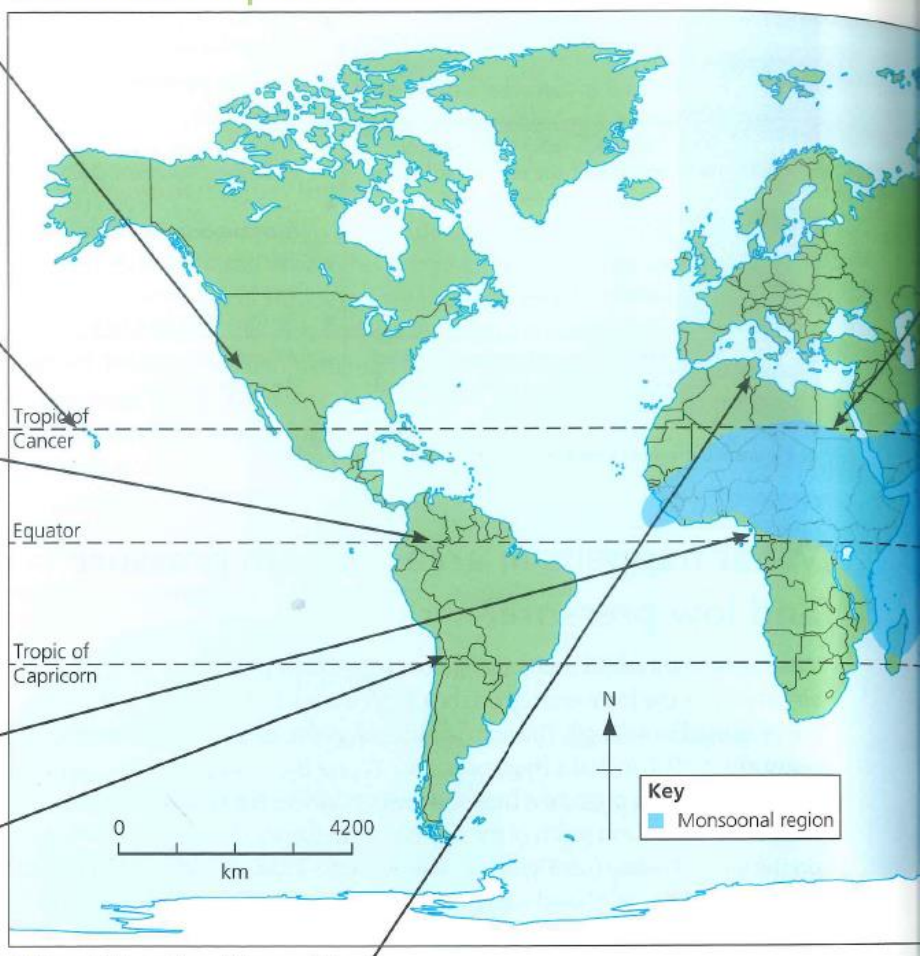
PUERTO LÓPEZ: A small fishing village in Colombia is one of the wettest places on Earth. It has an annual rainfall of 12,892 mm. In the mid-1980s, it rained every single day for two years!

URECA: Located on the southern tip of Bioko Island in Equatorial Guinea, this is the wettest location in Africa with an average annual rainfall of 10,450 mm.

ATACAMA DESERT: Coastal mountains to the west block moist air from the Pacific and the Andes block rain from the Amazon in the east (see Figure 13). The prevailing wind (most frequent wind direction) comes from the southeast and carries moist air from the Atlantic.

As the air is forced to rise to cross the Andes it cools, condenses and turns to rain on the eastern side of the Andes. This leaves the Atacama in the rain shadow, which means that it receives little rainfall as high land shelters it from rain-producing weather systems. This creates a 'shadow' of dry conditions on the western side of the Andes.

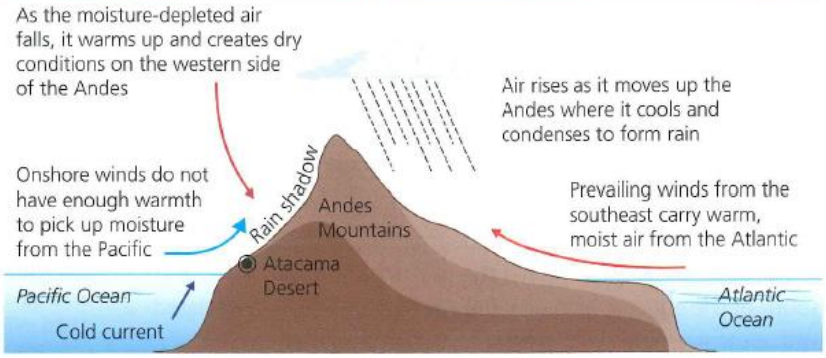
On its western side, the Atacama lies close to the ocean where a cold current flows northwards along the coastline. As it is cold, onshore winds do not have enough warmth to pick up moisture from the ocean surface. This lack of rising air prevents precipitation from forming.



▲ **Figure 12** Location of the world's weather extremes

AL–AZIZIYAH, LIBYA: The hottest place on Earth is Al-Aziziyah in Libya. 40 km south of Tripoli, Al-Aziziyah is where, on 13 September 1922, the world experienced its hottest air temperature ever recorded at 57.8 ° C.

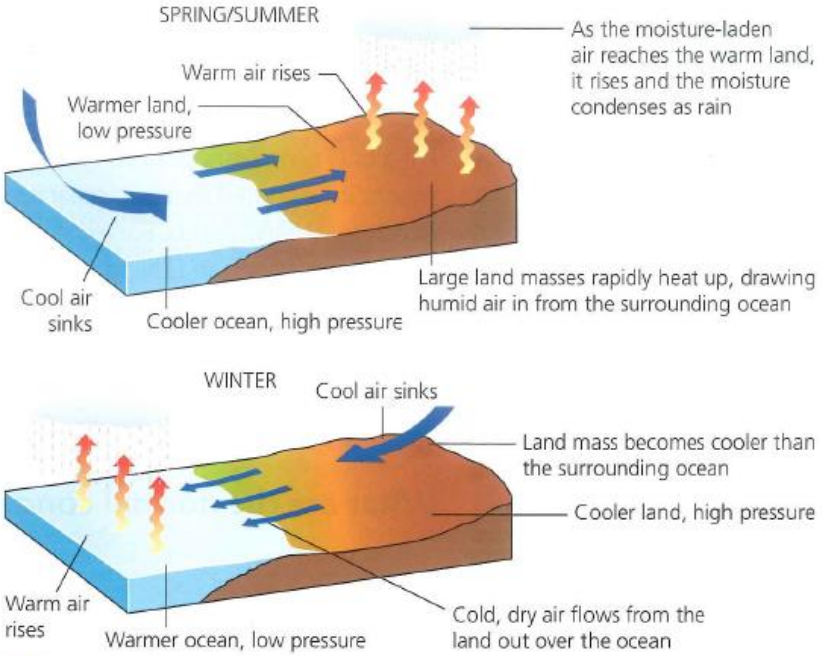
VOSTOK, ANTARCTICA: The coldest place on Earth is Vostok in Antarctica. At a height of around 3500 m above sea level, the Russian research station at Vostok is always cold. On 21 July 1983, the coldest air temperature on the planet was recorded here at -89.2 ° C.



▲ **Figure 13** Why is the Atacama Desert so dry?

ASWAN: Located in the driest region of Egypt, it has a rainfall of only 0.861 mm per year! Its proximity to the Tropic of Cancer contributes to the high temperatures and dry weather.

MAWSYNRAM: The 10,000 villagers of Mawsynram cope with 11 m of rain per year. That's 20 times the average rainfall for London! eighty per cent of all of India's rain arrives in the seasonal monsoon deluge from June to September. During this time, more heat from the Sun (solar radiation) is hitting the northern hemisphere. The monsoon is powered by the difference between land and sea and the ways that they respond to the Sun. The sea is cooler than the land as there is both more of it to be heated and it is always on the move due to the winds. The land therefore heats quicker than the sea. As the Sun bakes the land in India, the warm air above it rises and draws in cooler air from the sea. With the triangular shape of India and the long coastline, there is a powerful and sustained current of air moving northwards through India, which bring rains known as the monsoon.



▲ **Figure 14** The formation of monsoons

COMMONWEALTH BAY, ANTARCTICA: This is the windiest place on Earth with winds regularly exceeding 240 km/h, with an average annual wind speed of 80 km/h. Storms are causes by katabatic winds, which are winds that carry air from high ground down a slope due to gravity.

WELLINGTON, NEW ZEALAND: The highest gust of wind ever recorded in Wellington was 248 km/h and the average annual wind speed is 29 km/h. Gusts of wind exceed gale force (75 km/h) on 175 days of the year. The mountainous landscape either side of Wellington acts as a funnel for the winds, increasing their speed.

	Location	Rainfall (mm per year)
	London, UK	558
1	Mawsynram, India	11,871
2	Cherrapunji, India	11,777
3	Tutendo, Columbia	11,770
4	River Cropp waterfall, New Zealand	11,516
5	Ureca, Bioko Island in Equatorial Guinea, Africa	10,450
6	Debundscha, Cameroon, Africa	10,229
7	Big Bog in Maui, Hawaii	10,272
8	Mt Waialeale in Kauai, Hawaii	9,763
9	Kukui in Maui, Hawaii	9,293
10	Mount Emei, Sichuan Province in China	8,169

▲ **Figure 15:** Top ten wettest places in the world

How does El Niño and La Nina in the Pacific Ocean cause extreme weather?

El Niño Southern Oscillation

Key concept

The Pacific Ocean contains huge amounts of circulating warm and cold water. El Niño and La Niña are changes in this circulation, linked with changes in atmospheric processes. They are part of a continually oscillating climatic pattern called the El Niño Southern Oscillation (ENSO).

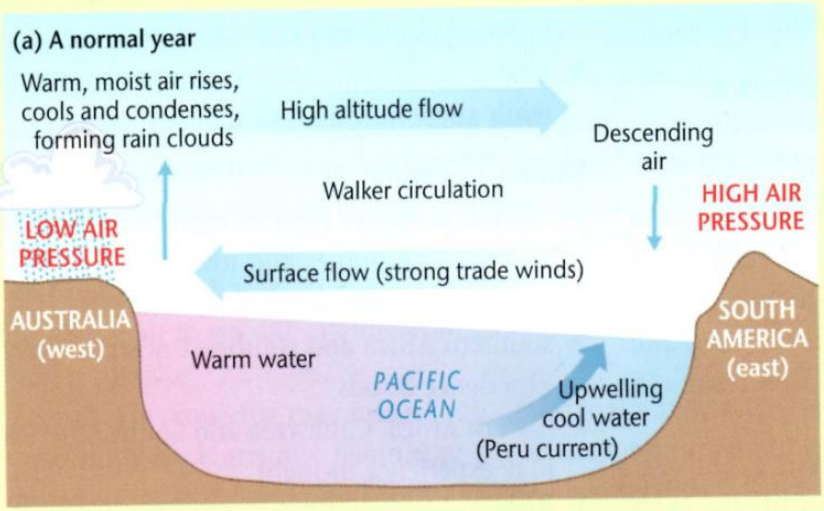
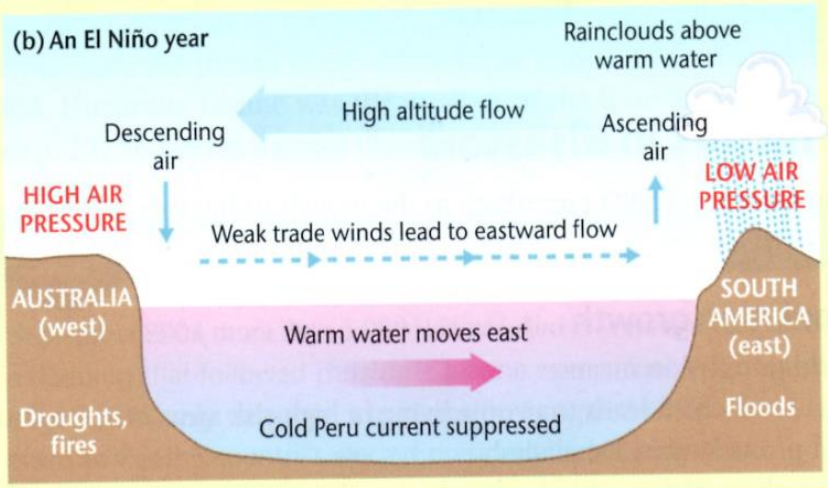
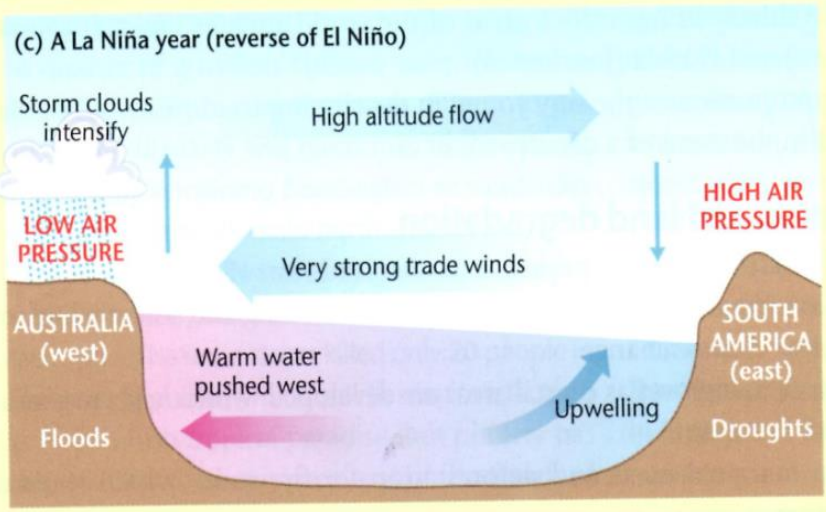


Figure 2.5 El Niño Southern Oscillation

- The trade winds move warm surface water towards the western Pacific
- Cold water wells up along the west coast of South America (the Peru or Humboldt current)



- Air pressure over the west coast of South America becomes unusually low and that over northern Australia particularly high
- The normal east to west trade winds over the Pacific are disrupted and warm water 'sloshes' eastwards
- Upwelling of cold water on the South American coast is suppressed



- Air pressure is unusually high over the west coast of South America and low over northern Australia
- The easterly trade winds are more intense than normal
- More warm water is pushed to the west of the Pacific Ocean

Note: Although these oscillations operate in the Pacific Ocean there are impacts on weather around the world. See p. 20.

What causes El Nino?

- Scientists continue to study what causes it → strong interaction between atmosphere and oceans so even small changes can have large-scale impacts.
- One theory was seafloor heating by volcanic activity e.g. Mount Pinatubo erupted and was then followed by an El Nino event. This is not a likely theory.
- More probable cause is small changes is sea surface temperature. This could be caused by tropical storms in the western area of the Pacific. If they are violent enough, they could start the movement of warm water towards the east.

During El Nino:

- Rainfall is reduced in Southeast Asia, Oceanic and India, leading to drought, crop failure and wildfires
- Heavy rain in California, Mexico and the Coasts of Peru and Ecuador often results in flooding and mudslides
- Suppression of the cold current in the east pacific devastates fish catches off the west coast of South America
- Tornados in the USA are reduced
- More cyclones in Hawaii and Polynesia but fewer in North Australia
- Southern Africa may experience drought
- East Africa may experience floods

During La Nina:

- Higher rainfall in Indonesia and the Philippines
- Lower rainfall on the west coast of South America
- Southern Africa and Southern Australia may experience floods
- Eastern Africa, California and South America may experience drought
- More hurricanes in the Caribbean and USA

How do we know if it is an El Nino year?

Many techniques have been used to identify and predict the occurrence of El Nino.

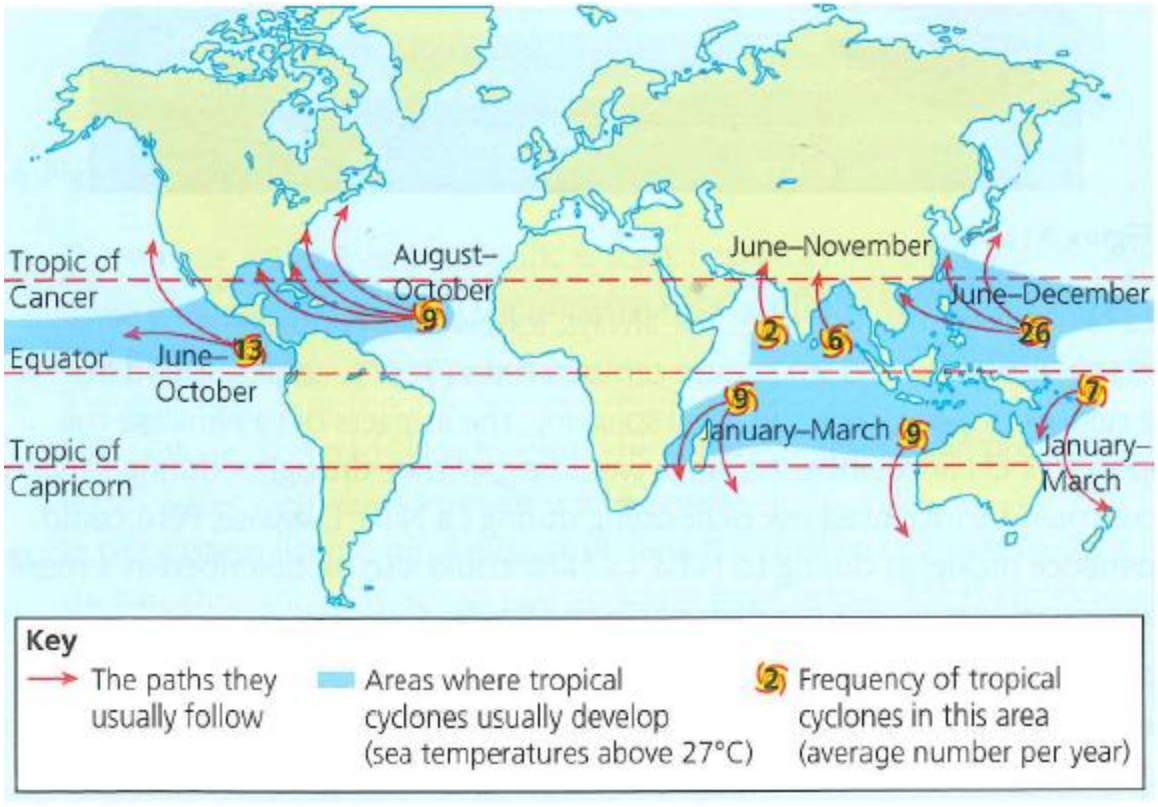
- Better satellite coverage looking for oceanic patterns.
- Design of buoys (floats that sit on the surface of the ocean) has improved. They can now measure surface temperatures, surface winds air temperatures and humidity.
- Buoys transmit this data to weather forecasting systems, sometimes every hour.
- Sea levels can be measured and recorded.

Tropical storms: what, where and when?

What?

- A low pressure weather system that begins as a tropical storm in the tropics and may develop into a hurricane/cyclone.
- It is a circular storm that forms over warm water and is characterised by heavy wind and rain.
- A tropical storm has wind speeds ranging from 63km/h to 118km/hour. When wind speeds reach 119km/hour the storm becomes a hurricane.
- Tropical cyclones are known as different things around the world:
    - North America and East Pacific they are known as hurricanes.
    - NW Pacific (e.g. Philippines) they are known as typhoons.
    - Northern Indian ocean (e.g. Bangladesh and Myanmar) they are known as cyclones.

Where?

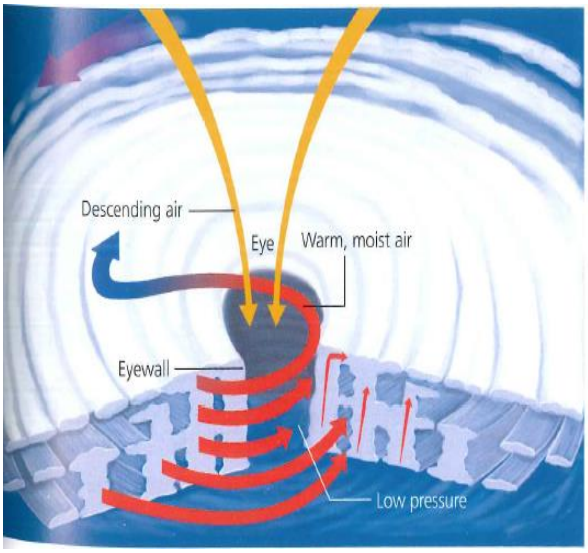


▲ **Figure 5** The global distribution of tropical storms

- As they need warm water to generate, they are found in very particular areas of the world.
- Tropical Storms start within 8º and 15º north and south of the equator where surface sea temperatures reach 27ºC.
- Hurricanes form 500km North and South of the equator where the Coriolis effect is strong enough to generate spin

How?

- There needs to be a movement in the air near the surface of the water. In the troposphere, the temperatures need to cool quickly enough for tall clouds to form through condensation.



- Fuelled by the warm ocean, water vapour is evaporated. As warm, moist air rises it expands, cools and condenses to form clouds. It maintains its strength as long it remains over warm water.
- Wind speeds increase towards the centre of the storm, around the eyewall.
- This is typically 15 – 30km from the centre of the storm.
- Deep clouds rise from the Earth's surface up to a height of 15 000m.
- This, combined with the heaviest rainfall, makes the eyewall the most destructive and dangerous part of the storm.
- When the vertical winds reach the top of the troposphere at 16km the air flows outward, deflected by the Coriolis effect (the spinning of the earth)
- This causes the hurricanes to spin.

Frequency?

- About 80 every year.
- Most found in Pacific Ocean, followed by Indian Ocean and then the Atlantic.
- Occur every year during the late summer months from June to November in the northern hemisphere and from November to April in the southern hemisphere.

Has the frequency changed over time?

- Number in Atlantic has increased since 1995 but no global trend.
- They are however, globally, becoming more intense (larger and with more damage). → It has been calculated that the energy released by the average hurricane has increased by 70% in the past 30 years.
- Scientists are in disagreement as to whether this is caused by climate change.

Droughts: what, where and when?

What?

- Drought occurs when a region experiences below average precipitation.
- It is a period of time with abnormally dry weather leading to shortage of water, which can have a negative effect on vegetation, animals and people over a large area.

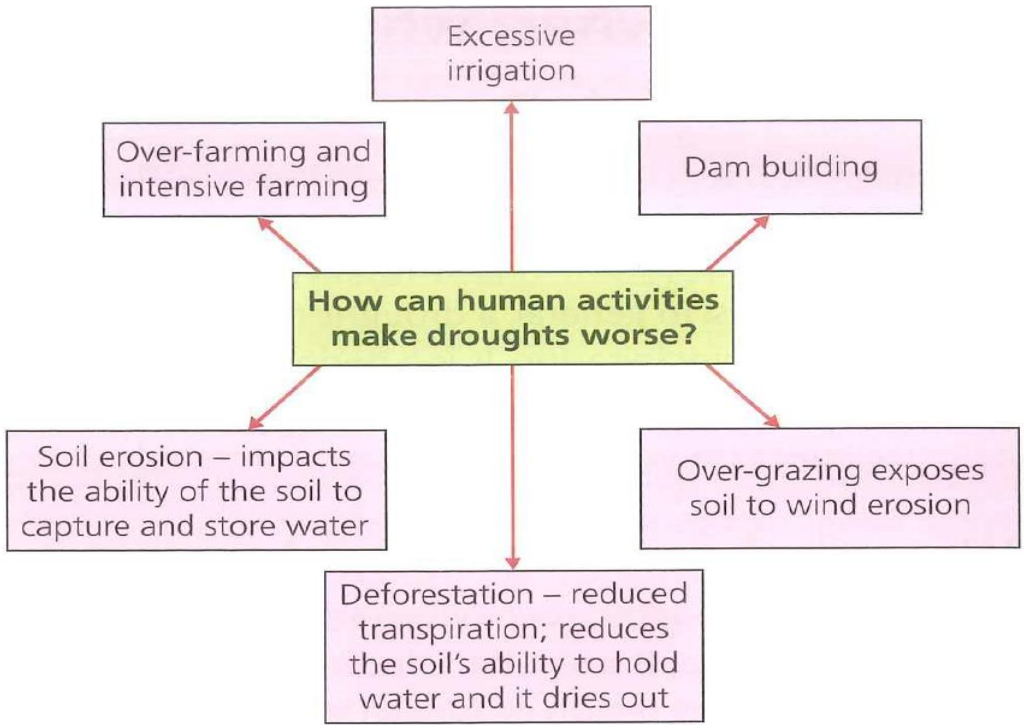
Where?

- Australia, Brazil, China, India, USA, Mexico and the Sahel region of Africa have all experienced severe droughts recently.
- Large parts of these countries and regions already have a dry climate and receive low amounts of rainfall already.

When?	Where?	What?
2002–2005	Amazon Basin, South America	• Parts of the basin experienced the worst drought in 100 years. • Towns lacked food, medicine and fuel as there was no access for boats. • The drought affected 1.9 million km^2 of rainforest. • 5 gigatons of carbon was released into the atmosphere as a result of dead trees fuelling forest fires. Usually, the Amazon actually absorbs 1.5 gigatons of carbon in a typical year.
2006	Sichuan Province, China	• 37.5 million people were affected. • Nearly 8 million people faced water shortages. • 129 million livestock died.
2010–2013	Texas, USA	• 2011 was the driest year in the state's history. • By 2013, 95% of the state was dealing with drought. • $5.2 billion in agricultural losses.
2011	East Africa including Somalia, Ethiopia, Kenya, Eritrea, Djibouti and South Sudan	• Caused by falling rains – the area received 30% less rain than the average. • 50,000 to 100,000 deaths. • 12 million people in need of food aid. • Crop failures and livestock deaths. • Increases in malaria and measles.
2012	Western Sahel including Niger, Mali, Mauritania and Burkina Faso	• 10 million people at risk of famine after a month-long heatwave. • Over 50% of the crop yield was lost.

What?

- Most droughts occur when the regular weather patterns have been disturbed.
- El Niño brings descending air and high pressure over Indonesia and Australia which leads to drought.
- As global temperatures increase, more water is needed to grow crops and more water is lost through evaporation.
- Intertropical convergence zone has been linked the occurrence of drought particularly in Africa.

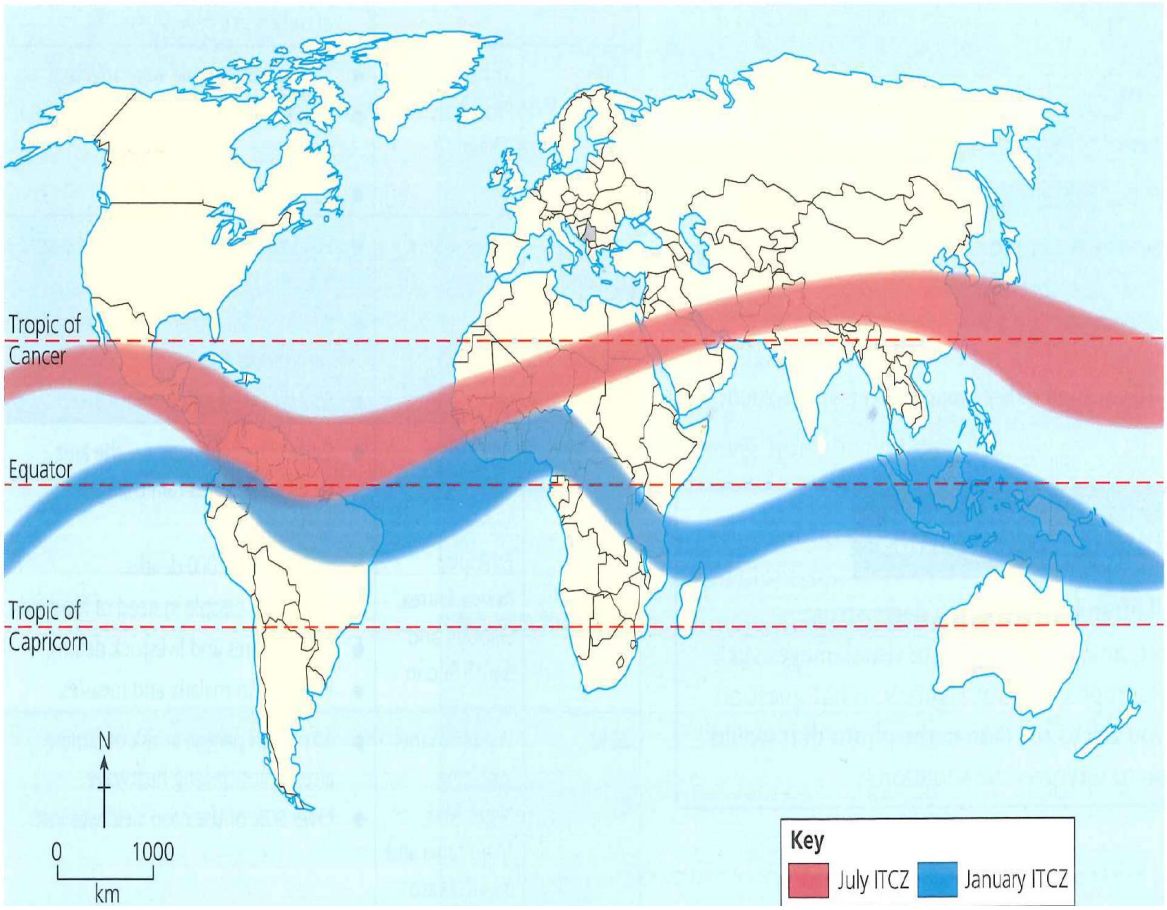


What is the intertropical convergence zone (ITCZ)?

The ITCZ is a low-pressure belt which encircles the globe around the Equator. It is where the trade winds from the northeast and southeast meet. The Earth is tilted on its orbit around the Sun, causing the ITCZ to migrate between the Tropics of Cancer and Capricorn with the seasons (see Figure 13). Around 20 June each year, the Sun is overhead at the Tropic of Cancer and around 20 December each year, the Sun is overhead at the Tropic of Capricorn.

Winds and pressure are shifted annually from north to south. The point where the two trade winds meet at the ITCZ results in heavy precipitation and thunderstorms as hot, dry air and warm, moist air combines. Consequently, Africa has parts of the continent that are in a cycle of dry and wet seasons.

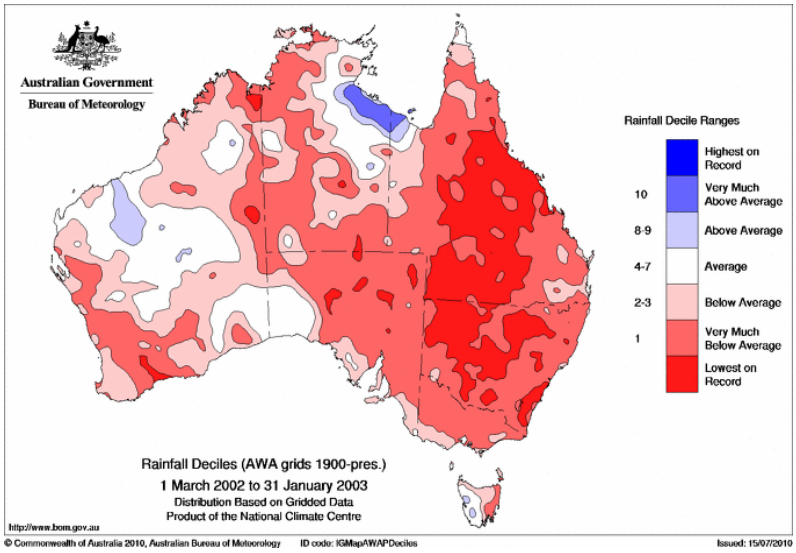
In some years, the ITCZ might not move as far northwards or southwards to reach some of the driest areas, and so not relieve them of the dry conditions they have experienced for half of the year. Local people in those regions may therefore be faced with a period of drought.



Case study – a drought event caused by El Nino/La nina: Big dry – Australia

Which regions of Australia were affected by drought?

- From 2002 – 2009 Australia experienced the driest period in 125 years, that became known as the big dry.
- Drought prone due to its geography and changeable rainfall patterns.
- Located in a sub-tropical area of the world that experiences dry, sinking air leading to clear skies and little rain.
- For most of the country, rainfall is low and irregular.
- In 2006, the annual rainfall was 40-60% below normal over most of Australia south of Tropic of Capricorn.



Causes?

<u>El Nino</u>

- Australia becomes drier than normal and the chances of rainfall decreases during El Nino.
- During El Nino, the trade winds over the Pacific Ocean that normally bring warm water weaken, causing the water to cool and the rainfall to diminish. Eastern Australia thus heats up and gets drier.

<u>Other causes?</u>

- Population growth in relation to amount of water and access cannot be maintained.
- Eastern Australia is home to the Murray – Darling river basin (MDRB).
    - The Murray River is the longest in Australia and it drains the size of France and Spain.
    - The river basin covers part of New South Wales, Victoria, Queensland and South Australia.
    - Home to 2 million people and is under a lot of pressure to provide the water needed to support agricultural production in the region.
    - 40% of the countries agricultural produce comes from this region.
    - Contains 70% of irrigated cropland and pasture.

SEE effects?

Social	Economic	Environmental
• People in rural areas left due to lack of water, putting more pressure on the cities. • Rural suicide rates soared.	• Farmers had to sell cattle as they could not afford to feed them. • Food prices rose as Australia became more dependent on imports • Water bills rose 20% in 2008 • Tourism was negatively affected.	• Loss of vegetation, wildlife and biodiversity as well as soil erosion. As the soil dries out, it becomes looser and it is easier for the wind to blow it away. • Grassland turned to scrubland

	• 10 000 people employed directly by the cotton growing industry were affected. • The number of dairy farms reduced by more than half.	• Energy from HEP was reduced leading to more pollution as Australia resorted to the use of fossil fuels. • Water quality reduced as toxic algal outbreaks occurred in depleted rivers, dams and lakes.

How have different stakeholders responded to the drought problems of Australia?