Local livelihoods in the context of deforestation and forest degradation: A study of three regions in Madagascar

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Abstract: The high value of Madagascar's flora and fauna that can be found in the remnants of primary and secondary forests requires sustainable forest management practices to reconcile the needs of the local population and the demands for biodiversity and ecosystem conservation. This study analyses different local contexts of deforestation and forest degradation in three regions in Madagascar representing different types of forests and livelihood strategies. It shows that a better understanding of local contexts and peculiarities is essential in order to appropriately address direct and underlying causes of deforestation and forest degradation and to incentivise sustainable forest management.

Keywords: Madagascar, deforestation, forest degradation, local livelihoods, dependency on deforestation

20.1 Introduction

Madagascar faces severe development challenges in the context of a decline in natural resources productivity and recurrent political and economic crisis. With 69% of the population living below the poverty line, it is one of the poorest countries in the world. Of the total population of 21.3 million, growing by 2.8% annually (UNFPA 2011), 61% lives in rural areas, with about 82% of the country's labour force engaged in agriculture (INSTAT 2006). Thus, livelihoods in Madagascar are highly dependent on the use of natural resources. Household energy consumption is mainly covered by firewood collected from forests (primarily in rural areas) and by charcoal (primarily in urban areas). In addition, forests provide a source of timber for satisfying basic needs such as the construction of houses and tools.

Madagascar has implemented conservation policies since the beginning of the 20th century. Nevertheless, environmental degradation continues even after the ambitious National Environmental Action Plan (NEAP) was launched at the beginning of the 1990s (Bertrand et al. 2009). The country is still considered one of the hottest biodiversity "hotspots" (Myers et al. 2000); its yearly deforestation rate was 0.45% between 2005 and 2010 (FAO 2010), a decrease from the estimated rate of 0.9% between1990 and 2000 (Harper et al. 2007). However, rates vary considerably, between 0.05% and 6% at the regional scale (period of 2000–2005, MEFT and USAID 2009). One of the major reasons cited for deforestation in Madagascar is slash-and-burn agriculture, called *tavy* in the Malagasy language, which is used by many farmers. Tavy is defined as an area of vegetation cleared and burned for cultivation (Vicariot 1970). The word *tavy* refers to the slash-and-burn practice itself as well as the area where the practice is applied. It may be practiced in both primary and secondary forest. Tavy constitutes a way to access land. Fallows also provide firewood, construction wood, medicinal plants, and fodder. According to Styger et al. (2007), the length of the fallow period, for instance, on the east coast of Madagascar, has declined from a period of 8–15 years to 3–5 years over the past 30 years. After these 3 to 5 years, the fertility of the soils on which tavy is practiced decreases due to increasing growth of weeds. Hence, farmers may decide to clear

another forest plot. The shortening of fallow periods may impact soil productivity and therefore its yield (Guillemin 1956).

As stated, tavy is described as one of the major drivers of deforestation. However, there is an ongoing discourse about the prevalent causes of deforestation in Madagascar. Bertrand et al. (2009) and Pollini (2010) explain that several narratives about deforestation in Madagascar describe rural people as an instrument of the environmental degradation. These narratives that overstate the role of the communities have been answered with a "reverse exaggeration." For the highlands of Madagascar, Pollini (2010) distinguishes three types of narratives: 1) the colonial narrative with "the myth of the green paradise" as an argument for keeping control over the communities; 2) the "modern" narrative, which emphasises both the role of non-human-induced fires and settlement in the expansion of grassland based on paleobotanical, archaeological, and paleontological studies; and 3) the political ecology narrative, which sees "ecosystems as changing rather than degrading" and "policies […] rather than traditional land uses" as drivers of degradation. Pollini concludes that each of these three narratives is tied to specific strategies for tackling social and environmental challenges and should all be taken into account.

In 1922, Chevalier, a French historian and geographer, argued that in all tropical forests the causes of forest clearing are the same and thus require the same solutions. He asserted that human activities, aggravated by colonisation, are similar throughout the tropics. Palo (1994) presented a more complex statement. He wrote that "a fundamental feature of excess deforestation is that the causal factors of deforestation are linked together like a set of chains or mechanisms into a causal system." Palo described a "system causality model of deforestation" that includes underlying factors (e.g. political, economic, technologic, climatic, and demographic) and direct factors (e.g. agriculture, logging, and grazing). Depending on the various links between the causal factors and their intensity, the deforestation is either accelerated or decelerated.

Other frameworks have also been developed that aim to design a more straightforward analytic approach towards addressing the complexity of the deforestation process and analysing the effects of individual drivers. These frameworks are similar in that they each distinguish direct (proximate, immediate) and indirect (underlying) causes. With the help of logistic regression, Mahapatra and Kant (2005) studied the dual effects of underlying causes directly on deforestation, i.e. either an increase or a decrease in deforestation.

Kaimowitz and Angelsen (1998) classified variables from a review of 140 models of deforestation into five categories: 1) the magnitude of deforestation (e.g. forest cover, biomass, and wood production), 2) the characteristics of the agents of deforestation (e.g. education, ethnic group, and initial capital), 3) the choice variables (e.g. land, labour, and capital allocation), 4) the agents' decision parameters (e.g. timber and agricultural prices), and 5) the macroeconomic variables and policy instruments (e.g. institutions, infrastructure, markets, and technology). They are classified as underlying causes, immediate causes, and sources of deforestation.

Geist and Lambin (2001) distinguish between proximate causes and underlying causes. Proximate causes refer to agricultural expansion, wood extraction, and infrastructure extension. The underlying causes are economic, policy/institutional, cultural, technological, and demographic. Further variables dealing with biophysical factors and "social trigger events" (such as wars and epidemics) are grouped as other factors.

Casse et al. (2004) mention the mutual independence of four identified direct causes (agriculture, timber, cattle, fuelwood) in southwestern Madagascar and add that these can be "sequential or complementary, rather than competing." Each direct cause is influenced by different indirect causes (e.g. migration, local market, and export prices). For Fisher et al. (2008), "attempts to understand causal linkages must be related to the contexts of specific situations." They add that to understand the underlying mechanisms, it is essential to take into account "multiple geographical scales and institutional levels."

The objective of this study is to characterise the drivers of deforestation and forest degradation in the local livelihood context. For this purpose, a multiple-scale approach is adopted. Characteristics of regional variables of deforestation are explored with secondary data. At the local scale, the characteristics of the deforestation and deforestation process are assessed through interviews with actors living in the hotspot areas. It is supposed that in each of the three areas, the local population's dependency on forests is different, and thus the role of deforestation and forest degradation in satisfying their basic needs also varies.

This study is based on data gathered in the REDD-FORECA project, a multi-institutional and multinational project to support the government of Madagascar in the development of a national REDD+ strategy (Baldauf et al. 2010, REDD-FORECA 2011).

REDD+ aims at the reduction of emissions from deforestation and forest degradation, conservation and sustainable management of forests, and the enhancement of forest carbon stocks. For an operational REDD+ methodology, a country needs to consider those forest areas that show ample changes in their size or carbon stock. It can be assumed that areas showing such changes are subject to at least one or more typical drivers of deforestation and for-

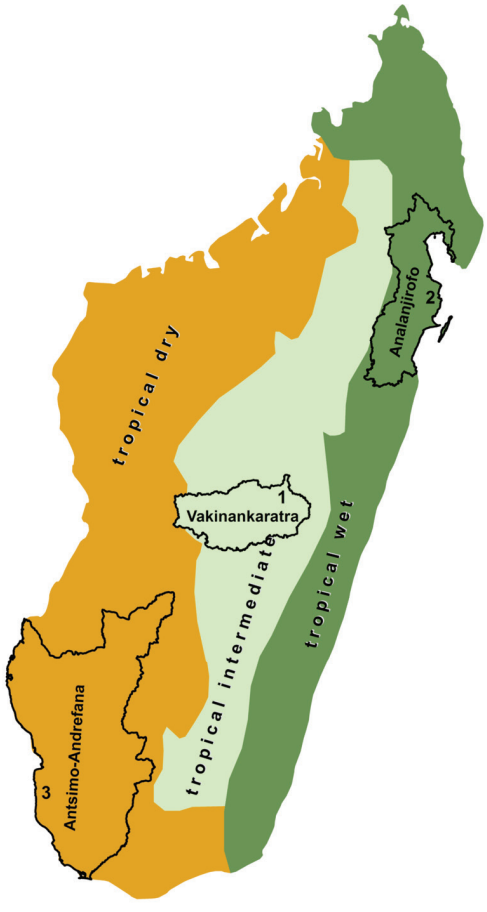

Figure II 20.1 The three study sites in Madagascar: 1 Tsinjoarivo, region of Vakinakaratra; 2 Manompana, region of Analanjirofo; 3 Tsimanampetsotsa, region of Atsimo-Andrefana.

est degradation (Bucki et al. 2012). In the scope of the REDD-FORECA project, three hotspots were identified – Tsinjoarivo, Manompana, and Tsimanampetsotsa – located in the regions of Vakinakaratra, Analanjirofo, and Atsimo-Andrefana (Figure II 20.1) and representing different forest formations (moist, deciduous, and dry) adapted from IPCC categories (IPCC 2003). An extensive overview of the applied methodology can be found in Plugge et al. (2010).

In the study areas, deforestation and forest degradation take place in regions that differ in their human (cultural and socio-economic characteristics) and environmental (type of forest) systems. Before presenting the method and the results of the study, an overview of political, economic, and institutional issues in Madagascar describes the broad context of deforestation and degradation in this country. Conclusions about the findings and their significance regarding the development of viable SFM close this chapter.

20.2 Policies, institutions, and governance in Madagascar

20.2.1 Commitment and crisis

The government of Madagascar signed the Convention on Biological Diversity (CBD) and implemented the convention through NEAP. A major step for the implementation of NEAP was the creation of the GELOSE process (see section 20.2.2) aimed at a decentralised community-based forest management. Through this, Madagascar promoted the sustainable use of formally state-owned forest resources by handing over forest-management rights to local communities. Furthermore, several projects have been launched in the country to develop a REDD+ strategy for Madagascar (Ferguson 2009). In 2010 Madagascar submitted its Readiness Preparation Proposal to the Forest Carbon Partnership Facility (FCPF) and implemented a technical committee for questions relating to implementing REDD+ activities in the country (FCPF 2010). However, since the coup in 2009, the country has struggled with the implementation of NEAP and the REDD+ policy reforms and is in urgent need of support from the scientific and development community to exchange information on approaches successfully implemented in other parts of the world. The recurrent political crises in Madagascar often hinder implementation of policies and measures for the conservation of the remaining ecosystems of the island by facilitating illegal activities and corruption and undermining long-term approaches.

In the 1990s, international financial support rose for NEAP. During the first phase of the plan (1991–1997), funds were allocated for the creation of protected areas and promotion of conservation. The second phase (1997–2003) was oriented towards the participation of the population in the management of natural resources in a context of political decentralisation (Bertrand et al. 2009). The third phase of NEAP started after the 2001–2002 political crises. To prove its commitment to nature conservation and sustainable development, the new government instituted an environmental policy in which tavy was severely punished (Pollini 2011).

Horning (2008) described a "veritable explosion" of foreign assistance in the 1990s. However, she adds that improvements remained insignificant for two reasons: first, foreign donors competed in influencing state policies for their own interests ("Aid has become a tool for legitimizing power at the domestic level."). Second, Madagascar abetted this competition in order to maintain a currency flow.

For Corson (2011), despite of millions of dollars for conservation, the creation of new protected areas in Madagascar has been conducted with inadequate

financial support for consultation processes with local communities. She argues that time pressures related to political agendas has led to a level of consultation that does not reach the villagers. In addition, the objectives of "consultation" and awareness were not differentiated in order to establish protected areas rapidly. She adds that park boundaries were based on biodiversity and not on local land uses and points out that conservation programs "reinforce nonlocal decision-making by creating a mechanism around which foreign conservationists, working with national government agencies, could influence Madagascar's forest policy." Pollini (2011), who analysed the failures of NEAP's conservation policies, presents similar conclusions. He explains that failures to link conservation and development are due to an international environmental agenda that does not meet the needs of the communities. He adds, "Priority was given to conservation, which led to the utilization of development activities as a Trojan horse for convincing farmers to accept conservation measures and adopt ill-designed agricultural techniques."

20.2.2 Community forest management

Since 1996 Madagascar has pursued the GELOSE legislation (GEstion LOcale SÉcurisée – Secure Local Management) to promote the sustainable use and conservation of natural resources. Theoretically, it implies that farmers are not bound by a centralised governmental land-use plan. Instead, they are granted a management right for some natural resources within a village territory (Bertrand et al. 2009) (Transfer of Management to local Communities). The local communities (French acronym COBAs) are legal entities formed by villagers. Management plans (e.g. for forests, water, or grassland) are developed with the support of several initiatives in which farmers, NGOs, and local decision-makers take part. A contract among governmental bodies, the commune (the smallest territorial division for administrative purposes), and the COBAs hands over the rights to use the resources according to the management plan. The COBAs themselves develop formal agreements for social enforcement of the contract terms (Antona et al. 2004). The use of forests is thus regulated by the COBAs according to their management plans, which are created for sustainable use of a forest resource and are counterchecked by governmental bodies, local authorities, and oftentimes by supporting NGOs. Officially, COBAs have to report all of their activities to local authorities. Nevertheless, there is no fixed scheme for continuous participatory forest monitoring.

COBAs exist in all three study sites and are supported by NGOs. In Manompana, the Koloala project of the Malagasy government and HELVETAS (Swiss Intercooperation Madagascar) aims at concerting the actions of several COBAs to apply community-based forest management, taking into account regional and ethnic circumstances. However, as an elder pointed out during the fieldwork in the south of Madagascar, the implementation of the GELOSE legislation may lead to conflicts between different stakeholders (Rqibate 2013). The community management contract does not allow people the individual use of plots located on their ancestral land, which is a common property. The state recognises the common property but restricts its use by co-owners.

20.2.3 Land and forest tenure

As described above, tenure rights play an important role in the management of natural resources. However, tenure is a highly complex issue in Madagascar. Legally, unregistered land in Madagascar is state-owned. However, due to traditional tenure rights of rural communities, there are parallel official (state) and local (community) tenure systems that oftentimes do not match and may complicate the implementation of conservation and poverty alleviation projects. To address land tenure issues, the government began to implement a National Land Tenure Program (PNF, French acronym for Programme National Foncier) in 2004. According to this program, land tenure security for the local population has to be assured by the "formalization of the non-written land tenure rights, the protection and regularization of the already written land tenure rights" (République de Madagascar 2005). Legislation provides the framework for the protection of land tenure for all land occupied via a traditional way: for example, family patrimony ("traditional meadow land of a family except for very wide meadows which will be legislated differently", PNF 2005), except land accessed through forest clearing. In the PNF, local communities have the responsibility for land-tenure mapping.

20.3 Method, data and results

20.3.1 Context of deforestation and forest degradation

Method

This first part of the study aimed to explore and highlight key variables that characterise the deforestation context in the project regions (Vakinakaratra, Analanjirofo and Atsimo-Andrefana) on the basis of a large existing data set.

Table II 20.1 Explanatory variables (INSTAT 2006, MEFT/USAID 2008) used for the factorial analysis; the deforestation rate in the time period 2000–2005 and percentage of forest cover are used as dependent variables (proxies of the magnitude of deforestation, Kaimowitz and Angelsen 1998) (Rqibate 2013).

Types of drivers of deforestation and forest degradation	Name of the proxy	Description of the proxy	PCA	MCA	DFA
Environmental	Forest type	Dry, deciduous, moist		Categorical variable Dry :1 Deciduous: 2 Moist: 3	
Social	Charcoal users	Percentage of population using charcoal as fuelwood	%	Ordinal variables Low: 1 Medium: 2 High: 3	%
	Collected wood users	Percentage of population using collected wood as fuelwood	%		%
	Urbanisation rate	Percentage of population living in urban area	%		%
	Education	Percentage of workers that have not attended school	%		%
Economic	Poverty	Percentage of the population considered to be poor	%		%
	Income	Mean annual income per household (Ariary)	Ar		Ar
Agricultural	Tavy	Percentage of commune practicing slash and burn	%		%
Demographic	Density	Density of population (persons/m²)	Pers./m²		Pers./m²
Institutional	Tenure	Percentage of families that accessed land through slash-and-burn farming	%		%

Direct and indirect variables classified as proxies of deforestation (Table II 20.1) by Kaimowitz and Angelsen (1998) and Geist and Lambin (2001) were used to perform a principal components analysis (PCA) at the regional scale. The PCA is a statistic tool that allows exploring and interpreting correlations within a large set of quantitative variables. Through the PCA, the set can be described with few factors, which are a linear combination of these variables. This tool allows a graphic representation of the variables that are projected in a map along two axes representing the factors that are interpreted a posteriori. The data set of each region contributes strongly or weakly to the construction of these factors. In addition, two further analyses, the multiple correspondence analysis (MCA) and discriminant factorial analysis (DFA) were performed for the exploration of qualitative data. As in PCA, MCA aims to analyse the relationships between variables and represent them graphically. The *x* and *y* axes are called dimensions. With the help of DFA, the characteristics of a specific attribute (here "forest type") can be highlighted.

Results of the regional analyses

The outputs of the PCA and MCA emphasise three factors and two dimensions. The variables of tavy and forest cover form a factor that can be interpreted as representing the direct causes of deforestation and forest degradation (see Figure II 20.2, Factor 3). The region of Analanjirofo is strongly represented by this factor (see Figure II 20.4). A high percentage of the communes in Analanjirofo are characterised by practicing tavy (79% versus 3% in Vakinankaratra and 36% in Atsimo Andrefana). The results of MCA give more information about the tavy and the context of its practice and highlight the difference in Vakinankaratra. Indeed, MCA (see Figure II 20.3) shows that the proxies discriminate the regions according to slash-and-burn practices (tavy, tenure) and forest attributes (forest cover, forest type). Analanjirofo has the highest forest cover (50% of the territory), which constitutes a means to access land for a quarter of the households (24% of households access land through slash-and-burn practices, compared with 6% in Vakinankaratra and 4% in Atsimo Andrefana). This result shows the opposing factors for Analanjirofo (high tavy, high forest cover) and Vakinankaratra (low tavy, low forest cover).

The variables of population density, deforestation rate, and education compose a factor that describes the underlying causes of deforestation and forest degradation (see Figure II 20.2, Factor 2). On the factorial map, Vakinankaratra contributes strongly to the construction of this factor (see Figure II 20.4). The population density in this region is indeed the third highest in the country (about 77 persons/m² against 38 and 37 persons/m² in Atsimo-Andrefana and Analanjirofo). The region is characterised by a high deforestation rate as well (4.1% versus 1% in Atsimo Andrefana and 0.1% in Analanjirofo during 2000–2005). DFA shows that the variables of forest cover and tavy are discriminant for forest type, which means that regarding these two variables, significant differences between the different forest types exist. In Vakinankaratra, only 0.6% of the region is covered by deciduous forest and few communes (4%) claim to practice tavy.

The data set of Atsimo-Andrefana contributes more weakly to the factor describing the underlying causes (see Figure II 20.4). The context of this region is characterised by a high percentage of workers without education (49.6% versus 17.8% in Vakinankaratra and 29% in Analanjirofo).

The variables of charcoal users and urbanisation rate, poverty, and collected wood users contribute to the formation of another factor (see Figure II 20.2, Factor 1). This factor opposes two types of fuelwood users depending on their economic background and location. The results of the MCA are similar (see Figure II 20.3). The group of variables charcoal users,

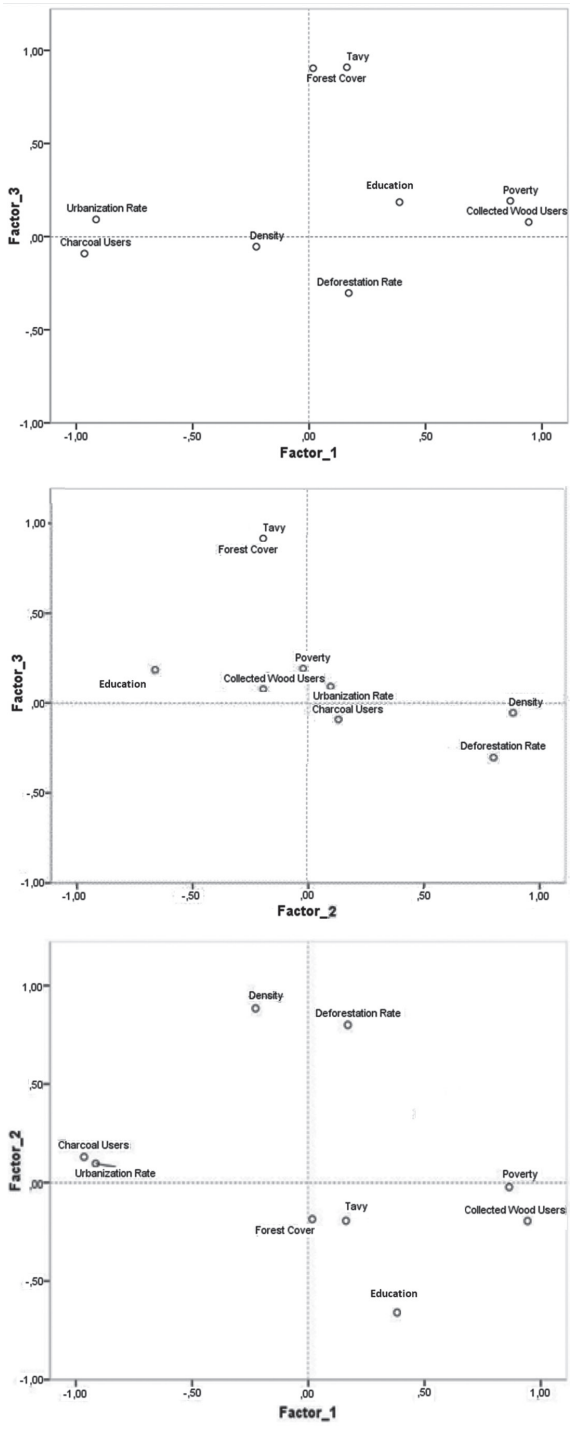

Figure II 20.2 Projection of the variables according to the factors 1, 2, and 3 (Rqibate 2013).

density, poverty, urbanisation, incomes, and collected wood users participate in the construction of a dimension. It represents the type of wood use according to economic (poverty, income) and demographic variables (urbanisation, density). Correlations between these variables show that poverty occurs more often in rural areas than in urban areas (poverty ratio and urbanisation rate have a strong negative correlation). Collected wood is used by rural households with low

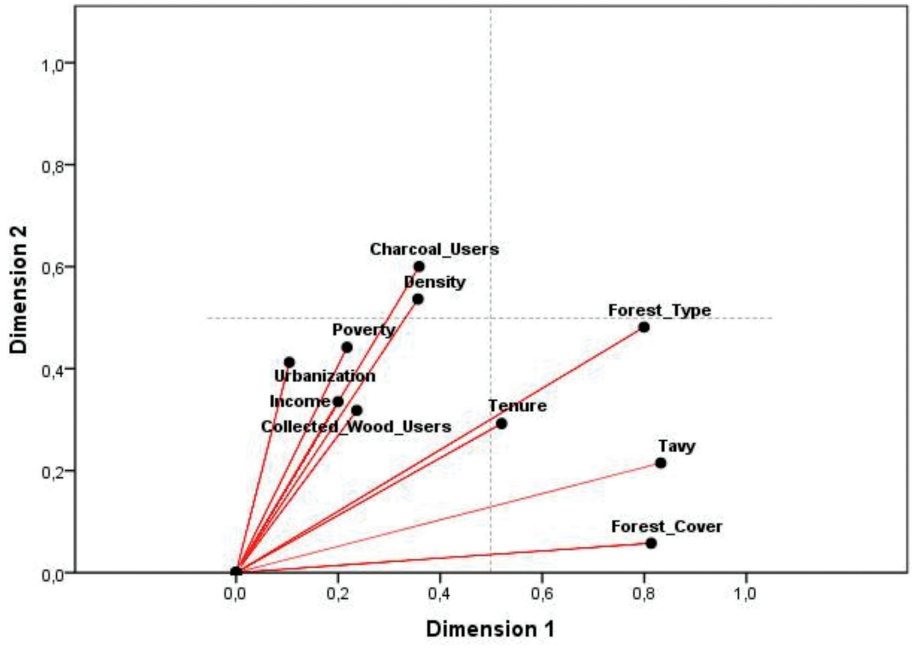

Figure II 20.3 MCA, projection of the variables in accordance with dimensions 1 and 2 (Rqibate 2013).

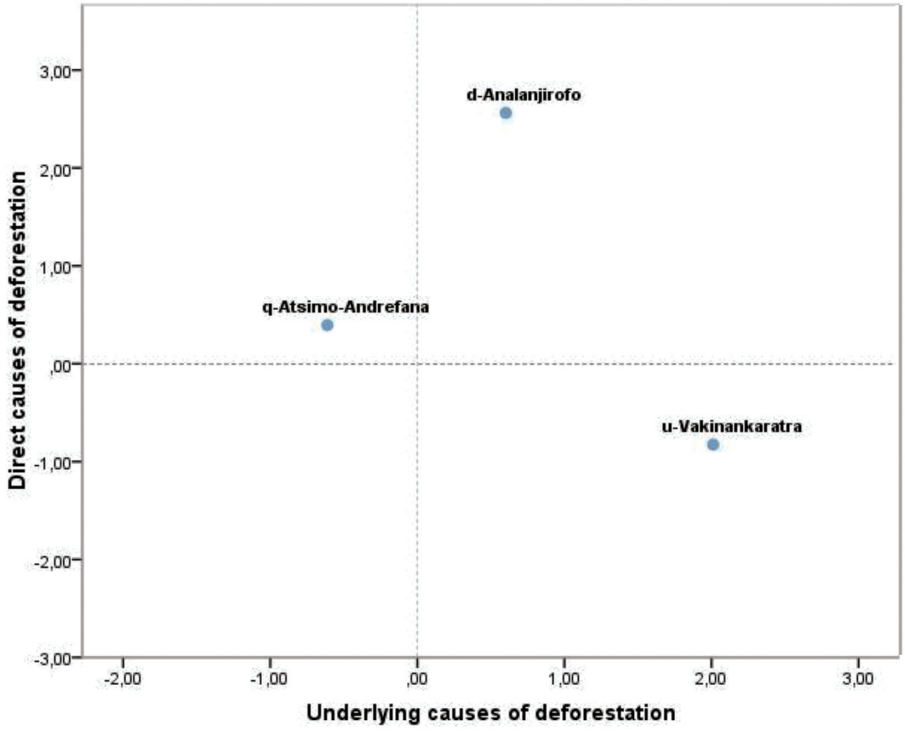

Figure II 20.4 Projection of Vakinankaratra, Analanjirofo, and Atsimo-Andrefana according to components 2 and 3 (letters *d*, *q*, *u* pertain to the rank of the region according to its deforestation rate) (Rqibate 2013).

incomes (collected wood and poverty ratio show a strong positive correlation).

Beyond the variables

Key variables (such as tavy, population, density, education) have emerged from the data set through the statistical analyses. These variables helped highlight main regional characteristics of deforestation and forest degradation and they have significance beyond their mere statistical relevance. Deforestation is an ancient issue in Vakinankaratra. At the beginning of the 20th century, plantations of *Pinus* and foremost *Eucalyptus* were already supplying fuelwood for numerous cities (including the capital) and the region itself. In the 1960s, programs for agricultural intensification took place in the highlands as response to demographic growth and the scarcity of agricultural areas, leading to further deforestation. The forests that remain in the region today are too remote to be utilised profitably (Rabetaliana et al. 2003). It seems then that at the regional scale the population has for a long time depended more on plantations than on natural forest resources.

According to the National Institute of Statistics Madagascar (INSTAT 2006), education level may have a significant impact on living conditions. It influences the decision to use firewood or charcoal and also has an effect on the level of consumption. Subsistence agriculture is practiced more by persons without education. It should be noted that in Atsimo-Andrefana and southwestern Madagascar in general, a major underlying cause of deforestation was the high demand for maize in the early 1980s. Maize export was facilitated and stimulated by measures (elimination of fixed prices for agricultural products, devaluation of currency) imposed by the International Monetary Fund in the face of an important national economic crisis (Scales 2011), and the production of maize changed from subsistence farming to cash-crop production.

In Analanjirofo, tavy is a tradition with religious elements, a manifestation of the ancestor cult – maybe the most important in the Betsimsaraka region (Vicariot 1970) – that continues to be upheld. The large moist-forest cover is a source of agricultural lands even though it is remote and hard to access in some areas. By practicing tavy, farmers have a guarantee to harvest rice although the yield can be insufficient. For Aubert et al. (2003), it is "a good compromise with regard to climatic hazards, labour availability, and food security." Family labour and fire are the major inputs into this agricultural system.

20.3.2 Traditional use of forests in hotspot areas

Method

At the scale of the project areas (Tsinjoarivo, Manompana, Tsimanampetsotsa), the context of deforestation and forest degradation was analysed with data collected through interviews. The viewpoints of local actors, relationships of farm households with the process of deforestation and degradation, and differences between the assessment areas were examined. The hotspots are located in rural areas where agriculture, either subsistence or market-oriented, is the most important source of livelihood. Features of traditional and economic structures of farm households were assessed using information from the interviews.

The farm households were selected on the basis of their distance to the contiguous forest in the study area. For selection of the villages and organisation of the field research, land-use maps were analysed with the help of key informants. Three categories were created according to the spatial organisation of the study area. The villages on the edge or inside the forest were classified in the forest-fringe category; Manompana and Tsimanampetsotsa villages on the coast were classified in the far-area category. In Tsinjoarivo, villages in the west were also classified in the far-area category. Villages between the forest fringe and the far area were classified in the intermediate-area category. Questionnaires for individuals (semi-structured) and group interviews were developed. The questionnaire addressed four topics:

1) characteristics of household and farm (age of the household's head, size of household, migration, land acquisition, area converted to agriculture, production, and quality of the production)
2) farm and off-farm economic data of the household (input and output of the farm for calculating farm income and off-farm income); farm incomes (tavy and non-tavy) disaggregated according to value of farm products (non-tavy); value of products cultivated on tavy plots; income from farm products (non-tavy) sold; income from farm products (tavy) sold; off-farm income
3) household's use of the forest (location of fuelwood collection and logging, wood species, forest activities)
4) informal discussion

Village meetings and discussions with authorities, key informants, and villagers (women, leaders, elders, merchants, cultivators, migrants) dealing with social, economic, environmental, and cultural aspects of the study area were also conducted.

Figure II 20.5 Woman preparing tavy rice in Manompana. ©Aziza Rqibate

Characteristics of the functions of deforestation and forest degradation and their links with the livelihoods of the population were assessed in the three project areas. We describe Manompana more in detail here as an example of the application of the method. The findings concerning the key differences between the hotspots are presented.

Results of the local analyses in Manompana

Ecological and human features

The Manompana study area "on the east coast of Madagascar (region of Analanjirofo) encompasses 46 095 ha, of which 75% remains forested (Plugge et al. 2010). The moist evergreen forest is characterised by high rainfall, a rich topography, and increasing fragmentation. It is part of the Koloala initiative of the government of Madagascar and HELVETAS, which promotes sustainable forest management (SFM). Accordingly, the forest here is classified as a sustainable production forest even though it has undergone some serious deforestation and degradation. The above-ground biomass is estimated to be 272.5 tons/ha (Plugge et al. 2010). The population (about 18 000 inhabitants) of Manompana belongs to the Betsimsaraka ethnic group. About 90% of them practice agriculture. They cultivate rice on hills and in valleys as well as cash crops (cloves, vanilla, and coffee) in mountainous areas. According to the Manompana Community Development Plan (PCD, French acronym) (2006), the principal causes of environmental degradation are the practice of tavy, bush fires, intensive logging, and lack of alternative livelihood options (Figure II 20.5). The acceleration of environmental degradation is stressed in a multitude of documents (e.g. PRD 2005): "At the rate we are heading now, in a few decades, there will be no more valuable primary forests in the region". For the area of Manompana, deforestation is higher than the regional rate. Eckert et al. (2011) estimate the total forest-cover loss between 1991 and 2009 to have been about 18% (1% per year). Analysis of satellite imagery (Baldauf et al. 2010) shows a loss of 1400 ha/year between 2004 and 2008.

The data for Manompana came from 49 interviews (16 in the category of far area, 13 in the intermediate area, and 20 at the forest fringe). In addition, three village meetings were held in which 15 additional actors (mayor, village chiefs, women, elders, cultivators) were interviewed. The mean number of persons who depend on the head of the household was six (± three individuals).

Use of wood for energy and construction

About 17 000 m³ of wood per year is consumed for domestic uses, of which about 12 000 m³ is fuelwood consumed by the population – no alternative source of energy supply is available. Also, small clove distilleries that bring complementary income have an especially high demand for fuelwood. Wood can be found in close proximity to villages and is free of direct costs; dead wood is collected in the forest or from small groves and solitary trees near the village. The remaining 5000 m³ of wood is used for constructing traditional houses, pirogues, and tools. There is also a high demand for wood from cities outside the assessment area. According to the mayor of Manompana, 90% of the round wood is exported.

Cultural function of forests

Resins of specific species are used during Bestimsaraka ceremonies. According to beliefs of this ethnic group, some forests are inhabited by ghost and witches and others are sacred. Villagers reported that "if there are spirits in the forest, deforestation can cause death." Also, "It is forbidden to clear the sacred forests – which are characterised by the presence of knots in vines – with the risk of getting sick." This traditional knowledge is passed from generation to generation and farmers know where they can practice tavy and where it is forbidden.

Forests as a source of off-farm income

Among the interviewed farmers, 80% used the forest as a source of income. Forest-related activities (of artisans, woodcutters, carpenters, transporters, charcoal producers, beekeepers, cloves distillers) contributed 40% to off-farm activities; the remaining 60% of off-farm activities relate to fishing. Alternative incomes were necessary because of the uncertainty of cash-crop cultivation. For example, one villager reported, "Villagers suffer from price fluctuations of vanilla. They should diversify their production to be less dependent on the vanilla prices," Logging activities are taxed and provide income for financing communal projects. However, illegal logging avoids tax payments.

Forest and tavy practice

Tavy, is defined as an area of vegetation cleared and burned for cultivation, with no soil preparation (Vicariot 1970). Tavy may be practiced on different types of vegetation in both primary forest and secondary forest. In Analanjirofo, where Manompana is situated, the poverty ratio is higher (78%) than in the two other regions of the study (73% in Atsimo-Andrefana and 69% in Vakinankaratra). This high ratio may be due to the size of the forest cover, the practice of tavy, and the remoteness of the area. The forest area is indeed large enough for accessing new cultivation plots by practicing slash-and-burn farming. However, the tavy's yield is very low (de Laulanié 2003) and the isolation of the households limits access to markets. Jepma (1995) explains that from the farmer's point of view, slash-and-burn farming could be seen as "rational" because it is economically the cheapest agricultural method. It needs low or no cash input since labour is provided by family members. Through slash-and-burn practices, farmers aim to ensure their subsistence "with a minimum risk" (Jepma 1995).

As mentioned earlier, in Analanjirofo tavy is an ongoing manifestation of the ancestor cult. Vicariot (1970) explains that the spirits of the ancestors are believed to be present on the field during the sowing period. It is an occasion for the family to stay with them for several months. Farmers have to ask the *psykidy* (head of the lineage) for the authorisation to practice tavy on a specific area. Animals are sacrificed before beginning the tavy.

Rice, cassava, potatoes, vanilla, coffee, sugar cane, and cloves are the typical crops cultivated by farmers in this region. All interviewed farmers cultivate rice: 82% in valleys, 76% in tavys, and 57% in both. The lack of valleys for cultivation is one of the major problems mentioned by farmers from the far area. Half of them own tavy rice plots in the forest in the west, requiring up to a six-hour walk to reach these plots. Low productivity of crops grown in tavys is often highlighted. Indeed, 76% of farmers judged their production of tavy rice as "bad," which means not sufficient for their subsistence. In addition, a cultivator living at the forest fringe highlighted the consequence of climate change on tavy production, explaining that "it used to be sunny during periods of burning; now it is raining. The growth of the rice is delayed and yields decrease."

The number of sold products is lower among the smallholder farmers at the forest fringe but they spend more money on agricultural products than those in the far area. This result may draw the picture of a farmer-consumer on the west and a farmer-seller on the east of Manompana, with both also practicing subsistence farming. The only permanent market is in the main village of Manompana located on the coast. During a village meeting at the forest fringe, this issue was raised: "Once we sold paddy rice in Manompana; now we have to buy it. Lower yields and population growth cause food shortages." The lowest farm incomes can be complemented by cash sources from off-farm activities. Furthermore, the ratio of tavy income/farm income was higher for those households with the lowest farm incomes. Tavy constituted the only income possibility for them if they could not complement it with off-farm activities. Farmers who had a non-tavy farm income (15 out

of 49) turned a high part of the value of their tavy production into income. Out of 20 respondents from the forest-fringe category practicing tavy, only five received profit from it.

Results of the local analyses in Tsimanampetsotsa

The study area of Tsimanampetsotsa is situated in southwestern Madagascar. It features a dry forest characterised by a very high rate of endemism in flora and fauna. The forest is partly situated on a limestone plateau and is part of one of the oldest protection areas in Madagascar, recently extended. Of the total area of 43 296 ha, 65% is still covered by forest due to the protected status. The above-ground biomass is estimated to be 98.9 tons/ha (Plugge et al. 2010).

Despite initial, mainly local initiatives to establish private plantations, the forest on the boundaries of the national park is facing high pressure (SuLaMa 2011). Wood may be logged inside the park with special authorisation and in areas for sustainable management allocated by the National Association for the Management of Protected Areas (ANGAP, French acronym, nowadays Madagascar National Parks, MNP). Permits for logging are predominantly given for construction of houses, bullock carts, coffins, and *aloala* (wooden ornaments for tombs). Only 1% of respondents in the 47 households gained ownership of land by deforestation (compared with 4% at the regional scale). Of the interviewed farmers, 21% acquired land by marking boundaries, such as with wood enclosures or plants.

Most slash-and-burn areas are near the recent national park's extension or on the plateau (areas of transhumance). Between April and August, parts of the forest are cleared for extensive cultivation of maize and cassava, which is mainly bought by traders from Toliara and Antananarivo. Farmers change acreages every two or three years, once soil fertility is depleted. Raising cattle is also a major activity in the study area. Cattle are kept mainly as a symbol of status or as a bank account (savings). The interviewed farmers and stockbreeders preferably located both off-farm and farm incomes in cattle activities.

Results of the local analyses in Tsinjoarivo

The study area of Tsinjoarivo is on the high plateau of Madagascar, situated approximately 100 km south of the capital of Madagascar, Antananarivo. The forest can be characterised as moist deciduous and is highly fragmented. Only 6% of the 32 272 ha in the study area is forested (Plugge et al. 2010). While there are initiatives to establish plantations, mainly pine, to meet the demand of local communities, pressure on the forest from its proximity to the capital is high. The above-ground biomass in the forest remnants is estimated to be 163.7 tons/ha (Plugge et al. 2010).

About 85% of the population of Tsinjoarivo lives from agriculture. Irrigated and rain-fed rice is grown and tree cropping (e.g. with *Eucalyptus*, *Pinus*, or fruit trees outside forests) is also practiced by farmers. Rice, cassava, maize, beans, potatoes, sorghum, and sweet potatoes are the principal crops of the commune. At the forest fringe (east of the commune), agriculture, livestock, and fish farming are the main activities; hunting and gathering are secondary. The lack of knowledge on appropriate agricultural practices is a major problem in the east. Cleared plots are thus underexploited. In degraded forests, cut permits are occasionally obtained to establish new agricultural areas if the need is proven. Two villager groups are responsible for the management of two logging areas in the forest. However, land conflicts exist between villagers not organised in these groups and the two groups. Some villagers claim land that has been cleared by their ancestors, yet these fields are located within the management areas.

In this area, 34 households responded to the questionnaire. In their responses, farmers complain about not being able to use the forest as their ancestors did (because of restraints on clearing). They explain that they need to cut trees around crop areas to increase sunlight and thereby increase production. They also need to clear the hillsides (*tanety*) to cultivate products that help finance rice cultivation (their staple food). Farmers claimed that they get cash from tanety and not from rice. Some of them work in other villages as labourers to finance their rice cultivation. They also carry wood to carpenters in the west for supplementary income. Because of clearing restrictions, inheritance poses a problem. Children must divide the plots of their parents and plot areas become too small to feed their families. One solution, if no authorisation to clear is obtained, is to buy existing neighbouring lands to enlarge the farming area. Unlike in the far area (west of Tsinjoarivo), many children do not attend school and there is no access to medical care.

A village chief in the intermediate area explained that shifting cultivation is not practiced in the forest. The rice plantations existed before the bans and they are not extended by their owners; however they cut the wood surrounding the plots to improve exposure to the sun. This wood is usually sold. In the past, farmers from the forest fringe supplied agricultural products to inhabitants of the far area. Now, the opposite occurs because of the difficulties of obtaining permits to clear forest areas. The land used to be fertile, but now yields are decreasing and farmers lack money to buy chemical fertilizers.

20.4 Comparison of local contexts of deforestation and forest degradation

In Tsimanampetsotsa the creation of the national park and its extension has been a long and difficult process of consultation, dealing with land tenure conflicts and the ancestral use of the forest. Conservation projects grant access to water to compensate villager groups for their efforts to manage their forests around the national park in a sustainable manner. In this area, about 75% of the interviewed farmers consider their subsistence as dependent on the forest.

This percentage decreases to 64% in Tsinjoarivo. However, there is a significant difference among the farmers of Tsinjoarivo, depending on their location. Interviewed farmers living far from the forest stated that their subsistence does not depend on the forest. However, even the use of the term *forest* is ambiguous because some consider small planted patched of *Pinus* and *Eucalyptus* as "the forest." In Tsinjoarivo, plantations are an important source of energy for households (75% comes from plantations) and of construction materials (66% from plantations). Construction and fuelwood come from private eucalyptus and pine plantations that also help to prevent erosion. In the forest fringe, fewer trees were planted by the farmers interviewed. Instead, they extracted wood resources directly from the forest and did not need to manage a plantation. In Manompana and Tsimanampetsotsa, farmers did not plant trees for fuelwood – they either collected it around the village or had to buy it.

Farm incomes in Tsinjoarivo contributed 80% to farmers' incomes (compared to 37% in Manompana and 10% in Tsimanampetsotsa). This can be explained by the opportunities available to sell products during two weekly markets and by road connections to the nearest city and the capital of Antananarivo, enabling distribution of the products. In Tsimanampetsotsa, the dryness of the region regularly leads to periods of starvation and prevents cultivation of as many vegetables and fruit trees as in Tsinjoarivo (five +/-two products versus ten +/-two products per farmer). Labour is generally provided by the family – only 8% of respondents paid for additional labour (compared to 21% in Tsinjoarivo and 28% in Manompana) to maximize their annual yields.

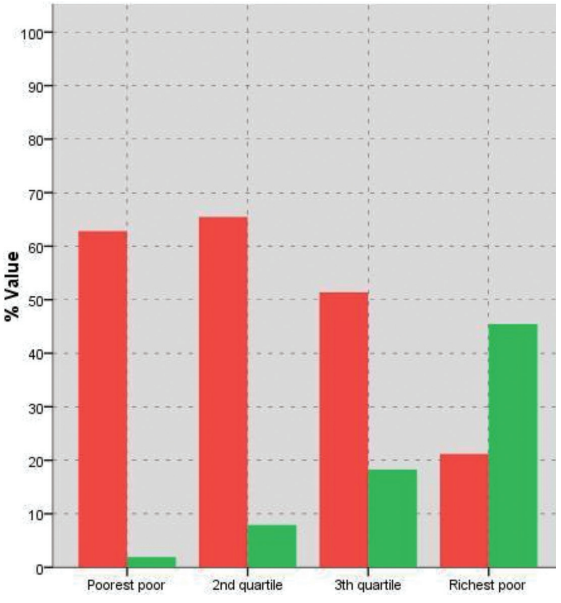

Figure II 20.6 Percentage of farm income from tavy products compared to total farm income and value of products from tavy for poorest poor to richest poor (Rqibate et al. 2010).

20.4.1 Dependency of poor and rich households on tavy products

In Figure II 20.6, farmers are ranked by their farm incomes and classified in quartiles (poorest poor to richest poor). The percentage of income from selling tavy products (rice in Manompana and maize or cassava in Tsimanampetsotsa) compared to the farm income (red bars) and the share of the total value of products from tavy (green bars) for each quartile is calculated. It shows that incomes of the poorest households are most dependent on tavy: their income from tavy products represents 63% of farm incomes (red bars), against 21% for the richest households. In addition, the figure indicates that the richest households benefit more from tavy than the poorer households as they are able to turn a large part of the tavy products that they cultivate into income. This income represents 45% (green bars) of the total value of the tavy products in Manompana and Tsimanampetsotsa (against 2% for the poorest households).

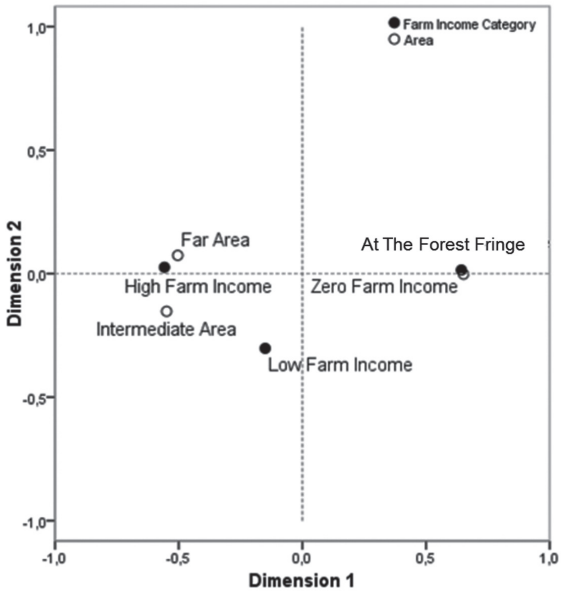

Figure II 20.7 Results of the correspondence analysis with representation of the variables of zero farm income, low farm income, high farm income, far area, intermediate area, and forest fringe on the factorial map (Rqibate 2013).

20.4.2 Distance from forest and farm incomes in Manompana and Tsinjoarivo

Figure II 20.7 resents the result of a correspondence analysis with farm incomes (turned into ordinal variables: zero farm income, low farm income, high farm income) and the areas (far area, intermediate area, and forest fringe) for Tsinjoarivo and Manompana. Dimension 1 separates high farm income, far area, and intermediate area on one side of the axis, with zero farm incomes and at the forest fringe on the other side. The figure illustrates that farmers at the forest fringe get less benefit from their agricultural activities.

20.5 Conclusions

Based on the findings described, the three regions show different prerequisites for the implementation of SFM. The possibilities or hindrances for implementing SFM are closely related to the characterisation of the causes of deforestation and forest degradation. On the east coast in the region of Analanjirofo, the implementation of SFM should focus on the direct causes of deforestation: the practice of tavy and illegal logging in Manompana. Adapted and viable SFM activities should be developed on the basis of the understanding of the local context of deforestation (migration, religious elements, subsistence use). In Vakinankaratra, the development of SFM activities appear to be more complicated and challenging since underlying causes of deforestation, such as population density, must be addressed. In Atsimo-Andrefana, SFM should deal with slash-and-burn practices and charcoal use, which depend on the economic background of the users and location.

The study highlights that cultural, social, economic, and environmental factors interact and guide the behaviour of the actors. Behaviour also depends on forest attributes at the local level. Alongside these, the subordination of technique and economy to social structures and the saturation of space need to be considered. The former describes traditional aspects of the Malagasy society, which may play a role in the poverty of Malagasy households. Lalaunié (2003) discusses social obstacles to economic development, more exactly, he cites André Piettre, who describes a "subordination of technique and economy to social structures." In the study area of Tsimanampetsotsa, for instance, the large number of cattle kept for funeral celebrations may constitute the capital of the owner, which can be sold or not, used for consumption, or used for agricultural work. The owner can perceive he is rich in the sense that he owns cattle. In Manompana, tavy is a traditional practice with religious elements and is still practiced even though its productivity is low. However, poverty is a subjective concept: a poor household (according to the formal definition) may have a positive opinion of its economic situation (INSTAT 2006).

Saturation of space in this context means that massive migration can exceed the capacity of the territory to provide sufficient natural resources to the inhabitants. Long fallow cannot be practiced where population density is too high. Intensification and temporary or long-term migration are among options for the farmers. Where available forest areas exist that have not been distributed among the descendants, settlers can establish their land rights by permanent cultivation. Among those interviewed in Manompana, 47% were migrants. The most common causes of migration were seeking fields for cultivation (33%) or clearing the forest (33%). To promote SFM, it is essential to consider the dynamics of space and population by addressing social issues (migration) and proposing alternatives to address the lack of available land.

These interactions should be taken into account when formulating policies and measures to promote SFM. Only with a thorough understanding of the local context can SFM schemes be adapted to be viably implemented and regarded as sustainable activities. The trend today also reflects this understanding; stakeholders currently involved in SFM tend more to a landscape management approach that respects the

socio-economic and socio-cultural values of forests and landscapes. The broader implementation of these approaches is hindered by unclear administrative issues, corruption, illegal logging, changes in political agendas and NGO priorities, and constrained time frames for project development and implementation. A national forest policy in Madagascar that can be supported by donor countries and international funding organisations is tenuous due to the lack of an elected government. The applied forest policy is weakened by the withdrawal of funds and increasing corruption as well as aforementioned security issues that are likely to worsen.

At the moment, promising SFM approaches focus on local livelihoods and the specific landscape in which they are situated. They involve meetings with communities and local stakeholders who are well aware of the negative impact of unsustainable forest management and seek support to turn the wheel. However, while many approaches to foster SFM exist in Madagascar, the lack of communication among and within institutions and projects as well as the changing political arena has a negative effect on their success. Sometimes various approaches are applied in parallel without identification of their synergies and trade-offs or gaps. This leads to confusion among local stakeholders and reduces their willingness to participate in such projects. The high importance of the remnants of primary as well as secondary forests of Madagascar, which are reserves of some of the most unique flora and fauna of the world, calls for concerted actions and ongoing support for the successful approaches that can be found throughout the country.

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