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PROBLEMS AND SOLUTIONS IN THE TROPICAL RAINFOREST

Introduction

Approximately 7% of the Earth's land area is covered in tropical rainforest (TRF) (Figure 1). This dense growth of forest is found mainly within the tropics where there is a hot, moist climate (Figure 3). It is thought that 66% of all the Earth's organisms (including a third of all bird species) are found within these forests, which form some of the most biodiverse ecosystems in the world. Tropical rainforests are characterised by containing a large number of different tree species – there can be up to 500 within one hectare and these provide many niches for other organisms allowing this large biodiversity to exist. Many specialised species may only be found on one tree type in one area. When a species is found in one area and nowhere else it is said to be endemic.

The hot, wet climate results in rapid vegetative growth but also in rapid decay as the remains of dead plants and animals decompose and their constituent elements are quickly released into the soil. The roots of plants then rapidly absorb these elements and they contribute to further growth. This is the nutrient cycle (Figure 4).

The structure of the rainforest is complex, with several layers (Figure 5). Plants such as lianas and climbers including the strangling figs use other plants as support and grow across the layered forest. Epiphytes grow on the upper branches of trees in order to gain access to more light and rainfall. Many plants in the rainforest are interdependent, and the removal of even some elements of the forest results in changes to the system as a whole.

Initially our limited understanding of the complexity of the tropical rainforests resulted in much damage to the ecosystem, and this continues, although we are beginning to appreciate the important roles this ecosystem plays within the biosphere.

The importance of the rainforests

It is now known that the tropical rainforest biome is not just important at a local level as an extractive resource,

Figure 1: World map showing distribution of tropical rainforest

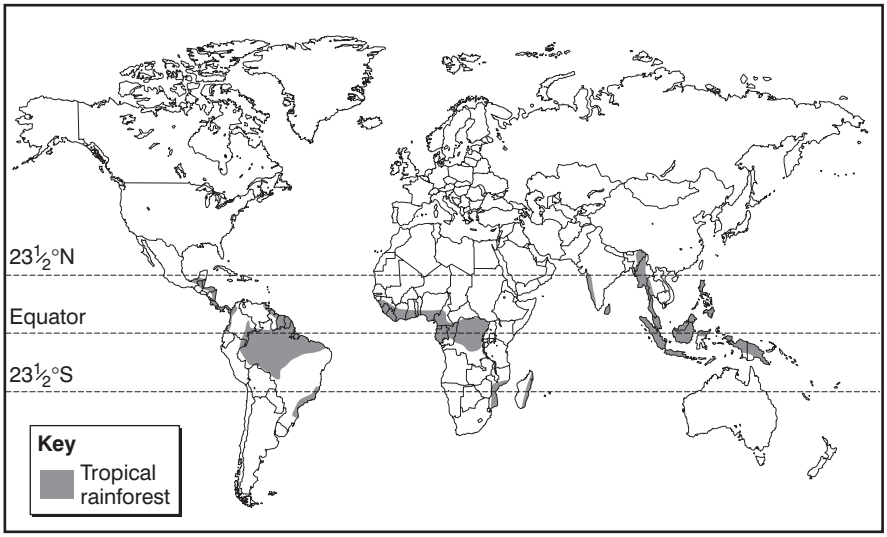


Figure 2: Tropical rainforest data box for selected countries

Country	Forest area (000 ha)	Forest (as % of land area)	Forest change 1990–2000 (000 ha)
Cameroon	23,858	51.3	–222
Congo	22,060	64.6	–17
Madacascar	11,727	20.2	–117
Malaysia	19,292	58.7	–237
Philippines	5,789	19.4	–89
Costa Rica	1,968	38.5	–16
Fiji	815	44.6	–2
Papua New Guinea	30,601	67.6	–113
Brazil	543,905	64.3	–2 309
Guyana	16,879	78.5	–49

Figure 3: Climate data for Manaus, Brazil(3.0°S 60.0°W)

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temp. °C	28	28	28	27	28	28	28	29	29	29	28	28
Rain mm	278	278	300	287	193	99	61	41	62	112	165	220

but that its destruction is likely to have serious global consequences too. Figure 6 summarises the value of tropical rainforests. The rich biodiversity means there exist some species humans have not yet identified. These may hold the key to future medical cures, or may constitute an important future food crop.

The huge tropical rainforests of Amazonia absorb massive amounts of carbon dioxide through the process of photosynthesis and store it in plant tissue, thus helping to counteract global warming. The trees also break up the impact of heavy tropical rainfall, allowing infiltration and minimising soil-eroding surface runoff. They also evapotranspire moisture back into the atmosphere, maintaining the hydrological cycles.

Problems facing tropical rainforests

Many of the world's areas of tropical rainforest are threatened by similar problems, which are summarised in Figure 7.

1. Population pressure
Most tropical rainforest is found in LEDCs and many of these countries are

Figure 4: Nutrient cycle in tropical rainforests

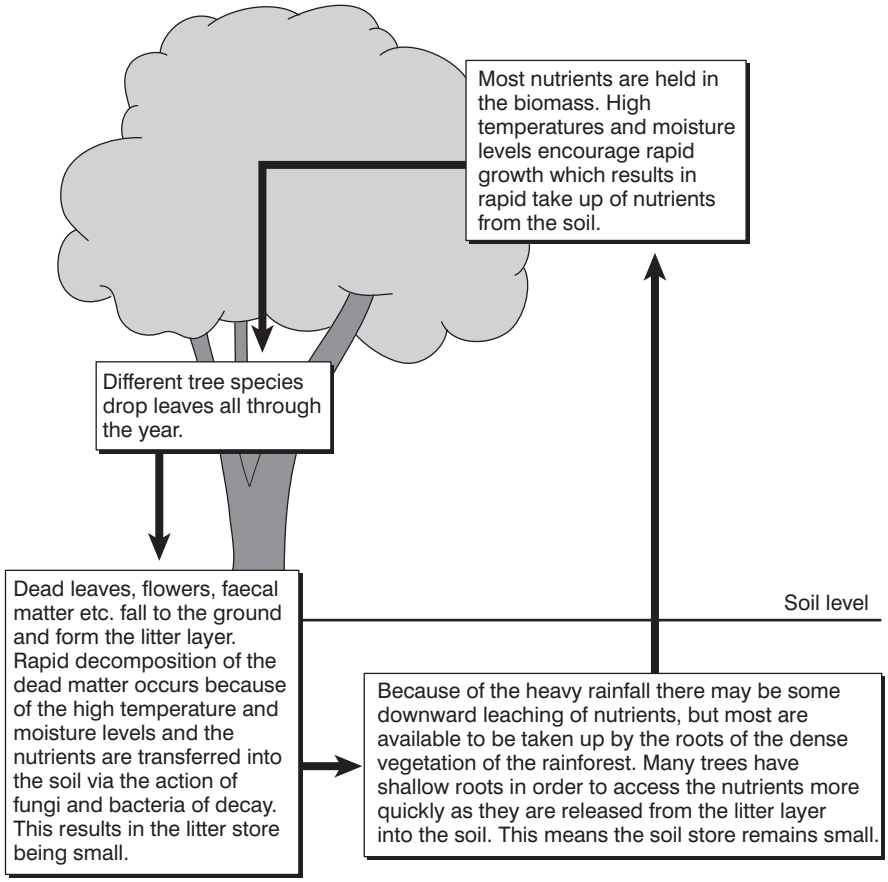
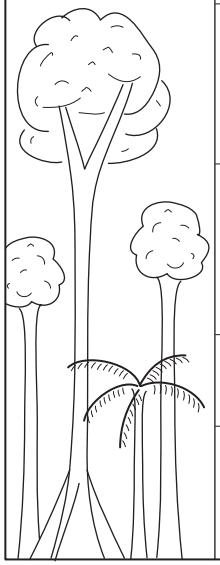


Figure 5: Structure of the tropical rainforest

STRUCTURE OF THE TROPICAL RAINFOREST



Layer	Microclimate	Flora	Fauna
Emergents Up to 60 metres	Trees emerge above canopy. Very windy and receive large amounts of solar energy. High rates of evapotranspiration	A typical tree species here is Araucaria. Umbrella shaped crowns are produced by trees in this layer. Roughly one emergent per hectare. Epiphytes grow on the trees, using them as a support but are not parasitic. They gain more sunlight.	Few mammals at this level. Mainly birds such as macaws and insects such as butterflies and beetles. Birds of prey such as harpy eagle will perch here.
Main canopy Up to 40 metres	Dense vegetation layer as trees compete for light. Humid beneath the top part of canopy. The canopy absorbs about 80% of the sunlight falling on the area.	Wider variety of tree species including kapok, figs and rosewood. Often covered in lianas and other climbing plants which use canopy trees to get to the sunlight and will flower once up in the open air.	This layer is where most life is found. It is the main routeway through the forest. Birds and insects tend to be brightly coloured, e.g. parakeets. Mammals such as monkeys live here.
Lower canopy Up to 10 metres	Most of light and rain has been intercepted by canopy. Dark and very little wind. Humid.	Trees have more pointed shape as they aim for the light. Saplings of canopy trees and smaller trees such as nutmeg.	Fewer species, more darkly coloured. Tree climbing cats e.g. ocelot. Frogs found at this level.
Ground level	Very dark unless a tree has fallen opening the canopy above. Less than 1% of light received by canopy falls in this layer. Humid and still.	Little growth unless near a river which opens up the forest and allows some light in near its banks.	Large cats such as jaguar. Frogs and animals that live on detritus/fungi such as peccaries. Also deer living off fallen seeds and fruit

experiencing rapid population growth. This leads to pressure on the land covered by the forests, which are often viewed as 'wasted' land. The best farmland tends to be in the hands of a very few wealthy landowning families who practise mechanised agriculture and have minimal need for agricultural labourers. Landless peasants see the TRF areas as a possibility to provide for their families. Once there they cut down the trees and burn them to release the nutrients, but these nutrients are only available for one or two seasons. The soil is nutrient-poor and after tree clearance it is exposed to heavy rainfall, causing soil erosion. After a year or so the farm plot is abandoned and the farmer moves on to clear another area of rainforest. The abandoned plot may take 100 years to recover fully, as the soil structure is often destroyed.

2. Commercial agriculture
In some areas, notably Brazil, landowners were given large tracts of land on the basis that they would clear that land of forest. This was then used for cattle ranching, responding to the demand for beef from MEDCs. However, much of the vegetation that replaces clear-felled TRF is not suitable as cattle fodder and yields of beef per hectare were very low.

There is also pressure for plantation agriculture to produce large amounts of crops such as pineapples and coffee for export. Generally it is the wealthy landowners that carry out this farming, as mechanisation and a high level of chemical input are required. Both of the above commercial agricultural systems reduce the multi-layered nature of the TRF.

3. Extractive industries
Logging causes huge damage to the TRF. Often the commercially more valuable trees, such as mahogany and sapele, are taken out first but their extraction usually damages the surrounding trees too. Figure 8 outlines some of the impacts of deforestation. If a forest is clear-felled, the industry then moves on to another area. Humans have always used the TRF; it is the speed with which it is being harvested that is unprecedented. Logging companies have failed to look at the long-term effect of their practices, and leave behind a degraded environment. What fuels their activities is demand from the MEDCs for tropical hardwoods. To access new logging areas, access roads have to be built, and this opens up previously isolated regions to farmer colonists.

Large-scale mining, such as the iron ore mine at Carajas, Brazil, results in a massive clearance of forest and the building of access roads. Gold mining is usually small-scale and carried out by individuals, but cyanide and mercury are used in the process and these toxins are then released into the rivers.

4. Infrastructure projects
Roads accessing both logging and mining areas lead to further settlement. There are many large HEP projects that have been completed, also requiring road construction. Large areas of forest are flooded behind the dams and once built, the dam changes the hydrology and ecosystems of the whole river basin.

5. Debt
Many LEDCs have huge international debts. They have to take a short-term

Figure 6: Value of tropical rainforests

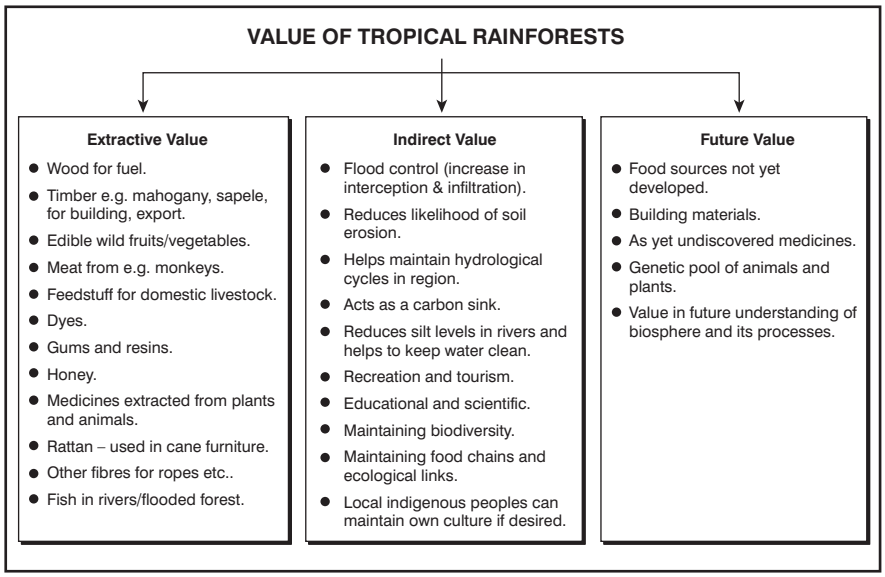


Figure 7: Problems facing the tropical rainforests

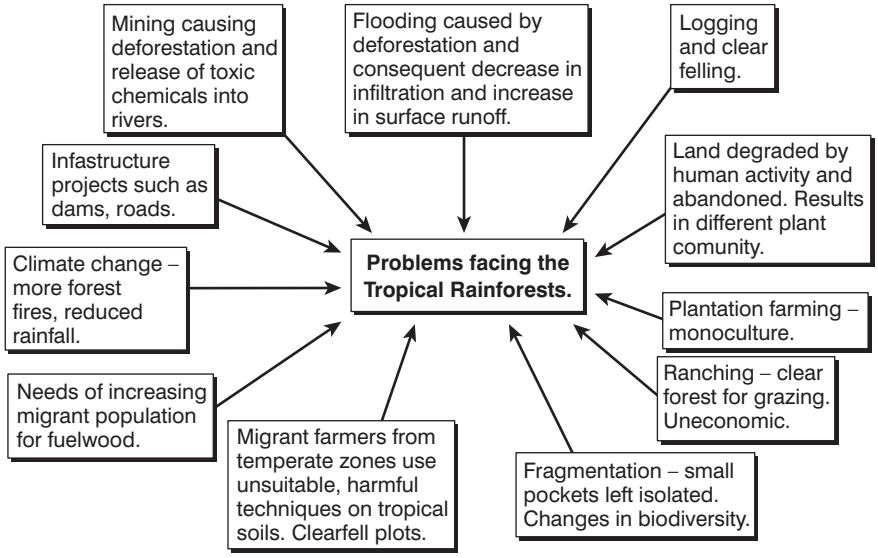


Figure 8: Impacts of deforestation

Before deforestation	After deforestation
• Rainfall intercepted by vegetation. Breaks force of rainfall.	• Most of rainfall reaches soil surface. Limited interception.
• Water reaching soil surface is infiltrated. More throughflow.	• Less infiltration so more surface runoff.
• Tree roots hold soil together.	• Soil not held by roots so more prone to water erosion.
• Nutrient and hydrological cycles kept intact.	• Input into litter layer greatly reduced.
• Diverse habitat provided.	• Higher albedo. Change in local microclimate.
• Large biodiversity	• Soil likely to become lateritic with exposure to rain and sun.
	• Nutrient and hydrological cycles are interrupted.
	• Huge reduction in habitat and biodiversity.

view and allow unregulated use of their forest resources in order to finance those debts.

Solutions

See Figure 9 for a summary of possible solutions.

Case studies of some solutions

Agroforestry in Amazonia

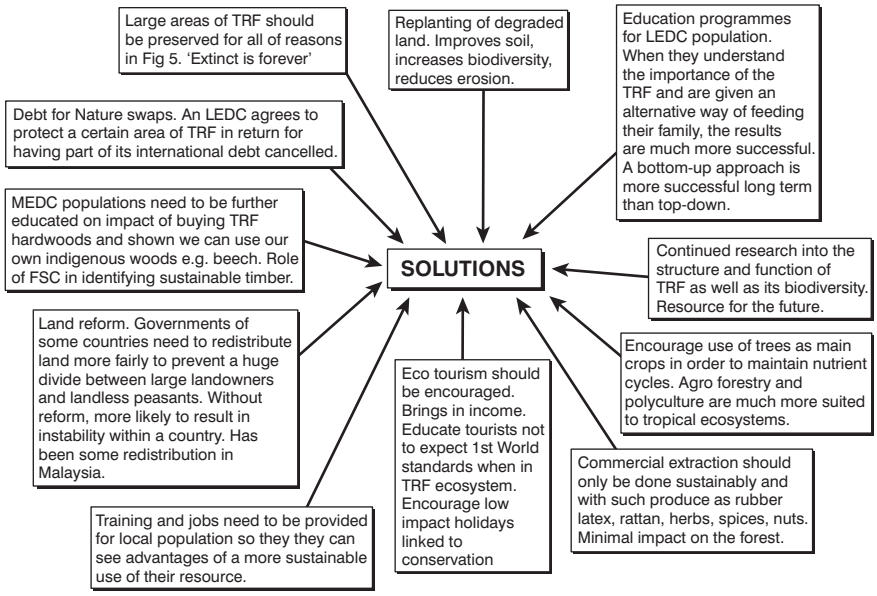
The Amazon still has the largest undisturbed area of tropical rainforest, but there are many threats to its existence. Towards the end of the 20th century research was done into the way that Caboclo villagers interacted with the rainforest, as they appear to live sustainably within the forest. Caboclo are rubber tappers, and moved into the forest early in the 20th century. Tapping rubber trees in the forest for rubber latex is their main commercial activity. This is a sustainable use of the forest, as the trees are not harmed. However, without government support, they cannot easily transport the latex to market, and so Brazil continues to import most of its rubber. The Caboclo grow trees such as jackfruit, breadfruit, bananas and coffee. These provide shade for other plants which grow beneath, such as beans and fruits. This mixture of crops is known as polyculture and suits the soils and climate of the tropical rainforest. Large areas of soil are not exposed at any one time as all the crops are harvested at different times of the year and the trees hold the soil together and provide shade. For meat, the Caboclo keep pigs and chickens which can forage in the surrounding forest. This too is a sustainable use of the forest and can support far higher numbers than the usual policy of clearing the forest and growing crops for just a year or two. One Brazil nut tree alone can provide more food than many of the colonist farmer plots where the forest is first cleared and a commercial crop planted, remaining fertile for just a year or two. Unfortunately there is as yet not much support for this type of agriculture which enables people to live sustainably within the forest.

Sustainable commercial forestry in Sabah, Malaysia

Malaysia has suffered from heavy logging during the late 20th century. Each state of Malaysia is responsible for its own forestry policy and there is a lack of overall national management. Although much legislation has been passed to protect the remaining forests, some logging companies have ignored the guidelines laid down by the individual authorities.

Reduced impact logging (RIL) is practised in the most vulnerable areas. This may include heli-logging, where the most valuable trees are taken out by helicopter to avoid damage to the surrounding trees. RIL also limits the

Figure 9: Possible solutions to the problems facing tropical rainforests



use of heavy machinery, which can compact the soil and when it rains lead to more surface runoff, soil erosion and siltation of rivers. In the forest areas of Sabah, buffer zones of vegetation are now left around streams and rivers so that surface runoff resulting from forest clearance can be absorbed and the precious silt does not go into the river.

In areas which have been heavily logged, palm oil plantations are often planted as a replacement. Although supporting a far poorer biodiversity when compared with the original forest, they do provide a long-term economic return, and maintain soil fertility and the local hydrological cycle.

Much logging is now in the form of strip logging rather than clear felling. This leaves a retreat for the forest fauna and encourages natural regrowth of the trees as the seed source is nearby. However, all logging companies are required to replant with native trees wherever this is possible. Although the legislation is in place, there are too few forest rangers as yet to fully monitor and control the situation.

Iwokrama- protecting diversity in a primary forest

The Iwokrama Project is a protected 371,000 ha area of tropical rainforest in Guyana, in the north-east of South America. There has as yet been very little impact by humans and the government of Guyana decided to protect this huge area of primary forest with financial help from the United Nations Development Programme and expertise from around the Commonwealth. Other partners are the Smithsonian Institute of the USA and the United Kingdom Department for International Development (DFID). Right from the beginning, the detailed knowledge of the local tribes has been valued and used in assessing the area's biodiversity. The International Centre for Rainforest Conservation and Development has been set up within the project and is of worldwide importance.

The forest has high levels of biodiversity with the following species numbers being identified:

- 420 fish
- 127 mammals (including 90 bats)
- 135 reptiles and amphibians
- 1,500 plants
- 500 birds.

There are two levels of protection within the project area. The Wilderness Preserve, which forms about half the area, has no roads or agriculture allowed within it. No mineral or forest extraction is permitted and there is only limited vehicle access, where necessary by the wardens or scientists. The Sustainable Utilisation Area (SUA) permits limited use of the forest but only after an environmental impact analysis has been carried out. Basic eco-tourist accommodation is allowed, and there are access trails. The local tribes are allowed to use the forest according to their traditions and some sustainable timber extraction is permitted. The result is a multi-purpose forest where conservation is the priority but that is still able to be used in a sustainable way to improve the life of local people and the economy of the country as a whole, especially with regard to tourism.

The Forestry Stewardship Council

In order that buyers of timber can be sure that timber they purchase is from sustainably managed forests, the Forestry Stewardship Council was set up in 1993. It operates in 30 countries and aims to promote the sustainable management of forestry reserves. Timber from such reserves can be recognised by the FSC label and logo. By refusing to purchase timber or timber products without this label, individuals are making illegal forestry less and less profitable.

Conclusion

Today we know more about the organisms and cycles of the rainforest and also realise there is much more to know. In order to protect and maintain the TRF of the world, we are realising the difficulty of trying to police the problem, as the areas are too vast. A better quality of life for local people needs to be one of the outcomes of any management of this biome, alongside TRF protection and sustaining the environment itself. Involving the people who live within the biome in the sustainable use and conservation of their environment is now recognised as being of primary importance.

Focus Questions

1. Assess the importance of the tropical rainforest biome at local, regional and global levels.

2. Outline (with examples) the threats that regions of tropical rainforest face at the beginning of the 21st century.

3. For a named ecosystem, show how management techniques can have both positive and negative impacts on biodiversity and natural cycles.

4. Outline some conservation strategies that have been used in tropical rainforest areas, and assess the level of their success.