The 'degraded' tapia woodlands of highland Madagascar: rural economy, fire ecology, and forest conservation

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Abstract
Madagascar is well-known for deforestation. However, highland "tapia" (*Uapaca bojeri*) woodlands may present a counter-example of indigenous management leading to woodland conservation. Contrary to common wisdom that these woodlands are degraded, tapia woodland extent and composition have seen little change this century. Tapia woodlands harbor many benefits, including wild silkworms (whose cocoons have been harvested for centuries to weave expensive burial shrouds), fruit, woodfuel, mushrooms, edible insects, and herbal medicines. As a result, villagers shape and maintain the woodlands. Burning favors the dominance of pyrophitic tapia trees and protects silkworms from parasites. Selective cutting of non-tapia species and pruning of dead branches also favors tapia dominance and perhaps growth. Finally, local and state-imposed regulations protect the woodlands from over-exploitation. These processes -- burning, cutting, and protection -- are embedded in complex and dynamic social, political, economic, and ecological contexts which are integral to the tapia woodlands as they exist today. As a result, I argue on a normative level that the creation and maintenance of the woodlands should not be seen as “degradation,” rather as a creative “transformation.”

INTRODUCTION

Few endemic forests exist in highland Madagascar, a region dominated by vast grasslands, rice paddies, dryland cropfields, and pine or eucalyptus woodlots. One exception is the tapia woodlands, dominated by the tapia tree (*Uapaca bojeri*). These woodlands or wooded savannas grow in several zones scattered across the western highlands, and have long been seen as remnants of previously grander and more diverse forests, degraded into their current shape by frequent burning (Gade 1996; Humbert 1949; Koechlin et al. 1974; Perrier 1921; Rakotoarivelo

1993). However, the tapia woodlands display strong adaptations to fire and play an important economic role for rural residents as a source of non-timber forest products (Gade 1985; Koechlin et al. 1974). Based on ethnographic, archival, and ecological research, this paper argues for a reevaluation of the tapia woodlands, arguing that not only are the woodlands pyrophytic, but that they are specifically human-shaped through burning, cutting, and protection, due to the local economic value of woodland products like wild silk and fruit. Three main tenets of current understandings of the tapia woodlands are addressed. One, the woodlands are not disappearing in the face of repeated burning. Two, fire disturbance, selective cutting, and active protection are integral processes to this vegetal formation. Finally, on a normative level, the creation and maintenance of tapia woodlands should be seen as "transformation" rather than "degradation."

A landscape and the processes which modify it can be interpreted in several ways, based on the perspective of the observer. Recent literature has shown how some assumptions and ideologies of environmental change hinder more accurate understandings of complex and dynamic society-environment relations (Dove 1983; Jarosz 1993; Leach and Mearns 1996; McCann 1997; Scoones 1999; Watts 1985). Perhaps most well-known is the work of James Fairhead and Melissa Leach (1996, 1998). They show how an ideology of deforestation led analysts in West Africa to overestimate original forest cover, misinterpret historical data, and misread human-created landscapes. The context of colonial science, together with forestry and conservation politics, led analysts to exaggerate deforestation.

Others have shown that the history of specific landscapes is opposite of that assumed. In West Africa, the forest islands of the Guinean savanna region were long assumed to be relicts of deforested woodlands. Fairhead and Leach (1996) demonstrate, however, that these patches of forest are human additions to a savanna landscape. In Brazil, the anthropogenic origins of forest islands on the rainforest-savanna border have been hotly debated (Parker 1992; Posey 1992). In Madagascar, paleoecological studies contradicted the idea of former island-wide forests with evidence of prehuman grasslands and fire (Burney 1997; Kull 2000a). Around the world, landscapes assumed to be relatively pristine are shown to hold significant human influences (Denevan 1992; McNeely 1994), and several authors champion the role of local people in creating, maintaining, and altering forest landscapes, e.g. Hecht and Cockburn (1989) in the Amazon and Peluso (1996) in Indonesian Borneo.

A related project has been to re-evaluate vilified land-use techniques such as shifting cultivation, vegetation fires, and grazing. Shifting cultivation, once decried as primitive and backwards, is now seen as a well-adapted, sustainable technique at low population densities (Conklin 1954; Dove 1983). Fire, once universally condemned as a factor of degradation, is now accepted as an efficient means to manage a variety of ecosystems for specific goals, from grassland grazing systems to production forests (Kull 2000b; Pyne 1995). Grazing has also received its share of criticism. Perevolotsky and Seligman (1998), however, challenge assessments of overgrazing in the Mediterranean rim, proposing that heavy grazing promotes the perpetuation of certain diverse ecosystems and mitigates against wildfire fuel buildup.

Together, many of the above studies are involved in the project of reconceptualizing human-environment relationships. They show how environments are shaped by the complex, dynamic intersection of ecological, social, political, and economic processes both over time and across scales (Scoones 1999). The present study contributes to this body of knowledge by investigating the social and ecological processes shaping Madagascar's tapia woodlands, contributing three main arguments.

First, previous work describes the tapia woodlands as “degraded” remnants of once larger, more-diverse forests (AOM mad-ggm-2d19bis#6; Gade 1996; Girod-Genet 1898; Koechlin et al. 1974). Before the arrival of fire-starting humans some 1500 years ago, portions of the highlands were certainly more wooded than today (Burney 1996, 1997), and current tapia woodland areas were probably more densely forested and more diverse. Over the past millennium, “degradation” -- in the strict ecological sense of reduced species diversity, thinning vegetal cover and undergrowth, and exploitation that changes the character of the woodland from its prehuman state -- cannot be denied. In most commentary about the tapia woodlands, however, the term “degradation" is used as a negative normative term, implying that the changes are “bad.” I argue that the changes are of economic value to the locals, and that the term “degradation” masks transformative, creative processes critical to the livelihoods of rural people. The term “transformation” may be more appropriate (Beinart 1996; Richard and O’Connor 1997).

Second, previous authors assert that the tapia woodlands are spared the fate of the rest of Madagascar (deforestation) due to their tolerance of fire and their economic usefulness to the locals (Gade 1985; Girod-Genet 1898; Humbert 1947; Koechlin et al. 1974; Perrier 1921; Raison 1984).[1] The woodlands host an endemic silkworm used to weave burial shrouds, and they produce large quantities of marketable fruit. However, other than Gade (1985) in his groundbreaking re-assessment of the tapia woodlands, nobody considered fire as a natural, normal part of these woodlands, and no one shows specifically how the locals harness the trees’ fire adaptation to shape the woodlands to meet the needs of their rural economy in the context of dynamic political and economic contexts. That is the role of this paper.

Third, multiple authors assert that the tapia woodlands are shrinking in the face of repeated burning (Gade 1985; Grangeon 1910; Humbert 1947; Perrier 1921; Ramamonjisoa 1995; Vignal 1963). While the trees may tolerate fire, too much fire eventually kills the trees and impedes regeneration. Based on diverse pieces of evidence, this paper argues that there is no convincing evidence for tapia woodland decline, and in fact, in the Col des Tapia region, there is significant evidence for stability and even cases of increase.

This paper is based on one year of field work in a village between Antsirabe and Ambositra in 1998-1999. I performed socio-economic surveys of 105 households, 30 semi-structured interviews, and observed an entire year’s cycle of ecological, agricultural, and cultural events. Two forestry students performed sylvicultural studies of the tapia forests, as well as additional interviews in and around the field site, and I monitored 10 plots for seedling mortality due to fire. In addition, archival research was performed at the *Archives Nationales* in Antananarivo, the French *Archives d'Outre-Mer*, and the Norwegian Lutheran Mission archives.

[INSERT FIGURE 1 APPROXIMATELY HERE]

THE TAPIA WOODLANDS

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[1][1]Others argued that the woodlands only persisted in rocky areas where fires penetrated less easily (e.g. Basse 1934; Humbert 1949; Perrier 1921; Salomon 1978). While this may play some role in the ruiniform canyons of the Isalo massif, it does little to stop fires in the Itremo, Imamo, and Col des Tapia regions. More likely, the correspondence of tapia to rocky areas is related to its edaphic preferences (Koechlin et al. 1974).

The tapia woodlands are a short, endemic, sclerophyllous formation which loosely resembles Mediterranean oak forests or southern Africa's miombo woodlands. They are found in several widely-scattered clusters, from Imamo just west of the capital, south to the Isalo massif (Fig. 1). The woodlands, found as small patches or lightly wooded savanna, cover approximately 2600 km^2 (DEF 1996). Tapia woodlands are the most xerophytic of the broadleaf evergreen forests of Madagascar, growing on the western slopes of the central highlands, where the dry season lasts up to seven months. This zone, ranging from 800 m to 1600 m above sea level, is warmer, drier, and sunnier than the rest of the highlands; precipitation ranges from 1000 to 1500 mm/yr and the mean annual temperature is 17 to 22° C.

Humbert (1949) asserted that tapia woodlands occupied tens of thousands of square kilometers in the western slope zone before human settlement. Koechlin et al. (1974) argue instead that much of the prehuman western slope zone actually hosted a transition forest between eastern rainforests and western dry forests, and that the tapia woodlands represented a special formation restricted in its distribution to areas of nutrient-poor or rocky soils underlain by granites and gneisses. More recently, palynologist Burney (1997) showed that many areas of the highlands were never forested at all during the Holocene.

Trees from 18 families and 26 genera grow in the "less-degraded" western slope sclerophyllous forests (Koechlin et al. 1974). Most woodland tree species are similarly shaped, with tortuous trunks, low branches and sclerophyllous leaves; they reach a maximum height of eight to twelve m. The dominant tapia trees, *Uapaca bojeri*, have oval evergreen leaves typically three by nine cm that vary from dull olive green to yellow-green. Typical understory components include immature trees, shrubs, various herbs, and grasses.

Most extant woodlands do not fit the above "less-degraded" description. Actual western slope forests are dominated by a few species (especially tapia) and have a largely herbaceous understory. These forests were called "degraded" and named *bois de tapia* (tapia woodlands) by Humbert and Perrier (Koechlin et al. 1974) or "open sclerophyllous forests" by a recent forest inventory (DEF 1996).

[INSERT FIGURE 2 APPROXIMATELY HERE]

The study site was located in the Col des Tapia woodlands, approximately 200 km south of Antananarivo (Fig. 1). The tapia woodlands in this area cover approximately 50 km^2 in discontinuous or loosely-stranded patches (Fig. 2). The woodlands are sprinkled on both sides of the 25 km long, 1300 m.a.s.l. Manandona and Sahatsiho river valley, spilling over the Col des Tapia towards the Ilaka basin. Outlying patches exist west of the 2000 m Ibity massif and east of Ilaka along the Isandra River. Forests are found on slopes of all aspects up to an altitude of 1600-1700 m; above this the woodlands give way to pasture.

Sylvicultural analyses of the study site woodlands underscore the dominance of *U. bojeri* (Table 1). Almost 90% of adult trees are tapia. This dominance is paralleled in other regions, such as Imamo (Rakotoarivelo 1993) and Itremo (pers. obs.).[2] Overall, 15 tree species and at least 34 non-herbaceous understory species were noted in the study site woodlands (Tables 1 and 2). These woodlands also contain a variety of herbaceous species, epiphytes, aloe, lichen, orchids, and mushrooms.

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[2]In Itremo, remote, higher altitude woodlands (such as at the 1600 m Col d'Itremo) are less dominated by tapia, with significant presence of trees of the Sarcolaenacae family.

[INSERT TABLE 1 AND TABLE 2 APPROXIMATELY HERE]

WOODLAND ECONOMY

The woodlands are a significant element of the local subsistence and exchange economy. While it by no means dominates among regional revenue sources, this economy of silk, fruit, and other products gives a crucial value to the woodland which leads to its management and protection.

Tapia woodlands have generally been managed as a community resource under formal state ownership. In the 19th century, the monarchy claimed ownership of all forests. In practice, state control was in name only and woodlands were managed by adjacent people (Bertrand and Sourdat 1998). The French colonial government claimed all forested or un-cultivated land as state land, but allowed for traditional use rights while at the same time regulating wild silk production. The independent government ceased controlling silk harvests yet maintained tapia woodlands as state property. In 1978, woodland control was theoretically decentralized to the local level, yet this policy was never formalized and legislation remains unchanged. Currently, state influence is thin beyond occasional enforcement of laws regarding cutting and burning. Bitterness remains about previous controls over silk harvests, and some local *commune rurale*[3] governments have run into popular protest upon attempting to regulate harvests (Kull 2000b).

Silk

Tapia leaves are the preferred fodder for an endemic silkworm, *Borocera madagascariensis*, known by the name *landibe*. Details of the silkworm, its biology, cocoon harvesting, and weaving traditions are amply described elsewhere (see especially Gade 1985; Grangeon 1910; Paulian 1953). In short, *landibe* produce cocoons twice a year, November-December and May-June. At this time, locals painstakingly gather the cocoons from tree branches, leaves, and grass tufts (Fig. 3). The chrysalid is removed and consumed. The empty cocoons are cooked, spun, and woven into silk fabrics (Fig. 4). Almost all *landibe* silk is used to produce ritual burial shrouds, *lambamena*, used at both funerals and reburial ceremonies (*famadihana*) throughout the highlands. In the study site, 65 percent of households collect landibe, and one in five women is involved in spinning and weaving; many cocoons are sold to weavers in Antsirabe or Sandrandahy (northeast of Ambositra). In Ambohimanjaka *Commune Rurale*, 34 percent of households earn cash income from the harvest (Randriamboavonjy 2000).

[INSERT FIGURE 3 AND FIGURE 4 APPROXIMATELY HERE]

This silk-based economy has been important for several centuries. *Landibe* silk was sold in highland markets in the 1800s (Callet 1958). Oral history in the study site tells of the locals using the silk harvest to buy their freedom during the Merina conquest. A Norwegian missionary based in Ilaka noted in 1878 that the entire village departed for weeks at a time to collect cocoons -- traveling as far as Ambatofinandrahana, 50 km away (Bekker 1878). Before 1896,

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[3]The *commune rurale*, governed by an elected mayor, is currently the primary state-sanctioned local governance unit. It serves 5000 to 10,000 citizens, on average.

one-tenth of the harvest in the Itremo area went to fill government coffers, and the harvest was controlled by specific nobles (ANM D100s, II.CC.196).

After the conquest in 1896, the French immediately sought to control the silk harvest, legislating the auctioning of collection rights in 1899 (Grangeon 1910; JOM 7 Mar 1899). France's silk industry was interested in the potential of new sources of silk; Governor Gallieni as a result wrote of "this important issue which directly affects the economic future of Madagascar" (ANM D100s/4). Colonial administrators debated the placement of district boundaries based on anticipated silk revenues in areas of tapia woodlands (ANM D435). Collection rights to the Ambositra province woodlands in 1910 were valued at an astonishing 40,000 francs (Grangeon 1910); collection right owners collected a royalty of 0.50 francs per basket (ANM D195s). From 1921 to 1927 the Colony established a short-lived *landibe* research center in Ambatofinandrahana. Over time, however, colonial efforts came to focus on the husbandry of Chinese silkworms (*Bombyx mori*, known locally as *landikely*) for export (ANM Ag78, D100s; Frappa 1947; Platon 1953). Wild *landibe* silk was simply found to be of a rougher, inferior quality.

In the Col des Tapia area, government-auctioned collection rights for the *landibe* harvest were controlled in the 1930s and 1940s by colonist J.-M. Castellani. During World War II, the exploitation of the tapia forests was tightly regulated as administrators feared textile shortages. By a governmental *arrêté*, the forests of Ambatofinandrahana and Ambositra were closed to *all* usage except for officially-organized harvests, enforced by numerous guards (ANM L806; JOM 30 Sep. 1944). New legislation in 1946 established *landibe* cooperatives, limiting silk harvesting to cooperative members with permits (Fig. 5) and controlling the transport of cocoons (JOM 18 Jan. 1947). Guards known as *fantsika* (literally, nails) were paid to control illegal harvesting.[4] This legislation is still officially in force, but ignored. The silk cooperatives continued into the 1960s, when they were disbanded due to peasant frustrations with their corruption. Today, in the study site, the mayor's office is supposed to collect a fee from silk buyers. In 1997, annual permits were issued to only three local buyers for 5000 fmg each; most sales are not reported to the commune.

[INSERT FIGURE 5 APPROXIMATELY HERE]

The larger rainy season silk harvest provides crucial cash income during the meager months before the harvest. Cocoons are sold both by weight or by number; a minimum of 2500 cocoons weighs about one kilogram.[5] In 1998, prices were 500-750 MGF per 100 *isan-dandy*,[6] or $0.10-0.15 for 200 plus cocoons. A finished 2m by 2m *lambamena* cost between 150,000 and 300,000 MGF ($30-60) in Antananarivo. Most marketed, unfinished silk comes from the Isalo tapia woodlands; the Itremo and Col des Tapia woodlands also contribute but to a lesser extent, while Imamo has ceased to produce *landibe* since the 1960s (Razafintsalama and Gautschi

[4] A poor woman, descendant of slaves, told me of going out as a child to collect *landibe* illicitly with her parents. She accused the *fantsika* of taking advantage of their positions to unfair advantage in the silk harvest, enforcing severely yet stealing cocoons from the forest themselves.

[5] Female cocoons average 300-400 mg each, male cocoons average 90-200 mg (Grangeon 1906); thus a mixed batch might number 5000 cocoons/kg.

[6] Cocoons are normally counted by twos (larger female cocoons), and sometimes by fours (smaller male cocoons); this figure is referred to as *isan-dandy*.

1999). Recently, financial strains on family budgets and the availability of cheap, long-lasting synthetic cloths have put a dent into the *lambamena* economy; meanwhile, however, a few artisanal tourist shops have begun to sell vests woven with *landibe* silk.

Cocoon harvests vary immensely from year to year in terms of quantity and location. Oral traditions tell of grand silk harvests in the past, when the worms ate the trees bare of leaves. Recent years' harvests have been smaller, most likely due to unlimited harvesting as well as natural fluctuations in insect populations. Informants, however, however, ascribe the size of the harvest to *zavadolo*, literally "spirit matters," evoking the unpredictability and lack of human control in silkworm populations. Informants also blame the lack of *soron-dandy*, or ceremonies performed to assure good silk harvests. In his day, colonist Castellani donated a steer to the ceremony each year. The last ceremony was held around 20 years ago. In 1997, due to concern for dwindling *landibe* harvests, local elders met to write down and preserve the traditions, [7] yet in 1998, a planned *soron-dandy* was hijacked into an election propaganda session by the political party which had donated the steer.

Tapia fruit

The tapia tree produces large quantities of a tasty small fruit, *voan'tapia*; trade in this fruit provides crucial income to woodland communities from mid-September to early December. The fruit is a small (2-3 cm diameter) round drupe, green to yellow on the tree and brown when ripe. As only fallen fruit are ripe, a strong taboo (*fady*) prohibits plucking fruit from the branches. In the study site, 87 percent of households, especially children, regularly set out at dawn in a rush to collect newly fallen fruit. In Ambohimanjaka *Commune Rurale*, 68 percent of households earn cash income from the sale of tapia fruit (Randriamboavonjy 2000).

Tapia fruit were sold in highland markets over 200 years ago (Callet 1958); people in the field site remember when fruit was carried to Antsirabe by porters or ox-cart. Now, villagers convene roadside each morning, selling fruit to local and outside collectors; these middlemen accompany dozens of sacks of fruit to market. Fruit is sold for 400 to 1200 MGF per *katinina* basket, about 4 kg or 7 l, equivalent to $0.02 to 0.06/kg (1998). The overall annual Col des Tapia region fruit production is on the order of 600 to 1500 tons.[8]

Fruit income comes at a crucial time, after the festive season (July and August), when families have little liquid cash. The fruit harvest provides a crucial income boost, allowing people to hire rice-transplanting labor and buy agricultural inputs. Increasing cash availability is reflected in the burgeoning number of items at markets and roadside stands by December. At this time, tapia prices drop due to the arrival of other fruit on the market (e.g. litchi, plum) and most people are too busy preparing rice fields to collect the remaining fruit.

Forest-dependent households

The tapia woodlands also provide many other resources. First, 92 percent of families in the study area rely on tapia forests for woodfuel. Second, during the rainy season, seven

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[7] Rituals vary from site to site. For example, in one area, a pair of silkworms is brought from the hills to a place where people dance dressed only in ferns. As a white-headed cow is sacrificed, people sing, asking "please give us *landy* for we have no clothes." In another, villagers assemble at a high granite outcrop above the forest, grave of an important ancestor. They sacrifice a black steer with a white head, and share it together with rice cooked in milk.

[8] Estimate based on survey in study site, where 500 kg are collected from 125 ha of forest daily; or about 4 kg/ha/day. Middlemen estimate that Ambohimanjaka *Commune Rurale*, which includes at least half of the Col des Tapia woodlands, exports four tons of fruit daily over a period of 2.5 months.

varieties of edible mushrooms are found in the woodlands, symbiotically associated with tree roots. All families collect mushrooms; one-tenth sell mushrooms locally and to regional markets. Third, as noted in Tables 1 and 2, many woodland species have medicinal value. These plants are largely used locally; three-quarters of households report using medicinal plants. Fourth, two insectivorous mammals of the tenrec family, *sora* and *trandraka* are hunted and savored for their meat. Fifth, woodland insects, such as *saroa* caterpillars and *landibe* chrysalises, are collected, consumed, and sometimes sold, they form an important part of hungry-season protein intake (Gade 1985). Finally, the berries of several trees and bushes are edible and provide snacks. Especially during the hungry period before the rice harvest, the tapia forest serves as an invaluable source of dietary supplements (Ramamonjisoa 1995).

Tapia woodlands provide significant income and subsistence to certain sectors of adjoining communities at a critical period of the year. A survey in Ambohimanjaka *Commune Rurale* (Randriamboavonjy 2000) showed that woodlands supply an average of 6.5 percent of the cash income of Col des Tapia households. However, dependence upon woodlands for cash income varies from zero to 40 percent. According to Randriamboavonjy (2000), five percent of families earn more than 25 % of their income from the woodland, while 66 % earn 0 to 5 % from the woodland. Families with a high percentage of woodland income tend to be those with the most available labor, e.g. children, or those with the least land and overall income. In my own field site, the household fruit harvest and household involvement in silk collection and production were also significantly correlated with family size (prob. t = 0.001), but not with land ownership and wealth. In a similar analysis of woodland dependent households in the Imamo tapia zone, Razafintsalama and Gautschi (1999) determined that poor households are most dependent on the woodlands for resources and monetary income. Poor families relied on woodlands for over 500,000 MGF/yr worth of products, while rich families used only 100,000 to 165,000 MGF/yr.

DOCUMENTING STABILITY

Most previous authors assert that tapia woodlands -- like all other forests in Madagascar -- are declining, albeit slowly due to their fire tolerance and economic importance. Girod-Genet (1898) calls the tapia woodlands a sign of previously grander forests. Perrier (1921) says the woodlands are disappearing in the face of the prairie; a 1935 Ambositra forest service report assumes that vast parts of the denuded landscape once hosted tapia forests (AOM mad ggm 2d19bis). Grangeon (1910), Humbert (1947), Vignal (1963), and Ramamonjisoa (1995) all cite a general decline in tapia woodlands. Koechlin et al. (1974) state that the tapia forests are degraded and disjointed remnants of previously bigger forests. Gade (1985, 1996) sees tapia woodlands as a stage in the long process of change from forests to grasslands, a tenuous plant-silk-people symbiosis at risk of destabilization. Finally, recent reports on the tapia woodlands invariably begin with a statement about their decline (Rakotoarivelo 1993; Rambeloarisoa 1999; Randriamboavonjy 2000). However, evidence from the Col des Tapia area suggests that woodland extent and composition has seen little change this century; declines in one area are complemented by advances in another.

[INSERT FIGURE 6 APPROXIMATELY HERE]

The oldest evidence comes from archival documents. Descriptions of the region by Norwegian missionaries do not indicate any radical difference with today.[9] A map produced by missionary J. Smith in 1888 of the Manandona-Ilaka region (Fig. 6) shows, in a generalized form, the location of tapia woodlands. The two forest clusters on his map, when compared with Fig. 2, tentatively suggest that the principle woodland zones have not changed in overall extent. In 1898, colonial Forest Service chief Girod-Genet toured the region. Except for the current proliferation of pine afforestations, his description of forest extent and quality could very well have been written today:

> "From Antsirabe to [Manandona] there are almost no trees or shrubs, except near villages. At [Manandona] there is evidence of former forests, due to the presence of numerous trees... That is where the tapia zone begins. At 2 hours march from the village, going south, one sees numerous trees of this species, at first isolated, then in small bosques, and then in stands that vary between 15 and 150 ha. The Manandona valley, and that of its affluent, the Sahatsiho, are forested almost purely by tapia; the tapia woods, seen from far, remind one of olive plantations in Provence. The woodlands only include tapia trees; there are no other species mixed in.... All the heights near Ambohimanjaka are covered with this precious species. It goes without saying that in several spots, tapia woods are very open.... Beginning at the [Col des Tapia], a two hour walk from Ambohimanjaka, tapia stands become rare, trees become isolated..." (1898, 2349-50, my translation).

Finally, the 1934 cadastral maps for the field site show the extent of the woodlands at the time of mapping, for the woodlands are zoned as state domain. Comparison with today shows that general forest boundaries are mostly stable, with only slight losses where a few houses and crop fields have been placed inside the forest area.

More recent evidence is based on photographs. Borie (1989) compared aerial photographs from 1965 to 1986 for the northern part of the Manandona Valley, finding that the tapia woodlands were spatially stable. My own analysis of the smaller-scale aerial photographs from 1949 and 1991 of the entire Col des Tapia region documents overall stability. Of 28 woodland zones where comparison was possible, 20 showed no change, three showed woodland loss, and five showed more or thicker woodlands (Table 3). Finally, through archives and informants I found five historical landscape photographs of the region dated 1956 through 1972. When compared with today, one photo demonstrates stability, three show *increases* in woodland density or extent (Fig. 7 and 8), while one shows both areas of growth and thinning.

[INSERT TABLE 3, FIGURE 7, AND FIGURE 8 APPROXIMATELY HERE]

Sylvicultural analyses of tapia woodlands at the Col des Tapia indicate a heavily exploited forest that nonetheless succeeds in maintaining itself (Randriamboavonjy 2000). An analysis of tree frequency by diameter class shows a negative exponential curve, sign of a heavily exploited forest. The height/diameter ratio of the woodlands varies between 25 and 39,

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[9] F. Bekker wrote in 1876 (my translation): "Right after Ambohimanjaka the path is very hilly again, but extremely interesting; because the path goes through a pretty forested area of tapia trees. These trees have short trunks and large crowns; they are similar to fruit trees in Norway. In addition to the trees there is a pretty undergrowth and murmuring brooks. One climbs up until Ilaka, then the path descends steeply" (NMS Boks 134/1).

which represents a "stable" forest.[10] The high density of young trees, including representatives of all mature species, shows that stand replacement is assured. The existence of even-aged stands in the field site and elsewhere (Gade 1985; Rakotoarivelo 1993) suggests that regeneration may be episodic or occur in pulses, and thus may be difficult to capture in short-term studies.

Evidence for tapia woodland change is inconclusive outside the Col des Tapia region. In Imamo, two important cases of deforestation have been noted (Paulian 1953; Rakotoarivelo pers. comm.), yet overall dynamics during the past century remain undocumented. The Itremo woodlands were mapped by missionary J. Smith in 1888 (NMS Kart Madag.) and by the French around 1898 (ANM D435). These maps document a patchy woodland that appears roughly similar in extent to today's Itremo woodlands, based on current maps and field reconnaissance, yet a detailed comparison remains to be done. Thus, while authors complain of declining tapia woodlands, evidence is lacking. Hopefully, additional archival research, air photo interpretation, ecological field work, and paleoecological pollen studies will further document tapia woodland dynamics.

SHAPING THE WOODLANDS

We have seen that the tapia woodlands have been more or less stable for the past century, and how important the woodland economy is to nearby communities. In this section, I demonstrate that these woodlands are fundamentally shaped and maintained by nearby communities through burning, cutting, and protection.

Burning

The first way in which humans shape the woodlands is by controlling the fire regime. Pre-human highland ecosystems burned occasionally due to lightning; the longer time between fires probably led to significant fuel build-up and hot fires. Since settlement, the woodlands burn much more frequently; in the most oft-burned forests, fires are restricted to the herbaceous understory. In the field site, between March and December 1998, seven burning events occurred in the tapia woodlands; 37 percent of monitored woodlands burned. The area of woodland burned that year was high, due to repeated locust invasions (Kull 2000b).

The characteristics of tapia trees suggest that some burning regimes favor the maintenance of *U. bojeri*-dominated open woodlands. Tapia's thick, fissured bark, its fire retardent leaves, and its ability to vigorously resprout from roots, stumps, and branches[11] make it a classic example of a pyrophytic species (Kuhnholtz-Lordat 1938). A study of fire mortality in the study site demonstrated that 65 percent of burned seedlings resprouted in the following rainy season.[12] Other experiments demonstrated that both germination and growth in tapia are

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[10]A ratio over 100 indicates a rapidly growing, immature forest of tall, thin trees (Oldeman 1975 *in* Randriamboavonjy 2000).

[11]Randriamboavonjy (2000) demonstrated that tapia regeneration in the Ambohimanjaka region consisted of 61 percent resprouts, 24 percent rhizomes, and 15 percent seed establishment.

[12]In July 1998, ten 1 by 5 m plots were established and all seedlings noted. Three plots burned in August 1998; plots were re-censused in December 1998, April 1999, and July 1999. Mortality in unburned plots was 3%. In the similar miombo woodlands, the majority of seedlings experience annual shoot die-backs caused by water stress or fire, yet the root often survives and produces a new shoot (Campbell 1996).

favored by direct sun exposure (Koechlin et al. 1974), an environmental condition created by fire disturbance. In fact, Koechlin et al. (1974) note that the oft-burned, more open-canopy Isalo tapia woodlands have more abundant tapia seedlings than the less-burned forests southwest of Ambositra. Similarly, Rakotoarivelo (1993) shows from a comparative study in Imamo that tapia seedlings are much less frequent in a shadier, less-burned forest than in a frequently-burned open canopy forest. Randriamboavonjy (2000) argues that tapia seedlings are shade tolerant, but need light to develop to adult dimensions.

These characteristics suggest that tapia gains its competitive advantage from fire, and flourishes in an anthropogenically-determined fire disturbance regime. Unfortunately, little ecological research has been performed on tapia woodlands, let alone on tapia fire ecology. It remains to be determined how tapia woodlands react to different frequencies, intensities, and seasons of fire.[13]

Fire also plays an important role in silk and firewood production. Burning may increase silk production by controlling populations of a parasitic ant, stimulating resprouts of grass and tapia leaves favored by *landibe*, and by keeping the woodlands open for supposedly heliophilic *landibe*. Colonial foresters noted these practices with disapproval (ANM D100s; AOM mad ggm 2d19bis6; Grangeon 1906, 1910; Paulian 1953), yet some Forest Service offices issued burn authorizations within the woodlands through about 1980. While explanations vary, it appears the practice involved light understory fires during or after the rainy season (January to May). Burning also plays a role in the production of firewood, by creating dead and downed wood one is allowed to collect. "*Miteraka kitay ny afo*" explained one informant: fire gives birth to fuelwood.

Cutting

The Malagasy also significantly shape the woodland by their cutting practices which favor tapia dominance and growth. First, people gathering woodfuel are more aggressive in cutting non-tapia species, like *fotona* and *voandrozana*. While the Forest Service prohibits the cutting of all live species tapia has the strongest prohibitions -- socially enforced -- due to the value of its associated products. Second, long-established and generally respected practices of woodfuel collection which emphasize dead, downed, and sick branches may have a pruning effect, removing inefficient lower branches, reducing the danger of crown fires, and perhaps increasing fruit and branch production.[14]

This is far from saying that cutting is always beneficial; indiscriminate cutting has led to forest loss. In the 1970s and 1980s, damage was done to Col des Tapia woodlands as people cut and burned entire tapia trees to make ashes used for soap and tobacco production. In 1998, a local man was charged with cutting 104 tapia trees for charcoal production. In the Imamo region, certain stands have been devastated for charcoal production. Such clear-cutting may have lasting consequences, since tapia woodland regeneration, like miombo woodlands

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[13]In Zimbabwe's miombo woodlands, long-term experiments showed that a rhythm of late dry season burning every one to two years produced grass-dominated plots, while plots burned in the late dry season every four years supported a near closed-canopy woodland. Other studies argue that early dry season fires are least harmful to woodland trees (Campbell 1996).

[14]Rambeloarisoa (1999) suggests pruning lower branches as a sylvicultural treatment for tapia woodlands. In Spanish oak forests, pruning is used to increase acorn production; southern Africa's miombo woodlands are managed for various goods by local people through selective pruning and cutting, among other techniques (Campbell 1996).

(Campbell 1996), occurs primarily through coppice regrowth and root suckers, and since tapia seeds have relatively low dispersability and no extended dormancy.

Excessive cutting of firewood can degrade woodlands. However, a calculation of firewood use in the study site suggests tentatively that it is sustainable.[15] If local protection of the woodlands is sufficiently effective (see following section), it is possible that woodfuel collection will remain sustainable despite population increases, as people resort to alternatives such as pine and eucalyptus (59 percent of study site households already grow pine or eucalyptus, if only a few trees) and aged fruit trees. Expanded urban woodfuel and charcoal markets are unlikely to affect the tapia woodlands, as long as the woodlands remain protected (see below) and as fuelwood demand has already been shown to cause massive private investment in fast-growing pine and eucalyptus woodlots.

Protection

Finally, tapia woodlands benefit from protection by both local traditions and government rules. Ancestral traditions spoke for the need to protect the woodlands, and *dina* or local agreements existed against tree cutting in some areas, such as Manandona (Borie 1989). In the field site, no formal *dina* exists, yet it is commonly understood that live trees should not be cut. One informant told of her uncle chopping an entire tree at night to access hundreds of cocoons at its summit; he was caught and made to plant trees by the local leaders. Writing about the Imamo region, Rakotoarivelo (1993) notes several poems, stories, and proverbs regarding the value of the tapia forest. Some sections of tapia are protected as sacred groves to commemorate deceased nobles, e.g. in Imamo (Razafintsalama and Gautschi 1999) or near Manandona. Girod-Genet (1898), Perrier (1921), Humbert (1947) and Koechlin et al. (1974) note how tapia is a tree appreciated and thus conserved by the Malagasy due to the services it provides in feeding the silkworm.

On top of these local rules, the Forest Service, in successive decrees, has placed strict restrictions on forest cutting and burning while allowing for traditional use rights. Decrees in 1900, 1913, 1930, and 1987 made it illegal to cut trees on state forest lands, which included tapia woodlands, without authorization. Fires were banned in and near all forests in 1900, 1907, 1913, 1930, 1937, and 1960. Local use rights to forest products were affirmed by legislation in 1900, 1913, 1930, and 1987. Enforcement during the colonial period was stricter than it is now; today only those laws that reinforce local agreements and traditions are enforced, others are ignored. However, drastic violations result in both local and Forest Service action. The man mentioned above who cut 104 trees was brought to Forest Service authorities and prosecuted. As long as communities continue to be interested in the forests, they will protect the forests from destructive cutting.

Forest products are protected loosely through a kind of common-property regime. An "ethic of access" (Peluso 1996) governs the use of each resource. Non-residents are allowed to collect occasional forest products for personal use, but commercial exploitation is not tolerated.

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[15]Fuelwood use averages 7-13 kg per person weekly. For the study site population of 581, this amounts to 200-400 t/yr. Assuming that *all* fuelwood is collected from the 125 ha of tapia woodlands in the study site results in a fuelwood pressure of 1.6 to 3.2 t/ha/yr. However, one-tenth of households use only pine or charcoal, and most others supplement tapia fuelwood with pine, eucalyptus, and aged fruit trees. Assuming that this represents a 20% reduction, we are left with 1.3 to 2.6 t/ha/yr. Growth rate estimates are unavailable for tapia woodlands, yet for the wet miombo woodlands of Zambia, growing in the same climate, estimates for mean annual biomass growth range from 2.15 to 3.37 t/ha/yr (Campbell 1996).

Fruit collection is open to all locals, first come first serve. Cocoon collection is also free to residents. As noted earlier, the silk harvest was historically tightly regulated, but access is now uncontrolled among locals. Contrary to Gade (1985), families do not limit their collection to designated clumps of trees. It is forbidden to break off large branches to access cocoons, though twigs are commonly broken to avoid touching the cocoon's spines. Fuelwood collection for household use is limited to dead or downed wood both by custom and Forest Service regulation. It is not uncommon, however, to see live branches cut.

New legislation in 1996 opened the way to officially decentralize management of state-owned renewable natural resources to adjacent communities. In theory, this new approach would aid woodland protection, by increasing stakeholder involvement in resource management. However, policy implementation has been hampered by the lack of enabling legislation, high costs, and the complexities of local governance (Kull 2000b, in press; Razafintsalama and Gautschi 1999).

Probably the most important threat to tapia woodlands is neither cutting nor fire, but invasion by exotic trees. Spontaneous colonization occurs from private and village woodlots, consisting particularly of pine (*P. khasya* and *P. patula*) in the Col des Tapia region (see Table 1) and *Eucalyptus* spp. in the Imamo region. According to villagers and local foresters, pines and eucalypts may damage tapia woodlands by shading out the heliophilic woodland species and changing soil characteristics; additional research is urgent.

CONCLUSION

Gade (1985) argues that the tapia woodlands are the result of a people/plant/animal symbiosis, and thus that "nature" and "culture" are not independent categories. The present paper builds on Gade's ground-breaking reassessment of the tapia woodlands. However, several of his central tenets deserve reconsideration. For one, Gade's analysis, made explicit in Figure 6 of his 1996 paper on highland deforestation, is based on the idea that this anthropogenic woodland is an intermediate seral stage in a Clementsian successional gradient between a diverse, pre-settlement "natural" forest and degraded grasslands. New ecological theories, such as state-transition models (Huntsinger and Bartolome 1992; Westoby et al. 1989) suggest it may be more productive to view the tapia forest as one of several possible "states" -- discrete vegetation groupings that remain fairly stable for the duration of a similar management or disturbance regime. Second, I disagree with Gade's view of the tapia woodlands as a stable, homeostatic system (the "tapia-protein-silk association") that is threatened by a variety of outside factors. This characterization plays down the changes and conflicts that have always occurred, interventions such as colonial meddling in the silk harvest or regulation of fire regimes.

I have shown that humans have fundamentally shaped the tapia woodlands, in a sense "creating" the ecological formation through hundreds of years of use. This contradicts the widespread vision of Madagascar as a place of environmental disasters, and more specifically differs with estimations of the tapia woodlands as "degraded remnants." I am not arguing, however, that the woodlands are the result of careful planning by romanticized indigenous people. The evidence which I have presented throughout shows that the processes which led to the current situation, and which will continue to shape the woodland of the future, are necessarily complicated and bumpy, sometimes fortuitous, often politically and economically influenced. Indigenous knowledge is detailed in some respects, and muddled in others. Forest users may conflict in their goals, as in a silk-protection fire ruining a fruit harvest. Criminality is not unknown, as seen by illicit ash or charcoal cutting. The economy of forest products like silk and fruit -- as well as the agricultural economy -- varies and determines much forest use. Finally, outside involvement insofar as fire and cutting regulations and enforcement, or silk harvest regulation, are just as much a part of the story as local rules and enforcement. These influences and factors must be included and central to the story of these woodlands, and the concept of "anthropogenic nature" should be one that includes the multitude of processes characterized by human society and ecological relationships, much as disturbances have become an integral part of ecosystems (Scoones 1999).

The old understanding about the tapia woodlands was that they are a degraded remnant of diverse prehuman forests, reduced to the most fire-tolerant species which coincidentally had economic value to the locals. This paper, together with other research, proposes a new understanding. The prehuman highlands were a constantly changing temporal and spatial mosaic of grasslands, savanna, heathland, woodland, and riparian forests, shaped by a natural lightning fire regime, grazing megafauna, and climate fluctuations (Burney 1996, 1997; Dewar 1984). As humans arrived, their fires, set to clear land for pasture, agriculture, and hunting, removed most woody vegetation. The tapia woodlands were preserved due to their economic value and fire-ecological characteristics, shaped through the centuries by the humans who used them, and have been more or less stable this century.

Much of the difference in the old story versus the new story is one of perspective, whether the human influence in tapia woodlands should be told as a story of "degradation" or as a story of "transformation." Implied in the distinction is a question of values: is a landscape untouched by humans worth more than a human-shaped landscape? I believe it is important to argue for an alternative conception. Humans *have* been in Madagascar for about 1500 years, are there to stay, and cannot be denied the legitimacy of earning a livelihood from the land. The processes of "forest shaping" documented above should more appropriately be seen as a transformation, and not as degradation. The story of degradation as a frame of analysis denigrates its principle characters -- the hardworking Malagasy farmers. It is an unrealistically nostalgic frame of analysis on which to base forward-thinking policy in the highlands, where anthropogenic tapia woodlands, vast pastures, woodlots, and agriculture -- and not "natural forests" -- dominate the landscape.

The long-term management of the tapia woodlands depends upon the recognition of the human role in forest-shaping and of the dependence of neighboring communities on forest resources. The new policy of decentralized resource management can be a positive step in this direction, as long as it can gain local legitimacy, negotiate the politics of stratified local communities, and find a way around restrictive anti-fire laws (Kull in press; Razafintsalama and Gautschi 1999). The future of the tapia woodlands, whether stability or change, depends upon varied, unpredictable, and continually evolving processes such as politics (e.g. the new decentralization policy), economics (e.g. changing demand for *lambamena*), and ecology (e.g. invasive pines, or climate change). Any attempt to manage the tapia woodlands in this context must necessarily be adaptive and attuned to both the human and ecological dynamics that are inscribed in the shape of the woodlands.

NOTES

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Note: The following reference citations are used within the text:

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ANM = *Archives Nationales*, Antananarivo, Madagascar.
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JOM = *Journal Officiel de Madagascar*, followed by date.

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FIGURE CAPTIONS

Figure 1. Locations of *Tapia* Woodlands in Madagascar. Based on FTM 1:500,000 series maps; cartography by Simon Roger.

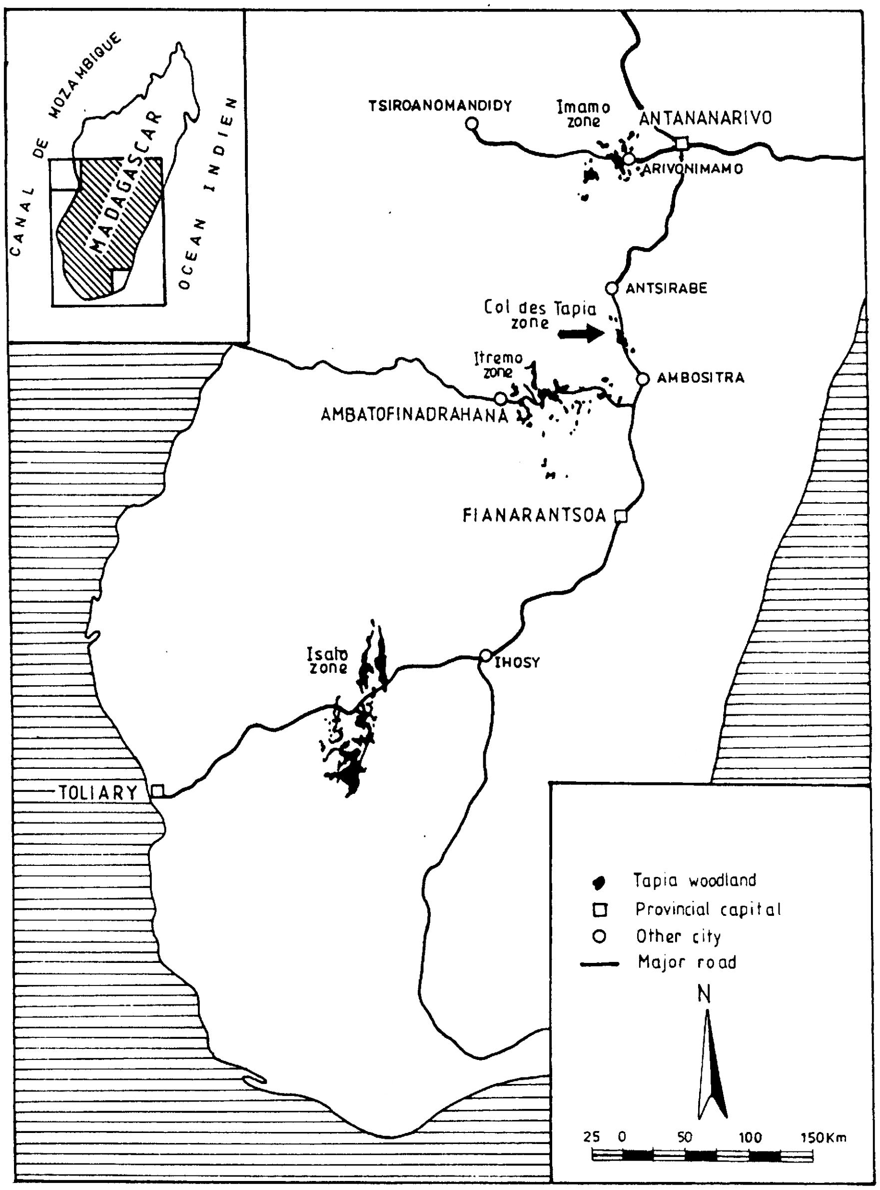


Figure 2. 1991 Woodland Cover in the Col des Tapia Zone. Based on 1991 air photos (source: FTM). Interpretation by author, cartography by Simon Roger.

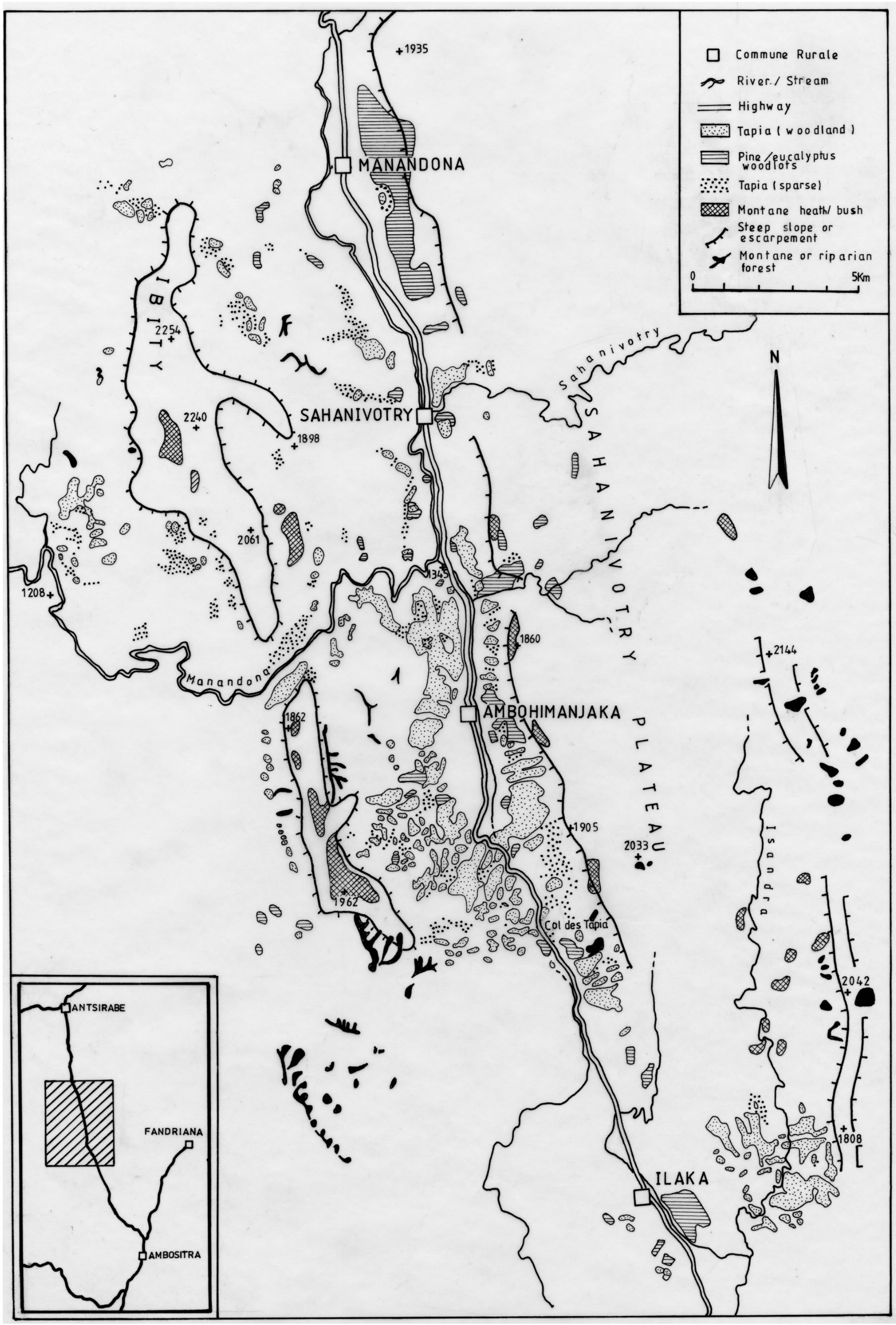


Figure 3. A Collector of Wild *Landibe* Silk Cocoons

Figure 4. Spinning Boiled *Landibe* Cocoons into Silk Threads.

Figure 5. Membership Card for the Silk Harvester Cooperative (1945).

Figure 6. Missionary J. Smith's 1888-9 Map of the Col des Tapia Zone. The two patches of tapia woodland indicated on this map (around Ambohimanjaka and Ambavatapia, and along the Isandrakely river) correspond roughly with the largest patches today (see Fig. 2). Source: NMS, Kart Madag.

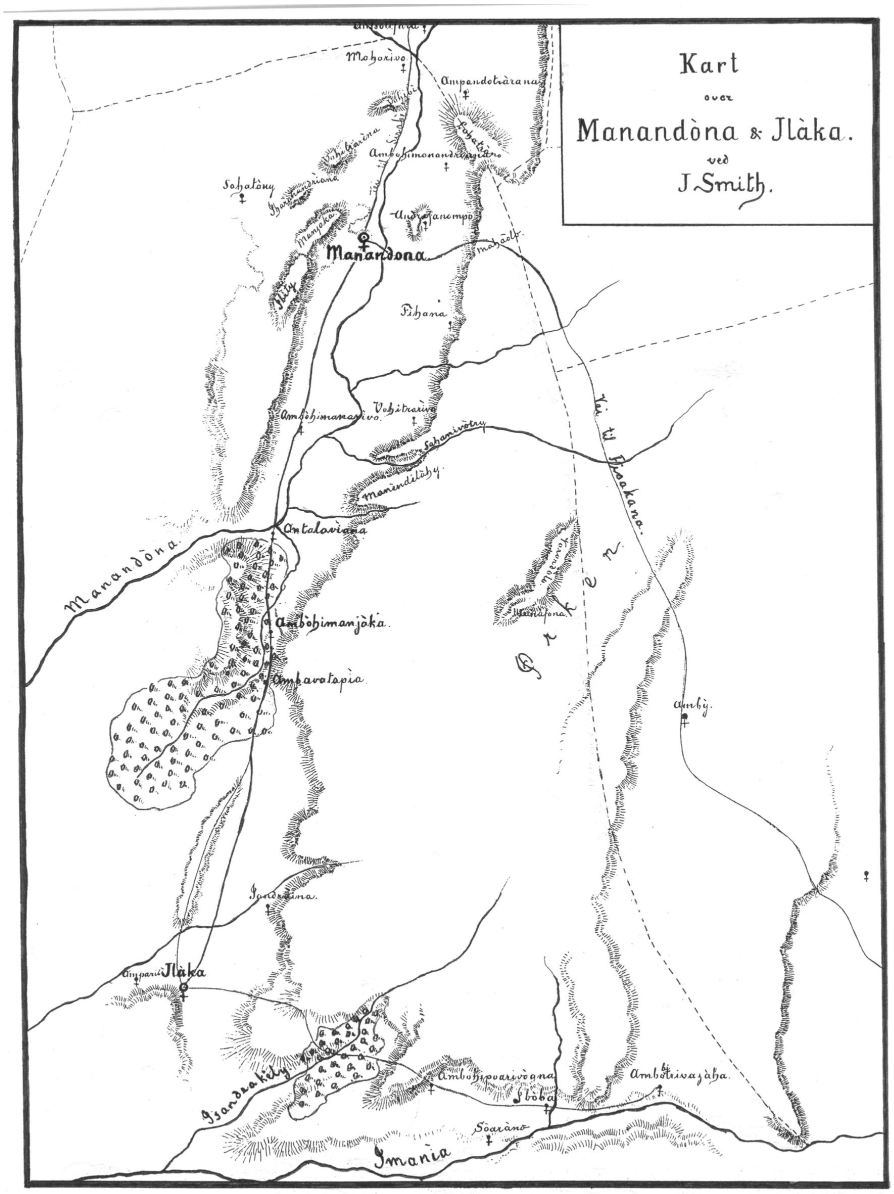
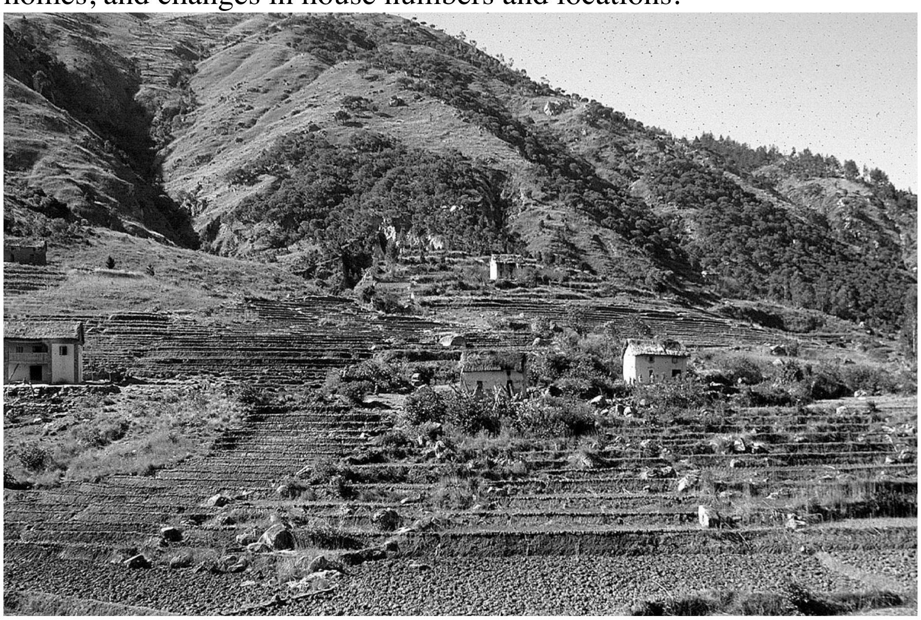


Figure 7. ***Tapia*** **Woodland Change: Ambatobe in 1970.** Photograph: P. Ottino. Source: NMS. Location: S 20°11.349', E 47°05.462'.

Figure 8. ***Tapia*** **Woodland Change: Ambatobe in 1998.** Note the thickening of tapia woodlands, partial stabilization of erosion gullies, afforestation in pine, growth in fruit trees near homes, and changes in house numbers and locations.



TABLES

Table 1. Tree Species Encountered in Col des Tapia Woodlands. "Dominance" represents percentage of trees encountered in a dozen 500 m^2 survey plots with dbh > 5cm. Data from author's fieldwork, local residents, Rakotoarivelo (1988) and Randriamboavonjy (2000); scientific names from above as well as Ratsimamanga (1968).

Genus, species, family	**Local name**	**Dominance**	**Uses**
Uapaca bojeri (Euphorbiaceae)	tapia	88.3	edible fruit, woodfuel, silkworm fodder, medicine (stomach, heart)
Sarcolaena eriophora (Sarcolaenaceae)	voandrozana	4.9	woodfuel, charcoal, small edible fruit
Pinus patula/khasya (Pinaceae)	kesika	3.7	construction, woodfuel
Leptolaena spp. (Sarcolaenaceae)	fotona	1.4	woodfuel, charcoal, small edible fruit
Trema spp. (Ulmacae)	andrarezina (tsivakimbaratra)	0.34	commercialized ashes
Xerochlamys bojeriana (Sarcolaenaceae)	hatsikana (katsikana)	0.34	woodfuel, roots used to flavor rum, tannins, medicine (sick pigs)
Popowia boivinii (Annonaceae)	fotsiavadika	0.2	medicine (stomach)
unidentified	ndretsimora (andriatsimora)	0.2	antivenom for scorpions, medicine (diarrhea)
unidentified	fanazana	0.2	tea, medicine (stomach, paranoia)
Agauria salicifolia (Ericaceae)	angavodiana	0.18	medicine (cuts/bleeding)
Cussonia bojeri (Araliaceae)	tsingila	0.15	medicine (stomach, last resort, cuts/bleeding)
Vaccinium emirnense (Ericaceae)	voaramontsina	0.15	woodfuel, fruit edible and tasty
Aphloia theaeformis (Flacourtiaceae)	voafotsy	-	popular tea
Rhus taratana (Anacardiaceae)	taratana	-	medicine (stomach, last resort)
Tambourissa spp. (Monimiaceae)	ambora	-	medicine (teeth)

Table 2. Understory Species Encountered in Study Site Woodlands. Data from author's fieldwork, local residents, Rakotoarivelo (1998), and Randriamboavonjy (2000); scientific names from above as well as Ratsimamanga (1968).

Genus, species, family	**Local name**	**Uses**
Aloe spp. (Liliaceae)	vahona	medicine (stomach, cuts/bleeding)
?*Asteropeia multiflora* (Theaceae)	fandambana	woodfuel
Brachylaena ramiflora (Asteraceae)	hazotokana	medicine (broad usage)
Carissa edulis (Apocynaceae)	voahangitanety	-
Cassia mimosoides (Caesalpiniaceae)	kelimanendilanita	medicine; ceremonial (ward off hail)
Caucalis melanantha (Apiaceae)	kisetroka	medicine (headaches, cold, blurred vision)
Dombeya greveana (Sterculiaceae)	ambiaty/ombiaty	burn to make commercial ashes
?*Dracaena reflexa* (Liliaceae)	ravoanjo/ranjo/ raivoanjo	for toilet training dogs (by rubbing leaves on the ground to deter dog from using that location)
?*Embelia* spp. (Myrsinaceae)	tateradela	medicine (for children, for cuts)
Erica spp (Ericaceae)	anjavidy	woodfuel, medicine (cough)
Helichrysum rusillonii (Asteraceae)	ahibalala	medicine (stomach, cough, fever, last resort)
?*Helichrysum* spp. (Asteraceae)	tsetsatsetsa	-
Maesa lanceolata (Myrsinaceae)	rafy	small sweet edible fruit, medicine (teeth, chest pain)
Plectronia spp. (Rubiaceae)	fatsikahidambo	medicine (paranoia)
Psiadia altissima (Asteraceae)	dingadingana	-
Psorospermum spp (Clusiaceae)	tambitsy	medicine (general)
Pterocaulon decurrens (Asteraceae)	ariandro	-
Radamaea montana (Scrophulariaceae)	tambarasaha	woodfuel, cosmetic
Rubus apetalus (Rosaceae)	rohifotsy	medicine (antivenom, heart, cuts)
Senecio faugasiodes (Asteraceae)	hanidraisoa,koboi-boy	medicine (cracks in feet, *fery*)
Solanum spp (Solanaceae)	sevalahy	-
Tetradenia fructicosa (Labiaceae)	bororohana	medicine (paranoia)
Vernonia glutinosa (Asteraceae)	ramanjoko	medicine (fever)
Vernonia spp. (Asteraceae)	kijejalahy	medicine (STD, fever, stomach, gen.)
(vine)	vahy famonololo	used to tie things, medicine (paranoia)
unidentified	arivoniraviny	wood for craft-making
unidentified	fano	-
unidentified	hazomiarotena	-
unidentified	(keli)boloana	medicine (fever, last resort)
unidentified	kiripika	-
unidentified	reniomby	medicine (for cattle illness)
unidentified	voamasonomby	medicine (constipation)
unidentified	voatainosy	woodfuel, tiny edible fruit, flavors rum
unidentified	voatsitakazaza	tiny edible fruit

Table 3. *Tapia* Woodland Change, 1949 to 1991, Col des Tapia Region. Changes in tapia woodland extent in the Col des Tapia region, based on air photos from 1949 and 1991 (source: FTM). Air photo interpretation performed by author. Place names from FTM topographic maps (N-50 and O-50) and field work.

Woodland sector	Observed change, 1949 to 1991
Tombonboanjo	same if not bigger
South of Kiboy	difficult interpretation
Fierenantsoa	same
Ambohiponana	same? (difficult interpretation)
Vohibongo	same
Vohitrafenana	much less
Fierenantsoa south	same
Ambero	slight increase
Andriamilarivo (north of gorge)	same
Maromanana	same
Fiakarandava	same
Farasotrina (south of gorge)	same
Sahatamiana (Ambolo south)	same (difficult interpretation)
Manandona	difficult interp. due to expansion of pines; Borie (1989) documents stability
Fierenantsoa-Mahaiza	less
Sahanivotry Itsoka	same if not thicker
Sahanivotry Itsoka (south of river)	same
Sahamalola	same
Faravondrona (Imaova)	same
Faravondrona (Vohitravoho)	same
Ambohitrambony	same
Marovato	same? (difficult interpretation)
Ambohinaorina	difficult interpretation
Ambohimanjaka west, north	less - thinner, cut by agric fields
Ambohipo	little change; pine invasion
Ankeniheny Ampieka	similar (difficult interpretation)
Ambatobe	difficult interpretation
Ampasambazimba-Tsinjoarivo	same
Ankaranosy-Vatonrdaisoa	similar; if not more dense
south of Somadex Rd., west of col	same
Fandrianzato	same
Isandra	same, if not thicker