How to design a pro-poor payments for environmental services (PES) mechanism in the forest frontier? Lessons from action-research in Madagascar

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Abstract

PES is considered new incentive tools for managing both the environment and rural development in developing countries. However, designing mechanisms tailored to smallholder characteristics and rural development requirements remains a challenge, particularly in tropical countries where the forest sector is characterized by long-standing patterns of inequality and poverty. In order to switch from theoretical principles to a really innovative management tool addressing local issues, we argue that it is necessary to include as from the beginning the characteristics of agricultural dynamics, and to involve local stakeholders in co-designing the ES and in solving problems encountered in their delivery. Through an action-research framework, we explored the characteristics of a "pro-poor" watershed-based PES mechanism associated with a hydropower project. The study site is located in the agricultural frontier of a rainforest in eastern Madagascar. We built a local and inclusive knowledge system based on (1) local and scientific knowledge on the relationships between land use and water services, (2) stakeholder perceptions on the electrification project, and (3) the heterogeneity of livelihoods of targeted households. We were then able to clarify what the environmental service and governance scheme could be. The main results show the necessity of going beyond economic and hydrologic rationales that usually underlie watershed-based PES development. In conclusion, we point out the main elements that underlined the design of a pro-poor PES scheme able to accompany or promote the changes that are advisable for agriculture in the forest frontier.

1. Introduction

The most widely used definition of payments for environmental/ecosystem/ecological services (ES) is that of Wunder (2005): *Payments for Environmental Services are voluntary transactions where a well-defined environmental service is bought by an environmental service buyer from an environmental service provider if and only if the environmental service provider secures environmental service provision.* PES were designed to translate external, non-market values of the environment into real financial incentives for local actors to provide ES (Engel *et al.*, 2008). They are based on the beneficiary-pays – rather than the polluter-pays – principle and, as such, are attractive in settings where ES providers are poor. As a consequence, in developing countries there has been much enthusiasm over this new tool, perceived as an alternative to indirect approaches for natural-resource management such as ICDPs. PES are commonly promoted as "win-win" solutions for conservation and development, although there are few examples of successful schemes. Many authors argue that is necessary to pay more attention to addressing the constraints to implementation and to the design process needed to reach equity, efficiency and efficacy in the context of poor rural communities and high pressure on natural resources (Pagiola, 2007; Leimona and Lee, 2008; Petheram and Campbell, 2010).

In this research, we explore perspectives of poor people living in the forest frontier, where introduction of watershed-based PES is being considered. In order to switch from theoretical principles to a really innovative management tool addressing local issues, we argue that it is necessary to co-define the PES, i.e., to anticipate collectively the problems that may be encountered in ES delivery and co-develop solutions with local stakeholders. The study site is located in a rainforest in eastern Madagascar, where a hydropower project is coming up. An action-research program was undertaken to explore the feasibility of a pro-poor watershed-based PES mechanism. This paper present some results from this program. First, we review questions and challenges in designing pro-poor watershed PES mechanisms. Then we present the social, environmental and economical contexts of the Tolongoina hydropower project. The main objectives and constraints to implementing a PES contract are then highlighted. In the third part, we explain the methodology we constructed based on a participatory framework. The results concern the main requirements that appeared important in designing a pro-poor watershed-based PES mechanism. In conclusion, we discuss the potential role for the PES tool in accompanying or promoting the changes that are advisable for agriculture in the forest frontier.

2. Designing a pro-poor PES mechanism: questions and challenges

PES was not initially conceptualized as an approach to alleviate poverty (Pagiola *et al.*, 2005). Many authors insist that poverty alleviation should not be considered a primary goal in its implementation (Wunder, 2005). However, some authors argue that conservation and poverty alleviation are inseparable and the impacts of PES programs on livelihoods must be taken into consideration (Landell-Mills and Porras, 2002; FAO, 2007). Nevertheless, these impacts remains variable, non-generalized and depends on several factors (Pagiola *et al.* ,2005). Key questions remaining unanswered include: whether or not business transaction-based mechanisms such as programs that pay for forest conservation or water protection can, in fact, contribute to both environmental conservation and poverty alleviation in particularly poor regions? What major limitations are likely to emerge? A viable solution is to design PES mechanisms that more specifically take into account, from the very beginning, the needs of poor smallholders to improve their livelihoods and address the constraints preventing them from doing so. To date, research and practice on PES mechanisms has largely been led by economic, political and ecological approaches at regional and international scales to address theoretical issues of effectiveness, equity, and efficiency. PES is a relatively new mechanism, and knowledge about it is rooted as much in the theoretical as in the empirical. There have been few instances of research focusing on the socio-economical and agricultural drivers at the household and community levels that could help evolve theoretical PES schemes from market-led conservation tools to local development ones. A review of the literature shows that those research efforts undertook mainly exploratory forays with regards to a fictitious PES. Two types of questions are usually addressed:

- Which groups of farmers are able or willing to participate in and benefit from a potential PES mechanism, in terms of costs and benefits (Kerr, 2002; Tschakert, 2004; 2007; Sommerville *et al.*, 2009)?
- Which processes and features will enhance the long-term adherence of local people to a PES program (Georgiva *et al.*, 2003; Pagiola *et al.*, 2005; Petheram and Campbell, 2010)?

Those studies did not really question the appropriateness of the tool with respect to local development issues. They tried to fit a social reality into a theoretical economic framework. PES is assumed to contribute to reducing poverty through the payments themselves, which are assumed to go mainly to poverty-stricken land users. In that case, income from PES might have a positive impact on local livelihoods if opportunity and transaction costs are carefully considered and if long-term contracts are signed – given the small amounts of payments per year. Besides, it is the characteristics of the concerned areas where PES programs are implemented that shape the relationship between PES and poverty alleviation: those studies mainly dealt with rewarding poor communities in rural areas with land rights

within state-owned and protected forests. In those cases, PES programs might enhance farmer livelihoods and also increase equity among communities and households. In other less "suitable" situations (very poor people who do not own or control land), Porras *et al*. (2008) found that *"the cash payments appear to be relatively insignificant, and there is an opinion that they function more like supports or a bonus than a real incentive for land-use change."* Wunder (2008), Porras *et al*. (2008) and Bond and Mayers (2010) all cite non-income gains as significant PES benefits. These include strengthened property rights, capacity building, and improvements in social organization. Bond and Mayers (2010) caution, however, that *"these effects are rarely specific to payments for watershed services and could potentially be generated through alternative actions."*

We assume that a PES scheme is pro-poor if it delivers ES without compromising future livelihoods of the poor (Tschakert, 2004; McElwee, 2009). By adapting the concept of ES locally for poor people, i.e., by taking into account livelihood strategies, households 'needs, local resource management norms and stakeholders expectations, we propose to go deeper into the principles that underlie a "pro-poor" PES.

3. Background information on agriculture, conservation tools and hydropower project in the study area

3.1. Previous history of the hydropower project

The study site is located in the agricultural frontier of the rainforest in eastern Madagascar. In the province of Fianarantsoa, one of the poorest in Madagascar[1], the Commune of Tolongoina is located in the lowlands on the eastern fringe of the forest corridor at an altitude of 500 meters, where live the Tanala ethnic people (Figure 1). The Tanala region is characterized by traditional land use based on shifting cultivation (rice and cassava) on sloping lands, known as *tavy*. Migration of Betsileo people from the western forest fringe to the Tanala region is ongoing today. The Tanala are not simply forest tribes practicing slash-and-burn agriculture. They also have experience in both lowland and upland rice cultivation. But as they have been repeatedly marginalized and removed to remote areas, they have never had the opportunity to establish permanent settlements. Land use is thus more a question of the physical environment and economic resources than a matter of culture and traditions (Serpantié *et al.*, 2007). Establishing sustainable paddy fields is a long process that can take generations, especially in this mountainous region where there are no large plains. Political instability and conflicts further prevent farmers from increasing their social and economic capital.

[1] In 2001, the poverty rate bordered on 80%, and 85% of the population lived in the countryside and was dependent on agriculture to make a living (INSTAT, 2001)

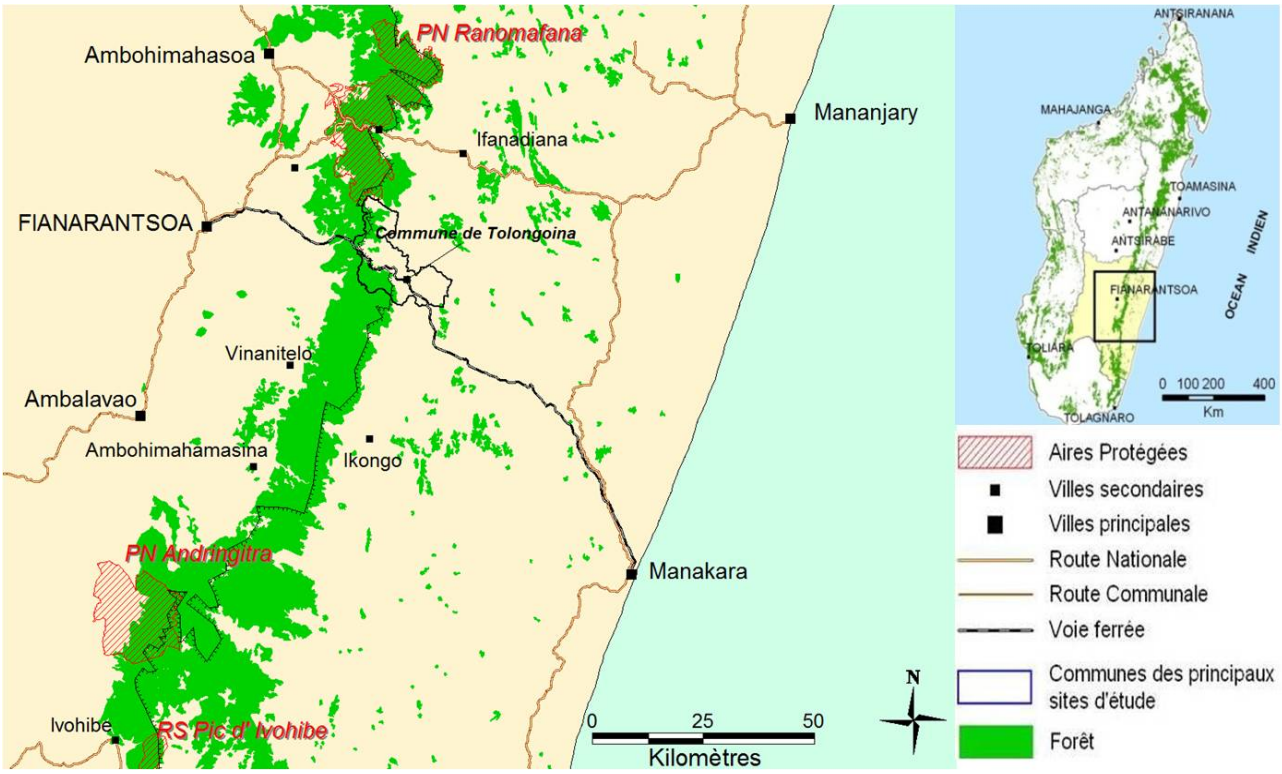

Figure 1 : Location of the Commune of Tolongoina in the forest corridor region

Since the 1990s the region of the forest corridor has undergone numerous ICDPs, mainly led by USAID. Under the *Gelose* law (1996), community-based forest management (CBFM) contracts have been entered into in village territories. In view of the unsatisfactory impacts of CBFMs on the improvement of livelihoods (Toillier *et al.*, 2011), USAID encouraged the exploration of economical valorization of the forest corridor in the early 2000s. Valorization of the water resource through a hydropower project has been quickly identified as a promising opportunity for both managing conservation and boosting development. In 2008, the RHYVIERE[2] program, aimed at developing micro hydropower for rural electrification, chose the commune of Tolongoina as one of its seven pilot study sites. This program is being implemented by the French NGO GRET[3] in partnership with ADER[4] and Energy Assistance. In this framework, GRET decided to implement a PES mechanism, which appeared as a suitable tool for guaranteeing the financial, social and technical sustainability of the hydroelectric microplant. They asked researchers[5] to develop an exploratory approach to design a pro-poor watershed-based PES scheme.

3.2. What is at stake in terms of local development? Current agriculture changes and environmental issues

In this region, and particularly in the Tolongoina commune, conservation policies have strenghtened agricultural transition processes (abandoning of slash-and-burn cultivation, intensification) and exacerbated disparities among rural communities.

The so-called “ICDPs” did not manage to offer substantial alternatives to the restrictions of forests use, which related to the extraction of forest resources for commercial activities; protection of woody fallows;

[2] Village Hydroelectric Network: Energy and Respect for the Environment, a 4-year program (2008–2012) funded by the European Union
[3] Group for Research and Technological Exchange
[4] Malagasy Rural Electrification Development Agency
[5] IRD-C3EDM SERENA program

banning of slash-and-burn practices and banning of forest clearing. In addition to the CBFM rules, from 2008 onwards, USAID convinced the Commune to adopt a new law banning fire use within the watershed. According to it, there were obvious links between the rate of flow, water quality and slash-and-burn practices. This law put an end to bean cultivation and reduced cassava yields. In consequence, relationships between watershed inhabitants and local authorities became tense. Toillier and Lardon (2009) showed that the farmers' capacities to adapt to the new rules were very heterogeneous, and conservation policies exacerbated disparities within the local population. While a few households managed to convert their traditional farming systems, based on shifting cultivation and rainfed hill rice, into a more diversified farming system combining rice fields, animal husbandry, cash crops and hill rice or cassava, others who found it more difficult to do so could rely on the traditional values that still underpin the extended family, in which sharing is obligatory and emergency help is assumed to be always available. Unfortunately, households located in the forest corridor and strongly impacted by the conservation measures because of the more restricted living conditions, were those of migrants from Betsileo country. In addition to increasing inequalities among households due to structural characteristics (household and farm characteristics, farmland structure), conservation policies exacerbated disparities and conflicts between the upland Betsileo migrants and the lowland autochthonous Tanala.

Furthermore, the watershed of the hydropower project is located in the uplands of the Tolongoina commune (***Figure 2***), where Betsileo migrants are settled. Many drivers led farmers to intensify their farming systems or to transgress conservation rules. On the one hand, climatic conditions are unfavourable to the standard Tanala hill rice and cassava varieties (Serpantié *et al.*, 2007). Low yields induce farmers to extend their farmland and to shorten crop-fallow rotations. On the other hand, the land available for agriculture is very limited due to constant demographic pressure, which also induces farmers to explore intensification options, for example, using plowing for ginger cultivation, which might increase erosion processes. The agricultural changes underway raised several questions on the sustainable management of water resources for the hydropower project.

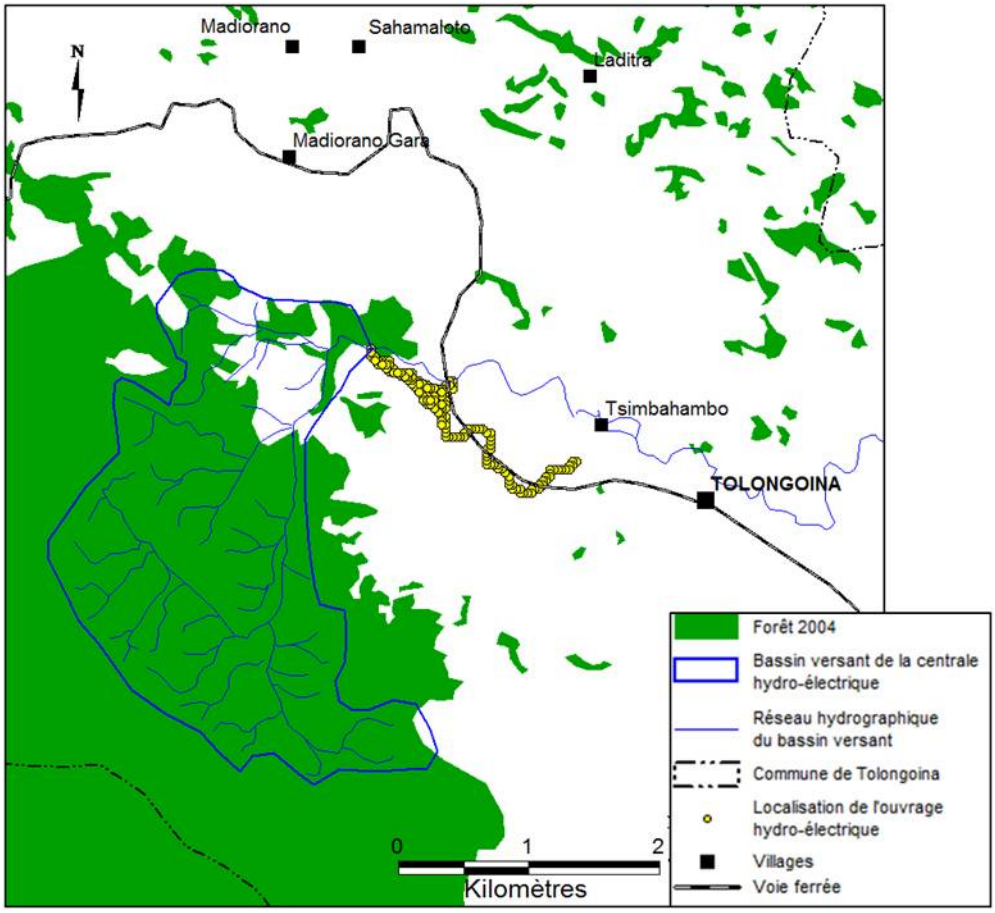

Figure 2 : Location of the watershed of the hydropower and the hydroelectric network

3.3. The expectations of the hydropower project's promoters from the PES tool

In this context, the RHYVIERE program decided to explore the possibility for a PES mechanism to address three main challenges:

- To ensure the provision of hydrological services for the technical functioning of the hydropower microplant, i.e., the maintenance of a stable streamflow during the dry season, reduced peak flows and a lower overall sediment yield (*technical perenniality*);
- To take into account the pre-existing social inequalities and conflicts among local communities described above, in particular the fact that the potential service providers are migrants who will not have access to electricity (the electricity network spreads only down the hill) and are already confronting additional constraints on their agricultural practices; the PES scheme must not increase conflicts, should help to reduce disparities among households by strengthening their adaptation capacities in a context of strong environmental constraints and should also lead to an improvement in the livelihoods of households (*social perenniality*);
- The cost of the PES mechanism should not threaten the profitability of the power plant, i.e., the cost allocated to the ES payments should not jeopardize the investments made by the private hydropower producer (*financial perenniality*).

4. A methodology based on the co-design of both environmental services and the governance scheme

The aim of this research was to develop a field-rooted approach to build a PES scheme addressing the different challenges listed above. Our approach fell into two steps: 1) the co-definition of environmental services; 2) the co-design of a governance scheme.

First, we assumed that both a shared representation of reality and an effective empowerment of local stakeholders form the basis for any collective action and also for a fair PES (Garcia and Lescuyer, 2008). We defined the co-design of environmental services as an iterative learning process between researchers and local stakeholders, based on the confrontation between hydrological theory and empiricism, local knowledge and observations of agricultural practices. This shared knowledge is supposed to facilitate a common understanding and definition of environmental services. It encompasses transdisciplinary studies in agronomy, hydrology and the social sciences. The hydrological behavior of the watershed has been modeled using low-cost data at the lowest water level, base flow and flood surveys (water and sediment load) within two sub-watersheds – one forested and one cultivated (Serpantié *et al., ongoing*). Research methods for accessing local knowledge included individual and group interviews and participant observations. In-depth interviews were conducted at the farm level in order to generate a representative typology of the diversity of livelihood strategies in the targeted watershed. Workshops were conducted regularly in order to report back and discuss research results with stakeholders, to facilitate the learning process and to provide insight into households' perspectives within a PES mechanism. Field studies were conducted from 2009 until now. Second, the co-design of a governance scheme took the form of consultation with the main social organizations that appeared to be involved in the PES scheme for defining environmental services. The NGO remained a leading actor in this design process and helped maintain coherence between procedures for decentralizing electrification, pre-existing environmental contracts in the Commune and the legal framework. Our aim was to identify the main issues – and arrive at results – for driving the design of the PES scheme and for mobilizing the stakeholders at each step.

5. Results

We highlight the key elements of the co-design approach by focusing on results of (1) the different stages of collective learning, (2) the knowledge used to take decisions at each stage, and (3) the main controversial topics raised by stakeholders. Results are divided into three parts: the nature of the ES taking into consideration hydrological data, agricultural dynamics and farmer expectations; types of payment; and the scheme for governing the PES mechanism.

5.1. Nature of the ES

A long-term management issue regarding the hydrological model and agricultural dynamics

Confrontation between our hydrological data and farmers' knowledge invalidated the NGO's beliefs on the links between deforestation and the drying up of springs, and between *tavy* and erosion. An undisturbed forest actually did not guarantee clean and regular water, conservation of dry season baseflows, or a great reduction in storm flows. The agriforested sub-watershed showed quite the same results in terms of hydrological services for hydroelectricity production. Agricultural practices only moderately impacted the rate of flow: an increase of 40% in water flow during moderate floods, no effect on sediment load, but an increase in landslides during cyclones. Lowest water levels were better in the agriforested sub-watershed than in the forested sub-watershed. Moreover, those moderate positive and negative effects of the agricultural area (which represents $1/6^{th}$ of the total watershed area) altered only very slightly the water quality and quantity at the outlet in the short term. Nevertheless, our hydrological model did show that a deforested watershed would significantly alter hydrological services. According to the current agricultural dynamics, the real threats to water services would then instead appear in the long term. Watershed management for the provision of hydrological services would then consist of delaying the savannization

process and the concomitant erosion phenomena and of halting deforestation, i.e., in observing current rules (no fire and CBFM contract).

Diversity of upstream farm households, understanding of ES and expectations

To generate a representative sample of the diversity of livelihood strategies and household needs with respect to constraints planned for the ES, we applied a typology based on criteria related to (1) farm characteristics: household demographics, household assets, cropping system and labor allocation, (2) farmland structure and use, and (3) constraints perceived as arising from the ES. The typology is composed of four types of households (Table 1).

ES was understood mainly through the provision of electricity. Households considered that they would do a favor to people downstream because even if they made an effort to adapt to rules they themselves would not get any electricity in return. They called it "*fanasoavana*," literally, "mutual aid."

The majority of famers said that they would be willing to change their agricultural practices in order to protect water resources. But there were differences between households type. Types 2 and 3 explained that they had already attempted to adapt their farming systems to bans (slash-and-burn and forest protection) and that they would need support since they did not know how to grow bean or cassava without using fire. They also did not know what kind of new cultivation could be adapted to the local context. Type 2 households mainly asked for technical and financial support whereas type 3 households split into two groups: those who mainly asked for technical support, new profitable cultivation and the right to use fire; and the others who did not express any specific needs except to be able to keep their lands. Type 1 households could not specify what changes they could make and did not consider themselves service providers. They mainly asked for financial support. Type 4 households were not really bothered by conservation rules in the watershed and did not expect too much from a PES mechanism.

Household type	**Livelihood strategies**	**% of total upstream farms**
Type 1	Small-sized farms that were primarily concerned with acquiring enough income to satisfy daily necessities, especially through off-farm employment.	24%
Type 2	Large, scattered farms that combined cash crops (banana, sugar cane, coffee) and food crops (cocoyam, cassava, sweet potatoes, rice). However, cash crops are slow-moving goods because of the distance to markets and unavailable labor force; loss of expected income is offset by off-farm employment.	39%
Type 3	Mature, well-capitalized households, with rice fields and large banana fields that are farmed thanks to off-farm workers. The sale of banana and rice production covers household needs. Their farming systems are the most diversified, with breeding activities (cattle, poultry and sometimes pigs) and experimentation of new cash crops adapted to local conditions (ginger, pineapple).	28%
Type 4	Farms located downhill which own crop fields in the watershed. They mainly cultivate bananas, cassava and cocoyam in order to assert the ownership of lands.	9%

Table 1: Upstream household types and livelihood strategies

A consensus on the PES mechanism's goals: to strike a balance between electricity beneficiaries and electricity non-beneficiaries

According to field studies, the main goal for a pro-poor PES mechanism would be to restabilize a social context between winners and losers resulting from conservation and development measures (forest conservation and provision of electricity). Since upstream farmers had to adapt to a number of bans without any compensation, they considered themselves as losing out. In their view, the PES mechanism should offer both incentives for the future and compensation for the past for "good environmental management" of the watershed. Compensation is expected for past efforts in conserving forests and in changing their agricultural practices following CBFM contracts (2003) and fire-use bans (2008). The adoption of new agricultural practices that would stop savannization processes required new incentives through technical and financial support.

5.2. Types and modes of payment

Among households located in the watershed, a consensus emerged about the need to decide by themselves the allocation of PES funds: no direct payments to individuals but collective decisions to choose activities to be financed for each household type. They also asked for there to be no intermediaries involved in the payment mechanism; they wanted to be directly linked to the service beneficiaries. They agreed with the idea of perhaps financing technicians for training on or support for specific activities.

Participatory workshops helped clarify the nature and mode of payments. It emerged that the main cultivations all households voluntarily wanted to improve and intensify were food crops (cassava and bean) and cash crops (bananas and coffee). Household types did not react in a similar uniform way to proposals for diversification of activities. Smallholders (type 1) and farms with small labor forces (type 2) preferred poultry breeding whereas large farms preferred new cash crops such as peanuts. These results were confirmed by the first technical support aimed at compensating farmers for past efforts. Their choices were consistent with previous analyses. The potential activities that could be funded by a PES scheme and their acceptability by household type are shown in Table 2.

Activities	Targeted household
Technical training with field visits and experiments	Types 2 and 3
Support for the creation of collective organizations (co-operatives for storage, marketing; nurseries) and for connecting with markets	All
Support for individual farm management (management advice)	All
Easier access to credit, fertilizer, seeds and plants, equipment	Types 2 and 3
Easier access to other lands outside the watershed, especially for cultivating food crops	Types 1 and 4
Priority in off-farm employment offers	Type 1
More communication and information about technical changes, research results and the PES mechanism	All

Table 2: Activities that could be funded by PES and their acceptability by household type

5.3. Governance scheme

Two site-specific governance issues emerged based on the definition of ES, PES's goals and farmer expectations:

- What is the role of the Commune given that it is both a service provider (as the guarantor of sound, long-term environmental management within its territory) and a service beneficiary (as an electricity user)?
- How to link together the CBFM contract and the PES contract? ES provision consists of combating processes of savannization and deforestation. Since CBFM regulations aim at protecting forests through forest guards and sanctions, they overlap with ES provisions.

These issues have been discussed between the Commune, the NGO and researchers. Governance choices have been made step by step, on the basis of various criteria. First, the NGO won acceptance for its approach of local development within the framework of the Rhyviere program. The program encouraged the empowerment of the Commune as a move towards decentralization and to strengthen local capacities. GRET proposed using the municipal tax applied to electricity bills in order to fund PES. The law planned a communal tax of 10% on the price of electricity to fund activities of public interest related to electricity distribution. This scenario offered two main advantages. First, the use of communal tax allows the PES mechanism to be backed by a legal framework. The Commune would become a legitimate intermediary between the private hydropower producer and service providers, by refunding a part of the tax to the association of watershed users. Second, the responsibility of long term environmental management would reside with the Commune and not with the private producer, who only has a medium-term concession contract. ES costs would be covered by the difference between the funds available (depending on the number of electricity users) and the cost of activities to be undertaken in the watershed.

The governance scheme is shown in **Error! Reference source not found.**. An association of representatives of watershed users, i.e., the presidents of COBA and farmer leaders, would receive cash payments and collectively decide on the allocation of funds according to the activities mentioned in the PES contract. The payments and activities undertaken would be monitored by the association of electricity users. Payments would be conditional on rules being followed. Violations of the main land-use bans (no fire, no deforestation) would be punished according to the rules of the valid CBFM contract and/or the rules of the Commune.

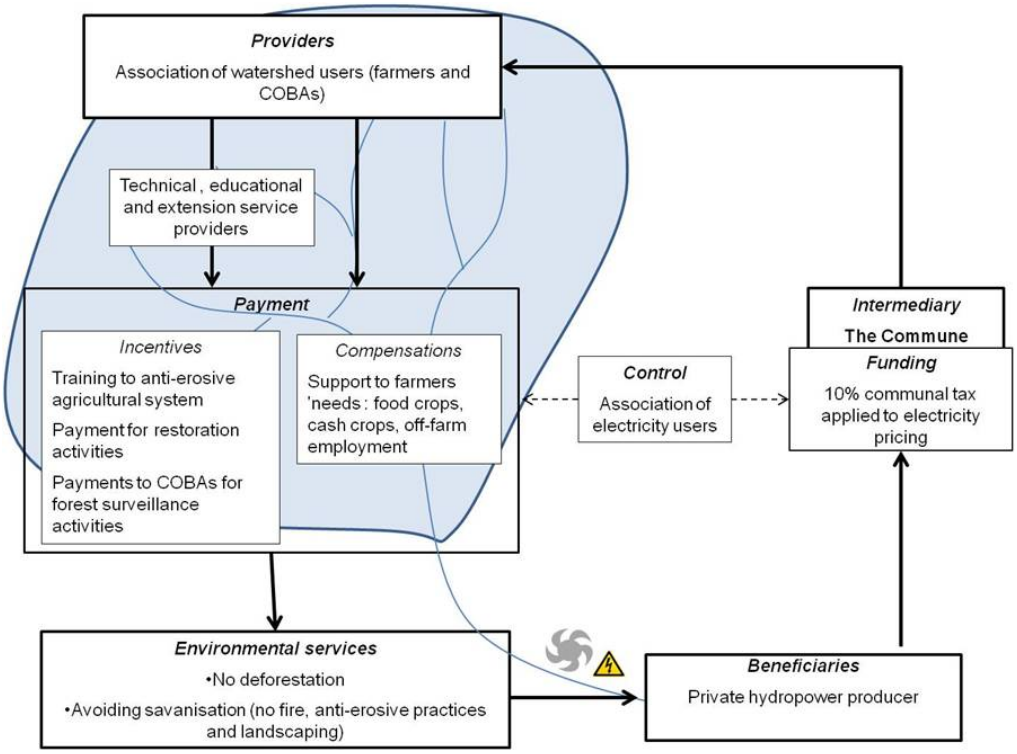

Figure 3: governance scheme

6. Discussion on and insights into pro-poor PES design

The outcomes of this study are discussed in terms of the overall objectives of this research, i.e., present lessons learnt from an action-research approach to accompany the design of a pro-poor PES mechanism and from participatory methods to explore the needs and expectations of poor people in the forest frontier.

6.1. An action-research approach to accompany the design of the PES mechanism

The cooperation between researchers and a development program led by an NGO was a suitable framework to explore whether a PES mechanism could be flexible enough to address local development issues. The keen interest of the local population in electricity supply and the driving role of the Commune in a decentralization process allowed a genuine mobilization of ES providers and beneficiaries in the co-design process. We were then able to overcome the usual theories about the willingness to participate of local people or their acceptance of a theoretical PES scheme. Indeed, the PES scheme was really designed and tried out step by step. Our approach drew from action-research principles and concepts (Neef and Neubert, 2011), in that the primary researcher was involved with local people in exploring their situation. This encouraged reflection and learning, and led to a deeper analysis of their views and future options within a PES scheme. Our results indicate an important role for cognitive interventions alongside structural ones: participatory and low-cost hydrological data surveys; participatory research in farmers' fields to examine erosion processes; collective agro-ecological diagnoses based on local knowledge; step-by-step agricultural technical support; the creation of local associations; and co-design of management rules. Such integration has never been extensively undertaken and needs to be further conceptualized in order to make it reproducible.

6.2. To reconcile perceptions of the public and of science of the role of forests in water services

The main result lies in the hybrid definition of ES. The combination of biophysical characteristics of targeted hydrological services, local knowledge and agricultural dynamics demonstrated to all stakeholders that it is a long-term management issue. Consequently, the PES mechanism will primarily act as a preventive tool to fight against the potential risk of savannization of the watershed. These results enabled the farmers' environmental responsibilities to be reduced in the short term and also reduced the risks of social stigmatization in case of serious damage, e.g., due to a cyclone. Moreover, these results are consistent with local knowledge, but not with common ideas about "regulated forest services," which refer to environmental orthodoxy (forests as water springs). The disparity between stakeholder perceptions must be addressed before financing mechanisms for forest conservation and before devising, developing and promoting agricultural changes. Indeed, if environmental measures are implemented independently of rooted knowledge, farmers simply will not cooperate or follow new rules. Many authors have shown that, generally, conservation tools for natural resource management are not sustainable unless there are clear interests for local populations (Bertrand *et al.*, 2008; Cranford and Mourato, 2011).

6.3. Providing a service or doing a favor? The true nature of pro-poor PES

The farmers' understanding of ES according to their culture, lifestyle and economic realities, confirmed the fact that direct payments to individuals are not a desirable feature of poverty alleviation tools or environmental management ones (e.g., Farley and Costanza, 2010; Sommerville *et al.*, 2009; Cranford and Mourato, 2011). Most of the farmers understood ES as doing a favor to the people downstream. Even though sharing and mutual aid remain fundamental values to these societies, farmers wanted incentives for future changes and compensations for past efforts in order to support and reinforce their strategies of adapting to conservation. But above all, farmers wanted a management tool to help realize their own development objectives. Targeting households with measures and activities that take into account their specific land-use dynamics, socioeconomic needs and adaptation capacities emerged as a suitable solution. These results strengthen the idea that watershed-based PES without hydrological and social foundations cannot address environmental issues in a sustainable way, nor help improve livelihoods. They also confirm Polanyi's (1957) assertion that aspects of nature are ''resistant'' to commodification due to their unique physical and social properties. A pro-poor PES specifically requires a systemic approach for successful implementation and its promoters cannot avoid a deep-rooted approach that will lead to a conveniently tailored mechanism, adapted to local norms, issues and expectations.

6.4. An "asset-building" PES as a tool to promote advisable changes for agriculture in the forest frontier

The project to co-design the Tolongoina PES scheme suggests a series of potential responses to key questions about suitable policy tools to accompany agricultural transitions in the forest frontier.

Given the agro-ecological conditions of the eastern rainforest in Madagascar and the growing demographic pressure, practitioners of agronomic research and providers of technical services have no sustainable farming system to propose yet. The farmers' knowledge also showed its limitations. This transition stage requires experimentation, both in the technical and the organizational fields. Technical experiments will help develop agro-ecological farming systems adapted to local economic and ecologic constraints. Organizational experiments are related to the search for new institutional arrangements based on new relationships that emerge between stakeholders in a resource-conservation context. In both cases, long-term approaches are necessary, but various activities must be considered: short-term activities in order to respond to the farmers' urgent needs (to eat, to clothe themselves, to access health services, to send children to school, etc.) and long-term investments that are aimed at transforming farming systems in a sustainable way. To sum up, gradual, systemic, local and scientific knowledge-

rooted and long-term approaches are needed to address challenges of the agricultural forest frontier. We showed that an "asset-building" PES[6] mechanism embedded in a participatory and systemic approach framework is flexible enough to address those challenges. PES rhetoric allowed the mobilization of local people concerned about an unfair socio-economical situation with losers and winners. Then co-designing the ES allowed the PES to be tailored more effectively to the needs of the poor smallholders. Further studies will be needed to explore the long-term effects of PES on environment and the welfare of farm households.

In conclusion, we call for further research to explicitly include from the beginning agricultural issues and local stakeholders in PES mechanism design.

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[6] Wunder (2005a) coined the term "asset-building" PES when ES providers receive payments (not necessarily monetary transfers) conditional on investing in alternative activities that are conducive to the permanence of the ecosystem service.

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