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### The Vanishing Jungle

Large tracts of tropical rain forest are being turned into barren waste by ill-prepared attempts to exploit them. Even carefully planned schemes are going awry. Earlier this year, Mr. Daniel Ludwig, the American shipping, farming and mining magnate, pulled out of the Jari project in Brazil, after spending \$1 billion to exploit 4m acres of Amazon forest. He had plenty of scientific advice, but the jungle refused to be tamed for the money.

Tropical rain forests are the home of nearly half the world's animal and plant species. They are also a potential economic resource for over-populated developing countries. But they are one of the least understood environments on earth. Neither conservation nor intelligent economic exploitation is possible without scientific insight into the complex, rich but fragile ecology of the jungle.

Jungle occupies 6% of the world's land area. One third of this is concentrated in Brazil; nearly three fifths in Latin America as a whole. Zaire and Indonesia each account for another 10% of the total.

The forest environment, hot and wet all the year round, generates an extraordinary diversity of life. In the Amazon, botanists have counted 300 species of tree within an area of 2 square kilometres. Some 500 plant species over 5 feet tall were found in just 1 five-acre patch. This diversity is accompanied by an astonishing interdependence between species. Central America has 40 species of fig and each relies on a different insect to pollinate it. When one plant depends on a single insect species for pollination, the pollinator often depends on a 3rd species for some stage in its life cycle. Remove one species from the chain and you may lose several other links.

Plants grow faster in the jungle than anywhere else on land; growth there typically yields over 2 kilos of dry weigh per square metre per year. Litter falling from the forest canopy is recycled rapidly, turning 1st into humus in the damp heat and then feeding fresh vegetation. This productivity is misleading. For a variety of reasons, cutting down the forest can cause the soil quickly to become infertile.

Experts cannot agree on how fast the forest is disappearing now, let alone on predictions of future rates of destruction. One estimate is that 11m hectares are being



**Figure 1.** Will anything grow here next year?

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lost each year, equivalent to 50 acres a minute or an area the size of East Germany annually. That is a yearly loss of 1.2% of the total forest. Other experts, popular with conservation groups, say the rate of destruction is twice as fast; yet others, popular with the more exploitive kind of businesses, say that it is only half as much. Inadequate surveys of the jungle wilderness are part of the problem. A recent survey in Brazil revealed a large tributary of the Amazon that nobody literate had known about before. In future, satellite photography should produce more accurate maps.

According to one estimate, West Africa has already lost 72% of its rain forest, while southern Asia has lost 63%. Another report suggests that half the Amazon forest and 28% of that remaining in Africa may be destroyed by the year 2000.

These guesses are probably too gloomy. According to analysers of satellite photographs, only 2% of Brazilian Amazonia has disappeared so far. A United Nations study, carried out by the Food and Agriculture Organization, suggested that the decline in forest by the year 2000 would be a modest 9% in Latin America; 6% in Africa south of the Sahara; and 13% in the developing parts of Asia.

Although the Amazon's future provokes most public concern, the smaller areas of forest are in greater immediate peril. For instance, over-greedy exploitation of timber in Thailand has already turned the country from a leading exporter of wood into an importer. The Philippines may suffer a similar fate.

### Extinctions

While the fate of the forests themselves is hard to predict, the number of species likely to be made extinct by deforestation is far more so. One report has put the number of rain-forest species likely to be extinguished by the end of this century at between 250,000 and 1.25m. This is up to half of all species thought to exist in these forests. Interpret these figures cautiously. Scientists have not yet classified most of the species presumed to exist in the rain forests.

Many of the threatened species have economic potential as sources of food, beverages, gums, resins, medicines, scents, pigments, pesticides, contraceptives, abortifacients and so on. And plant breeders are increasingly eager to preserve forest species as sources of genetic diversity. When Brazil's coffee crop was failing, it was African forests that provided genetic material to breed a new strain of coffee bushes more resistant to bad weather and leaf rust.

Scientists are still not agreed whether the removal of some forest species will lead to a domino effect, causing still more species to disappear. Some argue that the more species there are, the more interdependent each is on the others. The extinction of even a few species could upset the delicate system of checks and balances which maintains a stable ecology.

Others reckon, also pessimistically, that the ecology of the rain forest is peculiarly unstable in



**Figure 2.** Where rain forests are.

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the first place. They say the absence of seasons means that natural fluctuations of environmental conditions are relatively small. Each species is highly specialized to exploit a particular ecological niche and has little resistance to changes in its environment.

A more reassuring argument holds that the area of forest must have receded during past periods of glaciation, concentrating in small “islands” where genetic diversity was preserved. According to this view, given the right island areas, most species could be saved, even if only 10% of the forest survived.

### The Soil Crisis

Whatever the truth of the matter, large-scale forest clearance has already left behind tracts of land unable to support much life, either wild or cultivated. One part of Assam in India is the wettest region of the world, yet completely barren.

Several nasty things can happen to the soil when rain forest is cleared. The seriousness of each depends on the area of forest affected. One risk is loss of soil nutrients. In many forests, the bulk of the nutrients (nitrogen, carbon, essential minerals, etc) is stored in the vegetation rather than the soil. Remove the vegetation and you leave behind infertile soil.

This risk is serious in central and eastern parts of Amazonia where soils appear to be extremely low in all nutrients. This has to do with the region’s geological history. New rocks—containing fresh supplies of nutrients—have not been exposed recently. Meanwhile, the hot, wet climate has thoroughly weathered underlying rocks and has long ago leached out their minerals. And some of these rocks (such as the quartzites) were probably low in nutrients to start with. Plainly, forest removal is bad for the long-term health of the soil in such areas. Clearance is a costly mistake, since these areas are not suitable for most systems of agriculture.

In many other areas recent geological activity (volcanism, erosion or river-delta deposition) has provided nutrient-rich soils. In the Andes, for example, mountain building has brought un-

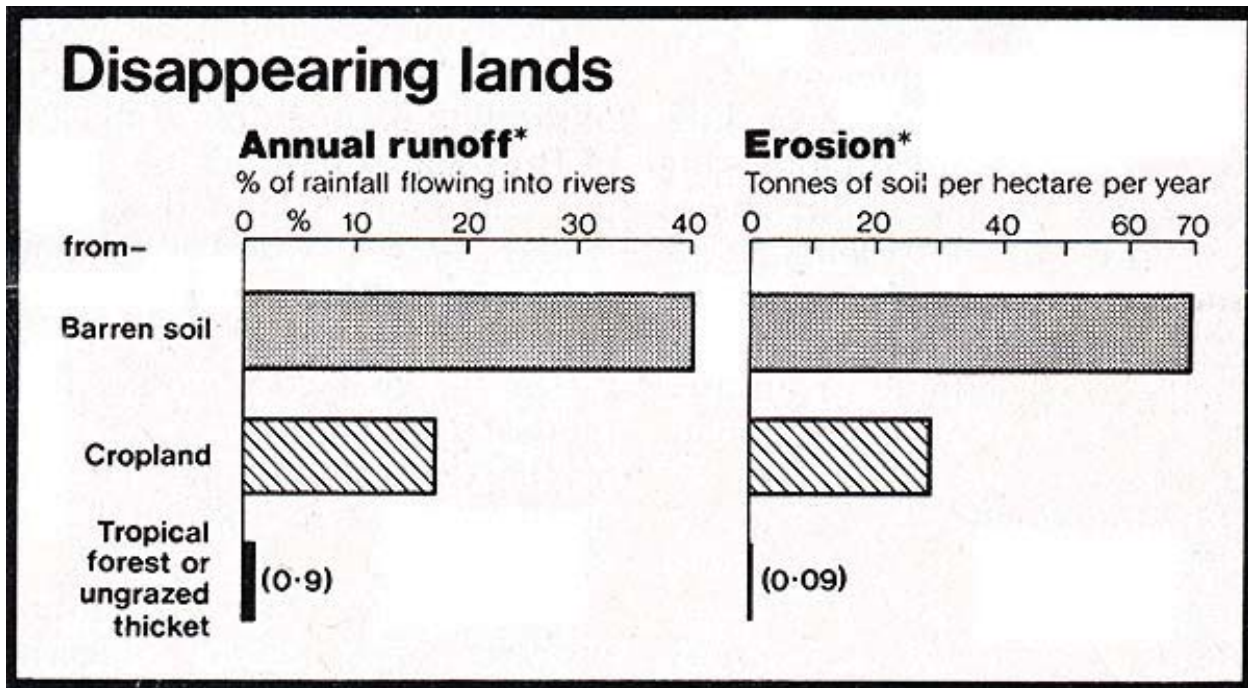


Figure 3. Disappearing lands

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weathered rocks, rich in essential elements, within reach of the surface of the earth. Rain in the Andes washes enormous quantities of this soil into the Amazon each year, the Amazon floods its banks and the flooded plains are made fertile. Similarly, flooding has enriched parts of south-east Asia, enabling them to support dense human populations over many centuries.

Another problem, besides low nutrient levels, is the richness of many tropical soils in so-called sesquioxides of iron and aluminium. Such soils are known as laterites. One of their properties is that they harden on exposure to air. Once hardened, they stay that way; the process cannot be reversed. The soil becomes hostile to the growth of plants.

Simple soil erosion is another big risk. The canopy of the forest shuts out sunlight, intercepts and softens torrential rainfalls. The roots of the thick vegetation also serve to bind, and so protect, the soil. When the forest is replaced by crops or fallow ground, 2 things happen. First, much more of the rainfall runs off into rivers, instead of irrigating the ground. Second, the run-off into rivers carries large quantities of soil with it (see Figure 3). Rivers, in consequence, become choked with sediment and more prone to flood.

### Tropical Farming

Traditional societies often build terraces on steep slopes to reduce erosion. Well-managed tea plantations can reduce erosion rates to more-or-less natural pre-cultivation levels. Less careful citizens of the tropics are having to learn how to cope with erosion—so far with only mixed results. In Upper Volta and Senegal, annual erosion rates of 10–20 tonnes per hectare have occurred on bare soil where the slope was only 0.5–1%.

In the tropics, forest clearance for farming has continued for at least 3,000 years in Africa, 7,000 years in central and southern America, and 9,000 years in India and New Guinea. But the traditional way of exploiting the tropical forest is a method of shifting agriculture called swidden. It does little permanent harm.

A small area of land is cleared by slashing and burning. Nutrients locked in the vegetation are released to the soil and a few trees are left to provide cover. Under the swidden system the soil's fertility declines after a few years and the farmers move on to clear another patch of forest. The forest is allowed to regrow on the old patch until, after 10 years or so, the farmer returns to clear it again.

With increasing population, areas of forest are being re-cleared too frequently. Intensive, continual cultivation by modern methods in forest soils would, it might seem, have even more devastating effects. Or would it?

Promising results achieved in Peru were reported recently in the magazine *Science* by soil scientists from North Carolina State University. Arguing that only 6% of the Amazon basin has soils that are suitable for normal farming, the researchers from Dixie have developed techniques in Peru that they think will work well on the acid, infertile soils that comprise 75% of Amazonia. They advocate clearing land by the traditional slash-and-burn method. This returns nutrients to the ground and avoids compacting of the soil with bulldozers.

Next comes crop selection, the identification of appropriate fertilizers and careful monitoring of changes in soil quality. Crops are rotated, to avoid any build-up of diseases in one type of crop. Three crops are grown a year, to keep the soil almost constantly covered. Over an 8 year period, farmers have achieved an annual yield of nearly 8 tonnes of grain per hectare by following these methods—and soil quality has actually improved.

Peruvian farmers applying the new system have achieved a fourfold increase in family in-

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come. Less forest is destroyed than with the old method of shifting agriculture. So there is a growing hope that science can be used to turn parts of the rain forest into an exploitable and sustainable economic resource.

### **All Things Beautiful**

The saddest result of forest destruction is the damage done to the world's remaining tribal people. Tribal cultures, with their rich customs and abiding knowledge of the forests, are vanishing fast. In Brazil, the Indian population was estimated at around 5m when the Portuguese arrived 450 years ago, it has now dwindled to 200,000. Many of the tribespeople are victims of the deliberate slaughter carried out by land-hungry developers up to quite recent years. Others have died of diseases brought by white men.

Around the world, more than 170,000 tribespeople were forced to move during the 1970s to make way for hydro-electric schemes. Resettlement is far harder for them than for "civilized" people. A tribe's entire way of life is a carefully evolved adaptation to the local ecology. Even when the tribes remain in place, the import of western technology can upset the balance. Among the wild men of Borneo, for instance, the acquisition of guns that are so much more efficient than traditional weapons has led to excessive killing of the animals they depend upon for food and clothing. To armchair anthropologists, watching tribal rites on television, the disappearance of this world seems all bad. To some overpopulated developing countries, it does not. They note that a lot of land is needed to support a few tribespeople. The hunter-gatherer's lifestyle is land-hungry, which is a reason why most societies have abandoned it.

That does not excuse the brutal way in which primitive peoples are often handled. Fortunately, some tribespeople are beginning to learn to lobby for their interests—and with some sense of panache. An Indian leader in Brazil, refused entry to a government building because he was not wearing suit and tie, decreed that Brazilian officials visiting his villages should in future wear penis sheaths, feathers and body paint.