Ecosystems

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The world is divided up into ten major ecosystems. These large-scale ecosystems are called *biomes*.

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The world is divided up into ten major ecosystems. These large-scale ecosystems are called *biomes*.

Biomes are large scale ecosystems defined by abiotic factors. These are:

- ✓ climate
- ✓ ***relief***
- ✓ ***geology***
- ✓ soils
- ✓ vegetation

Biome characteristics

Tropical forests are found near the equator in Central and South America, parts of Africa and Asia. They are hot and humid and contain a huge variety of plants and animals - around half of all the world's species. The trees are mostly hardwood. The climate is called equatorial.
Savannah or tropical grasslands are hot and dry, dominated by grass, ***scrub*** and occasional trees. They have two distinct seasons - a dry season when much of the vegetation dies back, and a rainy season when it grows rapidly. They are found in central Africa (Kenya, Zambia, Tanzania), northern Australia and central South America (Venezuela and Brazil).
Desert is the driest and hottest of areas. The world's largest desert is the Sahara in North Africa. Areas of scrub land that border the desert are called **desert scrub**.
Mediterranean climates are not too hot or cold. They are found around the Mediterranean Sea, near Cape Town in South Africa and Melbourne in Australia.
Temperate grasslands are dominated by grass and trees and large bushes are scarce. They have a temperate continental climate - the weather is mild with moderate rainfall. Grasslands include the Puszta in Hungary, the Veldt in South Africa, the Pampas in Argentina and the Prairies in the USA.
Temperate deciduous forests contain trees that lose their leaves and are found across Europe and USA. The weather is mild and wet. The climate is called temperate maritime.
Coniferous forests, containing evergreen trees, are found in Scandinavia, Russia and Canada. They have a cool climate with moderate rainfall called cool temperate.
Mountain areas can be very cold at night and during winter. The growing season is short and at higher levels trees will not grow.
Tundra surrounds the North and South poles. They have an extremely cold climate, with limited numbers of plants and animals able to survive there.

Tropical Rainforest

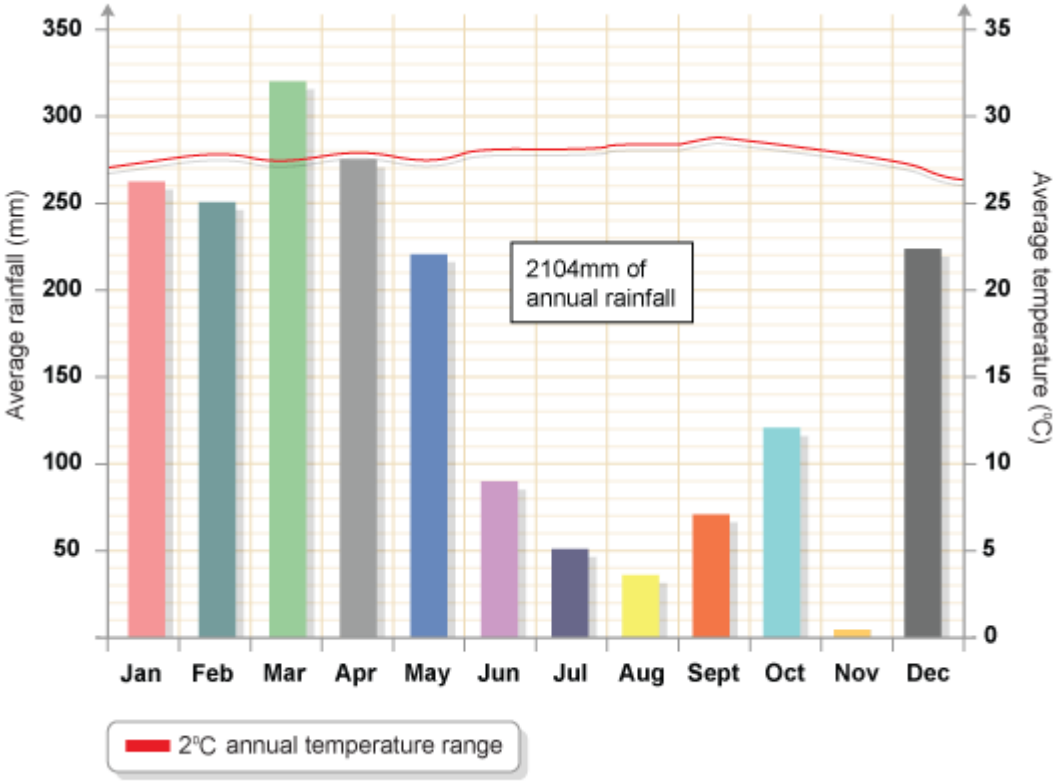
The tropical rainforest is a *biome* with a constant temperature and a high rainfall. The level of *humidity* and density of the vegetation give the ecosystem a unique water and nutrient cycle. Rainforests around the world are threatened by human expansion.

Characteristics and climate

A ***tropical*** rainforest biome is found in hot, humid environments in equatorial climates. They contain the most diverse range and highest volume of plant and animal life found anywhere on earth.

In general, tropical rainforests have hot and humid climates where it rains virtually everyday. The level of rainfall depends on the time of year. Temperatures vary through the year - but much less than the rainfall.

The graph shows average rainfall and temperature in Manaus, Brazil, in the Amazon rainforest. The rainy season is from December to May. Notice how much the rainfall varies over the year - the highest monthly rainfall is in March with over 300mm, while the lowest is in August with less than 50mm. Over the year, the temperature only varies by



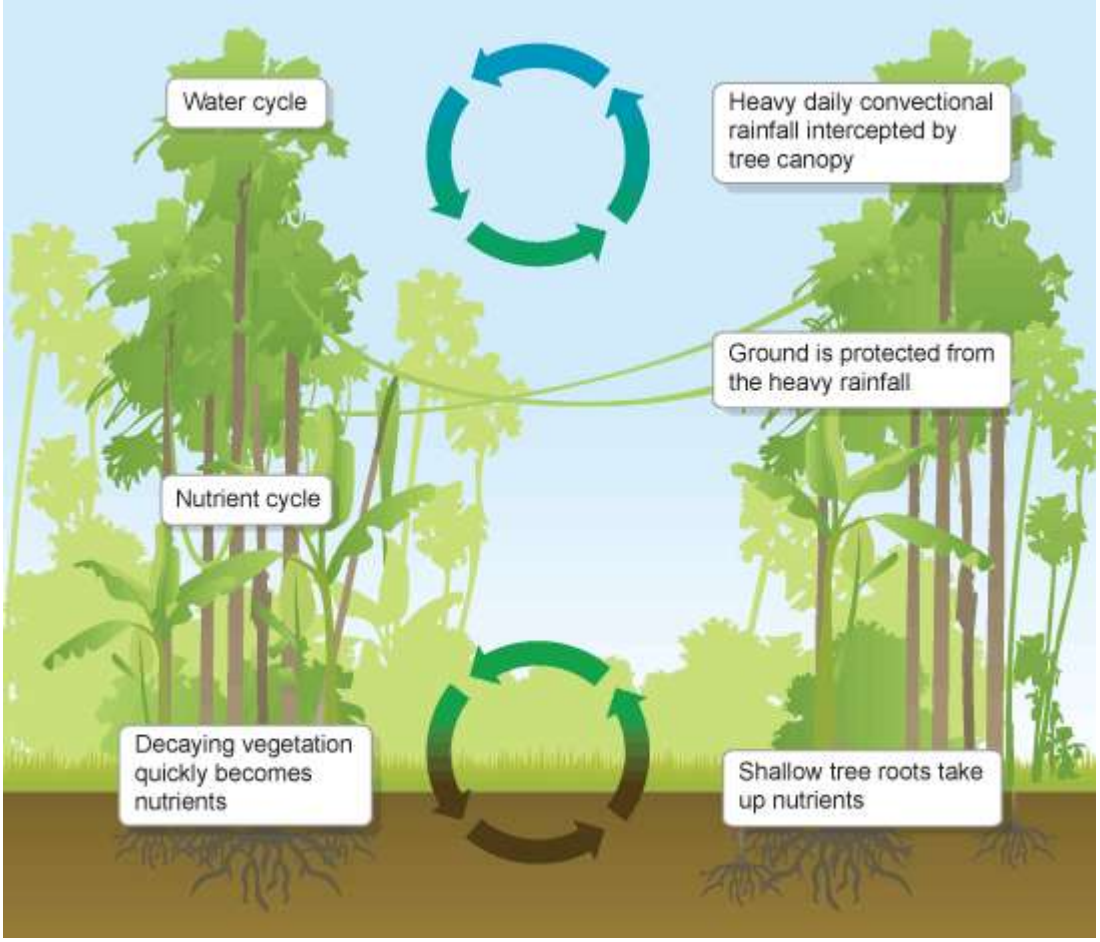
2°C.

Monthly average of rainfall/temp in rainforest area of Manaus, Brazil

Compare these patterns with the one for **savannah grassland** and **coniferous forest**. Make sure you know the differences between them!

Rainforest water and nutrient cycles

Rainforest ecosystems are characterised by heavy ***convectional rainfall***, high ***humidity***, lushness of vegetation and nutrient-rich but shallow soil. These factors give rise to a unique water and ***nutrient cycle***.



Rainforest nutrient and water cycle

Rainforest water cycle

The roots of plants take up water from the ground and the rain is intercepted as it falls - much of it at the canopy level. As the rainforest heats up, the water evaporates into the atmosphere and forms clouds to make the next day's rain. This is convectional rainfall.

Rainforest nutrient cycle

The rainforest nutrient cycling is rapid. The hot, damp conditions on the forest floor allow for the rapid decomposition of dead plant material. This provides plentiful nutrients that are easily absorbed by plant roots. However, as these ***nutrients*** are in high demand from the rainforest's many fast-growing plants, they do not remain in the soil for long and stay close to the surface of the soil. If vegetation is removed, the soils quickly become infertile and vulnerable to erosion.

If the rainforest is cleared for agriculture it will not make very good farmland, as the soil will not be rich in nutrients.

Soils are red due to the high iron and aluminium content. There is a thick layer of leaf litter and decomposing organic matter on the surface.

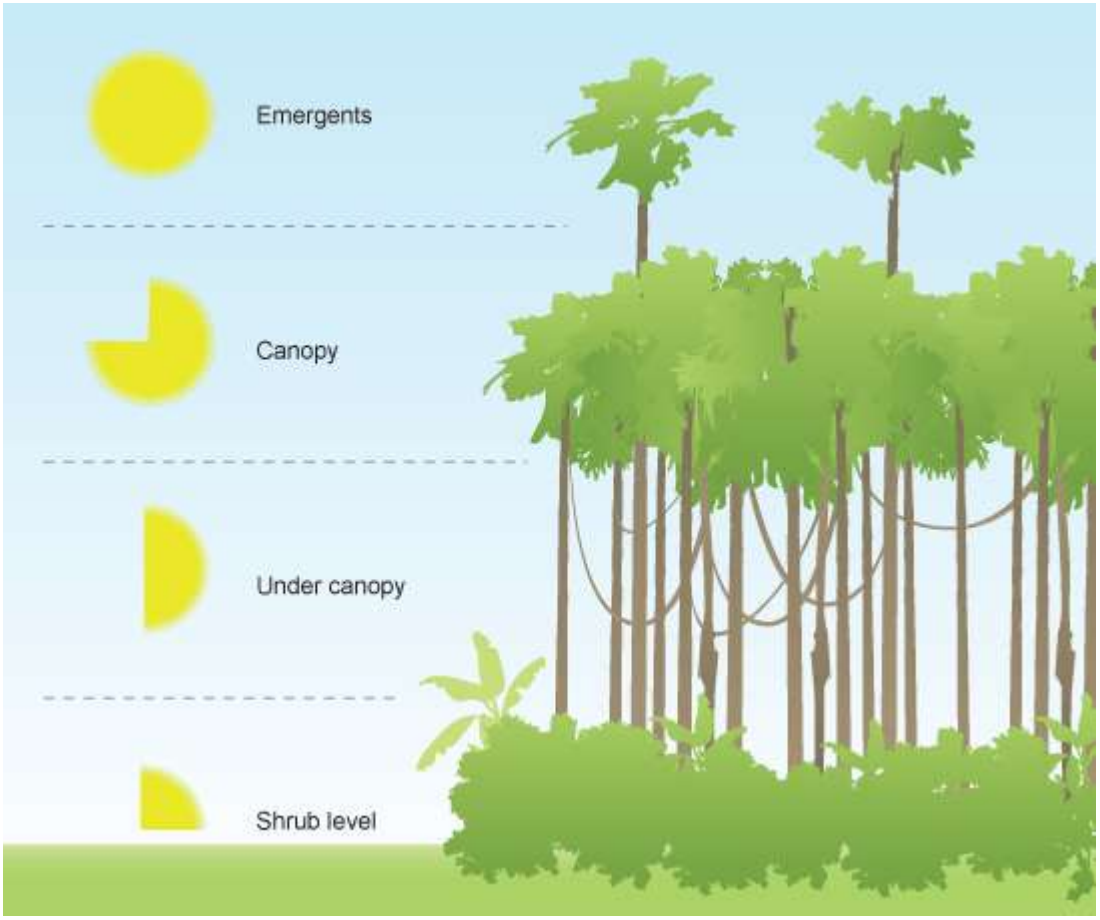
Rainforest vegetation levels

Tropical rainforests have dense vegetation. From ground level up these levels of vegetation are:

- ✓ The **shrub layer**. It is dark and gloomy with very little vegetation between the trees. During heavy rainfalls this area can flood.
- ✓ The **under canopy** is the second level up. There is limited sunlight. Saplings wait here for larger plants and trees to die, leaving a gap in the canopy which they can grow into. Woody climbers

called lianas avoid having to wait for gaps by rooting in the ground and climbing up trees to get to the sunlight.

- ✓ The **canopy** is where the upper parts of most of the trees are found. The canopy is typically about 65 to 130 feet (20 to 40 metres) tall. This leafy environment is home to insects, arachnids, birds and some mammals.
- ✓ **emergents** are the tops of the tallest trees in the rainforest. These are much higher, and so are able to get more light than the average trees in the forest canopy.
- ✓ The graphic shows the levels of rainforest vegetation and the relative amount of sunlight that each one receives.



Vegetation levels in tropical rainforest

Adapting to rainforest life

The vegetation in the rainforest has evolved characteristics which help it to survive in this unique environment.


A fan palm


Buttress roots


Lianas


Strangler fig

Each has adapted to rainforest conditions in a different way.

- ✓ **Fan palms** have large, fan-shaped leaves that are good for catching sunshine and water. The leaves are segmented, so excess water can drain away.
- ✓ Rainforests have a shallow layer of fertile soil, so trees only need shallow roots to reach the nutrients. However, shallow roots can't support huge rainforest trees, so many tropical trees have developed huge **buttress roots.** These stretch from the ground to two metres or more up the trunk and help to anchor the tree to the ground.
- ✓ ***Lianas*** are woody vines that start at ground level, and use trees to climb up to the canopy where they spread from tree to tree to get as much light as possible.
- ✓ **Strangler figs** start at the top of a tree and work down. The seed is dropped in a nook at the top of a tree and starts to grow, using the debris collected there as nourishment. Gradually the fig sends aerial roots down the trunk of the host, until they reach the ground and take root. As it matures, the fig will gradually surround the host, criss-cross its roots around the trunk and start to strangle. The figs branches will grow taller to catch the sunlight and invasive roots rob the host of nutrients. Eventually the host will die and decompose leaving the hollow but sturdy trunk of the strangler fig.

The Savannah

The savannah *biome* is located further away from the equator than the tropical rainforest biome in the central part of Africa and in South America. It is dry, but not as dry as desert areas.

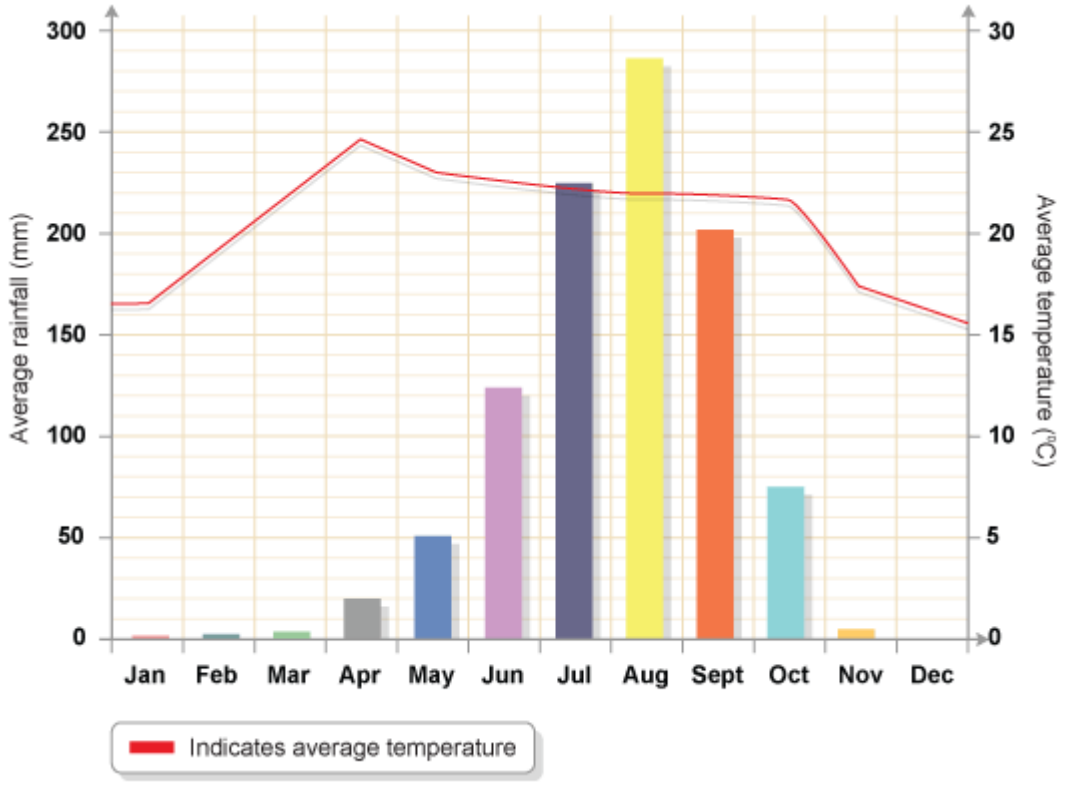
Characteristics

Savannahs - also known as tropical grasslands - are found to the north and south of tropical rainforest biomes. The largest expanses of savannah are in Africa, where much of the central part of the continent, for example **Kenya** and **Tanzania**, consists of tropical grassland. Savannah grasslands can also be found in **Brazil** in South America.

Savannah regions have two distinct seasons - a wet season and a dry season. There is very little rain in the dry season. In the wet season vegetation grows, including lush green grasses and wooded areas. As you move further away from the equator and its heavy rainfall, the grassland becomes drier and drier - particularly in the dry season. Savannah vegetation includes ***scrub***, grasses and occasional trees, which grow near ***water holes***, seasonal rivers or ***aquifers***.

Plants and animals have to adapt to the long dry periods. Many plants are ***xerophytic*** - for example, the acacia tree with its small, waxy leaves and thorns. Plants may also store water, for example the baobab tree) or have long roots that reach down to the water table. Animals may ***migrate*** great distances in search of food and water.

The graph below shows average monthly temperatures and rainfall levels in the savannah region of Mali. Notice how the temperature and rainfall patterns relate to each other - the hottest temperatures come just before heavy rainfall, and the coolest time of the year comes just after the rains. This pattern is typical of savannah climates.

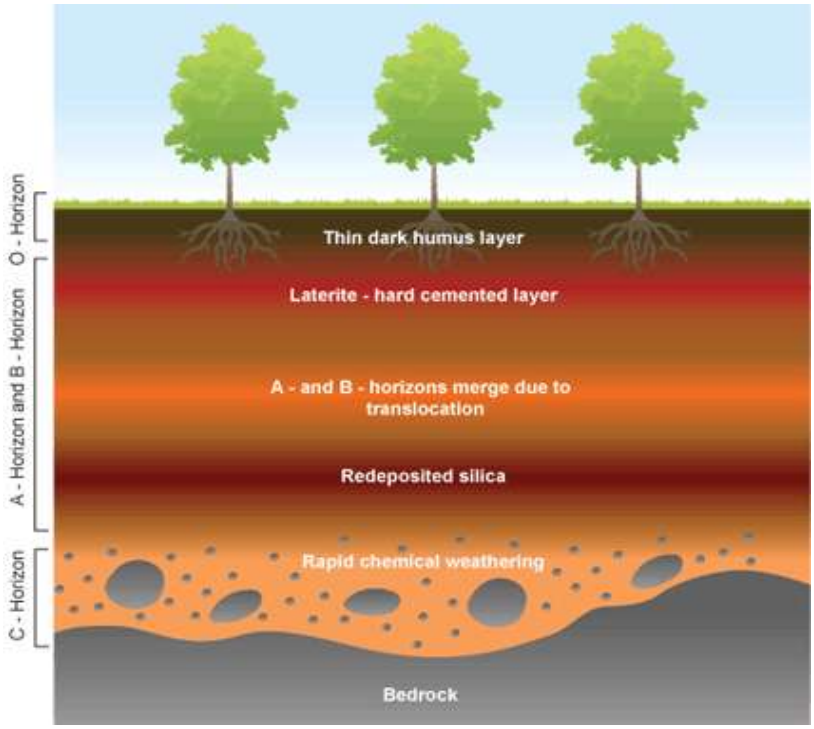


Temperature and rainfall in Mali

Soils

Savannah grassland soils are not very fertile. The nutrients in the soil are found near the surface as they come from decayed organic matter (vegetation) from the previous growing season. This organic matter decays rapidly due to the high temperatures.

Soils tend to be red in colour due to their high iron content. The diagram below shows the different horizons, or layers, of soil in savannah grassland. Plant roots cannot penetrate the hard 'pan' layer in the B-horizon, or subsoil. This restricts vegetation growth.



Savannah soil profile

The Serengeti

Map showing location of the Serengeti

The Serengeti plains of Tanzania are probably the best known African savannah.

There are two main types of vegetation in the Serengeti. Grasses cover the vast open plains of the southeast while in the central region, acacia plants are more common. The Serengeti is rich in wildlife -

including giraffes, zebras, elephants, lions and over 2 million wildebeest. Many of the animals found on the Serengeti can be found nowhere else in the world.

Humans intervene in tropical rainforests in order to bring real or imagined benefits to themselves or the local population.

Case study: human intervention in the Amazon

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.

A village in a cleared area of rainforest

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.

The case study of human intervention in the Amazon looks at some of the issues around rainforest development.

Positive impacts of human intervention

- ✓ Improved **transportation** - new roads and airports. Better transportation means easier access to raw materials like minerals and timber. Rainforest resources can be transported away and sold.
- ✓ **Infrastructure**, hospitals and education can be improved from the money gained from selling natural resources.
- ✓ **Profits** from selling resources can be used to improve a country's infrastructure. For example, profits from from the sale of rainforest resources can be used to build schools and hospitals.
- ✓ **Raw materials**, eg tropical hardwoods such as ebony and mahogany, can be sold for a good price abroad.
- ✓ **Mineral deposits** in the Amazon include bauxite (the main constituent of aluminium), iron ore, manganese, gold, silver and diamonds. Minerals can be sold for high profits.
- ✓ **Large-scale farming** brings money into the country and provides food and jobs for the country's growing population.
- ✓ **Small-scale farming** provides food for rainforest communities and the landless poor of Brazil.

Problems of human intervention

Commercial logging activty

- ✓ New **roads** divide up parts of the rainforest and can cut off connections between different biotic and abiotic systems. For example, a road can stop monkeys such as the golden lion tamarin from travelling to gather food and, in turn, distribute seeds to re-sow plants in the forest.
- ✓ **Land clearance** for farming, transportation and mining can lead to **deforestation.** Hardwood trees take many years to grow so can be difficult to replace.
- ✓ **Fertile soils** that make farming possible are quickly washed away when the forest is cleared. If soil ends up in rivers, this can lead to flooding.
- ✓ **Loss of animal habitat** occurs when trees are cut down. Hence, deforestation can result in endangering animals and plant life, or even causing them to become extinct.
- ✓ **Profits** from large-scale farming and selling resources often go back to MEDCs or large companies and don't benefit the rainforest communities.

Shifting cultivation

Shifting cultivation is a traditional, sustainable method of agriculture which has been practised by indigenous tribes for centuries. It occurs in areas of the Amazon rainforest, Central and West Africa and Indonesia. Along with other aspects of their culture and traditional way of life, it is under threat from large-scale clearance of the forests.

A burning section of the Amazon in Para State, Brazil

A small area of land is cleared and the vegetation burned, providing a source of nutrients from the ash.
For a few years the soil remains sufficiently fertile for the tribe to grow crops.
When the soil's fertility is exhausted, the tribe moves on and clears another small area of forest.
The original area is regenerated, as it receives nutrients and seeds from surrounding vegetation.
As no lasting damage occurs, this method of agriculture is sustainable.
It is sometimes called 'slash and burn' agriculture.

Sustainable management of the forest

Brazil needs to exploit the Amazon's resources to dvelop, 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 Brazils population without compromising the needs of future generations.

Possible strategies include:

- ✓ Agro-forestry – growing trees and crops at the same time. The lets farmers take advantage of shelter from the canopy of trees. This 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 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.

The savannah ecosystem is a delicate balance of interdependent relationships between different species. This balance is easily disrupted by any human intervention, and the smallest change can have knock-on effects on other people, animals, plants and the wider environment.

Desertification

Desertification can result from poorly managed human intervention in the savannah. Areas of desert are created by the destruction of natural vegetation. Causes of desertification include:

- ✓ Removal of vegetation cover.
- ✓ Overgrazing.
- ✓ Uncontrolled fuel wood collection.
- ✓ Unsustainable farming practice and loss in fertility of soil.
- ✓ Excessive tree felling.

The Masai and desertification

Masai women in the Amboseli National Park, Kenya

Many people in central Africa farm to produce the food they eat. The Masai tribe of the Kenyan Serengeti practise ***nomadic farming***, a traditional method of farming allows vegetation to recover from animal grazing whenever the farmers move on to another area.

However, in the past 40 - 50 years the Masai's way of life and farming have been disrupted as a result of commercial pressures and government policies. The ecosystem has also started to suffer.

Commercial farmers, encouraged by government policies, have moved into the best dry-season land and converted it to commercial agriculture. As savannah is converted into cropland, the natural vegetation is removed and the soil's nutrients are rapidly used up.
When the Serengeti National Park was established in the 1950s to conserve wildlife and encourage tourism, human access to the park was restricted and the Masai were excluded from it.
The Serengeti's population has expanded rapidly over the past 30 years. This has resulted in larger herds grazing the grassland and more trees being cut down for fuel. As vegetation is removed there is a risk of soil erosion.
These interventions forced the nomadic Masai farmers onto marginal land. Their traditional pastoral migration patterns have been disrupted and they have been compelled to use smaller areas of land for their cattle. Overgrazing has been the inevitable result.

The Serengeti's increasing population has resulted in a growth in demand for meat, which has led to a rapid increase in meat ***poaching***. Poachers are now killing around 150,000 wildebeest a year - and a dramatic fall in the wildebeest population will cause a knock-on effect throughout the ecosystem.

Tourism in the Serengeti

A lioness stands in front of a safari jeep

Tourism brings income to Kenya and gives tourists a greater understanding of the area's animals and plants. The Serengeti is especially popular for safari holidays, which give tourists a chance to observe the annual migration of the wildebeest and zebra.

Tourism can also have negative impacts on the area. These need to be managed carefully to ensure that the natural environment isn't damaged for future generations.

Positive impacts of tourism

- ✓ **Conservation.** Tourism has supplied the economic incentive to set up national parks and conservation areas which protect wildlife.
- ✓ **Employment.** Tourism has generated jobs, improving the living standards for local communities.
- ✓ **Infrastructure.** Roads, airports and other facilities have been built.
- ✓ **Investment.** Profits from tourism have been invested in education and other programmes for local communities.

Negative impacts of tourism

- ✓ **Environmental damage.** Roads and tracks for safari jeeps can erode grass cover, damaging plants and animals and disturbing local habitats. The removal of trees and other vegetation for the construction of roads can lead to soil erosion.

- ✓ **Inequality.** Often the profits of tourism are reaped by wealthy landowners or the hotel and travel companies in MEDCs.
- ✓ **Loss of traditional cultures.** The Masai's way of life and traditional farming methods have been by the setting up of the Serengeti National Park.
- ✓ **Water cycle damage.** Diverting water for tourists can exploit local water reserves, leaving local people, plants and animals short of water. Tourist hotels sometimes dump waste into rivers.

Sustainable management of the savannah

Conservation is the key to protecting the Serengeti for future generations. A sustainable future could be achieved if the following policies are adopted:

- ✓ Local people employed by investors.
- ✓ Respect for local cultures and customs.
- ✓ Local people should receive some financial rewards from tourism.
- ✓ Sustainable methods are used in order to protect the environment.
- ✓ Improved conservation education programmes for local communities and farmers.

Possible strategies to achieve these goals:

- ✓ Harvesting branches rather then whole trees to prevent deforestation, soil erosion and desertification.
- ✓ Controlled burning of grassland to avoid wildfires.
- ✓ Crop rotation to keep a varied supply of nutrients in the soil and prevent soil erosion and desertification.
- ✓ Stone lines along the soil contours keep it in place, prevent erosion and improve crop yields. Projects such as this can involve the whole community and give them a sense of ownership and responsibility.
- ✓ Managing grazing land to avoid overgrazing, soil erosion and desertification.

Solutions to desertification – some disadvantages

- ✓ Afforestation – newly planted trees need water, which will be a problem in a drought stricken region.
- ✓ Building stone lines – reduces soil erosion, but is a labour intensive process which diverts the community from tasks essential to their survival.
- ✓ Decreasing livestock – solves the problem of overgrazing but requires people to adapt if they rely on cattle or goats for their livelihoods.