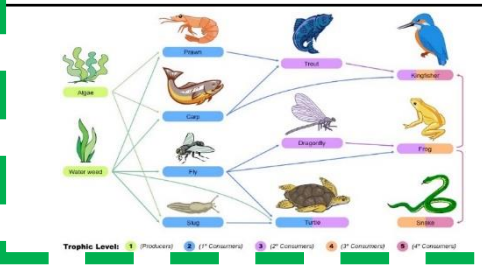
An ECOSYSTEM is a natural system made up of plants, animals and the environment. There are many complex interrelationships (links) between the living (plants & animal) and non-living (atmosphere & soils) components. Ecosystems can be as small as a hedgerow or pond. Larger ecosystems, on a global scale, are known as biomes, such as tropical rainforest or the desert.

| | |
|---|---|
| **Producer** | Organisms that get their food from the natural environment (*photosynthesis*) |
| **Consumer** | Organisms that feed on other organisms (producers and consumers).<br>• herbivores (only eats plants)<br>• carnivores (eat only animals)<br>• omnivores (eats animals and plants) |
| **Decomposer** | Decomposers (fungi, bacteria) feed on dead producers & consumers. This dead material is known as litter. They break down the litter and recycle the nutrients back to the soil. |
| **Food Chain** | A food chain is a single line of linkages between producers and consumers. **It shows what eats what.** |
| **Food Web** | A food web shows all the linkages between the producers and consumers in an ecosystem. **A food web shows what eats what.** |
| **Nutrient Cycle** | The movement of nutrients around an ecosystem. *e.g. when dead material is decomposed, nutrients are released into the soil. The nutrients are then taken up from the soil by plants. The nutrients are then passed to consumers when they eat the plants. When the consumers die, decomposers return the nutrients to the soil. This is the nutrient cycle.* |

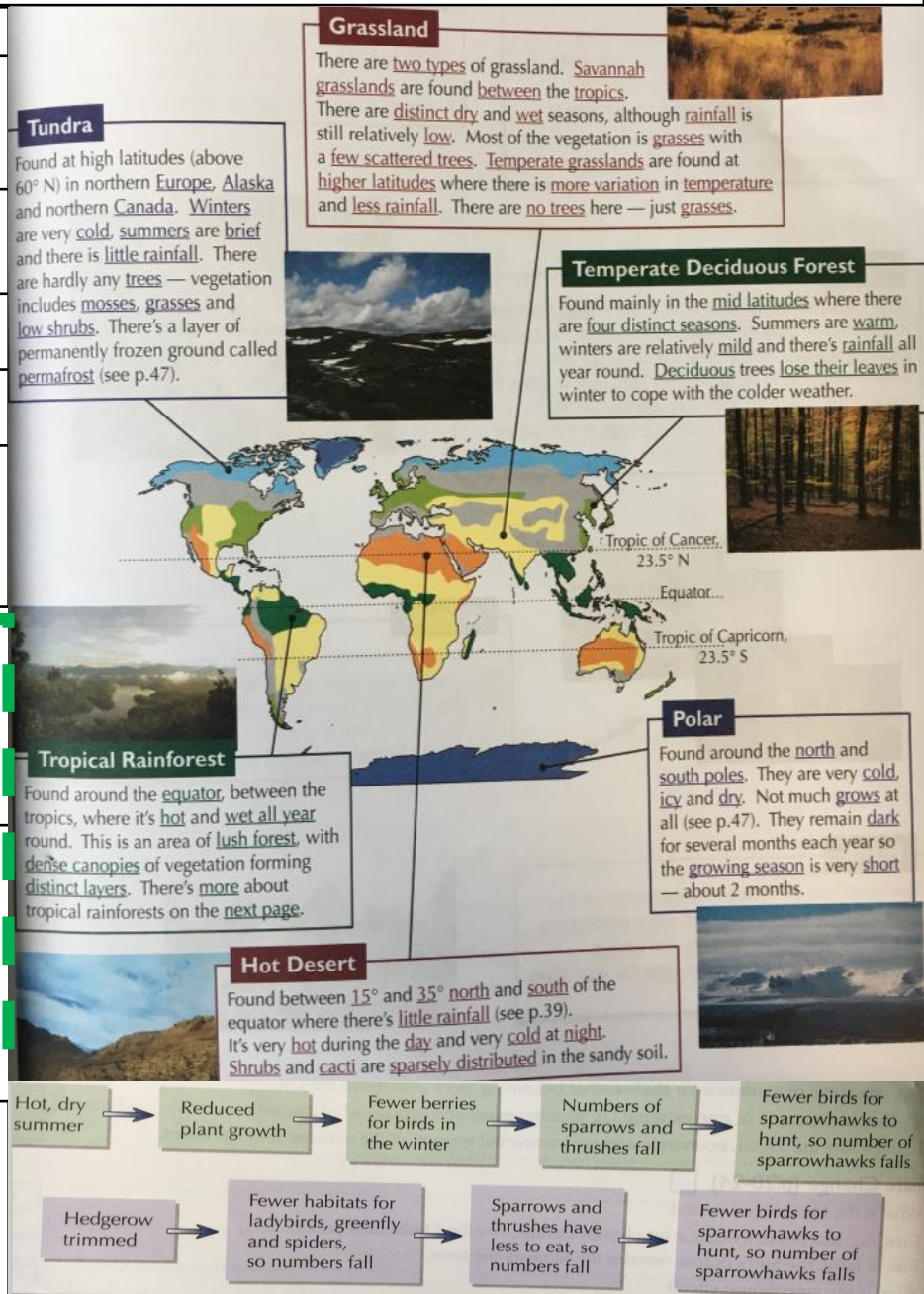
A freshwater pond ecosystem is an example of a small scale ecosystem in the UK. It provides a variety of habitats for plants and animals, due to changes in oxygen, water and light.

It is made up of the plants, fish, birds and other organisms that live within it, as well as the water, sunlight, temperature in the area.

- Producers: algae, marsh marigold, waterlily
- Consumers: frog, heron, fish (e.g. perch), duck, waterworms, rat tailed maggot



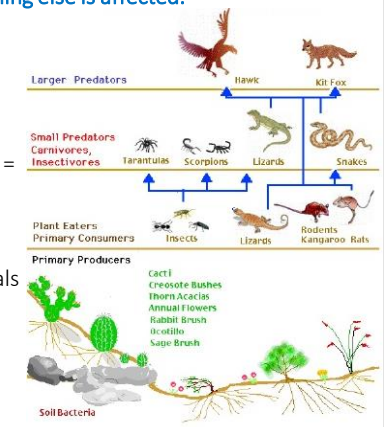
A change in one part of an ecosystem has an impact on other parts of the ecosystem. Some parts of an ecosystem depend on the others (e.g. consumers depend on producers for a source of food) and some depend on them for a habitat. So if one part changes it affects all the other parts that depend on it. Two examples can be seen to the right.

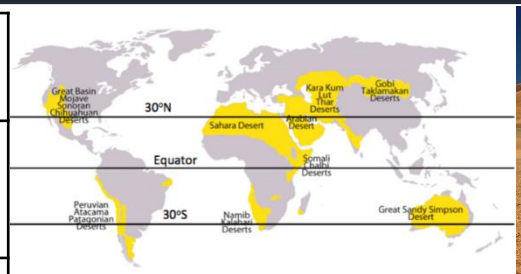


| | |
|---|---|
| **Location** | Deserts are located along the Tropic of Cancer & Tropic Capricorn (23.5° – 30° north and south of the equator latitude),<br>Examples: Sahara Desert: Africa (Algeria, Egypt), Mojave desert: USA |
| **Climate** | Hot and dry: arid.<br>2 seasons (summer and winter).<br>Temperature range: over 40°C in the day – less than 5°C at night<br>Precipitation: less than 250mm per year. In some areas as low as 70mm per year |
| **Vegetation** | Very sparse (cactus, Joshua tree, desert daisy) |
| **Animals** | Very few (lizards, scorpion, camel, wolf spider, kangaroo) |
| **Soil** | Not very fertile as there is hardly any decaying plants to add nutrients to the soil.<br>It is shallow, dry and has a coarse, gravelly texture. |
| **People** | Indigenous people in the desert are usually nomadic farmers who travel with their herd (goats and sheep) in search of food, water.<br>New groups have started to live in the desert to use their natural resources (e.g. oil, farming, tourism, renewable energy) |
| **Biodiversity** | The variety of organisms living in a particular area (plants and animals) |
| **Biodiversity in the desert** | Deserts have low biodiversity.<br>➢ Small areas of the desert, that are near water (rivers, ponds) have higher diversity of plants, animals and humans. |
| **Threats to the desert** | • Desertification on the fringe of the hot desert. This is causing the desert to get larger and the soils to become drier = erosion.<br>• Climate change = more extreme weather (e.g. droughts) = plants/animals unable to survive the even hotter and drier weather = loss of biodiversity. |

**All parts of the desert ecosystem are linked together (climate, soil, water, animals, plants and people). If one of them changes, everything else is affected.**

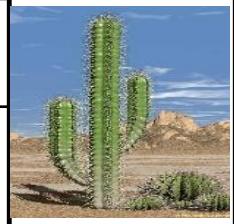
- ➢ Plants get their nutrients from the soils. Animals get their nutrients from the plants.
- ➢ Animals spread seeds in their dung (poo), helping new plants to grow.
- ➢ Hot and dry climate = water is very quickly evaporated = leave salts behind = salinity/salty soils.
- ➢ Very few nutrients are recycled as there is so little vegetation = very litter decay.
- ➢ Sparse vegetation = lack of food = low density of animals
- ➢ Water supplies in the desert are caused due to low rainfall and quick evaporation. As a result humans use irrigation to water their crops using deep wells = less water available for plants and animals.



## VEGETATION ADAPTATIONS

**Cactus**



- Some have deep roots to reach water deep under the ground
- Some have a very shallow horizontal root system, just below the surface, so that it can soak up water before it evaporates.
- Succulent: store water in the stems.
- Thick, waxy skin to reduce water loss from transpiration
- Spines reduce water loss and protect the cacti from predators who might try and steal the water stored in their stem.

**Joshua Tree**

- Deep roots to reach water deep under the ground
- Small needle like leaves to reduce water loss.
- Leaves are covered in a waxy resin to avoid water loss

## ANIMAL ADAPTATIONS

**Camel**

- Large, flat feet to spread their weight on the sand.
- Triple eye lids and long eyelashes keep sand out of their eyes.
- Their colour helps them camouflage (blend in)
- Store fat in their hump, which can be used for energy. They can also break this down into water when needed.

**Lizard**

- Burrow during the hot days and emerge at night to feed.
- Their colour helps them camouflage (blend in)
- Nocturnal – only come out at night when cooler.

**Other adaptations**

- Some animals sit very still in the shade during the hottest part of the day (e.g. fennec foxes).
- Some animals are nocturnal, meaning they burrow and sleep in the hot days and come out during the cooler evenings.

**People use the Sahara Desert in a number of ways. These are known as economic opportunities.**

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| **Mining for Oil and Gas** | **What**: digging under the desert for oil and gas.<br>**Where**: Hassi Messaoud oilfield in Algeria, Sahara Desert, Northern Africa<br>***Good**: 60% of Algeria's GDP comes from oil and gas, Hassi Messaoud employs 40,000 people*<br>***Bad**: must fly 40,000 workers to the remote oilfield, fly out water and food reserves, difficult to drill hundreds of metres beneath desert and hard to construct pipelines 100s of kilometres across the desert to the coastline.* |
| **Solar Panels** | **What**: solar panels are built to make use of the 12+ hours of bright sunshine in the desert<br>**Where**: Tunisia, Northern Africa<br>***Good**: energy is sold to Western Europe = money for development, it is clean renewable energy.*<br>***Bad**: sandstorms destroy solar panels & dusty conditions mean they need cleaning. This requires 10,300 gallons of water per day.* |
| **Agriculture** | **What**: using the River Nile to irrigate land and grow crops (dates, figs and fruit) to feed increasing population (20 to 79 million in last 25 years).<br>**Where**: Next to the River Nile, Egypt, Northern Africa.<br>***Good**: accounts for 13% of Egypt's income, employs 32% of Egypt's labour force.*<br>***Bad**: rapid evaporation of irrigation water, leaves salt crystals = salinity.* |
| **Tourism** | **What**: visit world's largest desert, Egyptian culture, pyramids, camel treks.<br>**Where:** Egypt, Northern Africa<br>***Good**: income for development, employment, development of transport and infrastructure.*<br>***Bad**: pollution from development, overuse of water, cultures are used as entertainment rather than tourists learning about their tradition,* |

**Development in the Sahara Desert is challenging due to:**

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| **Extreme Temperatures** | • Daily temperatures can reach over 40°C, whereas evening temperatures can go below freezing<br>• Hot temperatures can be too hot for tourists. It can also make farming and mining difficult. |
| **Inaccessibility** | • The Sahara is HUGE = people often have to travel long distances, usually by plane which is expensive.<br>• It is difficult to provide services across such a large area<br>• It is difficult to transport products from oil or energy fields, as extensive pipelines have to be built. |
| **Water Supply** | There is very low rainfall in the Sahara Desert (less than 70mm in some places). As a result providing water to workers, tourists or for irrigation difficult. Also 10,300 gallons of water is needed to wash the solar panels eachday. |

**DESERTIFICATION is the process where land gradually turns into a desert. It becomes drier, less fertile and is vulnerable to erosion.**

**Causes of desertification**

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| Climate change | Climate change results in extreme weather, such as droughts.<br>Lack of rainfall = not enough rain for the soils to have moisture and stay healthy. Also plants die due to lack of water = roots no longer hold the soil together = vulnerable to erosion.<br>High temperatures = any water is immediately evaporated leaving the soil very dry. Also salts in the water are left on the soil after the water is evaporated = salty, dry soil that is vulnerable to erosion. |
| Over-grazing | Too many cattle and sheep eat the vegetation = the soil is no longer held together by the plants = vulnerable to soil erosion. |
| Over-cultivation | Population growth = more demand for food.<br>As a result land is being over-farmed. This uses up all the nutrients in the soil, leaving it dry and exposed to erosion. |
| Deforestation | Population growth = increased demand for fuel wood = increased deforestation.<br>The roots therefore no longer bind the soil together and the nutrient cycle is stopped = soil becomes dry and exposed to erosion. |

**Responding to desertification: how can we reduce the risk of desertification?**

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| **Afforestation** (planting trees) | The roots also help to hold the soil together and prevent erosion.<br>When the plants/leaves die, their nutrients are giving back to their soil.<br>They act as windbreakers and therefore reduce wind erosion. |
| **Crop Rotation**<br>**Grazing Rotation** | When farmers allow a field to rest between farming. This allows the soil time to repair and get their nutrients back. This prevents over-cultivation.<br>Move the animals from place to place to reduce the amount of vegetation eaten or reduce the number of farm animals. This prevents over-grazing. |
| **Water Management** | Grow crops that don't need a lot of water (e.g. millet or olives)<br>Use irrigation techniques that use very little water (e.g. drip irrigation) |
| **Appropriate Technologies** | Use cheap, sustainable and easily available materials<br>Earth Dams: collect and store water in the wet season. The stored water is then used to irrigate crops in the dry season.<br>Using Manure: animal manure is used to fertilise the soil by adding nutrients. |

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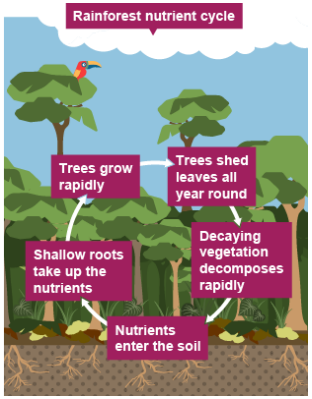
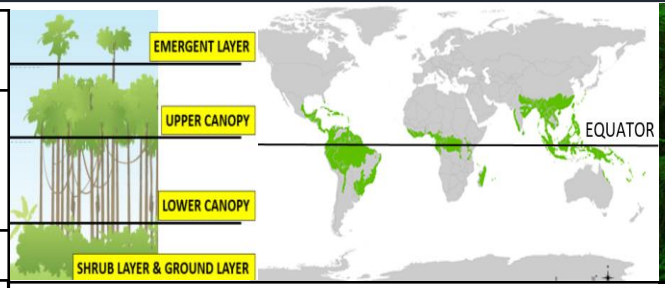
| **Location** | Rainforests are located along the equator (0° latitude).<br>Examples: South America (Brazil), Asia (Indonesia), Africa (Congo). |
| **Climate** | Hot and wet (humid).<br>No seasons<br>Temperature range: 20-30°C (due to direct sunlight from the sun)<br>Precipitation range: 160 – 330mm/month or 2000mm per year |
| **Vegetation** | Very dense and varied (e.g. banana and rubber trees). |
| **Animals** | Very dense and varied (e.g. apes, parrots, jaguars, insects) |
| **Soil** | Not very fertile, as heavy rainfall washes nutrients away. This is known as leaching.<br>Most nutrients are in the top layer of the soil due to nutrient cycling from the decayed leaves. As a result most trees have a shallow root system. |
| **People** | Tribes have lived in rainforests for a long time (sustainable).<br>New groups of people and companies have arrived more recently, trying to make money from the rainforests through logging, energy, mining…etc (unsustainable) |
| **Biodiversity** | The variety of organisms living in a particular area (plants and animals) |
| **Biodiversity in the rainforest** | Deserts have very high biodiversity. Rainforests contain around 50% of the world's plants, animals and insect species. |
| **Threats to the rainforest** | Deforestation is causing a loss of biodiversity in the rainforest, as many animals and plants become endangered or extinct. |

**All parts of the rainforest ecosystem are linked together (climate, soil, water, animals, plants and people). If one of them changes, everything else is affected.**

- The humid climate = dead plants and animals decompose quickly by decomposers (fungi and bacteria) on the forest floor = the nutrients from the decaying plants/animals makes the top layer of the soil very nutrient rich = lots of plants can grow.
- Plants pass on their nutrients when they are eaten by animals There is a lot of vegetation = lots of animals.
- People remove trees (deforestation) = less carbon dioxide is removed from the atmosphere = more greenhouse gases = more climate change.
- Trees absorb water = this water travels through the tree to the leaves = transpiration evaporates water from the trees' leaves to the atmosphere = condensation in the atmosphere creates clouds = precipitation. The trees are one of the main reasons there is so much rainfall in the rainforest.



## VEGETATION ADAPTATIONS

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| **Layers** | The rainforest has four layers (emergent, upper canopy, lower canopy and shrub & ground layer). Vegetation adapts to each layer. |
| **Trees** *(height, buttress roots, bark)* | The trees can grow to over 40 meters high in order to find sunlight.<br>To help support their height, they have buttress roots. These are large root systems above the ground that act as an anchor and support the tall trees.<br>Trees have a smooth, thin bark = helps water to run off easily. |
| **Lianas** | Woody vines that use trees to climb up to the upper canopy where they spread from tree to tree to get as much light as possible. |
| **Leaves** | On the shrub and ground layer, it is very dark due to the canopy. As a result, their leaves have a large surface area to catch as much sunlight as possible.<br>Many leaves have drip tips and a waxy coating. This help shed water easily.<br>Some plants, *e.g. the fan palm*, have large fan-shaped leaves which are segmented so that excess water drains away easily. |

## ANIMAL ADAPTATIONS

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|---|---|
| **Spider monkey** | Have long, strong arms and tails so they can swing between the trees in the upper canopy. Some animals spend their entire lives in the upper canopy. |
| **Leaf-tailed gecko & chameleon** | Are camouflaged so can blend into their surroundings to hide from predators |
| **Jaguar** | Can swim due to high rainfalls and many rivers. |
| **Red-eyed tree frog** | Have suction cups on their feet and hands to help them climb up trees and leaves. |
| **Anteater** | Some animals have adapted to the low light levels in the shrub and ground layer. Have a sharp sense of smell and hearing so they an detect predators without seeing them. This helps them survive in the low light levels in the shrub & ground layer. |

**People use the Amazon Rainforest in a number of ways.**

| | |
|---|---|
| Cattle farming | Clear land for massive, commercial cattle farms. This causes 70% of deforestation in the rainforest. |
| Logging | Cutting down hardwood trees to sell. This causes 3% of deforestation in the rainforest. |
| Hydro-electric energy | Build dam and reservoir to create and sell hydro-electric energy. (e.g. Belo Monte dam in Brazil) |
| Mining | Digging to extract iron ore, aluminum, copper, tin and gold to sell. (e.g. The Carajas Mine in Brazil) |
| Building roads | Logging companies, cattle ranches, farms, mines need roads to reach them and transport products to the coast to export = roads built. |
| Urban growth | Increasing population = increasing urban areas. (e.g. Manaus' pop. Grew 22% between 2000 – 2010 reaching 1.7million) |
| Subsistence farming | Local famers clear the land using slash and burn and grow only enough food for their family to eat. This causes 20% of deforestation in the rainforest. |

**These uses of the rainforest have a number of positive and negative impacts.**

POSITIVE ECONOMIC AND ENVIRONMENTAL IMPACTS

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|---|---|
| Economic | • **Jobs** – mines, farms, power stations, construction. In Peru the Buenaventura mining company employs 3100 people.<br>• **Development**. Money from companies is used to develop Brazil. In 2008 Brazil made $6.9 billion from selling cattle.<br>• **Improved transportation** make trading faster and easier = more is exported. |

There are no positive **environmental** impacts from human use of the rainforest.

NEGATIVE ECONOMIC AND ENVIRONMENTAL IMPACTS

**The Amazon Rainforest is the largest rainforest on earth, covering 8 million $km_2$ of land. Since 1978, 750 000$km_2$ of land has been deforested. This is three times the size of the UK!**

| | |
|---|---|
| Economic | Some famers (e.g. rubber tappers) have lost their job due to deforestation of rubber trees. |
| Environmental | • **Habitat loss** – many animals live in the tree canopy. If the trees are cut down their habitats are lost.<br>• **Loss of animal biodiversity** – plants and animals are endangered or becoming extinct as trees are deforested.<br>• **Climate change** – trees remove $CO_2$ from the atmosphere during photosynthesis. If there are less trees, less $CO_2$ is removed = more greenhouse gases in atmosphere. The Amazon Rainforest stores 100 billion tons of carbon.<br>• **Climate change** – large cattle ranches contain lots of cattle. These release a lot of methane when they fart and poo).<br>• **Soil erosion** – deforested trees cannot hold the soil together. As a result heavy rains wash away the soil (erosion). |

**SUSTAINABILITY IN THE RAINFOREST:** ***Allow people get what they need today, without stopping people in the future getting what they need.***

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| Selective logging | Only some trees are cut down (usually the older ones), rather than cutting down all the trees in an area. As a result the rainforest canopy is saved where many of the animals live. |
| Afforestation | Afforestation is when new trees are planted as others are cut down. In some countries it is law to replant trees. |
| International: debt relief | HICs reduce the amount of debt LICs owe them so that they do not have to use their rainforest resources (trees, mining, cattle farming) to pay back the debt, which all cause deforestation. Unfortunately there is no guarantee the money saved, will be spent on conservation/protection instead. It is therefore better to make a conservation swap that guarantees this.<br>• *e.g. In 2008 the USA reduced the debt that Peru owed them by $25 million. In exchange Peru had to conserve/look after part of their rainforest.* |
| International: carbon sinks | Trees remove carbon dioxide during photosynthesis and are therefore known as carbon sinks. Rainforests are protected due to their role in reducing global warming.<br>• *e.g. The Gola Forest in Sierra Leone (Africa) is protected for its role in reducing global warming, using money from the European Commission, French Government and NGOs.* |
| National parks | Areas are protected from development and deforestation. It is difficult to police these areas through. As a result, illegal logging still occurs.<br>• e.g. The Tumucumaque National park in Brazil is the largest in the world. It protects over 38,000 square kilometres of rainforest. |
| Promoting responsible management | Forest Stewardship Council (FSC) and Rainforest Alliance are organisations that put their logo on hardwood trees that have been deforested in a sustainable way. Therefore consumers can choose products that are not contributing to unsustainable deforestation. |
| Ecotourism – sustainable tourism | Tourist resorts that use sustainable practices to reduce their impact. In Costa Rica eco-tourism is the largest source of income. It protects 21% of the country from development.<br>• *e.g. reduce negative environmental impacts: renewable energies, water tanks, grey water,*<br>• *e.g. improve social impacts: local employees, use local produce and materials. Money goes into local economy. If locals have a job, they do not need to illegally log.* |