Emerald Isle or Paradise Lost?

by William J. McConnell

FEW PLACES on Earth evoke such simultaneous awe and consternation as Madagascar, a country with unique biological riches on a seemingly immutable path of impoverishment. Secluded 250 kilometers off the coast of Mozambique, the world's fourth largest island split from Africa during the breakup of the southern conti-

A S C A R

nents more than 100 million years ago. The resulting isolation left Madagascar's plants and animals to evolve independently and, today, most are found nowhere else on Earth.

Using a measure of this "biological endemism," conservationists such as Norman Myers, a well-known consultant in environment and development and a senior associate with the World Conservation Union, have ranked Madagascar's flora and fauna among the most valuable in the world. The country's status as one of the three "hottest" of Earth's 25 biodiversity hotspots (see Figure 1 on this page) reflects not only its natural variety but also the dismay of conservationists at the alleged plundering of these biological riches by an incessantly burgeoning human population.[1]

Although there is no single authoritative definition of "forest" in Madagascar, Conservation International estimates that deforestation is occurring at a rate of about 150,000 to 200,000 hectares per year.[2] The most recent *Forest Resources Assessment* of the United Nations Food and Agriculture Organization shows that Madagascar's forests are comprised of nearly 1,600 plant and tree species, of which almost one-third is endangered.[3] In addition, these forests provide habitat for many rare animals, including numerous species of lemur that are found only in Madagascar and that can be as small as mice or as large as pandas. As evidence of the global value of the country's biological resources, conservationists often point to the rosy periwinkle (*Catharanthus roseus*), an important source of alkaloids useful in treating childhood leukemia and Hodgkin's disease.[4] Among the other benefits of preserving Madagascar's—and the world's—forests is their role in sequestering (absorbing) carbon that otherwise would be in the atmosphere contributing to global warming.

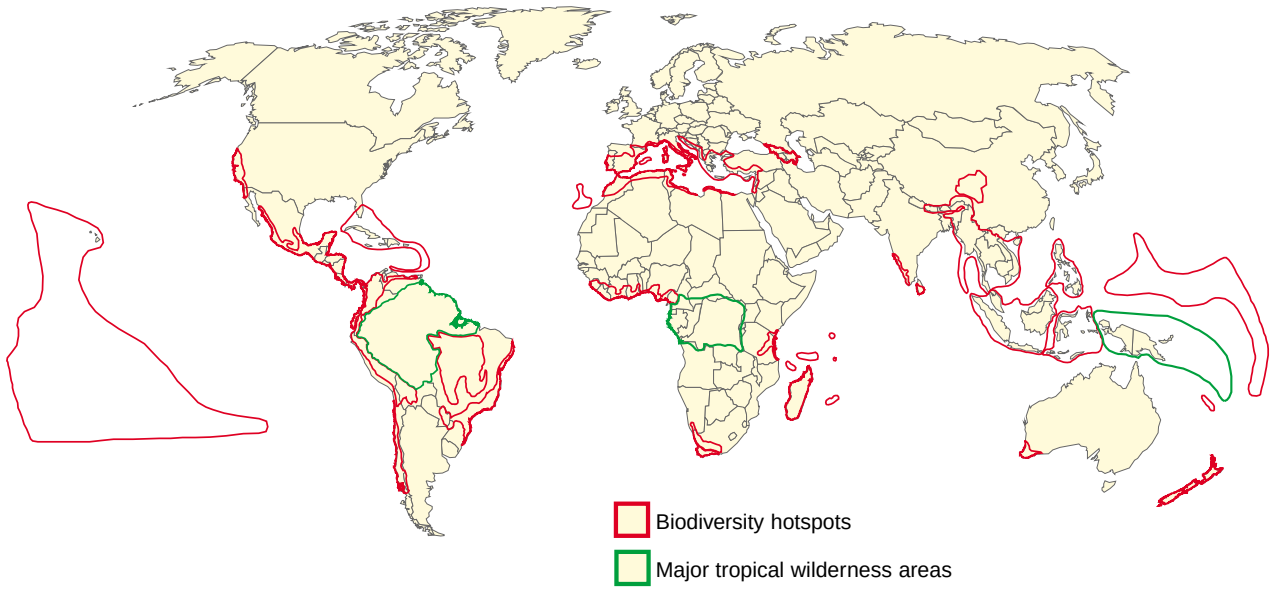
The Deforestation Debate

The first evidence of human occupation of Madagascar dates back less than 2,000 years. Conservationists accuse the Malagasy people of having razed the island's vegetative mantle since then, leaving only meager shards of forest clinging to the steepest slopes of the island's eastern escarpment.[5] According to one perspective:

The Malagasy are a frontier people, having come to Madagascar barely 1,500 years ago from the African continent and the Malay Archipelago. Tradition pits them against the wilderness, growing poverty spurs them to an increasingly ferocious assault. Four fifths of Madagascar now stands barren, burned over by subsistence farmers and cattle herders. Whenever it rains, Madagascar's gullied hills bleed red into the sea.[6]

Conservationists warn that if nothing is done to halt this onslaught, Madagascar's unique plant and animal resources will be destroyed. As a result, a consortium of international conservation organizations, funded by European and U.S. foreign aid, has set about establishing a network of protected areas. Farming communities throughout the country have been struggling to cope with the abrupt closing of the agricultural frontier around this system of protected areas, designed to keep the remainder of the island's rich forest habitat from the farmer's axe. With the formation during the past decade of more than 40 parks and reserves, which cover about 7,000

Figure 1. Earth's biodiversity hotspots



SOURCE: Population Action International, "People in the Balance: Population and Natural Resources at the Turn of the Millenium" (2002), accessible via http://www.populationaction.org/resources/publications/peopleinthebalance/pb_land.shtml.

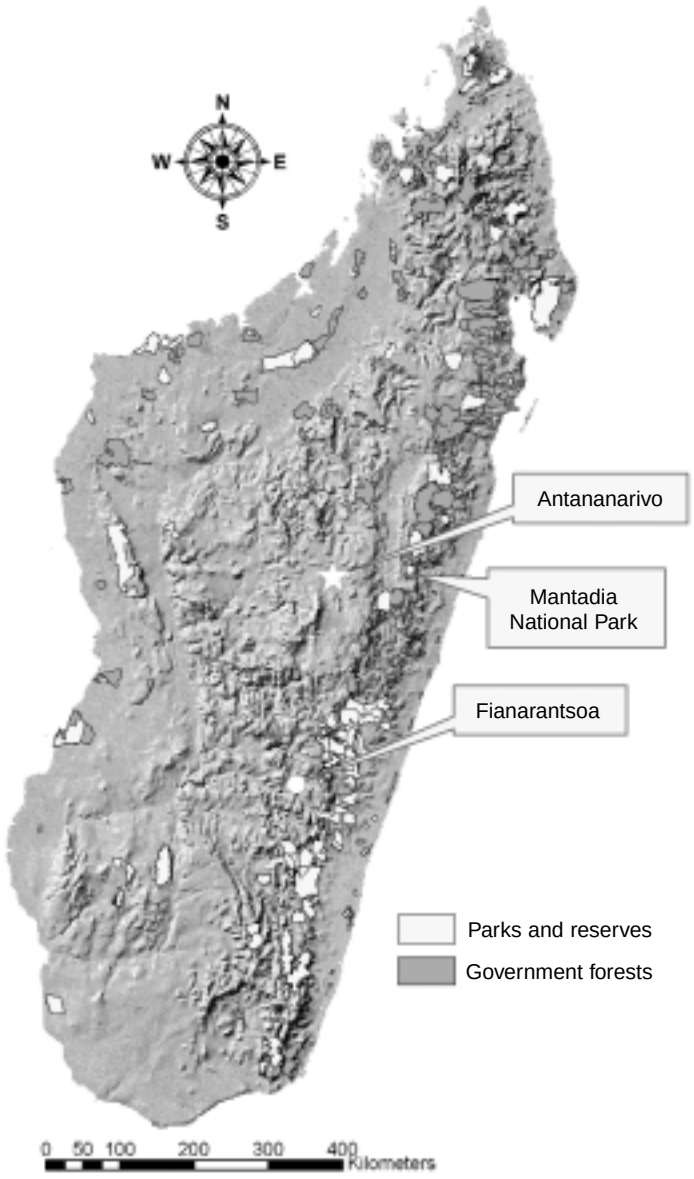
square kilometers (km^2), the conservation community hopes to keep Madagascar's rapidly growing population and traditional slash-and-burn farming practices at bay.[7] Figure 2 on this page shows the location of Madagascar's parks, reserves, and government forests as of 1999.

Recent research, however, has begun to erode the "crisis narrative" of human-environment relations in Madagascar, indicating that deforestation has not been as dramatic as is widely believed, and moreover, that much of the deforestation that has occurred cannot be attributed directly to rapid population growth. New findings suggest that the first inhabitants found much less of the island covered by forest than has been thought, that much of the forest was felled when population growth was low, and that clearing for agriculture has taken place in areas of moderate population density, while areas adjacent to the most populous centers actually have been sites of aforestation and environmental rehabilitation.

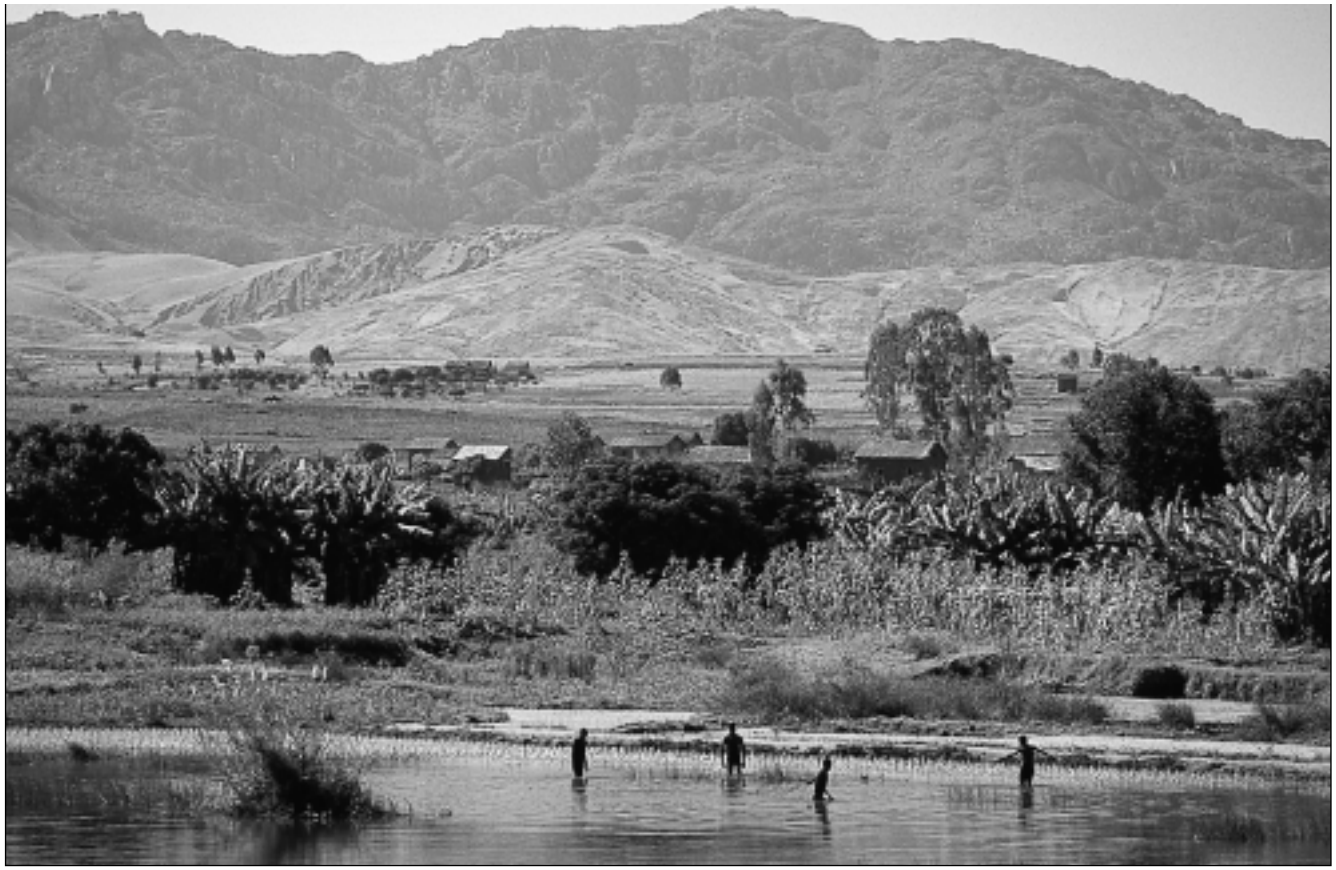
As in many areas of Africa, the conventional view that blames farmers for mismanaging natural resources to their own—and the world's—detriment is being challenged. Instead, new research indicts extractive colonial industries as a major perpetrator of deforestation. Meanwhile, evidence is mounting of the constructive role local land managers play when institutional conditions are right.[8] The classic Malthusian assertion that population growth will inevitably outstrip agricultural capacity has been disproved throughout the world.[9] However, its underlying logic is still visible in the rhetoric of the international biodiversity conservation community. Likewise, the notion that a "tragedy of the commons"—in which people will act in their own best interests and deplete natural resources for personal gain—will ensue from the absence of European-style private property rights has been effectively demolished, but aid programs in Madagascar and elsewhere continue to suggest that land registration is a prerequisite to the sustainable management of natural resources.[10]

Which view is correct? The stakes are high: A misdiagnosis of the nature and causes of environmental change in Madagascar can only undermine conservation efforts and cause unnecessary hardship for its residents. Reconciling these contrasting conclusions requires an examination of the ways in which the different perspectives employed in studying a problem can shape the resulting explanation. In particular, an examination reveals that simple relationships discovered at coarse scales of analysis can mask localized patterns and events that explain much of the change that has taken place. In many cases, institutional factors, including the actions of local, national, and foreign governments, have

Figure 2. Parks, reserves, and government forests in Madagascar (1999)



SOURCE: U.S. Geological Survey and Association Nationale pour la Gestion des Aires Protégées (National Association for the Management of Protected Areas).



Fishermen trawl a lake in the Ambositra region of Madagascar, where the conventional belief that native farmers have mismanaged natural resources and contributed to deforestation is being challenged.

strongly influenced human-environment relations in Madagascar.

Measuring Madagascar's Forests

It is not clear where the idea arose that the first human inhabitants of Madagascar found the country completely covered in forest. In 1988, Sherry Olson, a historian at the University of Connecticut, stated: "The island of Madagascar was once wholly clothed in forests of fabulous diversity."[11] Few scientists would venture such a claim today, although the voluminous work of two early twentieth-century botanists, Henri Perrier de la Bathie and Henri Humbert, was interpreted for many years as supporting this view. A closer reading of their work, however, reveals that neither of them claimed the island ever was completely covered in unbroken rainforest.[12] Furthermore, analysis of lake sediment cores in the past decade has revealed considerable quantities of grass pollen, leading paleoecologists such as Fordham University's David Burney to conclude that much of the central highlands was covered in a mosaic of grasslands and open woodlands prior to the arrival of humans. In addition, the presence of charcoal in this sediment shows that fire was a part of the island's ecology long before the Malagasy people began using it to clear land for crops and pasture.

Such a revision of canonical views has been occurring throughout Africa. James McCann, professor of history and director of the African Studies Center at Boston University, charges that development agencies have adopted conjecture that Ethopia was nearly completely forested prior to human occupation as "standard boilerplate," despite photographic evidence to the contrary.[13]

Likewise, James Fairhead and Melissa Leach, social anthropologists at the Universities of Oxford and Sussex, have challenged the long-held notion that forest patches in the Guinean forests of West Africa are relicts of previously thick forest cover. Their examination of aerial photographs instead reveals that contemporary forest patches result from the tethering of animals and other practices in and around villages that promote the sprouting of woody vegetation in what previously was open grasslands. When these settlements are abandoned in favor of more fertile agricultural and grazing lands, the human-built earthen structures dissolve, leaving behind new forest patches.[14] Similarly, an article recently published in *Environment* contradicts claims of severe and widespread soil degradation in the West African Sahel and actually supports evidence of increased soil productivity and fertility, despite long-standing claims to the contrary.[15]

The rapid development of Earth observation technology in the past 50 years—which might lead us to expect more reliable measurements—has resulted in the publication of several discordant estimates of Madagascar's forest cover.[16] The discrepancies among these estimates of standing forests often exceed any reasonable calculation of forest-cover change. Table 1 on page 15 shows a variety of estimates of Madagascar's forest cover during the last century—the seemingly erratic nature of growth and decline are largely the result of different estimation methods. A comparison of two of these data sets illus-

trates the nature of these differences: Figure 3 on page 16 shows the results of overlaying one of the first nationwide forest-cover maps developed with Landsat satellite imagery from the 1970s with the National Ecological Forest Inventory completed by the Malagasy national forest service in 1990 and based on similar data.[17] Using geographic information systems (GIS) technology to overlay these maps indicates a forest-cover loss of nearly 27,000 km^2, accompanied by a gain of more than 10,000 km^2. A gain in primary forest of this magnitude over a span of just 20 years is not plausible, and close scrutiny reveals that much of the apparent change is actually the result of misregistration (in other words, the maps don't "fit" one another geometrically) as well as inconsistency in deciding what is forest and what is not.

For example, by looking in more detail at the Ambositra region alone (see Figure 3), along the upper edge of the eastern rainforest, the GIS overlay suggests an even more dramatic—and even less plausible—loss of more than 260 km^2 of forest, which is almost completely offset by a gain of more than 250 km^2. In this instance, the problem appears to lie mainly with the inconsistencies among data sources and analytical techniques. Although the earlier assessment classified a large area as a mixed formation of secondary forest and fallow fields, the later assessment was more liberal in its interpretation of humid forest. This discrepancy accounts for the spurious gain of primary forest.

As explained in an article in the January/February 2002 issue of *Environment*, different satellite sensors record information in different portions of the electromagnetic spectrum, making their data to some degree incompatible.[18] In addition, a range of techniques is employed for extracting information from raw data into map form, which also leads to different outcomes. Until these data sets are subjected to rigorous accuracy assessment, estimates of forest-cover dynamics based upon them must be treated with great caution.

Population Pressure and Forests

Although there is considerable uncertainty over the rate of deforestation in Madagascar, there is virtually unanimous agreement that it is proceeding far too rapidly. According to the U.S. Agency for International Development (USAID), "Slash-and-burn agriculture has destroyed over 80 percent of the tropical forest cover."[19] Given this conclusion, the agency is faced with the issue of where, on an island of more than 500,000 km^2, it should focus its efforts.

One of the most influential studies of forest-cover dynamics in Madagascar set out to answer this policy question by testing the degree to which deforestation could be ascribed to topographic and demographic factors.[20] Published in *Science* in 1990, the findings of the landmark study by Washington University scientists Glen Green and Robert Sussman—that deforestation has been most rapid in flatter and more densely populated areas—have been cited widely in most subsequent work on Madagascar as well as in similar studies in other parts of the world. Furthermore, the quantitative results often appear—albeit anonymously—in documents justifying the international biodiversity conservation community's rather successful efforts to garner resources for work in Madagascar and to bolster the notion that deforestation in Madagascar can be attributed simply to population pressure.

To assess the impact of population pressure on the island's eastern rainforests, Green and Sussman compared maps of deforestation from the 1950s and 1980s, based on aerial photographs and satellite imagery, respectively (see Figure 4 on page 18), with a map of population density in 1966 from the *Atlas de Madagascar* (see Figure 5 on page 19).[21] Because they derive from very different sources and were interpreted using different techniques, the forest-cover data were incongruous and could not accurately estimate change in forest cover. Ideally, a new set of aerial photographs would have been acquired and interpreted in the same fashion as the previous ones, but this would have been time-consuming and expensive.

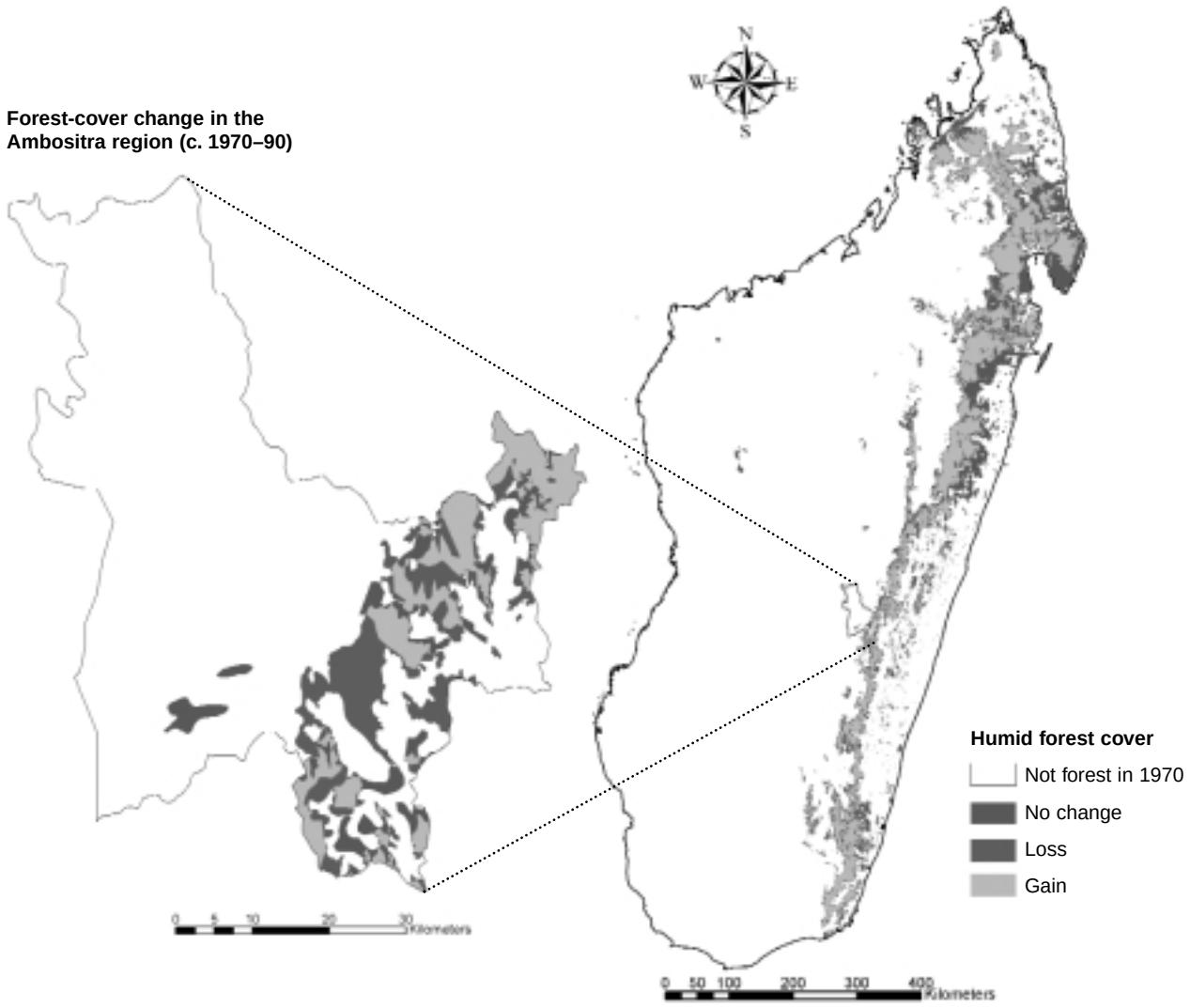
Table 1. Estimates of Madagascar's forest cover

Date or period	Forest cover (in millions of hectares)	Source
1895	20.0	Lavauden (1934)
1899	12.0	Girod-Genet (1899)
1921	7.0	Perrier de la Bathie (1921)
1931	10.0	Lavauden (1934)
1936	17.0	Perrier de la Bathie (1936)
1949–57	16.7	Guichon (1960)
1949–57	19.1	Humbert and Cours Darne (1965)
1949–57	12.4	Direction des Eaux et Forêts (1953–74)
1949–57	10.3	Lanley (1981)
1972–79	15.8	Faramalala (1995)
1974	7.5	Persson (1974)
1990	5.8	Nelson and Horning (1993)
1990–94	13.3	Inventaire Ecologique Forestier National (1996)

NOTE: The source column lists researchers and the year their estimate was published.

SOURCE: Inventaire Ecologique Forestier National (National Ecological Forest Inventory).

Figure 3. Change in Madagascar's forest cover (c. 1970–90)



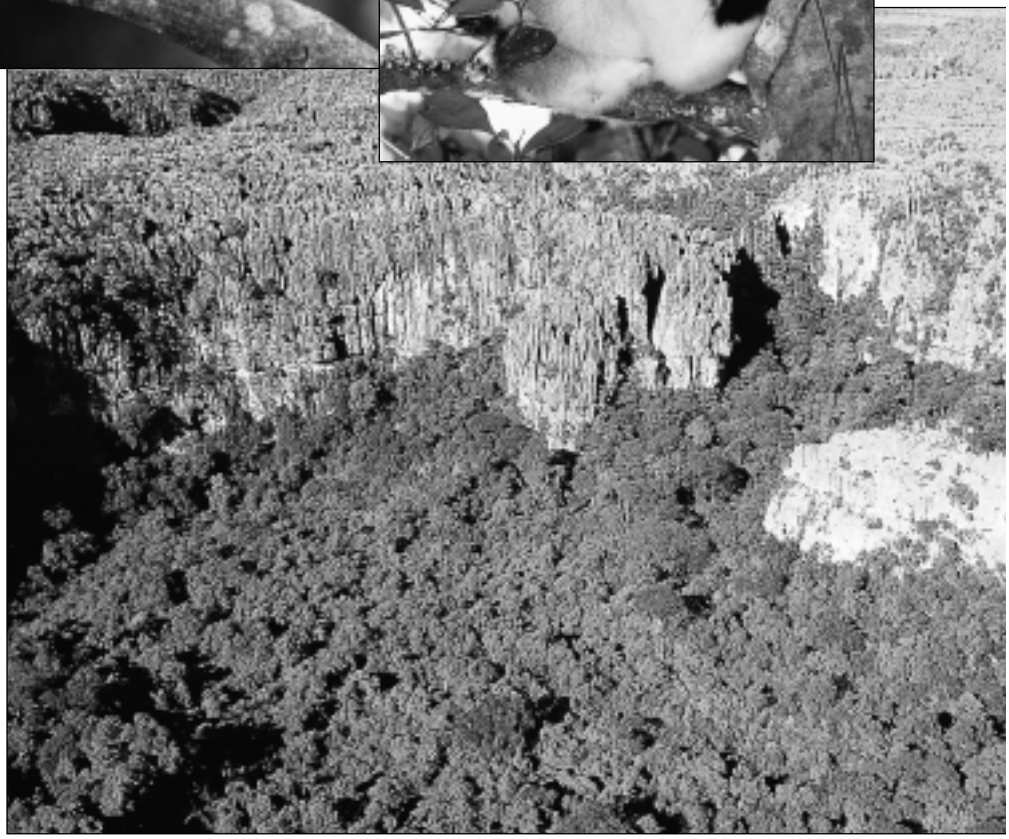
NOTE: Because several satellite images were used for each data set, precise years cannot be provided.

SOURCE: Direction des Eaux et Forêts (Madagascar Water and Forest Service), Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (German Agency for Technical Cooperation), Enterprise d'Etudes de Développement Rural "Mamokatra," and Foiben-Taosarintanin'i Madagasikara (Geographic and Hydrological Institute of Madagascar), *Inventaire Ecologique Forestier National: Situation de Départ, Résultats, Analyses et Recommandations* (National Forest Ecological Inventory: Starting Situation, Results, Analyses and Recommendations), Ministère de l'Environnement, Plan d'Actions Environnementales, Programme Environnemental—Phase 1 (Madagascar: Direction des Eaux et Forêts, 1996).

In addition, the study simplified the population density map, condensing the seven categories set forth in the 1966 atlas into three classes, including a "high density" class that not only encompassed the area in which forest-cover change was most dramatic but that also included the most densely populated urban areas, which account for about one-third of the island's population but are quite distant from the remaining forests.

Retaining the atlas's original specificity would have led to a different conclusion—that forest-cover change actually was most dramatic in areas of moderate population density. The high-density regions immediately adjacent to the two main highland urban centers, Antananarivo and Fianarantsoa (shown in the original atlas), are associated with aforestation. For example, forest plantations to the east of Antananarivo supply the capital with most of its woodfuel

Madagascar is home to many diverse plant and animal species, including the chameleon and the Indri indri *lemur.*



Although the extent of deforestation in Madagascar is not as severe as is widely thought, conservationists have been closing the forest frontier in an effort to save habitat.

(especially charcoal) and building materials.[22] The same is true of small towns and villages on the plateau that runs down the center of the island from north to south. Clearly, monocrop pine and eucalyptus plantations cannot replace natural forest in providing a full range of habitat and other ecological services, but after only two generations of experience planting trees, rural Malagasy are experimenting actively with other species. For example, in the village of Anevoka on the eastern escarpment, farmers are allowing indigenous trees to recolonize a eucalyptus plantation following charcoal harvesting. The forest of nearby Analamazaotra, one of the most popular destinations for viewing the highly charismatic *Indri indri* lemur in its "natural" habitat, actually is largely secondary growth, having been heavily logged prior to being set aside as a special reserve.

It is clear that different tools and techniques can yield quite incongruous views of the phenomena under investigation. Moreover, the relationship between two patterns—in this case population pressure and forest cover—can be dominated by the effects of spatial and spectral scalar dynamics. In addition to discovering where deforestation has occurred, however, it also is crucial to know *when* it occurred. Population data are collected at most every 10 years, while comprehensive forest-cover assessment is even more rare. The poor temporal coincidence of these data makes their comparison dubious.

It seems quite natural to ascribe deforestation in Madagascar to the growth of the human population, but this may be too simplistic. While the population of the island clearly has grown to about 12 million in less than 2,000 years, it is not certain that this growth has been steady or continuous.[23] In fact, there is as much uncertainty surrounding estimates of the island's population as there is about its forest cover. In 1996, Lucy Jarosz, a geographer at the University of Washington, analyzed colonial-era records and found strong

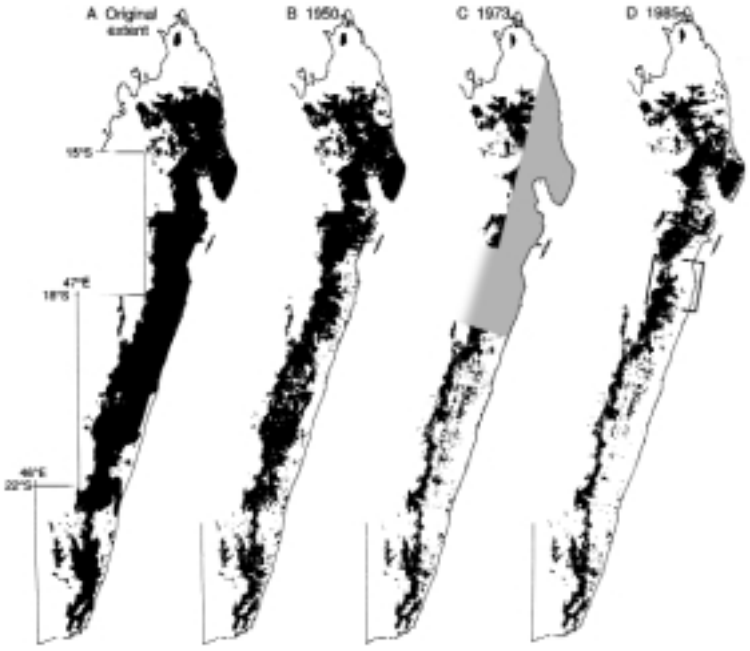
evidence that population growth during the French colonial period was stagnant, or even negative, while several million hectares of forest were cut by commercial interests under license from the colonial regime.[24] Likewise, major human relocation within Madagascar has been an important part of the island's settlement history and often has been associated with periods of political instability. The Zafimaniry people, for example, sought refuge in the forests of the Ambositra region during the tumultuous period of the early nineteenth century when the indigenous Merina monarchy was fighting with local chiefs to consolidate its control of the island.[25]

In these and other cases it is not enough to know that the human population is growing. Rather, one must understand how social and political institutions mediate relationships between people and the environment. The term "institutions" is used here in a broad sense that encompasses the full range of more and less formal rules that affect the dos and don'ts of access to forest resources.[26] The crafting of successful policy to preserve remaining resources, in Madagascar as elsewhere, requires a sound understanding of these institutional dynamics.

Institutions and Forest Governance

Both the cause and the diagnosis of deforestation in Madagascar are tied intricately to the institutions that have tried to regulate the way rural Malagasy earn their livelihoods from the land. From the perspective of farmers in the affected communities, the recent creation of protected areas in the nascent national park system is but another chapter in a history marked by outsiders asserting exclusive rights to forest land that villagers consider a direct inheritance from their ancestors. The latest effort to end the conversion of forest land for agricultural uses, however, aims to ensure the participation of affected communities in the management of pro-

Figure 4. Area of Madagascar's eastern rainforest, for the periods and population densities specified

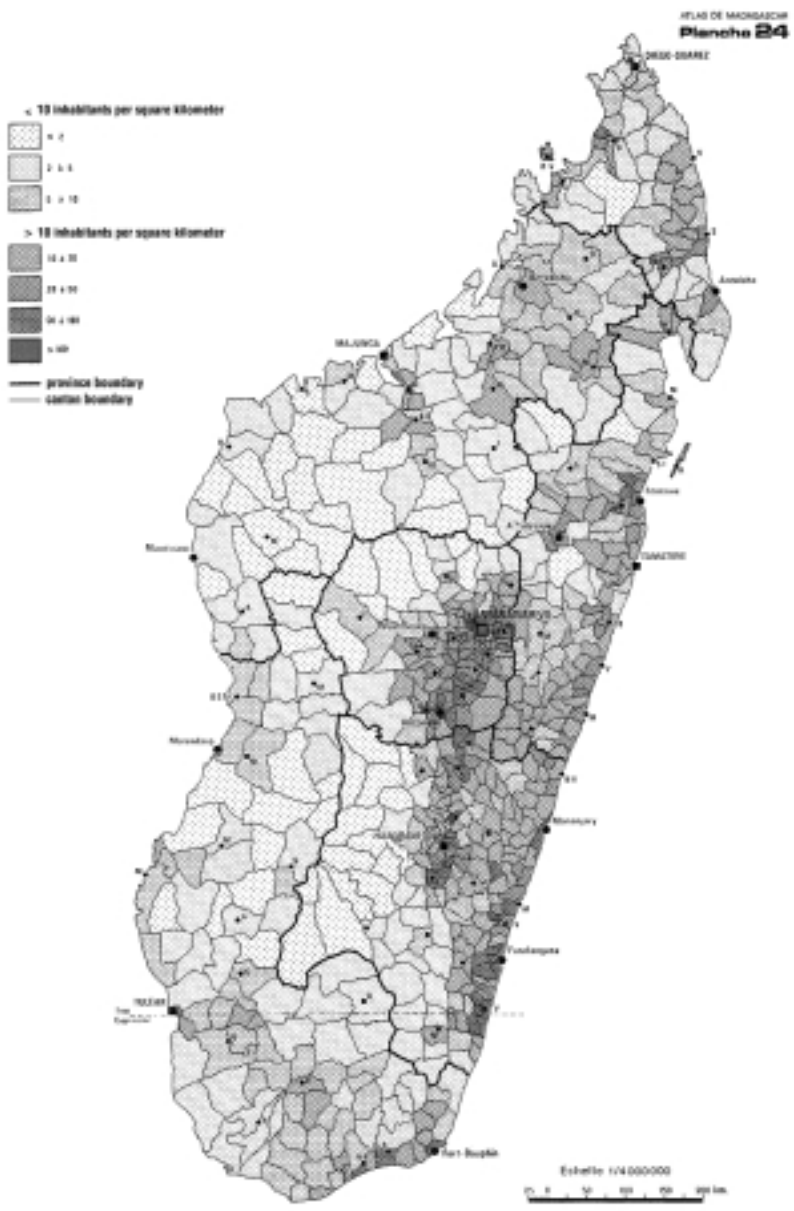


Year	Areal exent (ha x 10^6)	Forest remaining (percentage)	Forest perimeter (km x 10^3)	Deforestation rates from 1950 to 1985 (ha x 10^3/year)
High population density (>10 inhabitants per square kilometer)				
Original	4.7	100	3.5	
1950	2.4	50	7.8	43
1985	0.89	19	4.5	
Medium population density (5 to 10 inhabitants per square kilometer)				
Original	3.4	100	2.2	
1950	2.5	76	4.9	37
1985	1.3	38	5.0	
Low population density (< 5 inhabitants per square kilometer)				
Original	3.1	100	3.4	
1950	2.7	86	5.0	31
1985	1.6	51	6.1	
Total				
Original	11.5	100	9.1	
1950	7.6	67	17.7	111
1985	3.8	34	15.6	

NOTE: ha = hectares, km = kilometers. "Original" refers to the time before human occupation of the island (see H. Humbert and G. Cours Darne, *Carte Internationale du Tapis Vegetale: Madagascar* (International Vegetation Map: Madagascar) (Toulouse, France: French Institute of Pondichory, 1965). Extensive cloud cover permitted only partial mapping in 1973.

SOURCE: G. M. Green and R. W. Sussman, "Deforestation History of the Eastern Rainforests of Madagascar from Satellite Images," *Science* 248 (1990).

Figure 5. Population density of Madagascar (1966)



SOURCE: Association des Géographes de Madagascar (Association of Geographers of Madagascar), *Atlas de Madagascar* (Paris and Antananarivo, Madagascar, Bureau pour le Dévéloppement de la Production Agricole Madagascar (Office for the Development of Agricultural Production in Madagascar), 1969).

tected areas, including a condition that local residents share in the benefits of forest preservation, especially revenue from tourism.

To protect Madagascar's biodiversity, the international conservation community and the Malagasy government are employing a set of policies not very different from those used by King Andrianapoinimerina, the Merina ruler of the early nineteenth century, and the French colonial government that succeeded him. These policies include the criminalization of the traditional slash-and-burn agricultural practice known as *tavy*; the exclusion of farming populations from a series of protected areas; and the promotion of alternative, permanent agricultural practices such as irrigated rice, tree crops, and various soil and water conservation practices.

The effectiveness of these policies has been and continues to be determined largely by institutional dynamics. Not surprisingly, successive governments have encountered great difficulty in convincing farmers to abandon their traditional practices, through which farmers maintain ties with their ancestors and thus retain their cultural and spiritual identity. The willful disregard of prohibitions on tavy is a way for the rural Malagasy to reaffirm their affinity with these ancestors over distant and foreign authorities. In favoring educated Merina people from the highlands—who have long used permanent agricultural practices—for government and development project positions, national and international institutions fuel the fires they are hoping to extinguish, as resentment leads to flaunting of the rules, and sometimes even to malicious fires.[27]

Policies of exclusion from protected areas have suffered from another set of institutional blinders. The enforcement of these policies has relied mainly on the staff of the forest service, which is struggling to survive in an age of budget cutting and structural adjustment policies imposed by the International Monetary Fund. Recently, it has become clear that the institutional capacity to monitor activities along the thousands of kilometers of forest edge best resides with the communities located within it.

Early experiences with community-based natural-resource management in Madagascar and elsewhere in Africa, however, have shown that simplistic views of a traditional, unified community that is able to expand its already effective decisionmaking power to regulate forest use in the interest of the government—or the international community—are doomed to failure. Aid agencies have spent two decades learn-

Local institutional dynamics play an important role in the creation of rules governing agricultural lands and resource use in rural Malagasy communities such as this farm near Manjakandriana.

ing how to establish sound relationships with rural communities, including a great deal of experimentation with methods of rapid and more or less participatory rural appraisal. Effective decentralization of forest governance requires knowledge of the conditions under which local groups are able to effectively manage local resources.[28] For example, rather than automatically viewing traditional land-tenure rules as leading to insecure title and prescribing Western-style private property rights, as so often has been done, it is necessary to learn which types of rules already are being enforced effectively and how enforcement is being accomplished.[29]

The promotion of permanent agriculture as a way to avoid the clearing of forested hillsides for *tavy* likewise has been a standard of antideforestation policy by successive regimes. In the early 1990s, the staff of a USAID-sponsored Integrated Conservation and Development Project attempted to convince farmers in communities neighboring the Mantadia National Park to adopt an exhaustive list of soil and water conservation practices in exchange for the right to continue farming land that had already been cleared inside of the park. Having completed a rapid appraisal exercise, the project staff was confident that it had a sufficient understanding of community dynamics.[30] A year later, however, the staff found that the test plots were being farmed using traditional techniques. The farmers were expelled from the park, which constituted some of the most fertile lands in the area. More careful—and time-consuming—work with some of the communities near the park revealed that agricultural practices and local institutions were much more dynamic than previously had been thought. Detailed land-use mapping, involving the farmers' interpreting large-format prints of recent color aerial photographs, brought the outsiders' attention to previously unseen intensive land-management practices that were tucked away in small, protected agroecological niches.

These gardens, or *tanimboly*, tend to contain a great diversity of crops and often function to stabilize some of the steepest, most erosion-prone land. This type of overlooked experimentation with permanent agriculture provides a much better starting point for promoting agricultural intensification than a textbook list of conservation practices.[31]

At the same time, conservation staff became aware that land-management institutions in farming communities in the region were considerably more complex and flexible than the traditional model, in which an elder of the lineage group, called the *tangalamena*, decides

which fields farmers may use each year and ensures special protection for the land surrounding the village tomb, known as the *sembontrano*.[32] The land-use mapping exercise revealed that these communities, founded during successive waves of immigration related to railway and mining operations, maintained not just one but several *sembontrano*, and that access to land was controlled by several *tangalamena*. Furthermore, in response to the expulsion of farmers from the proposed buffer zone, the rules governing access to the *sembontrano* had been relaxed temporarily to enable farmers access during the crisis.[33] In countless examples such as this one, development project staff are learning to engage with local communities to constructively manage natural resources.

Preserving Paradise

Saving Madagascar's forests has proved quite a difficult task, given the lack of certainty in measuring progress to date and the ways that misunderstanding the biophysical and social processes at work can hamper the success of well-meaning initiatives. It is undeniable that much of the island's forest has been felled to make way for crops and animals. At the finest scales, the basic theory holds true—forest has been felled more rapidly where more people live. But at intermediate and temporal scales, the relationship is much more ambiguous and institutions mediate, determining not only the rate and location but also the direction of forest-cover change.[34] At the local level, compliance with land-use policies varies widely, and much of this is due to village-level institutions. Many villages have installed and maintain plantations to meet their needs for fuel and construction materials while preserving the natural forest. Yet such efforts may be undermined easily by the actions of corrupt officials who use their positions to exploit forest resources for personal gain.

Immediate solutions may be ineffective if they fail to appreciate local institutional dynamics. It is noteworthy that the power of exclusion from Madagascar's forests had to become as distant and diffuse as possible from those forests before devolution of control to local institutions would become the operative mode. In effect, the most distant outsiders with the least knowledge of the sociocultural milieu are designing the programs that will shift power to the local level. There are no sustainable shortcuts for changing people's farming practices. The answer to the shortcomings of a rushed approach is a long-term, concerted effort that can afford to understand the problems being addressed and seriously engage farmers and their communities in a truly collaborative process. Trust takes a long time to build, especially when there have been numerous false starts. Fortunately, experienced and dedicated scientists in Madagascar are trying to better understand the institutional dynamics of the communities in which they work. In many ways, it could be argued that it is the onerous demands of their own institution—the international bureaucracy—that stands in the way of better progress on the ground and not the traditional structures that resist change.

The conventional wisdom of the conservation community that blames ignorant, overly conservative farmers for the destruction of Eden has been largely revised in Madagascar. During the past decade, conservation and development projects have progressed far beyond the mentality of fences and guards protecting pristine forest. The current round of projects seeks to discover and encourage alternative livelihood strategies in larger regions surrounding protected areas.[35] Using lessons learned from earlier efforts, rapid appraisal approaches are evolving toward more nuanced engagement with communities and building on local agricultural experimentation. A growing cadre of local nongovernmental organizations with experienced staff can attest to the country's capacity to rise to the occasion. The first formal contractual arrangements concerning forest man-

Effective preservation projects must address the capabilities of local institutions, the needs of farming communities, and their use of traditional practices such as tavy.

agement are being crafted between village organizations and the government, giving grounds for optimism about the future of Madagascar's landscapes.

Over the past year, progress has been largely on hold as the country struggled through a political stalemate between rival presidential candidates, which at times bore overtones of some of the highland-coastal divisions mentioned earlier. The Malagasy appear once again to have weathered a political crisis with relatively little bloodshed, and attention can be turned to the crucial business of ensuring an equitable and sustainable future for the island and its people.

William J. McConnell is the science officer for the Focus 1 Office of the Land Use and Cover Change Project, a joint core project of the International Geosphere-Biosphere Programme and the International Human Dimensions Programme on Global Environmental Change. The Focus 1 Office, housed at Indiana University's Anthropological Center for Training and Research on Global Environmental Change, coordinates research on land-use dynamics through comparative case-study analysis. McConnell holds a B.S. in the political economy of natural resources from the University of California, Berkeley, and an M.A. in international development and a Ph.D. in geography from Clark University. His research concerns human-environment relations in sub-Saharan Africa and, most recently, the scalar dynamics of population and forest-cover change in Madagascar. He may be contacted via e-mail at wjmcconn@indiana.edu.

NOTES

1. N. Myers, R. A. Mittermeier, C. G. Mittermeier, G. A. B. da Fonseca, and J. Kent, "Biodiversity Hotspots for Conservation Priorities," *Nature* 403 (2000): 853–58.

2. Conservation International is one of the main organizations striving to save Madagascar's biological resources; see http://www.conservation.org/xp/CIWEB/regions/africa/madagascar/madagascar.xml. (The figures cited on this web site are not attributed, nor is "forest" defined.)

3. Food and Agriculture Organization (FAO), *Global Forest Resources Assessment* (2000), accessible via http://www.fao.org/forestry/fo/fra/main/index.jsp.

4. General information on the rosy periwinkle can be obtained from the National Wildlife Federation web site, accessible via http://www.nwf.org/wildalive/periwinkle/sciencefacts.html.

5. For a discussion of the conflict between native Malagasy farmers and herders and state authorities over the use of fire for preparing cropfields and pastures, see C. A. Kull, "Madagascar's Burning Issue: The Persistent Conflict over Fire," *Environment*, April 2002, 8–19.

6. A. Jolly, "Madagascar: A World Apart," *National Geographic Magazine*, February 1987, 160.

7. Madagascar's system of protected areas is managed by the Association Nationale pour la Gestion des Aires Protégées (National Association for the Management of Protected Areas), a nongovernmental organization intended to become the country's national park service (see http://www.parcs-madagascar.com/angap.htm).

8. M. Leach and R. Mearns, eds., *The Lie of the Land: Challenging Received Wisdom on the African Environment* (Oxford, U.K.: James Curry/International African Institute and Heinemann, 1996).

9. For more on Thomas R. Malthus's early nineteenth-century theory, see D. Niemeijer and V. Mazzucato, "Soil Degradation in the West African Sahel: How Serious Is It?" *Environment*, March 2002, 31, note 15.

10. E. Ostrom et al., eds., *The Drama of the Commons* (Washington, D.C.: National Academy Press, 2002); and G. Hardin, "The Tragedy of the Commons," *Science* 162 (1968): 1,243–48.

11. S. H. Olson, "Environments as Shock Absorbers: Examples from Madagascar," *Environmental Review* 12, no. 4 (1988): 61.

12. P. Lowry II, G. Schatz, and P. Phillipson, "The Classification of Natural and Anthropogenic Vegetation in Madagascar," in S. M. Goodman and B. D. Patterson, eds., *Natural Change and Human Impact in Madagascar* (Washington D.C.: Smithsonian Institution Press, 1997).

13. J. C. McCann, "The Plow and the Forest—Narratives of Deforestation in Ethiopia, 1840–1992," *Environmental History* 2, no. 2 (1997): 138–59.

14. J. Fairhead and M. Leach, "Misreading the African Landscape: Society and Ecology in a Forest-Savanna Mosaic," *African Studies Series* 90 (Cambridge, U.K: Cambridge University Press, 1996).

15. Niemeijer and Mazzucato, note 9 above, pages 20–31.

16. P. Mayaux, V. Gond, and E. Bartholome, "A Near-Real Time Forest-Cover Map of Madagascar Derived from SPOT-4 VEGETATION Data," *International Journal of Remote Sensing* 21, no. 16 (2000): 3,139–44; and R. Nelson and N. Horning, "AVHRR-LAC Estimates of Forest Area in Madagascar, 1990," *International Journal of Remote Sensing* 14, no. 8: (1993): 1,463–75. See also M. H. Faramalala, "Etude de la Vegetation de Madagascar à l'Aide des Donnees Spatiales" (A Study of Madagascar's Vegetation with Remote Sensing) (Ph.D. thesis, Université Paul Sabatier de Toulouse (Sciences), 1988); Direction des Eaux et Forêts (Madagascar Water and Forest Service), Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (German Agency for Technical Cooperation), Enterprise d'Etudes de Développement Rural "Mamokatra," and Foiben-Taosarintanin'i Madagasikara (Geographic and Hydrological Institute of Madagascar), *Inventaire Ecologique Forestier National: Situation de Départ, Résultats, Analyses et Recommandations* (National Forest Ecological Inventory: Starting Situation, Results, Analyses and Recommendations), Ministère de l'Environnement, Plan d'Actions Environnementales, Programme Environnemental—Phase 1 (Madagascar: Direction des Eaux et Forêts, 1996); and G. M. Green and R. W. Sussman, "Deforestation History of the Eastern Rainforests of Madagascar from Satellite Images," *Science* 248 (1990): 212–15.

17. Direction des Eaux et Forêts, ibid.

18. A. de Sherbinin, K. Kline, and K. Raustiala, "Remote Sensing Data: Valuable Support for Environmental Treaties," *Environment*, January/February 2002, 20–31.

19. U.S. Agency for International Development (USAID), "USAID Congressional Presentation FY 1997: Madagascar," accessible at http://www.usaid.gov/pubs/cp97/countries/mg.htm (accessed 25 July 2000).

20. Green and Sussman, note 16 above.

21. Association des Géographes de Madagascar (Association of Geographers of Madagascar), *Atlas de Madagascar* (Paris and Antananarivo, Madagascar: Bureau pour le Développement de la Production Agricole Madagascar (Office for the Development of Agricultural Production), 1969).

22. H. Ramiarantsoa, "Les Boisements d'Eucalyptus dans l'Est de l'Imerina (Madagascar)" (Eucalyptus Plantations in Eastern Imerina (Madagascar)), in C. Blanc-Pamard and L. Cambrezy, eds., *Terre, Terroir, Territoire: Les Tensions Foncieres* (Land, Soil, and Territory: Fundamental Tensions) (Paris: ORSTOM Editions, 1995). See also A. Bertrand, "The Planted Forest of the Madagascan Highlands," *Forest, Trees and People Newsletter* 15 (1992): 45–48.

23. G. Campbell, "Madagascar and the Slave Trade, 1810–1895," *Journal of African History*, no. 22 (1981): 203–27.

24. L. Jarosz, "Defining Deforestation in Madagascar," in R. Peet and M. Watts, eds., *Liberation Ecologies: Environment, Development, and Social Movements* (New York: Routledge, 1996).

25. The emigration of the Ma'anyan people—widely recognized as the main ancestors of the Malagasy—from southern Borneo about 1,500 years ago appears to be linked to the closing of the overland trade between China and India resulting from the loss of control by China of its northern territories. On the Zafimaniry, see D. Coulaud, *Les Zafimaniry: Un Group Ethnique de Madagascar à la Poursuite de la Forêt* (The Zafimaniry: An Ethnic Group in Pursuit of the Forest in Madagascar) (Antananarivo, Madagascar: Fanotam-Boky Malagasy, 1973).

26. See Ostrom et al., note 10 above.

27. G. Sodikoff, "Plunder, Fire and Deliverance: A Study of Forest Conservation, Rice Farming and Eco-Capitalism in Madagascar" (master's thesis, Clark University, Worcester, Mass., 1998).

28. J. Ribot, "Decentralization, Participation and Accountability in Sahelian Forestry: Legal Instruments of Political-Administrative Control," *Africa, Journal of the International African Institute* 69, no. 1 (1999).

29. Among the studies suggesting that the creation of private land tenure will lead to better land management in Madagascar are D. Gade, "Deforestation and Its Effects in Highland Madagascar," *Mountain Research and Development* 16, no. 2 (1996): 101–16; and A. Keck, N. Sharma, and G. Feder, "Population Growth, Shifting Cultivation, and Unsustainable Agricultural Development: A Case Study in Madagascar," World Bank Discussion Papers: Africa Technical Department Series No. 234 (Washington, D.C.: World Bank, 1994).

30. N. Razakamarina et al., "Negotiating Conservation: Reflection on Linking Conservation and Development in Madagascar" (Interim thoughts on collaborative approaches to sustainable livelihoods and resource conservation around the Andasibe/Mantadia Protected Areas, Madagascar) (working paper, Clark University Program for International Development/Aires Protégées d'Andasibe-Mantadia (Andasibe-Mantadia Protected Area Project), Worcester, Mass., 1996).

31. The Terre Tany/Projet Bilan Ecologique à Madagascar (BEMA, Madagascar Ecological Assessment Project) has achieved great strides in this domain. Their findings are available at http://www.cde.unibe.ch/programmes/africa/afr25.html.

32. Keck, Sharma, and Feder, note 29 above; and K. Schoonmaker-Freudenberger, "Tree and Land Tenure: Using Rapid Appraisal to Study Natural Resource Management: A Case Study from Anivorano, Madagascar" (Rome: FAO, 1995).

33. W. McConnell, "Misconstrued Land Use in Vohibazaha: Participatory Planning in the Periphery of Madagascar's Mantadia National Park," *Land Use Policy* 19, no. 3 (2002): 217–30.

34. A. Agarwal, "Common Property Institutions and Sustainable Governance of Resources," *World Development* 29, no. 10 (2001): 1,649–72.

35. Information about USAID's Landscape Development Interventions Project is accessible via http://www.ldi.mg.