

From forest-clearers to environmental managers: farmers' adaptation capacities in the eastern rainforest of Madagascar

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Abstract: *Considering the low success rates of national parks and forest reserves in both conserving natural forests and supporting agricultural development, the Malagasy government recently chose to decentralize forest resource management. Community-based forest management could be a solution: it began in 1996 under the new Gestion Locale Securisée (GELOSE) law. Evaluations reveal unintended impacts, such as the resistance of local population and the continuation of deforestation. New land use policy alters inevitably the context in which farmers plan their livelihood strategies, that could lead, deliberately or not, to livelihood changes and subsequent disagreements with local population. The question of how farming systems can or cannot adapt to conservation is a central focus of academic debate and public policy concern. In this paper we assume that conservation measures create disparities among local communities and that farmers' adaptation capacities are different. Which types of farmers are more capable of adaptation? What are their room for manoeuvre to become "environmental managers"? From a case study in the eastern rainforest of Madagascar, we propose to seek factors influencing variability in farmers adaptation capacities among contrasting farming systems in the Fianarantsoa forest corridor. We categorise farms on the basis of livelihood and land use strategies, and analyse responses to conservation measures. Our results explain heterogeneity in adaptation capacities, which could be of great interest for a better understanding of farm's possible evolution in the current perspective of agriculture role in land management and forest conservation.*

Keywords: *small-holder farmers, forest conservation, adaptation capacities, land use planning, Fianarantsoa forest corridor, Madagascar*

Introduction

In tropical countries, community-based forest management (CBFM) is considered as a solution to cope with the limited capacities of national institutions to achieve both conservation and rural development (Agrawal, 2001). This change of emphasis in forest management and conservation was developed within the larger context of broader movement that strove for increased social inclusion and participation and challenges to top-down management, underlying the importance of grass-root initiatives (Chambers, 1994). These new approaches aim to involve and integrate rural communities in management processes within a structured policy framework (i.e. not wholly top-down or bottom-up), that take into account the innovative ability and indigenous knowledge of farmers. The community-based approach also relies on the idea that forest conservation objectives require a co-ordination of activities at a greater scale than household scale. However, evidence emerging from many parts of the world suggests that forest conversion into agricultural field will continue as long as it makes sense to rural livelihoods, given incentive and constraints they face, regardless of the costs to the larger community (Vosti et al., 1996).

The majority of forest-dwelling populations are farmers. Forest represents a wide range of resources (lands for cultivation, food supplement in time of hardship, raw material for farming, housing and handcraft, and also medicinal plant). However conceptual debates around livelihood strategies in the tropics now recognize that, within a community, households vary considerably in the degree and manner to which they incorporate forest resources into their livelihoods (Agrawal et al., 1999; Bahuguna, 2000; McSweeney, 2002). In consequence, CBFM induces different constraints for households according to their pre-existing livelihood strategy and forest-dependency level. We think that the efficiency of CBFM partly depends on the capacity of each household concerned to react in time to conservation pressure and to integrate conservation measures into their farming system.

Farmers have been adapting their agricultural practices and natural resource management to suit changing conditions for centuries (Boserup, 1965). In the past, apart from natural disaster, change has usually taken place slowly at such a rate that has enable farmers to assess the need for changes to their agricultural system and to implement them. The implementation of a new conservation policy, inducing new government-sponsored land use patterns and changes in forest access rules, took place very quickly and creates a major peak in pressure beyond the normal range of variability in which households operate. Coping and adaptive strategies are reactive and proactive “decisions” by households for reducing risk, regarding their capacities, and maintaining or enhancing their livelihood options by creating a positive change in their lives. Coping strategies are immediate reaction to a quick change and might not be sustainable. Smallholder farmers have been singled out as one population that may be particularly sensitive to fast changes, based on the observation that they tend to have relatively few resources with which to cope (O'Brien, 2002). Adaptive strategies correspond to livelihood evolutions in the long term in response to a stress, which is increasing pressure or regular disaster commonly within the range of normal variability. We assume that their ability to become environmental manager depend on their capacity to switch from coping strategies to adaptive strategies. Based on two case studies in the eastern rainforests of Madagascar, this paper sets out to explore following specific questions:

1. How does CBFM affect, deliberately or unintentionally, different farming systems?
2. How do households change their livelihoods in order to cope, to adapt, and to recover when changes in resource uses and land tenure policy happened?
3. What kind of difficulties is beyond their room for manoeuvre and should be bridged by non-governmental organizations (NGOs) or by the government? Which specific factors could be used as catalysts in order to help households' adaptation processes? In the context of small-holders living in self-subsistence the factors that led farmers to adopt sedentary agriculture and to use land intensively rather than extensively are still not fully understood (Brady, 1996; Pagiola et al., 2001). The capacity of households to intensify and diversified their farming system depends on a multitude of factors, whose roles and interactions have not been clearly identified yet: endogenous factors such their assets, their existing strength and constraints which define their vulnerability (Goldman, 1995; Ellis, 2000) and external factor such as right policy and technology, physical environment, infrastructure and access to market (Reardon et al., 2001), land tenure security (Roy, 1995).

This study aims at filling this gap by examining the role of selected historical, geographical and social factors in shaping adaptation process in response to conservation measures. In a precedent study (Toillier et al., in press), we elaborated a typology based on land use pattern and livelihood strategy at farm level in order to examine diversity in room for manoeuvre among a local community and the consequences in terms of land use changes and conservation outcomes. The analysis of spatial patterns produced by different livelihood strategies under conservation pressure allowed us to examine the compatibility between conservation and agricultural production in a given case study. In this paper, we explore the role for external factors in encouraging and accelerating the process of adaptation of households by using a comparison of household adaptation capacities in two different farming systems. As an explorative study, this research was designed to generate hypotheses about the particular attributes both at household and region scales that may be important in facilitating or inhibiting adaptation processes.

The two study sites

Farming systems and causes of deforestation

In the Eastern-Malagasy province of Fianarantsoa, what is left of the tropical rainforest spans either side of the longitudinal escarpment separating coastline and highlands (1200 m a.s.l.), thereby creating what looks like a 150 km-long and almost constantly 10 km-wide forest corridor. This corridor is relied upon to maintain biodiversity migrations between several protected areas (figure 1). It would be the vestige of a vast forest stretching away to the East coast before the arrival of the man (Green et al., 1990). The forest corridor is flanked by two rural areas differentiated by their biogeographics and their native populations. To the west, at an average altitude of 1200 metres, lies Betsileo country, and to the east below the 'escarpment' at an altitude of 500 metres, lies Tanala country. Demographic growth on each side of the forest has led to a multitude of human-induced pressures, including deforestation and biodiversity loss.

The study examined two sites located on each side of the corridor (figure 1). The selected sites varied in terms of land and forest use, social organization, infrastructure and access to market (table 1). On the west fringe of the forest, the Betsileo, who are traditionally sedentary farmers, are settled for more than a century. Agriculture is their main source of livelihood. They mainly practice irrigated rice in inland-valleys in association with cattle breeding and rainfed crops on sloping lands. Cash crops are almost inexistent and off-farm opportunities are very limited. Forest resources provide a safety net in assisting households to cope in times of hardships. Forest products are very diverse: raw materials for farming, housing and handcrafts, and also plants for weaving straw mats, baskets, and clothing, for fermenting artisanal rum or for medicinal uses. A few farmers are specialized in the manufacture of wooden-made spade handles, which are sold in the whole province of Fianarantsoa by way of nearby markets. This production contributes to a third of their annual income. Forest is also a reserve of lands when food production is insufficient in savannah. Temporary fields are cleared, usually burned, and subsequently cropped for one or two years with maize and bean before being fallowed for many years. They are usually hidden in remote areas in order to escape from authority control. A few hamlets are settled in the heart of the forest; based on slash-and-burn cultivation around rice fields, extensive forms of the traditional betsileo farming system are practiced. On the east fringe, the Tanala region is characterized by traditional land use based on itinerant rainfed hillrice cultivation on sloping lands, known as *tavy*. The Tanala have various ethnic origins and are instead defined by their marginal social situation, their standard of living in the forest and their quest for free land. Migration of Betsileo people to the Tanala region is ongoing today, as attested by the existence of mixed Betsileo-Tanala villages where the social organization of the Tanala is adopted by both entities. This history also shows that Tanala people are not simply forest tribes practicing slash-and-burn agriculture. As most other groups in Madagascar, they have experience in both lowland and upland rice cultivation. But as they have been repeatedly marginalized and removed to remote areas, they never had the opportunity to definitively establish permanent settlements. Land use would thus be more a question of physical environment and economic resources than a matter of culture and traditions. Establishing sustainable paddy fields is a long process which can take generations, especially in this mountainous region where large plains are absent, and when political instability and conflicts impede farmers from increasing their social and economic capital.

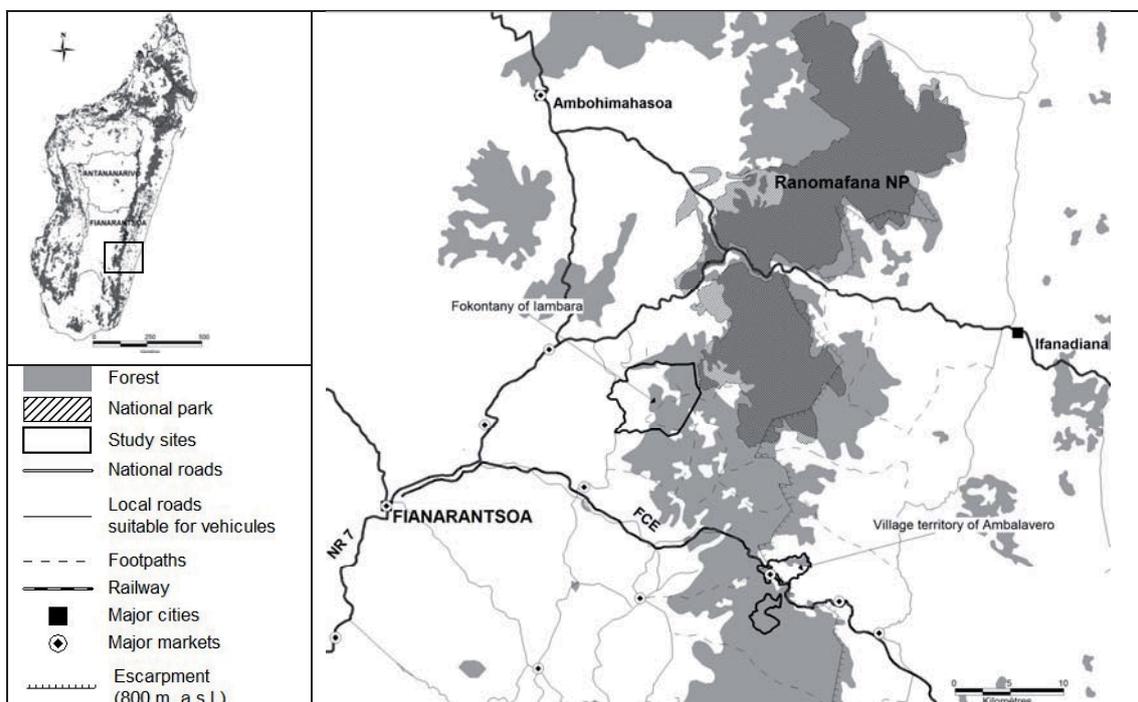


Figure 1. Location of the study sites in the northern part of the corridor Ranomafana-Andringitra (sources: BD 500, 1994 FTM)

According to demographic data, infrastructures, market access, environmental constraints, the sites chosen are representative in size, physical structure and accessibility of many villages in the northern part of the corridor.

Table 1. Main features of selected study sites

Study site name	Fokontany of lambara	Village of Ambalavero
Location	Western forest fringe	Eastern forest fringe
Elevation	1200m a.s.l.	500m a.s.l.
Ethnicity	Betsileo	Tanala
Nb. of hamlets and villages	13	1
Access	footpaths	Railway
Main forest uses	Wooden-made tools and furniture Reserve of lands for rice fields	Slash-and-burn agriculture to grow rainfed hill rice
Pop density	38 hab/km ²	43 hab/km ²
Pop growth	2.4%	2.6%
Forest area within the territory	32%	40%
Environmental constraints	Erosion, acidic soils	Annual flooding and cyclone
Distance to major market	180 min.	30 min.
NGO assistance	intensive irrigated rice systems, fertilized production, pisciculture	Ecotourism, flood barriers

Implementation of CBFM and disparate conservation pressure

Programs began in 1996 under the GELOSE law which led to the *Gestion contractualisée des Forêts* (GCF) decree applied since 2001. Based on conservation objectives, forest restoration and sustainable timber harvesting, zoning-based plans for forest management have been developed in village territories. The state delegates management rights (but not tenure rights) with conservation goals to a legally recognized local community institution (*Communauté de base* or COBA). The contract is signed between the Forest and Water Resources service and the COBA, who must demonstrate during an initial 3-years contract its capacity for sound environmental management of the designated site. Continued effective management during a subsequent 10-years should be allowed after an official evaluation which should give the possibility to revise rules according to each subscribers. A non-governmental organism or an international agency is also designated in order to support the contractualization process and to help to define the management site and forest access rules during participatory workshops with local population and forest service agents. If they have at their disposal enough funds, they provide facilities which could encourage and accelerate the adaptation process of local resource management and farming systems. As yet, any official evaluation of contract efficiency has been done in the Fianarantsoa forest region because of the current reorganization of the Ministry of Forest and Water Resources in the broader context of the national decentralization movement. Contracts have been tacitly renewed, without any modification.

In the two study areas, the main interventions for development and conservation were led by a project of the United State Agency for International Development (USAID). In the Betsileo region, designated sites to be transferred have been chosen within the *fokontany*, which is the smallest administrative unit in Madagascar and gathers several villages. Our study site, the *fokontany* of lambara is located in the south-west of the Ranomafana national park (figure 1). The extraction of forest resources for commercial activities has been totally forbidden. The spade handles production has been found unsustainable regarding to conservation goals. All the woody fallows of 8 years of age or older has been included in the conservation area in order to be protected from the culture extensions, even if they were located in the cultivation area granted by the Forest Service in the seventies. Extraction of wood items for personal use is permitted in a small area (45 ha) in the southern part of the GCF area; the location should change every 3 years in order to avoid an overexploitation, which has not been done yet. Forest clearing is forbidden with the exception of a 25 meters strip on either side of rice fields. Firebreaks around fields are compulsory. Crayfishes can be collected in limited quantities and only during specific periods in the year. Bush-fires are totally forbidden excepted every 3 years after an approval of the forest service. For all the above-mentioned cases, authorizations must be conceded by the president of COBA and dues have to be paid. Apart from migrants who should be excluded from the territory, even non-members of the COBA are able to get an authorization but dues are higher. Any malpractice comes down to a fine.

In the Tanala region, designated sites correspond with village territories which are usually composed of forest lands down and up the escarpment (figure 1). The forest areas uphill has never been attractive since usual tanala hill rice and cassava varieties didn't fit with climatic conditions in the highlands. Only raw material for farming, housing and handcraft, and medicinal plants were extracted. In the late 90s, some farmers went upwards because forest lands became scarce in lowlands. They mainly cultivated bananas and sugar cane. The forest management plan is very similar to the GCF

contract of *Iambara*, with the exception of a production area for timber harvesting located up the escarpment. Any forest exploitation has been organized yet. Then conservation measures mainly impeded hill rice cultivation in low lands around the village and led to a large reduction of land available for agriculture

In both cases the establishment of GCF has caused a decrease of incomes through the prohibition of forest products sells. Any alternative activities have been found yet. Development supports from USAID consisted mainly in usual technologies for intensive irrigated rice systems, fertilizer production, and the promotion of pisciculture associated with rice fields, without any distinction of local specificities. Nevertheless they promoted ecotourism in Tanala villages settled along the railway.

A spatially-explicit typology in order to differentiate households' sensitivity to conservation

So as to generate a representative sample of the diversity of livelihood strategies and forest-dependency level, we applied a typology based on criteria related to i) farm characteristics: household demographics, household assets, cropping system and labor allocation and ii) farmland structure and use (Toillier et al, in press). According to Lena (1992), the chronological history of household from beginning to retirement and the associated processes of accumulation at each stage of lifecycle have a spatial footprint spread out within the whole territory. The first settlements became remote from forest fringe; either farmers have turned toward non-forest activities and tried to intensify or diversify their farming system (animal production, cash crops) or they migrated. Farmers originating from savannah villages and recently settled in the forest adapted their farming systems and practiced shifting cultivation. The typology is composed of five types of household:

- The type 1 is composed of medium farms settled on inherited lands which have been cultivated for many years and have lost their fertility. Households, made up of young couple or elderly people are characterized by a high labor force but they are limited by land scarcity and erosion. Small plots don't allow them to develop cattle breeding nor to practice long fallows. They compensate the lack of production by high sources of incomes: cash crops (bananas, sugar cane) and forest products sale. They also looked for free forest land in order to widen their farmland. They mainly practice daily off-farm employment because they can't only rely on farm production.
- The type 2 is composed of mature households well capitalized. Their wide farmland is constituted of several fields scattered between "savannah" and forest areas. They aimed at owning and cultivating lands so as to maintain their upper social position and prepare inheritance to leave to their offspring in anticipation of the scarcity of fertile lands. They also attempt to diversify practices and land use.
- The type 3 is composed of young households with many young children and a slight labor force. They have to face a long lean period. Their farmland is split up between small areas of rice fields or unfertile sloping lands nearby villages and remote forested lands. They are forced to share their place of residence in order to take care of cultures; fastidious and labor-intensive alteration works called for supplement workforces; they afford it thanks to rum production, forest products sale and off-farm employment.
- The type 4 is composed of large scattered farms in self-subsistence and settled in forest. Their land use strategy mainly consisted in marking their farmland by practicing shifting cultivation on sloping lands, developing rice fields in inland-valley and converting rice fields let lie in fallow into pastures. Familial mutual aid allowed them to clear new forest land but a large part remained in fallow. The majority of young men are employed as workers. This main source of income, allowed buying rice in order to finance some alteration works and to face the long lean period. Additional sales of forest products remained paltry.
- The type 5 corresponds to small farms settled in forest with a weak labor force and insufficient food production inducing a long lean period. These few cases belonged to family clans who had no more free forest lands at their disposal or to migrants. Their farmland was then grouped together in remote areas in the forest. They were primarily concerned with acquiring income to satisfy daily necessities especially through forest products sells.

A set of 70 households was designed (33 in the Betsileo study site and 37 in the Tanala study site). Firstly we categorized households using the spatially-explicit typology. We identified household sensitivity for each type within each study site. Sensitivity characterizes the constraints arising from GCF regulations through the time limit the household has to adapt to those constraints. Short-term sensitivity means that GCF regulations immediately impacted household including drops into food intake or incomes. Middle-term sensitivity corresponds with constraints that would appear subsequently to the growth of the family, in a few years. Long term sensitivity means that GCF regulations would cause problems for the household reproduction (no inheritance for offspring). We assume that short-term sensitivity leads to coping strategies in response to conservation measure whereas long-term sensitivity makes it easier for household to display adaptive strategy and integrate conservation measures into their farming system. Secondly, we compared adaptation processes for the same type of household between the two study sites and the role for external factors: access to market, geographical isolation, NGO supports and off-far-employment. Then we analyzed consequences in term of forest conservation outcomes and agricultural development.

Heterogeneity of adaptation capacities and environmental outcomes

The distribution of households within the two study sites is presented in table 2. It appeared that the two samples present a similar distribution of types 2 and 3. As land scarcity is more important in the Tanala study site, a higher number of type 1-household has been found. We observe also that the relatively "rich" households, i.e. land-wealthier, labor-richer, well-capitalized (types 2 and 4), are the dominant type settled in the Betsileo forest, whereas it is the relatively "poor" ones in the Tanala site (type 5). The type 4 has not been observed in the Tanala study site since Tanala farming systems didn't operate in the forest up the escarpment. For each type of household we identified the room for manoeuvre they used in order to adapt to conservation measures (Table 2).

Table 2. Distribution of household (HH) types among study sites, room for manoeuvre used in order to adapt to GCF regulations and subsequent land use changes.

HH type	Type 1	Type 2	Type 3	Type 4	Type 5	Total
Betsileo farms						
#	4	10	9	7	3	33
%	12%	30%	27%	21%	9%	100%
Sensitivity	short-term	Long-term	short-term	Long-term	Short-term	
Room for manoeuvre	Labor force Land use Food intakes Migration	Land access (GCF regulations) Spatial organization	Labor force Land access Off-farm employment	Land access Labor access (GCF regulations)	Labor force Off-farm employment	
Land use changes	Intensification	Extension Diversification	Extension Specialisation (rum)	Extension	Desertion	
Tanala farms						
#	12	10	10	0	5	37
%	32%	27%	27%	0	14%	100%
Sensitivity	Short-term	Long-term	Middle-term	X	Middle-term	
Room for manoeuvre	Labor force Land use Food intakes Ecotourism	Land access (GCF regulations) Spatial organization Market access	Labor force Spatial organization Land use Market access	X	Market access Off-farm employment	
Land use changes	Intensification	Extension Diversification	Intensification Diversification	X	Specialisation (bananas) Desertion	

The types 1 and 5 (excepted Tanala type 5) were short-term sensitive to conservation measures because they couldn't rely on agriculture to secure their livelihood and forest was considered as a safety net. In the Tanala study site, the presence of railway allowed type 5-household to develop banana plantations into the forest; they didn't need to practice annual clearing of their fields. The conservation measures would raise problem only for the extension of farmland. The types 2 and 4

were long-term sensitive thanks to land reserves. The Betsileo type 3 was sensitive in the short-term because of the prohibition of spade handles sales. The Tanala type 3 was sensitive in the middle-term, because several fields had been recently clear-cut (during the announcement of GCF implementation) and could support a few more cropping cycles before the need of new fertile lands.

The dominant response of type 1 households consisted both in short term and long term adaptations. In a context of land scarcity without free access to new lands, their objectives were to intensify rice production, to increase animal production and to purchase lands, possibly in other villages and especially in Tanala villages for Betsileo farmers. In the short term, they decreased their food intakes in order to do savings (they increased rice sales) and put a lot of labor force into improving agricultural practices and yields toward a more intensive farming system. They developed terraces to reduce erosion and to increase surfaces or rice fields; they built irrigation canals and increased the use of fertilizers thanks to NGOs support. Most part of Tanala farms stopped hill rice cultivation unless some relative lent them a fertile land, and turned toward rice fields. The low yields and small available surfaces impelled farmers to consume more cassava cultivating on poor sloping lands and to look for off-farm employment such as the portage of bananas up to the railway station. A few of them turned toward ecotourism activities developed by NGOs. In both cases, adaptations consisted in changes in land use inducing agricultural intensification.

The type 2 and 4 households were the less sensitive to GCF regulations and paradoxically they were the most pro-active in turning rules to their own advantage. Betsileo farms organized clandestine collections of wood to sale wooden made tools, justifying this activity with consideration that they had never received any benefits from forest conservation as outlined in the GCF contract. They also extended their fields thanks to the 25 meters authorization around rice fields in forest and thanks to the conversion of pine plantations into cassava-fields, which have been abandoned by the Forest service; Tanala farms kept on clearing woody fallows, even with a forest aspect, by exploiting the lack of precision in age and size of protected trees in GCF regulations and the absence of marks around conservation areas in the village territory. Nevertheless, in the context of increasing population pressure and shifting cultivation farming system, fallow cycles would decline quickly inducing erosion. Then, Tanala farmers also developed rice fields and the use of manure.

In response to the prohibition of forest products sales, the type 3 households resorted to a specialization in cash crops and rum production thanks to their spatial organization; they owned fertile lands recently created on forest land before the GCF implementation. Tanala farms were able to cultivate bananas, ginger and pineapple sold in the proximate market at the railway station and Betsileo farms mainly turned toward sugar cane in order to sell rum in the proximate markets. Generally, their incomes increased since rum and cash crops were much more lucrative than forest product sales.

Among the type 5 households (grouped farms settled in forest), tanala farms found more alternatives thanks to market proximity for daily bananas sales and off-farm employment. Some of them abandoned their lands and bought new ones downward near the railway thanks to their savings. Betsileo farms increased the period of off-farm employment in Tanala region. These households complained of a decrease of their food intake due to a decrease of yields and of lands under cultivation because of the slash-and-burn prohibition. Their incomes were barely enough to buy food for the whole year. In both cases they respected GCF regulation for fear of the repression. In this case conservation outcomes were reached but Betsileo household welfare decreased a lot and they couldn't anymore earn their living by cultivating.

The mismatch between farmers' adaptation capacities and CBFM approach

This research provides a more widespread understanding of the constraints and objectives that forest-dwelling populations face daily in two different farming systems. Our results raise questions about the suitability of community-based forest management in these village territories in that we observed that the new policy strengthened disparities within the local population and have led to unintended effects from a conservation perspective.

On an agricultural perspective, the GCF encouraged farmers to increase the amount of land under cultivation in order to adapt to conservation measures. Pre-existing land use trends have been

reinforced such as the development of rice fields in the Betsileo forest and in the Tanala village territory, as well as intensification on sloping lands inducing erosion.

In summary we observed that most of Tanala households were converting their traditional farming system based on shifting cultivation and rain fed hill rice towards a more diversify farming system combining rice fields, cattle breeding, cash crops and hill rice thanks to favorable environmental conditions (fertile lands, water sources) and infrastructure and access to market (railway). Under these circumstances, households with difficulties could rely on the old values that still undergrid the extended family, sharing is obligatory and emergency help is assumed to be always available. In time of hardship, members of household are then often moving from a place to another even, to another village where they have relatives, in order to find better livelihood conditions.

In the Betsileo study site, the absence of alternatives to their traditional farming system induced a transgression of GCF rules. The wealthiest households took advantage to GCF regulations to develop rice fields into the forest and to create new settlements; their distance to markets didn't allow them to develop cash crops in a great extent. As a more individual land tenure than the Tanala ones was operating, the familial mutual aid for household with difficulties is less developed. Migration was often the chosen solution. At a village level, farmers' responses to GCF regulations did not, on the whole, support conservation outcomes in the landscape, but emphasized in many cases, expansion of cultivation onto previously forested lands. New settlements induced forest fragmentation in the forest corridor, and many farmers reported a decrease in food intake or other conditions impacting household welfare. In this case, agricultural sustainability, as well as forest conservation seems to be jeopardized.

In both sites, a dominant land use driving force consisted in forest land colonization leading to struggle between familial clans. GCF regulations increased land pressure and race for uncultivated lands. Then, even if alternatives to deforestation were found by farmers, forested areas remained threatened by the wealthier households, not for survival reasons but in anticipation of the needs of future generation; the succession of forest regulation schemes over the last 50 years and the decline of state control provided little incentive for farmers to take new government-sponsored conservation rules and guidelines into account in their land-use decisions. Above all, the GCF is seen as a way for the government to better achieve conservation goals at national scale. They did not feel like conservation strategies were taking into account their need to survive from agriculture.

Moreover, some households encountered such difficulties at farm level that the collective capacities to solve individual problems were very limited, especially in the Betsileo study site. The community in charge of the implementation of GCF rules preferred to make the rules more flexible in order to avoid a social crisis. Very few infractions had been reported by the president of the COBA, in comparison with our field observations and what we were told during the enquiries. In the past, it has already been observed that the local communities had a weak capacity to undertake collective actions such as collective water management, control of bush fires, producers organization or to face problems such as robbery or trails degradation. They had a few opportunities to acquire autonomous collective capacities indeed. The government has always utilized local communities as a way to better achieve national objectives. Moreover, in a context of impoverishment and increase of economic disparities, farmers would rather to act only for themselves than to take into account collective interests. Nevertheless they remained opened to new social organizations as long as they are supported by developers. Those new structures take the risk to remain superficial, more turned toward external support than deep-rooted in an endogenous social dynamic.

Conclusion: toward an adaptive management

Our findings explain heterogeneity in farmers' adaptation capacities, pointing out the critical importance of differential characteristics at territory level. These capacities helps in facilitating the processes that allow farmers to switch over to activities directed toward supporting conservation outcomes without threatening their survival.

In both sites, the wealthier households, who combine traditional extensive farming system on sloping lands, diversification and intensive lowland rice cultivation, appeared to be most capable of adaptation but the reproduction of their farming system is jeopardized. It means that their offspring should have to reorganize farmland use or develop new extra-agricultural remunerative activities. Then this type of households might tend to disappear.

The other households, with the same structural characteristics (labor force, land access, holdings) didn't exhibit the same adaptation capacities by using specific characteristics of the territory (resource abundance, market access, social capital). In the Tanala site, market access, water resources and soil fertility allowed farmers to intensify and diversify their farming system. The more disadvantaged households were supported by the community. In the Betsileo site, because of the absence of short-term alternatives GCF regulations led to perverse effects that didn't encourage farmers to act within the logic of conservation. Although farmers have the knowledge and innovative ability to address the problems arising from conservation measures, driving force at a broader scale, especially land conquest in these case studies, encourage the wealthier households to continue with the conversion of forest into cultivated land. External catalysts and institutional supports are then needed to promote adaptation strategies related to external factors (cash crops) and to solve collective problems mostly related to land ownership titles. As farmers' priorities have not well been taking into account (land secure, agricultural support and daily welfare improvement), and benefits promised by NGOs are still absent, they have not been drawn into a "decentralized process" in sufficient measure to make them buy into conservation and become "environmental managers".

In conclusion, several processes of adaptation have been displayed by the different types of households. Those processes might require a stage during which farmers' practices are in contradiction with conservation measures before they find an adequate land use system which fits with their own development objectives. But new land use systems alter the landscape, which raises new questions about environmental outcomes. Then forest management for conservation and development purposes should be considered as a process of co-evolution between agricultural activities and ecological dynamics. In consequence, such contracts as the GCF should rather deal with the evolution of households' adaptation capacities than with rigid, one-size-fits-all conservation regulations. Regular evaluations of measures that are being implemented could be done in function of the diversity of adaptation capacities and environmental outcomes in order to gradually adjust regulations.

References

- Agrawal, A., Gibson, C., 1999. Enchantment and disenchantment: the role of community in natural resource conservation. *World development*, 27, 4, 629-649.
- Agrawal, A., 2001. Common property institutions and sustainable governance of resources. *World Development*, 29,10, 1649-1672.
- Bahuguna, V.K., 2000. Forests in the economy of the rural poor: an estimation of the dependency level. *Ambio* 29, 3, 126-129.
- Boserup, E., 1965. *The Conditions of Agricultural Growth*, Aldine, Chicago.
- Chambers, R. 1994. The origins and practice of Participatory Rural Appraisal. *World Development* 22, 953-969.
- Brady, N. C., 1996. Alternatives to slash-and-burn: a global imperative. *Agriculture, Ecosystem and Environment*, 58, 3-11.
- Ellis, F., 2000. *Rural Livelihoods and Diversity in Developing Countries*, Oxford University Press, New York.
- Goldman, A. C., 1995. Threats to sustainability in African agriculture: searching for appropriate paradigms. *Human Ecology*,23, 3, 291-334.
- Green, G. M., Sussman, R.W., 1990. Deforestation history of the Eastern rain forests of Madagascar from satellite images. *Science* 248, 212-215.
- Léna P., 1992. Trajectoires sociales, mobilité spatiale et accumulation paysanne en Amazonie brésilienne : un exemple en Rondônia. *Cahiers des Sciences Humaines*, 28, 2, 209-234.
- McSweeney, K., 2002. Who is forest-dependent? Capturing local variation in forest-product sale, Eastern Honduras. *The Professional Geographer*, 54, 2, 158-174.
- O'Brien, 2002. The nature of shifting cultivation: stories of harmonies, degradation and redemption. *Human ecology*, 30, 4, 483-502

- Pagiola, S., Holden, S., 2001. Farm household intensification decisions and the environment, in Lee, R., Barret, C.B. (Eds.), *Tradeoffs and synergies? Agricultural intensification, economic development and the environment*, Wallingford, UK: CABI publishing, 73-87.
- Perz, S., 2003. Are agricultural production and forest conservation compatible? Agricultural Diversity, Agricultural Incomes and Primary Forest Cover Among Small Farm Colonists in the Amazon. *World Development*, 32, 6, 957-977.
- Reardon, T., Vosti, S.A., 1995. Links between rural poverty and the environment in developing countries: asset categories and investment poverty. *World development*, 23, 9, 1495-1506
- Reardon, T., Barret, C.B., Kelly, B., Savadogo, K., 2001. Sustainable versus unsustainable agricultural intensification in Africa: Focus on policy reforms and market conditions, in Lee, R., Barret, C.B. (Eds), *Tradeoffs and Synergies? Agricultural intensification, economic development and the environment* Wallingford, UK: CABI publishing, 73-87
- Roy, R. D., 1995. Land rights, land use and indigenous people in the Chittagong Hill Tracts, in Gain P. (Ed.), *Bangladesh land forest and forest people*, Dhaka, Bangladesh: Society for Environment and Human Development (SEHD), 53-118
- Serpantié G, Ramiarantsoa M, Rakotondramana M, Toillier A, 2007. Intensifier la riziculture autour du corridor : l'offre technique est-elle adaptée à la diversité des situations des ménages ?, in Serpantié, G, Rasolofoharinoro, Carrière S (eds), *Transitions agraires, dynamiques écologiques et conservation. Le corridor Ranomafana-Andringitra, Madagascar*. CITE-IRD, Antananarivo, 201-211.
- Toillier A., Serpantié G., Hervé, H., Lardon, S., in press. Livelihood strategies and land use changes in response to conservation: an insight into pitfalls of community-based forest management in Madagascar. *Journal of Sustainable Forestry*.
- Turner, B., R. Kasperson, P. Matson, J. McCarthy, R. Corell, L. Christensen, N. Eckley, J. Kasperson, A. Luers, M. Martello, C. Polsky, A. Pulsipher, Shiller, A., 2003. A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences*, 100, 14, 8074-8079.
- Vosti S., Witcover, J., 1996. Slash-and-burn agriculture: households' perspectives. *Agriculture Ecosystem and Environment*, 58, 23-28.