

AQA Geography GCSE

3.1.2.2: Tropical Rainforests

Detailed Notes

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Tropical Rainforests

What is a Tropical Rainforest?

A **tropical rainforest** is a **warm, wet ecosystem** located within the **Tropics** (between the Tropic of Cancer and the Tropic of Capricorn).

The photo to the right was taken in the **Amazon Rainforest**, the world's **largest rainforest**. The **lush, dense vegetation** seen here is extremely typical of rainforests.



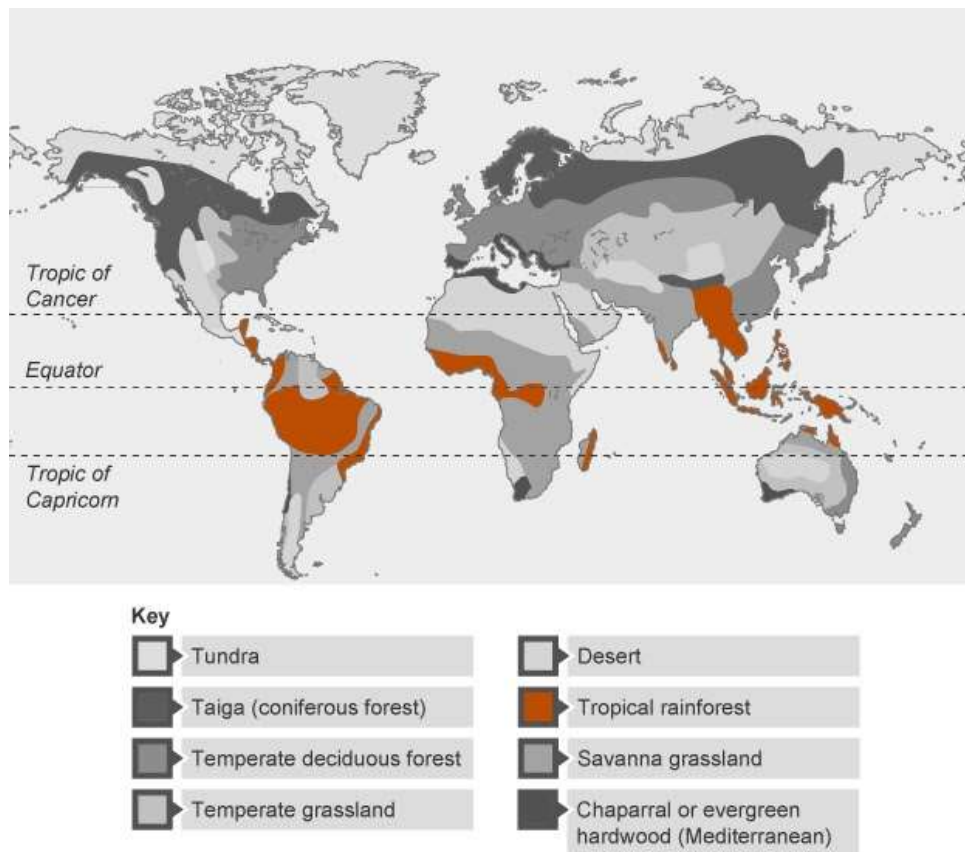
(Source: Pete Oxford / Corbis)

Distribution of Tropical Rainforests

Tropical rainforests are located along a **large band surrounding the equator**.

Examples of tropical rainforests include:

- Amazon Rainforest, South America
- Congolian Rainforests, Central Africa
- Daintree Rainforest, Australia
- South-East Asian Rainforests, Asia



(Source: BBC Bitesize)



Tropical Rainforest Characteristics

Like all **global-scale ecosystems**, tropical rainforests around the world have similar environmental characteristics, including their **climate, soil type, and plant and animal life**.

Climate Characteristics

Rainfall

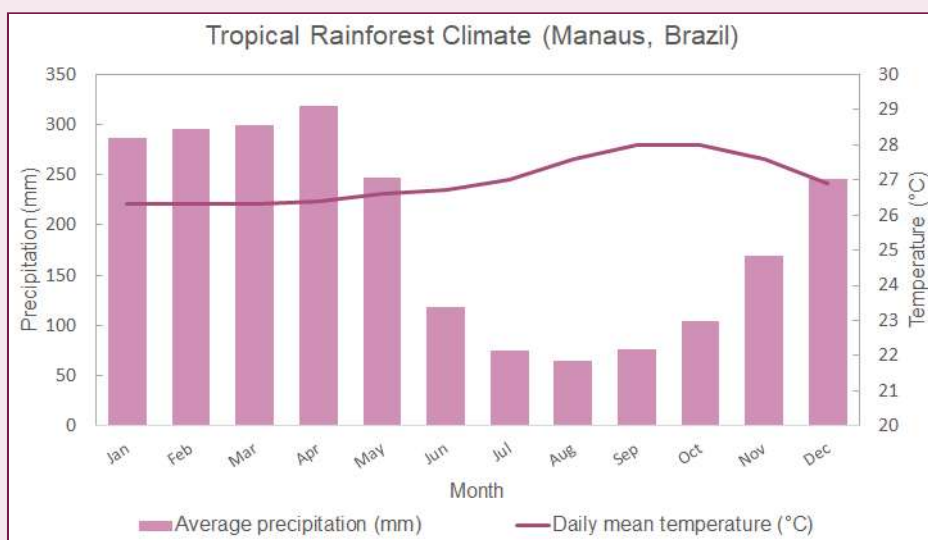
- Tropical rainforests are characterised by **extremely high rainfall**. In fact, tropical rainforests are some of the **wettest biomes in the world**.
- Annually, rainfall exceeds **2000mm per year**, which is over **double** the amount of rainfall the UK receives!
- Rainfall is usually **seasonal**, with a distinct **wet season** where monthly rainfall can exceed **well over 200mm of rain**. All of this rain also means tropical rainforests are **very humid**.



(Source: [Center for International Forestry Research](#))

Temperature

- Temperatures in tropical rainforests are **high**, at around 26-27°C.
- Temperatures stay **consistent throughout the year**, with little variation seasonally.
- Temperatures are **high** and **consistent** due to the sun shining **directly on the equator** throughout the year. These patterns of temperature can be seen on the **climate graph** for Manaus in Brazil below.



Soil Characteristics

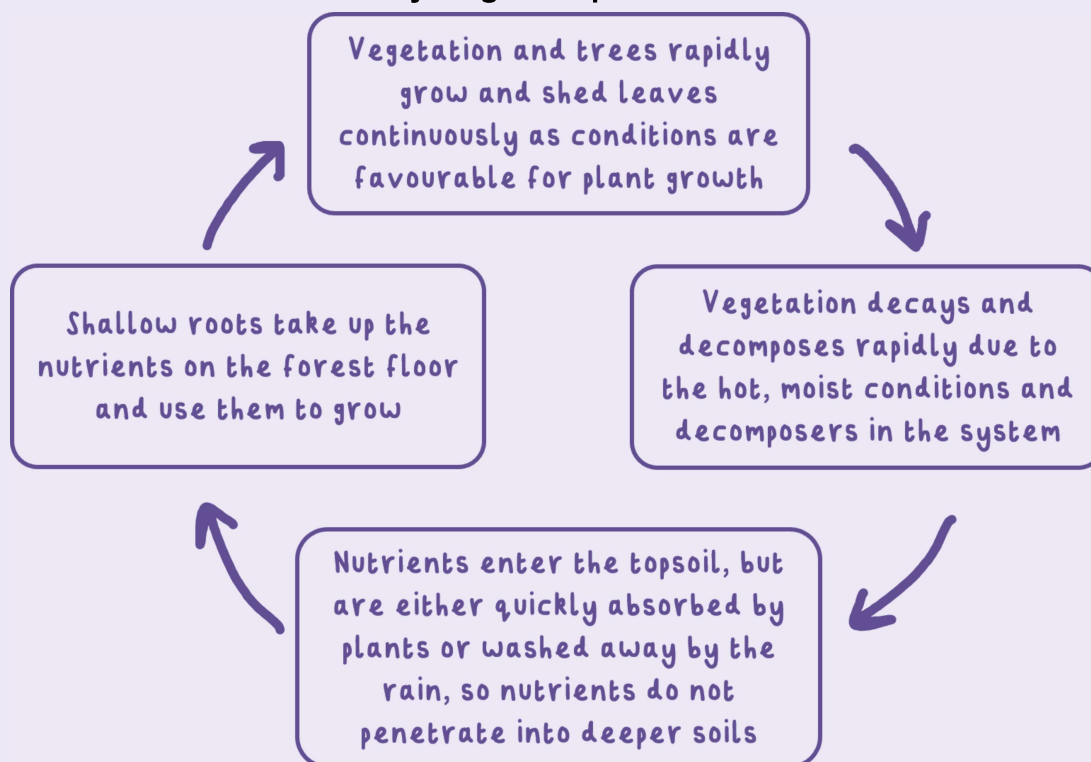
- Despite the **lush vegetation** in tropical rainforests, the soils are actually **extremely nutrient deprived** and **infertile**. This is because nutrients are **washed away and dissolved very quickly** by the intense and continuous rainfall in a process known as **leaching**. This leaves an infertile, iron-rich soil called a **latosol**.
- Plants get their nutrients from the layer of **decomposing organic matter** that sits on the top of the **nutrient poor soil**. Dead plants and animals fall here and are **broken down by decomposers**, sped up by the **hot and humid conditions**. The nutrients released by decomposition are then rapidly absorbed by roots and put back into the living ecosystem.



(Source: earthobservatory.nasa.gov/features/Deforestation)

The **nutrient cycle** in tropical rainforests is very **quick**, which means the nutrients are transported from vegetation (and animals when they eat the vegetation), to the soils, back to vegetation relatively **rapidly**.

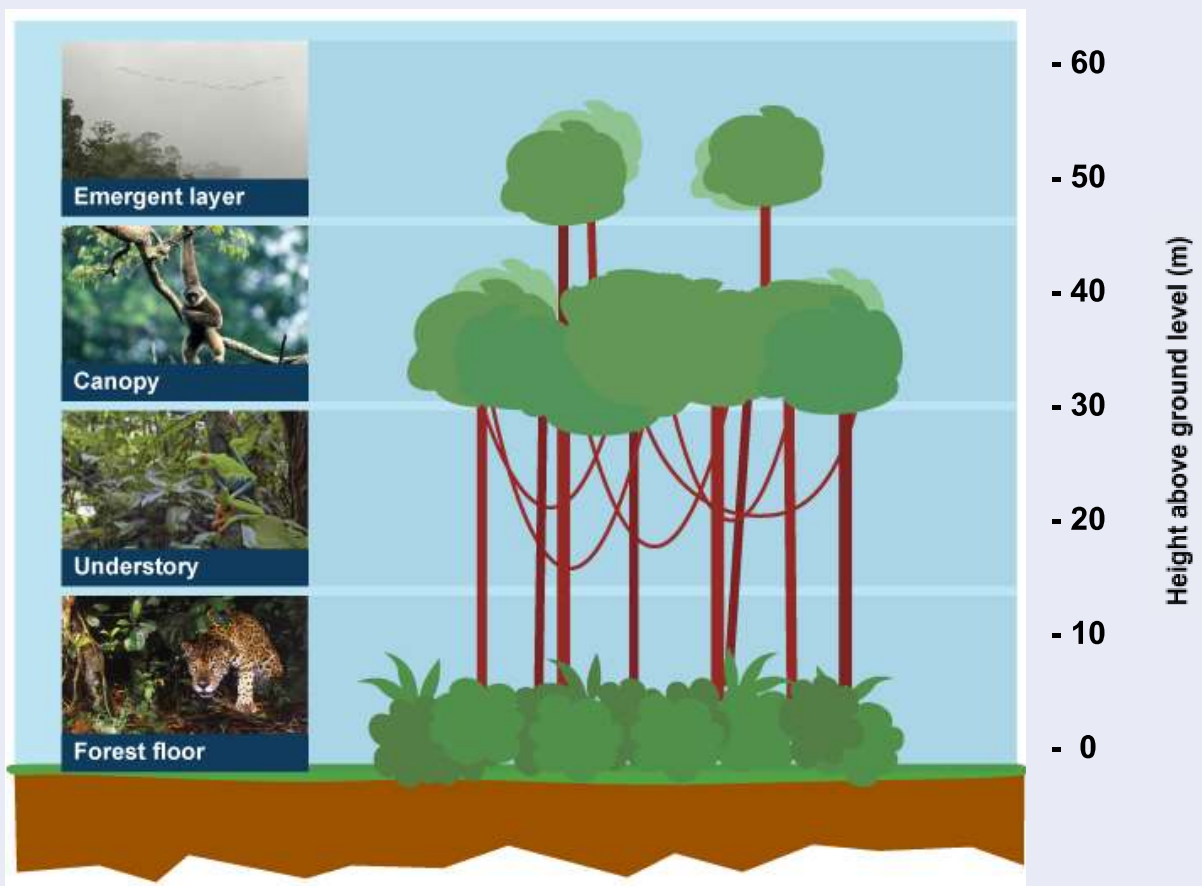
Nutrient Cycling in Tropical Rainforests:



Plant and Animal Characteristics

- Tropical rainforests have huge **biodiversity**. Over half of **all of the world's plant and animal species** are found within this ecosystem.
- The tropical rainforest ecosystem is separated into **layers**, which can be seen in the diagram below.
 - **Birds** and **flowers** live amongst **very tall** fast-growing **trees** in the **upper canopy**.
 - Mammals such as monkeys and sloths live in the **canopy**.
 - Insects, snakes, frogs, and other animals live in the **understory** beneath the canopy, away from predators on the forest floor. Some predators also hunt in the understory, like jaguars.
 - Rodents, larger mammals and **decomposers** (like fungi) live on the forest floor within the decaying organic matter.

Typical Structure of A Tropical Rainforest Ecosystem



(Source: www.bbc.co.uk/bitesize/guides/zpmnb9q/revision/1)



Plant Adaptations

Plants have adapted to the tropical rainforest climate and soils in different ways:

Buttress roots

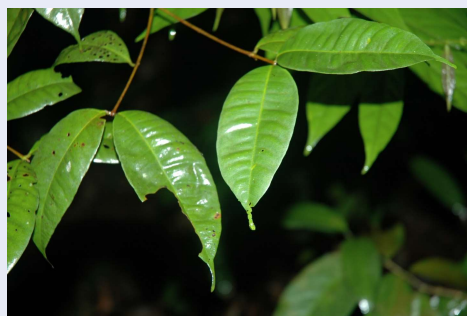
- These are large, above ground roots that look like **ridges** at the bases of large tropical trees.
- Some trees have adapted to the **nutrient deprived**, waterlogged soils by growing large roots above ground.
- Buttress roots ensure tall trees are kept **stable** without growing roots **far down into the soil**. Having the roots above ground also ensures the roots receive enough **air**.



(Source: <https://flic.kr/p/2G6GLW>)

Leaf structure

- Some leaves have adapted to the **heavy and consistent rainfall** in tropical rainforests by developing '**drip-tips**'.
- A drip-tip is a **tapered end** of a leaf that allows excess rainfall to quickly drip off the leaf, ensuring plants are not left **too wet**, which can cause rotting.
- Many leaves also have '**flexible**' stems that move to find light, which is important as the **dense canopy blocks light** from reaching lower levels of the rainforest.



(Source: <https://flic.kr/p/7ReuBn>)

Lianas

- Lianas are **woody vines** that have adapted to the **dark** lower levels of tropical rainforests.
- Lianas have roots that grow **in the ground**, but their vines grow **high up** into the canopy by climbing and wrapping around trees.
- This means lianas can access the nutrients on the forest floor, but can access the light in the canopy.



Epiphytes

- Epiphytes are plants that live on the **surface of other plants**, receiving their nutrients from these plants.
- They have adapted to **growing on trees** high up in the canopy so they receive more **sunlight**, as the forest floor is so dark.



(Source: [/Flickr - _ggallice - _Bromeliads.jpg](#))



Animal Adaptations

Animals in tropical rainforests have had to adapt to the **physical conditions**, as well as **threats from predators** and **competition for resources** as there are **so many different animals** living in this ecosystem. The **high biodiversity** in this ecosystem means there is a lot of competition.

Poisons and venoms

- Animals have adapted to the threat of **being eaten** by the thousands of predators in rainforests by developing **poisons** or carrying **venoms**.
- Many ants, spiders, snakes and frogs can **paralyse** and **kill** other animals. Some animals sting or bite if they feel **threatened**, whereas others are **poisonous to eat**. The photo to the right is a **golden poison frog**, which holds enough poison to kill 10 people!



(Source: Dirk Ercken/Shutterstock)

Physical characteristics

- Animals that **live in trees** have developed adaptations to help them move around and find food.
- Primates** such as the spider monkey have adapted by developing very **long limbs** and long, **strong tails** to help them swing between trees and avoid predators.
- Some animals have **strong claws** to assist with climbing trees. Geckos have special pads that 'stick' to **leaves and trees** to assist with climbing.



Camouflage

- To hide from **predators**, some animals **camouflage** by blending in with sticks and vegetation. Leaf-tailed geckos have a tail that looks like a **leaf** to camouflage from predators. Look how difficult it is to spot in this image!



(Source: Thomas Marent/Minden Pictures)

Size

- To ensure animals can move through the **dense vegetation**, many have adapted to be a smaller size so they can **move through the growth** easily.
- Jaguars** found in tropical rainforests are **significantly smaller** than jaguars found elsewhere in the world. The smaller size is advantageous for moving through the dense forest. They usually do not exceed 6 foot in length.



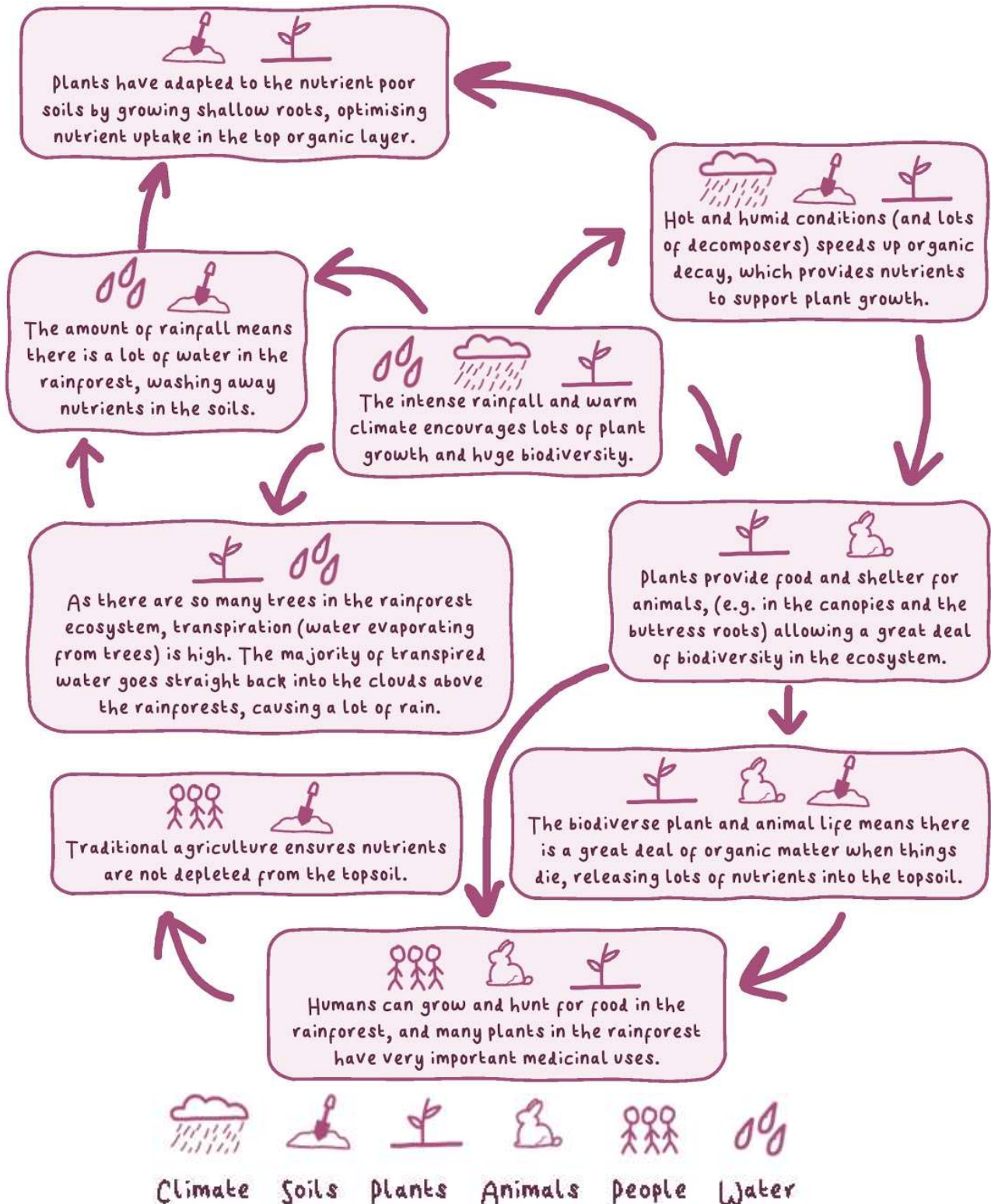
(Source: Getty Images/iStockphoto)



Interdependence in Tropical Rainforests

Within tropical rainforests, the **abiotic** (non-living) and **biotic** (living) factors of the ecosystem **interact with and influence each other**. These complex interactions are important to keep the rainforest ecosystem in a delicate balance.

There are many **examples of interdependence** within tropical rainforests; some examples of the interactions between physical and biological aspects of the ecosystem are outlined below.



Deforestation

Deforestation is the **permanent** and usually **large-scale removal of trees**.

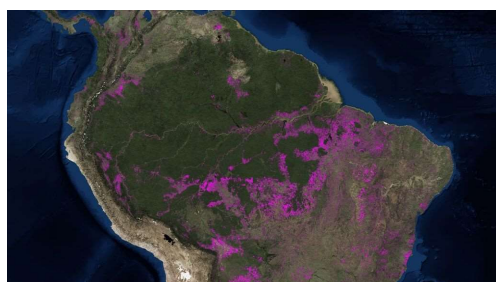
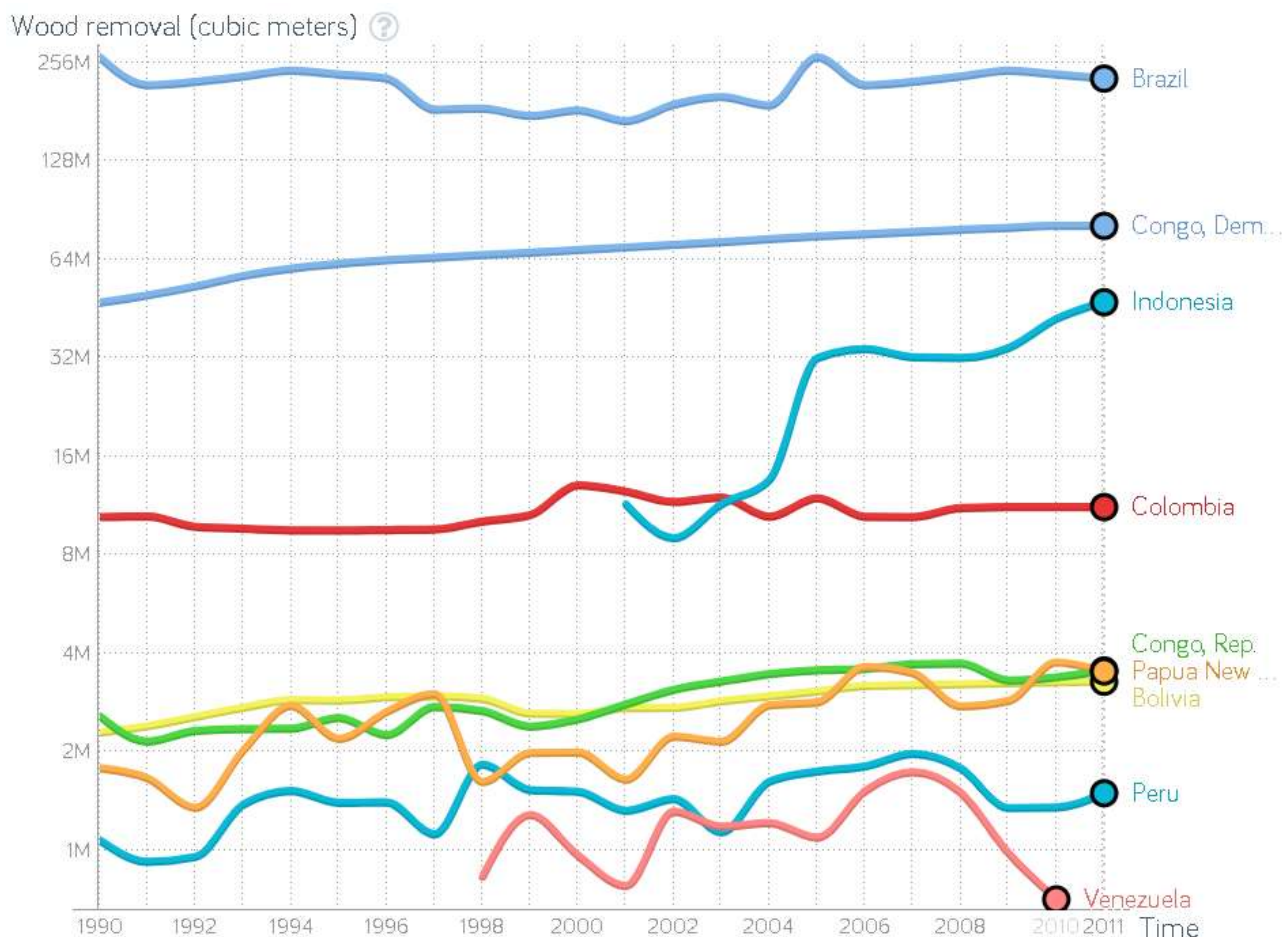
Deforestation has been occurring on a **huge scale** in tropical rainforests all over the world, usually for timber or to clear land for agriculture. Deforestation is a huge **threat** to the delicate **tropical rainforest ecosystem**.



(Source: Mongabay)

It is estimated that global rainforest cover has reduced from **6 million square miles to 2.4 million square miles**. In 2019, a football pitch-size patch of tropical rainforest was lost every six seconds. Brazil, the DRC and Indonesia have lost the most tropical rainforest from deforestation.

Wood removal in tropical rainforests from 1990



The Amazon Rainforest is estimated to have lost around **17% of forest cover in 50 years**. The majority of this deforestation is due to land clearing for **cattle ranching**, as well as **plantations**. The **purple** on the map to the left shows tree cover lost to deforestation in The Amazon.

(Source: Global Forest Watch)

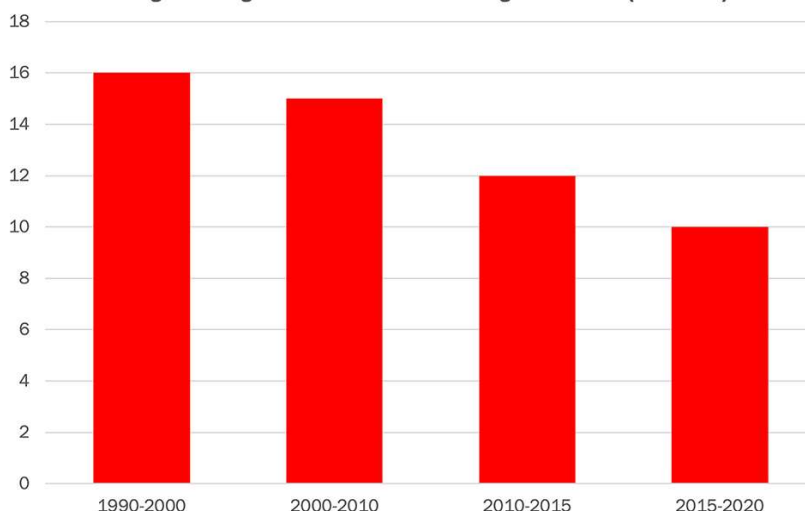


Rates of Deforestation

Although deforestation continues to be a serious ecological issue all over the world, **annual rates of deforestation are decreasing globally**.

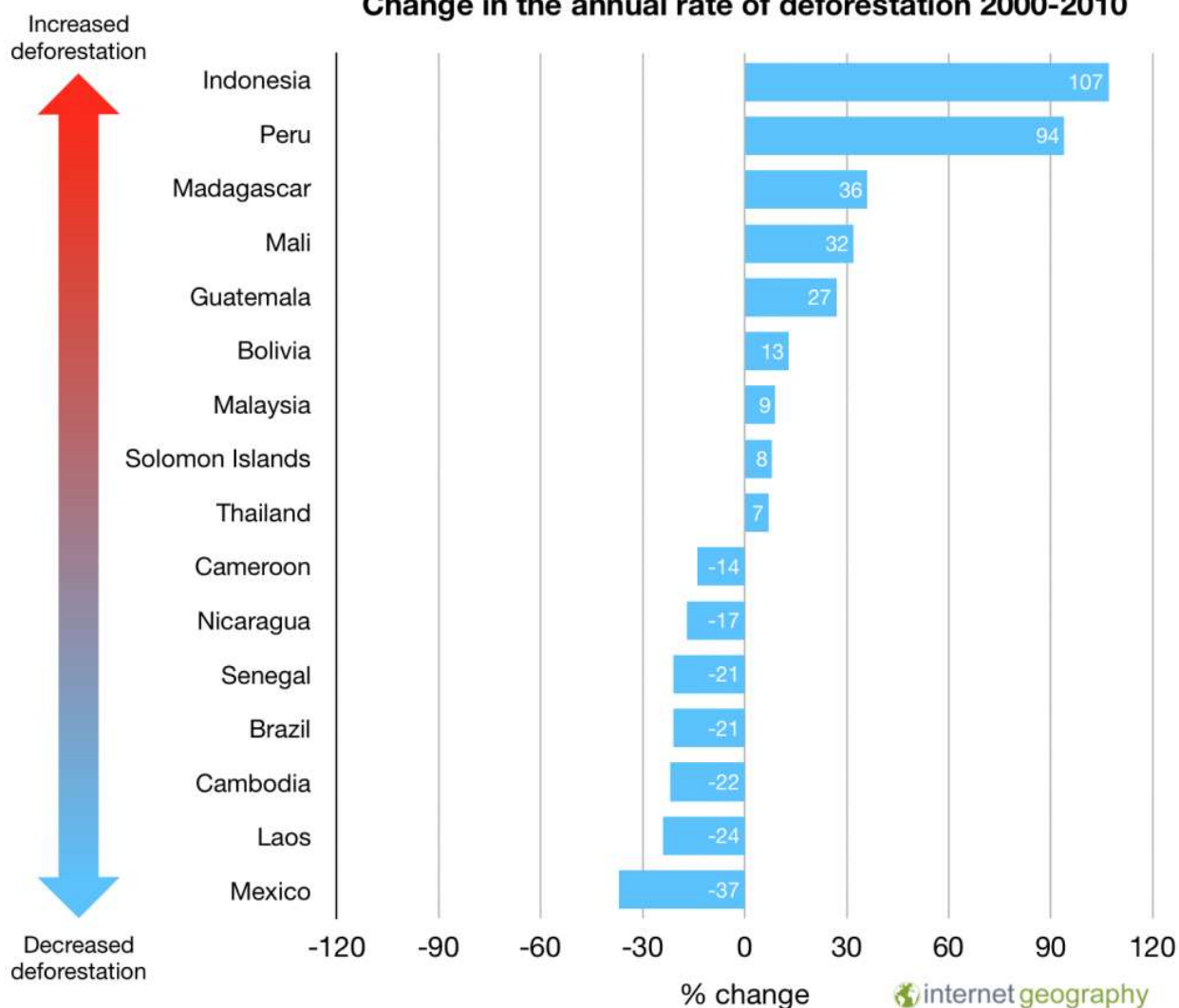
Deforestation in Brazil has fallen by nearly **80% since 2004**, and this is similar in many other countries with tropical rainforests. However, deforestation rates are **not decreasing everywhere**. Indonesia especially is seeing **very high deforestation rates**.

Average annual global deforestation according to FAO 2020 (million ha)



(Source: rainforests.mongabay.com/facts/rainforest-facts.html#8)

Change in the annual rate of deforestation 2000-2010



Causes and Impacts of Tropical Deforestation

There are many reasons why deforestation occurs on such a **huge scale** in tropical rainforests. Tropical deforestation has many environmental, social and economic impacts.

Subsistence Farming

Subsistence farming is where farmers only produce enough food for **themselves and their families to eat**, rather than growing **surplus** food for **profit**.

In tropical rainforests, subsistence farmers usually clear land using **slash-and-burn**:



(Source: KU Leuven - Pieter Moonen)

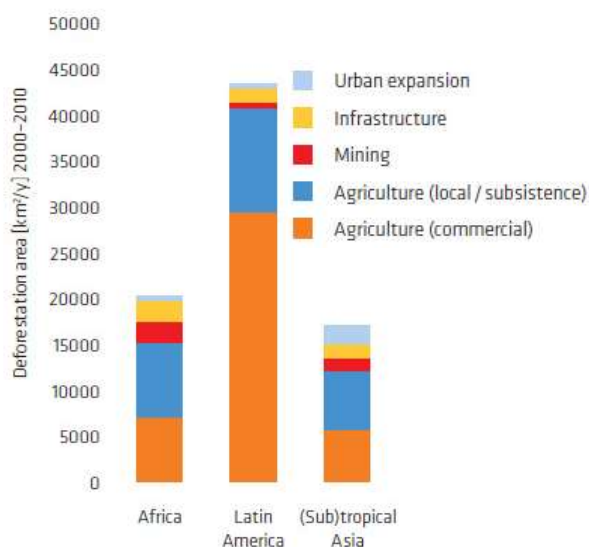
- Farmers **cut down trees** and use the wood for building materials or to sell.
- The land is left to **dry out**.
- The **shrubbery** left behind is then purposefully **burnt**, as this clears the land quickly and **the ash releases nutrients into the soil**.
- After a **few years** of cultivation, the soil becomes **infertile**, so farmers leave the land to recover (usually from 20-100 years) and move to a different area.

This traditional method has historically been **sustainable** as the land has been left to recover. However, with more people moving into rainforest areas, there is **less land available** and some are not **educated** in the subsistence farming practice.

Less time is being left for the rainforest to **fully recover** (only 5-8 years) before it is burnt again, permanently altering the ecology of the rainforest. Also, poorly controlled fires can grow out of control and lead to **wildfires**.

Commercial Farming

b) Area proportion of deforestation drivers



Unlike subsistence farming, **commercial farming** is agriculture with the direct intention of making **profit** from the produce.

Commercial farming is a massive contributor to tropical deforestation, as huge areas of land are cleared to make space for **plantations** (such as **soy** or **palm oil**) or **cattle ranches** for beef production.

Furthermore, a lot of deforestation for commercial agriculture is done **illegally**, often with little consideration for the **environmental impacts**.

(Source: <https://news.mongabay.com>)



Clearing land for palm oil plantations has accounted for **47% of all deforestation on Borneo since 2000**. This has huge environmental consequences, especially for the wildlife. Deforestation and hunting killed nearly **150,000 Bornean orangutans** from 1999 to 2015.

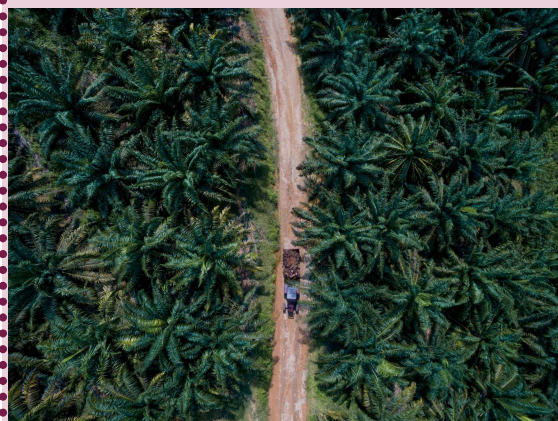
Cattle ranching accounts for up to **80% of all deforestation in the Amazon**.



(Source: João Laet/The Guardian)

This [article](https://www.nationalgeographic.com/magazine/2018/12/palm-oil-products-borneo-africa-environment-impact/) by National Geographic questions whether palm oil can ever be cultivated sustainably.

(www.nationalgeographic.com/magazine/2018/12/palm-oil-products-borneo-africa-environment-impact/)



Logging

Logging is the process of **cutting down trees for wood**, which is then sold as timber or processed into other products. Logging occurs in rainforests as **tropical hardwoods** are very popular woods and can sell for **high prices**.

Clear felling (or clear cutting) is a form of logging where **all the trees in an area** are cut down, including young trees. This method is more **profitable** as it can be done quickly.

However, there are obviously **huge environmental effects** with this method of logging. **Habitats** are **completely destroyed**, other vegetation is usually severely disrupted and animals are displaced. Also, leaving the land bare exposes the soil to the heavy rainfall, causing **soil erosion**.



(Source: Romeo Gacad/AFP/Getty Images)



Road Building

Roads are built in tropical rainforests to **provide access** to areas, to transport **goods**, and to allow **heavy machinery** into areas for **construction, logging** and **mining**.

Large stretches of land are **deforested** to make room for road construction. Many animals are **killed on roads**, and **chemicals** from the roads can be **washed into the tropical rainforest ecosystem**, causing **environmental damage**.



The Trans-Amazonian Highway

(Source: www.bbc.com/travel)

Mineral Extraction



Some areas of tropical rainforests have vast reserves in **metals, gemstones** and **fossil fuels** which are extracted by **mining** and **drilling**.

Large areas of land need to be cleared for **roads and mines**, which causes severe environmental degradation. The rainforest ecosystem is unlikely to recover from this level of damage and deforestation, leaving vast areas of tropical rainforest bare for hundreds of years.

Energy Development

Hydroelectric power is a rapidly growing form of **energy production** in **tropical rainforests** (**80%** of Brazil's energy comes from hydroelectric power!) as the large rivers and huge drainage



Itaipu dam on the Brazil-Paraguay border

(Source: Ember Stefano/Agfotostock)

basins generate a lot of **water movement**. In order to **harness this energy**, **huge dams** have been constructed in tropical rainforests throughout the world, with many more planned.

Dam construction causes deforestation as **large areas of land need to be flooded** to make reservoirs. As tropical rainforests are very **flat**, a lot more land is flooded than necessary, completely destroying **terrestrial habitats** and **displacing indigenous communities**.



Population Pressure

In the 20th century, urban areas became overpopulated due to the growing population. To tackle overpopulation, governments encouraged people to **migrate away from densely populated urban areas to rural tropical rainforests**. This was especially popular in Indonesia, and 'transmigration' schemes were set up, moving **825,000 families from Java to rural areas between 1950-1990**.

Large areas of land needed to be **deforested** to make space for **settlements**. Many people then set up **plantations** to **earn a living**, which required the land to be cleared (often in an **unsustainable way** as migrants were not educated in methods of land clearing).



(Source: <http://www.michr.net>)

The Value of Tropical Rainforests

Tropical rainforests are **extremely valuable ecosystems**, and are important to both **people** and the **environment**.

Natural resources

Rainforests are **rich in natural resources**, such as food and other commodities. Around **25% of all medicines** come from rainforest plants, and the tropical climate is also ideal for growing fruits, nuts, coffee, hardwood and rubber, to name a few examples.

Carbon sink

Rainforests **absorb** and **store** a lot of carbon dioxide within the soil and trees, meaning they are important **carbon sinks** and slow global warming. The Amazon rainforest alone absorbs **5% of the world's carbon emissions** per year.

Clean water

Rainforests provide clean water **to millions of people**. 20% of the world's fresh water is sourced from the Amazon Basin.

Communities

Many people **live in tropical rainforests** and depend upon them for survival. Indigenous communities have lived in rainforests for generations and **displacing these communities** would force them to live very different lifestyles.

The atmosphere

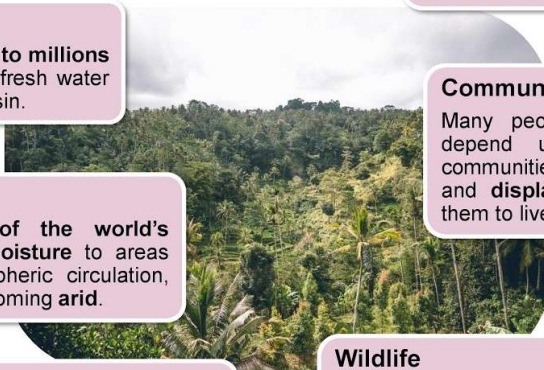
Rainforests produce **28% of the world's oxygen**, and also provide **moisture** to areas around the world via atmospheric circulation, stopping many areas from becoming **arid**.

Research

Tropical rainforests are also a valuable resource to scientists as a lot of tropical rainforests are relatively **untouched by humans**, making it a good environment for ecological and climate research.

Wildlife

There is **huge biodiversity** within rainforests, so it is important to **protect these areas** to conserve the wildlife living within them. It is estimated that in **four square miles** of a rainforest, there are up to 1,500 flowering plants, 750 species of trees, 400 species of birds, and 150 species of butterflies!



Sustainable Management of Tropical Rainforests

To **preserve tropical rainforests** for years to come, sustainable management is necessary:

Selective logging & replanting

Selective logging is the **partial** felling of trees in an area, intended to reduce the **environmental impact of logging** as disturbances are limited. Usually, **only mature trees** are cut down; younger trees are **left in the ecosystem** to grow. Trees are also cut to **fall away from other trees** so they do not damage them, and trees are marked so **illegal logging can be traced**.

Replanting reduces environmental impacts further by preventing **soil erosion** and ensuring **carbon dioxide intake** is not lost. After many years, replanted trees can eventually be felled, meaning this is **a sustainable practice**.



Ecotourism

Ecotourism is a form of **sustainable** tourism that aims to have **reduced environmental impact** and support **conservation efforts**. **Tropical rainforest ecotourism** is becoming more common, as many people want to **visit rainforests** and take part in activities (bird watching, canoeing, wildlife photography etc.) in a sustainable way.

Ecotourism can also **provide income** to indigenous populations **and fund conservation efforts**. For example, The Chalalan ecolodge in Bolivia is ran by an **indigenous community** and is eco-friendly, attracting 1600 tourists a year.



Sustainable Management of Tropical Rainforests

International agreements

Debt-for-nature swaps are agreements where one country **cancels part of the debt owed by another country** in return for the owing country agreeing that they will **conserve and protect their environment**.

The **Tropical Forest Conservation Act** has enabled many debt-for-nature swaps. The US recently **cancelled \$30 million of debt** owed by Indonesia in agreement that Indonesia would better protect Sumatra Island, for example.

International agreements are also useful ways to spread awareness of issues and collaborate with other countries to find solutions. **The 2006 International Tropical Timber Agreement** works to develop **sustainable sources of tropical hardwood** for trading. Tropical hardwoods are **valuable** as they are in high demand, which has caused issues surrounding **unsustainable logging**.

Conservation & Education

Designating **protected status** to tropical rainforests **legally enforces protection** by making environmentally-damaging activities illegal. **National parks and nature reserves** are a sustainable way to **allow wildlife to live** undisturbed, and also encourage **tourism** (which is economically beneficial and can **support conservation**).

Educating **consumers** and **companies** on the **environmental impacts** of rainforest products (meat, palm oil etc.) reduces the demand for these products, and encourages brands to use more **sustainable products**.

