

Challenges of forest governance in Madagascar

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There has been a huge surge in interest in the preservation of Madagascar's forests in the past two decades, but despite the investment of hundreds of millions of dollars, the goal remains elusive. Recent legislation has given the government the authority to enter into contractual arrangements with communities for the management of the country's public forests, so it has become crucial to grapple with the significant challenges involved. This paper explores the enormity of the challenge of forest governance in Madagascar in an era of decentralization. By examining several forests in one part of the country, it reveals a dizzying range of forest types and forms of use and governance within a fairly small portion of the country. These examples make it apparent that the history of forest management in Madagascar constitutes a broad-ranging experiment with forest governance. Simply monitoring the dynamics of the forest canopy is a significant technical challenge. However, this pales in comparison to the difficulties inherent in explaining those dynamics and assessing the sustainability and equity of different management regimes. Of the forests considered in the study, those where the Malagasy state has partnered with international conservation and development organizations seem to stand out, both in terms of stabilized, or even growing, forest cover, as well as a balance of interests among users.

KEY WORDS: Madagascar, forests, remote sensing, biodiversity conservation, institutions, decentralization

Introduction

Madagascar hosts large and unique forest resources, and attempts to protect them from conversion to agriculture date back at least two centuries, with a huge surge in interest in the past two decades. From the early nineteenth century, the island's forests have been claimed by the state – first by the Merina Monarchy, then by the colonial French regime, and finally by the independent Malagasy Republics. In the early 1990s, the international biodiversity conservation community entered the scene, leading the country to be the first in Africa to develop a National Environmental Action Plan, largely centred on the preservation of biological diversity (Larson 1994; Kull 1996). The task has never been simple, however, and despite the investment of hundreds of millions of dollars, the goal of conserving the country's forests remains elusive. Along with preservation of remaining natural forests, significant effort has been expended on

supplying timber and other forest products through plantations. The legacy of French colonial initiatives has important implications in this regard, as exotic plantations are found throughout the country, and many are under the direct control of Malagasy state.

Through the last decade of international intervention, the traditional approach to conservation – the creation of parks (fences and guards) – has been tempered with calls for a community-based approach, mirroring the emergence of decentralization of natural resource management in other developing countries. In Madagascar, recent legislation (GELOSE) has given the government the authority to enter into contractual arrangements with communities for the management of the country's public forests, but the success of this new approach will depend on how well the government and its partners handle the significant challenges involved (Marcus and Kull 1999; Buck *et al.* 2001).

This paper explores the enormity of the challenge of forest governance in Madagascar in an era of



Figure 1 The study sites in Madagascar

Source: Inventaire écologique forestier national (DEF 1996)

decentralization. The examination of several forests (Figure 1) reveals a dizzying range of forest types, as well as forms of use and governance, within a fairly small portion of the country. At the same time, our research highlights the difficulties of monitoring and explaining the dynamics of the country's forest resources. The paper begins with a brief review of recent theoretical developments in the analysis of institutions and common-pool resources, and their importance in the search for workable forms of forest governance in Madagascar. The paper then undertakes a comparative analysis of six forests in the east-central part of the island, presenting their environmental settings, their floristic and structural composition, and their use and management regimes. A time series of satellite images is then used to compare the forest dynamics over the past quarter century. These six examples show that the history of forest management in Madagascar constitutes a broad-ranging

experiment with forest governance, providing lessons for future efforts.

Forest resources and institutions

Forest resources are often the sites of negotiation and contestation in large part because they potentially provide a broad range of ecosystem goods and services, and priorities of the various stakeholders in a forest can differ widely. Priorities can include obtaining goods and services that require maintaining the forest and others that involve converting or modifying certain aspects of the forest (Bishop and Landell-Mills 2002; Brown and Rosendo 2000). For example, harvesting trees for timber products is often, but not always, linked to the conversion of land from forest to other uses, especially agricultural production. Examples of goods and services that accrue from avoiding modification or conversion of the resource include maintenance of hydrological functions (e.g. watershed protection) or biological resources (e.g. genetic diversity, carbon sequestration). Like all governments, the Malagasy state must balance the various interests of its citizens and the international community, each of which places different values on various ecosystem goods and services. On one hand, the high rate of endemism of the island's flora and fauna attracts the biodiversity conservation community's interest in maintenance, and considerable pressure has been brought to bear on, and support provided to, the government to conserve the forests intact. On the other hand, the huge majority of the island's population derives its livelihood directly from the land, and thus closing the forest frontier has serious implications for well-being.

Over the past decade there has been a strong push to accomplish forest conservation in Madagascar, as elsewhere, through the formal decentralization of forest resource governance. The growing experience in actually implementing decentralization throughout Africa, however, has begun to reveal some real difficulties. A main critique of such programs charges that they reify monolithic communities to which authority can be rapidly devolved, when in fact these 'local communities' are difficult to define, much less successfully engage in conservation activities, especially after a long era of strong state control (Agrawal and Ribot 1999; Gibson *et al.* 2000; see also Twyman 2000; Brown 2002). At the same time, all forests are not alike, suggesting that different approaches may be required in different places, taking into account the nature of the forests, as well as the characteristics of the various user groups and the products and services sought by each. This realization lies at the heart of much of the research conducted by scholars in the

Workshop of Political Theory and Policy Analysis at Indiana University, and has led to the development of the Institutional Analysis and Development framework to examine how institutions – the formal rules and rules-in-use – affect human incentives and behavior (McGinnis 1999).

At the core of the . . . approach are individuals who hold different positions (e.g., member of a forest user group, forest official, local forest user group official, landowner, elected local, regional and/or national official) who must decide upon actions (e.g., what to plant, protect, harvest, monitor, or sanction) that cumulatively affect outcomes in the world (e.g., a forest ecosystem and the distribution of forest benefits and costs).

Gibson *et al.* 2000, 9

Carrying this perspective specifically into the domain of forest resources, the International Forestry Resources and Institutions (IFRI) research programme focuses on the institutional rules-in-use shaping the use of forests. IFRI Collaborating Research Centers collect data on forests around the world according to standardized protocols in order to enable comparative analysis (Gibson *et al.* 2000; Ostrom and Wertime 2000). The study described in this paper draws upon and contributes to these analytical perspectives.

The forests: location and composition

According to Madagascar's most recent and authoritative land-cover assessment, the *Inventaire Ecologique Forestier National*, forests covered almost a quarter of the island in the early 1990s (DEF 1996). Of these 13 000 000 ha of forest, a considerable portion is found within the country's hundreds of parks, reserves, and other lands directly under the state's control; just over 1 000 000 ha are in plantations (Table 1). Based solely on the size of the resource, it is clear that the management task is huge, but when the communities using the resource are considered, the challenge is more daunting still. The country's population of more than 12 million, comprising some 13 000 communities, is mainly concentrated in the more humid areas where most of the forests are also found (Green and Sussman 1990; Bertrand 1999). Forest resources play a vital role in the country's economy, through the provision of a range of goods and services. Fuel wood remains an important source of energy in urban areas and is the sole source of cooking and heating for the majority of the rural population. In addition to providing a number of other products and services, forest land is the main source of new agricultural land. Thus, many rural

Table 1 Madagascar forest resources

	Extent of island	58 700 000 ha
	Extent of forest	13 260 000 ha
State forest types	No.	Area (ha)
National parks	5	175 361
Special reserves	23	371 393
Integral natural reserves	11	569 542
Classified forests and forest reserves	259	4 023 446
Forest stations	23	57 294
Hunting reserves	4	n/a
Reforestation and restoration areas	101	1 044 895
Total	426	6 241 931

Source: DEF (1996)

livelihoods are directly dependent on forest resources. Meanwhile, tourism is the country's most important source of foreign exchange, and most of this is targeted in forest areas.

In order to illuminate the diversity of forest types and management regimes currently in place, this study considers six forests in the east-central part of the country, presenting information collected in initial surveys carried out in 1998 and 1999 and follow-up visits in 2001. Initial data collection proceeded according to the IFRI protocols, including standard forms for the collection of information on forests and the communities that use them (Rakotozafy *et al.* 2002). Part of this data collection involved the derivation of sketch maps showing the land management units within each forest under study. The follow-up visits served mainly to collect 'training samples' – information used in the interpretation of satellite images to monitor changes in forest resources over time (described later). Both initial surveys and follow-up visits included basic forest mensuration (e.g. key arboreal species, height of canopy and emergent trees, tree diameter, etc.), as well as individual and group interviews with forest users.

Finally, satellite images acquired in 1985, 1994, and 2000 were analysed, along with land-cover information extracted from topographic maps, which are based on aerial photographs from 1957 (McConnell *et al.* 2004), in order to assess land-cover change in the forests. It should be noted that the information on forest dynamics presented here is limited by the spatial and spectral properties of the satellite images relative to the complexity of the landscapes in question, and by the brevity of the fieldwork undertaken. The analysis relied

primarily on Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) images, which contain information on the Earth's surface in pixels with a nominal spatial resolution of 30 m. At this resolution, the smallest forest unit analysed is represented by approximately 5000 pixels, of which a significant proportion are along the edge, where change – and confusion in classification – are most likely to occur.

The results of the discrete classification process, in which the spectral data were converted into land-cover classes (in this case, binary forest-cover maps), should not be accorded undue certitude. While the TM and ETM+ sensors are designed in large part to discriminate between vegetation types, the spectral signatures – the information recorded by the satellite across six windows of the electromagnetic spectrum – of broken-canopy mature forest are quite similar to those of advanced successional forests, and both of these are similar to various stages of coppice regrowth (Mausel *et al.* 1993; Nelson and Horning 1993). In addition, it is difficult to assess the impact of seasonality. The differences in the acquisition dates, March 1985 and December 1994, of the scenes covering the highland sites could result in some confusion between succession and seasonal greening. Inconsistencies in class composition can potentially produce exaggerated land-cover change results. Every attempt was made to minimize the impact of seasonality by employing all available training data.

Classification training data were derived from 43 *in situ* training samples, dozens of field photos, as well as field notes, including land-use histories. Spectral signatures derived from training data were plotted over a band 3/band 4 scatterplot for each image and class signatures generated from areas of interest (AOIs) that delineated class clusters, using ERDAS Imagine™. Pixels located within the AOIs were classified by the non-parametric decision rule of Feature Space. Pixels falling into the overlap region of two or more AOIs, or outside of all AOIs, were classified by a parametric decision rule based on the probability of a pixel belonging to a given class, using the maximum likelihood algorithm. The classes were subsequently collapsed, and a majority filter, using a 3 × 3 moving window, was applied. Once the images were classified into forest/non-forest maps, they were overlaid to yield forest-cover change maps and statistical summaries.

The forests analysed here included a very broad range of forest types, situated within a relatively narrow range of environmental conditions. This variation in forest types is important in understanding the range of resources that are in play in forest governance. While the sample is quite varied, it represented a small subset of the overall variation

in forest types and environmental settings found in Madagascar. All of the forests considered here were located in the mountainous terrain of Madagascar's central highlands and eastern escarpment, with a maximum elevation ranging from about 1000 to 2000 m above mean sea level. The average annual temperature ranges from 13 to 24 °C, while precipitation ranges from 1200 to almost 2200 mm per year. The forests were all within a few hours' drive from the capital Antananarivo (20–165 km), and within 15 km of the nearest administrative centre.

The forests varied considerably in size, although it is important to note that determining the size of a forest management unit can be difficult. In the absence of reliable, current cadastral maps, boundaries on sketch-based maps, such as those completed as part of IFRI's Site Overview Form, may be the best approximation. At the same time, the management definition of a forest often will exceed in size the boundaries of a forest defined by morphological or floristic criteria. In other cases, a management unit may be just a portion of a larger forested area. In the simplest cases considered here, the 450 ha Tsiakarana forest and the 900 ha Manjakatempo forest, both in the interior of the central plateau, had quite distinct boundaries, as they were completely surrounded by agricultural lands. Two other forests consisted of portions of the long, thin forested area marking the eastern edge of the island's central highlands at the upper edge of the escarpment. These include the 800 ha Beorana forest and the nearly 4000 ha Durand Devillaine forest. The remaining two forests likewise constituted portions of a much larger forest mass, in this case in the mountains between the central highlands and the east coast: the Vohidrazana and Maromizaha forests were contiguous portions of a forest mass of over 30 000 ha to the south of Route Nationale 2, which breaks the corridor as it runs from the capital to the coast (the 10 000 ha Mantadia National Park forest lies to the north of the highway).

The forests also varied in terms of floristic and structural composition, ranging from relatively pristine, 'natural' forest to homogeneous plantations of exotic species, with various mixtures of these types in between. At the natural end of the spectrum, the Vohidrazana forest was a largely intact cloud/rain forest containing a wide range of indigenous flora and fauna bordered by agricultural lands. At the other end of the spectrum, the Tsiakarana forest consisted mainly of two species of pine (*Pinus patula* and *P. khesia*) in stands of various ages, resulting from a checkerboard clear-cutting–replanting management scheme. There was also a stand of mature eucalypts (*Eucalyptus* spp.) within

the Tsiakarana forest, and the adjacent grassy hills were being planted in eucalyptus as well. The remaining forests in this study were hybrids, containing plantations of exotic trees, including pine, eucalyptus, mimosa (*Acacia* spp.), and quinine (*Cinchona* spp.) stands within or adjacent to natural forest. The Manjakatempo forest was an interesting outlier in this respect, as the 'natural' portion of the forest was composed of an unusually narrow set of indigenous species.

Forest use and management

It should not be surprising that these diverse forest types, existing in different ecological settings, were subject to quite different use and management regimes. In the classic formulation of forest conservation, the Malagasy state is concerned with restricting access of farming communities to the natural forests. Farmers would traditionally cut and burn this forest to prepare it for planting of hill rice. Known in the Malagasy language as *tavy*, this system has long been employed throughout the world for the itinerant production of rain-fed crops such as rice (Conklin 1954; Jarosz 1993; Messerli 2000; Laney 2002). The Malagasy brought this practice with them when they migrated from Kalimantan some 1200 years ago (Dahl 1991). The sustainability of the system depends on the availability of sufficient land, such that after one or two years of cultivation the plots may be left in fallow long enough for the forest to re-establish itself. Land pressure eventually requires farmers to re-use land more frequently, and natural succession is curtailed. The state's intervention, closely supported by international donors and conservation groups, is intended to interrupt this cycle and protect remaining forest from such conversion.

This classic case was closely approximated in the Vohidrazana forest. As described earlier, the Malagasy state has long asserted control over forests that farming communities consider their ancestral domains. Thus, devolution of forest governance would constitute a return of some measure of control over the resource to those communities. In practice, it is extremely difficult to exclude neighbouring populations from access to the many resources of the forest. In Madagascar, as in many other parts of the world, national and international agencies have attempted to halt, or at least slow, forest conversion through the promotion of intensive, permanent agriculture – a process fraught with difficulties (Keck *et al.* 1994; Messerli 2000; McConnell 2001).

Other forests under state control differed substantially from this classic formulation. The Tsiakarana plantation, on the outskirts of the capital city, was created by the planting of exotic tree species on

hilltop grasslands. The management goals were those of industrial forestry – maximum sustainable yield while minimizing management costs. Meanwhile, the presence of large plantations of exotic trees alongside the natural forests at Beorana, Durand, and Manjakatempo led to 'hybrid' management schemes, encompassing both conservation and production goals.

The following sections consider the products and services derived from each of the forests, the user groups, and the rules governing users' access to those products and services.

Attributes of the resource

Information collected on the IFRI forest and forest product forms reveals that the products garnered from the six forests included both timber and wood products as well as a range of non-timber forest products, and services including tourism and religious observance. Vohidrazana (a natural forest) and Tsiakarana (a plantation) provided relatively restricted sets of products and services, while the uses of the hybrid forests were quite varied.

In terms of traditional forest products, all of the forests in this study were subject to some harvesting of timber for construction materials and fuel wood, although at very different intensities. The Tsiakarana plantation was the most intensively harvested for timber, while fuel wood extraction was decidedly more prevalent in the natural Vohidrazana forest. In addition to these products, the hybrid forests – Beorana, Durand, and Manjakatempo – also hosted charcoaling activities from both their natural and artificial (exotic) stands.

Non-timber forest products collected from the forests included honey, leaves, bark, crayfish, minerals (construction materials and semi-precious stones), and livestock browse. Many of these were likely under-reported in the survey data, but there appeared to be little pattern to their extraction across forest types, other than their near complete absence in the Tsiakarana plantation. Tourism appeared to offer potentially lucrative returns in those natural forests well situated and developed to accommodate visitors, including the Manjakatempo and Maromizaha forests, although tourism in Madagascar still required heavy subsidies. The level of provision of religious services was more difficult to assess. While the Manjakatempo hosted large numbers of pilgrims in its sacred sites, sacred groves were found within and adjacent to many other forests. In a broader sense, all natural forests are considered by rural society to have a certain sacred value, often with attendant rituals observed before entrance into and exploitation of the forest.

All forests included here were located within or adjacent to agricultural landscapes, and it can be argued that conversion of forest to agricultural uses was an important service demanded of the forest land. In those instances where the boundary of the forest was formally demarcated, and inside of which farming was taking place, the demand for conversion was clearly seen.

Attributes of the users

As described above, the number of products and services derived from the 'purely natural' and 'purely exotic' forests were restricted compared with the broader range extracted from the hybrid forests. Information collected on various IFRI forms concerning the users of the resource showed that the number and characteristics of the user groups mirrored this pattern. With the exception of the privately owned Durand, all of the forests were under the formal jurisdiction of the Malagasy agency responsible for forest management, the Ministry of Waters and Forests (*Ministere des Eaux et Forêts*, or MEF, which has since merged with the Ministry of the Environment).

In the classic case, the main dynamic in forest governance is between the legal owners of the forest (public or private) and neighbouring farming communities whose members wish to extract products and services from the forest (or convert the forest to agricultural land). Again, the natural forest of Vohidrazana best typified this dynamic; although there were other actors involved in exploiting the forests (including clandestine timber harvesters), the farming communities were the only organized and recognized user groups. It would be a mistake, however, to characterize the dozens of farming communities surrounding this, or any other, forest as internally homogeneous. Wide disparities have been noted both among and within such communities in terms of the levels of social differentiation and cohesion, as well as access to and dependence on forest products and services (Ribot 1995; Laney 2002). Nevertheless, with respect to the other forests covered in this analysis, the number and diversity of the user groups in the Vohidrazana forest and Tsiakarana plantation were quite limited. In the latter, the private, for-profit timber company Sahy enjoyed a contractual relationship with the MEF for the harvesting of timber. Meanwhile, neighbouring communities enjoyed the right to glean fuel wood following harvesting.

In those forests where other uses were possible or permitted, more user groups were involved in exploiting those resources. For example, when tourism was a viable commodity, such as in the Maromizaha and Manjakatempo forests, tourists

constituted a significant user group, as did the guides, who in both cases belonged to formal organizations. In those publicly owned forests that included significant plantation stands (Beorona and Manjakatempo), user groups had formed around timber harvesting and/or charcoal production. In addition, user groups had formed for the exploitation of a variety of other goods and services, including the gathering of non-timber forest products for medicinal or small-scale consumptive, artisanal, or commercial purposes, as well as religious observance.

Management regimes

The six forests represented quite an array of approaches to forest management, including private ownership backed by the authority of the state and state ownership with varying levels of both co-management and outside assistance. In terms of both products and services and the groups involved in their exploitation, discussed earlier, the Vohidrazana forest and the Tsiakarana plantation were found to exhibit relatively restricted ranges of conditions, while the hybrid forests were much more complex. Thus, one might expect the management regimes to be more complex in the hybrid forests, and this is indeed the case.

Clearing of forest land for agriculture (*tavy*) in the Vohidrazana and Maromizaha forests was regulated by a traditional system of lineage tenure, overlaid by a formal system requiring a permit from the forest service. In each community, clan patriarchs (*tangalamenas*) granted rights to create *tavy*, and ideally a permit was obtained from the MEF. Prior analyses of satellite images demonstrate that rapid conversion of forest to agricultural land over the past quarter century abated in the past decade, although signs of clandestine agricultural conversion deep in the forest interior were detected (Schoonmaker-Freudenberger 1995; McConnell *et al.* 2004). Restrictions on the harvesting of fuel wood (limited to deadwood) appeared to be largely respected, but during the field visit to the Vohidrazana forest, lumber extraction was observed, reportedly an illicit use involving a local municipal official. A similar situation prevailed in the natural portion of the Maromizaha forest, although here illicit use involved the production of charcoal rather than lumber.

There had been a significant level of outside intervention in this region over the past decade, including Swiss and American-funded projects, particularly in the Maromizaha forest, with its elevation to the status of a buffer within the Mantadia-Analamazaotra Protected Areas Complex (APAM). The possibility for tourism in the buffer zone added another layer of complexity to the governance of

forest resources at the site, and several residents were members of APAM's tourist guide association, *Isavalalana/Association des Guides d'Andasibe*. In principle, the village of Anevoka would have participated in the APAM Integrated Conservation and Development Project, which was to involve representatives from surrounding communities in decisions about the management of the protected areas (including the use of tourist revenues) (Ford and McConnell 2001). The residents of Anevoka, however, reported no involvement in the making of formal rules for the use of forest resources.

Residents were, however, actively experimenting with the management of exotic plantations in this area, including generations-old eucalyptus timber stands, and the development of a rice–eucalyptus rotation wherein rain-fed rice was planted following eucalyptus coppicing, taking advantage of the much maligned sterilizing properties of the eucalyptus litter to repel rice pests. These developments were striking given that there was barely more than one generation's experience with tree management.

Unlike the harvesting in Vohidrazana and the hybrid forests, harvesting of both timber and fuel wood in Tsiakarana appeared to largely conform to formal rules, with the notable exception of the tapping of pine resin to make fire-starters for sale in Antananarivo. The Tsiakarana pine plantation was begun in the late 1960s under the youth employment initiative *Zatovo Ory Asa Malagasy* to provide pulp for a paper factory. A fire almost completely destroyed the plantation during a period of widespread social unrest throughout the country in 1974. By 1987, the plantation had sufficiently regenerated that it required pruning, and local residents were allowed to harvest firewood under a tacit arrangement with the field forester.

In 1996 MEF's *Direction Interregional* in Antananarivo began undertaking contractual arrangements with private logging firms, for example, the Sahy Company, under a formal management plan. The surrounding communities benefited from this management regime both through wage labour and through the right to glean logging by-products and dead wood (during the wet season) for domestic consumption. The right to glean fuel wood from logging slash was codified in a 1996 Order by the Commune of Masindray, establishing a formal relationship between the local population and the MEF, while the right to remove dead wood remained informal.

Strong demand for fuel from the nearby capital made monitoring of illegal consumption in this forest quite difficult. The extraction of resin to make fire starters was particularly problematic, as it results in the mutilation of the pine bark. In response, the MEF sought to increase the degree of community

participation, including the labour-intensive monitoring and expansion of the plantation. These efforts were being implemented through *fokontany*-level committees for the forest and the environment (*Komitin'ny Ala sy ny Tontolo Iainana*), who typically work on a voluntary basis (the *fokontany* is an administrative sub-division of the commune). Among the seven *fokontany* in the vicinity, those to the south were actively participating, while those to the north, who had reportedly turned a blind eye (at least) to the resin tapping, were less enthusiastic. This reticence may be related to lingering resentment over the communities' limited management role in the forest, despite having provided the labour for its establishment and monitoring, and to the replacement of their pruning with contractual logging, in whose profits they did not share.

One of the more problematic cases in terms of management is the Beorana quinine plantation and its adjoining natural forest. Here, the MEF's limited ability to monitor formal rules has led to a tacit devolution to former plantation workers since the late 1980s. The result was an open-access situation, with plantation workers competing with residents of surrounding communities. Local communities in and around Beorana, despite having no formal responsibility for forest management, have nevertheless been held responsible for damage caused by fire. Unlike Tsiakarana, however, no formal arrangement had been made either with private-sector firms or local communities, and there was evidence that authorities had been bribed to avoid fines for illegal charcoal production. By the summer of 2001, private individuals from the capital were seeking formal title to lands within the forest and had begun constructing residences and fences.

Perhaps even more problematic is the privately owned Durand forest. Originally claimed by a French colonist, the forest was ceded to one of his Malagasy employees following independence in 1963, and finally inherited by a set of siblings. While the Ramaherison family consisted of some 69 households, the 13 direct heirs owned the land and sold forest resources. These activities were coordinated with MEF's regional and local offices, as well as with the commune of Ambatolaona.

Residents of surrounding communities had negotiated informal arrangements with individual family members concerning the harvesting of forest resources, often resembling share-cropping. In addition, some residents have contested the family's claim to a portion of the forest through the courts. The conflict has led to the levying of fines against local residents, and even to their confinement in jail.

The Manjakatempo forest is an interesting case. Tradition holds that the forest was 'moved' to its

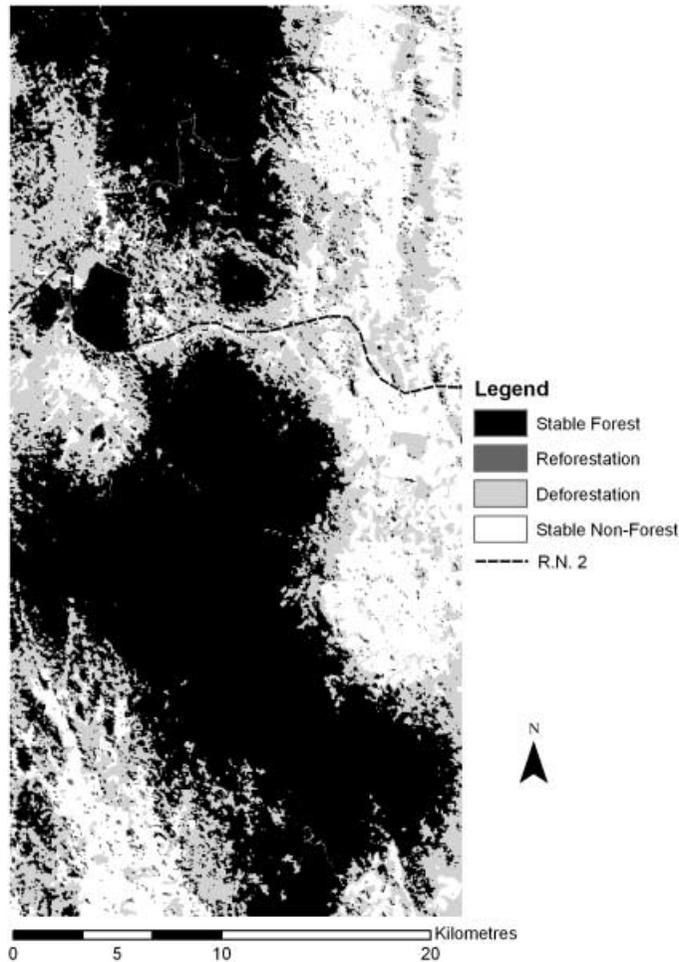


Figure 2 Maromizaha and Vohidrazana forests, 1957–2000¹

current location several generations ago in order to secure an alliance between a group in this area, which then had no substantial forest cover, and another group living at the forest edge on the escarpment 50 km away. Reportedly, seeds from the forest were ingested by members of the more distant community, carried in the intestinal tracts, and subsequently deposited at the site.

Since 1996, Manjakatempo has been managed under a formal contractual arrangement between the MEF and an association representing users in three communes in the *fivondronampokontany* (a higher-level administrative unit) of Ambatolampy. The *Union Forestiere d'Ambatolampy* (UFA) is governed by a six-member executive committee consisting of representatives of the two neighbouring villages' forest maintenance groups (*Vondron'ny Mponina Mpanazary ny Ala*, or VMMA). The manage-

ment plan for the forest, agreed at an annual general membership meeting, was purposely complex. Neighbouring residents were accorded rights to pasture animals and to collect household firewood and medicinal plants. The UFA authorized commercial logging by the VMMA and sanctioned tour guides for national and international visitors; both involved local labour. Meanwhile, the use of the forest for religious purposes was coordinated by a group of traditional doctors (*zandrano*), consisting of about two dozen households who have reportedly been organized since 1560. Very little illegal exploitation of timber or fuel wood had taken place in the Manjakatempo forest. The success of this arrangement cannot be divorced from the integrated forest development project (*Projet de Developpement Forestiere Intégré du Vakinankaratra*) of the German development agency GTZ.

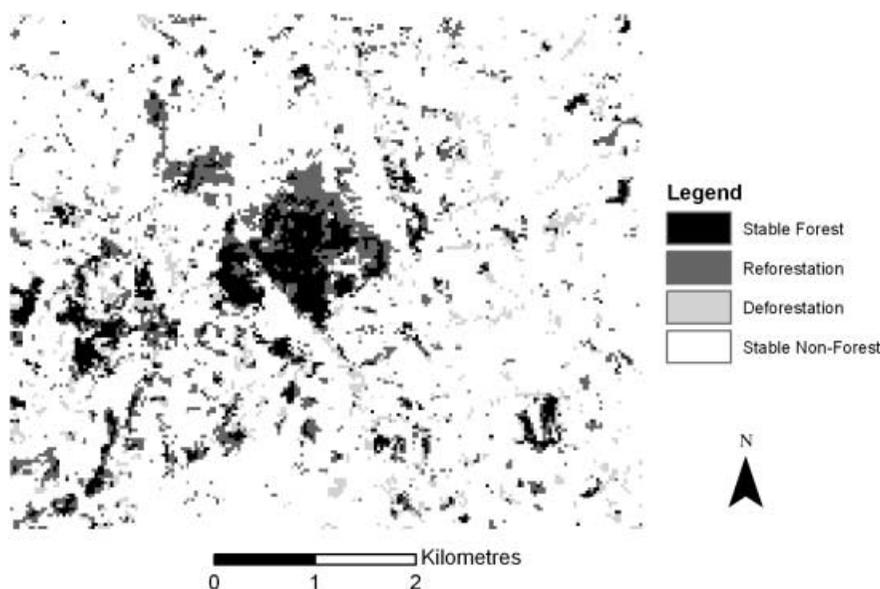


Figure 3 Tsiakarana forest, 1985–2000²

Forest dynamics

Satellite images provide a view of the trajectory of a forest's canopy, and while much goes on beneath the canopy that cannot be seen, this synoptic view of the overall stand dynamics is important in assessing forest management. This section reviews the results of change detection carried out using the satellite images described above.

The six forests showed considerable variation in the level of stand dynamics, measured in terms of both overall (net) change in forest extent and internal dynamics of clearing and replacement, within what are called here land management units (LMUs). The latter dynamics resulted from both the replacement of natural forests with exotic plantations and cyclic coppicing (lopping and sprouting) and harvest-replanting within established plantations, as well as from clearing for agriculture and subsequent fallowing or abandonment and forest succession. Vohidrazana forest and Tsiakarana plantation are very active in terms of net change, and display clear trends.

The Vohidrazana and Maromizaha forests underwent significant contraction over the past half century, with more than a quarter of the forested area cleared for agriculture between 1957 and 2000 (Figure 2). However, these rates dramatically levelled off in the 1990s (McConnell *et al.* 2004). While there are some plantations on the outskirts of the forests,

fieldwork indicated that these had been largely quite stable. For example, the mature eucalyptus grove in Ambalavero was established decades ago and provides lumber for home construction. The eucalyptus stands in the Maromizaha forest around Anevoka are coppiced at a younger age for charcoaling.

In contrast, the Tsiakarana pine plantation expanded by more than 30% between 1976 and 2000, recovering from the fire in 1974 (Figure 3). The stands within the Tsiakarana plantation are harvested in a regular rotation, with regularly spaced individual trees left standing to provide natural reseeding. Thus, the dynamics of the two 'extreme' cases are quite clear: expansion of the plantation accompanied by high internal dynamics and attenuated contraction of the natural forest with a very quiet core.

Not surprisingly, the hybrid forests present a more ambiguous picture, with moderate overall dynamics. Partitioning change among the natural and plantation components of the hybrid forests from satellite images is quite challenging for several reasons, in addition to the difficulties of delineating forests discussed earlier. The spectral signatures of eucalyptus, mimosa, and quinine are particularly difficult to distinguish from one another and from those of natural forests, especially in rough terrain, where topographic shadowing is severe. In addition, while a cartographically accurate

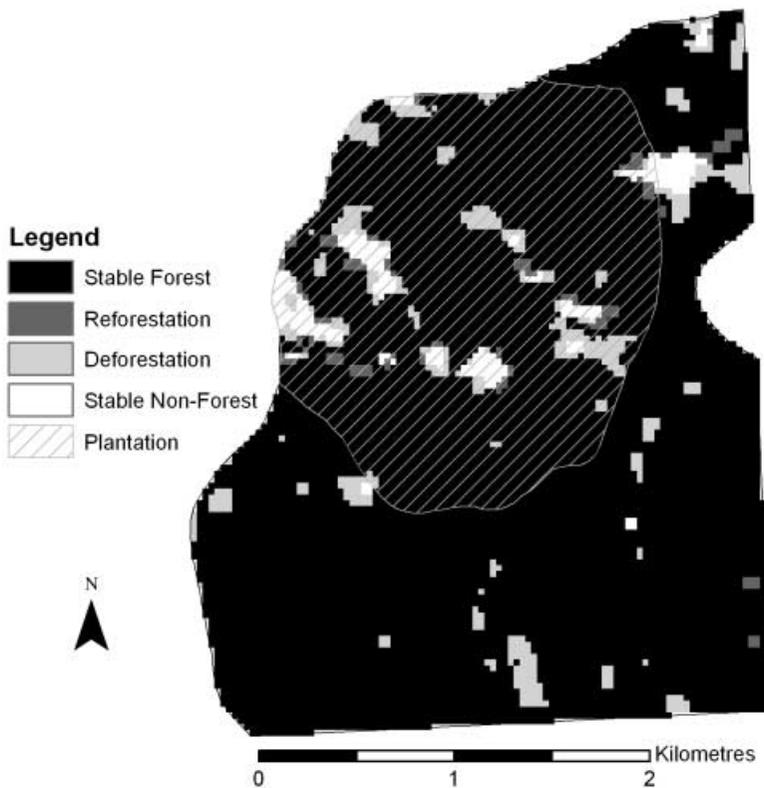


Figure 4 Beorana forest, 1985–1994³

base map of the Manjakatampo site enabled reliable discrimination of dynamics in different portions of the forest, georeferencing of the sketch maps of the Beorana and Durand forests was difficult, and the results presented here should be treated with some caution. Nevertheless, some qualified observations can be made.

The majority of deforestation between 1985 and 1994 in and around the Beorana site (Figure 4) occurred outside the portion of the forest considered here, along the western and northern edges of the forest mass – that is, southward and eastward recession of the forest edge. This recessional clearing appears to be associated with surrounding settlements: the southwestward recession is adjacent to the village of Amboavahy; the southeastward recession is in proximity to the villages of Ambodisaonjo and Ambero; and the westward recession is adjacent to the village of Ambosipotsy. Within the natural forest LMU, the forest experienced a slight contraction, mainly concentrated in the south and northeast. The patches of deforestation in the south lie near a much larger forest area that reportedly burned later (in 1995) near a hamlet of Ambosipotsy.

Other patches in the northeast are adjacent to previously non-forested areas. A small amount of new growth was detected in the areas not under forest in 1985, with a resulting net loss of 4% of the initial forest cover in this LMU. The trends within Beorana's quinine plantations were similar: a net loss of just under 4%. In terms of spatial patterns, land-cover dynamics in both of Beorana's LMUs were concentrated around the forest edges and in close proximity to roads and paths.

A great deal of deforestation also occurred outside the Durand forest boundaries between 1985 and 1994 (Figure 5), particularly to the east and northeast. Within Durand's natural forest LMU, considerable clearing took place, mainly near the northeastern corner, with patchy clearing in the northwest at or near the edge of non-forested areas. This was more than offset by afforestation, resulting in a net gain of almost 2% of the LMU. The length of the period obscures highly dynamic coppicing known to exist in the acacia and eucalyptus plantations, but major afforestation, particularly acacia, resulted in a significant net gain of 14%. Unlike in Beorana, there is no clear spatial pattern of deforestation and

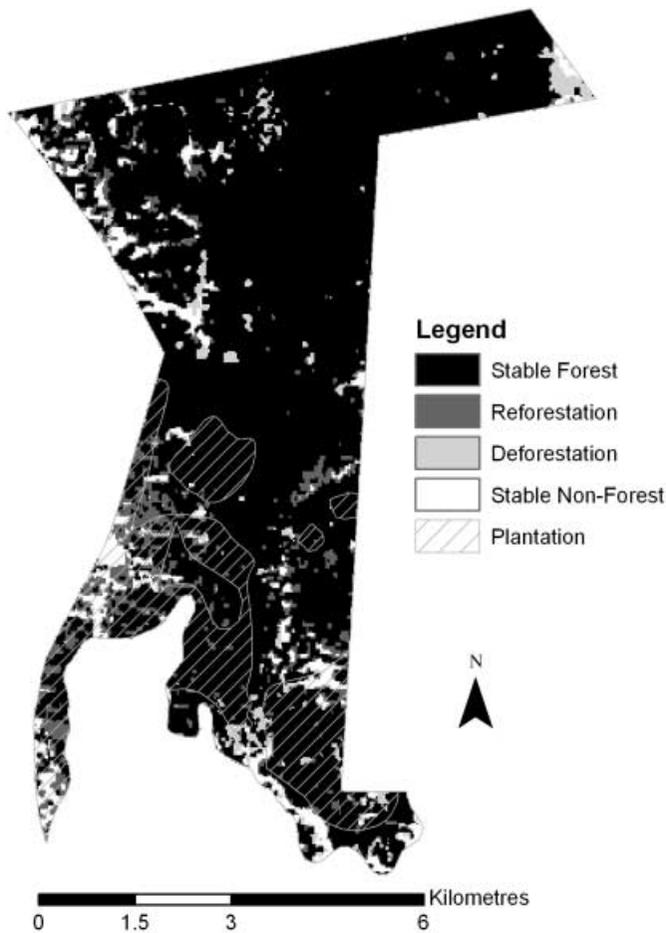


Figure 5 Durand Devillaine forest, 1985–1994⁴

regeneration in either of Durand's LMUs, but rather a patchwork of change.

Cloud cover limited the analysis of land cover in Manjakatombo between 1985 and 1994 to the eastern third of the forest (Figure 6(a)), but earlier (1976) and later (2000) images indicate that the eastern area has been the most dynamic part of the forest. The natural forest LMU experienced a net loss of almost 10%. Areas of conversion were largely concentrated in the two large blocks of forest in the northeast, with some of the cutting reaching far into the interior of the forests. During this period, a great deal of activity was seen in the plantation LMU, with huge clearing in the northeast portion and new growth in the central and southern portions, resulting in a net loss of over 9%.

The availability of cloud-free images in this region permitted the analysis of dynamics in a

second, shorter period, from 1994 to 2000 (Figure 6(b)). By 2000, the Manjakatombo forest had made a remarkable recovery from its decline in the previous period. In the natural forest LMU, the clearing–afforestation relationship almost perfectly reversed, leading to an 11% increase in forest cover. The situation in the plantation LMU was equally dramatic, where forest cover grew by almost 13%. Note that the second period covers just six years, compared with nine years between the earlier dates. In both LMUs, forest was usually cleared in large, continuous blocks, giving the appearance of systematic and localized use.

Comparing these three hybrid cases (Figure 7), the small, remote Beorana forest was the quietest from 1985 to 1994. During a period of nearly complete state neglect, it suffered minor contraction in forest cover in both the natural and

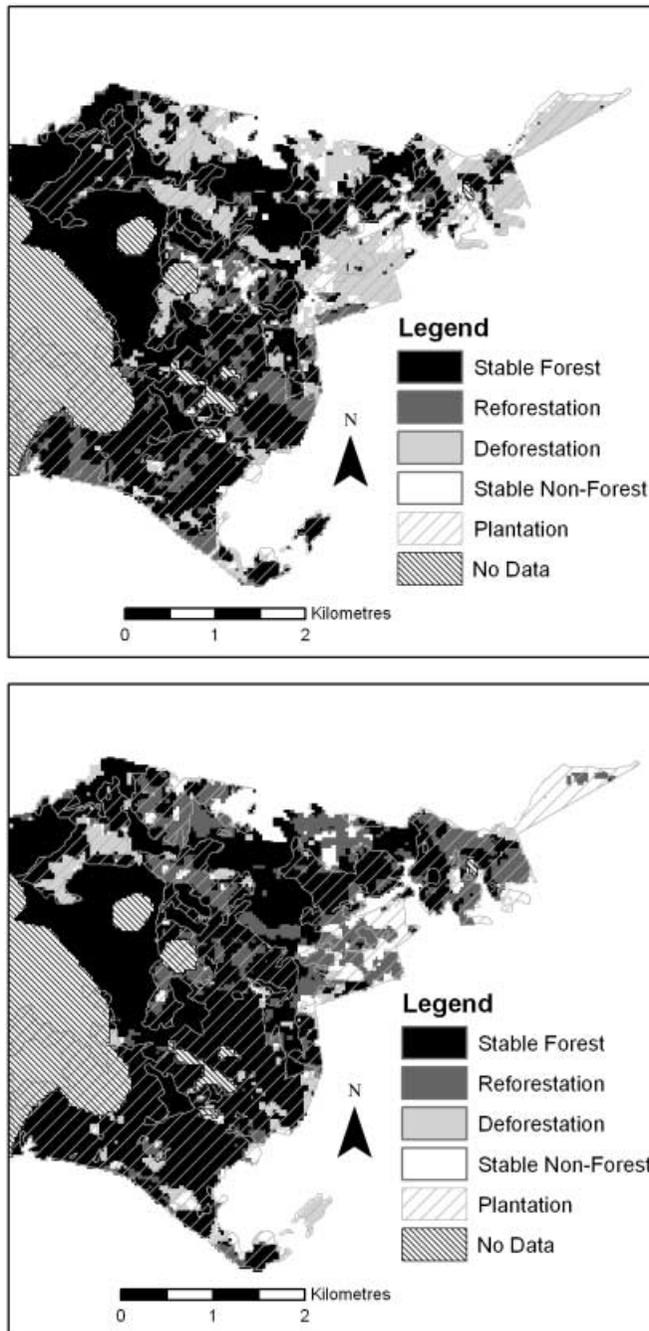


Figure 6 Eastern Manjakatempo forest: (a) 1985–1994; (b) 1994–2000⁵

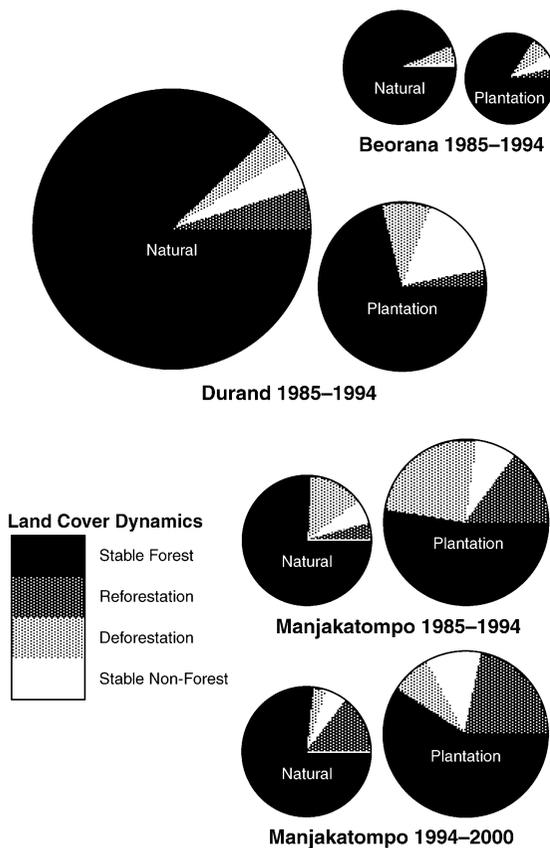


Figure 7 Comparison of forest dynamics in Beorana, Durand, and Manjakatempo

plantation LMUs, with less than 10% of these areas undergoing either deforestation or afforestation. The Durand forest, five times the size of Beorana, was much more dynamic, even when taking its size into account. In the midst of hotly contested rights, 10% of the natural forest LMU underwent change, while a fifth of the plantation LMU was 'in play', mostly accounted for by shifts from non-forest to forest. Meanwhile, the three dates of images available for the Manjakatempo site tell a Cinderella story. In the earlier period (1985-94) both LMUs were quite active. Change was detected in about 18% of the natural forest LMU and 40% of the plantations, resulting in significant contraction of forest cover in both cases. Overall dynamics in the later (shorter) period, during which the GTZ-supported contractual arrangement between MEF and UFA began, were relatively muted, but the net effects were completely reversed, with major expansion in forest cover in both LMUs.

One might expect the plantations to be the least complicated in terms of forest dynamics, products and services, user groups, and management regimes, and this appears to be the case. However, the natural forests are also relatively simple. The most complex and dynamic forests are the hybrid forests, where people have been planting trees, exploiting other resources, and forming groups in addition to the traditional community. This is where the MEF has the richest experience in interacting with a range of groups with varying interests, influence and skills, and this is an important testing ground for approaches to forest governance.

Discussion

The success of a forest governance regime may be judged along both biophysical and social dimensions. Biophysical management goals may range from preserving biodiversity by maintaining as much 'natural' forest intact as possible, to the maximization of either woody biomass in place (i.e. for carbon sequestration) or biomass harvesting (e.g. timber, pulp). Social goals may range from the maximization of total revenue (be it from tourism, or from the production of timber or other products), to the provision of services, whilst ensuring sustainability and equity in the enjoyment of such benefits may be a major consideration.

The traditional approach followed by various governments in Madagascar has been for the state to assert sole ownership and to attempt direct, centralized management of the country's forests. This approach is limited by the sheer physical extent of the resource, and the large number of users seeking products and services therein, which together prohibit effective monitoring by a central authority alone. It is not surprising, then, that Malagasy governments, from the Merina monarchy onward, have relied on some more localized authorities to ensure compliance with their centralized control, and have thus been engaged in some form of co-management for centuries. The evidence from the six forests analysed here provides some indications of the results of pursuing different forms of co-management, as measured along the biophysical and social dimensions outlined above.

One approach to co-management is for the state to support private ownership of forests. This comparative analysis includes only a single such case, the Durand forest, but the evidence is not encouraging. While forest cover was found to have expanded, this was achieved in large measure through reforestation following the clearing of natural forest, with consequent negative impacts on biodiversity. From the standpoint of total production, the management regime may have been quite

successful, but the continued contestation of community rights to access, marked by fines and imprisonment, was evidence of serious equity concerns, and brings into question the sustainability of the management regime.

The problems encountered when the state exerts central control without sufficient financial resources is well illustrated by the case of the Beorana forest. The physical dynamics at this site had largely been limited by its physical geography and related infrastructure and settlement pattern. Thus the forest canopy had been relatively stable, but the overall trend detected was a net loss of cover in both the natural and plantation areas. In terms of social dimensions, the effective neglect had enabled surrounding communities to continue gaining access to agricultural lands, but punishment of these communities for their perceived responsibility for forest fires attests to a dysfunctional relationship. The informal arrangement with former plantation workers complicated the situation, and is difficult to interpret as a constructive example of co-management. Private individuals were reportedly seeking title to land in the forest, and the experience in the Durand forest does not lend optimism for the success of this development.

The remaining forests – Vohidrazana, Maromizaha, Tsiakarana, Manjakatempo – are cases in which more concerted attempts had been made to engage local communities in managing state-owned forest resources. The recent declines in deforestation rates in the Vohidrazana and Maromizaha natural forests were encouraging, as was the stability of their abutting plantations. The clandestine opening of clearings in the interior indicated less-than-perfect community cohesion, but Swiss and American conservation and development projects were making strides in building strong relationships as the foundation for more formal collaboration between the communities and the state. Agreements with communities neighbouring the Tsiakarana pine plantation had been crafted, and while some resistance was evident, the management of the forest appeared to be resulting in sustainable, and even expanding, timber production (the maintenance of biodiversity not being a relevant management goal). Communities were benefiting from wage labour participation in the local logging industry and from access to domestic fuel wood. There was clearly room for improvement, in terms of limiting destructive resin tapping and achieving broader and deeper collaboration, but the experience permits some optimism.

From the evidence presented here, the Manjakatempo forest appears to present a valuable example for the crafting of multiple-use, multiple-user forest management regimes. The canopy had begun

recovering from rapid decline, and the forest was providing a broad range of products and services to local residents, as well as to visitors from around the country and from abroad. The management plan was derived from a broadly collaborative process, based on the formalized participation of villages and other groups. As such, it comes closest to what has been called 'adaptive collaborative management' (Buck *et al.* 2001).

Conclusions

The main conclusion to be drawn from the examination of these six forests is that there exists in Madagascar a huge variety of forest types, uses, users, and management regimes. The forests presented here comprise only 0.3% of the island's total forest, and just 0.6% of the protected forests. Simply monitoring the dynamics of the forest canopy is a significant technical challenge, and despite considerable investment over the past half century, there remain considerable uncertainties in the actual quantities, locations, and rates of change (Nelson and Horning 1993; DEF 1996). The challenge of monitoring, however, pales in comparison to the difficulties inherent in explaining those dynamics and assessing the sustainability and equity of different management regimes (McConnell 2002).

If successful management of forest resources were easy, it would be done by now. Clearly it is not. But just saying it is difficult is not good enough, and decentralization is no panacea. 'Shouting slogans about the desirability of decentralization or civil society contributes little toward the crucially important task of sustaining capacities for self-governance' (McGinnis 1999, xii). Equitable and sustainable management of Madagascar's forest is most likely to result from careful, rigorous analysis of the physical dynamics, and from a process of learning from the range of governance arrangements that have been tried in the past. Long-term commitments on the part of international conservation and development agencies may well prove decisive in this process.

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user groups in the forests. Responsibility for any errors, omissions or misinterpretation of this information rests with the authors. The 2001 field visits and satellite image analysis were made possible by National Science Foundation grant SBR9521918 to the Center for the Study of Institutions, Population, and Environmental Change at Indiana University. CIPEC colleagues Jon Unruh and Nathan Vogt participated in the 2001 field visit, and Joanna Broderick provided assistance with the preparation of the manuscript; their assistance was invaluable. Finally, the careful reading and constructive comments of two anonymous reviewers are gratefully acknowledged.

Notes

- 1 *Source*: Topographic map name: Manjakatampo; scale: 1:20 000; projection: Conformal Laborde; publisher: Institut Geographique et Hydrographique National/Foiben-Taosarintanin'i Madagasikara [Madagascar]. Scene ID: LE7158073000011050; platform: Landsat 7 Enhanced Thematic Mapper; acquisition date: 19 April 2000; path: 158; row: 073; cell size: 30 m; registration: 55 control points; RMS error: 0.5692.
- 2 *Source*: Scene ID: LT5159073008506710; platform: Landsat 5 Thematic Mapper; acquisition date: 8 March 1985; path: 159; row: 073; cell size: 30 m; registration: 35 control points; RMS error: 0.5583. Scene ID: LE7159073000013350; platform: Landsat 7 Enhanced Thematic Mapper; acquisition date: 12 May 2000; path: 159; row: 073; cell size: 30 m; registration: 26 control points; RMS error: 0.6727.
- 3 *Source*: Scene ID: LT5159073008506710; platform: Landsat 5 Thematic Mapper; acquisition date: 8 March 1985; path: 159; row: 073; cell size: 30 m; registration: 35 control points; RMS error: 0.5583. Scene ID: LT5159073009434810; platform: Landsat 5 Thematic Mapper; acquisition date: 14 December 1994; path: 159; row: 073; cell size: 30 m; registration: 32 control points; RMS error: 0.5443.
- 4 *Source*: Scene ID: LT5159073008506710; platform: Landsat 5 Thematic Mapper; acquisition date: 8 March 1985; path: 159; row: 073; cell size: 30 m; registration: 35 control points; RMS error: 0.5583. Scene ID: LT5159073009434810; platform: Landsat 5 Thematic Mapper; acquisition date: 14 December 1994; path: 159; row: 073; cell size: 30 m; registration: 32 control points; RMS error: 0.5443.
- 5 *Source*: Scene ID: LT5159073008506710; platform: Landsat 5 Thematic Mapper; acquisition date: 8 March 1985; path: 159; row: 073; cell size: 30 m; registration: 35 control points; RMS error: 0.5583. Scene ID: LT5159073009434810; platform: Landsat 5 Thematic Mapper; acquisition date: 14 December 1994; path: 159; row: 073; cell size: 30 m; registration: 32 control points; RMS error: 0.5443. Scene ID: LE7159073000013350; platform: Landsat 7 Enhanced Thematic Mapper; acquisition date: 12 May 2000; path: 159; row: 073; cell size: 30 m; registration: 26 control points; RMS error: 0.6727.

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