# Edexcel Geography GCSE

## People and the Biosphere

### Detailed Notes

# Biomes

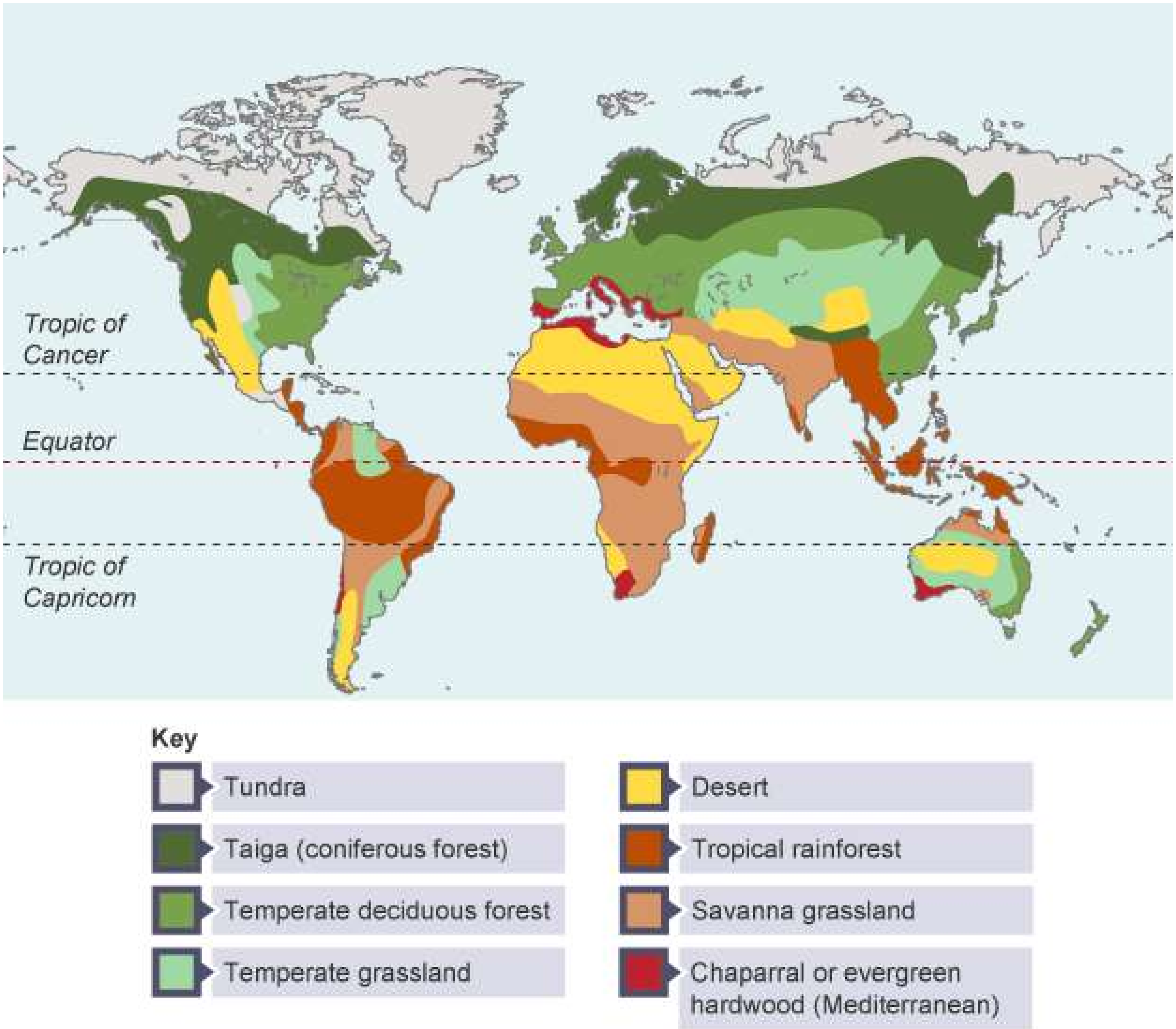
## What is a Biome?

Biomes are global-scale ecosystems that exist throughout the world, categorised by **similar environmental characteristics** such as **climate, vegetation type and soil**.

Biomes usually occur in **latitudinal belts**, meaning they are present across the world at **similar latitudes** (horizontally on a typical map).

These **latitudinal patterns** occur because the climate in these regions is similar due to **atmospheric circulation**. However, there are **some variations** in biome distribution due to other influences, like **ocean currents, winds** and **land-sea temperature differences.**

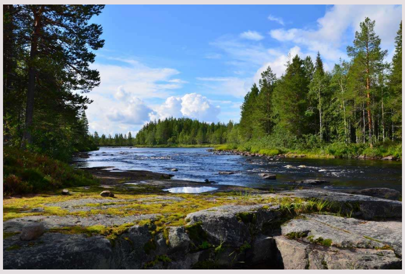
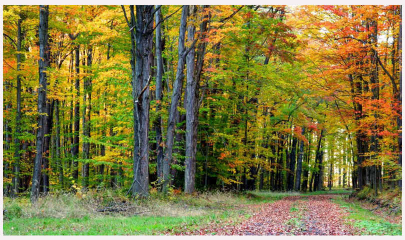
**Global Distribution of Biomes**




Some of the biomes (polar, monsoon etc.) are not included in this map because they are small, and the **definition of biomes varies.**

## Characteristics

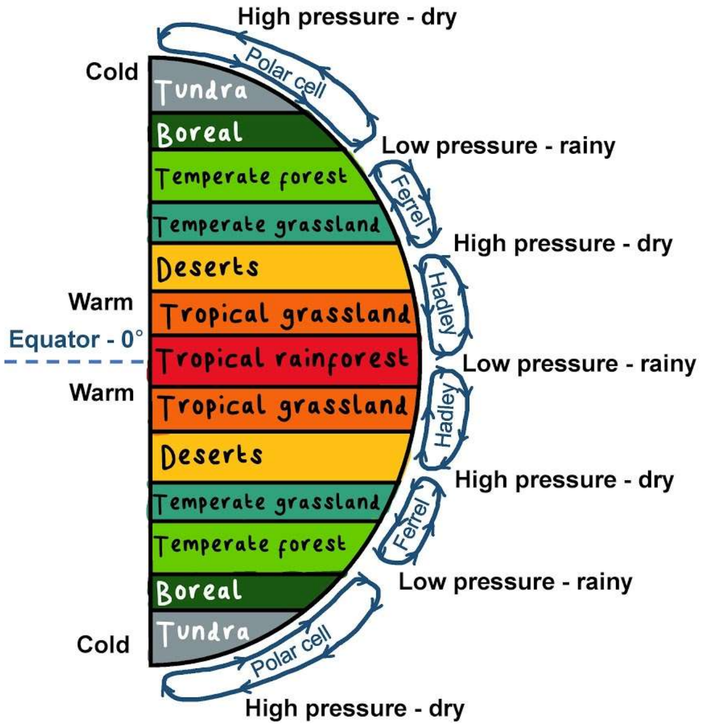
Global ecosystems have different defining **characteristics**. These are outlined in the table below.

| Ecosystem | Location | Characteristics |
|---|---|---|
| **Tundra**  | Located in the **far north**. Arctic circle to 60-70°N (e.g. Canada, Northern Russia, coastal Greenland).<br><br>Not as prevalent in the **southern hemisphere** as there aren't as many land masses far south. | • **Harsh, cold winters** and extremely **short summers**.<br>• **Treeless** ecosystem as it is too cold and not wet enough for trees.<br>• **Precipitation** is **extremely low** (10-25cm/yr)<br>• Short growing season, **nutrient poor** soils and lack of **biodiversity**.<br>• Animals are usually **migratory** (i.e. they move further south in winter)<br>• Soils are **permanently frozen** (permafrost). |
| **Taiga (coniferous forest/boreal)**  | Located at latitudes **below the tundra biome**, anywhere from 50-70°N (e.g. North America, Russia, Scandinavia). | • **Coniferous forest** (conifers) which are **drought resistant**, cone-bearing trees.<br>• They retain their leaves all year round to **maximise photosynthesis**, especially during short summers.<br>• Around 50cm/yr of rainfall and a **longer growing season**, meaning there are more plants.<br>• Small animals and migrating birds are present. Coniferous forests may also contain wolves, bears and moose. |
| **Temperate deciduous forest**  | Around 40-50°N and S of the equator, although this varies.<br><br>Located in Eastern USA, Europe - including the UK - Eastern Australia. | • Deciduous vegetation (broad-leaf trees that shed their leaves in winter to retain moisture)<br>• Oak, maple, beech trees common.<br>• Highly seasonal temperatures: hot summers and cold winters.<br>• Moderate precipitation - 75-150cm/yr.<br>• Animals include deer, bear and small animals. |

| | | |
|---|---|---|
| **Temperate grassland (prairie, steppe, pampas)**<br> | Located roughly 30-40°N and S of the equator, away from coastal areas.<br><br>E.g. Central Europe and Asia, Central USA, Central Australia, some parts of South America.<br><br>Prairie = USA<br>Steppe = Europe/Siberia<br>Pampas = South America | • Dominant vegetation is **grasses** due to **periodic fires** and precipitation being **too low to support trees**.<br>• **Low precipitation** (25-75cm/yr).<br>• Animals include prairie dogs and originally bison, although these were overhunted in the past.<br>• **Hot summers, cold winters**. |
| **Desert**<br> | Around 30°N and S of the equator.<br><br>E.g. Northern Africa, Australia, Eastern USA, Middle-East, southern South America. | • **Precipitation** is extremely low - under 25cm/yr.<br>• **Temperature fluctuates** from well above 20°C in the day to below 0°C at night.<br>• Precipitation greatly limits **plant growth,** soil is very low in nutrients and high in salts. Mainly cacti and sagebrushes.<br>• **Small animals** live in deserts, often **nocturnal** to regulate body temperature.<br>• Deserts cover **one fifth** of the world's land surface. |
| **Tropical rainforest**<br> | Close to the equator. E.g. equatorial South America, South-East Asia. | • **Species rich ecosystem**, with over half of the world's species of plants and animals.<br>• **Warm, moist climate** throughout the year with little variation, perfect for plant growth. Temperatures stay around 26°C.<br>• Precipitation is **extremely high** (200-450cm/yr).<br>• Very quick **nutrient cycle**, soils are nutrient poor but there is a thin layer of organic matter on the top of soils that makes plants **very productive**.<br>• Animals include **many insects**, reptiles and amphibians. |

| | | |
|---|---|---|
| **Savanna (tropical grassland)**  | Located between 15-30° N and S of the equator.<br><br>India, Central Africa, Central South America. | • Temperature varies **little throughout the year**, staying in the **high 20°Cs**.<br>• **Precipitation is very seasonal**, with distinct **wet and dry seasons**. Yearly precipitation is around 76-150cm/yr, though most of this falls in winter.<br>• Tropical grassland dry seasons are characterised by **wildfires**, and the vegetation is **adapted to this**.<br>• Wide expanses of grass means this ecosystem is often used for **animal grazing.**<br>• Hoofed animals and **herds** are common in this ecosystem, as well as **large predators** like lions and leopards. |
| **Mediterranean (chaparral)**  | Around 40-45°N of the equator.<br><br>South of the equator, the Mediterranean biome exists in some areas of **South Africa and Western Australia**. | • Mild, moist winters. Hot, dry summers (precipitation around 50cm/yr).<br>• Frequent **wildfires**, with vegetation adapted to this.<br>• Dense growth of **shrubs**, as well as fruit trees.<br>• Diverse **wildlife** - animals include foxes, pumas, tortoises, lizards. |

## The Influence of Climate on Biomes




The **distribution** and **characteristics** of biomes are affected by the **climate** (e.g. **precipitation, temperature and sunlight exposure**).

The climate has major influence over the **type of vegetation that can grow**, what **animals can survive** and what the **soils are like** in a particular biome.

### Precipitation

**Forest biomes** are found in areas of **low pressure** as these climates are rainy, which support **tree growth**.

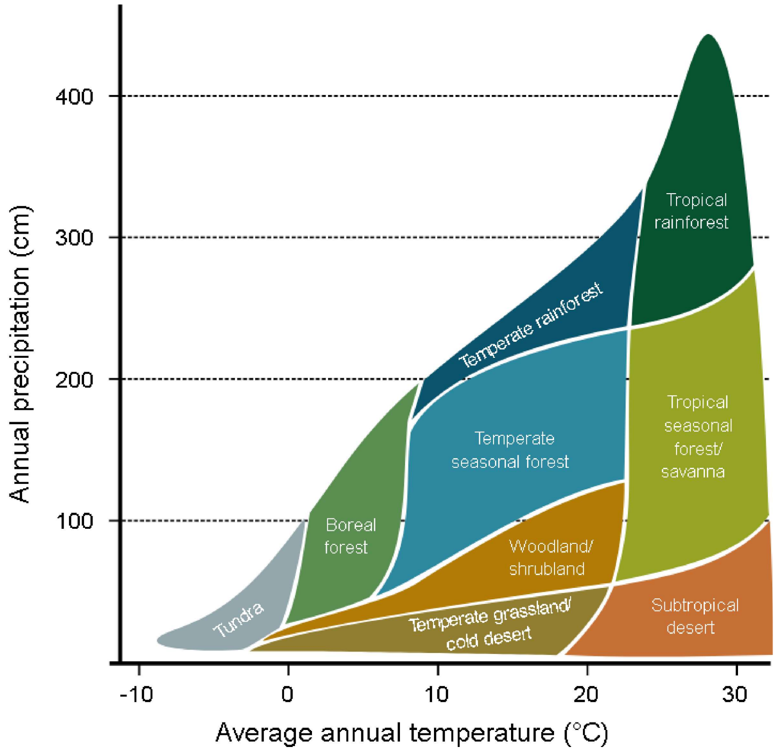
**Grasslands and deserts** are found in areas of **high pressure** as precipitation is too low for forested ecosystems.

### Temperature

As well as precipitation, **temperature** and **sunlight** has a huge influence on a **biome's characteristics**. The average **temperature** of an area is impacted by the **angle of the sun**.

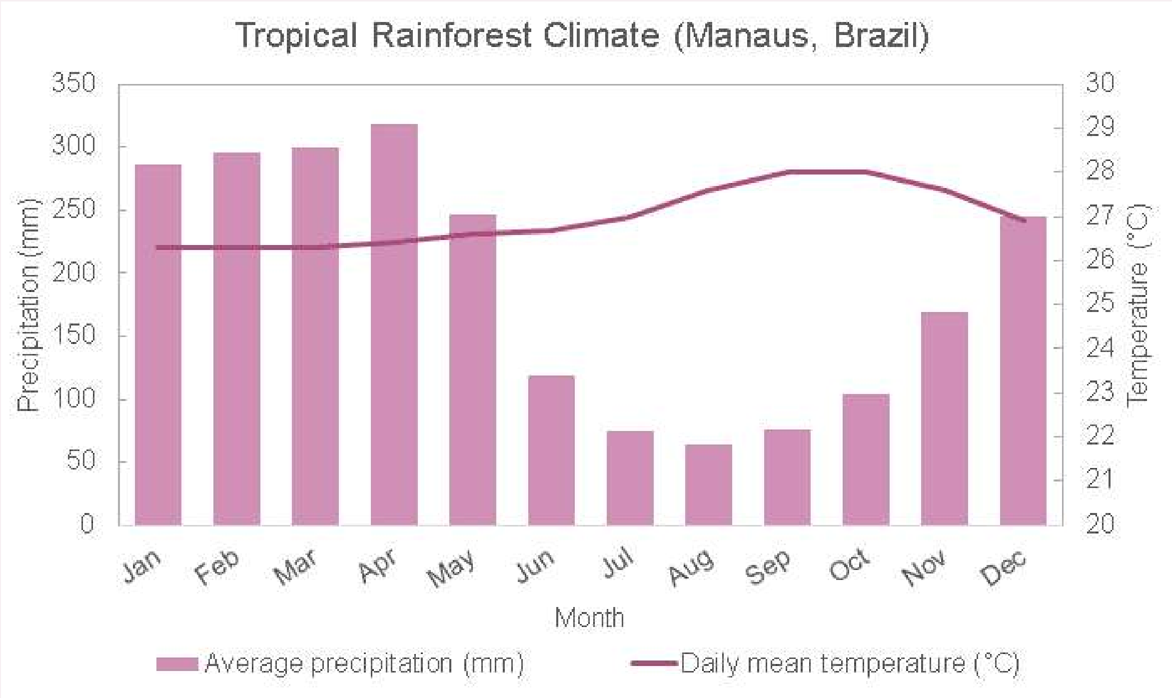
- Around the **equator**, the **sun shines directly onto the land**, making it very **warm**. This causes plants to be **more productive** (when there's enough rain), creating **tropical rainforest biomes**.
- At **higher latitudes**, sunlight becomes **less intense** and **sunlight becomes more seasonal**, influencing the type of vegetation that can grow. At the poles, the low temperatures, low precipitation and lack of light limit plant growth.

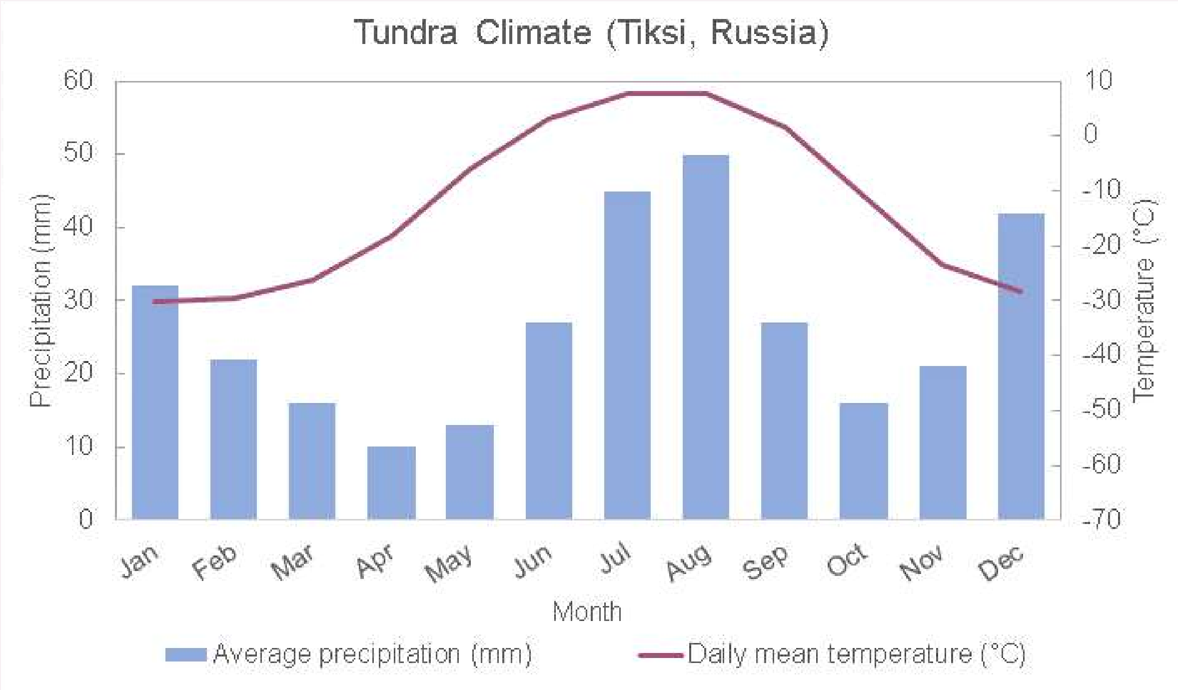
The relationship between **temperature, precipitation and biome type** can be seen in this graph, first created by Robert Whittaker. However, biomes may not always follow this trend as there are **local factors** that influence biome type (such as **topography** or the presence of **wildfires**).



## Thinking Further: Comparing Biomes

**Climate graphs** are a helpful way to **compare different biomes** and see how the climate changes **seasonally**. The climate graphs below show two very different biomes - a **tundra** biome and a **tropical rainforest** biome. Compare the two climate graphs to see how these biomes differ and how they change over the seasons.



## The Influence of Local Factors on Biomes

As well as the climate, **local factors** also have an influence on **biome distribution**. Local factors are **aspects of the surrounding environment** that causes the ecosystem to **behave differently to how we would expect** in that area given the climate. Local factors include:

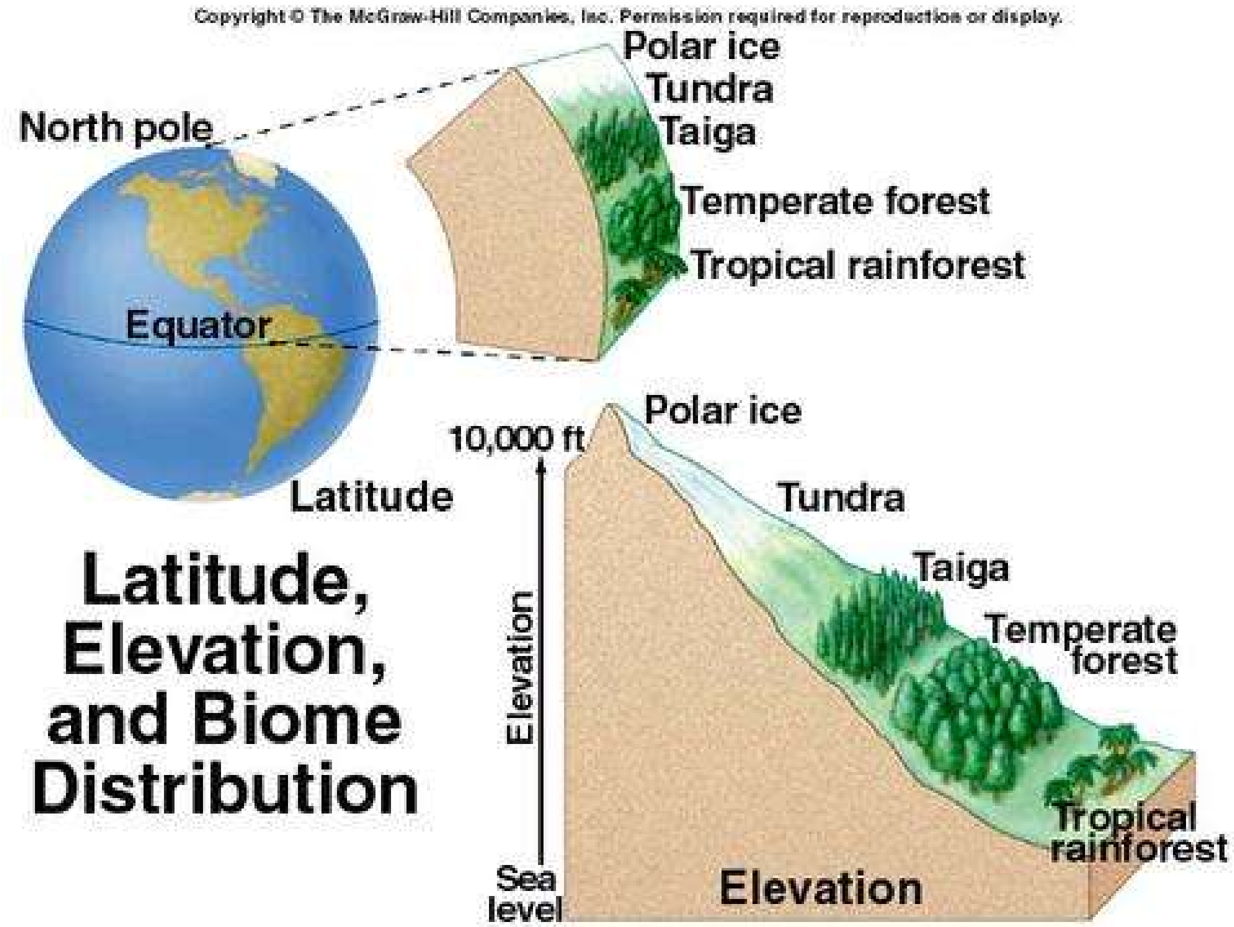
- Altitude
- Rock and soil type
- Drainage

### Altitude

**Altitude** refers to the **height of the land**, measured by **height above sea level** (elevation). As **altitude increases** (e.g. on hills and mountains) **the local climate changes**, creating different biomes. Altitude has the following effects:

- The **temperature** gets **colder with increasing height**. For every 1000m change in height, temperature drops by around 6.5°C. At high latitudes, temperatures can reach below freezing, and stay this cold for weeks (or even months).
- **Precipitation usually increases with height**, which alters the vegetation and soil at different altitudes.

**Altitudinal zonation** refers to the pattern we see on hills and mountains where the ecosystem changes with increasing elevation. This can be seen in the diagram below, where the vegetation is split into different 'zones' of biomes depending on the elevation. **Patterns of altitude can sometimes mirror patterns of latitude**, which is also shown on the diagram below.



## Rock and Soil Type

Rock and soil type can cause major differences in **vegetation and wildlife** in a particular area.

When **rocks** are broken down during **weathering**, **chemicals and nutrients** are released from rocks into soils. These chemicals influence a range of soil factors, such as **pH** and **fertility**, which dictates what type of plants can grow.

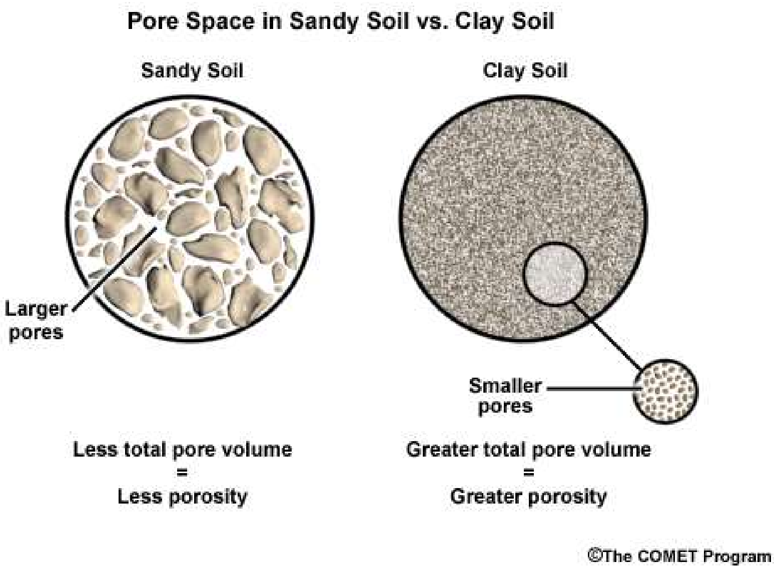
The plant to the right is a hydrangea, which grows blue in acidic soils and pink in alkaline soils!

The **bedrock** of an area also influences **soil composition and grain size** (e.g. whether it is a sandy soil or a clay soil etc.), which affects things like **permeability**, **vulnerability to erosion** and **drainage**. All of these aspects can influence biome type.

## Drainage

Drainage is **how fast water enters and leaves soil**. **Well-drained soils** do not retain excess water, whereas **poorly drained soils** can be left **waterlogged** and **boggy**. Ecosystems adapt to different drainage types (e.g. willow trees are found in waterlogged, marshy areas). Drainage is influenced by different local factors, such as:

- **Topography and relief** - some areas may receive more water due to the shape of the land, like in valleys.
- **Soil type** - more permeable soils like sandy soils are well-drained, whereas very porous soils (clays) retain water.
- **Amount of vegetation** - trees and plants **intercept and store water**, influencing how wet an area is.
- **Precipitation and temperature** - more precipitation obviously leads to wetter soils, and higher temperatures causes more evaporation.



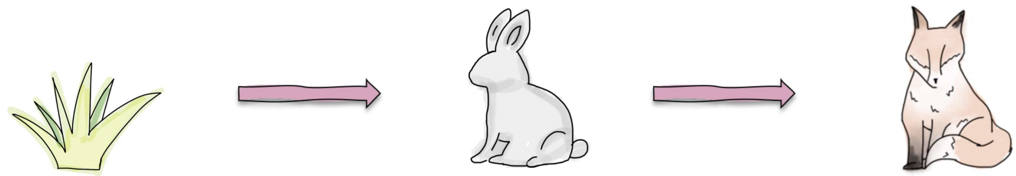
## Biotic and Abiotic Interactions

Within biomes, there are interactions between **biotic components** and **abiotic components**.

- **Biotic components** refer to **living organisms**, such as plants (flora) and animals (fauna).
- **Abiotic components** refer to the non-living **environmental factors** which have influence over the ecosystem such as climate (temperature, humidity and precipitation), light exposure, soil type, rock type, the atmosphere, water availability etc.

**Biotic** and **abiotic** components **interact with each other** within biomes:

- **Plants** (producers) take up carbon dioxide in the **atmosphere** during photosynthesis and convert it into energy (glucose). They use **energy from the sun** to do this. This energy is **passed through the food chain** into **animals** (primary consumers) when they eat **plants**, and then **carnivores** (secondary consumers) when they eat primary consumers.



**Grass (producer)** **Rabbit (consumer)** **Fox (consumer)**

- **Plants** give out oxygen during photosynthesis, which goes into the **atmosphere** and is **taken up by animals**. **Animals** give out carbon dioxide during respiration, which goes into the **atmosphere** and is taken up by **plants**.
- When **animals and plants die**, they are broken down by **decomposers**. Decomposition releases nutrients into the **soil**, where they are taken back up by **plant roots**.

**Dead animal matter** **Decomposers** **Plants (producers)**

- **Water falls as precipitation** and is taken up by **plants and animals**. Water is lost through urinating, respiration or when organic matter decays, where it is transferred **back into the atmosphere**.
- **Water** breaks up rocks through weathering, which releases chemicals into the **soil**. These chemicals are taken up by **plants** and used as nutrients to help them grow. They are then passed onto **animals** when they eat plants, and put back into the **soil** when they decompose.

## The Biosphere as a Life-Support System

The **biosphere** is the living layer of Earth between the **atmosphere** (air) and the **lithosphere** (crust) where **all plants and animals are found**. Within the biosphere, we find all of the Earth's **biomes**.

The biosphere is essential for human life as it supports us by providing us with **goods and services**.

**Goods** refer to **physical materials** the biosphere produces. These include:

- **Food and water**: Meat, berries, crops, nuts etc.
- **Energy sources**: Fossil fuels, timber (for burning).
- **Materials**: Metal, rock, wood and other raw materials for building, medicine, or to **process into other things** (e.g. cotton for clothes).

**Services** refer to the **processes** in the biosphere that support life. These include:

- **Atmosphere regulation**: The production and maintenance of gases in our atmosphere for respiration, photosynthesis and the greenhouse effect.
- **Soil formation and nutrient cycling**: The transfer of nutrients through plants and animals into soil, and back into plants and animals, allowing growth and reproduction.
- **The hydrological cycle**: The movement and purification of water throughout the biosphere, allowing humans to have drinking water and sanitation/hygiene.

### The Importance of the Biosphere on Indigenous Populations

**Indigeous peoples** are the **earliest known settlers** in an area, making them native to that land. When indigenous peoples originally settled in areas in the past, they relied heavily on **ecosystem goods and services** in that area for food, shelter and fuel.

(Source: Robert C. Bailey)

Some indigenous peoples live in areas untouched by the rest of the world, and **rely on ecosystem goods and services for their daily lives**.

The Efe people are indigenous peoples native to the Ituri tropical rainforest in the Congo Basin. Efe hunt and gather food, and use **natural resources found in the rainforest** to build their homes (leaves), make fire and produce medicines.

## Exploitation of the Biosphere

The biosphere is **delicately balanced**, and needs **time to recover** from the use of its **goods and services** (e.g. trees need to regrow, carbon dioxide needs to be absorbed, groundwater stores need to be replenished etc.).

However, **human activities** have been **exploiting** the goods and services at an **unsustainable rate**, meaning the biosphere **cannot recover and regenerate** in a timeframe that **keeps up with these levels of exploitation**. Continuing to exploit the biosphere may **throw off its balance**, potentially removing these goods and services forever.

The biosphere is being exploited by humans for **energy, water and mineral resources**:

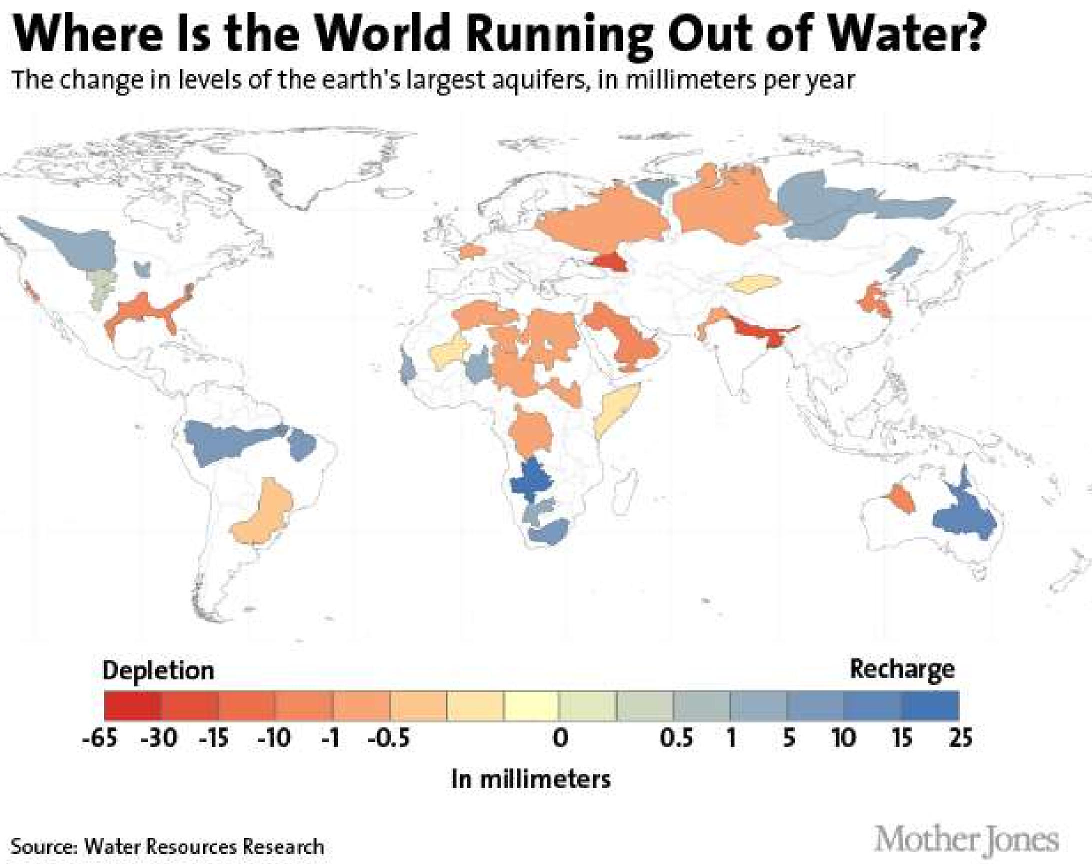
### Energy

Within the biosphere, we find our energy supplies of **fossil fuels** (decomposed ancient **organic matter**). Fossil fuels are being extracted at an **unsustainable rate** to meet the energy demands of a growing population. It takes **millions of years** to produce coal, oil and gas and it is being consumed at a much faster rate. Extraction creates **lasting environmental damage** (e.g. mines) and fossil fuel combustion releases **greenhouse gases** into the atmosphere, which is changing the **delicate balance of carbon** in the biosphere.

### Water

To provide **freshwater** for **drinking and hygiene**, the population requires **long lasting, clean** water sources. However, water resources are being depleted, which is altering the **hydrological (water) cycle**.

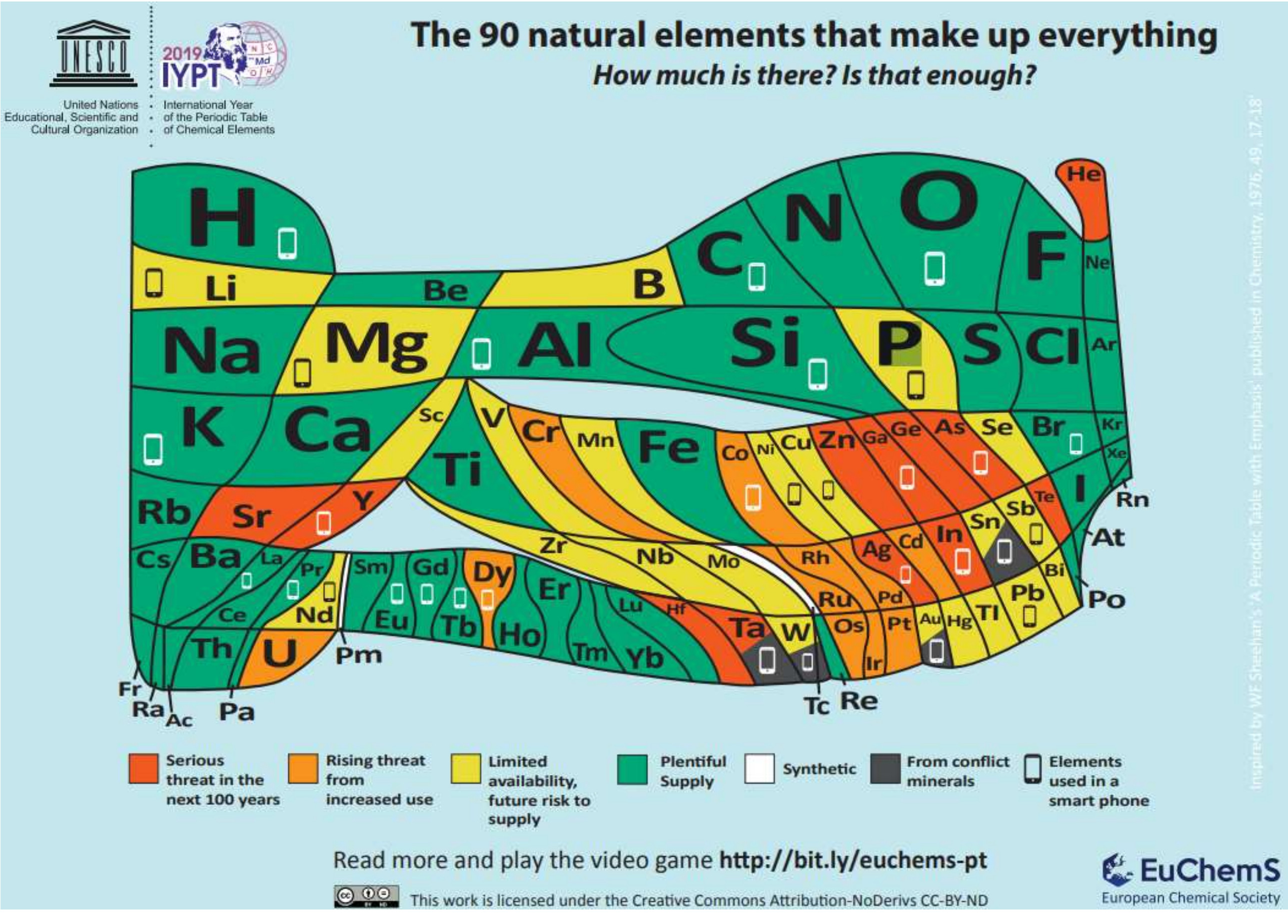
Groundwater stores called **aquifers** are being **depleted** at a faster rate than **replenishment**. This means there is an issue with **water security**, and many places may face water shortages.



## Mineral Resources

**Mineral resources** are naturally occurring elements or compounds that humans use and benefit from. Some minerals can take **billions of years** to form, but are being depleted at a much faster rate for **commercial uses**, for example:

- **Consumer goods** like makeup, jewelry, phones, televisions, etc. require certain minerals to be produced
- **Construction** of buildings and infrastructure needs (e.g. metal, limestone)
- Many **medicines** are derived from minerals
- Some **fertilisers** are made of minerals (especially phosphorus). Crop yields and food supply need to rise to support **population growth**, so these fertilisers may be in higher demand in the future.



## The Role of The Biosphere

The biosphere is very important for **regulating** different globally important services that humans depend on for survival, such as: the composition of the **atmosphere**, **soil** health and **water** within the hydrological cycle.

### Regulation of the Atmosphere

The biosphere maintains the composition of our atmosphere in different ways:

- Maintains **greenhouse gases** (carbon dioxide, nitrous oxides and methane) in our atmosphere, which are important for keeping the planet **warm** enough to live on.
- Regulates the amount of **carbon dioxide** and **oxygen** by photosynthesis. Forest biomes (especially tropical rainforests) are very important carbon sinks, and give out a lot of oxygen.

**Photosynthesis**

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

carbon dioxide + water → glucose + oxygen

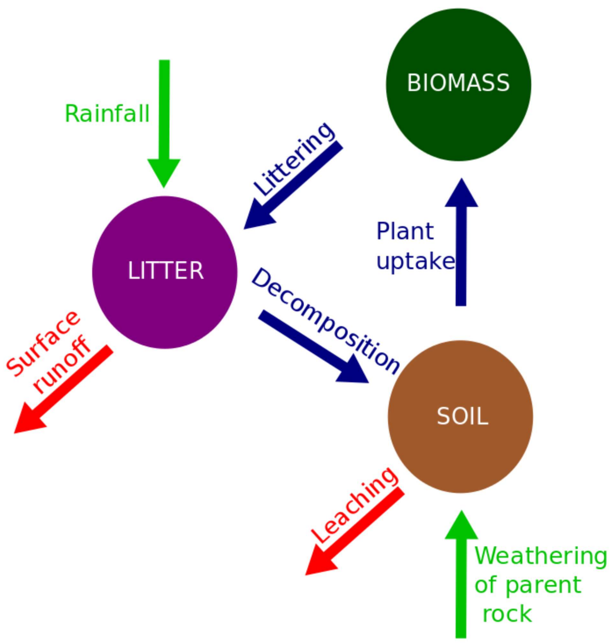
- Regulates carbon dioxide and methane levels by **carbon sequestration** (locking up of carbon). Carbon is stored in **trees, soils, permafrost, the sea, rocks** and many other places in the biosphere.

As humans continue to **emit greenhouse gases** and **remove carbon sinks** (e.g. through deforestation, melting permafrost) levels of atmospheric gases are changing, leading to **global warming**.

### Maintaining Soil Health

Healthy soils are vital for **plant growth**, which humans depend on for food, carbon dioxide absorption, medicine, wood and many other uses.

The biosphere keeps soils **fertile** through **nutrient cycling**, which is the **movement of nutrients** around the biosphere between **soils**, plants and animals (**biomass**) and organic matter (**litter**). The nutrient cycle (in blue) can be seen in the diagram to the right.

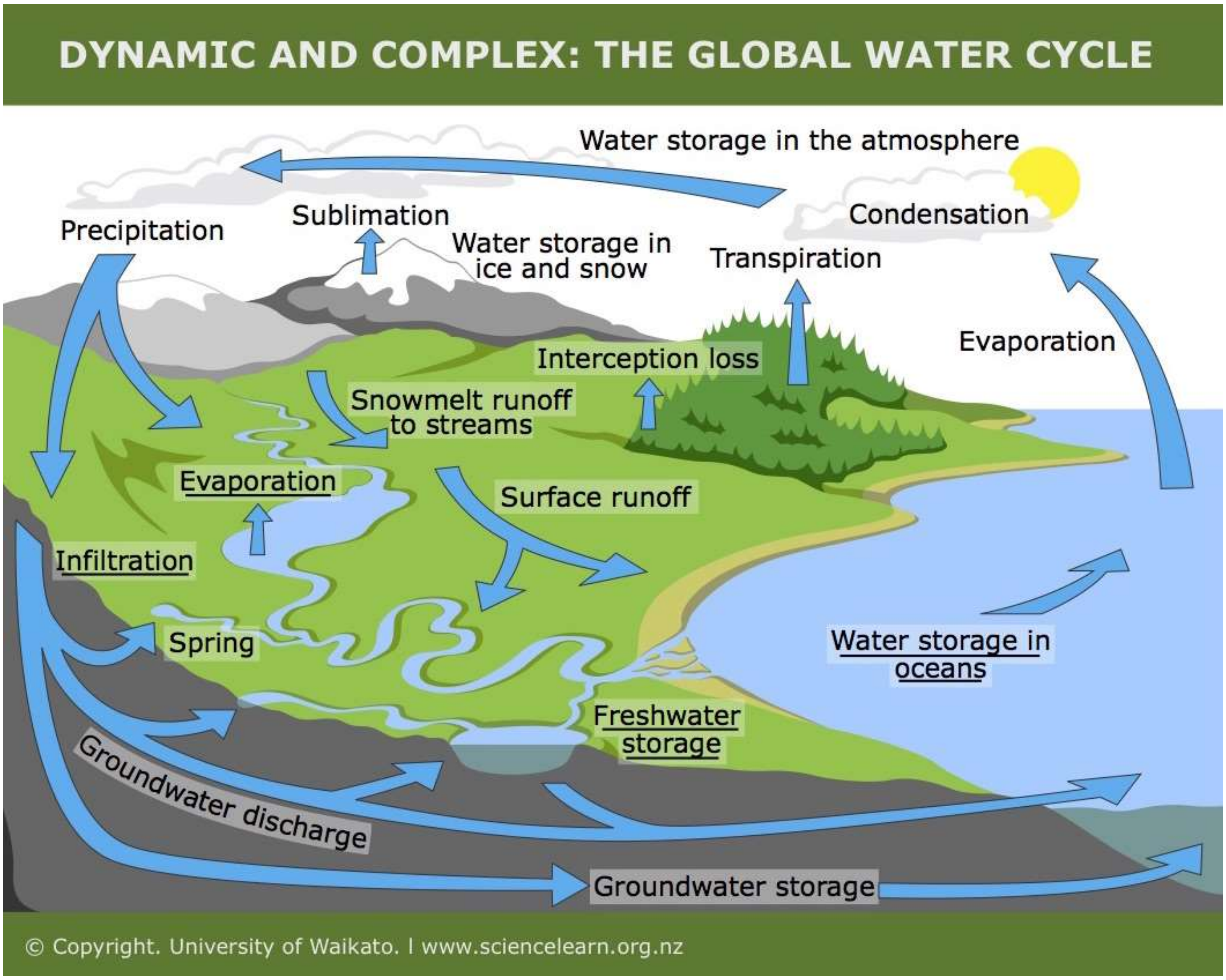



(Source: Kayau - Own work, CC BY-SA 3.0, ://commons.wikimedia.org/w/index.php?curid=23790222)

**Water Regulation in the Hydrological Cycle**

**The hydrological cycle** refers to how water is transferred throughout the world from **different sources** into **different states** (solid, liquid, gas). The biosphere plays a major role in the hydrological cycle, especially the interaction between **trees and water**.

Trees **intercept**, **absorb** and **transpire** (evaporate) water, which puts **water vapour back into the atmosphere**, where it will fall again as precipitation.



## The Growing Demand for Resources

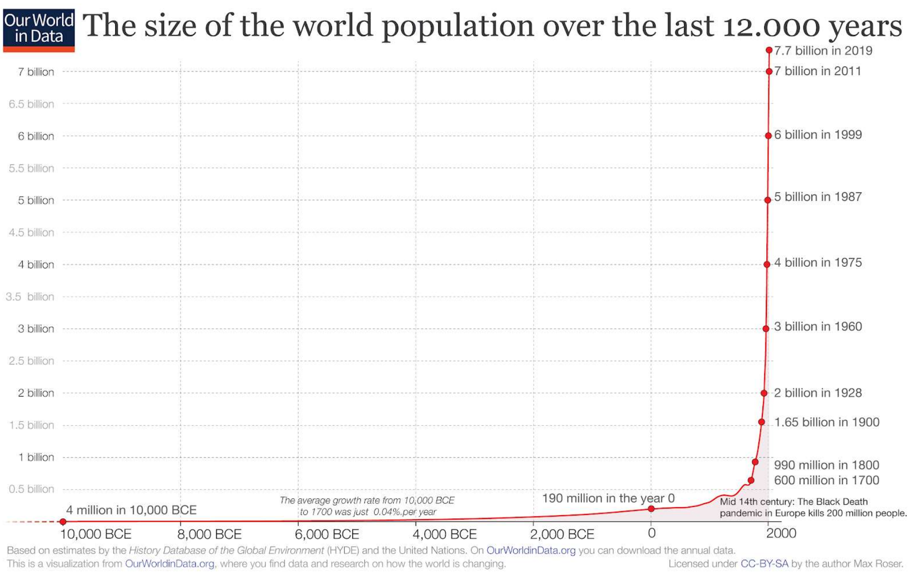
Earth's **natural resources** are being depleted at **unprecedented** rates due to **societal changes**. Globally, there is an **increased demand for food, energy and water**, all of which are putting strain on the biosphere. There are several reasons why demand for natural resources is growing:

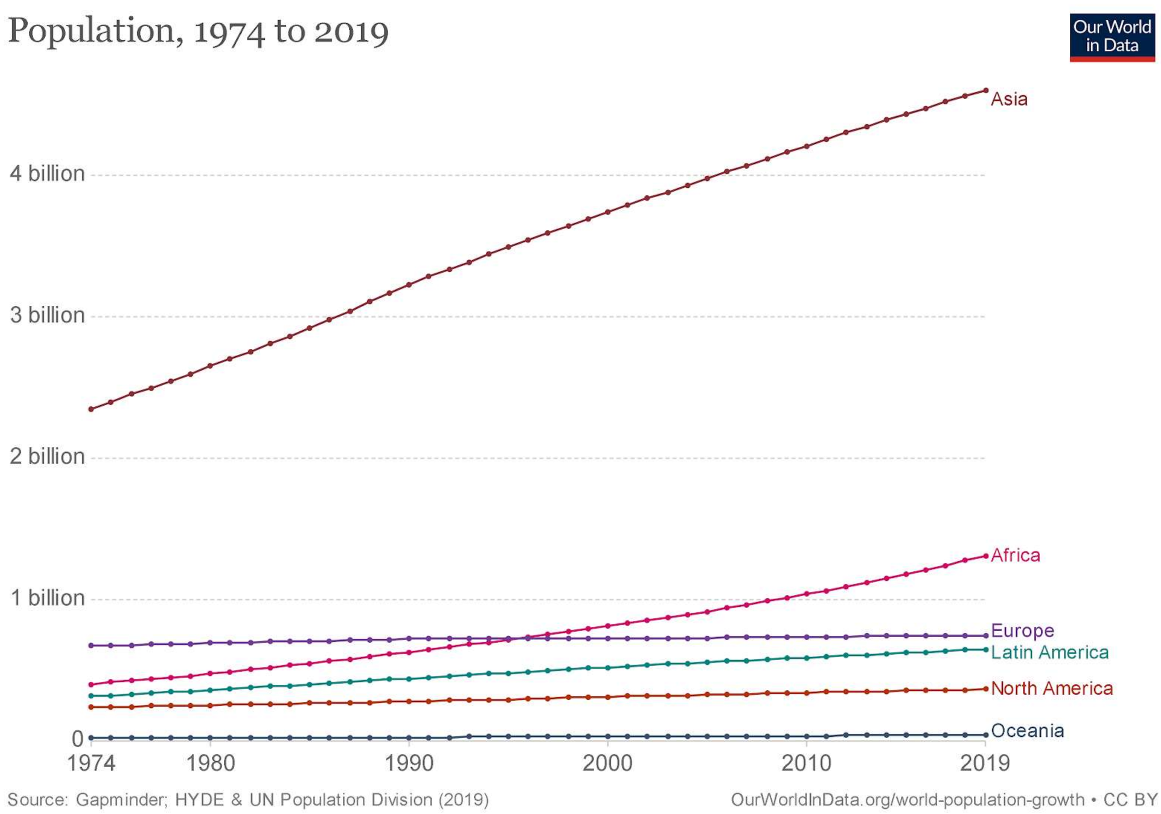
### 1. The Population is Growing

The global population has grown massively in the past few decades, from **4 billion in 1975 to 7.7 billion in 2019**. This means there are **more homes to build, more people to feed, and more energy to supply**.

Population growth has been **very high in Asia** (the population has doubled since 1975), but **is slowing**. The population of Africa is **lower** but population growth rate is **increasing** rapidly in many countries.

Europe especially is seeing a **slowing of population growth**, which is projected to level off in the future.



### 2. The World is Getting Richer

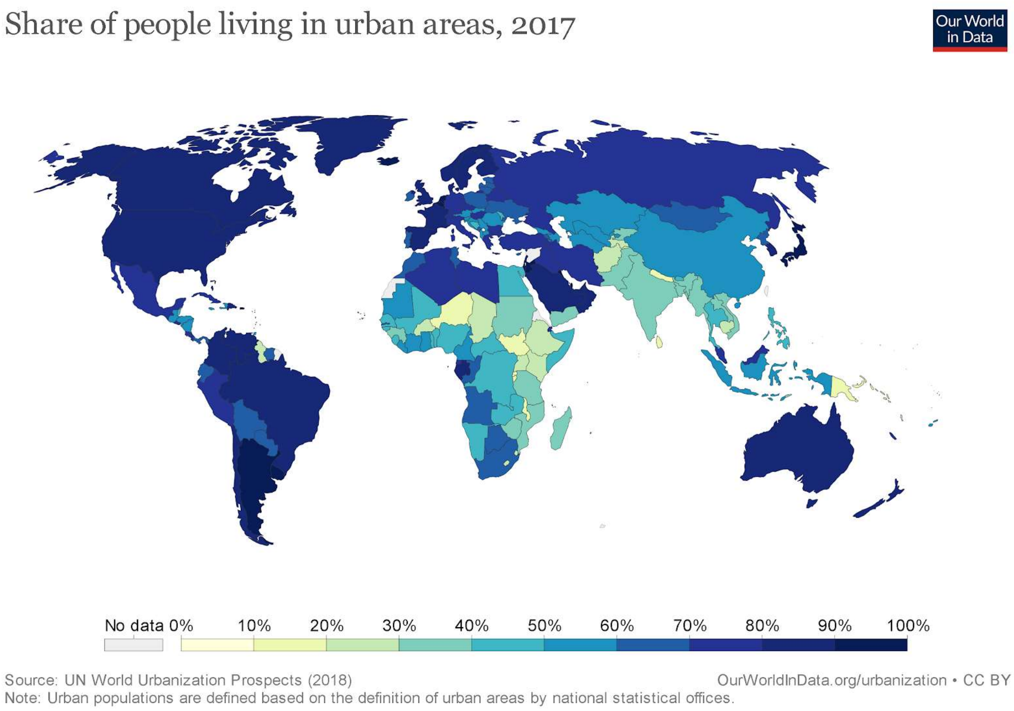
As well as there being more people, people are becoming more **affluent**, meaning they can afford to **buy and consume** more energy, food, goods and water. In 1975, average income per person was US$3700, and in 2015 that nearly tripled to US$10400 per person. Higher wealth is usually associated with certain changes in lifestyle:

- People can buy and consume more **food**, which requires **land and resources** to produce. Also, the **type of food people eat usually changes**; those in higher income countries generally consume more meat, dairy, oils, fats and sugars, requiring more land for cattle ranches and plantations.
- More people can afford cars, safe housing, electricity etc. which requires **energy and resources**.
- Investments into **sanitation, hygiene and drinking water**, which requires **water sources**.
- More people have a **disposable income**, allowing them to go on **holiday** (flying in planes that require fossil fuels to run) and **buy consumer goods** like smart phones (requiring mineral resources).

Wealth levels have increased at **different rates in different parts of the world**. In the lowest income countries, many are still affected by severe food insecurity and poverty. However, in some countries in Africa and East Asia especially, GDP (gross domestic product) has been rising rapidly, causing increased consumption levels and a **higher demand for resources**.

### 3. Urbanisation is Increasing

Urbanisation is the **increase of people living in urban areas**. Urbanisation has increased massively in recent decades, and how over **half of the world live in urban areas**. This value is **much higher in high income countries**, but the **rate of urbanisation in lower income countries is growing rapidly,** especially in Africa and Asia. Urbanisation requires more resources for **construction**, as well as more **energy** for transport, electricity etc.

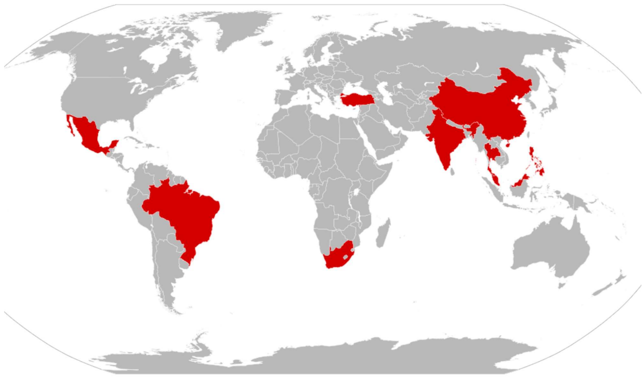


### 4. Industrialisation is Increasing in Poorer Regions

Industrialisation is the development of the **industrial sector** (i.e. construction and manufacturing goods). In Europe and North America, industrialisation began in the 18th century during the **Industrial Revolution**.

However - in **Asia** especially - countries have begun the socioeconomic shift to **industrialisation**, seen in countries such as China, India, South Korea, and Thailand. A large amount of **factories have been built**, **investments** into **industry** have been made, and people have been **migrating** from rural areas (where agriculture is the main source of income) to urban areas to work in the industrial sector.

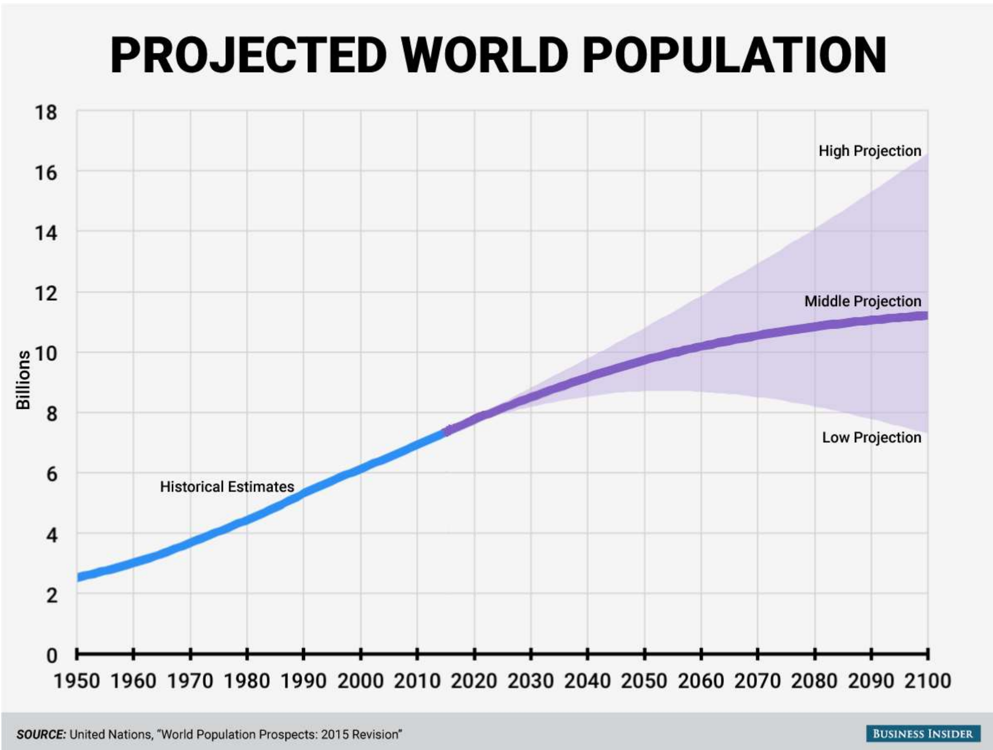
Industrialisation has led to an increase in **urbanisation** as more people choose to live in urban areas for work, and greater **energy consumption** to power industrialisation.



*Newly industrialised countries*
(source: Alex Covarrubias commons.wikimedia.org/w/index.php?curid=8749715)

## Theories on Population-Resource Relationships

It can be said with some certainty that - with current population projections - there is currently not enough resources to keep up with **current levels of consumption**. The graph below shows **population projections** made by the UN, that estimate a population of nearly **11 billion by 2100**.



**Population theorists** have published their opinions on how **resource supply** will affect population numbers. Some of these theories are **pessimistic** (meaning they estimate the **population will exceed resource supply**, leading shortages, famine and death etc.), while others are **optimistic** (the population will **always have sufficient resource supply** as humans will continue to **invent** new ways of creating resources).

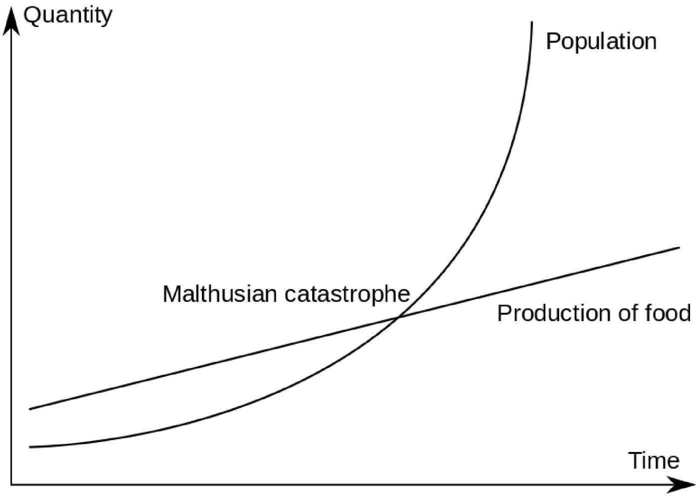
## Pessimistic Views: Malthusianism

Thomas Malthus published ***An Essay on the Principle of Population* (1798)** which **theorised** that **population increases exponentially**, but **resources only increase linearly**, meaning the population will eventually **run out of food and resources** (seen in the graph to the right) and **decrease** due to deaths and low birth rates.

Malthus also described how the population will decrease due to a number of **positive** and **preventative** checks when the population becomes too high.

**Positive check:** disease, war, famine - a **disaster** that significantly reduces a population by increasing **deaths**.

**Preventative check:** a cultural choice to lower population, such as choosing not to have children as you will not be able to support them, lowering **birth rate**.




(Source: commons.wikimedia.org/wiki/File:Malthus_PL_en.svg)

## Optimistic Views: The Boserupian View

Ester Boserup was an economist who published ***The Conditions of Agricultural Growth* (1965)**. In this book, she argued that no matter how large the population grows, the **population will always discover new ways to sustain food supplies**, such as new **agricultural technologies** and systems to ensure **food security**. These new discoveries are illustrated by the **steps** on the graph to the right.

This view echoed the optimism created by the **Green Revolution** at the time, which was a major increase in **agricultural yields worldwide** due to new **farming technologies**.