



Loren McIntyre/NOVA

Saving the Amazon

Saving the world's least-known biome will benefit more than its dwellers

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Two hours by jeep from the city of Manaus, deep in the Amazon jungle, Rob Bierregaard has carefully marked off ten hectares of a tract that is earmarked for development and is trapping, cataloging and tagging the exotic, brightly colored native birds. When this site and numerous other swatches of up to ten thousand hectares have been cataloged, the surrounding forest will be cut, leaving Bierregaard's sites as eerie jungle relief in the midst of cattle range or cropland.

Bierregaard is one of 15 or 20 American and Brazilian scientists working on a project to determine the minimum area capable of preserving a maximum number of plant and animal species. The project, conducted by the World Wildlife Fund and Brazil's National Institute for Research on Amazonia, will compare the success of the various-sized areas in preserving the incredibly diverse insect, animal and plant life of the largest rain forest in the world.

Its aim is to provide scientific advice to the Brazilian government on how best to enforce a recent government dictum re-

quiring that 50 percent of the land bought for development in the 4.9-million-square-kilometer Amazon region be left in its natural state. Parcel size and shape will be important in determining the future of such highly mobile, symbiotic jungle species as the birds that exist by flying before advancing lines of army ants and snatching their fleeing prey.

When left alone, tropical moist forests like the Amazon excel at supporting genetic diversity. According to one National Research Council report released this year ("Research Priorities in Tropical Biology"), "(t)here are probably at least 4.5 million kinds of organisms in the world, of which at least three million occur in the tropics." For example, Southeast Asia, a region smaller than Western Europe, contains 25,000 species of flowering plants or about one in 10 of the world's flora, ecologist Norman Myers says. Great Britain, on the other hand, has 1,430 native plant species, while the Malay Peninsula—about only half Great Britain's size—has 7,900. One in five birds and an estimated 20 percent of all known higher plant species evolved in the Amazon's lowland forests. In his book *The Sinking Ark*, Myers notes that while one hectare of temperate-zone forest usually carries no more than 10 different species of trees, a single hectare near Manaus features 235 separate tree species.

But the wealth of ecological diversity

Plantation forestry is less damaging than most forest-use schemes. It's hoped that Ludwig's project in Jari (above) demonstrates how sustainable that option is.

common in tropical forests also signals how rare many of their species are. Up to one half of the 100 tree species typical of any hectare in the Amazon forest may not be found in another hectare as little as one kilometer away, Myers says.

Despite their remote origins, many tropical-forest species still benefit human welfare. They supplied the original stock for many food staples, including rice, millet, cassava, yams, bananas, pineapple and sugarcane. Countless more await exploitation. In New Guinea alone some 250 different trees bear edible fruit, though only 43 have been cultivated. Fruit of the Chinese gooseberry is 15 to 18 times richer in vitamin C than is orange juice. And Myers cites the "hitherto uncultivated" mangosteen of Southeast Asia as a hidden pearl; it has been called "perhaps the world's best tasting fruit."

Crossbreeding wild relatives with refined crops can offer farmers fresh gene plasm to resist new pests, diseases and other blights that threaten their fields. Or they can be used to increase the yield and nutrition of their harvest. To grasp the impact tropical species can offer, one \$35,000 importation of three types of parasitic wasps allowed Florida citrus growers to save \$25 million to \$35 million in pesticide costs.

A virtual pharmacopoeia, tropical moist forests are also home to most of the world's drug-yielding plants. Roughly 70

percent of those plants — at least 3,000 — that exhibit cancer-fighting powers come from the tropics, mostly from moist forests. And Myers points out that rhizomes from one Mexican yam species, which grows only in tropical forests, produce virtually all of the world's diosgenin. (Diosgenin is used in preparing many sex hormones, including some used in birth-control pills. Diosgenin-based contraceptives are a \$700-million-a-year industry.) In all, more than 260 South American plants have exhibited some level of contraceptive power, but as tropical forests are transformed by man, most such drugs could disappear with the native tribes that first discovered them.

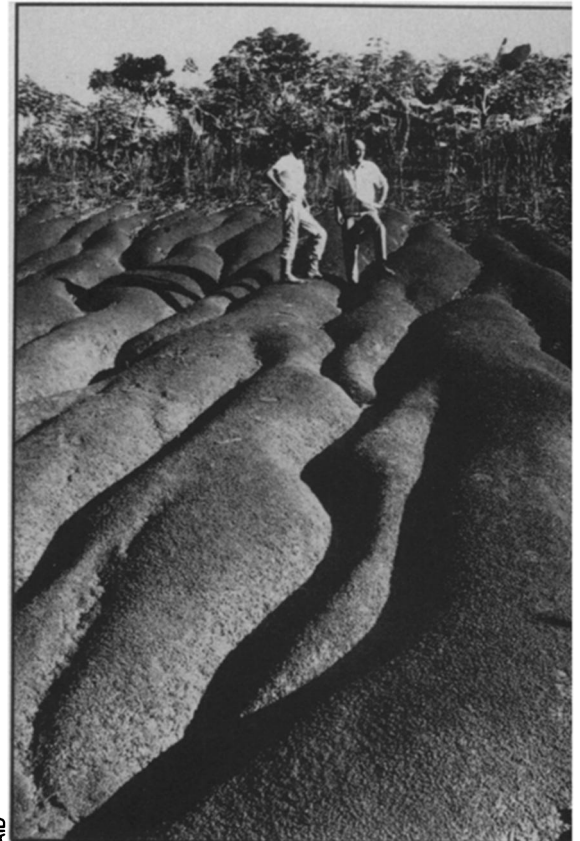
A portrait of that transformation is painted in the NRC report and it is grim: "Even though tropical moist forests may persist in western Brazilian Amazonia and Central Africa for another 40 or 50 years, in most other areas [the forests] will be reduced much sooner to scattered degraded remnants on steep slopes, to severely flooded delta areas, and to a few parks and reserves."

Myers, who drafted the National Academy of Sciences report "Conversion of Tropical Moist Forests" (1980), suggests that even that may be conservative. "We could be losing . . . almost 50 hectares per minute," reports the Nairobi-based researcher. "When the figures are extrapolated, they suggest that all tropical moist forests could be destroyed within less than 40 years."

And the effects of such widespread reductions in the planet's tropical canopy might spell the beginning of major changes throughout the global environment. For instance, there are a growing number of researchers who argue that rapid rates of deforestation increase the amount of carbon dioxide entering the atmosphere through decomposition of vegetation and wood burning. (It has been estimated that throughout the world, nearly half of all wood cut is for fuel.) Scientists already worry that atmospheric CO₂ increases from fossil-fuel burning will foster a global warming and major climatological changes. However, points out Leslie Holdridge of the Tropical Science Center in San José, Costa Rica, until a tree reaches maturity or harvest, it is a net CO₂ sink. Therefore, sound timber management and reforestation could actually induce tropical forests to absorb a higher percentage of the CO₂ released by fossil fuels.

The problem facing tropical nations like Brazil is to discover how to manage and conserve their moist arboreal resources. There have been plenty of incentives to exploit forests. In fact, tropical timber is one of the developing world's fastest-growing exports, with revenues rivaling those from sugar, cotton or copper.

Many early logging ventures were unduly destructive. "Surveys in Southeast Asia reveal that average logging leaves between one-third and two-thirds of residual trees effectively wrecked," notes Myers.



AID

Erosion gouges former Colombian forest.

"On top of this, almost one-third of the ground may be left bare, in many instances with soil impacted through heavy machinery." Things are changing for the better, although the short-term economic return necessary to keep small entrepreneurs solvent still favors profit and exploitation over conservation.

More devastating than logging is agriculture. "(F)orest farmers use about a fifth of the entire biome and their activities constitute the largest factor in conversion of tropical moist forest," according to the NRC report. And with 90 percent of the world population growth over the next 20 years expected to occur in the tropics, pressure to exploit lush forests — where population density is as low as that of the Sahara Desert — will only increase.

In fact, the "lush" appearance of moist forest — especially rain forests such as those covering practically all of Amazonia — has deceived many a farmer and rancher. Unlike in the temperate zone, soils are not the major reservoir for nutrients in the tropics. High rainfall levels leach minerals from the soil, while massive root structures — triple the density of those associated with trees in temperate forests — efficiently drink them back in.

But Pedro Sanchez of North Carolina State University, an expert on jungle soils, believes the soil does not present an untoward impediment. In addition to the eight percent of the Amazon that has naturally fertile, farmable soil, another 75 percent is arable. "The well-drained acid soils

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Mary Hill/World Bank

Farming trees, like the palm, for crops is among sounder forest-conversion options.

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of the Amazon are the same soils as in the southeastern United States from east Texas to Virginia. With proper care, you can grow crops continuously in this soil," he says. Working in the Peruvian Amazon, Sanchez and others have grown three crops per year, without irrigation, for seven years. Using careful application of fertilizers and lime on selected species of rice, corn, soybeans and peanuts, they've gotten \$5.00 worth of crops for every \$1.00 in fertilizer — "a good payback," Sanchez says. The yields are comparable to those anywhere else in the world, he says. As for the soil that turns brick-hard when exposed to air, Sanchez explains: "This layer is beneath the topsoil. The upper layer has to be eroded first for damage to be done," he says, and erosion can be prevented.

"I don't want to advocate cutting down the entire Amazon," he says. "I think if we have decent technology for cattle and crops, then the amount of land cleared can be kept to a minimum."

But everyone has not been careful. Erosion does occur. Forest cover usually holds erosion to less than one ton of soil per hectare annually. With human made pasturelands, erosion can total 20 to 200 tons per hectare annually. Erosion on crop fields can reach 1,000 tons per hectare annually.

"It is now generally conceded that over most... of Amazonia, soils without agricultural inputs will not support continuous annual cropping for much longer than five years... never much more than ten," World Bank ecologist Robert Goodland says. By way of example, he points out that rice, the most widely planted crop in Amazonia, can be sustained for only a year or two.

Speaking of the most fragile of the moist zones, Goodland predicts "the increase in human well being or the amount of economic return accruing per unit area transformed will probably be less in... rain forests than in any other biome in the world. Calculated by orthodox analysis, no economically feasible type of development has yet been achieved which is compatible with... sustainable exploitation for human benefit."

Nonetheless, tropical societies will exploit their forests. With this in mind, Goodland and others have sought to rank potential development options. Plantation forestry is currently getting a tentative nod of approval. Goodland describes it as much less damaging than most alternatives. Capital intensive as the option is, he points out that "plantation forests can be up to 20 times as productive as native forests."

But mistakes made in the past show that a very careful approach must be taken. Since the late 1960s, billionaire Daniel Ludwig has had to invest roughly half a billion dollars to turn part of his 3.5 million acres near the mouth of the Amazon into a forestry and paper mill, and some scientists believe his single-culture forests

From trees to burgers

In the 1960s, after many notable failures in converting the lush Amazon rain forests to sustainable farms, Latin and South American governments were persuaded to lend support to a new endeavor—cattle ranching. "However," says World Bank ecologist Robert Goodland in the spring 1980 ENVIRONMENTAL CONSERVATION, "the new policy was disastrous both financially and environmentally."

From 1965 to 1978, more than \$1 billion was pumped into raising beef cattle; Brazil alone had 336 ranches. In Central America, at least, beef consumption declined over a period that saw a doubling in the number of cattle raised for meat.

"A main stimulus for this outburst of cattle raising is the growing demand from markets in the developed world for 'noninflationary' beef," according to a National Academy of Sciences report issued earlier this year. "Due to low costs of land and labor, grass-fed beef can be produced in tropical Latin America at only one-quarter the price of similar beef in the United States." While this beef represented only a quarter of that imported by the United States, ecologist Norman Myers, the report's author, found that "as a factor contributing to conversion of Latin America's tropical moist forest, this international beef trade is far from trifling." As it happens, the grass-fed beef is considered only suitable in the United States for the fast-food trade—hamburgers, hot dogs and processed meats.

Converting rain forests to pastures for cattle "rates the worst environmentally of all conceivable alternatives," Goodland says. The animal takes in nutrients that already were in short supply, and returns precious few. Overgrazing is rampant. Soils become trampled, compacted, oxidized and then baked hard by the equatorial sun. Rain, when it comes, erodes the soil and leaches nutrients beyond the depth accessible to many grasses. Weeds, many of them toxic to cattle, eventually win out over the pasture grasses. Sums up Goodland: "To environmentalists it will come as no surprise that nearly all these projects have been abandoned."

planted on slash-and-burned Amazon jungle could easily be wiped out by an effective disease or insect parasite.

Before tropical nations offer an unconditional green light to any development project, scientists would like to see more research along the lines of Bierregaard's project in Brazil. "Although the conversion of tropical forest often results in immediate economic gain, systems that lead to the sustained productivity of most tropical soils have not been achieved with existing technology," reports the NRC's Committee on Research Priorities in Tropical Biology.

This is largely because little is known about the tropical forest environment or about the millions of yet unidentified species inhabiting it. The committee fears that without more data on tropical forests and how they operate, "it will be impossible to construct ecologically sound systems capable of supporting the numbers of people living in the tropics, to say nothing of improving the condition of those people."

But Brazil still has a chance, and researchers today are more optimistic than they were a decade or so ago. Then it looked as if the Brazilian government was hurtling toward rapid, destructive exploitation. The government's position was understandable. Faced with an enormous population boom on its coasts (50 percent of the population is younger than 50 years of age), a national debt that today has risen to \$55 billion, and dependence on foreign countries for fuel and even pulpwood, the government saw the lush, verdant, seemingly endless Amazon as the ultimate resource.

After investors rushed in and stripped the land for cattle pastures and cropland, the soil went dead within three years and many investors went bankrupt. That's when the Brazilian government started taking the idea of conservation seriously. Today developers must leave 50 percent of the jungle standing. And the government is fully cooperating with such studies as the maximum-yield project.

The administration that came into office in March of 1979 has displayed greater sympathy to questions on environment and the Amazon, notes Thomas Lovejoy of the World Wildlife Fund, who with Herbert Schubart runs the maximum-yield project. "The new president has doubled to tripled the area of national parks. There used to be only one, and now there are six," he says, though he admits all are in remote areas, making them easy to set aside. The president also appointed a commission on forest policy in May of 1979, which sent what Lovejoy considers an environmentally sound report on to the president's office five months later. But for a year now the report has just sat there. There are other negative signs: Last year the parks budget was slashed to 2.5 percent of what it had been, and while some of this money has been restored, it shook the confidence of many ecologists. And Brazil's economy, says World Bank economist Dennis Mahar, "is the worst it's been in a long time."

Still, Brazil has time to make its decision. Notes Bierregaard, "We're still looking at such a huge tract, the risk isn't immediate." Only two to five percent of the Amazon has been disturbed. As Bierregaard says, "There's still lots and lots of forest left." □