Edexcel IAL Geography

Biodiversity Under Threat

Detailed Notes

Defining Biodiversity

Biodiversity is most commonly defined as the variation in wildlife and vegetation within a region. However, it may also be defined focussing on a particular aspect of variation:

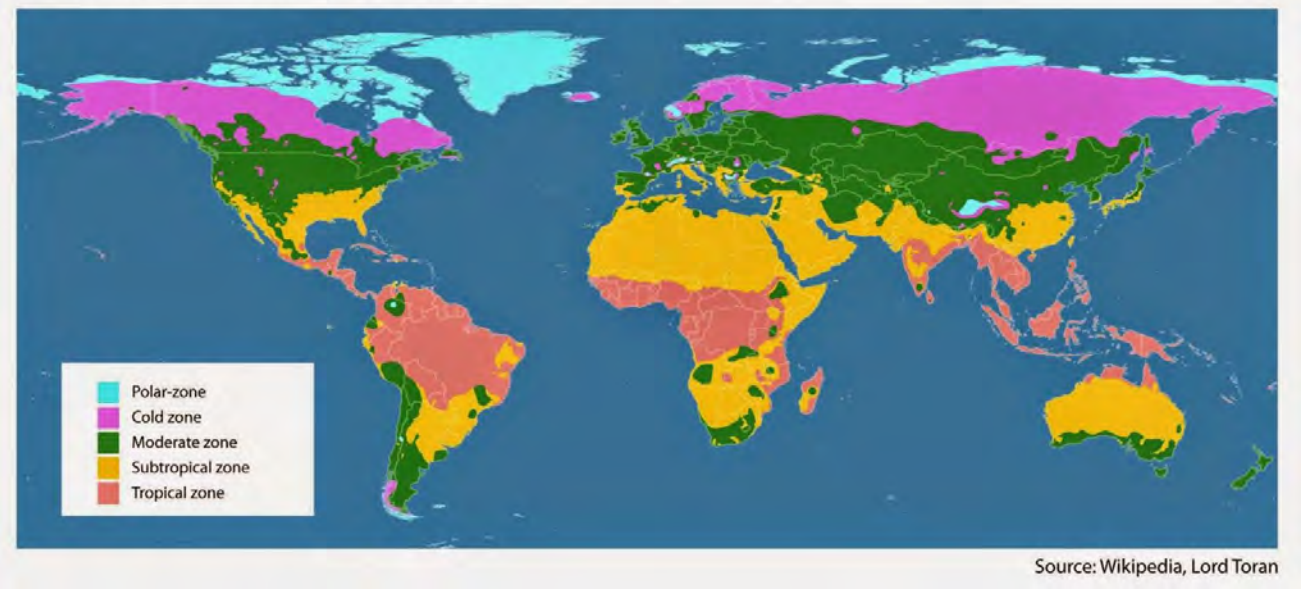
- **Genetic Biodiversity** - Variations within the **genetics and DNA** of a species. For example, the variation of a species depending on its locations may be easily described by studying the genes of the species. However, genes can only be **studied forensically** and can involve complicated and expensive equipment.

- **Species Biodiversity** - The **variety in species** within an area. Species includes both animals and vegetation. This may involve a **count** of different species within a defined area. The ease of counting depends on the size of the species - for example, lions and giraffes may be much easier to spot than crickets or moles.

- **Ecosystem Biodiversity** - The number of **ecosystems or habitats** within an area. For example a typical UK countryside may contain dense woodland, open grassland, rivers and lakes within one biome. Ecosystem biodiversity is a good measure of biodiversity so long as the area being measured is well defined and large enough to contain variations in habitats.

Distribution of Biodiversity

Biodiversity isn't equal across the globe and **varies** between countries and continents. Globally, biodiversity correlates to the **climate** of the area.



Hotter and drier climates (**subtropical**) tend to have **lower species biodiversity**; there are higher rates of evaporation in these regions, so fewer species can survive with limited water supplies. The **highest levels of species biodiversity** are found in **tropical climates**, where rainforests have high densities of species and vegetation.

Genetic biodiversity is most prominent when comparing species across islands, as the same species may have become isolated by water and left to adapt to the individual island's climates. Such is the case for **Darwin's Finches**, whose genetics vary drastically across the **Galapagos Islands**.

Factors that affect Biodiversity

Biodiversity also varies due to **localised factors**, which explain small scale variations in biodiversity such as variations across a country or between regions. **Human and physical factors** both affect the **distribution of biodiversity**:

Anthropogenic (Human) Factors	Physical Factors
- **Hunting and foresting** - particular species are more valuable and useful for locals to eat or use as medicines. - **Pollution** - Different species have different tolerances to pollution. Pollution may be plastic waste in the oceans, oil spills, fly-tipping and unmanaged waste disposal. - The **damming of rivers and lakes** will restrict the flow of species upstream and reduce nutrients available in the water for species.	- **Altitude** - Fewer species can survive with limited oxygen levels at high altitudes. - The **rate of nutrients recycled** - It is necessary for vegetation and dead animals to decay for the nutrients to return into the soil for new plants to uptake. - The amount of **direct sunlight** will affect the growth of vegetation. - The amount of **water moisture available** - Many plants and animals require daily water intake to survive.

Biodiversity Hotspots - *Source: mrgeorgewagg.wordpress.com*

Across the world, there are **biodiversity hotspots** - regions of **extremely high species diversity** with several species unique to that area (**endemism**).

These are **pivotal regions** as these regions are incredibly **valuable** to the global system and also have **scientific significance** (undiscovered species, potential new medical cures). However, these regions are **threatened by human exploitation** and anthropogenic **climate change**.

Biomes and Ecosystems

Biomes and **ecosystems** are easily confused; they are similar, but there is a difference between a biome and an ecosystem. A biome is a **region of land**, often large in size, categorised by its climate and conditions whereas an ecosystem is the combination of **biotic** (both flora - plants - and fauna - animals) and **abiotic** components (the physical environment that they live in).

It is important to note that a biome can contain **multiple** ecosystems. So a biome can be thought of as a **country**, and the ecosystem are **towns and cities**.

There are two kinds of biomes - **terrestrial and aquatic**:

Terrestrial Biomes	Aquatic Biomes
• Polar • Desert • Grasslands • Forest	• Freshwater (including wetlands) • Marine (including Coral Reefs, salt marshes and estuaries)

Ecosystems are **valuable** both locally and globally:

- **Provision** of goods and resources, essential to the **health and development** of the local community
- Some ecosystems hold **cultural** and **religious significance**. Indigenous communities especially value their ecosystem in spiritual ways.
- Ecosystems **regulate** the natural environment:
    - **Water** is purified through vegetation and the flow is regulated to **avoid flooding**
    - Vegetation removes **carbon dioxide** and produces oxygen, maintaining **atmospheric balance**
    - Natural **wildfires** encourage new vegetation growth

Some people benefit from ecosystems more than others and there is sometimes **inequality** in the provisions from an ecosystem. For example, **Alberta's ecosystems** have been exploited by a number of **international TNCs** for tar sands, leaving the **indigenous community** without their spiritual homeplace.

Ecosystem Processes

There are several flows through an ecosystem, which maintain a healthy ecosystem and keep organisms living within it. There are nutrient cycles and energy flows, which affect both flora and fauna.

Energy Flow

The accumulation and movement of **energy** through an ecosystem is closely linked with the **food chains**.

The **flow of energy** through an ecosystem begins with the vegetation and energy transfers between a number of organisms:

1. Vegetation (fauna) transfer **solar energy** into **chemical energy** (glucose) through **photosynthesis**.
2. The vegetation is consumed by **primary consumers** (herbivores or omnivores) such as giraffes, cows and caterpillars.
3. Primary consumers are consumed by **secondary consumers** which may be carnivorous or omnivorous e.g. mice and fish.

At **each stage** of a food chain, energy is lost through **respiration** of the organism. Therefore, food chains with **large numbers of consumers** will transfer the **least amount of energy**.

Food chains are rarely separate and individual, and instead organisms can consume a **variety of different sources**. For example, foxes (native to the UK) are known to have one of the most varied diets in the world and can eat rabbits, birds, frogs, earthworms, nuts and fruit. Therefore, ecosystems contain **food webs** consisting of **multiple food chains** and so energy is transferred between organisms in a variety of different ways.

Nutrient Cycle

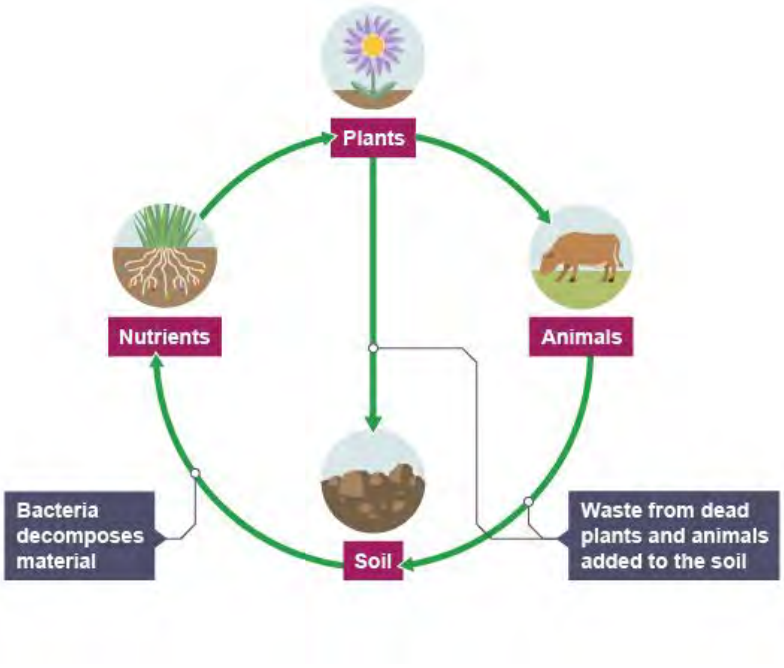
Nutrient cycles **transfer minerals and biomass** between organisms, fauna and the physical environment. There are two types of nutrients that are transferred within an ecosystem:

- **Inorganic Compounds**, such as phosphate and nitrates, sourced from the soil or natural gases from the atmosphere, such as carbon dioxide.
- **Organic Compounds**, such as carbohydrates or protein, produced within organisms.

As the inorganic compounds is passed further up the **food chain**, it is processed into **complex** organic compounds. Organic compounds can be used as a **chemical store of energy** or for the **growth** of an organism.

The nutrient cycle contains **food chains**, but also the **death and decomposition** of organisms:

1. Vegetation intakes **inorganic compounds** from the soil, which is used for the plant's growth and repair, and from the atmosphere. These compounds form more complex organic compounds, such as glucose, during **photosynthesis**.
2. The minerals are transferred within the vegetations' biomass when the fauna is **consumed** by a primary consumer.
3. The minerals continue to be passed up the food chain, with amounts being used by an organism's body at every stage of the nutrient cycle.
4. When an organism **dies**, the minerals within its body will be trapped. They are only released as **decomposers** break down the **complex organic compounds** - such as carbohydrates - into **simple inorganic compounds** back into the soil or into the atmosphere (as the decomposer **respires**).



Source: www.bbc.com

Nutrient cycle and energy flow are closely linked, since **energy and nutrients** are both essential for organisms to live and grow.

Factors that Affect Ecosystem Processes

The **rate** of the nutrient cycle and energy flow is determined by several factors:

- **Temperature and Humidity** - Hot and damp are favourable conditions for decomposers, therefore the rate of decomposition will increase
- **Amount of Sunlight** - Solar energy is necessary for photosynthesis, which determines the growth of vegetation. Since fauna is the bottom of the food chain, all organisms later in the food chain rely on good vegetation growth.
- **Epidemics** - Disease affecting the population of consumers will impact the nutrient cycle, since there is more material to decompose and fewer left to consume vegetation and primary organisms.

For a steady cycle of both nutrients and energy, the **food chain** must be **balanced**. Therefore **human intervention** - hunting, fishing, cattle rearing, farming - will impact both the nutrient cycle and energy flow significantly.

Types of Terrestrial Biomes

Tropical Rainforest

Tropical rainforests tend to be found along the **tropics**. They are some of the **most diverse biomes** in the world, due to the **high density of species** within a rainforest and the low inhabitants **protects unique species** from extinction.

Source: sciencestruck.com

The nutrients cycle is fast within a rainforest since the **conditions for decomposers** are **optimum**. Also, daily **convectional rainfall** maintains the water moisture levels for optimum plant growth. However, there is **limited sunlight** on the floor of the rainforest so new vegetation growth is limited.

There are several **threats** to the rainforest posed by humans. **Local threats** include:

- **Deforestation** will clear vast amounts of the rainforest for farming or residential areas, destroying the natural biome and forced displacement of the species living there.
- Land may be cleared using **slash-and-burn techniques**, releasing large quantities of carbon dioxide into the atmosphere and interrupting the nutrients cycle - decomposers don't decay the felled plant matter and so the nutrients isn't released back into the soil.

Tropical rainforests have an **international impact**, since they are important to the **global carbon cycle** and influential over the rate of the **enhanced greenhouse effect**.

- Rainforests are becoming the focus of **scientific research**, with the discovery of new species offering new medicines. If research isn't conducted sustainably, unique species could become threatened or extinct. Research teams tend to consist of international students, rather than locals.
- **Wildfires** are becoming more common threats to rainforests. The Amazon has recently suffered from an influx of wildfires, some started naturally during the dry season and some caused by slash-and-burn getting out of control. Governments across the world have pledged money to try to extinguish a number of fires.

Savannah Grassland

Savannah grasslands can be found between the **Tropics** (where tropical rainforests are found) and the **Equator** (where deserts can be found). The **East African Savannahs** are the most well-known savannahs, such as the Serengeti Savannah in Tanzania, which contain acacia trees, giraffes, lions and zebras.

Source: travour.com

Savannah grasslands have **dry and wet seasons**; during the dry season, most vegetation dies and

non-perennial rivers dry up whereas during the wet season flora flourish. This means that minerals return back into the soil during the dry season and is taken out of the soil by plant uptake during the wet season. The **nutrient cycle** takes a year to complete.

The savannah grasslands have many stages to their **food chains**, since there are many **carnivores** such as lions and hyenas that survive here. Therefore, there is **greater energy loss** during the energy flow.

The savannah isn't the most threatened biome in the world, but does face **risks**. Local threats include:

- **Hunting** - Some species have been hunted for **sport or ivory,** leaving them **threatened to extinction**. Species threatened include black rhinos and elephants. Also, trees are **felled** to make carvings for tourists which is increasing at an unsustainable rate.
- **Farming and Agriculture** - **Intensive grazing** and trampling kills vegetation off, leaving the soil prone to erosion and desertification. If the land isn't properly irrigated for crop growth, there will be a **build up of salt** contained within the soil.

International threats include:

- **Tourism** - Safari tours and tourism in the savannah has vastly increased. As a result, the amount of traffic and **carbon emissions** produced has surged. Most tourists want to view the species biodiversity, but a few tourists come for **hunting trips**.
- **Desertification** - One third of the world's surface is threatened by desertification, predominantly savannah grasslands. **Climate Change** is increasing the average temperature of savannah grasslands, and so the rate of evaporation increases. There is **less water moisture** stored within the soils and so the soil becomes more **vulnerable to erosion** and vegetation less likely to survive.

Temperate Forest

Temperate forests are found at higher latitudes above the Tropics, such as Europe, North America and Eastern Asia. They require **high levels of precipitation** and vegetation is typically **deciduous** (trees that lose their leaves during the winter season).

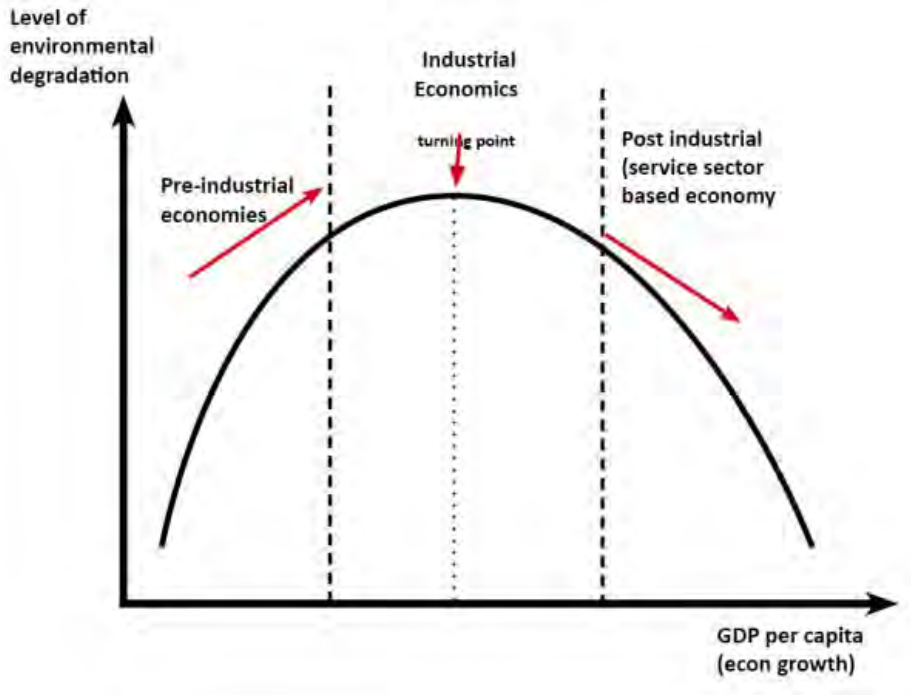
The nutrient cycle is relatively quick, due to high water moisture assisting vegetation breakdown and making **favourable conditions** for decomposers such as lichen and worms. Soils remain **nutrient-rich**.

However, there are a few threats to temperate forests:

- **Deforestation** - The **timber trade** is very profitable in deciduous forests, since the trees grow relatively quickly and the timber is sold for a good price for furniture or construction. However, if trees are felled at an **unsustainable rate**, the deciduous forest may not recover. Also, land is cleared for agriculture and property development.
- **Non-Native Species** - Alien invasive species have been introduced to deciduous forests, who outcompete native species and thrive in the favourable ecosystem. Non-native species include the grey squirrel and the Asian Gypsy Moth.

Conservation of Ecosystems

Ecosystems and Development



Source: economicshelp.org

Economic **development** has **environmental consequences** for the local ecosystems. This can be described by **Kuznet's curve**.

As a country initially develops, environmental degradation and damage to the ecosystem will increase:

- The local government may not have regulations in place, so TNCs and businesses may **exploit their environment** and people for profit
- **Carbon emissions** will increase with the levels of manufacturing and secondary industry
- As the wealth of residents increases, more locals can afford technology and vehicles which improve their quality of life but **demand energy** (often generated using non-renewable sources)

At the **turning point** of the Kuznet's Curve, the country experiences the worst levels of environmental degradation. This is the case for many **developing countries**, especially in urban cities:

- Urban cities have **sprawled** into rural ecosystems, and further land is cleared agriculture to sustain the city's population.
- **Overcrowding** means that green open spaces have been constructed on and lakes filled in for more houses, leaving no vegetation within the city.
- There is **little waste management**
- Few species are able to survive in the urban built environment, so are **displaced** from the area.

However, countries with **high levels of economic development** may decline in environmental degradation. This tends to happen post industrial development, when **industry shifts** from manufacturing (secondary) to tertiary (service provision) and quaternary (technology).

- Residents in urban spaces demand a higher quality of life, so **green spaces** are planted and **gardens increase** in numbers
- **Stricter regulations** are put into place by government regarding carbon emissions, waste disposal, business exploitation and protecting remaining ecosystems
- **Urban sprawl** may halt as rural-urban migration reduces as more people favour rural living conditions
- The country may now be able to **afford renewable energy** sources and low-emission/ high-efficiency technology, reducing carbon emissions by energy production

Some countries are **exceptions** from Kuznet's curve because they have a different attitude to the protection of their ecosystem than other countries of similar economic development.

Some countries with low GDP per capita have **strict regulations** and **strong beliefs** in the importance of their ecosystems, such as Bolivia and the Laws of Mother Nature. However, there are MEDCs that continue to **pollute and exploit their ecosystems**. The USA, for example, continues to degrade its natural resources for oil.

Also, the attitudes towards species conservation vary within a population. For example, **iconic species** with cultural or religious significance are more likely to be protected than **keystone species**, important to maintaining the health of the ecosystem. The disappearance of keystone species will impact iconic species, but this is not reflected in the population's attitudes or legislation.

Ecosystem Management

There are different levels of **management** of ecosystem, depending on how restricted vegetation and species growth are. This is determined by a variety of **key players**, both **local and international**:

- ➔ **Local Businesses**: Farmers, Miners, Timber Fellers, etc - who voice their concerns about resource security and about the effect of legislation on business and the local economy
- ➔ **Indigneous communities** and local religious groups - who protest against threats to their link with nature.
- ➔ **Local and National Governments** - who implement legislation and provide funds for some projects.
- ➔ **Wildlife Preservation Charities** - who provide funds and lobby governments to protect particular species.
- ➔ **The UN and other IGOs** - who start projects for sustainable local management and protection of the ecosystem as a whole

Most key players focus on the **financial value** of the ecosystem or the **social connection** to locals. Mainly charities and NGOs focus on the **environmental cost** of losing an ecosystem. Key players may not agree on the management strategies and sometimes there is a conflict of opinions.

There are many different approaches and examples of ecosystem management:

- **Education of Locals** - Educating locals about the importance of their local ecosystem and the species within it takes place from a young age in primary education. NGOs may also try to educate **farmers** in adopting more **sustainable methods** of agriculture:
    - Crop rotation and having a fallow where crops aren't grown on the field
    - Drip-fed irrigation, minimising waste water
    - Not using fertilisers or pesticides on crops

  👍 Education can provide the locals with **options and alternatives** to unsustainable methods of business

  👍 Sustainable methods of agriculture will protect the soil's health, the **nutrient cycle** and **water consumption**

  👎 Farmers may choose to use their old, unsustainable methods, since it may cost them **more money or time** to be sustainable

- **Restoring a degraded environment** - In the case where ecosystems have lost trees and vegetation through deforestation, the soil may be prone to **erosion** and the ecosystem's nutrient cycle collapse. By replanting lost trees and vegetation through **afforestation**, there is a chance of recovering the ecosystem.

  👍 Relatively **cheap and easy** way of repairing a damaged ecosystem.

  👍 In semi-arid biomes, this is essential to **reduce desertification**. In the case of the sahel, a band of trees are being planted across Africa to halt the spread on the Sahara northwards.

  👎 This method depends on the **success of plant growth**. If the vegetation fails to grow or the soil is beyond repair, afforestation won't work.

- **National Legislation** - Governments can protect areas of land through laws and legislation. For example, many MEDCs have created **national parks** or **wildlife sanctuaries** were construction is prohibited, paid wardens protect the species and monitor the ecosystem and locals use the space for leisure.

  👍 The laws that protect national parks prohibit businesses, construction firms and resource exploiters from destroying the protected ecosystem.

  👍 National parks can become a **local attraction for tourism** and boost the local economy.

  👎 Should the government change and their opinion of national parks change, they can stop protection. Such is the case for Trump, who wishes to revoke Alaska's national park protection to exploit oil in the national parks.

- **Protecting Species at Risk** - Charities and NGOs may build **animal sanctuaries** within an ecosystem. The sanctuary will take in injured or endangered species, with the aim of reintroducing them back into the ecosystem. Sanctuaries also become a point of **scientific research** and the health of the ecosystem and species biodiversity are monitored from here.

👍 Animal sanctuaries are also **tourist attractions** and are used to **educate** the public about species protection.

👍 Sanctuaries try to maintain species populations in the ecosystem and reduce the **risk of endangerment**

👎 Sanctuaries depend on NGOs funds, often generated through **fundraising**, so may not have enough funds to protect all species within an ecosystem.

- **International Agreements** - **Debt-for-nature swaps** are trying to encourage developing countries to protect their ecosystems. **Developing countries** in debt have some of their debts cancelled, if they promise to protect their environment and halt degradation to their ecosystems. Such is the case for Indonesia, Peru and Madagascar, who have all had their debts reduced in a debt-for-nature swaps.

  👍 Developing countries may not have been able to **afford** putting protection in place before the swap, due to their debt. They may now be able to afford nature wardens, enforcing the law with offending businesses and restoration projects.

  👎 Businesses who exploit the country's ecosystem may still remain, since the country may **rely on their income**. These businesses include: palm oil growers, timber fellers, energy companies, etc.

- **Global Protection Frameworks** - There are some agreements and global policies to try to protect global biodiversity and enforce governments to protect their ecosystems. Examples include the UNESCO Biosphere Reserves and CITES Biodiversity Action Plans.

  👍 **Cross-boundary** agreements encourage cooperation between countries and tries to encourage everyone to share similar ecosystem protection policies

  👎 Frameworks require a large amount of **funds** to monitor and regulate member countries

Futurity of Ecosystems

The **future of ecosystems** are uncertain, as there are many factors that could determine the longevity of ecosystems:

- The **growing global population**, and if they need more space to live in or resources to consume
- The success of **restoration projects** and **frameworks** in protecting and replenishing ecosystems at risk
- **Climate Change** will affect ecosystems, as the conditions of each ecosystem will change and the survival of species will be impacted as a result

Growing resource consumption can be sustainable if it remains within a **sustainable yield** - the amount allowed to be consumed/harvested before it threatens the **self-renewability** of the resource. Sustainable yield can be enforced both locally by the business and farmers themselves, or at a national level through government legislation.