

THE LIVING WORLD



## WHAT IS AN 'ECOSYSTEM'?

An **ECOSYSTEM** is a natural system which is made up of plants, animals and the environment. Within an ecosystem, there is usually a complex series of links between living and non-living features. It is important to note that ecosystems can be local (e.g. ponds) and global (e.g. tropical rainforest). However, those at a global level are also called **BIOMES**.

## ABIOTIC VS BIOTIC FEATURES

**ABIOTIC** features of an ecosystem are those that are non-living environmental factors. It can include temperature, rainfall, soil and light.

**BIOTIC** features are living features of an ecosystem. These can include animals and plants.

## ECOSYSTEM KEY WORDS

**PRODUCERS** convert energy from the environment into sugars. Main example is plants that convert energy from sunlight into food via photosynthesis.

**DECOMPOSERS** break down plant and animal material into components, returning nutrients back to the soil. Examples include fungi and bacteria.

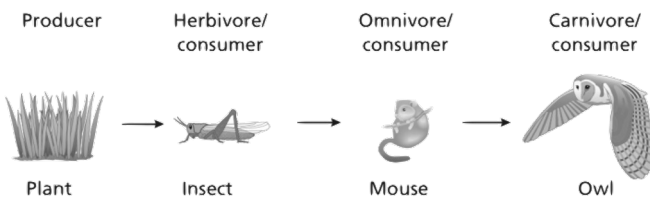
**FOOD WEBS** show the complex relationship between a variety of producers and consumers. It is more complicated than a simple line so is done in the form of a web to show how energy is transferred.

**CONSUMERS** get energy from the sugars created by producers; this means they usually eat plants as the main part of their diet. Examples can include snails.

**FOOD CHAINS** show the direct links between producer and consumer. They take the form of a simple line to represent how nutrients move between the two groups.

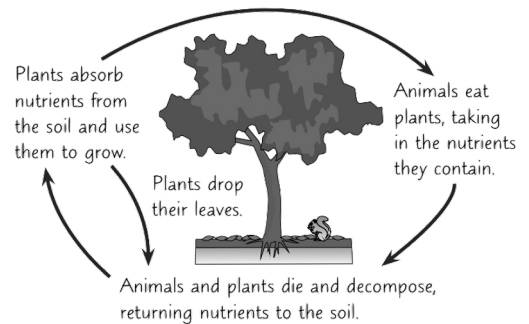
Within an ecosystem, living animals tend to be **HERBIVORES**, **OMNIVORES**, or **CARNIVORES**. Herbivores only eat plants, carnivores only eat meat and omnivores both – all are consumers though!

## FOOD CHAIN EXAMPLE

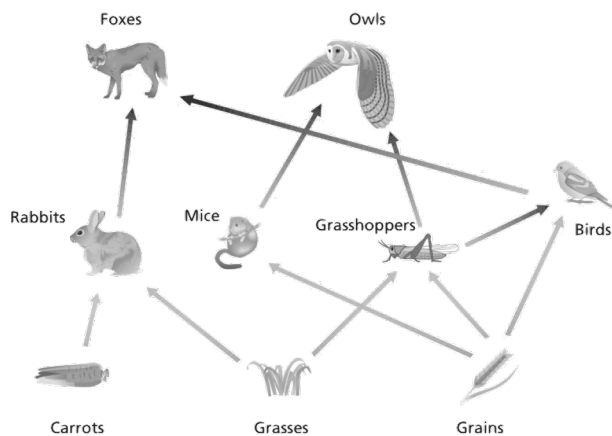


## WHAT IS 'NUTRIENT CYCLING'?

When dead material decomposes, nutrients are released into the soil. The nutrients are then taken up from the soil by plants. The plants may be eaten by consumers. When the plants or consumers die, the nutrients are returned to the soil. This transfer of nutrients is called **NUTRIENT CYCLING**.



## FOOD WEB EXAMPLE



## BALANCE IN THE ECOSYSTEMS

Balance is critical for ecosystems, and life, to survive on Earth. Ecosystems generally manage themselves through a series of complex processes. For example, too many grasshoppers can cause devastation to plant-life but balance is maintained by natural predators such as owls and other birds. This means that an ecosystem can sustain itself - providing nothing interrupts this process. Remember one change in an ecosystem can have a massive impact.

## NATURAL CHANGE

Generally, ecosystems will see slow changes that are necessary to ensure that the ecosystem maintains balance. For example, an increase in owl population could occur as a result of grasshopper increases. However, sudden and rapid changes can occur. Changing climate is one such example; droughts can destroy freshwater ponds. This could destroy the ecosystem to the point that it cannot sustain itself, highlighting the possible problems climate change represents for ecosystems.

## HUMAN INTERACTION &amp; IMPACT

Humans interact with ecosystems in a variety of ways. Firstly, it is important to realise that in a food web, humans take the role of an omnivore using a combination of producers and consumers for our nutrients. Secondly, we also use ecosystems for resources to support our way of life. Finally, we also use ecosystems for our own recreational and entertainment purposes.

Human interaction can have massive impacts on ecosystems. Removing woodland destroys habitats for wildlife and affect the nutrient cycle. Removing hedgerows for bigger fields destroys habitats and upsets the balance between animals and plants. The use of fertilisers can also cause eutrophication – increased algae, less oxygen and death of fish.



**LOCATION**

Epping Forest is an ancient deciduous woodland that runs north-east of London on a high gravel ridge.



It covers an area of about 2,500 ha (hectares) and is about 19 km long and 4km wide. It is the largest area of public open space near London.



**KEY FACTS**

- 70% of Epping Forest is deciduous woodland (mostly beech)
- 1,600ha of the forest has been designated a Site of Special Scientific Interest and a European Special Area of Conservation meaning it is protected
- The forest is home to deer, cattle, lizards, grass snakes and an estimated 10 species of bat
- Over 100 lakes and ponds providing important habitats for numerous species of fauna (animals) and flora (plants)

**HUMAN USE**

**AS A RESOURCE** - wood is used for fuel (firewood) or as timber for buildings.



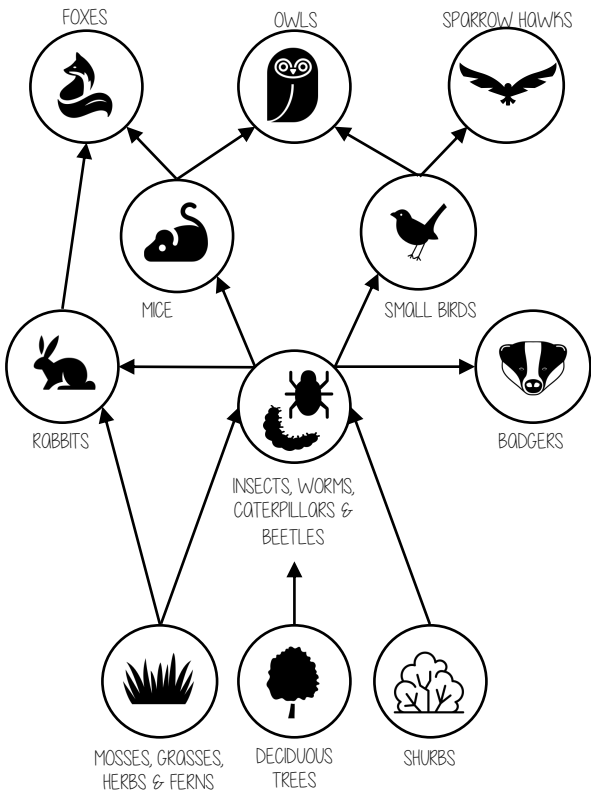
**FOR RECREATION** - for example for walks



**FOR CONSERVATION** - to protect ecosystems



**THE FOOD WEB OF EPPING FOREST**



**UNDERSTANDING EPPING FOREST'S ECOSYSTEM**

	A wide variety of native tree species that include beech, elm, oak and ash,	} PRODUCERS 
	A shrub layer consisting of hazel and holly, along with grasses, brambles, fern, bracken and flowering plants.	
	177 species of lichen and moss survive in the Epping Forest, providing nutrients for the consumers.	
	Many primary consumers including insects and small mammals and deer, along with 38 species of birds	} PRIMARY CONSUMERS 
	Secondary consumers such as owls, adders and foxes exist within the Epping Forest, consuming the primary consumers.	} SECONDARY CONSUMERS 
	700 species of fungi, important decomposers, which are common due to a large amount of dead wood,	} DECOMPOSERS 

**SUSTAINABLE MANAGEMENT**

**WHAT DOES SUSTAINABLE MEAN?**

The term **SUSTAINABLE** means meeting the needs of the future without compromising the needs of today. Basically, it means ensuring that we can use resources today without destroying them for future generations to use.



**GOVERNMENT ACTIONS**

In 1878, the Epping Forest Act was passed by Parliament. It stated that 'the Conservators shall at all times keep Epping Forest unenclosed and unbuilt on as an open space for the recreation and enjoyment of the people'. As a result, the forest has been managed by the City of London Corporation since.

**MANAGING TOURISM**

- Providing car parks, toilets and refreshment facilities
- Maintaining footpaths
- Providing three easy-access car parks for people with disabilities
- Preserving ancient earthworks and buildings

**OTHER ACTIONS**

- Allowing old trees to die and collapse naturally (unless they're dangerous) so as to provide habitats
- Encouraging grazing (there's a herd of cows and deer) to maintain the grassland and its flora and fauna
- Some grassy areas are left uncut to encourage wildlife like butterflies

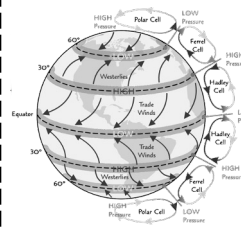
**POLLARDING**

This involves cutting trees down to about shoulder height, above the level of browsing by animals such as deer. They reshoot producing new wood for future cutting. This helps trees live longer as it removes the crown which can become too heavy and lead to toppling or splitting. By only taking the top of the tree, it ensures wood for human use whilst also keeping the forest relatively intact – including many of the ancient trees.



## WHAT IS A 'BIOME'?

**BIOMES** are large-scale global ecosystems and are usually defined by the type of vegetation found there. They are distributed in broad latitudinal 'belts' across the world with key climate characteristics determined by the global atmospheric model.



**EQUATOR:** hot, humid conditions in which high rainfall occurs due to low pressure and rising air — great for tropical rainforests.

**30° NORTH AND SOUTH OF THE EQUATOR:** sinking air and high pressure limit rainfall and help create deserts.

**BRITAIN:** perfect for cloud and rain with surface winds that can bring warm air from the south and cool air from the north.

## KEY CHARACTERISTICS OF BIOMES



**POLAR:** At the extreme north of the planet and furthest away from the equator with temperatures below  $-50^{\circ}\text{C}$ . As a result, they are very cold all year round with a permanent or semi-permanent layer of ice, leading to little plant and animal life. They are mainly found in the Arctic and Antarctic.

**TUNDRA:** To the far north between the Arctic Circle and  $60^{\circ}$ - $70^{\circ}$  North with below freezing temperatures for most of the year. Here, the ground is permanently frozen and there is often light snow which has resulted in low growing plants emerging.



**TAIGA:** Also known as coniferous forest, these occur at  $60^{\circ}$  north of the equator and around mountains. They had long, cold winters with short mild summers along with limited rainfall and coniferous trees. Also known as **Boreal Forests**.



**TEMPERATURE GRASSLAND:**  $40^{\circ}$ - $60^{\circ}$  north and south of the equator with warm summers and very cold winters. As a result of low rainfall, this area is mainly grassland.

**DECIDUOUS FOREST:**  $40^{\circ}$ - $60^{\circ}$  north and south of the equator with cool summers and mild winters along with rain throughout the year. Rich deciduous woodlands dominate this biome.

**MEDITERRANEAN:**  $30^{\circ}$ - $40^{\circ}$  north and south of the equator and around mountains. Hot, dry summers with warm, wet winters have led to the evolution of shrubs, herbs and olive trees that are all capable of surviving the summer drought.



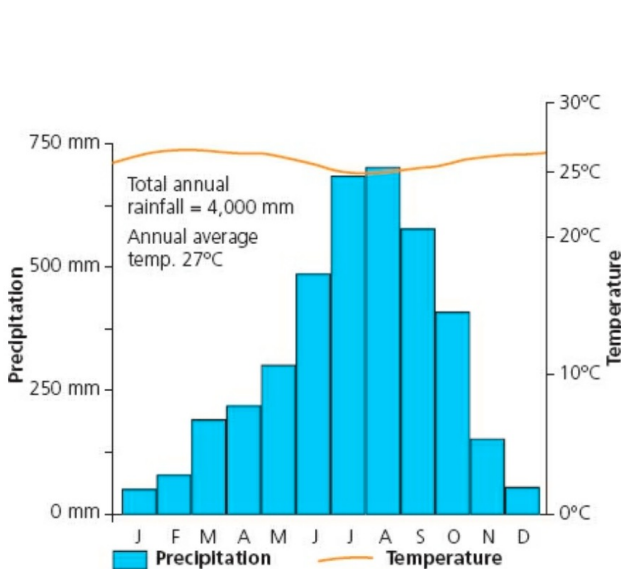
**DESERT:**  $15^{\circ}$ - $30^{\circ}$  north and south of the equator, deserts are very hot and dry places that are incredibly difficult to live due to environmental factors which has led to the development of few plants, all of which have adapted to survive in the biome.

**SAVANNA:** Also known as tropical grasslands and occur within the tropics between  $5^{\circ}$ - $15^{\circ}$  north and south of the equator. These grasslands are hot with a wet and dry season. They are mainly grass with a few specially adapted trees.

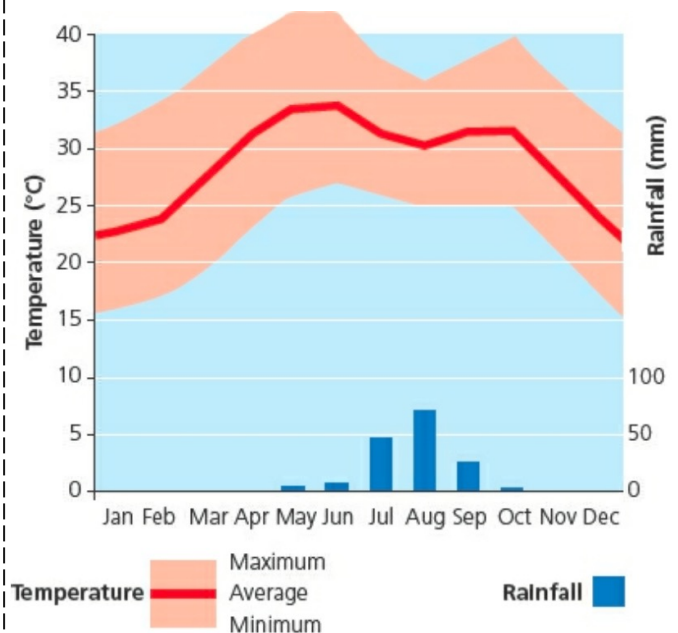


**TROPICAL RAINFOREST:** Occurring between  $23\frac{1}{2}^{\circ}$  north and south of the equator, these biomes are hot and wet all year. As a result, they are also rich in a variety of plant and animal life.

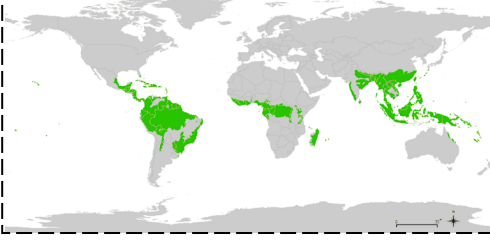
## TRF CLIMATE GRAPH



## HOT DESERTS CLIMATE GRAPH



Tropical Rainforests are found between  $23\frac{1}{2}^{\circ}$  north and  $23\frac{1}{2}^{\circ}$  south of the equator – between the Tropic of Cancer and the Tropic of Capricorn.



## KEY CHARACTERISTICS OF TROPICAL RAINFORESTS



**CLIMATE:** hot and humid all year round with high, variable rainfalls. No distinctive seasons.



**BIODIVERSITY:** supports a remarkable variety of plants, and animals – more than other biomes.



**BALANCE:** perfect balanced system with animal and plant life adapted to survive including soils which rapidly cycle nutrients to support growth of other organisms.

## LAYERS OF THE RAINFOREST

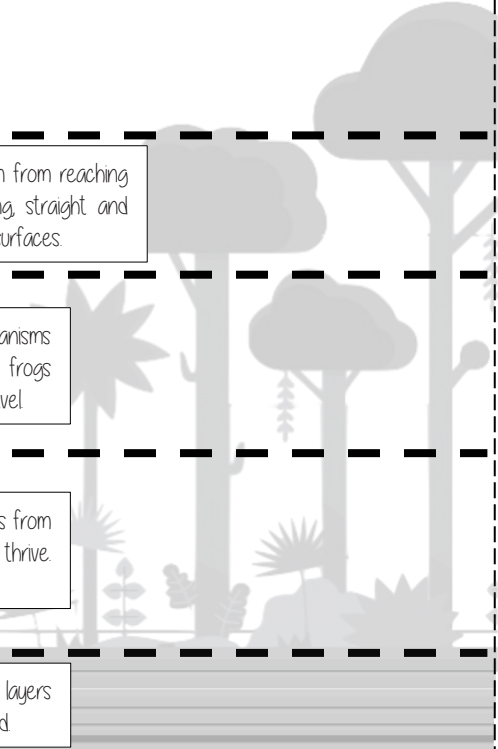
The **EMERGENT LAYER** is the tallest layer with isolated trees over 40 metres tall that rise above the canopy. This layer is made for living in dry conditions as they are constantly exposed to the sun.

The **MIDDLE CANOPY (20m-35m)** is the most productive part of the rainforest. It blocks out the sun from reaching the lower levels as well as catches rainfall, shedding it effectively through drip tips. They grow long, straight and branchless in competition to reach the sunlight with mushroom shaped tops to maximise photosynthetic surfaces.

The **UNDER CANOPY (10m-20m)** consists of shorter trees and bushes sheltered by the canopy. Organisms here have adapted to the low levels of light and dampness with animals like the jaguar, sloths and frogs common. Interlocking branches and woody creepers (lianas) form green corridors that animals use to travel.

The **SHRUB LAYER (0-10m)** receives very little light as it is blocked out by the layers above. Dead leaves from the above trees cover the ground, which fungi feed upon. Plants therefore grow slowly but many insects thrive. Thick buttress roots are common and help to spread the weight of the trees.

**SOIL, or LATOSOLS,** cycle nutrients rapidly to support new growth. However, they are reliant on the layers above to offer them protection and material – without them, nutrients will leach quickly and be exhausted.



## ANIMAL ADAPTIONS



The **SLOTH** had adapted to the rainforest by using camouflage to blend into its surroundings and moving very slowly – all to make it difficult to spot by predators. They also are nocturnal due to it being cooler.

**HOWLER MONKEYS** have developed strong limbs so that they can spend the majority of their lives in the canopy.



**POISON DART FROG** has fully webbed hands and feet along with a flap of loose skin that stretches between its limbs; this is to increase surface area and provide the frog with more grip in the damp understory. They are also brightly coloured which serves warn off predators.

The **JAGUAR** has patterned fur which keeps it camouflaged by blending into the dark understory layer. They have also developed large claws which enable them to climb small trees and catch their prey. They can also swim which allows them to escape flooding and reach a wider variety of food.



**TOUCANS** have adapted to have long, large bills to reach food at the end of branches that will not take their weight, meaning they can reach a greater range of food.

## PLANT ADAPTIONS



**LIANAS** are woody vines that have roots in the ground. However, they have adapted to climb up the trees to reach the sunlight, allowing leaves and flowers to grow in the canopy.



**TREE TRUNKS** have smooth bark which allows water to flow down to the roots easily.



Some plants have developed **DRIP TIPS**, these are thick, leathery leaves with pointy tips that allows water to run off the leaf quickly. This is important as it reduces the damage from water a leaf may suffer whilst also ensuring that the water reaches the forest floor more effectively. The leaves themselves are also **WAXY** and thicker – this allows them to repel water so as to reduce damage.



**BUTTRESS ROOTS** are found in many rainforests; this is where large roots have developed ridges which help to increase the surface area for nutrient absorption as well as support for the towering tree.



Some plants also grow in the nook of trees, using rotting debris for nutrients as well as sending aerial roots down the trunk. They steal the resources from the host tree and are known as **EPIPHYTES**.

The term **SUSTAINABLE** means meeting the needs of the future without compromising the needs of today. Basically, it means ensuring that we can use resources today without destroying them for future generations to use.

## THE IMPORTANCE OF TROPICAL RAINFORESTS



**RESOURCES:** many products including rubber, coffee and chocolate come from rainforests. Additionally, 25% of medicine come directly from the rainforest and with species facing extinction due to deforestation, the chances of discovering new medicine declines.



**CLIMATE CONTROL:** rainforests influence the greenhouse effect by serving as CO<sub>2</sub> sinks. Removing the rainforest therefore can have global impacts as they help to regulate the climate and water cycle. This means they influence all nations so no single country should have direct influence over the rainforest due to its global reach. It is called the 'lungs of the world' as an estimated 28% of oxygen is produced in rainforests.

## INDIGENOUS PEOPLE OF THE AMAZON

The Kayapo Tribe live in the Amazon Rainforest and are an example of how humans have adapted to survive in that biome. They speak both their own native language, Kayapo, and Portuguese. The tribe have adapted what is known as a 'slash and burn' culture whereby they farm their land until it is leached of resources and then move, usually every couple of years. However, before they leave they burn the area to support the release of nutrients back into the soil. They live in thatched roof huts made out of palm tree whilst their main food source is fruits, vegetable and fish. Medicine is created from the forest. They are also skilled hunters and use blowguns and darts.

VIDEO LINKS



SCAN ME

BBC Bitesize Revision  
Video on Rainforests  
and Biomes.

Vox documentary on  
the destruction of  
the Amazon.



SCAN ME

## SUSTAINABLE MANAGEMENT STRATEGIES FOR THE TROPICAL RAINFOREST



**REPLANTING** involves planting new trees to replace those destroyed. The tree type must match those cut down to maintain the ecosystem. Some nations have made this compulsory for logging companies.



**SELECTIVE LOGGING** focuses on only removing certain trees such as the eldest. This means the forest keeps its structure in place as entire areas are not destroyed, preventing the soil from being washed away and allowing regeneration to continue. In Sarawak (Malaysia), logging companies have also stopped using roads and trucks - instead they use helicopters to remove cut-down trees in a process known as 'Helicopter Logging'.



**CONSERVATION** focuses protecting the rainforest. Some nations have setup national parks and nature reserves to prevent damaging activities in certain regions. However, this is expensive so many countries have setup funds that overseas business and government can invest in to support these conservation areas by enforce bans on damaging activity and promote sustainable uses. For example, Brazil established the Amazon Fund which in 2018 received a \$70 million grant from Norway.



**HARDWOOD AGREEMENTS** involving the Forest Stewardship Council (FSC) ensure that wood originating from the rainforest is logged in a sustainable way. It does this through education programmes.

**ECOTOURISM** is focused on reducing the impact to the environment resulting from tourism. One such method controls the number of people to a region, reducing waste and litter to minimise impact. It also often includes local communities to provide them with income by employing them as guides or encouraging the provision of accommodation, this all reduces the need for local people to log or farm the rainforest, but instead conserve it! For example, in Costa Rica 21% of the nation's income is linked to ecotourism.

**EDUCATION** is another strategy. Many local people are not aware of the long-term consequences of deforestation. Teaching them alternative methods to make money has been adapted in places like Guatemala through the Rainforest Alliance.

Most rainforests are found in low income countries who have historical borrowed from more developed nations; this has created debt which nations like Brazil pay back through damaging activities such as logging and mining. If developed nations agreed to **DEBT REDUCTION**, less demand on rainforest-related products would exist. However, reducing debt would not guarantee greater conservation so some countries have only agreed to debt reduction as part of a conservation swap. For example, the USA reduced Indonesian debt by \$29 million in return for a legal promise to conserve the Indonesian Rainforest.

Study **Figure 1** It shows photographs of animals that live in tropical rainforests.



Study **Figure 2** It lists some of the ways that animals have adapted to the rainforest.

Camouflage  
Living in Canopy  
Diet  
Sleeping Habits

**PRACTICE QUESTION 1:** USE FIGURE 1, FIGURE 2 AND YOUR OWN KNOWLEDGE TO EXPLAIN HOW ANIMALS HAVE ADAPTED TO THE PHYSICAL CONDITIONS OF THE TROPICAL RAINFORESTS. (4 MARKS)



## LOCATION

It sits within the Amazon River basin and covers 40% of the South American continent.

It is in 8 countries including Brazil, Bolivia, Peru, Ecuador, Colombia. However, nearly 2/3rds is found in Brazil.



## KEY FACTS

- The Amazon is the world's biggest rainforest; it covers 8 million square kilometres, it's so big that the UK and Ireland would fit into it 17 times!
- 70% of South America's GDP is produced in areas that receive rainfall or water from the Amazon.
- More than half of the 10 million known species of animals and plants call the Amazon Rainforest home.
- There are around 40,000 plant species, 1,300 bird species, 3,000 types of fish, 430 mammals and a whopping 25 million different insects.

## UNDERSTANDING DEFORESTATION IN THE AMAZON RAINFOREST

The Amazon Rainforest is an abundant source of resources for the countries it exists within; one of the primary resources it provides is wood. Almost 18 million hectares of forest were lost between 2001 and 2012 — an average of 14 million hectares were lost per year in this period. Furthermore, it is estimated that almost 30% of the Amazon will have been deforested by 2030 if the current rate of deforestation is not reduced.

## CAUSES OF DEFORESTATION



## COMMERCIAL FARMING

Cattle ranching is the main cause of deforestation - in Brazil, there are around 200 million cattle on about 450,000 km<sup>2</sup> of pasture which all involve removal of trees to allow cattle grazing. Soy is another commercially farmed crop with up to 250,000 km<sup>2</sup> of former forest used for its production. Rice, corn and sugar cane are also grown.



## SUBSISTENCE FARMING

Small-scale farmers clear forest as they need land to grow food for themselves and their families. Many indigenous people are subsistence farmers.



## LOGGING

Valuable hardwood trees including mahogany makes logging extremely tempting — with both legal and illegal businesses emerging.



## MINERALS

The Amazon is full of minerals including bauxite, gold, iron ore and copper which are mined and exported to help boost countries' development. As part of this process, explosives are sometimes used to clear earth, and deep pits have to be dug to reach the mineral deposits, both of which destroy the ecosystem.



## ENERGY

Providing energy has led to the building of hydroelectric dams for which large areas of forest have been flooded. Balbina Dam (near Manaus, Brazil) saw 2,400 km<sup>2</sup> of rainforest flooded.



## ROADS

The Trans-Amazonian Highway was built in 1972 and is 5,000 km long. This destroyed a massive amount of rainforest. Research has shown that 95% of deforestation occurs within 7km of a road.



## POPULATION

Growing population has forced governments to open up land for farmers and encourage movement from overpopulated urban areas.

## IMPACTS OF DEFORESTATION



## CLIMATE CHANGE

The Amazon, and rainforests in general, are carbon sinks; they absorb and store a tremendous amount of CO<sub>2</sub>. It is estimated that the Amazon stores 140 billion tonnes of CO<sub>2</sub>. With deforestation occurring, this CO<sub>2</sub> is released and contributes to global warming. It is believed that 75% of Brazil's CO<sub>2</sub> emissions are the result of deforestation.



## SOIL EROSION

On estimated 100 tonnes of topsoil per hectare are lost in Brazil each year. As a result, there is an increased risk of landslides and flooding in the future. Less trees mean the canopy is not as effective at intercepting rainfall and when combined with fewer tree roots to absorb it, more water reaches the soil. This is damaging as the excess water simply washes the nutrients away and disturbs the cycle. Finally, when farmers suffer from soil erosion and leached nutrients they simply move, this means more deforestation in new sites.



## ECONOMIC IMPACT

Farming has brought wealth; for example, Brazil made almost \$600 million from beef exports in March 2018. Mining has also benefited nations; for instance, the Buenaventura mining company in Peru employs over 8,000 people. However, deforestation has had negative impacts. Removing trees in Brazil in tourism as the attractiveness of the Amazon is diminished. Also, people who extract natural rubber from rubber trees have lost their livelihoods as trees have been cut down.

## REDUCING DEFORESTATION

From 2004 to 2012, deforestation rates in Brazil dropped by 80%, in part because of the Paris Agreement in which Brazil pledged to drop CO<sub>2</sub> emissions by 37% by 2025. Furthermore, consumers have changed attitudes as shown by companies like Iceland refusing to manufacture palm oil goods which are linked to deforestation. Other strategies include using funds from the World Bank and WWF to protect over 44% of the Amazon whilst the Brazilian government has begun to use satellite imagery to prevent large-scale illegal logging.



15°-30° north and south of the equator, deserts are very hot and dry places that are incredibly difficult to live due to environmental factors which has led to the development of few plants, all of which have adapted to survive in the biome.



## KEY CHARACTERISTICS OF HOT DESERTS



**CLIMATE:** the persistent high pressure at the Equator means that clouds do not form, rainfall is low and daytime temperatures are high. Temperatures can reach 45°C in the day before dropping to 0°C at night.

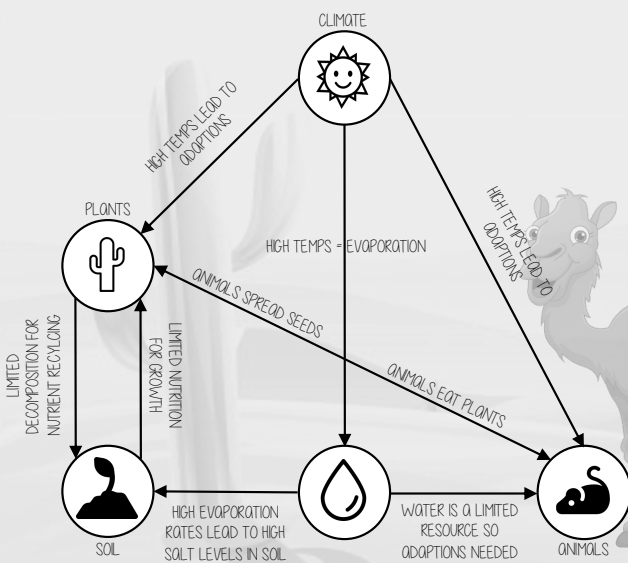


**SOIL:** tend to be sandy or stony with little living matter due to the lack of plants. Whilst they are dry, they can soak up water incredibly quickly. High temperature leads to evaporation also draws salt to the surface, leaving a white powder on the ground. All this results in desert soil not being very fertile.



**FRAGILE BALANCE:** due to the harshness of the environment, the abiotic and biotic components are in a much more fragile balance than other ecosystems. The slightest change can destroy this balance.

## UNDERSTANDING THE INTERDEPENDENCY OF THE HOT DESERT



**HUMAN** involvement in the hot desert biome can upset the fragile balance that exists as their actions can easily upset the system to devastating effect. For example, allowing cattle to overgraze can cause soil erosion. With fewer plant roots stabilising the soil, the wind can blow fine sand particles into the atmosphere, forming dust clouds. These reduce rainfall, making deserts even drier. Without rainfall, water supplies can dry up and people, plants and livestock may die.



Hot deserts have **LOW BIODIVERSITY**, most of this is centred around ephemeral (temporary) water sources or on the margins of deserts which can lead to biodiversity hotspots. However, these same areas that have water sources have also come to be dominated by humans who create roads, habitats and migrate – all which can cause desertification as it places great strain on what is a fragile ecosystem.

## ANIMAL ADAPTIONS

Some animals have evolved to be **NOCTURNAL**. During the day when temperature is at its highest, animals like the coyote rest.

**LONG LIMBS** and **EARS** are also common, animals like the fennec fox have large ears which increase surface area for the release of heat.

**HABITATS** for desert animals also look different. Many, including the desert tortoise, live in underground burrows which have lower temperatures. For the desert tortoise it is estimated that they spend 95% of their time in the burrow.

**STORING FAT** is also common. For example, camels store fat in their hump which they break down into water when needed.

Alternative means to either access **WATER** or preserve it. Cactus mice, unsurprisingly, get their water from cactus fruits whilst kangaroo rats don't sweat and have concentrated urine – all to preserve water.

The camel is full of adaptations, to block sand, it has triple eyelids, long eyelashes and can close its nostrils. To walk across sand, they have large flat feet to increase surface area and distribute weight so not sinking.

## PLANT ADAPTIONS

**PLANT ROOTS** have developed two possible adaptations, either long to reach deep water supplies (mesquite roots can reach 50m) or wide and near the surface to absorb as much water as possible during rainfall (prickly pear roots).

Many, like the cactus, are **SUCCULENTS**. They have large, fleshy stems in which water is stored along with thick waxy skin to reduce transpiration (water loss).

**LEAVES** have also adapted, some plants grow very small leaves or spines which reduce surface area for transpiration. As a bonus, some plants have developed spines that contain toxins to protect the plant from predators.

Some plants, like the brittlebush, have changed how they release seeds. In the desert, they have evolved to only **GERMINATE** after it rains! If it is too dry, the seeds will stay dormant.

Sticking with seeds and new plants, many have evolved so that when they start to grow, they do so **RAPIDLY** meaning they reach full size very quickly.



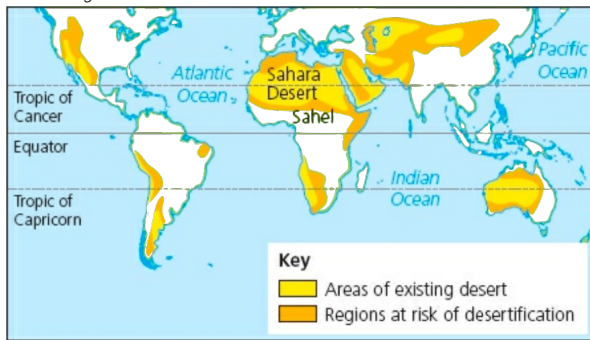


## WHAT IS 'DESERTIFICATION'?

This is where land degrades, making it drier and less productive. Desertification occurs when vegetation dies or is removed, meaning that exposed soil is easily removed by wind or water as there are no roots to hold it together. Nutrients in the soil are therefore lost, making it unproductive. Eventually the ground becomes sandy, dusty, stony or bare rock.

## WHERE IS AT RISK?

It is estimated that a third of the world's land is at risk of desertification. Most of these areas are on the borders, or margins, of existing deserts like the Sahel on the margin of the Sahara Desert where an estimated 100 million people live in low income communities. Perhaps most worryingly, it is estimated that nearly one billion people live in the regions most at risk of desertification.



## WHAT CAUSES DESERTIFICATION?



**CLIMATE CHANGE - RAINFALL:** in areas with already low rainfall, this is expected to become worse as the climate changes meaning even less rainfall. Less rain means less water which can affect plant growth and cause more to die, exposing soil and causing desertification.



**CLIMATE CHANGE - TEMPERATURE:** more places in the world will experience higher temperatures as global temperature increases. This will cause more water to evaporate in areas of higher temperature, drying out soils and exposing the soil so that plants struggle to grow.



**OVERUSE FOR FARMING:** humans use land for cattle and farming. Overgrazing is the result of too many cattle eating plants quicker than they can regrow which exposes soil and means nutrients are lost. Over-cultivation is when crops are planted in the same area continually and remove all nutrients from the soil, meaning nothing can grow there.



**HUMAN USE OF FUEL WOOD:** many people in at risk areas rely on wood for fuel. However, as most of these regions are arid (dry) removing the wood also removes the protection trees offer soil which leads to soil being exposed and increased soil erosion.



**POPULATION GROWTH:** more people means more resources are needed, be that fuel wood or farming land. All of this puts more pressure on the land and can start the process of desertification.

## REDUCING THE RISK OF DESERTIFICATION



**REDUCE WATER USAGE IN FARMING** by using crops that require little water to grow. Examples include millet, sorghum or olives.



**CHANGES TO IRRIGATION** have seen farmers use drip irrigation which only reduces small amounts of water and reduces the risk of soil being washed away.



**SOIL MANAGEMENT** is implemented by allowing fields to rest and rotating crops. For fields left to rest, they can recover the nutrients lost to crops whilst in rotating crops, they ensure that the same nutrients are not always taken from the same fields. Additionally, compost is now used to provide extra nutrients.



Using **APPROPRIATE TECHNOLOGY** has also helped to reduce the risk. As most deserts are in low income countries, solutions using materials affordable and accessible for that region are vital. For example, in Burkina Faso 'magic stones' have been used to build low walls and prevent water from escaping along with soil.

**STORE WATER** more effectively to reduce soil erosion has meant the use of low walls to create ponding banks in which water is trapped and stored. A variation of this in Badia, Jordan saw walls created on slopes to prevent water flowing away. It is then used to irrigate plants such as the *atriplex* which holds the soil together and provides food for animals.

**TREE PLANTING** is also used. These new trees act as windbreaks which reduces soil erosion whilst also stabilising the desert sand and supporting farms by providing shade for crops which reduces temperature and evaporation rates.

**NATIONAL PARKS** have also been created by governments to protect the most at risk areas from further desertification. This includes Zion National Park in Nevada which was created in 1919 to protect a desert canyon near Las Vegas.

**PRACTICE QUESTION 1:** "DESERTIFICATION IS LARGELY CAUSED BY POOR LAND MANAGEMENT." USE EVIDENCE TO DISCUSS THIS STATEMENT. (6 MARKS)



SCAN ME

BBC Bitesize Revision  
Video on Deserts and  
Biomes

Documentary on the  
Great Green Wall  
strategy in the Sahel



SCAN ME

## LOCATION



It stretches across north-west India and Pakistan with the majority in the Indian state of Rajasthan.

Covers an area of about 200,000km<sup>2</sup>

## KEY FACTS

- The 18th largest hot desert in the world, approximately 500mi (800km) long, and 250mi (400km) wide.
- It is the most populated desert in the world with 83 people per km<sup>2</sup>.
- Rainfall in the Thar Desert is low - typically between 120 and 240mm per year.
- The desert is very dry and often hot - the average temperature is well above 30°C and day time temperatures can top 50°C! It is becoming increasingly common for the area to hit temperatures as high as 53°C in July!



In-depth documentary on the Thar Desert

SCAN ME

## OPPORTUNITIES IN THE THAR

**RESEARCH** Scientists at the Central Arid Zone Research Institute have developed a hardy breed of plum tree called the Ber tree. It produces large fruits and can survive in low rainfall conditions. The fruits can be sold and there is the potential to make a decent profit.

**FORMING** The main form of irrigation in the desert is the Indira Gandhi Canal. Constructed in 1958 with a total length of 650km, it benefits the cities of Jodhpur and Jaisalmer by irrigating over 3,500km<sup>2</sup> for farming. Commercial farming can therefore produce pulses, sesame, mustard, maize, cotton and wheat for sale and export.

**MINERAL EXTRACTION** The desert region has valuable reserves of gypsum (used in making plaster for the construction industry and in making cement), feldspar (used to make ceramics) and kaolin (used as a whitener in paper).

**TOURISM** The Thar Desert has become a popular tourist destination. Desert safaris on camels, based out of Jaisalmer, have become particularly popular. Local people benefit by acting as guides or rearing and looking after camels.

**ENERGY** It has come to provide an abundant amount of energy resources for the region. This includes the Jaisalmer Wind Farm along with solar, coal and oil energy.

## CHALLENGES OF THE THAR

**POPULATION** It is the most densely populated desert in the world, with a population density of 83 people per km<sup>2</sup>, and the population is increasing. This is putting extra pressure on the fragile desert ecosystem.

**WATER MANAGEMENT** Sources of water in the desert are limited due to low rainfall and only a small number of traditional water stores, including aquifers which are often salty. This has also worsened as excessive irrigation in some places has led to waterlogging of the ground. Where this has happened, salts poisonous to plants have been deposited on the ground surface.

**SOIL EROSION** Overcultivation and overgrazing have damaged the vegetation in places, leading to soil erosion by wind and rain. Once eroded away, the soil takes thousands of years to re-form.

**TEMPERATURE** Extremely high temperatures make physical work by farmers hard, causes high levels of evaporation leading to soil erosion and has led to limited biodiversity in the area.

**ACCESS** Deserts are isolated places with few transport links to them. Roads are rare as the temperature can reach high enough to melt the tarmac. This means that many places in the desert are only accessible by camel.

## SUSTAINABLE MANAGEMENT

In 1977, the government-funded **DESERT DEVELOPMENT PROGRAMME** was started. Its main aims are to restore the ecological balance of the region by conserving, developing and harnessing land, water, livestock and human resources. In Rajasthan, it has been particularly concerned with developing forestry and addressing the issue of sand dune stabilisation.

The sand dunes in the Thar Desert are very mobile, meaning they have become a focus for **STABILISATION**. In some areas, they form a threat to farmland, roads and waterways. Various approaches have been adopted to stabilise the sand dunes, including planting blocks of trees and establishing shelterbelts of fences and trees alongside roads and canals. This has often taken the form of planting the *Prosopis cineraria* which develops strong roots.

**PRACTICE QUESTION:** SUGGEST TWO REASONS WHY IRRIGATION IS IMPORTANT FOR THE FUTURE DEVELOPMENT OF THE THAR DESERT. (4 MARKS)