

Tropical rainforests: the water cycle

In this section you will learn about the water cycle in tropical rainforests and how it is affected by human activity and environmental change

What are the main characteristics of tropical rainforests?

Tropical rainforests are found in a broad belt from Central and South America, through central parts of Africa, south-east Asia and into the northern part of Australia (Figure 1).

- Annual rainfall 2000+ mm; 27 °C temperatures throughout the year – ideal for plant growth.
- Home to 200 million people and to about half of the world species of plants and animals.
- A rich biodiversity of plants and animals.
- Plants form distinct layers, with some trees reaching heights of 45 m.
- They absorb huge quantities of CO₂ and emit 28 per cent of the world's oxygen.

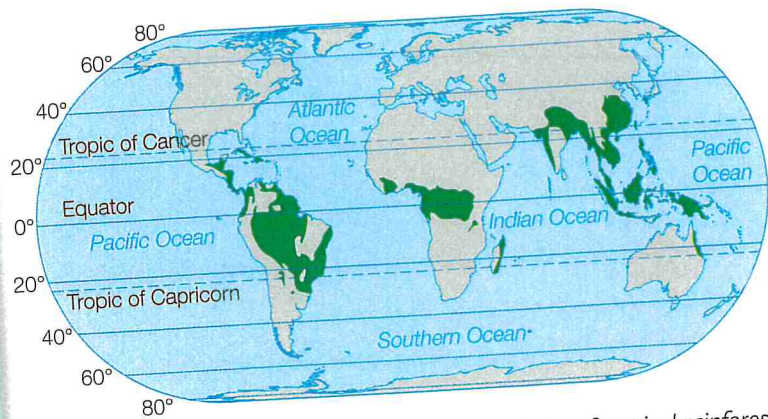


Figure 1 Global distribution and characteristics of tropical rainforest

The tropical rainforest water cycle

The water cycle operating in a tropical rainforest setting is shown in Figure 2. Precipitation is very high, mostly exceeding 2000 mm per year. This is due to the high humidity and unstable weather conditions associated with the tropics. Rainfall occurs on most days and often takes the form of torrential downpours.

The dense forest canopy intercepts up to 75 per cent of this rainfall. Some drips to the ground from leaves or flows down tree trunks as stemflow. About 25 per cent of the rainfall is evaporates. Of the remaining 75 per cent, approximately half is used by the plants and eventually returned to the atmosphere by evapotranspiration. The other half infiltrates into the soil – stored temporarily on the ground surface or flowing overland to river channels. In effect this is runoff.

What is the impact of human activity and environmental change?

Half of the world's rainforests have already been wiped out to make way for commercial farming (plantations and ranching), mining, logging and settlements. Although deforestation appears to be slowing down in some regions, (e.g. The Amazon), it is still a widespread and serious issue in countries such as Indonesia.

Look at Figure 3. Notice that the removal of the trees has a massive impact on the rainforest water cycle, almost wiping out some of the components and significantly affecting others.

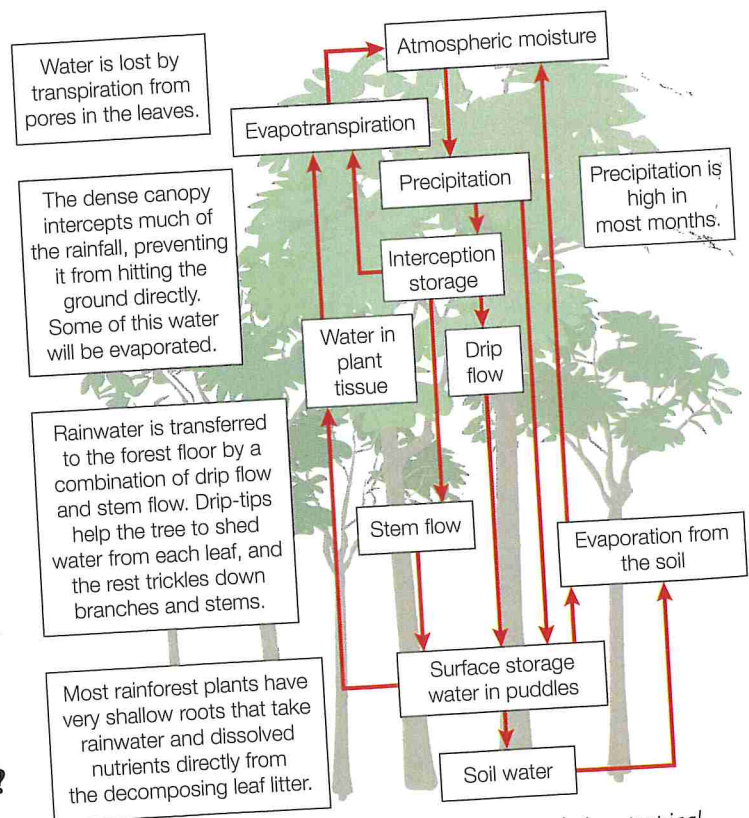


Figure 2 The water cycle in a tropical rainforest setting

Atmosphere becomes less humid as evapotranspiration is reduced.

With few trees, most rainfall reaches the ground immediately, compacting it and encouraging overland flow.

Exposed to the sun, the soil will become very dry and vulnerable to erosion.



Figure 3 Deforestation in the Amazon Basin, Brazil.

Few trees remain, so very little interception of rainfall or evaporation off leaves. Transpiration will be virtually zero.

Rates of runoff will increase, with an increased risk of flooding.

Can deforestation affect climate and rainfall patterns?

For several decades scientists have tried to understand the impacts of deforestation on climate and rainfall. Rainforests allow a considerable amount of water to be returned to the atmosphere through evapotranspiration. When forests are replaced by pasture or crops evapotranspiration is typically reduced, leading to reduced atmospheric humidity and suppressing precipitation (Figure 4).

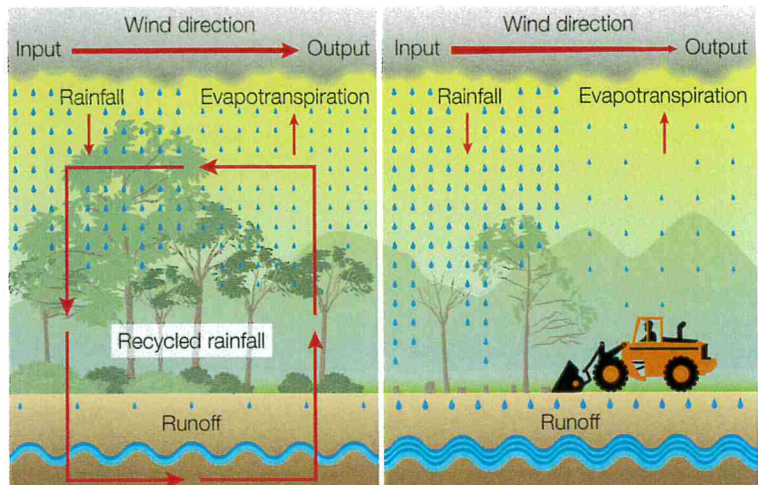


Figure 4 Impact of deforestation on the tropical rainforest water cycle

ACTIVITIES

- S** 1 Study Figure 2. Make a large copy of the tropical rainforest water cycle. Use colours and a key to identify the inputs, stores, flows and outputs. Write the percentages given in the text to indicate the relative importance of the flows.
- 2 Study Figure 3. Draw a simple diagram with detailed annotations to show the impacts of deforestation on the tropical rainforest water cycle. Use Figure 2 to provide you with a checklist of the stores and flows to consider.
- 3 Study Figure 4. Notice that the right side of the diagram shows the impacts of deforestation on the rainforest water cycle.
 - a Describe and account for the changes to:
 - evapotranspiration
 - runoff
 - soil water transfers.
 - b Suggest why the amount of precipitation may be expected to decrease downwind of an area that has been deforested.
 - c Should climate scientists be concerned about the impacts of deforestation on global climates?
 - d Suggest how sustainable forest management could minimise the impact on the rainforest water cycle.

Deforestation and rainfall

Some previous studies have shown an *increase* in local rainfall downwind of a deforested area. However, a recent study by the University of Leeds (Spracklen et al., 2012) provided the first observational evidence of a significant effect on remote rainfall (i.e. hundreds to thousands of kilometres downwind).

‘We discovered that for more than 60 per cent of the tropical land surface, air that had passed over extensive forest in the preceding few days produced at least twice as much rain as air that had passed over little forest. We estimated that future deforestation of the Amazon rainforest could lead to 20 per cent declines in regional rainfall’ (Spracklen et al., 2012).

www.see.leeds.ac.uk/admissions-and-study/research-degrees/icas/spracklenarnold/

STRETCH YOURSELF

On an outline map of South America, draw the extent of the Amazon rainforest and the prevailing wind directions. Refer to the internet or an atlas to assist you. Explain the hypothetical impact of widespread deforestation in South America (refer to the University of Leeds research). Consider the social, economic, political and environmental implications. A similar exercise could be undertaken for other rainforests.

Tropical rainforests: the carbon cycle

In this section you will learn about the carbon cycle in tropical rainforests and how it is affected by human activity and environmental change

The tropical rainforest carbon cycle

Look at Figure 1. It shows the carbon cycle operating in a tropical rainforest setting. Notice the following characteristics:

- ◆ The warm and wet tropical climate is ideal for plant growth. This promotes the process of photosynthesis, which absorbs huge quantities of carbon dioxide from the atmosphere (see Figure 2). In return, the rainforests emit a great deal of oxygen, hence the term 'lungs of the Earth' – a good way to describe the impact of tropical rainforests on the world's climate.
- ◆ Wood is about 50 per cent carbon, so rainforest plants and trees are a huge carbon store. They are important 'carbon sinks' in mitigating the effects of global warming.
- ◆ Respiration by plants, trees and the many animals in the rainforest returns carbon dioxide to the atmosphere.
- ◆ Decomposition is an active process in tropical climates. Decomposers such as bacteria and fungi thrive in the warm and wet conditions (Figure 3). This process releases carbon dioxide back to the atmosphere.
- ◆ Some carbon may also be stored within the soil or dissolved and then removed by streams as an output from the rainforest system.

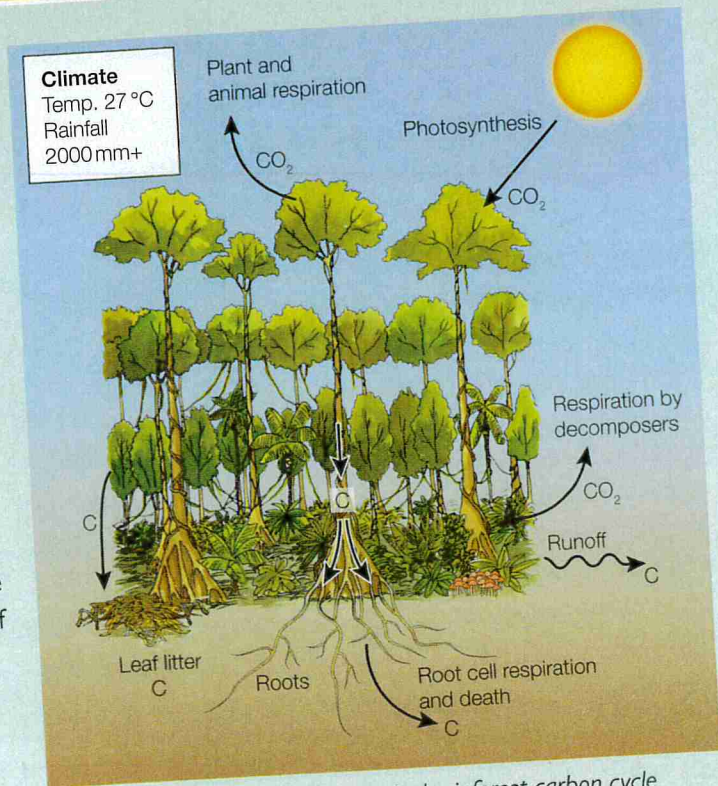


Figure 1 The tropical rainforest carbon cycle

Figure 2 Carbon absorption (fixing) resulting from photosynthesis in selected ecosystems

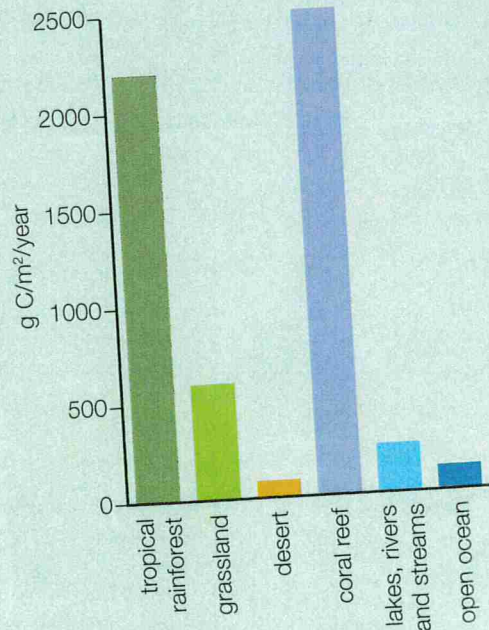


Figure 3 Fungi decomposing leaf litter on the rainforest floor

What is the impact of human activity and environmental change?

Tropical rainforests are cleared to provide land for farming, mining, roads and settlements. One of the most common methods used for clearing is burning. It is cheap and is very effective – often too effective, as fires can burn out of control for weeks and spread, literally, like wild fire!

Look at Figure 4, which shows an area of burnt rainforest in the Amazon. The blackened stumps and ground surface is effectively carbonised wood. Apart from this burnt debris, the rest of the carbon stored in the trees has been emitted into the atmosphere as carbon dioxide. Deforestation is one of the main contributors to the greenhouse gases that are responsible for climate change.

Consider other effects of deforestation on the carbon cycle stores and flows.

- ◆ Photosynthesis pretty much ceases, at least until new plants start to colonise the area. This is by far the most significant impact of deforestation on the carbon cycle.
- ◆ Plant and animal respiration also drops to almost zero.
- ◆ Rain washes ash into the ground, increasing the carbon content of the soil. Carbon in runoff may increase too.
- ◆ Decomposers will be largely absent from this environment.

Replacing rainforest with alternative land uses, such as crops and pasture, reintroduces stores and flows, although operating at much less effective levels – compare grassland absorption with tropical rainforests in Figure 2.

Human activity in the rainforest can take place with minimal impact on the carbon cycle. In parts of Malaysia forests are managed by strict regulation of selective logging followed by replanting, which is both sustainable and has little impact on the carbon cycle.

▼ **Figure 4** Burnt tropical rainforest in the Amazon Basin, Brazil

