GCSE GEOGRAPHY KNOWLEDGE BOOK

Unit 1:
Living with the Physical Environment

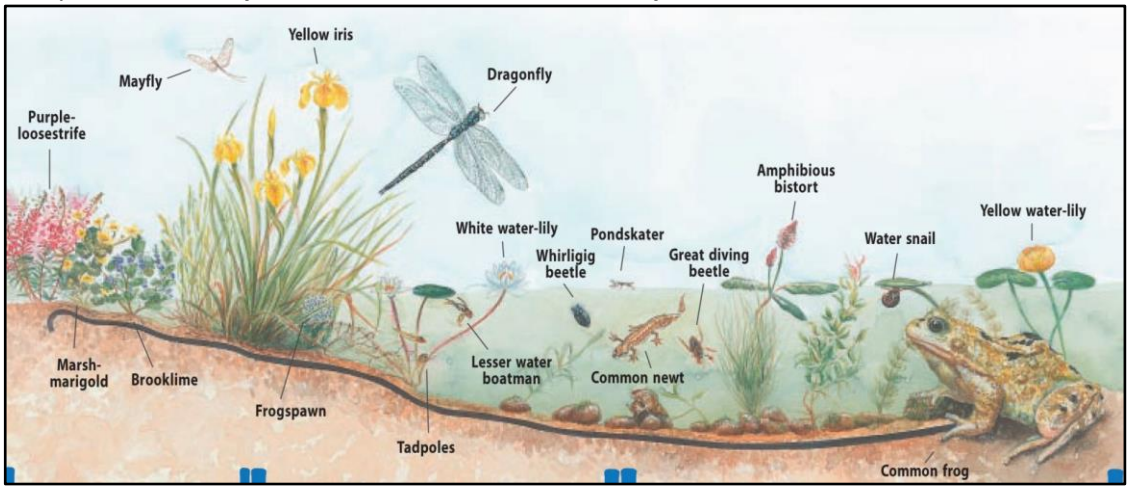
Section B:
The Living World

- Ecosystems
- Tropical Rainforests
- Cold Environments

The information here is what all students MUST know. Use this document as a checklist to identify what is clear to you, what you need to work on and what you can tick off once revised. If you have any doubts or questions, please come and see your teacher – we are happy to help

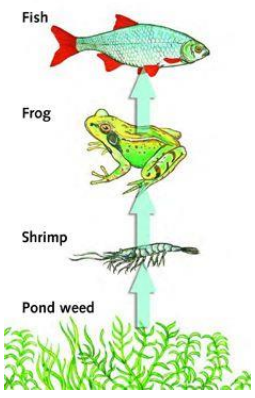
ECOSYSTEMS

Key content	What you need to know
What is an ecosystem?	An ecosystem is a natural system that is made up of plants, animals and the environment in which they live. The components of an ecosystem are interlinked and if one changes, it can have a significant impact on the rest of the ecosystem. **Biotic:** plants, animals, bacteria fungi and **Abiotic:** climate, water, soil. Ecosystems contain **producers, consumers** and **decomposers.**

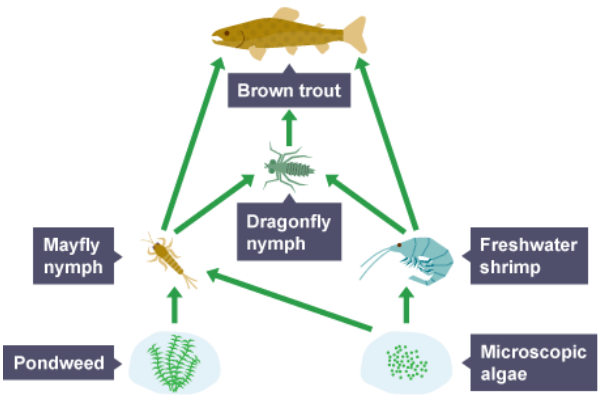


- Above the pond surface: birds and animals breathe oxygen. Food is found at the margins or on the surface
- Pond margin: lots of oxygen and light. Plenty of shelter for insects and small mammals.
- Pond surface: plenty of oxygen and light. Animals breathe through their gills, lungs or skin
- Mid pond: animals breathe through gills or skin. Fish are the main predators. Food is found on the surface
- Pond bottom: little oxygen or light. Plenty of shelter (rotting plants and stones) and flood. Decomposers and scavengers live here.

Food Chain shows direct links between different organisms that rely on each other for food.
Food Web shows a complex hierarchy of plants and animals that rely on each other for food.



Food Chain



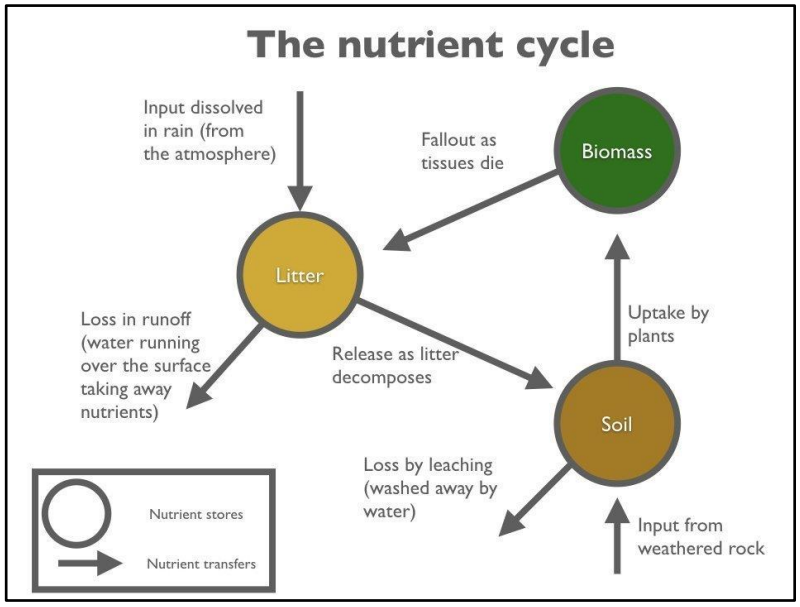
Food Web

What is nutrient cycling?

Nutrient Cycling

Nutrients are foods used by plants and animals and come from two main sources:

- **Rainwater:** washing chemicals out of the atmosphere
- **Weathering of rocks:** releasing chemicals into the soil.



Nutrient cycles are made up of **flows** and **stores.** Stores can vary in size according to which ecosystem they are operating in. e.g. most nutrients are stored in the biomass within a tropical rainforest ecosystem. Nutrients in the litter and soil are so quickly recycled in the hot and humid climate, that the trees and plants contain the most nutrients.

What is the impact of change on an ecosystem?

Ecosystems can take hundreds of years to develop but they can be fundamentally altered overnight by seemingly small changes. An ecosystem's success is dependent on the complex interrelationships that exist within it.

Natural Change:

- Extreme weather events (e.g. floods, droughts)
- Fire (e.g. lightning strikes in forests)
- Climate change and global warming (e.g. coral reef bleaching)
- Spread of invasive species (e.g. Asian Hornet)

Human-induced change:

- Land use change (e.g. deforestation, draining of marshes)
- Chemical alteration to water (e.g. fertilizers leaching into rivers from farms)
- Alteration to soil (e.g. fertilizers and pesticides added to farmland)
- Hunting and trapping (e.g. beaver, wolf, lynx, Auroch, wild boar were all once native to the British Isles but were hunted to extinction)
- Introduction of alien species (e.g rabbits in Australia)

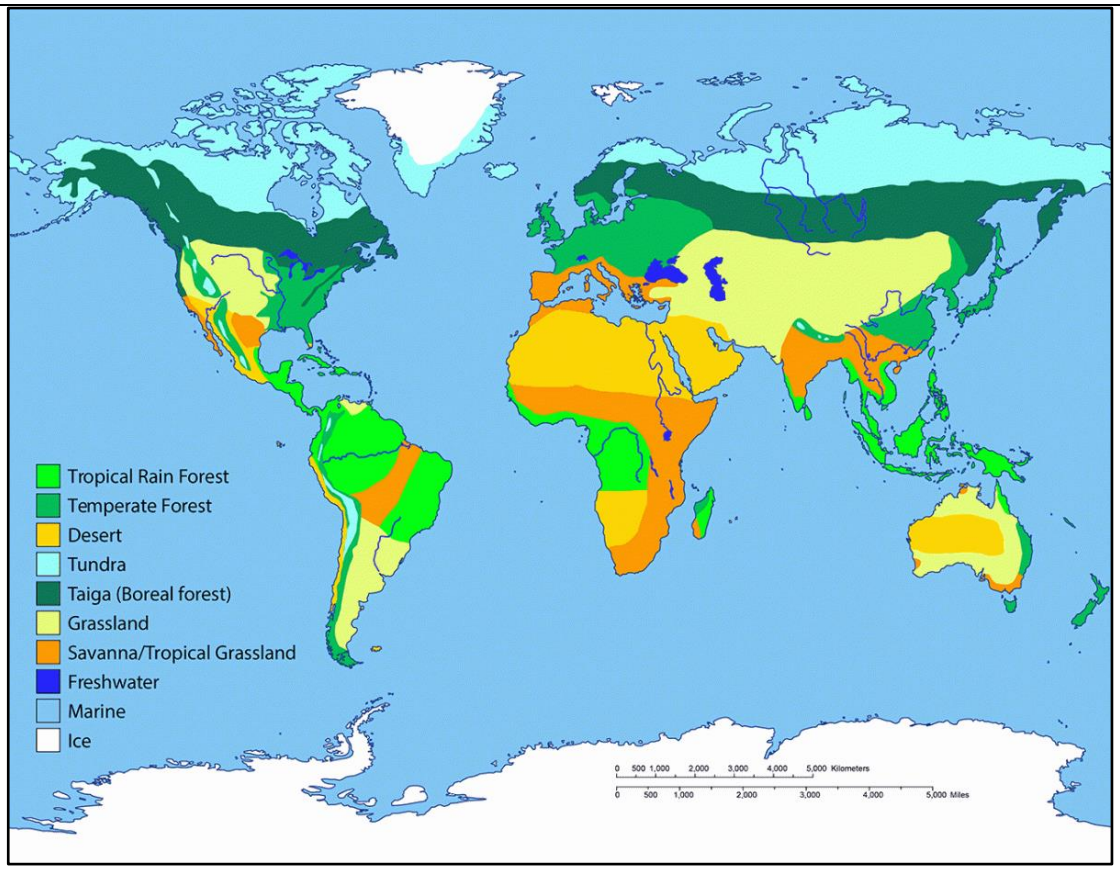
How can changes affect the pond system?

Climate change: heatwaves can affect water levels (lower) and increase competition for available habitat. Temperature increase in smaller ponds can add stress to species.

Fertilisers: runoff from farmland can increase nutrients that promote rapid growth of algae. This starves the pond of oxygen

Alien Species: If a species of predatory fish is introduced (pike, perch) it will quickly consume small fish and frogs and make it harder for other species to predate in the pond. These species would leave, therefore reducing biodiversity.

What are global ecosystems?



Global ecosystems contain millions of species of organisms arrayed in a very complex pattern driven by many interacting physical environmental factors, plant nutrients and other chemical factors, competition between organisms, predation, human disturbance, and other biotic interactions.

A **biome** is an area of the planet that can be classified according to the plants and animals that live in it. ... A biome is a specific geographic area notable for the species living there. A biome can be made up of many ecosystems. For example, an aquatic biome can contain ecosystems such as coral reefs and kelp forests

The main factor affecting the pattern of global ecosystems is **climate.** Most global ecosystems form latitudinal belts across the world.

<u>Biome types</u>

Tropical Rainforest: Located close to the equator. The tropical rainforest receives high temperatures and heavy rainfall associated with the equatorial low-pressure belt, creating ideal conditions for plants to grow (the sun's rays are concentrated at this latitude, heating moist air which rises and lead to heavy rainfall). Rainforest cover 6% of the Earths land surface. More than half the world's species of plants and animals live in this global ecosystem. A quarter of all medicines come from rainforest plants.

Desert: Located roughly 30° north and south of the Equator close to the tropics of Cancer and Capricorn. Deserts cover on fifth of the world's land surface. Hot deserts are associated with the sub-tropical high pressure belts. Sinking air stops clouds from forming, resulting in high day time temperatures, low nighttime temperatures and low rainfall. Plants and animals have to be well adapted to survive in these conditions.

Deciduous Forests: These grow in many places at higher latitudes. Found in Western Europe, where rain bearing storms arrive regularly thanks to the jet stream, and the east coasts of Asia, North America and New Zealand. The sun's rays are weaker at this latitude. As a result of these conditions deciduous trees shed their leaves in winter to retain moisture.

Coniferous Forests: Found at 60 north where winter temperatures are extremely cold due to lack of isolation. Due to the earth's tilt there is no sunlight for some months of the year. Coniferous trees have evolved needle leaves that reduce moisture and heat loss during the cold dark winter months. They also are known as evergreens as they retain their leaves to maximise photosynthesis during the brief summer months.

Tundra: These areas are found at the Arctic Circle to about 60-70° north, such as Canada and Northern Europe. There are only very small areas of tundra in the southern hemisphere due to the lack of land at these latitudes. Temperatures are below freezing for most of the year. Only tough, short grasses can survive, often in waterlogged conditions (surface ice thawing). The plants and grasses that live in the tundra are adapted to retain heat and moisture in the cold, windy and dry conditions. It is a fragile ecosystem easily damaged by developments such as oil exploitation and tourism. Animals such as reindeer are adapted to survive the cold.

Polar: Located at the Arctic and Antarctic. Cold air sinks at the north and south poles, resulting in very low temperatures and dry conditions. The main polar regions are Antarctica and Greenland where temperatures can fall below -50°C.

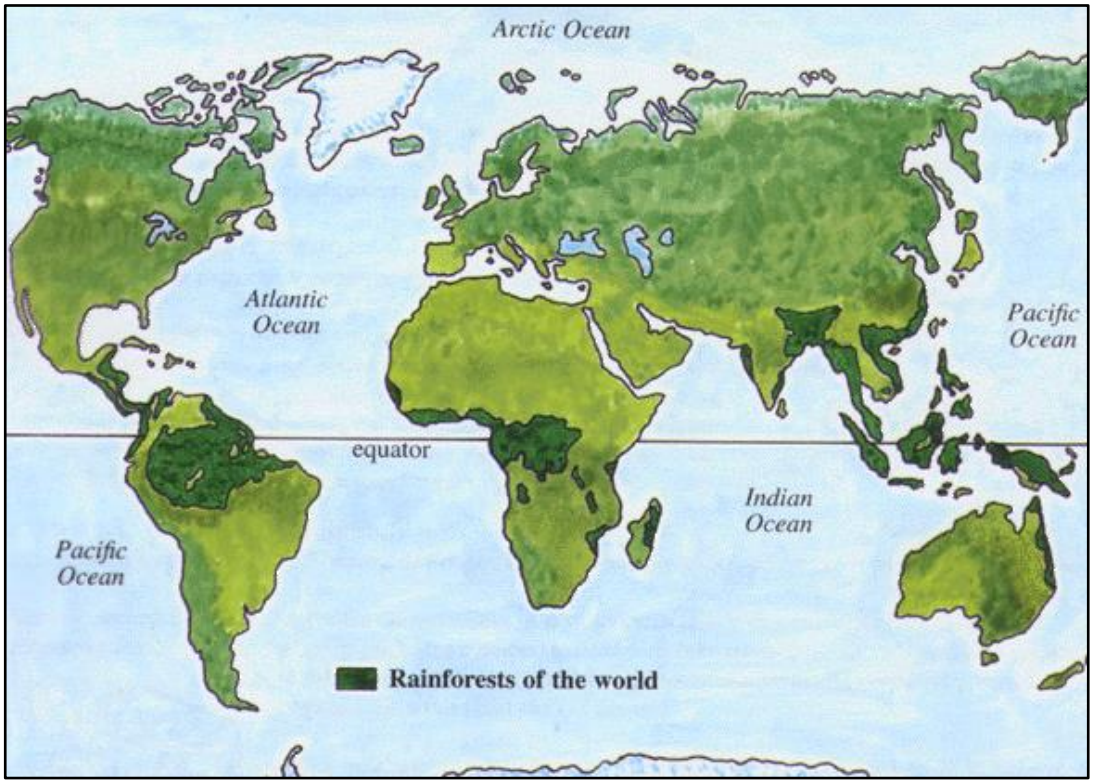
Savanna: Located between 15-30° north and south of the Equator. The tropical climate in these low latitudes is characterised by distinct wet and dry seasons. The dry season can be very hot and wild fires can break out. Violent thunder storms can occur during the wet season. Large herds of animals graze on these grasslands, along with predators such as lions and leopards.

Mediterranean: Located about 40-45° north of the Equator. Also located in isolated locations south of the Equator such as South Africa and Western Australia. Countries around the Mediterranean enjoy hot, sunny and dry summers, with mild winters. This is due to the pressure belts migrating slightly north and south during the year. Mediterranean includes olive trees and fruit trees such as lemons and oranges. Other parts of the world have a similar climate, for example California (USA), South Africa and parts of Australia.

Temperate Grasslands: Located about 30-40° north and south of the Equator. Inland away from coasts, with hot summers and cold winters. This includes the vast areas of grassland in North America (prairies) and Easter Europe (steppes). These areas experience warm dry summers and cold winters. Grasses can tolerate these conditions and this land is mainly used for grazing animals. The Steppe biome is a dry, cold, grassland that is found in all of the continents except Australia and Antarctica. It is mostly found in the USA, Mongolia, Siberia, Tibet and China. There isn't much humidity in the air because Steppe is located away from the ocean and close to mountain barriers.

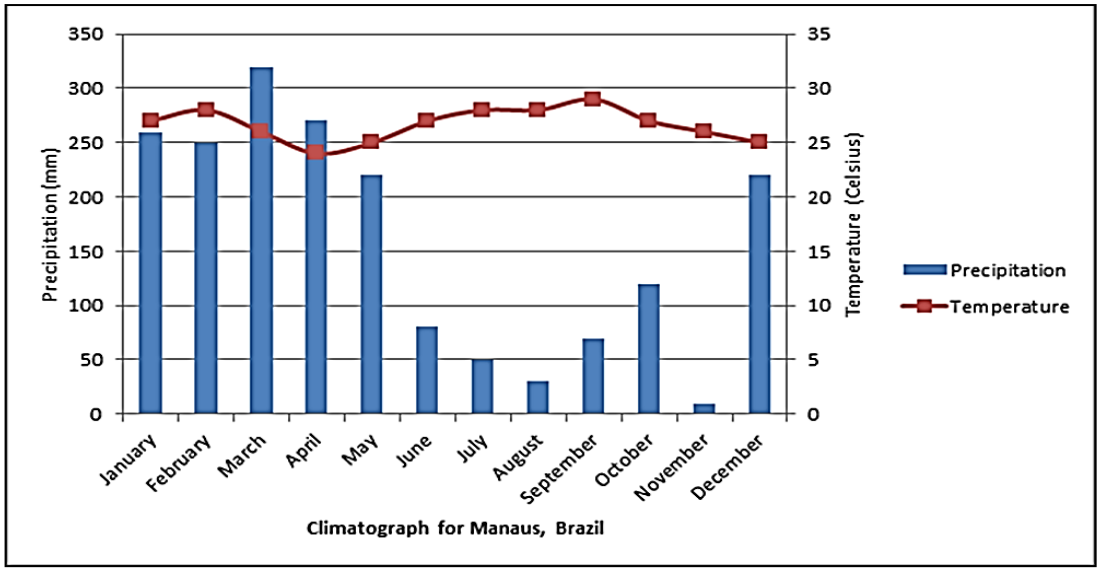
TROPICAL RAINFORESTS

Where are tropical rainforests found?



Covering approximately 2% of the Earth's surface, Tropical rainforests are found in a narrow band close to the Equator. They exist in South America (e.g. the Amazon), Africa (e.g. Congo Basin), South East Asia (e.g. Borneo) and Northern Australia.

What are the physical characteristics of tropical rainforests?



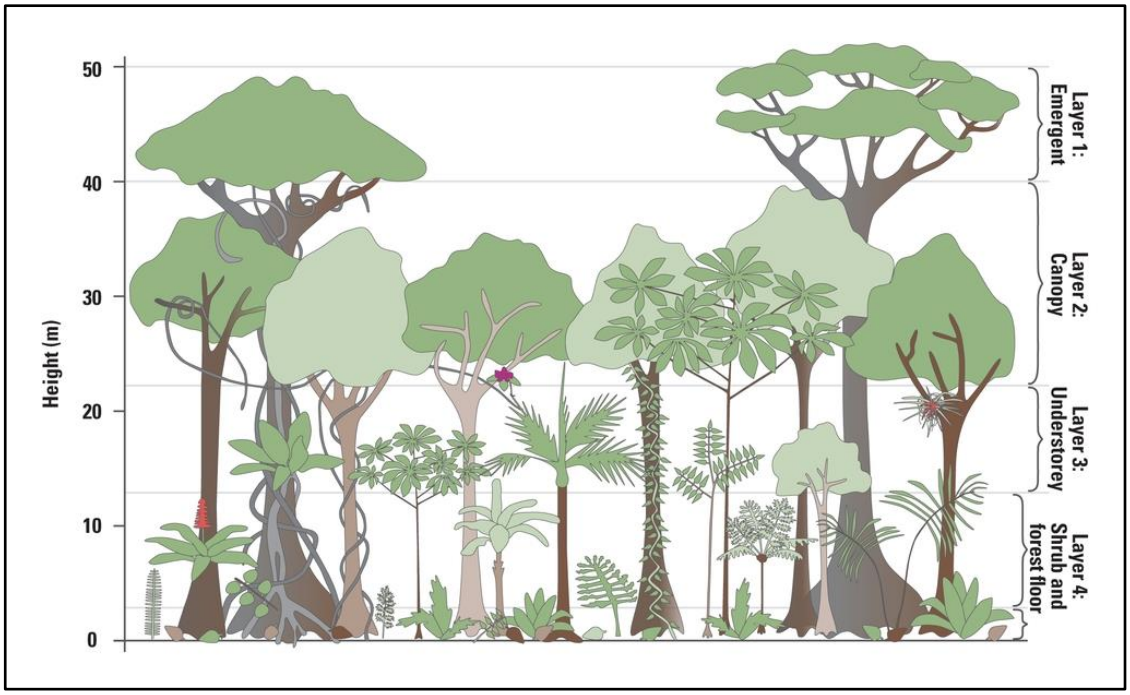
- **25˚C+ Everyday!**
- **12hrs sunshine Everyday!**
- **2000-3000mm rain per year**
- **(Luton has about 400-500mm)**

The hot and wet climate means that a wide range of plants and trees are able to grow which provide many natural habitats for animals.

Many parts of the rainforest are untouched by people, enabling a range of plants and animals to thrive.

The rapid recycling of nutrients speeds up plant growth (producers) and produces plentiful food for consumers.

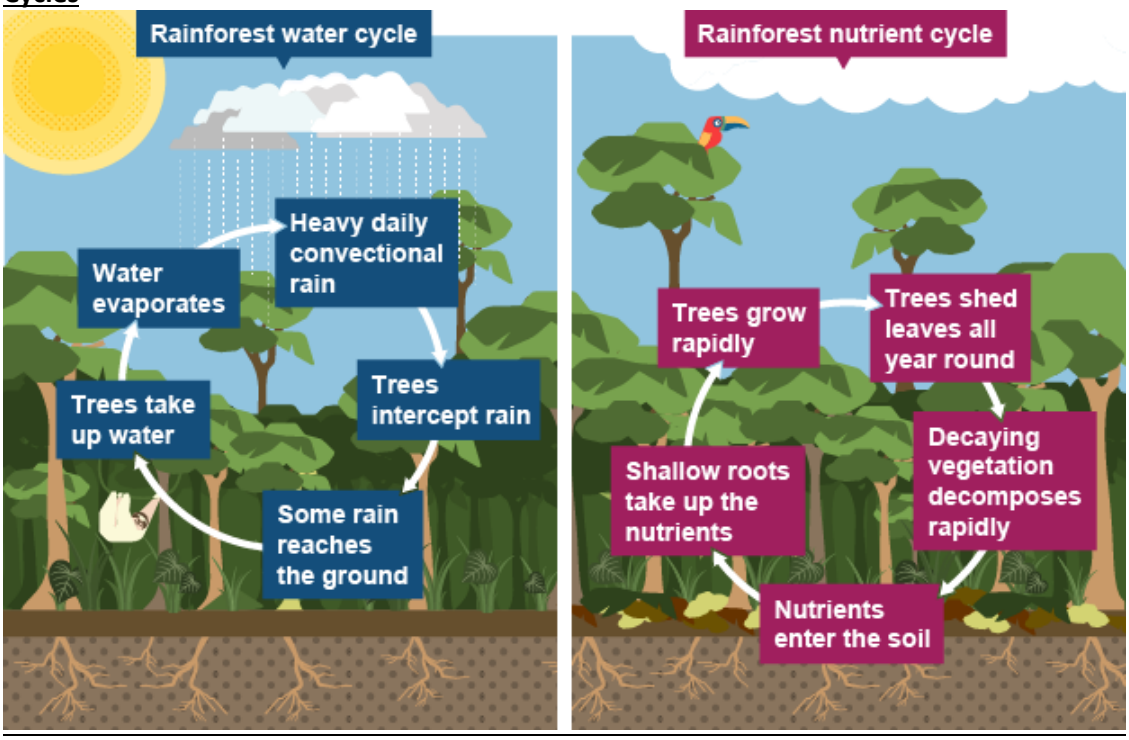
Structure of the Rainforest



Layers are dominated by the amount of sunlight available to them. This light energy decreases as you move down towards the rainforest floor.

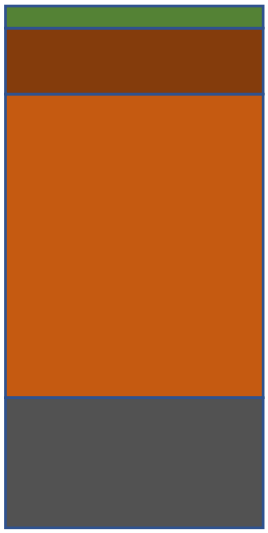
LAYER	CHARACTERISTICS (also add plant and animal species)
Emergent	Emergents are the tallest trees and are usually over 50 metres tall. The Kapok tree is an example of an emergent.
Canopy	The sea of leaves blocking out the sun from the lower layers is called the canopy. The canopy contains over 50% of the rainforest wildlife. This includes birds, snakes and monkeys. Lianas (vines) climb to the canopy to reach sunlight. Epiphytes, or air plants, are also found in this layer. An epiphyte is an organism that grows on the surface of a plant and gets its moisture and nutrients from the air, rain, water or from debris gathering around it.
Under-Canopy	The under canopy mainly contains bare tree trunks and lianas. Lianas are vines that climb the vegetation in a bid to reach sunlight.
Forest floor and shrub layer	The shrub layer has the densest plant growth. It contains shrubs and ferns and other plants needing less light. Saplings of emergents and canopy trees can also be found here. The forest floor is usually dark and damp. It contains a layer of rotting leaves and dead animals called litter. This decomposes rapidly (within 6 weeks) to form a thin humus, rich in nutrients. Below the rich top soil the soil lacks nutrients. This is because nutrients are rapidly absorbed by vegetation.

Cycles



Soils

The soil is low in nutrients as they are quickly taken up by trees



Litter: The very thin litter layer rapidly decomposes in heat
Topsoil: Shallow topsoil is a mixture of decomposed organic matter and minerals

Sub-Soil: The sub-soil is deep due to weathering of rocks below

Bedrock: Underlying rock weathers quickly at high temperatures to form sub-soil

Plant adaptations

Trees in the emergent layer have **thick waxy waterproof leaves.** This acts as a physical barrier to the high temperatures and prevents moisture loss from within

The leaves of forest trees have adapted to cope with exceptionally high rainfall by having a **drip tip.** This enables rain drops to run off quickly. Plants need to shed water to avoid growth of fungus and bacteria in the warm, wet tropical rainforest.

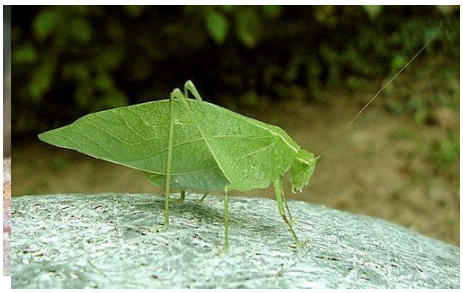
Buttress roots support the trees as they grow incredibly tall (over 50 m) as there is great competition for sunlight. This helps stabilise them in the thin soils.

Lianas are climbing woody vines that drape rainforest trees. They have adapted by having their roots in the ground and climbing high into the tree canopy to reach available sunlight.
Other plants on the forest floor have broad leaves with a big surface area to maximise the intake of sunlight

Animal adaptations

Competition for food and the fight for survival is intense in the tropical rainforest biome. Some of these are examples of adaptations:

1. Camouflage (e.g. chameleon and Giant Leaf Gecko)
2. Mimicry (e.g. Katydid, a grasshopper that looks like a leaf)
3. Having A Limited Diet (e.g. Toucan's are able to eat fruit and nuts that other birds cannot because of their long narrow beaks)
4. Poison (e.g poison dart frog)
5. Reduction of Size and Stature (e.g. jaguar)
6. Nocturnality (e.g. bearded pig, Aye-Aye)
7. Changing of Habitats (e.g. Sloth)



< A warning to all teenagers: This is what happens to you if you stay up too late

What are the biodiversity issues?

Key Points

- Tropical rainforests cover about 2% of the earth's surface yet are home to more than half the world's species. They contain 170,000 of the world's 250,000 known species.
- In the Amazon TRF there are 487 tree species in a single hectare. By comparison, there are 700 tree species in the whole of North America.
- About 20% of all medicine comes from rainforest plants. Less than 1% of rainforest plants and trees have been tested by scientists for their medicinal qualities.
- Rainforests contribute to 28% of the world's oxygen.
- Rainforests act as an important 'carbon sink' and help to offset global warming by absorbing carbon dioxide in the atmosphere, an important greenhouse gas.
- 50% of the Amazon rainforest has already been destroyed due to burning or felling.

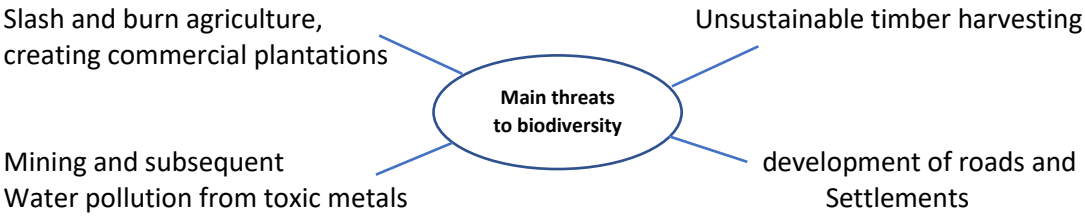
If biodiversity falls:

- Indigenous tribes risk being unable to survive in rainforests and abandon their traditions if biodiversity falls
- Plant and animal species may become extinct – sometimes before they have even been discovered
- Important medical plants may become extinct.

Why are there high levels of biodiversity?

1. Wet and warm climate encourages a wide range of plants and trees to grow which provide habitats for animals
2. Rapid recycling of nutrients speeds up plant growth (producers) and provides plentiful food for consumers.
3. Many parts of tropical rainforests remain untouched by people, enabling plants and animals to thrive.

Threats come from lightning strikes (fires), floods, disease but mostly people:



Keystone Species in Tropical Rainforests

A species with multiple connections with other species – there can be serious knock-on effects if numbers decline.

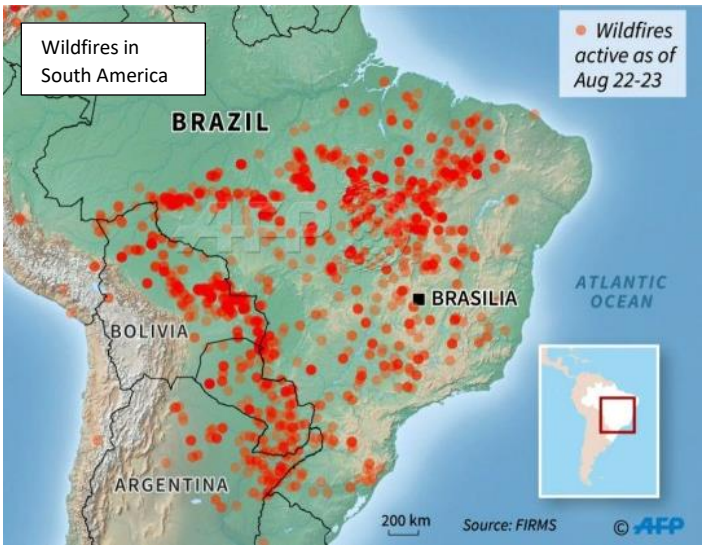
e.g. Orangutans - Borneo

1. Fig trees are pollenated by fig-wasps – orangutans eat figs and when they travel they disperse the seeds in their droppings.
2. Orangutan numbers are declining due to hunting and habitat destruction
3. Fig trees will decline in numbers
4. all species that rely on the fig trees will be affected.

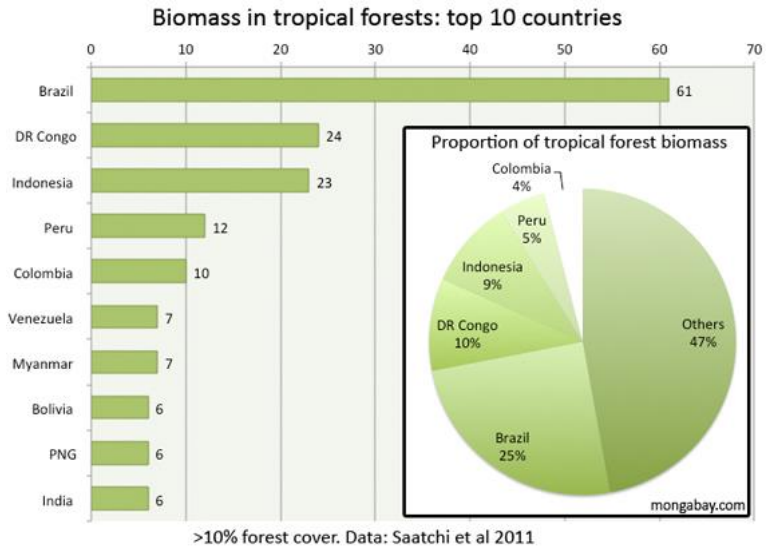
What is deforestation?

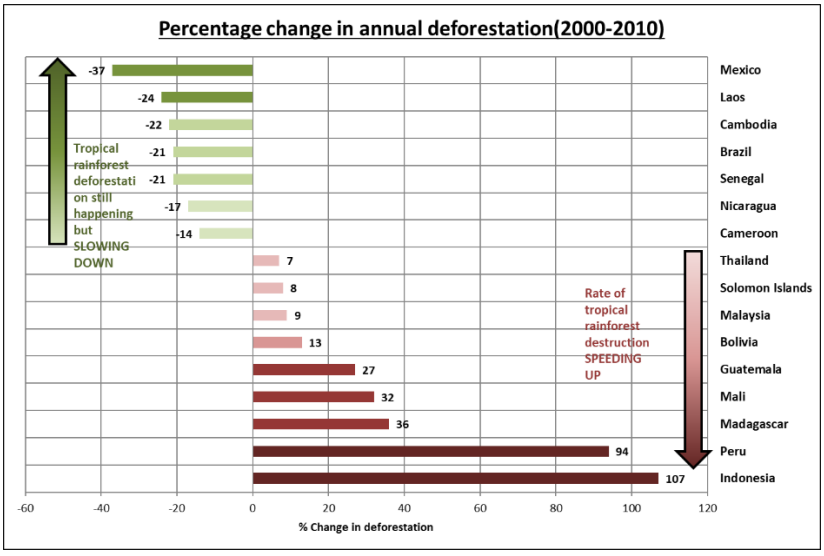
Since 1970 – 20% of the Amazon has been deforested – about 3 times the size of the UK

Until Jair Bolsonaro took power in 2019, protection measures in Brazil had really slowed the rate of deforestation. Over half of the **Amazon rainforest** was protected from deforestation but this protection has now been put at risk.



Peru and Indonesia deforestation is increasing rapidly. Over 31 million hectares (100 x 100m) is deforested each year. This image shows forest clearance in Indonesia making way for palm oil plantations.





What are the causes of deforestation?
What are the impacts of deforestation?
How can tropical rainforests be managed sustainability?
What is the value of tropical rainforests to people and the environment?

Refer to the Tropical Rainforest Case Study Knowledge book on Malaysia for these section headings.

GCSE GEOGRAPHY
CASE STUDY
KNOWLEDGE BOOK

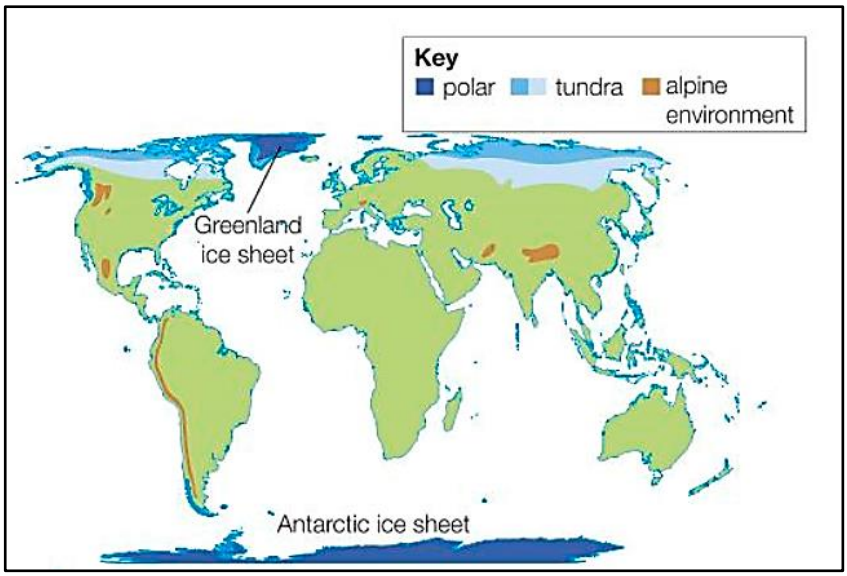
Tropical rainforest case study: Malaysia

COLD CLIMATES

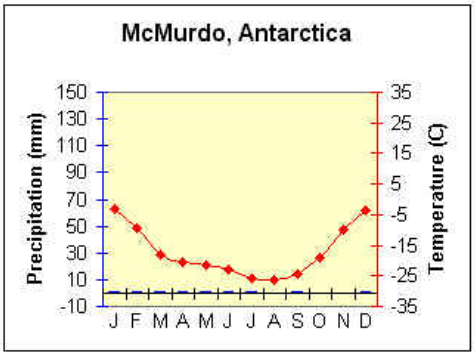
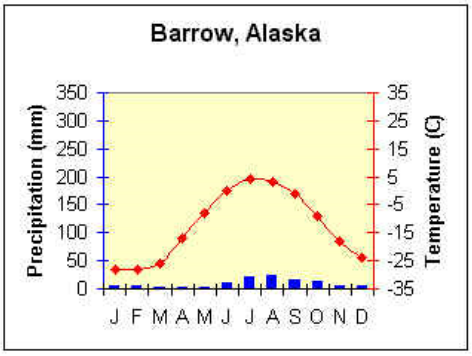
What are the physical characteristics of cold environments?

Polar environments are the most extreme cold environment and are located to the far north and south of the globe. They are found within the higher latitudes in excess of 70 degrees north and south of the Equator. They include Antarctica, the Arctic and much of Greenland. Extreme cold and permanent darkness in winter make this one of the most inhospitable places on Earth.

Tundra is a cold environment bordering the polar region and includes Canada, Alaska, Northern Europe and Russia and the tip of Chile. Conditions are cold in winter but less harsh than polar conditions and life can thrive in the summer months.



Climate

Polar	Tundra
Temperatures usually remain below freezing all year	Significant annual temperature range (from below -30°C in winter to well above freezing in summer)
Temperatures in winter can drop to below -50°C	Precipitation is higher, especially in the summer when the warm air holds more moisture. Coastal regions can receive heavy snowfall in winter.
Precipitation (snow) is low; this is a cold desert	Winter months experience near or total darkness
Winters are permanently dark, no sunshine for several months	
	

Permafrost

Permafrost is permanently frozen ground. In tundra environments, the upper surface layer of a few cm melts in the summer. This is known as the **active layer** and can become mobile on slopes, slowly slumping downhill through a process called **solifluction** (this means soil flow). This process is on the increase due to climate change. Permafrost is hard and impermeable and so becomes waterlogged in the summer.

Soils

Cold environments do not favour soil formation which require warmth and high rainfall.

Polar	Tundra
Almost no existent unless they were formed in past climatic conditions. Most polar environments are just frozen bare rock	Soils are thin, not particularly fertile, waterlogged in the summer and frozen in winter. Soil gets deeper further away from the poles and so biodiversity increases.

Plants

- Apart from moss and lichens, there are very few plants in polar environments.
- Plants are much more prolific in tundra environments where they exhibit many adaptations.
- Shallow root systems to enable them to access nutrients close to the surface in the active layer
- Low growing 'cushions' of plants retain moisture and provide shelter from the strong winds e.g. arctic willow
- Mosses that can cope both with water-logged conditions in the summer, and winter periods of drought.
- Flowering plants, such as the artic poppy and snow buttercup, which can flower and seed very quickly during the short summer season

  <u>Adaptations e.g. Bearberry Plant (Tundra)</u>

  1. Small leathery leaves help retain moisture in dry conditions
  2. Bright berries attract birds/owls which aids seed dispersal (droppings)
  3. Hairy, thick stems help the plant to retain heat and withstand the strong winds and cold temperatures
  4. Low growing (5-15cm) to survive the strong winds

Animals

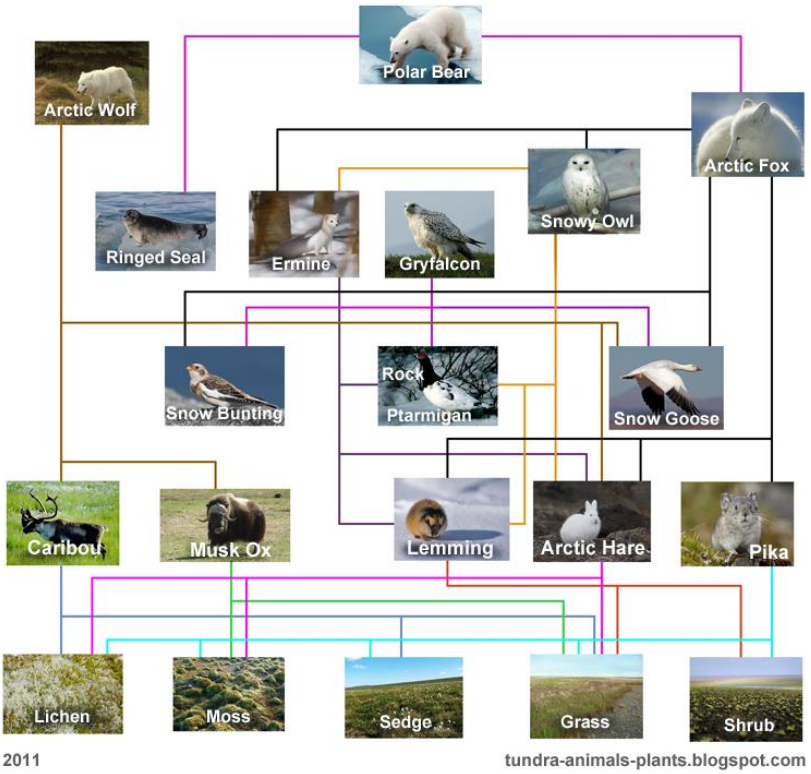
Polar	Tundra
Food supply is generally in the oceans. Polar bears survive on seal. Antarctic: penguins feed on fish and krill. Food chains are short and basic	Presence of plants means that food webs are more complex, with greater biodiversity.

People

- Indigenous groups such as the Inuit do live in Tundra regions but there are no permanent populations in Polar regions.
- Most people live by the coast to access resources such as fish and to allow easier movement in summer months.
- The Inuit of Greenland, Alaska and Canada cannot grow crops and so rely on hunter gathering by fishing and hunting.

How is a cold environment inter-dependent?

- Indigenous people once depended on animals such as whales and seals for clothing, food, heating, lighting oil. Snow and ice used for building igloos.
- Plants form dense cushions on the ground to retain moisture and heat and shelter from wind
- Bearberries are bright red to attract owls and other birds. Once eaten, the seeds are dispersed.
- Arctic birds use moss for warmth in nests



How biodiverse are cold environments?

Tundra regions are very biodiverse and depend heavily on the summer months when the surface of the permafrost thaws.

Group	No. Of species
Mammals	75
Birds	240
Insects	3300
Flowering plants and shrubs	1700
Mosses	600
Lichens	2000

It is sensitive to change however;

- Climate change will bring longer, **warmer susmmers** and potentially increase biodiversity but some species may increase too rapidly and create an **imbalance.**
- Melting permafrost releases vast amounts of **methane and CO2** into the atmosphere. This will accelerate climate change.
- Increased access to areas for **oil extraction** and other resources may result in pollution.
- Warming of the oceans may affect the distribution of **nutrients** which may affect concentrations of krill, fish and crustaceans.

CASE STUDY: development of cold environments

Alaska, USA

Alaska is the most northern American state. It lies to the north west of Canada. It covers a vast area (2 million km2).

Development opportunities

Minerals: Alaska has a rich resource base. It was part of the 'gold rush' in the 1800s. **Gold** still accounts for **20%** of the mineral wealth. Other minerals include silver, zinc and lead.

Energy: Alaska has vast reserves of oil and gas in the north of the state. The industry employs **10,000** people and accounts for a third of the state's income. Oil is transported 1,300km from Prudhoe Bay in the north to the port of Valdez in the south by the **Trans-Alaskan pipeline.** From Valdez it can be transported by tanker through ice free waters. There are huge concerns over this continued extraction in the pristine wilderness in the north of the state.

Fishing: Alaska's rivers and coastal waters are rich in salmon, trout and cod. **80,000** people are employed in the industry and is worth **$6billion** a year.

Tourism: Alaska's mountains, glaciers, national parks and untouched wilderness attracts **2million** tourists a year. **Cruises** account for **60%** of visitors and **adventure tourism** is on the increase.

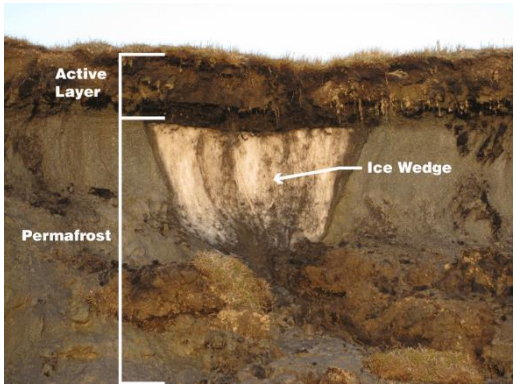
Challenges

Extreme Temperatures: Winter temperatures in the north fall well below **-30°C.** This creates hostile working conditions. In the winter, the sea freezes and road conditions become treacherous.

Inaccessibility: Alaska is a very remote region accessible mostly by plane or ship. Road transport through Canada is lengthy and difficult in winter. **Anchorage** is the main international gateway by plane, with local services operating to smaller towns. Individuals rely on 4x4 vehicles or snowmobiles in winter.

Buildings and Infrastructure: Extreme cold, high winter snowfall and presence of permafrost present challenges for building and infrastructure. To prevent melting of permafrost & subsidence, roads are constructed on raised gravel beds to prevent heat transfer. Domestic services are provided in above-ground insulated 'utilidors' . Airport runways are painted white to reflect sunlight and prevent them from heating up.

Road damaged by melting permafrost



melting permafrost cross section.

Protection of cold environments as wilderness areas.	**Wilderness** areas are unspoilt, remote parts of the world such as hot deserts, mountains and cold environments. **Fragile environments** develop extremely slowly and take many years to recover from any damage inflicted by people. Even a footprint on tundra vegetation can remain for 10 years!!! **<u>Why protect wilderness?</u>** • Scientists conduct research there to understand global processes of change e.g. global warming • Cold environments provide important habitats for many species of plants and animals • There is a moral responsibility to retain some wilderness areas that reflect the natural world without human interference. • Some wilderness areas are inhabited by indigenous people, e.g. the Inuit • Polar and tundra regions are fragile environments. They develop very slowly and take many years to recover from damage
What strategies can be used to maintain cold environments?	**<u>TECHNOLOGY</u>** can provide solutions to some of the challenges of developing cold environments. On a small-scale, this can include the use of insulated pipes inside containers called utilidors which carry domestic services into peoples' houses. This stops the permafrost from melting which would cause subsidence. On a large-scale, the trans-Alaskan pipeline is a perfect example of how technology helps development without damaging the environment. • The pipes are insulated to retain the heat of the oil & prevent the permafrost from melting. • The pipes are suspended above ground to allow herds of wild animals such as caribou to migrate across the area • Special slides enable the pipeline to accommodate movement during an earthquake. • Pumps keep the oil flowing over mountainous terrain **<u>GOVERNMENT ACTION</u>** The US government has been involved in the protection of Alaska since oil was discovered in the 1960s. They have introduced the following protection measures: • Fisheries and marine habitats are monitored and protected by the **NOAA** (National Oceanic and Atmospheric Administration) • The **Western Arctic Reserve** is an area in the north of Alaska which is protected from oil and gas developments to conserve the habitats of animals such as caribou and migrating birds **<u>CONSERVATION GROUPS</u>** The Worldwide Fund for Nature (WWF) works with governments, businesses and local communities across the Arctic to protect the regions biodiversity. In 1992 it launched the **WWF Arctic Programme** to work with governments on various issues in the Arctic. Projects to date have included: • Scientific research to protect endangered species such as polar bears and Greenland sharks • Working with indigenous communities, oil companies and governments to promote sustainable development • Monitoring & seeking the protection of endangered ecosystems. **<u>INTERNATIONAL AGREEMENTS</u>** The continent of Antarctica is known as the 'world's last great wilderness'. Despite its rich reserves of valuable minerals, it has remained undeveloped due to an international agreement signed in 1959 called the **Antarctic Treaty,** which came into force in 1961. This treaty: • States that Antarctica should only be used for peaceful purposes with all military activities banned • Promotes international co-operation in scientific research • Bans the disposal of nuclear waste • Encourages tourism but applies strict controls in terms of numbers & landing sites to minimise impact