

### What is an ecosystem?

An ecosystem is a natural environment and includes the flora (plants) and fauna (animals) that live and interact within that environment. Flora, fauna and bacteria are the biotic or living components of the ecosystem. Ecosystems are dependent on the following abiotic or non-living components:

- climate - the temperature and amount of rainfall are very important in determining which species can survive in the ecosystem
- soil - the soil type is important as this provides nutrients that will support different plants
- water - the amount of water available in an ecosystem will determine what plants and animals can be supported

### Changes to ecosystems

Ecosystems are very sensitive to change. The living and non-living components of the ecosystem can be altered by either natural factors or human management.

Changes to the ecosystem caused by natural factors include:

- drought
  - flood
  - fire
  - disease
- Changes to the ecosystem caused by human management include:
- introducing more fish (fish stocking)
  - altering the drainage of the land which may influence the amount of water
  - changing the pH level of the water
  - altering the nutrient levels of the water if fertilisers are leached into the water resulting in eutrophication

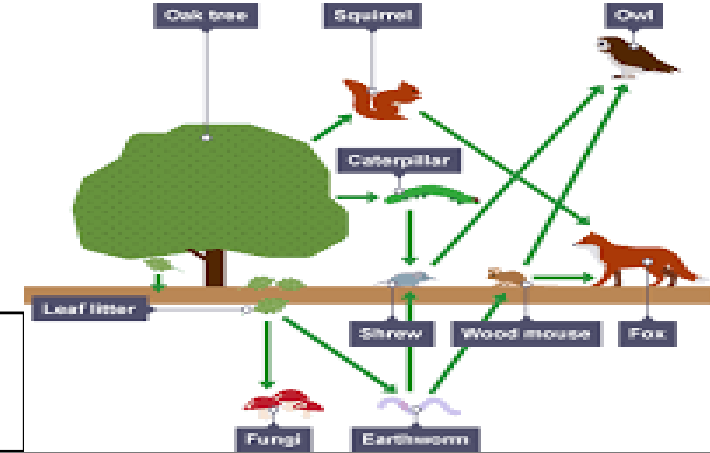
### The food chain

A food chain shows how each living thing gets food. In a food chain, energy and nutrients are passed from one organism to the next. The producer provides the basic source of food which other organisms, the consumers, then feed on.

- E.g. for Sankey Valley: common oak → acorns → squirrel

### The food web

This includes all of the connections between producers and consumers in an ecosystem. The food web shows how interconnected all of the different organisms are.



# Ecosystems

## Case Study of a Small Scale Ecosystem-Sankey Valley, Blackbrook, St Helens, Merseyside.

- The UK's climatic classification is *cool temperate*
- It lies in the temperate zone and its northerly latitude makes it cool
- Hundreds of years ago most of the British Isles was covered in mixed deciduous woodland

### **Temperate Deciduous Woodland Layers**

- Tallest trees-oak and beech can reach 30m high
- Smaller silver birch trees and younger species grow below the canopy
- Growth of a shrub layer of brambles is limited
- Ground cover is rich in bracken, grass and low growing green plants
- Species include bluebells and wood anemones, flowering in May

### Characteristics of World Biomes

- Tundra - found near the North and South poles. Very few plants and animals can survive here.
- Taiga (coniferous forest) - found in Scandinavia, Russia and Canada. Evergreen trees thrive in this cool temperate climate.
- Temperate deciduous forest - found across Europe and in the USA. These trees lose their leaves every year and thrive in mild and wet conditions known as a temperate maritime climate.
- Temperate grassland - found in Hungary, South Africa, Argentina and the USA. Consists of grass and trees that thrive in a temperate continental climate of moderate rainfall and mild conditions.
- Chaparral or evergreen hardwood (Mediterranean) - found around the Mediterranean Sea, around Perth and Melbourne in Australia and California in the USA.
- Desert - found near the Tropics of Cancer and Capricorn. Conditions here are very hot and dry. Plants and animals are specially adapted to survive in the harsh conditions.
- Tropical rainforest - found near the Equator. The climate is hot and humid and many different species can be found here.
- Savannah grassland - found mainly in central Africa, southern India, northern Australia and central South America. Long grasses and a few scattered trees are found in these hot and dry conditions.

Ecosystems change gradually between the Equator and the Poles

What is an ecosystem?

An ecosystem is

- climate –
- soil -
- water -

Changes to ecosystems

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The food chain

- E.g.  
The food web

# Ecosystems

Case Study of a Small Scale Ecosystem-

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**Temperate Deciduous Woodland Layers**

Characteristics of World Biomes

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Ecosystems change gradually between

### The global distributions of ecosystems

The distribution of large-scale ecosystems (biomes) is determined by climate. Latitude, air pressure and winds are important factors that determine the climate of a place.

#### Latitude

- Latitude is one of the most important factors in determining global climate patterns.
- In the lower latitudes, such as the tropics, temperatures are the highest. This is because the sun's rays travel a shorter distance to the Equator and are therefore more concentrated.
- However, in the higher latitudes, such as the polar regions of the world, temperatures are lowest. This is due to the sun's rays travelling a longer distance and being spread over a wider area of the Earth's surface. When these rays approach the Earth, they do so at a sloping angle, resulting in lower surface temperatures.

#### High and low air pressure

- Differences in temperature lead to variations in air pressure around the world. Low-pressure areas are created when air rises. This is called low pressure because the weight of the air above the Earth's surface is lower than average. High-pressure areas are created when air sinks. This is called high pressure because the weight of the air is above average when it sinks to the Earth's surface.

Low-pressure areas are associated with cloud and precipitation (rainfall) because:

- as the air rises it cools, condenses and forms clouds
- the water droplets in the clouds increase in size
- they eventually become too heavy to be held and fall as precipitation

The air above the Equator is very hot and rises, creating an area of low pressure. The Equator experiences high amounts of rainfall due to this rising air resulting in a warm and wet equatorial climate (eg Amazon and Congo tropical rainforests).

High-pressure areas are associated with dry, warm and settled weather conditions. This is because sinking air does not result in precipitation

### Adaptations

#### **Plant adaptations**

The following adaptations allow plants to survive in the conditions of the rainforest.

- Lianas - these are woody vines that have roots in the ground but climb up the trees to reach the sunlight. Their leaves and flowers grow in the canopy.
- Tree trunks - these are tall and thin to allow trees to reach the sunlight. The bark on these trees is smooth to allow water to flow down to the roots easily.
- Drip tips - plants have leaves with pointy tips. This allows water to run off the leaves quickly without damaging or breaking them.
- Buttress roots - large roots have ridges which create a large surface area that help to support large trees.
- Epiphytes - these are plants which live on the branches of trees high up in the canopy. They get their nutrients from the air and water, not from the soil.

# Tropical Rainforests

### Characteristics of tropical rainforests

Tropical rainforests have distinct characteristics that support a wide variety of different species. This means that they have a high biodiversity. The biotic or living components of the ecosystem and the abiotic or non-living components of the ecosystem depend on one another - a change in one leads to a change in the other.

#### Climate

- Very wet with over 2,000 mm of rainfall per year.
- Very warm with an average daily temperature of 28°C. The temperature never drops below 20°C and rarely exceeds 35°C.
- The atmosphere is hot and humid.
- The climate is consistent all year round. There are no seasons.
- Soil
- Most of the soil is not very fertile.
- A thin layer of fertile soil is found at the surface where the dead leaves decompose.
- It is red in colour because it is rich in iron.
- Due to heavy rainfall the nutrients are quickly washed out of the soil.

#### Plants and animals

- The warm and very wet climate provides perfect conditions for plant growth.
- The wide range of plant species supports many different animals, birds and insects.
- Species have adapted to the conditions of the rainforest, eg trees and plants have shallow-reaching roots to absorb nutrients from the thin fertile layer in the soil.

#### Structure of a tropical rainforest

A tropical rainforest is made up of the following layers:

- ground level
- shrub layer
- under canopy
- (main) canopy
- emergents

### Animal adaptations

Many animals have adapted to the unique conditions of the tropical rainforests.

- The sloth uses camouflage and moves very slowly to make it difficult for predators to spot. A sloth hangs from a tree.
- The spider monkey has long, strong limbs to help it to climb through the rainforest trees.
- The flying frog has fully webbed hands and feet, and a flap of loose skin that stretches between its limbs, which allows it to glide from plant to plant.
- The toucan has a long, large bill to allow it to reach and cut fruit from branches that are too weak to support its weight.

### Location of Tropical Rainforests

- Tropical rainforests are located between the Tropic of Cancer and the Tropic of Capricorn
- They are found in South America, Africa, Southern Asian and Northern Australia.

### Climate of Tropical Rainforests

- Over 2000mm of rainfall, annually
- Temperatures are generally between 20°C and 35°C

<div><div><div><u>The global distributions of ecosystems</u></div><div><div><u>Latitude</u></div><div><u>High and low air pressure</u></div><div><u>Low-pressure areas are associated with cloud and precipitation (rainfall) because</u></div></div></div></div> <div><div><div><u>Adaptations</u></div><div><div><b>Plant adaptations</b></div><div>The following adaptations allow plants to survive in the conditions of the rainforest.</div><div><div><div>• Lianas –</div><div>• Tree trunks –</div><div>• Drip tips –</div><div>• Buttress roots –</div><div>• Epiphytes –</div></div></div></div></div></div>	
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### Threats to the tropical rainforest

The tropical rainforests of the Amazon Basin face the threat of deforestation. Deforestation is happening due to the following reasons:

- **Farming** - large areas are cleared for pastoral farming. As the global demand for meat has increased many cattle farms have opened in the Amazon Basin for beef farming. Arable farming is also responsible for the loss of tropical rainforest as many farmers are clearing land to grow cash crops, such as soya beans.
- **Logging** - tropical rainforests are cut down so that valuable trees like mahogany can be accessed and sold for timber to make furniture. Other trees are cut down for making paper products.
- **Mining** - the Amazon Basin is rich in natural resources such as iron ore, copper, tin, aluminium, manganese and gold. This has led to the development of mines which results in the clearance of tropical rainforest. The Carajas mine in Brazil is the world's largest iron ore mine.
- **Roads** - the construction of access roads for farmers, loggers and miners results in large parts of the tropical rainforest being destroyed.
- **Hydroelectric power (HEP)** - The creation of HEP stations in the Amazon Basin has resulted in large areas of forest being flooded to create the reservoirs and dams. The flooding of the Balbina dam in Brazil resulted in the loss of 920 square miles of tropical rainforest.
- **Population** - population growth has resulted in the loss of tropical rainforest as land is cleared to build houses and infrastructure.

### Management of tropical rainforests

Tropical rainforests can be managed in the following ways to reduce deforestation:

- **Logging and replanting** - selective logging of mature trees ensures that the rainforest canopy is preserved. This method allows the forest to recover because the younger trees gain more space and sunlight to grow. Planned and controlled logging ensures that for every tree logged another is planted.
- **Education** - It is important that local people, businesses and politicians understand the true value of the tropical rainforest. Once they understand the value of biodiversity, particularly in terms of tourism, they will be more likely to want to protect it from deforestation.
- **Ecotourism** - this encourages sustainable tourism that creates jobs for local people whilst ensuring that the money generated is used to protect and conserve the tropical rainforest for future generations to enjoy.
- **International agreements** - agreements to protect tropical rainforests have been made between different countries through debt-for-nature swaps. This is when a country which is owed money by another country cancels part of the debt if an agreement is made by the debtor country to ensure the conservation of its tropical rainforests.

# Deforestation

### Impacts of tropical rainforest loss

The impacts of the deforestation of the Amazon Basin include the following:

#### **Soil erosion**

- Once the land is cleared of rainforest vegetation the soil is left bare. When it rains, the nutrients in the soil are washed away. The nutrient cycle stops because there are no plants or trees shedding leaves to replace the nutrients in the soil. The soil is no longer able to support plant life because it is not fertile. The roots of plants and trees no longer hold the soil together so it is easily eroded.

#### **Loss of biodiversity**

- Many different species of plants and animals die because of deforestation. As plants and animals are closely connected through the food web, deforestation this reduces the biodiversity, or variety of species found in the tropical rainforest.

#### **Climate change**

- The trees and plants of the Amazon Basin absorb carbon dioxide during the process of photosynthesis. If there are fewer trees and plants, due to deforestation, then less carbon dioxide is removed from the atmosphere. In this way deforestation contributes to global warming and therefore climate change.

#### **Economic development**

- The creation of mines, farms and roads - which caused deforestation - has also led to economic development. The money created from these enterprises allows a country to generate foreign income, which can then be used to pay off debts or be invested in further development projects.

### Case Study: Human Intervention in the Amazon Rainforest

The short-term benefits of clearing rainforest areas include:

- land for agriculture, houses and roads
- jobs for local workers in road building, logging, agriculture, mining and construction
- the generation of income (often in valuable foreign currency) for the LEDC when wood, minerals, and other resources are sold
- scientific investigation into rainforest plants may provide new food sources and medicines

These benefits, however, come at a cost:

- Clearing rainforest threatens the survival of many plant and animal species and can lead to serious environmental degradation.
- Widespread deforestation damages the whole biosphere (the balance of living and non-living things) with serious long-term consequences

#### **Sustainable management of the forest**

Brazil needs to exploit the Amazon's resources to develop, so leaving it untouched is not an option. Uncontrolled and unchecked exploitation can cause irreversible damage such as loss of biodiversity, soil erosion, flooding and climate change. So, sustainable use of the forest is essential. Sustainable development will meet the needs of Brazil's population without compromising the needs of future generations.

Possible strategies include:

- **Agro-forestry** - growing trees and crops at the same time. This lets farmers take advantage of shelter from the canopy of trees. It prevents soil erosion and the crops benefit from the nutrients from the dead organic matter.
- **Selective logging** - trees are only felled when they reach a particular height. This allows young trees a guaranteed life span and the forest will regain full maturity after around 30-50 years.
- **Education** - ensuring those involved in exploitation and management of the forest understand the consequences behind their actions.
- **Afforestation** - the opposite of deforestation. If trees are cut down, they are replaced to maintain the canopy.
- **Forest reserves** - areas protected from exploitation.
- **Monitoring** - use of satellite technology and photography to check that any activities taking place are legal and follow guidelines for sustainability

Threats to the tropical rainforest

The tropical rainforests of the Amazon Basin face the threat of deforestation. Deforestation is happening due to the following reasons:

Management of tropical rainforests

Tropical rainforests can be managed in the following ways to reduce deforestation:

Deforestation

Impacts of tropical rainforest loss

The impacts of the deforestation of the Amazon Basin include the following:

- Soil erosion
- Loss of biodiversity
- Climate change
- Economic development

Case Study: Human Intervention in the Amazon Rainforest

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**Sustainable management of the forest**

Possible strategies include:

### Characteristics

Hot deserts have an extreme climate and challenging environment. There is very little biodiversity in hot deserts because of the harsh climate. Few species are specialised enough to survive there. Plants and animals which do survive there have adapted to difficult conditions. The biotic or living components and the abiotic or non-living components of the hot desert rely on one another - a change in one will lead to a change in the other.

### **Climate**

- The climate is very hot. Summer day time temperatures can exceed 40°C. However, at night the temperature can drop below 0°C.
- The climate is very dry with less than 250 mm of rainfall a year.
- Hot deserts have two distinct seasons: summer, when the temperature ranges between 35-40°C, and winter, when the temperature ranges between 20-30°C.

### **Soil**

- Desert soils are thin, sandy, rocky and generally grey in colour.
- Desert soils are very dry. When it does rain they soak up the water very quickly.
- The surface of the soil may appear crusty. This is due to the lack of rainfall. As it is so hot water is drawn up to the surface of the soil by evaporation. As the water evaporates, salts are left behind on the surface of the soil.

### Desertification

Desertification is the process of land turning into desert as the quality of the soil declines over time. The main causes of desertification include:

- Population growth - the population in some desert areas is increasing. In places where there are developments in mining and tourism, people are attracted by jobs. An increased population is putting greater pressure on the environment for resources such as wood and water.
- Removal of wood - in developing countries, people use wood for cooking. As the population in desert areas increases, there is a greater need for fuel wood. When the land is cleared of trees, the roots of the trees no longer hold the soil together so it is more vulnerable to soil erosion.
- Overgrazing - an increasing population results in larger desert areas being farmed. Sheep, cattle and goats are overgrazing the vegetation. This leaves the soil exposed to erosion.
- Soil erosion - this is made worse by overgrazing and the removal of wood. Population growth is the primary cause of soil erosion.
- Climate change - the global climate is getting warmer. In desert regions conditions are not only getting warmer but drier too. On average there is less rain now in desert regions than there was 50 years ago.

# Hot Deserts

### Plant adaptations

Plants with adaptations which allow them to live in hot and dry conditions are called xerophytic. The following adaptations allow plants to survive in the hot desert environment: Small leaves - these ensure that less water is lost from the plant by transpiration because the leaf has a smaller surface area.

- Tap roots - these are long roots (7-10 metres long) that reach deep under the ground to access water supplies. The tap roots are much longer and bigger than the plant which is visible at the surface.
- Spines - some plants have spines instead of leaves, eg cactuses. Spines lose less water than leaves so are very efficient in a hot climate. Spines also prevent animals from eating the plant.
- Waxy skin - some leaves have a thick, waxy skin on their surface. This reduces water loss by transpiration.
- Water storage - some plants, known as succulents, store water in their stems, leaves, roots or even fruits. Plants which store water in their leaves and stems also have a thick waxy skin so that they lose less water by transpiration.

### Strategies to reduce desertification

Desertification can be reduced by adopting the following strategies:

- Planting more trees - the roots of trees hold the soil together and help to reduce soil erosion from wind and rain.
- Improving the quality of the soil - this can be managed by encouraging people to reduce the number of grazing animals they have and grow crops instead. The animal manure can be used to fertilise the crops grown. Growing crops in this way can improve the quality of the soil as it is held together by the roots of plants and protected from erosion. This type of farming is more sustainable.
- Water management - water can be stored in earth dams in the wet season and used to irrigate crops during the dry season. This is an example of using appropriate technology to manage water supplies in the desert environment.

Characteristics

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Soil

Desertification

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# Hot Deserts

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Strategies to reduce desertification

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Case study: Economic Activity in Hot Deserts in HICs: Las Vegas, Mojave Desert

Las Vegas is an example of a city which is built in a desert area. Las Vegas is a fast-growing city - the population is expected to double in 40 years. It is located in the Mojave desert - one of America's smallest and driest deserts, which has 15-25 cm of rain per year. To cope with the population's demand for water, Las Vegas diverts the water supply from Lake Mead on the Colorado River.

650,000 people live in the desert. In addition the Mojave desert is used by:

- tourists - visiting areas such as Death Valley
- military, as they test out airplanes and train troops
- hikers and rock climbers
- off-road vehicles - including quad bikes and motorcycles making use of the varied terrain
- solar and wind energy generation
- film makers, attracted by the scenery

The way deserts are used presents many challenges. The off-road vehicles damage the sensitive desert ecosystem. The growth of urban areas threatens the desert area, and pollutes the air. The demand for water increases. The city officials have encouraged the use of recycled waste water and the removal of water thirsty lawns.

Fibre optic cables are routed through the desert connecting urban areas - disrupting the fragile ecosystem and allowing weeds to grow.

Case study: Economic Activity in Hot Deserts in LICs: The Thar Desert, Pakistan

The Thar Desert is one of the major hot deserts in the world. It stretches across north-west India and Pakistan. The desert covers an area of about 200,000 square km, mostly in the Indian state of Rajasthan. Rainfall in the Thar Desert is low - typically between 120 and 240mm per year - and summer temperatures in July can reach 53°. Much of the desert is sandy hills with extensive mobile sand dunes and clumps of thorn forest vegetation, a mixture of small trees, shrubs and grasses. The soils are generally sandy and not very fertile, as there is little organic matter to enrich them. They drain quickly so there is little surface water.

**Economic Opportunities in the Desert**

Subsistence Farming

- Most of the people living in the desert are involved with farming.
- The climate presents huge challenges, with unreliable rainfall and frequent droughts.
- The most successful, basic farming systems involve keeping a few animals on the grassy areas and cultivating vegetables and fruit trees.
- Although a good deal of the farming is subsistence farming, some crops are sold at local markets.
- Over the border in Pakistan's Thar region, the Kohlis tribe are descendants of hunter-gatherers who survived in the desert by hunting animals and gathering fruit and natural products, such as honey.
- This type of subsistence farming is the most basic form of farming and is rarely found in the world today.

# Hot Deserts Case Studies

The Thar Desert faces a number of challenges for the future:

- Population pressure - the Thar desert is the most densely populated desert in the world, with a population density of 83 people per km squared, and the population is increasing. This is putting extra pressure on the fragile desert ecosystem and leading to overgrazing and overcultivation.
- Water management - 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. This is called salinisation and is a big problem in deserts. Elsewhere, excessive demand for water has caused an unsustainable fall in water tables.
- 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.
- Fuel - reserves of firewood, the main source of fuel, are dwindling with the result that many people are using manure as fuel rather than using it to improve the quality of the soil.
- Tourism - although tourists bring benefits such as employment and extra incomes, the environment that they enjoy is fragile and will suffer if tourism becomes overdeveloped.

Irrigation and Commercial Farming

- Irrigation in parts of the Thar Desert has revolutionised farming in the area.
- The main form of irrigation in the desert is the Indira Gandhi (Rajasthan) Canal.
- The canal was constructed in 1958 and has a total length of 650km. Two of the main areas to benefit centred on the city of Jodhpur and Jaisalmer, where over 3,500km squared of land is under irrigation.
- Commercial farming in the form of crops such as wheat and cotton now flourishes in an area that used to be scrub desert. The canal also provides drinking water to many people in the desert.

Mining and Industry

- The state of Rajasthan is rich in minerals.
- 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), phospherite (used for making fertiliser) and kaolin (used as a whitener in paper).
- There are valuable reserves of stone in the area. At Jaisalmer the Sanu limestone is main source of limestone for India's steel industry. Limestone is also quarried for making cement.
- Valuable reserves of the rock marble are now quarried near Jodhpur for use in the construction industry.
- Local hide and wool industries form a ready market for livestock that are reared in the area.

Tourism

- In the last few years, the Thar Desert, with its beautiful landscapes, has become a popular tourist destination.
- Desert safaris on camels, based at Jaisalmer, have become particularly popular with foreigner as well as with wealthy Indians from elsewhere in the country.
- Local people benefit by acting as guides or rearing and looking after camels.

Case study: Economic Activity in Hot Deserts in HICs: Las Vegas, Mojave Desert

The way deserts are used presents many challenges.

Case study: Economic Activity in Hot Deserts in LICs: The Thar Desert, Pakistan

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