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Amazonian Communities: Are Forests or People More Vulnerable?

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Global Change: How Vulnerable Are North and South Communities?

Edited by

Dennis Conway
and
James C. White II

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Indiana Center
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GLOBAL CHANGE HOW VULNERABLE ARE NORTH AND SOUTH COMMUNITIES?

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CHAPTER 2

AMAZONIAN COMMUNITIES: ARE FORESTS OR PEOPLE MORE VULNERABLE?

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INTRODUCTION

After 1985, deforestation in the Amazon Basin became a matter of international concern. Deforestation reached a peak in 1987 when it was reported that 8 million hectares[2] of forest had been burned.[3] Although rates of deforestation have declined since then due to economic recession that has reduced available funds for cutting forest. An increase in selective cutting in previously logged areas has also been observed.[4] Primary concern has focused, as

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[2] A hectare is equivalent to about 2.47 acres.

[3] William Booth. 1989. "Monitoring the Fate of the Forests From Space. 243 *Science*, 1428-1429.

[4] Daniel Nepstadt, and others. 1991. "Recuperation of a Degraded Amazonian Landscape: Forest Recovery and Agricultural Restoration." 20 (6) *Ambio*, 248-255.

well it should, on the effects of this destruction on species diversity and on atmospheric chemistry. The Amazon Basin is host to about half of the world's species, and its continental size and high evapotranspiration rates make it a notable influence on world climate. According to some, large-scale removal of Amazonian vegetation may bring about changes in the region's hydrological cycle and climate massive enough that the forests may not be able to reestablish themselves.[5]

Not only will the forest have difficulty in reestablishing itself, but climate changes may be expected. The climate change that will accompany the destruction of forest cover has received relatively little attention.[6] One sustained effort to date that has been undertaken to try to assess the impact of land-cover change. In this study, four scenarios were explored: one in which 50 percent had been converted to agriculture, 25 percent to urban industrial use, and 25 percent remained in forest cover. Another used a schema in which 75 percent of the region was turned to savanna. A third estimate anticipated that 50 percent of the forest would be turned to agriculture, and lastly, the fourth posited little change in forest cover taking place. Predictably, these climatologists had difficulty predicting the outcomes of these changes, but they did emphasize what was needed in the years ahead. Especially important were research on climate, the hydrological cycle and regional development; study of biogeochemical cycles with a focus on soil and river nutrient cycles; study of biological systems and environmental interactions; and the

[5] J. Shukla, C. Nobre, and R. Sellers. 1990. "Amazon Deforestation and Climate Change." 247 *Science*, 1322-1325.

[6] R. E. Dickinson, ed. 1987. *The Geophysiology of Amazonia: Vegetation and Climate Interactions*. New York: Wiley for the United Nations University, 505.

assessment of the social impacts of development on Amazonian communities.[7]

Those concerned with loss of biological diversity in the Amazon have all too often put the blame on the peoples who live there. Concern in the North with the loss of germplasm in the tropics alludes to the importance of still unknown plants to the discovery of new cures for diseases that plague us now or will plague us in the future. They rarely remind us that the native populations of tropical forests have provided stewardship of those resources for millenia, and that one place for us to begin is by understanding their knowledge of the forest. Conservation biologists often refer to people as the agents of destruction; they have called for their removal from conservation areas if the native species are to be protected. Who is more threatened by the loss of forests, the flora and fauna or the people who live in the forests? People are being displaced by development schemes, or are being encouraged to destroy their own forests by the seduction of subsidies, credit schemes, and other forms of use-now, pay-later stratagems. This paper examines the kinds of losses taking place--both biological and human--in the hope of bringing some balance to our concern with the destruction of tropical forests.

THE LOSS OF FORESTS

According to Molion, by 1989, the total altered area of Amazonian forests was 397,000 square kilometers or 10.8 percent of

[7] Dickinson, ed. *Geophysiology of Amazonia*, 512-14)

he Brazilian Amazon forest.[8] The most recent estimates, based ıpon detailed examination of satellite data collected between 1978 ınd 1988, lowers the estimate of the total area deforested to 230,000 ıquare kilometers. However, it raises the total area of forest affected ›y deforestation to 588,000 square kilometers when the edge effects ›f one kilometer into adjacent areas of forest are computed.[9] In ›ther words, the most recent assessment of the entire region ıuggests that because of the changes in species composition along he edges of deforested areas, the actual areas impacted biologically ›y deforestation are twice as high as initial estimates and are in fact ılready nearly 15 percent of the entire basin.

This destruction in South America follows earlier episodes of :ropical forest clearing in Asia. By 1988, all of the primary moist lorests of Bangladesh were gone. Fifty percent of the forests in China's Xinhuangbana Province were gone. Nearly all primary moist lorests in Haiti were gone. Nearly all primary moist forests of India were gone. Fifty-five percent of the tropical moist forests of the Philippines were gone. Almost all primary moist forests of Sri Lanka were gone. Fourty-five percent of such forests in Thailand were gone.[10]

[8] L. C. B. Molion. 1991. "Amazonia: Burning and Global Climate Impacts," in J. S. Levine, ed. *Global Biomass Burning: Atmospheric, Climatic, and Biospheric Implications*. Cambridge: MIT Press, 457-462.

[9] D. Skole and C. Tucker. 1993. "Tropical Deforestation and Habitat Fragmentation in the Amazon: Satellite Data from 1978 to 1933. 260 *Science*, 1905-910.

[10] C. Park. 1992. *Tropical Rainforests*. London: Routledge, citing "World Wide Fund for Nature, 1988."

Thus, what has been true in Asia since World War II, has now reached the continental parts of the Americas. Today, the Amazon is considered a "hot spot," that is, an area where clearing rates are dangerously high and where much attention is directed by climate, biological, and social scientists. Estimates by the World Wide Fund for Nature suggest that by the year 2000, one-third of the Amazon forest could be gone.[11] We are already half-way there.

The loss of forests imperils a significant fauna. Brazil, with an area of 8,511,965 square kilometers and a human population of 147 million is perhaps the single richest country in the world in overall species diversity. It tops the world list in diversity for many different groups of organisms, among them primates (55 species, 24 percent of the world total), amphibians (516 species), terrestrial vertebrates (3,010 species), flowering plants (55,000, 22 percent of the world total), freshwater fish (more than 3,000 species, three times more than any other country), and insects (estimated at 10 to 15 million species, most of them still undescribed). When it is not the single richest country in species diversity, Brazil is usually not far behind. It ranks fourth in reptile diversity (467 species) and mammals (428 species), and third in birds (1,622 species), and palms (387 species).[12] Even more significant is the fact that Brazil has the most closed tropical forest in the world. The forest covers 357 million hectares, which is 30 percent of the world's total. This exceeds the second richest country (Indonesia) by three times. It has more tropical forest than all of Asia and all of Africa put together.

[11] Park, *Tropical Rainforests*, citing "World Wide Fund for Nature, 1988."

[12] J. McNeely, and others. 1990. *Conserving the World's Biological Diversity*. Washington, DC: The World Bank, 92.

Not to be outdone, neighboring Colombia is close to Brazil in species diversity despite its much smaller total area. Colombia has 45 to 50,000 higher plant species, a figure that approaches that of Brazil. It tops all lists in number of orchid species, and more bird species than any other country with 1,721 species, 20 percent of the world's total. The Choco region is considered by biologists to be the single richest area of the world for endemic species in a continental area.[13]

Large-scale deforestation in the Amazon Basin began with the construction of the Belem-Brasilia Highway in 1958. In its first 20 years, even though it was only a dirt road that was not paved until 1973, over two million people settled along it. Cattle increased from near zero to over five million in the same twenty-year time period.[14] Additional roads opened up the rest of the Basin to development schemes after 1970. The conversion of forest to pasture took place at a rate of approximately eight to ten thousand square kilometers per year in the 1970s,[15] and it averaged 35,000 square kilometers in the 1980s.[16]

Much of the deforestation that took place in the 1970s and 1980s was a product of fiscal incentives and tax holidays provided by the government to encourage capital investment and economic development in the Amazon region. Over 80 percent of the defores-

[13] McNeely, and others, *Conserving the World's Biological Diversity*, 93.

[14] Dennis Mahar. 1988. *Government Policies and Deforestation in Brazil's Amazon Region*. Washington, DC: The World Bank.

[15] Mahar, *Government Policies and Deforestation.*

[16] Philip Fearnside. 1989. "A Prescription for Slowing Deforestation in Amazonia." 31(4) *Environment*, 17-20, 39-40.

tation during this period can be attributed to these policies. These fiscal incentives were formally removed in the late 1980s through international pressure on Brazil. Cattle ranches currently cover at least 8.4 million hectares.[17] There can be little doubt that without the subsidies provided by the government to encourage land clearing, deforestation rates would have been much lower. This has been demonstrated by the decline in rates of deforestation since the removal of most fiscal incentives and tax advantages in 1987. The area cleared declined from 8 million hectares in 1988 to 1.8 million hectares in 1989, to 1.38 million hectares in 1990, and down to 1.1 million hectares in 1991.[18] The removal of the incentives, together with economic recession and hyperinflation, have contributed to the reduction of the benefits to be derived from additional land clearing.

The conversion of forest to pasture is not the result of local population pressure as is often assumed by scholars unfamiliar with the peculiar political economy of Brazil.[19] In fact, there is growing evidence that the conversion of forest to pasture leads to rural depopulation in Amazonia.[20] While aggregate population has increased in the Brazilian Amazon, most counties have lost popu-

[17] Mahar, *Government Policies and Deforestation.*

[18] R. A. Houghton. 1992. "The Extent of Land Use Change Worldwide." Paper presented at the meeting of the Ecological Society of America, Honolulu, HI.

[19] William Denevan. 1980. "Swidden and Cattle versus Forest: The Imminent Demise of the Amazon Rain Forest Reexamined." 13 *Studies in Third World Societies*, 25-44.

[20] Luc Mougeot and L. Aragon, eds. 1981. *O Despovoamento do Território Amazônico*. Belem, Pará: Cadernos do Nucllo de Altos Estudos Amazonicos (NAEA), Universidade Federal do Pará.

lation. The only exceptions are those with cities that have become centers of economic activity and have concentrated the population from all over the nearby countryside.

In addition to fiscal incentives, two other sources of deforestation in the Brazilian Amazon are mining and timber activities. One recent large-scale mining project has begun to have a potentially devastating impact. Tax holidays were offered for the production of pig-iron in the Great Carajas region, which accounts for 10 percent of Brazil's total territory. The factories were designed to operate using locally produced charcoal. This will result in 610,000 hectares of forest per year being cut to make charcoal for the smelters in the Greater Carajas pig-iron projects alone.

The importance of timber exploitation in deforestation begins to be noticed only in the 1980s. In the most recent statistics, four of the six states in the region depend on wood products for more than 25 percent of their industrial output.[21] In Rondonia and Roraima, wood products account for 60 percent of the region's industrial output. The number of licensed mills has increased more than eightfold since 1965, and the annual output per mill has doubled during the same period. The Amazon region of Brazil accounted in 1984 for 43.6 percent of national roundwood production, as compared with only 14.3 percent ten years earlier.[22] The declining contribution of Asian forests to the world's demand for tropical wood

[21] John Browder. 1986. "Logging the Rainforest: A Political Economy of Timber Extraction and Unequal Exchange in the Brazilian Amazon." Ph.D. dissertation, University of Pennsylvania, 65.

[22] John Browder. 1988. "Public Policy and Deforestation in the Brazilian Amazon," in R. Repetto and M. Gillis, eds. Public Policies and the Misuse of Forest Resources. Washington, DC: World Resources Institute and Cambridge University Press, 249.

products will undoubtedly lead to further increases in these activities in the 1990s.

The net result of road-building and the associated activities of farming, ranching, mining, and logging has been devastating to the tropical forests of the Amazon. This attention on deforestation, however, overlooks the fact that just as people cut the trees, they also nurture them. The destroyers can be the stewards as well. Unless this is taken into account, the destruction will continue.

Besides the difficulty in determining how great the loss of species is, there are other negative consequences of the loss of tropical forests. One is downstream silting, which can increase the possibility of flooding downstream. This is particularly significant in the Western Amazon where the slope of the land can contribute to increasing the erodability of the landscape after removal of forests. Since so much of the Amazon is at a very low altitude, it is extremely vulnerable to rising river and sea levels. Whether it will be from global warming or from increased water volume flow downstream from deforested areas, many low-lying areas of the Amazon are likely to go underwater seasonally should changes occur in river or sea levels.

Increased deforestation also tends to bring about shifts in precipitation and temperature. Areas where deforestation has been in excess of 40 percent show evidence of greater periodicity in precipitation and in cycles of drought and flood. These cycles are well known in the valley lands of south Asia. Malaysia, Philippines, Ivory Coast and Costa Rica all suffered from them, and they have begun to affect farmers in Amazonia as well.[23] Additionally, increased forest clearing raises both the albedo and the temperature.

[23] Norman Myers. 1988. "Tropical Deforestation and Remote Sensing." 23 *Forest Ecology and Management*. 215-225.

These in turn affect the entire hydrologic cycle by reducing water infiltration, increasing runoff, reducing convective rainfall, and decreasing evapotranspiration.

Current on-going research by anthropologists, geographers and forest ecologists at Indiana University and Indiana State University, with the collaboration of Brazilian botanists, climatologists, and soil scientists at the Center for the Study of the Humid Tropics (EMBRAPA and CPATU) addresses these processes through their multi-temporal analysis of Landsat satellite images of the Amazon Basin. These are complemented with field studies of forest structure and studies of the history of land use in specific fields.[24]

Analysis of the satellite data allows us to ask questions about dimensions of the region's ecology that are harder to address by ground-level surveys, limited as these must be in the total area covered. On the one hand, unlike site-specific studies, satellite data permit a broad analysis of regions that is rarely possible by field methods alone. On the other hand, field studies can verify the accuracy of the satellite image analysis and assure the accuracy of the regional assessment.

The long-term objective of this research is, first, to use satellite data to discover areas that are experiencing rapid regrowth, and then to find out through field studies what the impact is on rates of regrowth as an outcome of different forms of land-use practices, soil types, and size of the area cleared. This approach is based on the assumption that local strategies have a greater potential for being used in the region, since they are products of the political, economic,

[24] E. F. Moran, and others, 1994. "Integrated Study of Amazonian Vegetation, Land Use, and Satellite Data. 44 (5) *BioScience*, 329-338; E. F. Moran, and others. 1994. "Monitoring Secondary Succession."10 (4) *Research and Exploration*, 458-476.

and environmental setting within which they came about, rather than being idealized solutions generated elsewhere. This is an eminently interdisciplinary project. It call for expertise from agronomy, anthropology, the biological sciences, climatology, forestry, geography, and other fields. Remote sensing seems particularly valuable for work in inaccessible regions, such as the Amazon Basin, where assessment of vegetation and soils by field studies is difficult.[25]

Our current research takes a more fine-grained view than is sometimes taken in Landsat satellite image analysis. This is because we are more concerned with discovering strategies for the restoration of deforested area, rather than with documenting the extent of deforestation as such. In such an approach, it is imperative that fields as small as one hectare be identified accurately. To do so, we use Landsat Thematic Mapper (TM), which has 30 m resolution.

A significant portion of the moist forests and liana forests in the Altamira region of the Xingu Basin have been converted to agricultural areas. Field crops, tree crops, and pasture have been introduced since the roads were built in the early 1970s. Between 1985 and 1991, considerable areas have gone from bare soil in 1985 (35,267 hectares or 13.19 percent of the study area) to various degrees of secondary succession, crop, pasture and other vegetation

[25] W. A. Danjoy. 1977. *Use of Remote Sensing Systems: The Potential of the Aguaje Palm in the Peruvian Jungle*. Lima: ONERN and Danjoy, 1984. "Use of Remote Sensing for Monitoring and Control of Deforestation in the High Jungle of Peru." *Proceedings of the 18th International Symposium on Remote Sensing of the Environment*. Ann Arbor: Environmental Research Institute of Michigan; Myers, "Tropical Deforestation," 215-25; Y. Shimabukuro and others. 1984. "Vegetation Survey in Amazonia Using Landsat Data." *Proceedings of the 16th International Symposium on Remote Sensing of the Environment*. Ann Arbor: Environmental Research Institute of Michigan.

TABLE 1
Land-Cover Changes in Amazonia: 1985-1991

Location and Feature	1985 Percentage	1985 Hectares	1991 Percentage	1991 Hectares	Percentage Change
Eastern Altamira					
Water	5.23	13,991	5.27	14,091	0.76
Wetland	0.16	428	0.17	455	6.31
Bare	13.20	35,285	1.38	3,689	-89.55
Crop	2.02	5,404	4.26	11,390	110.77
Forest	64.30	171,901	57.10	152,673	-11.19
Pasture	1.24	3,318	7.03	18,797	466.52
Initial Secondary Succession	7.35	19,662	8.45	22,593	14.91
Intermediate Secondary Succession	5.26	14,071	11.84	31,658	124.99
Advanced Secondary Succession	1.24	3,318	4.50	12,032	262.63
Total	100.00	267,378	100.00	267,378	

TABLE 1, *continued*

Location and Feature	1985 Percentage	1985 Hectares	1991 Percentage	1991 Hectares	Percentage Change
Western Altamira					
Water	0.05	117	0.05	117	.0
Wetland	0.05	120	0.05	120	.0
Bare	7.58	17,697	0.58	1,354	-92.39
Crop	1.15	2,685	1.21	2,825	5.21
Forest	74.60	174,162	70.53	164,661	-5.46
Pasture	2.07	4,833	3.48	8,125	68.12
Initial Secondary Succession	7.64	17,837	8.06	18,817	5.50
Intermediate Secondary Succession	5.09	11,883	13.04	30,443	156.19
Advanced Secondary Succession	1.77	4,132	3.00	7,004	69.51
Total	100.00	233,466	100.00	233,466	

Source: Emilio F. Moran, and others. "Integrating Amazonian Vegetation, Land-use, and Satellite Data: Attention to differential patterns and rates of secondary succession can inform future policies." 44 (5) *BioScience*, 329-338.

cover (see Table 1). Forest declined by slightly more than one percent annually--a rate higher than the Amazon-wide average of 0.4 percent of the Basin, according to the latest estimates of Skole and Tucker.[26] More striking, however, is that for the same period of 1985 to 1991, there was a large increment in secondary successional land cover, about 32,000 hectares.[27] After 15 years of advanced secondary succession, the difference in reflectance seems to be getting very close to mature forest in these areas.

Between 1985 and 1991 in this colonization zone, we found few cases of land going from cropland back to secondary growth without first going through a pastureland period. Traditional populations living in the area, the Cabocios, for instance, are among the few who may leave an area fallow without using it as a pasture.[28] Despite more than 20 years of deforestation and land-cover changes, undisturbed forest is still the most common feature. Intermediate secondary forest growth is the most frequent culturally induced land-cover type, not pasture as was usually thought.

The persistence of this pattern is a product of the decline in subsidized credit and other policies that favored deforestation. Agriculture throughout most of the Amazon accounts for less than five percent of land use, while pasture is a considerably larger proportion. Agroforestry is a concept rather than a reality in most of the Basin. Much of the so-called pasture in the Amazon rarely lasts

[26] Skole and Tucker, "Tropical Deforestation," 1905-1910.

[27] Emilio Moran, and others. 1994. "Integrated Study of Amazonian Vegetation." 44 (5) *BioScience*, 329-338.

[28] Emilio Moran. 1974. "The Adaptive System of the Amazon Cabucho," in C. Wagley, ed. Man in the Amazon." Gainsville: University of Florida Press.

more than a couple of years in a homogenous state. Pastures are quickly invaded by pioneer species. Depending on the resources of the rancher, the land may be kept in pasture for a few more years. If not, it will continue its way along the path of secondary succession. In areas near markets, some of these secondary growth areas will be recut and burned and pastures reestablished. Alternatives to this option are needed that provide both use and conservation of flora, fauna, and land cover with functional characteristics like those of forest area.

HUMAN VULNERABILITY

There can be little question that the impacts of deforestation on plant and animal species and on regional and global climate are potentially severe. In all Global Climate Models, the Amazon region, and most of the humid tropics, for that matter, are noted as being most negatively impacted by global warming. Due to its already high temperatures, plant productivity is not predicted to increase substantially; it may even decline marginally. Due to the high prevalence of nutrient-poor and acidic soils in many regions, agriculture will benefit little from climate changes. The areas with the best soils are in those regions most likely to experience increased variability in temperature and rainfall. Crops growing in these favorable areas will therefore be more susceptible to droughts/floods.

By far the most direct and long-lasting impact is likely to be felt by native forest peoples. While governments often like to pretend that tropical moist and rain forests are demographically "empty" this is simply bureaucratic subterfuge. It allows governments to displace

the local people and to replace them with populations from other regions or with large-scale development schemes that transform the landscape.

Local peoples use the forest and its bounty. They do not benefit from its large-scale destruction. Instead, they rely on it for their livelihood. They use forest species for food, for medicine, for construction of their dwellings, and for firewood. The forest is often the home of the spirits in which they believe. Should the population size of these peoples increase exponentially, we can anticipate their greater numbers would bring about unplanned-for destruction of the forest. However, in most cases the peoples living in the forest have had modest rates of growth. The high rates of population growth observed today in tropical forest regions are a product of migration and of the high fertility of immigrants.

Despite their need to take care of the forest, native peoples are often blamed for its destruction. Norman Myers is an influential environmentalist who often blames the smallholder for the destruction of tropical forests. He forgets to tell us that this smallholder is often an immigrant sent into the forest by the national government for geopolitical reasons and/or to assist in meeting national development goals. These individuals come from different environments and try to reproduce the landscapes of their original homes. In the process, they destroy much that is of value in their new environment. Moreover, their immigration leads to conflict with the native peoples already present whom the government has long since forgotten or discounts as politically insignificant.

There is no present evidence to show that moving people into the rain forests leads to any reduction in national population. Onthe contrary, the evidence we have is that people moving into the forest to start farming reach some of the highest known levels of fertility. The scarcity of labor in forested frontiers has motivated the adults to have as many children as possible to help with the work of clearing and farming.

Earlier, I discussed the rates of decline of forest, estimated to reach one third by the year 2,000. This impact pales in comparison to that of outsiders on the peoples of the Amazon. From the five million people estimated to have lived in the Amazon in 1500, their number today has declined to about 250,000. More than 80 distinct ethnic groups have ceased to exist in the twentieth century alone. Mortality rates of up to 75 percent have been recorded for recently contacted groups such as the Surui in Rondonia.[29] The Waimiri-Troari stood at 6,000 in 1903 when first contacted. By 1973, their number had declined to 3,500, and by 1986, their number had been reduced to 374 after a series of epidemics had affected them. Many died from measles, and a few were shot by gunmen for large-scale landowners who were eager to have Indian lands.

And if the attraction of taking over the lands of the native peoples was not enough, the Amazon has turned out to have perhaps as much gold as was imagined when the legend of El Dorado was invented. Invasion of native lands, such as that of the Yanomamo, have become common; the riches to be obtained make murder and violence even more frequent than in the struggle for agricultural land. Gold, uranium, bauxite, and other valued minerals drive national development strategies to build infrastructure into the forest, but appropriate steps are not being taken to ensure that the population already there does not have its human rights violated.

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[29] Carlos Coimbra. 1989. "From Shifting Cultivation to Coffee Farming: The Impact of Change on the Health and Ecology of the Sunui Indians in the Brazilian Amazon." Ph.D. Dissertation, Indiana University, Bloomington, IN.

Not only are the indigenous people being killed--so too are some of the immigrants. In the southern part of Para state in Brazil, the number of violent deaths rose from an average of 2.3 per year between 1964 and 1972 to 9.3 between 1973 and 1979. During the following decade the number of deaths increased still further to an average of about 37 per year.[30] In 1983, for example, land conflicts led to a reported 403 death threats, 114 imprisonments, and 116 beatings and tortures. Approximately 1,179 families were threatened with expulsion, 361 were actually expelled, and 272 houses were burned to encourage departures. Reported land conflicts affected 13,191 families in 1984; they resulted in 29 deaths and 25 injuries.[31] In the Amazon frontier, the number of gunmen proliferate, eager to be hired by large-scale landholders who need protection from immigrants seeking land.

No place exemplifies this violence better than the Araguaia region in the eastern Amazon. In this territory alone, in the decade between 1982 and 1992, there were a total of 1,017 land-related murders. Only 17 of the guilty parties were sent to prison. Peasants can be murdered in exchange for a sum of money that is scarcely larger than the price of a good meal, while priests and church activists can cost fifty times more. Here is one region that exemplifies the nationwide phenomenon of land concentration in the hands of the few and the tendency to protect these large properties with private armies of gunmen.

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[30] M. Schmink and C. Wood. 1992. *Contested Frontiers in Amazonia*. New York: Columbia University Press, 187.

[31] Schmink and Wood, *Contested Frontiers in Amazonia*, 187.

CONCLUSIONS

The question posed in the title of this paper does not imply that we must decide whether the people or the flora and fauna are more vulnerable to environmental change stemming from activities such as deforestation. Both the physical environment and the people are at risk in these regions of the world. To reduce the vulnerability of the forests and its people, a number of actions will be necessary:

1. One necessary step is to reduce the rates of deforestation. This has begun to happen through removal of credit subsidies and tax holidays. Additional policy interventions can be taken to stimulate this reduction further, as noted below.

2. Guaranteeing the rights of native peoples to the forested lands in which they live is also a basic step. This would ensure that the relationship between native peoples and their forests will not undermined. As possessors of considerable knowledge of how to manage the forests and live in harmony with them, the native people and their expertise needs to be used as a source of knowledge and protected for its value to national security.

3. Such a right to land, however, would be an empty provision unless steps were taken to give added value to products of the forest and to protect the intellectual property rights of local people to the germplasm they have protected from destruction to date. This is a delicate issue that must engage specialists in fields from law to ethics, from the employees of pharmaceutical companies to social scientists,

for devising appropriate systems. Some of the suggestions being made could actually destroy the value of the forest as a source of income for many native peoples by removing incentives to companies to value their products.

4. Forestry must surely be one of the economic roles the Amazon can play in the economy of local and national populations. But the Amazon, and other tropical moist forests, are more than simply forests. They vary in their biomass, productivity, and vulnerability to environmental change. The eastern Amazon area would be more likely to become a seasonal forest in a warmer world than would the forests of the northwest and western portion of the Amazon. The latter might evolve from rain forest to moist forests under some of the global climate-change scenarios. Given the dynamics of patches in the forest, this process is more likely to occur if we know a great deal more about restoration of ecosystems and about the relationship between different edaphic conditions and species survival.

5. An alliance of forestry specialists with native specialists in plants of the forest can be one way to achieve a more adaptable mix of economic activities in the future. Such a partnership would do much toward realizing sustainable productivity under the varied conditions in the Basin.

6. Such an alliance would need additional support. A system of environmental monitoring oriented toward local-level observation of changes in environmental features, especially evidence for vegetation stress and for shifts in cover with environmental change, is called for. The use of

satellite platforms could be linked to field studies. This alliance could create a powerful result. By linking the observations of native peoples on the ground to regional-level data sets collected every few days by satellite, shifts in vegetation, moisture, and human settlement can be observed. Appropriate actions can be taken to mitigate potential impact and to plan for necessary adaptive actions.

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No. 94-01
Moran. E.F., E.S. Brondizio, P. Mausel, and Y. Wu. "Integrating Amazonian Vegetation, Land Use, and Satellite Data." *BioScience* 44(5):329-338.

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