ENVIRONMENTAL PROSPECTIVE IN KODAGU (KARNATAKA, INDIA)

HOW TO ENHANCE BIODIVERSITY AND WATERSHED RESOURCES MANAGEMENT?

POST MASTER PROGRAMME "INTERNATIONAL MANAGEMENT, NATURE AND SOCIETY"

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Summary

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Foreword

The collective training period in India brings together the eight students of the Advance Master “Forest, Nature and Society”, option “International Management, Nature and Society” of AgroParisTech university (APT). The staff is composed of one researcher of the AgroParisTech training and research team “Environmental Management of Ecosystems and Tropical Forests”, Pierre-Marie Aubert, and one pedagogic and logistic manager with previous experience in this training field, Jérémy Vendé. The Indian partners are the College of Forestry of Ponnampet (University of Agricultural Sciences) and the French Institute of Pondicherry.

This training period is first of all an educational exercise. It is preceded by three weeks of preparatory work in France, focused on Strategic Environmental Management Analysis (SEMA) and on the global value chain (GVC) of the coffee to apply in Kodagu. Three weeks were spent in the field. Then one week is allocated to write this report on our return to France.

This is the second time that the team has come to India for this particular exercise. Students have been able to elaborate on 2011’s work to carry out their study and go further in understanding biodiversity management.

Coming back to India was also an opportunity for AgroParisTech to strengthen its partnership with several Indian institutions: the University of Agricultural Sciences of Bangalore, College of Forestry Ponnampet, the French Institute of Pondicherry, and ATREE.

Introduction

The challenges of biodiversity and water issues in a global context

Our study, an Environmental Prospective, takes place in the Western Ghats area in south-west India: The Kodagu district, a part of Karnataka State. Kodagu is endowed with magnificent forests which are considered to be a unique ecosystem in the world for many valuable tree species, and has a high rate of endemism. As such, the district is included in one of the 35 world biodiversity hotspots as defined by Conservation International (Myers and al. 2000).

Nevertheless forests remain an important source of livelihood for people. 554,762 people lived in Kodagu in March 2011, that is to say 0.91% of Karnatakas population. With a density of 135hab/km², Kodagu is one of the least populated areas in the state because of the specific topography, the high precipitation regime and the dense forest cover (Ramakrishnan, Chandrashekara et al. 2000). The decadal demographic growth rate was very low (1.13 % from 2001 to 2011) compared to the decadal growth rate of the Karnataka (15.3%) (Census of India 2011).

In this district, coffee has been the main agricultural crop and source of export earnings for the last 100 years. Economic activities are mainly oriented towards coffee cultivation, using complex agroforestry systems. These Coffee Agroforestery Systems (CAFS) are known for their environmental quality. Indeed, planters have mainly kept coffee under shade to prevent damage to the coffee bushes during the long dry season. The composition of the canopy cover can be quite similar to the one from nearby forest fragments. As a consequence, biodiversity in coffee estates is higher than in most coffee plantations overseas (Ambinakudige and Satish 2008). However, over the past decade, these Coffee Agroforestery Systems (CAFS) have been subject to important intensification through the use of chemical fertilizers and pesticides, the decrease of tree cover fraction and the development of irrigation. This has led to different environmental problems: biodiversity loss, increased “human elephant conflict”, and soil erosion.

The Kodagu district is also well known for the importance of its protected areas. These are spread across several forest types ranging from evergreen to scrub type forest, representing different eco-systems, each containing rare and endangered species of plants as well as animals and birds (KFD, 2006). In order to mitigate environmental and erosion problems, major initiatives have been launched by the Government of India and by Karnataka state for protection of biodiversity (Project Tiger in 1998, Project Elephant, The Karnataka Sustainable Forest Management and Biodiversity Conservation project…).

One last important factor for natural resources management in this district is that it contains the source of one of the major rivers of Southern India, the Kavery. Originating in the west, the Kavery flows through the district and irrigates the surrounding hills, providing water for

big cities like Bangalore, before reaching the Bay of Bengal after irrigating the rice plains of Tamil Nadu. Millions of people depend on the Kavery for their livelihoods: 8 425 000 in Bangalore and 800 000 in Mysore. Moreover, the bulk of the Kaverys flow is in Kodagu, which leads one to question the water management in the district.

From our point of view, biodiversity and water resources management are the two most important issues for Kodagus future. Last year, students from AgroParisTech concentrated on drivers for biodiversity conservation (coffee market, tourism industry…), but didn't yet identify the role of the link between biodiversity management and water resources.

The aim of this study is, first, to understand and analyse actors' strategies, their interactions, and the effects of actual management systems on Kodagus forest ecosystems, their biodiversity and water regulation. Secondly, we aim to explore how management could change in order to counter biodiversity loss and to allow ecosystems to regenerate to a significant level.

What we wanted to get is an environmental prospective of management systems that could prevent destruction of biodiversity and degradation of water resources quality and quantity:

How environmental management arrangements could enhance ecosystems ecological state in the Kodagu?

Our work will be divided into four main parts: at first our methods will be presented (i). Then the territorial diagnosis will distinguish the actual management from the intentional management (ii), followed by a prospective exercise in which four original scenarios -based on structural hypotheses- will be identified (iii). Finally, the results and debates produced by the two restitutions of our work, at the College of Forestry (Ponampet) and in the University of Agricultural Sciences (Bangalore), will be discussed (iv)

Methods

This environmental prospective is first a social sciences educational exercise, using the Strategic Environmental Management Analysis framework (Mermet & al., 2005, Mermet, 2011). This framework allows us to analyse the environmental dimension of complex environmental management situations. The direct application of this framework is intended to guide the diagnosis of an environmental field situation with conservation problems to be resolved (Leroy, 2006, Taravella, 2011).

The field study focuses on the actors' strategies, their interactions, and their effects on Kodagus forest ecosystems and biodiversity.

There are five themes guiding this environmental prospective:

- Founding the analysis on scientific data and field interviews;
- Founding the analysis upon environmental issues: water and biodiversity;
- Identifying Kodagu actors' practices (farmers, tribes, inhabitants, administration, NGOs);
- Identifying the existing devices to tackle the negative impacts on the environment;
- Understanding and analysing the actors practices and intentions (action system) up to national level.

The specificity of this approach stems from its environmental standpoint, chosen as a normative reference to study the social and economic functioning of the area. This preconception seeks to propose environmental efficiency criteria as a foundation for further analysis and projections into the future. This means identifying the social institutions from the perspective of their environmental impacts on the ecosystems.

First, we'll define our prospective approach and explain its added value with respect to other forecasting studies. Second, we'll explain the articulations between strategic analysis and prospective through an interview-based methodology combined with bibliography and ecological data. Finally, we'll develop the different steps of the methods to reach the four scenarios of the future of the territory.

An original approach to prospective

The objective of prospective thinking is to explore long term changes that may occur for a given social and ecological system. In our view, the first step of a prospective study is the elaboration of assumptions about the future of this system. This step has to be followed by a second one that consists of opening a discussion about these assumptions between actors involved in the system (Mermet, 2005).

For this, our methodology relies on a four step approach:

1. Outlining the critical tipping points that can affect the whole system;
2. Calling upon peoples imagination through interviews to identify possible levers of

action;

3. Building contrasted scenarios based on strategic assessment;
4. Triggering debates with our interviewees on possible futures.

Therefore, questioning the future is not the ultimate goal of this analysisbut a way to address new questions and possibilities, through debates and discussions of the scenarios with the stakeholders. Also it is important to underline that a prospective is not a prediction of the future, nor a planning exercise,

Objectives

Participating in collective knowledge and triggering debates

Our prospective here is a way to present a broad picture of the different strategies adopted by the stakeholders, underlying their possibilities in the long term. We expected to generate some collective knowledge, some transparency and some motivation from those involved in environmental issues.

Discussing the scenario is a constitutive stage of the territorial prospective exercise. The idea is to involve the different stakeholders of environmental and development projects in an open debate. Indeed, each actor involved in preserving the environment has their beliefs and ideas of what might or might not work from the point of view of their own analysis.

If collective actions for environmental protection are already structured throughout constituted networks, the added value of such a discussion can be to outline new possible alliances or in this case new possible management devices.

Storytelling about possible future dynamics

Our scenario building method distinguishes the present diagnosis and the future picture of the territory, or its synchronic description, from the progression, or its diachronic analysis. The two temporal landmarks – present and future – outline the temporal boundaries of our scenarios. These original pictures result from past and present trends occurring in the territory. Therefore it is necessary to establish a diagnosis, as a basis for the scenarios. It has to be accurate and synthetic enough to be used as a starting point for the different possible progressions of the system. The idea is to be able to precisely describe the path leading from the present situation to contrasted future pictures of the territory with a 30 year temporal horizon (Mermet & Poux, 2002, Poux, 2005).

To describe both present and future images of the landscape, as well as possible progression from one state to another, our methodology relies on several types of data, among which interviews are of a critical importance.

A strategic diagnosis to understand the territory

From an ecological standpoint

Our research standpoint implies a clear formulation of the environmental issues that are the reference for analysis. To be relevant, this ecological reference has to be defined by specific and accurate criteria, upon which is it possible to base a qualitative judgment on the state of the environment. Here, we'll focus mainly on biodiversity and water conservation with two main indicators for each concern: tree cover in forested areas and biodiversity in coffee agroforest for the biodiversity issue and water resource quality and quantity for the water issue.

To draw up this referential, we started with a revue of grey literature regarding the Kodagu agroforest system, watershed management, and water linkage with the forest; then from the field, we collected actors' points of view about their practices and their impact on biodiversity and water uses. Then, we tried to identify the most noticeable dynamics over the past years. These discussions were coupled with ongoing bibliographical work on national regulations, environmental management arrangements and ecological data obtained from many different sources such as national and international research institutes, National universities of sciences, some state departments and local actors.

From actual management to intentional management

The ecological referential serves as a starting point to understand the territorial structure, i.e. how actors take actions, devise strategies, and form alliances between each other. The main idea is to delineate the intentional management from the actual management of the environment. The actual management encompasses all the activities which have an impact on the ecosystems. Studying the intentional management is to look at what the stakeholders' actions are when planned with the purpose of moving towards a better environment as far as biodiversity and water are concerned.

Interviews to understand the present and speak about the future

The second step of the research process was to conduct interviews with different actors in the Kodagu territory. Our objectives were to understand their own stakes, their short and long term strategies, their interactions with the other stakeholders of territory. Based on these first objectives we had to understand the actual practices of each actor and then their intentional management as well. With all the information, we could extract key variables of change. These key variables were combined with ecological data in order to build scenarios.

Interview Guidelines

The main requirement for an interview is to establish a symmetrical relationship between the interviewer and the interviewee. To achieve this goal, the idea is to introduce ourselves and deliver the information we have on the subject.

We globally organized our interview grid around 4 main topics;

- *Work*: A first survey topic relates to the activity of the interviewee: what are people in charge of? What are their responsibilities?
- *Relation*: A second axis seeks to understand with who the respondent is in interaction when carrying out his day to day activities: Which alliances exist, for what purpose?
- *Problems*:To go further, we question people on their difficulties; we ask them to recall the action taken to tackle the problems they might face and get their perception on the issues. This gives access to the strategic dimension of the interviewee.
- *Future and Legacy*: To conclude the interview, we call upon people's point of view on their own future and to elicit their vision of their territory. We presented our hypotheses, even the implausible ones, and ask people what they thought of them, what alternatives or solutions they could come up with.

Discussing the future leads to contrasted visions of the territory. We thus gathered different pictures of possible evolutions, based on present and past trends.

Producing knowledge from interviews: an inductive approach

Induction

We adopt a hypothetico-inductive method for our study. There are at least two reasons for this. First, to investigate the field in detail, we must keep in mind some important actors, events, structuring trends… etc which might have been forgotten during the first literature review. Secondly, from a theoretical point of view, we assume that no simple determinisms can explain either current trends nor future possible evolutions, and that actors possess a fundamental margin of liberty as well as good reasons to do what they do and how they do it, that have to be discovered through field investigation (Crozier & Friedberg, 1980 [1977])

We look for diverse and heterogeneous points of views that can be confronted and discussed.

Triangulation to consolidate our results

Two types of information are available for the study: interviews and the printed sources. Accumulation of information from interviews can be a long and arduous process. An optimal ratio of information/interview time is met upon reaching saturation, after which we do not learn new information through new interviews. The short time we spent for fieldwork (10 days) prevented us from reaching this point. However, all the information presented in this report has been triangulated between interviews and available bibliography, in particular during collective discussions (Olivier de Sardan, 1995, Olivier de Sardan, 2003).

Snowball sampling

At the end of each interview, we asked the interviewee for contacts he might have with other potentially interesting persons. This highlights the networks and connections among the interviewees (Olivier de Sardan, 2005 [1995]). Starting with respondents belonging to different networks, this method offers the possibility to explore these different networks individually (Treyer & Aubert, 2009).

We conducted 70 interviews during our field work (Kodagu district and Bangalore). Interviewees were quite balanced between administrative bodies (17%), agricultural actors (15%), water management actors (17%), forest department officers (15%) and researchers (12%), as shown in Figure 1.

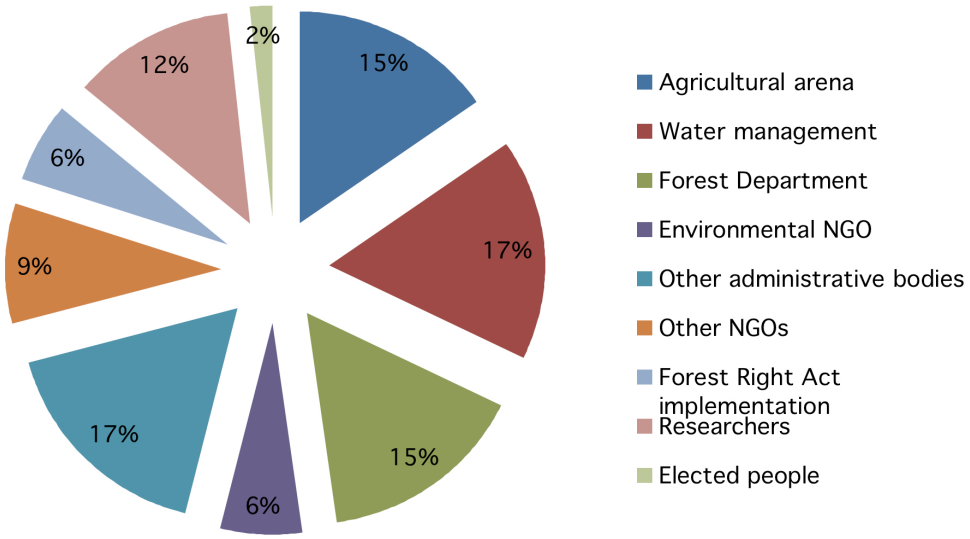

Figure 1: pie chart of interviewees sampling

Implementing our methodology: a four step approach

To implement this methodology, we proceeded in four steps, as shown on the diagram below (Figure 2). All the interviews are conducted in both English and Kannada by a group of 2 students with assistants/translators.

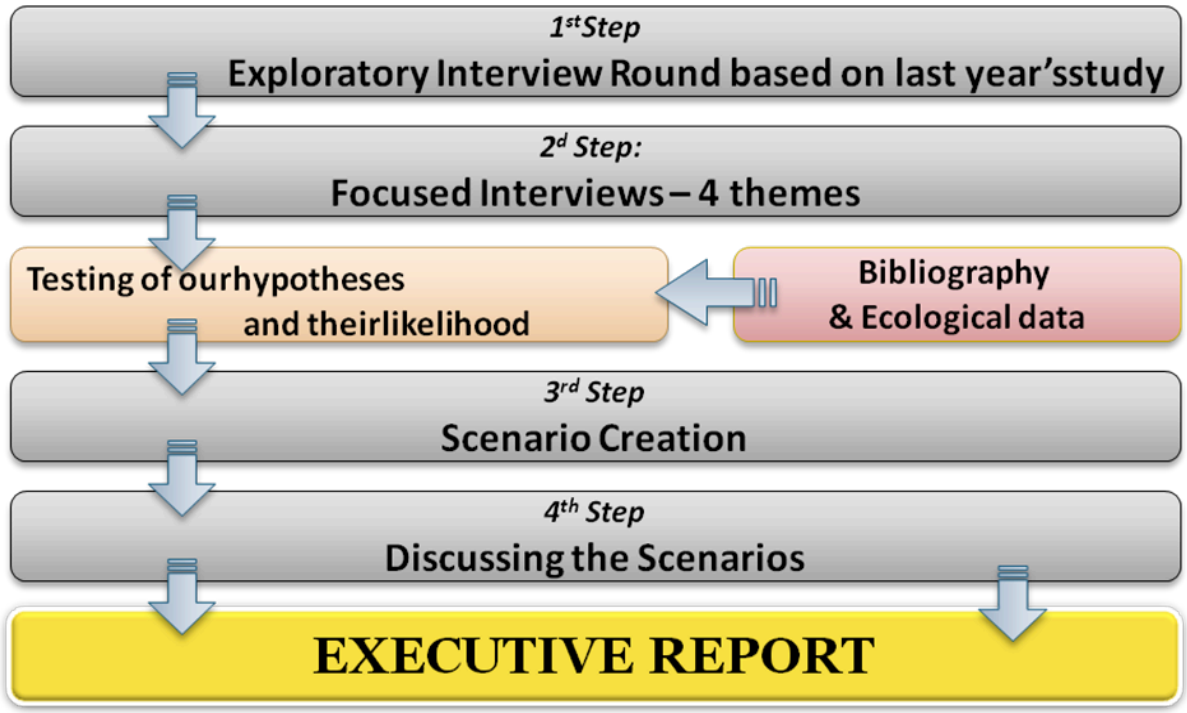

Figure 2: research steps followed

The explorative phase

The first week of the field work is dedicated to an exploratory interview round. Results are shared among the groups every evening during a collective brainstorming session. The idea is first to cross check the information, to limit personal bias or mistranslations; these collective sessions are also a way to formulate interpretations while data is still "fresh" and to construct provisional models that are as close as possible to the empirical material (Bierschenk & Olivier de Sardan, 1997).

During this first period, a systemic representation of the territory is formulated; identifying the major components that shape the territorial dynamics. The component will be analysed in more detail below. Some components have been left out of the analysis, firstly because the team focused on elements that were considered determinant by us. Also because we do not intend to emphasize everything as we may lack the required expertise to tackle all the topics.

The thematic phase

During a second round of interviews, we split up into thematic groups. Each group was in charge of formulating a precise diagnosis for each component. The fourth groups were divided as following: water, infrastructure, FRA implementation and farmers. Information concerning past evolutions, stakeholders, management systems, threats, trends and possible evolutions for each component were thus gathered and crosschecked with the literature to

consolidate our understanding and stabilize our hypothesis. We finally identified the key drivers of changes under each component structuring possible trends of the system.

Scenario creation

Thanks to the diagnosis of the territory, its main components and the identification of their possible evolutions, it becomes possible to create plausible scenarios; stories of possible futures for Kodagu district. The stories are "told" on a "what if" basis. What if this or that happens to this component? How are the other components likely to react? The main task consists of the creation of a story, as plausible as possible, that includes as many elements as possible.

Discussing the scenarios

Following Mermet and al. approach to the prospective (Mermet, 2005), these scenarios are finally to be presented to, and discussed by, those involved in the future of the territory. Two presentations have been prepared, one locally, at the College of forestry of Ponnampet, and the other University of Agricultural Sciences in Bangalore. The results of these debates are presented in the last section of the present report.

Diagnosis

Landscape model

If one wants to understand the Kodagu territory, one needs to take a look back on the districts history. After a long history of conflicts, of government changes from the Rajas to British colonial rule and finally independence, there are now, in 2012, more than 32 types of land tenure.

- One of the main types is the “Jamma land” which was granted by the Rajas at the end of the 19th century. These lands cannot be sold directly. These lands can only be inherited by children from their parents and are split into as many parcels as there are children. Trees in Jamma land are usually government property.
- One other is the “Sagu land” where full assessment is required to be paid by the owner to the Revenue Department. Sagu lands can be sold easily. Tree rights in Sagu land must comply with the Karnataka Tree Preservation Act.
- Finally we have the “Bane land” which is forest granted for the maintenance of wetland to which it is allotted. Bane lands are used for grazing, to supply leaf manure, firewood and timber required for agricultural and domestic purposes. Bane lands are converted today into CAFS. The tree rights in Bane lands are restricted by the Karnataka Tree Preservation Act

If these types of land tenures are the main ones, there are many others, which complicate the analysis. Moreover as some types of land tenure are highly restrictive, it’s difficult to analyse what the consequences of a deregulation could be.

In addition to diverse models of land tenure, tree rights ownership rules further complicate the analysis of the landscape. Indeed, the tree rights limit the possibilities of selling native trees especially for high value native trees. There are two types of tree rights:

- Trees on unredeemed lands belong to the State of Karnataka. If the owner wants ownership, particularly in the case he wants to harvest it, he must pay a fee to the Government, corresponding to a market rate fixed by the KFD.
- Trees on redeemed lands belong to the landholder. Nevertheless, if the owner wants to cut the trees, he must follow a long procedure.

According to this first analysis of the territory, it seems that the possible evolution of these rights will have an important effect on the dynamics of the territory.

On these land tenures different cultures are grown, but the main one is coffee. This is a very traditional crop, which was already important at the time of British colonization. In 1997 coffee production occupied 29% of the territory (Ramakrishnan & al., 2000). But during the last 30 years there has been large-scale conversion of forests (on private land) into CAFS. Today, only small fragments remain unexploited (Garcia & al., 2010).

Kodagu district is also changing as quickly as the Indian economy is growing. Currently an increasing number of Indian investors are buying land. As it's a new phenomenon there is a lack of published scientific evidence, but numerous interviews revealed this trend. This buying of land has also lead to increasing development of infrastructure. These land use changes affect the water availability downstream, as will be developed later.

As already explained, we've looked at the Kodagu landscape with two focuses: the biodiversity and the watershed management. In order to evaluate these criteria, we choose the following indicators:

Biodiversity:

- Tree cover in forested areas
- Biodiversity in coffee agro-forest systems

Watershed management:

- Water availability
- Water quality

Considering these criteria and the current trends in the Kodagu, the landscape can be divided into 3 areas: the agriculture area, the reserved forest and the protected areas with a transversal issue, which is the water as shown in the graph below (Figure 3).

Actors and practices leading to environmental changes

After presenting a brief overview of Kodagus landscape drivers, we have identified the normative referential, meaning different criteria which will allow us to measure precisely the impacts on the environment: water quality and availability, tree cover, biodiversity. In order to justify this choice, we will describe the practices we identified as having an impact on the environment, and we will then describe the actors who are related to those practices.

Practices

Coffee based agroforests (CAFS) intensification: CAFS cover around 1/3 of the district and the coffee production reaches 1/3 of the total Indian production (Coffee Board of India, 2010). Robusta (*Coffea canephora* var *robusta*) is the main variety cultivated. The size of the coffee estates' goes from less than 1 acre to several thousands of hectares for the largest corporate estates (Garcia et al 2009). Management practices are very heterogeneous regarding key components of the production system: chemical inputs, certification, types of shrub in use, etc. However, coffee cultivation is globally more and more intensive in the district. There are three ways for intensification that combine together: increasing the use of chemical inputs, developing the irrigation and opening the agroforest canopy, associated with the replacement of native trees by exotic species.

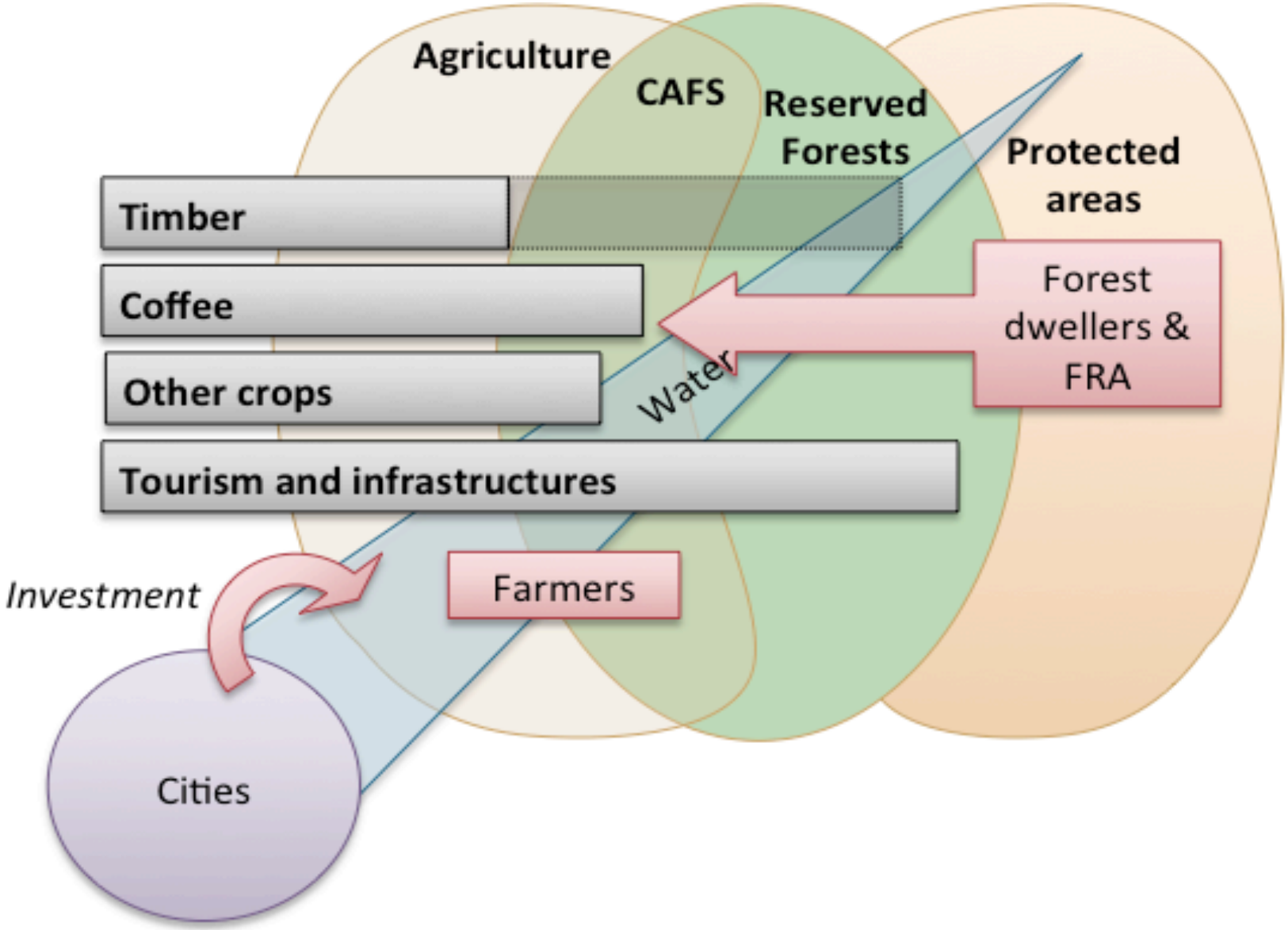

Figure 3: Landscape model of Kodagu district

Paddy field conversion: rice cultivation occurs in wetlands. The water storage in the paddies allows the water to percolate into the soil. The ground water therefore increases in quantity. The ground water quality will depend on the ground filtering. Paddies also play a buffer role as it slows the water coming from the mountains and can therefore mitigate flooding problems. The evapo-transpiration of the paddies could have an influence in the rainfall intensity in the region.

Development infrastructures: The construction of buildings, roads and electricity lines cause deforestation and forest fragmentation. The soil also deteriorates.

Forest Rights Act (FRA) implementation: this law allows forest dwellers to own land in the forest. This law could change the forest dwellers practices in terms of conversion of land and development of infrastructures inside the forest.

Actors

Tree logging occurs in CAFS as the planters sell the native trees for money. The tree rights push the planters to plant trees which they will subsequently be allowed to own.

Tree logging in forests is mainly due to smugglers and the expansion of agriculture. Due to new regulations (the implementation of the Forest Right Act, see below), this practice might increase (agriculture, construction of infrastructures...).

Farmers chose to convert the paddy fields because despite government subsidies, rice cultivation is not profitable enough.

Constant demographic and economic growth creates the need for more and more infrastructure. Companies and the government are implementing these projects. Therefore, measuring the tree cover will allow us to measure the extent of deforestation.

All these practices may have an influence on the water issue. The water issue concerns all the actors and all the territory covered by our study. Therefore, through the water issue we will have a transversal point of view of Kodagus environmental concerns.

Species biodiversity is a way to measure not only the impacts of deforestation but also the degree of degradation of the environment.

Following this analysis, if one wants to understand how the Kodagu landscape could evolve, it is necessary to focus on the agriculture, the development of infrastructures as well as the implementation of the forest rights act. One should always keep in mind the common, transversal issue to all these action systems, which is water.

Water issues

Water resource management is a rising challenge in Southern India, with the increase of irrigation in agriculture and the growing need for water in cities, and in a general context of uncertainty due to climate change. Protecting the Kavery River's catchment area and

improving the practices determining water quality and availability is therefore becoming an important issue.

Water management and the stakes at local level

The network of the actors involved in water management is quite complex in India, from the central State to the village level there are many departments (national and local), institutions, commissions, boards, inter-departments, programmes etc. dealing with the quality or the quantity of the water. Here below we tried to understand the governance of this resource both at state and district level.

Actors involved at State level:

- Water Resource Dept. (Quantity)
- Ecology and Environment Dept. (Quality)
- Karnataka pollution control board
- Central Ground Water Board
- Central Water Commission
- C.A.D.A.
- E.N.G.O.
- Karnataka Farmers Cooperative Federation

Actors involved at District level

- Irrigation Dept.
- Revenue Dept.
- Minor and major irrigation departments
- Zilla department (irrigation from river inf.40ha)
- Gram

Among the others water stakeholders are the following: Farmers (paddy and coffee), Industries, Hydro-energy companies, Political, ENGOs, and inhabitants.

Global water situation in the district

At the Kodagu level, the water situation is quite simple, if we consider that currently there is no major issue of quantity nor quality. In any case, the main trends such as population growth, deforestation, land conversion, development of chemical treatments, development of mining extraction, development of pulping activities with no treatment of waste etc. should be monitored with precise indicators and then assessed in order to anticipate potential water problems in the future.

Kodagu ground water situation

Data from the central ground water commission and field interviews show that ground water is the main source of drinking water for the 3 Taluks[1] except for Madikeri and Kushalnagar where a small amount comes from surface water. Sewage treatment is not developed in the district but until now no water-bound disease epidemic has occurred.

About 2% of the net sown area is irrigated and of this, around 10% is irrigated by ground water water. The water level for most of the stations shows a rising trend. However, according to the Central Water Commission officers interviewed, the groundwater quantity is considered to be sustainable in the district. Both the shallow and the deep aquifer waters conform to drinking water standards on all the important parameters. In a few places higher concentrations of nitrates and chlorides were found.

Different taxes are also collected by the gram (village) and then by the revenue department. Until now there have been no significant problems concerning non payment of taxes.

Kodagu surface water situation

Unlike the rest of the state, in Kodagu district irrigation is not a common practice in the way indicated above. However for the few crops irrigated, data from field interviews with the local administration show that the water comes from Kaverys tributaries for the paddy lands and private water sources for coffee plantations.

However, we were able to verify that significant subsidies for equipment purchase have been allocated to encourage irrigation activity. For paddy field irrigation, for example, farmers can obtain a subsidy from the Agriculture Ministry of between 50 and 75% of their equipment purchase. In theory these subsidies are intended for paddy field cultivation but in reality they are actually used for coffee cultivation. Water subsidies for the irrigation of coffee plantations are given by the coffee board.

Water issues at the state level

At State level, water policy gives priority to drinking water, irrigation, hydro-electric power, and industry. However, according to official government statistical sources, the distribution of water resources is as follows (Government of India, s.d.):

- Irrigation: 88.62%
- Domestic uses: 4.24%
- Industry use: 0.38%
- Other: 6.76%

[1] Territorial divisions in India.

To go further on the water management issue, it is important to indicate that Karnataka is the second driest state of India and that the ongoing conflict around the Kavery River between Tamil Nadu and Karnataka has not ended (Cauvery water dispute tribunal, 2007).

The information obtained from interviews suggests that the Kavery conflict is a political conflict between states more than a water conflict. Nevertheless, there are continuous problems concerning water in Karnataka, which are not specific to the Kavery watershed: the decrease in water per capita availability due to demographic growth (5177 m3 in 1951, 1650 m^3 in 2003), the deterioration in water quality (fertilizer/sewage/industrial pollution), the over exploitation of ground water resources, the poor efficiency of facilities for water utilization, the increase in demand for water (population growth, urbanization, agriculture, industrialization), the over use of surface water, untreated sewage in urban areas and the effects of industrial activity etc. (Government of India, s.d.).

Out of these main problems a certain number of priority issues can be identified: improvement of the water facilities efficiency in rural and urban areas, equal access to water resources, specifically in urban areas, the collection of farmers' taxes (only 17% collected) and the development of a kind of CESS Act for farmers etc.

Concerning this last issue we can see a confrontation between the opposing strategies of the Ministry of Agriculture (subsidies for chemicals use and agricultural irrigation development) and the Ministry of Water Resource (irrigation efficiency, adopting less water dependent crops etc).

Critical uncertainties concerning water in Kodagu

In order to carry out an environmental prospective which includes the water issue, critical uncertainties have been identified: the development of irrigation, the development of fertilizers, the loss of tree cover in the CAFs, the change of crops on paddies, the development of pulping, the development of mining industries, and urbanization.

Actual management

The actual management designates all action systems that have an impact on the ecosystem with respect to the two environmental stakes chosen.

Agricultural action systems

Two action systems will be considered according to their differences of actors, stakes and impacts on the environment; the coffee system and the paddy fields systems.

The Coffee Agro-Forestry System

Coffee production represents an important economic activity for the Kodagu district. In fact this district produces a third of the total Indian production (CAFNET, 2011)[2].

The Kodagu CAFS, have the particularity to support an important biodiversity as shown in the graph below (Figure 4).

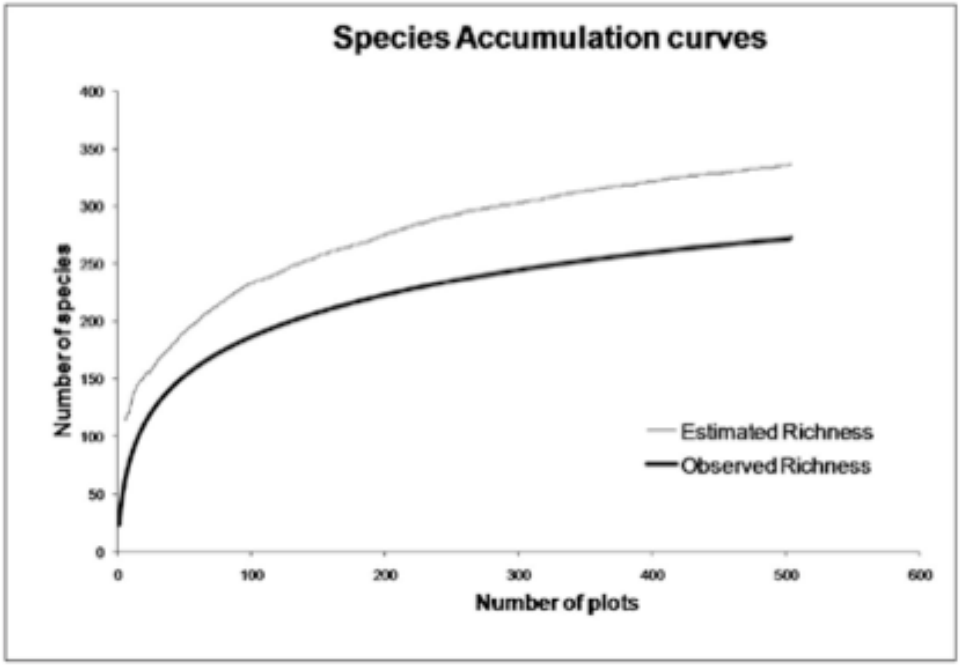

Figure 4: Species accumulation curves showing the species richness observed an estimated with sampling effort. CAFNET.

Currently, we are seeing a rapid reduction in canopy cover in most coffee estates, due to increased felling and timber production. Irrigation and the difficulties in securing labour also contribute to this deforestation (Garcia & al., 2010). At the same time the Indian coffee exporters face strong competition on the international market with the arrival of low-cost

[2] The bulk of Indian coffee is exported. Mainstream quality represents approximately 90% of the exported production. Sustainable standards penetration is marginal in the Indian coffee industry. The domestic market represents 30% of the Indian production thanks to very high import taxes for foreign coffee. In India coffee is mainly mixed with chicory, and drunk with milk and sugar (Mercereau & Vignault, 2008).

producers like Vietnam, the Philippines and other south-east Asian nations (Business Standard, 2010).

In order to analyse the functioning of Coffee Agro-Forestry Systems, we will divide it into 3 sectors, the wood sector, the coffee sector and the labour sector.

The wood sector

Over the last few years an important trend of Silver Oak plantation instead of native trees has been seen. This has happened for several reasons, firstly because the planters wanted to diversify and supplement their incomes with trees and pepper production. Currently the Karnataka Forest Department doesn't allow them to cut and sell without an authorisation and the levying of taxes. However, as this system is complex and time consuming, a black market for local timber has developed. Currently the Silver Oak represents around 20% of tree species in the Kavery watershed (CAFNET, 2011). In fact this species is in strong demand, and grows fast and straight which is very good for the pepper production. In addition, exotic seedlings such as Silver Oak are way cheaper in the market than native species seedlings. Some planters think that Silver Oak jeopardises soil fertility and has other negative effects on the coffee. But it seems that these disadvantages are not sufficient to outweigh its competitive advantage.

Most of the planters and planters associations plead for tree rights for planters, arguing that it will allow them to earn money with native trees and consequently to maintain the biodiversity in the CAFS. According to a CAFNET study this would not be the case, and that tree rights to the planters will lead to a progressive replacement of native trees by Silver Oak, even in the business as usual scenario (CAFNET, 2011).

The coffee sector

In Kodagu, the coffee cultivated is Robusta. It is used in the global market as low-grade filter coffee. Two big trends are driving the coffee sector in Kodagu. Firstly, the growth of domestic consumption, and secondly, certified coffee, although the development of certified coffee has been very limited.

Here the only disincentive to intensifying production comes from the certified market. Most of the certification standards have criteria on chemical inputs and biodiversity that would have a beneficial effect on both water quality and specific diversity. However we quickly encounter two problem issues. First, most of the biodiversity standards aren't adapted to the Indian CAFS. For example the Rain Forest Alliance certification requires 12 different species per hectare on average (RainForest Alliance, 2010), whereas a typical plantation in Kodagu would have around 32 species by hectare (Garcia, unpublished). Therefore there is no real incentive to protect biodiversity. Moreover if the organic certification could create an incentive to maintain water quality, it doesn't bring sufficient price premium to be adopted widely.

The labour sector

With economic growth come new job opportunities for the younger generation who no longer wish to work in the fields as their parents did. The cost of labour is thus rising and this trend is very likely to continue in the coming years. Considering the huge competition in the global market that's another intensification incentive.

To sum up, the following diagram (Figure 5) represents the actual management of the coffee system:

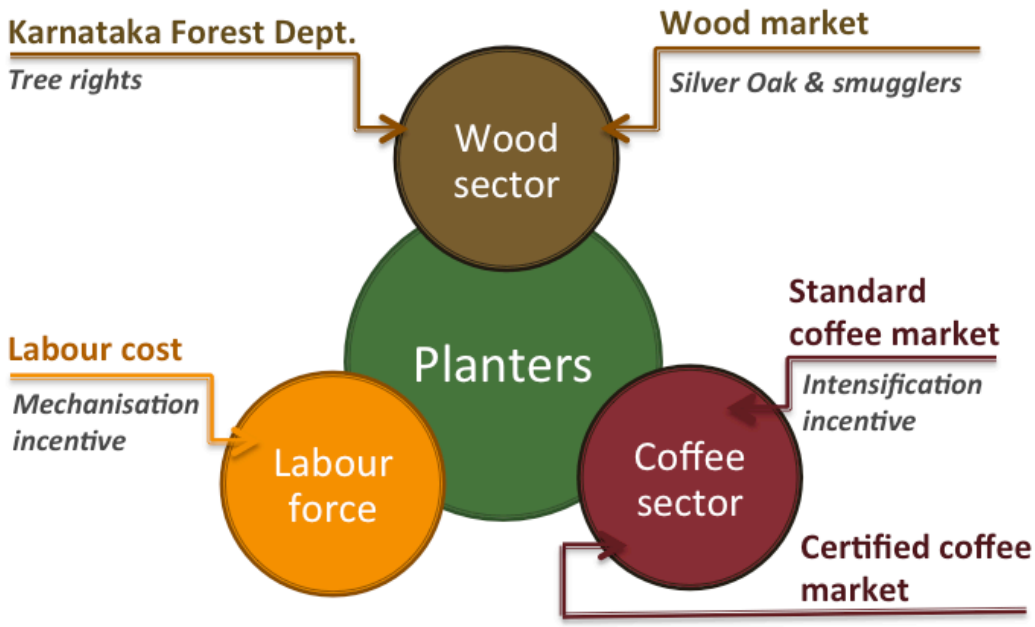

Figure 5: Diagram of CAFS actual management and drivers

According to this representation we can see that the system isn't very balanced; only the KFD's tree rights and the limited certified market tend to limit the biodiversity degradation.

The paddy fields

Rice market

The local market price for rice is very low; paddy cultivation is barely profitable at that price according to the interviews. To face this problem the government has created a regulated market in several places as an incentive. But not all the farmers can afford the cost of transport to these regulated markets. Looking at the market for rice we can see that apart from growing rice for their own consumption, it is only the government regulated market price makes this crop profitable and sustainable for farmers.

Other markets

If we take a look at the market price for alternative crops we understand more the opportunity cost that rice represents compare to some other crops like palm or banana

which are more profitable and less labour intensive which is an important aspect for the farmers

Labour sector

If the labour costs are higher for rice cultivation than for coffee or other crops, it is for two reasons. First the cropping period is longer than most of the other crops. Secondly, there is a shortage in the workforce, and workers prefer to work under the shade of the trees than in bright sunlight in the paddies.

Labour force perhaps more than the low market price is the factor limiting profitability. In fact, even using irrigation to produce two yields per year, rice production is still barely viable.

You can see below the representation of the actual management of rice systems (Figure 6).

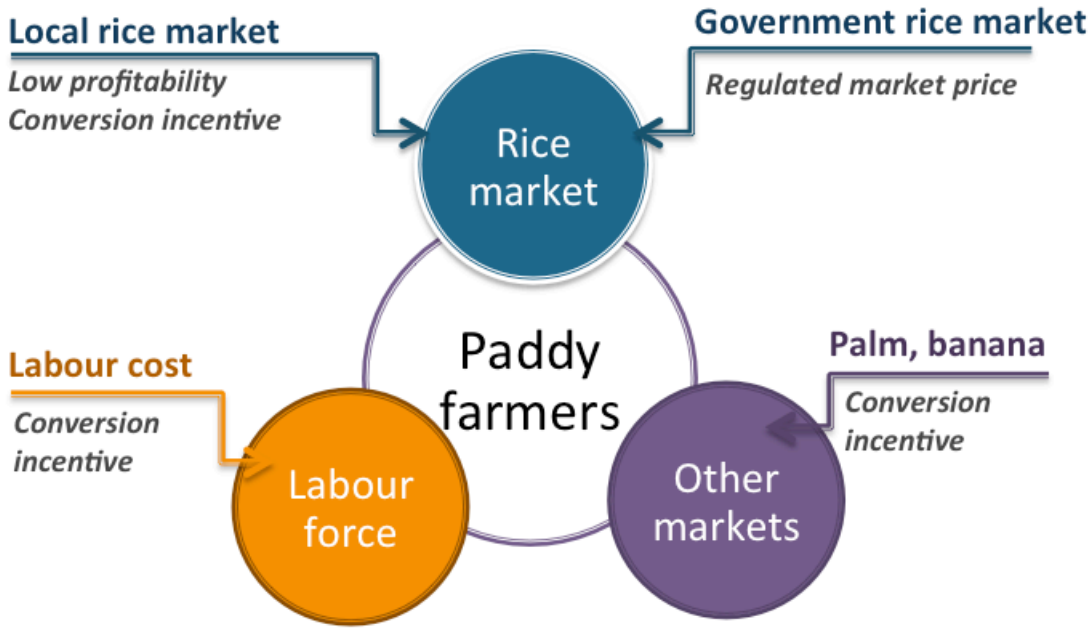

Figure 6: Diagram of the paddy fields actual management and drivers

Only the government rice market can stop the conversion of those paddies which are not for family consumed food production. As this market is not accessible by everybody and its sustainability is uncertain we can see here a strong dynamic for the conversion of rice paddies to palm, banana or other more profitable crops.

System stability and hypotheses for the future

The agriculture action system doesn't seem to be very stable. In fact the tree rights and the certification market only support biodiversity preservation inside the CAFS. The paddy field system is unstable with a conversion dynamic. According to our analysis, what the agricultural system could be in the future depends on the development of the following factors:

- Currently the certification standards are not adapted to Kodagus biodiversity and certification isn't profitable for planters. The development of a certified market and the creation of new standards will be essential for biodiversity preservation.
- Moreover, the land tenure system is now becoming deregulated and there is intense lobbying by planters for tree ownership. Will the tree rights system be maintained in the future?
- At the same time, considering the growing competition in the global coffee market, we can wonder to what extent will coffee production be intensified?
- The cultivation of paddy fields isn't profitable compared to other crops. With the migration of young people to big cities and new investors coming from outside, there is an important conversion dynamic, but how far could it go?

Infrastructure development action system

Infrastructure projects and environmental impacts

The district of Kodagu is a predominantly rural area dotted with small towns (Madikeri has 30,000 inhabitants account for example).

The demographic context for Kodagu is particular; the birth rate is lower than the rest of the region, and lower than the national average. Lower birth rates and longer life expectancy can be seen to cause a phenomonen of demographic transition which is already ending. ?

Migration exerts a more complex influence: insufficient local labour to work in coffee plantations brings migration from Kerala and other states, while the young people leave Kodagu towards economically attractive urban centers; as a consequence the population only increased by 1.13% between 2001 and 2011 (Census of India, 2011), whilst by comparison, the national average population growth was 15.6% in the last 10 years, and 46% for Bangalore because of the massive influx of migrants!

However the population is 554,000 inhabitants with a large proportion of young people; the proximity and dynamism of Bangalore creates an incentive for private investment projects and the economy must provide for the social needs of the population (health, education, public buildings, roads)

As a consequence, two types of investments have been made in recent years:

- Public, State funded, or regionally funded investments destined for essential public infrastructure projects such as roads, electrification, railways, sewage systems, etc.
- The other investments come from private companies: for example, dams, mining, quarries, hydroelectric projects. These have to be economically viable.

We can assume that all of these investments are likely to increase, and that the creation of these infrastructures will have a considerable impact on the environment.

Demographic expansion has also increased the demand for land and consequently put more pressure on the forests; development activities like roads, railway-line construction, irrigation, mining and power projects, aggravates the problem. Human encroachment into forests and degradation due to illicit removal of trees are the two major problems facing forest management.

For example, the lake "Honnammana kere" in Doddamalthe village (Somwarpet taluk) is under threat: it is the biggest lake in Kodagu but recent findings from the Revenue department show that around 5 acres of this lake have already been appropriated by human (industrial or agricultural) activities. But in the meanwhile, the lake is the water source to over 200 acres of agriculture land with nearby villages (the lake never dries up during summer and water is available throughout the year). Furthermore, the water level in the Harangi reservoir has dropped drastically which has caused concern over water availability amongst farmers.

Actors systems

Actors involved in investments projects i.e.investors, have to submit their projects to the administration. Private firms have to request authorization from the Deputy Commissioner before the beginning of any work.

An assessment can be made to forecast the environmental impacts that might be expected as a result of each project; this is a recommended possibility but not mandatory. Although it exists, this assessment isn't an obstacle as it doesn't necessarily stop any projects from going ahead. The Pollution control Board may give its approval even if the project does have an impact on the environment. The authorisation from the administration can then be granted and the project can be implemented.

In recent years, major projects have encountered serious difficulties because insufficient care has been taken to manage their relationship with the surrounding environment. Private companies interests tend not to take the environment into consideration. In the absence of environmental impact assessment, the pressures on environment tend to be unlimited: soil and water pollution, greenhouse gas emissions, deforestation and forest fragmentation, biodiversity loss… Since tourism is also booming, homestays, gusthouses and resorts are also on the project.

All these projects were encouraged by the State government with the aim of creating employment in the district and might soon be implemented.

System stability and hypotheses for the future

This current system is stable and could continue in the future. Therefore damage to natural resources will probably increase.

For our prospective exercise, the following alternative hypotheses about future dynamics can be made:

- A strong development of public infrastructure projects will occur but with a negligable level of private investment
- A strong progression of capitalist investment will occur with few public infrastructure projects
- Both the public and private sectors will invest on a large scale to sustain development and urbanisation

The Forest Rights Act

The FRA implementation process

Forest in India covers over 70 million hectares, and is inhabited by 250 million people. Tribal people (Adivasi) and non tribal peoples livelihoods have depended on the forest for centuries, however, no official acts have ever recognised the rights of these forest dwellers to forest land and its resources. Forest land is owned by the Ministry of Environment and Forests (MoEF) and administered by the State Forestry Department.

In order to compensate the historical injustice done to *Adivasi* and Other Forest Dwelling communities, the Recognition of Forest Rights Act was voted in 2006. It was enacted in 2007 by the Ministry of Tribal Affairs (MoTA) but came into effect on the 1st January 2008. In order to claim for their rights, Scheduled Tribes (STs) and other forest dwellers are asked to constitute Village Forest Rights Act Committees (VFRACs). In the Karnataka 2,521 Forest Rights Act Committees have been registered.

Among the different rights that can be granted, the FRA comprises two important rights: the IFR (Individual Forest Rights) and the CFR (Community Forest Rights).

IFRs give beneficiaries a plot of land of up to ten acres. These rights are to be applied throughout all government forest lands; Reserved Forests, Wildlife Sanctuaries and National Parks (Figure 7).

CFR designates an area of forest up to five kilometres around the *Hadis* (Adivasis villages) whose inhabitants are given the right to collect Minor Forest Products (MFPs). Basic facilities such as hospitals, schools and community halls could then be developed.

The FRAs application involves the Gram Sabha, who initiates the process, and the Sub-Divisional Level Committee (SDLC). However the final decision is made by the District Level committee which comprises the Deputy Commissioner, the Divisional Forest Officer, three members of the district Panchayat, and an officer of the Tribal Welfare Department. In order to assess the FRA and to manage implementation issues, a committee was created in 2010 by the MoTA and the MoEF. It appears that since 2008 the adoption of the Forest Rights Act has been weak and slow, and that peoples livelihoods, forest governance, and conservation management have poorly improved.

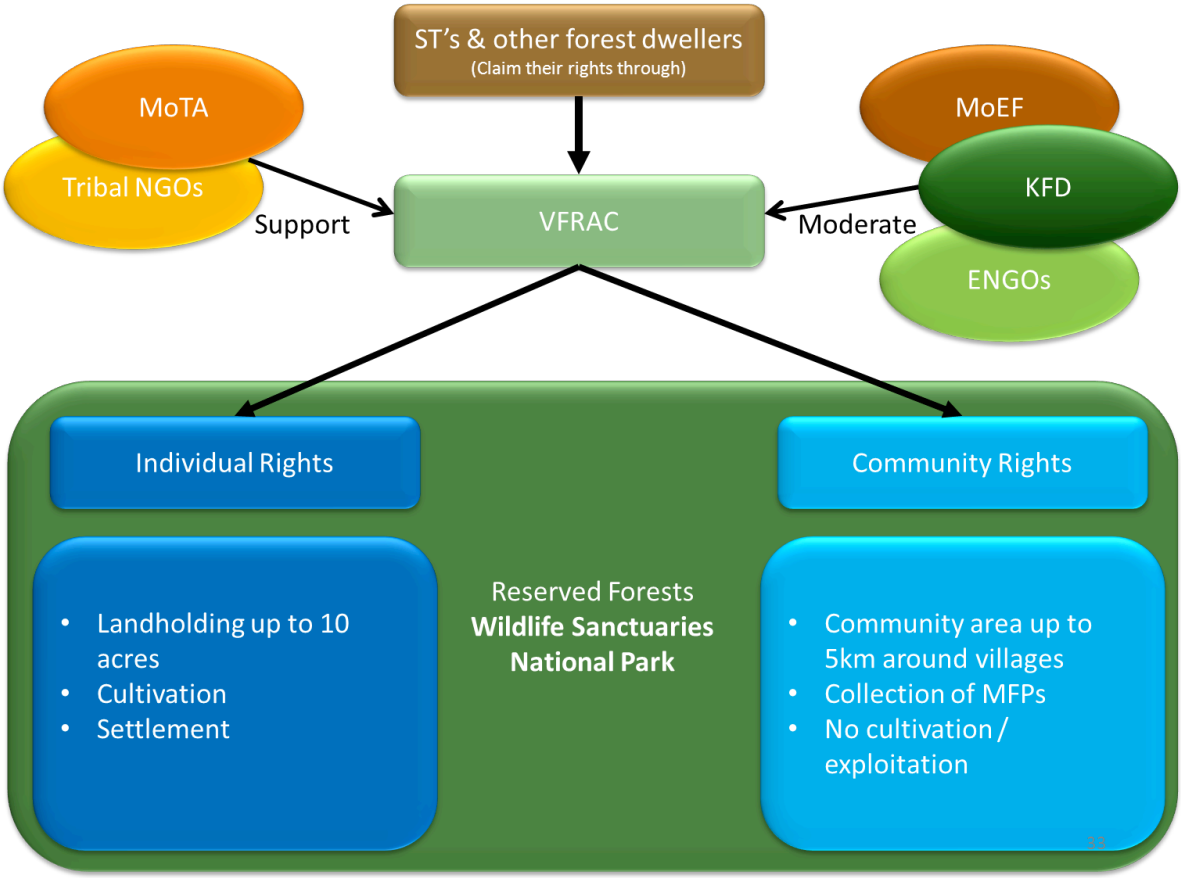

Figure 7 : The FRA implementation process

Conservation controversy

There are territorial differences of opinion between the States concerning FRA implementation. FRA implementation is proceeding unevenly throughout the Indian states in terms of the size of population implicated and in terms of the number of rights granted. Currently the adoption of the CFR (Community Forest Rights) is quite a slow process principally because of institutional issues: the Forest Department is showing extreme prudence in allocating rights as it is very concerned by the conservation of government forest lands. There is a controversy about protected areas. People who are against the FRA believe granting rights to Tribal people, especially in national parks and wildlife sanctuaries would cause wildlife conservation problems. They forecast increased human encroachment into forest and conversion of forest to agricultural lands, more frequent human-wildlife conflicts, black market activity, frauds and other potential problems. However the people who support the FRA think that Tribal people live in perfect harmony with the forest ecosystems, that the Adivasis have a legitimate right to use the forest's natural resources because it has been their ancestral land for centuries and because their way of living causes few threats to wildlife. In the context of this ongoing controversy, over the past five years, the majority of rights granted have been IFRs, which concern much smaller areas.

Possible future dynamics

A first possible dynamic concerning the Forest Rights Act implementation would be that CFR will be generalized. Schedules Tribes and Other Forest Dwellers would then stay in the forests. This doesn't involve that the KFD will abandon its position against anthropogenic disturbance on forests, but tat it will have to adapt itself to the new situation.

Another possible dynamic would be that IFRs continue to be granted whilst only a few CFRs are given to tribal people. Then because of political, economic, or other reasons, the social pressure will force forest dwellers into mainstream civilisation.

Intentional management

Theoretical perspective

The “intentional management” can be defined as the voluntary actions and strategies aiming to improve the environmental quality of a given system (Mermet, 2011). It is rooted in particular interpretations of what the actual management is not doing, or doing wrong regarding environmental issues and it proposes new ways of dealing with the environmental issues at stake. Thus, the intentional management model pertaining to each stakeholder reflects its motivations as well as the means of its implementation, which are both technical means and social means. Researching this aspect raises multiple questions, all linked together by one main idea: it is the collision of the actual and intentional managements that create a dynamic of change towards a new situation.

In this study, the most relevant way to approach the intentional management is the analysis of the projects of management arrangement that different stakeholders are proposing to tackle environmental issues. In French we call these management arrangement *dispositifs*, or, let’s say, *devices*, as the word “dispositif” cannot be literally translated in English (disposition). In such a perspective, and following (Lascoumes & Le Galès, 2004) and (Berry, 1983), analysing an environmental management device can help to decode various dimension of any action situation

First of all, management devices are structured by interwoven socio-technical ensembles (Lascoumes & Le Galès, 2004). This stresses the need to clearly identify the project holders and their relationships, but also their motivation. The rationales upon which are based their vision for a future “good management” are thus an integral part of the device itself. This rationale asserts that the actual management is insufficient, and proposes new modes of management on the basis of a particular action theory. Moreover, a management device can be proposed by stakeholders that might have neither the same interests nor the same motives in the debate. It can thus appear in a different manner depending on the targeted group. Management devices are also the concrete instruments around which the debate can evolve. As such, studying them allows us to map the various stakeholders and their power relationships, the resources they have and the strategies they elaborate to promote their own agenda. This makes up the action system, where different stakeholders with different interests are implicated in the same mechanism. The proposition of a management device also carries ideas regarding the action system it supposes and how that functions.

To this first perspective can be added a second one, where the devices can be analysed through their “anchors” (Berry, 1983) through a more dynamic perspective. When they are already implemented, they can be seen as institutions, with a set of rules and an inner meaning. However, most of the devices that are considered here, are in the process of seeking institutionalization. The anchors detailed by Berry, are the material basis (the data) from which they originate, the rationale they are rooted to, and the degree of acceptance or

demand by society. Thus, when institutionalization has not yet been reached, these last three points can be viewed as possible triggers to attain it.

When management devices are voluntary, this need for institutionalisation appears to be less of a condition, given that being of a voluntary nature, action does not need endorsement by any institution. Other constraints might cause reluctance to a wider adoption. However, as they rely on complex mechanisms based on criteria and indicators, they are also subject to similar conditions and functioning mechanisms as non voluntary management models methods arrangements.

The way a management device functions is its core characteristic. On one hand, management devices set specific objectives, such as environmental impact reduction, and evaluating the results is of utmost importance. On the other hand, as management devices require the implementation of specific logics and mechanisms, they also induce side effects; by side effects we mean that they do not address the primary objectives. For instance, management devices can rely on a specific bureaucracy or technical tools requiring specific training, and this can slow down if not alter the initial objectives. Thus, when analysing a management device, one must pay attention not only to its objectives, but also to the underlying mechanisms that are necessary for its implementation. This is where issues of poor governance and training can bring to light important information affecting the project proposal, its feasibility and the way project holders deal with these necessities.

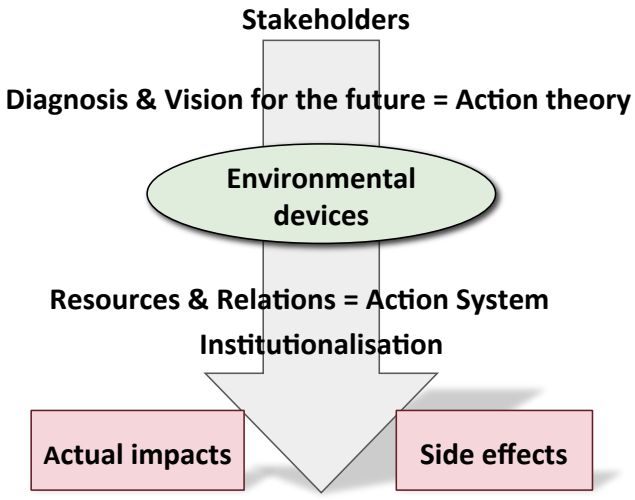

Figure 8: Environmental device design and implementation

Finally, these management devices should be understood in a broader context, and this is a key issue in this study that does not appear in the existing literature. The local stakeholders, dealing with local issues, might not always be aware of these issues implications at a higher decision-making level.

It is thus crucial to understand whether or not the management devices proposed by the project holders are considered in a wider context, and whether this wider context limits or enhances its implementation. Although this dimension might be included within the action system, it needs to be particularly stressed in cases where the decision makers and project holders are geographically distant. In Kodagu, where only two people get elected to participate in State-level decisions and where there is a very specific environmental and social situation, it is important to analyse management devices in a way that takes into consideration the effects of multiple scales in the decision chain.

The various actors contributing to the intentional management system will be detailed below, along with the management devices they are proposing for changing the actual management situation.

Agricultural action system

A lot of work has been done to make the agricultural action system coherent with the CAFS ecosystem. The actual management has shown several incentives for production intensification but some actors try to decrease the opportunity cost of biodiversity conservation through market devices.

For more than 4 years, the CAFNET programme has focused on the CAFS. A lot of actors had been involved in this project in order to implement devices that would improve the environmental management. Some have already been implemented like the certification; others are ongoing projects like the Payment for Ecosystem Services.

All of these devices have one thing in common; they need a strong implication of a central actor. The CAFNET programme is over, and now the College of Forestry is trying to promote a PES project. How this central actor will be able to gather all the stakeholders will be a key point for the success of the biodiversity protection objectives.

Certification

Using certification as a market tool, the producer will obtain a premium in return for respect of good socio-ecological practices that will lead to environmental benefits. The good practices depend on the certification standard but usually concern the use of chemical, the specific diversity or the labour management. It is a voluntary based action often motivated by the market and a group of planters already certified. The whole idea is to give to the Kodagu ecosystem a value that will be paid by the consumer.

Currently the certification standards used are mainly the UTZ certification and the Rain Forest Alliance certification.

UTZ is a certification programme for agricultural products launched in 2002, which claims to be the largest coffee certifier in the world. This certification is an internationally recognized set of criteria for professional coffee growing, which includes socially and environmentally appropriate coffee growing practices, and efficient farm management.

It's the most developed certification in the Kodagu district. During the CAFNET programme, the project team trained farmers groups across the district and helped them to create links with the major buyers of certified coffees like Ecom Gill.

But this certification doesn't guarantee the planters a minimum price for their crops. Environmental standards are less demanding than other certifications such as Fair-trade. Chemical input regulations don't really go further than the EU and US regulations. Furthermore, the standards don't impose any restriction on tree diversity management. UTZ is also criticized about worker remuneration: national laws are respected but there are no additional benefits.

The Rainforest Alliance's sustainable agriculture programme oversees the certification of farms that produce tropical crops, including coffee, bananas, cocoa, oranges, cut flowers, ferns, and tea. To obtain certification, farms must meet a set of environmental and social standards, including agrochemical reduction, ecosystem conservation, and worker health and safety. CAFNET participated in satellite meetings by the Rainforest Alliance on the new proposal of climate plus for the Sustainable Agricultural Standards (SAS). In this meeting the team suggested that local indicators need to be developed and included for the certification standards and some of the parameters proposed are very difficult to quantify and monitor by the research teams and farmers.

The environmental standards concerning the shade management and the tree diversity management are not adapted to the local conditions. So negotiations are ongoing to create local standards for the Rainforest Alliance certification.

Currently neither UTZ nor the Rainforest Alliance are able to prevent biodiversity degradation in the Western Ghats. The development of the local market could be the key to this mechanism efficiency. A demand from the urban middle classes for certified coffee, with at the same time; the promotion of a higher standard seems to be the only way certification could preserve Kodagus biodiversity.

The certification mechanism is presented below (Figure 9).

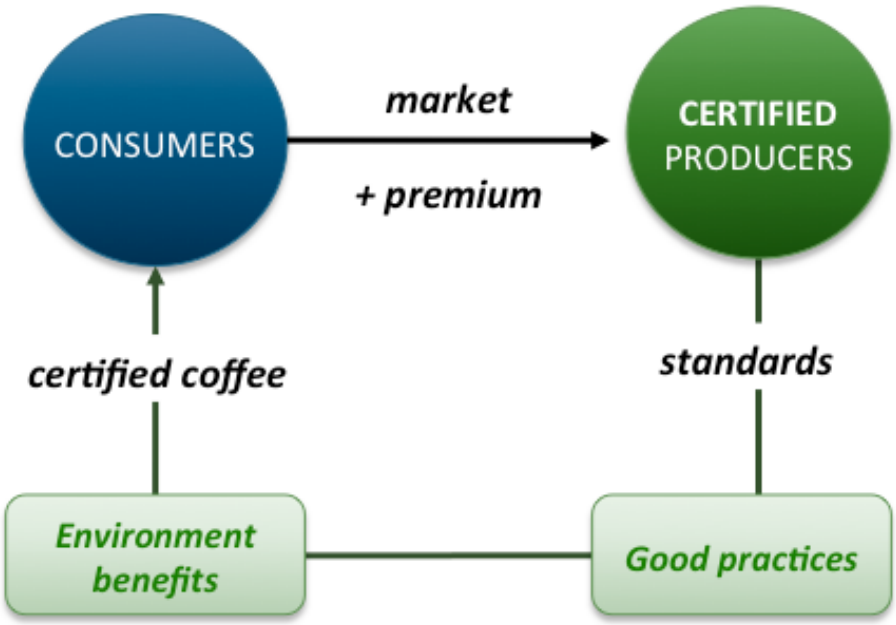

Figure 9: Schematic diagram of certification mechanism

Payment for Ecosystem Services

As the College of Forestry is trying to implement Payment for Ecosystem Services in order to protect the biodiversity of Kodagu, a special focus will be done on this device.

As depicted in Figure 10, in such a PES mechanism the planters would be remunerated for good environmental practices in terms of biodiversity conservation, water management or carbon sequestration. It is implemented on a voluntary basis from the producer who will receive money to change or maintain his practices leading to environmental services (Laurans & al., 2011).

An important point in the PES implementation is the link between the good practices and the environmental benefits, which has to be proven with strong scientific data.

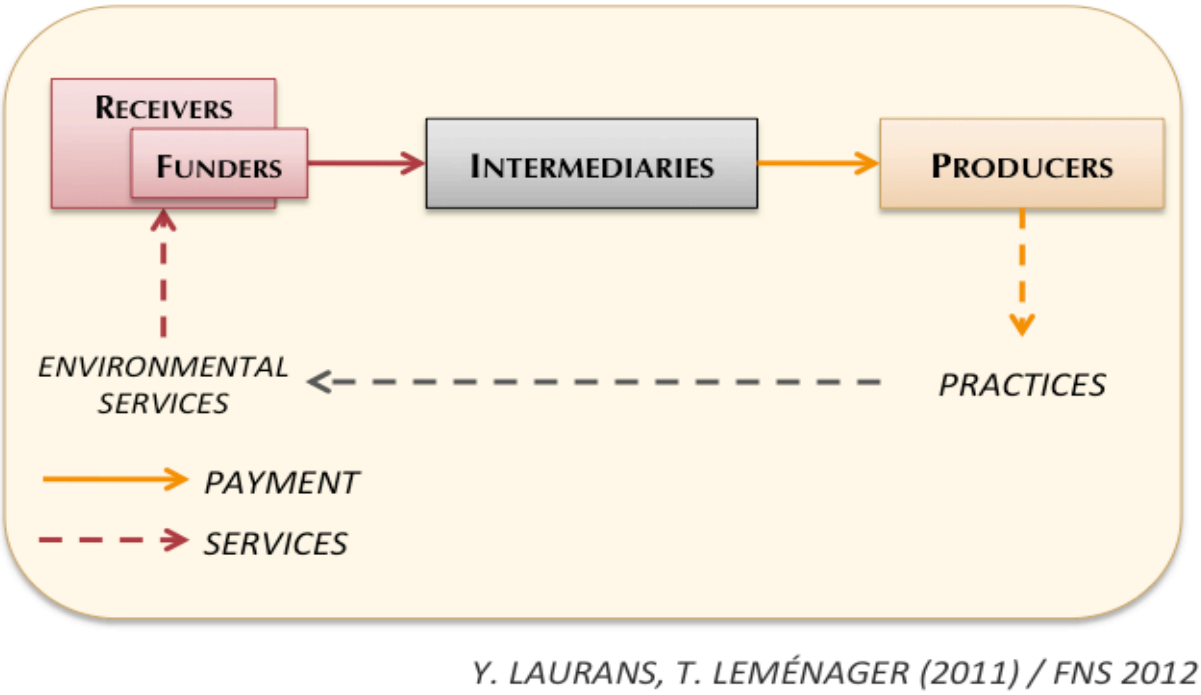

Figure 10: general representation of PES mechanisms. Adapted from Laurens, Leménager et al.2011

In this part we will consider different PES: water, biodiversity and carbon.

Water PES

In this case, as shown in Figure 11, the Coffee planters would be funded by the city of Bangalore, through a committee we can call the "Kodagu water PES committee" that will collect, manage and redistribute the fund. The money will be used to reduce the opportunity cost of an intensive land use with irrigation and/or chemical inputs. These practices are expected to lead to an improvement of the water quantity and quality that will benefit Bangalores inhabitants.

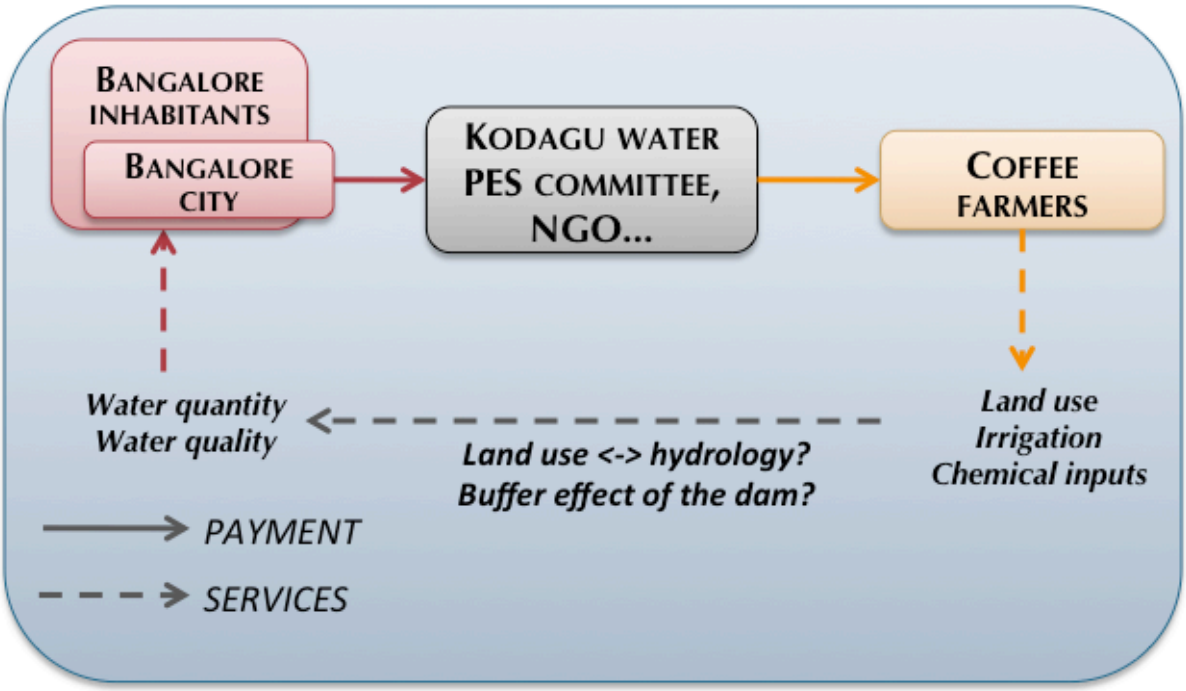

Figure 11: schematic representation of the water PES mechanism envisioned. Adapted from Laurens, Leménager et al. 2011

However, the Bangalore administration doesn't seem very enthusiastic for a PES which remunerates the Kodagu district for their environmental practices. In fact a lot of other devices are implemented in order to improve the water quality and the Kodagu district doesn't seem to be a major preoccupation for the Bangalore authorities. According to some institutes like the Central Ground Water Board, Kodagu will be their last preoccupation.

Moreover, as coffee farmers are considered as the richest farmers of the area, and even of the whole south-Indian region, there are strong equity and institutional concerns in setting up compensation mechanisms for environmental services provision in Coorg (Vignault, 2009).

In fact, the water PES implementation needs be on a wider scale. Here the action systems involved are much more numerous and complex. The efficiency of a water PES in the Kodagu district is relative to the efficiency of some other devices in the industry or the water sewage that could be more cost-efficient.

Moreover the link between land use and hydrology is very controversial. Regarding the complexity of interacting factors in watersheds and the difficulty of isolating variables, forest hydrology is still a complex issue. The debate around the linkage between forest and water is quite an historical one which has existed since antiquity (Andréassian, 2004).

The scientific controversy concerning forest and water

In a binary way the scientific debate is as follows. On one hand, forests are considered as sponges, influence rainfall, raise water yield, and conserve water. This is the global and

popular belief of “No-forest-no-river”. on the other hand, forests are said to have no influence on rainfall, to decrease the river flows, and to consume water.

Actually, changes in forest cover in tropical regions result in multi-dimensional changes in the watershed: soil erosion, peak and low-flow levels, groundwater recharge, and water quality. There are still large gaps remaining in the question of how different types of forest transitions affect low flows, and on the socio-hydrological links which are inadequately studied (Lele, 2009). In order to include these analyses in the frame of our prospective we'll first consider the studies done from local scale (*demand-side school*), to global scale (*supply-side school*) (Ellison & al., 2011). Then we'll carry out a review of the forest hydrology in India, and then consider how these different analyses affect our environmental prospective.

Local studies

The local research methods in this field are still undertaken in quite a traditional way. These methods leave much room for improvement and have been widely criticised (Andréassian, 2004). The paired-watershed experiments are the most classical studies of the impact on hydrology of land use changes. The method used is to take two quite similar basins with highly correlated behaviour, in geographical proximity and with a stationary basin (Andréassian, 2004). Actually, this method points out that deforestation increases the annual flow and that reforestation decreases it but increases flood volumes and flood peaks etc.

We have to underline that results are extremely scattered and uncertain. To give an example, increasing floods may reveal rather an impact of exploitation than that of the forest cover itself as shown by Andréassian in a brilliant synthesis (2004).sentence incomprehensible

As a first conclusion of these local studies, we notice that on one hand several experiments show that if the forests are removed then it will raise the downstream water availability. However, other experiments indicate that planting additional forests would raise downstream water availability and intensify the hydrologic cycle (Andréassian, 2004). This *demand-side* view states that the forests compete against other important water-consuming activities as such as agriculture, energy, industry, households.

Regional & global studies

Regarding the regional and more global scales the scientific results reveal quite different conclusions. In contrast with the small water catchment literature, Ellison &co argue that the forest cover increases water supply at regional and global scales, specifically through the intensification of the water cycle. They demonstrated that the precipitation recycling not only raises the likelihood of local precipitations, it also favours the cross-continental transport of moisture vapour and thus increased precipitations in locations further from the ocean-based hydrological cycle(Ellison & al., 2011).

The *supply-side school* clearly state that the overall impact of forests is one of improving water availability at the regional and/or global scale (Ellison & al., 2011). Their main arguments are firstly that large forests have to be seen as biotic pumps ; also regionally, deforestation has been linked to reduced precipitation, increased low flow events, extended dry spells and drought.

Evapotranspiration is a key factor in these studies. Actually, the conclusions depend on the scale, from local to global; from short term period to long term period. More precisely, the timescales of ecosystem regeneration represent a further complication given that time obviously matters in the forest-water relationship. Furthermore, forest ecosystems potential for soil water storage and ground water recharge would also require long regeneration periods (Ellison & al., 2011).

To sum up, evapotranspiration consumes water at local scale but supplies water to the atmosphere, facilitating cross-continental transport of moisture and causing precipitation at regional and global scales.

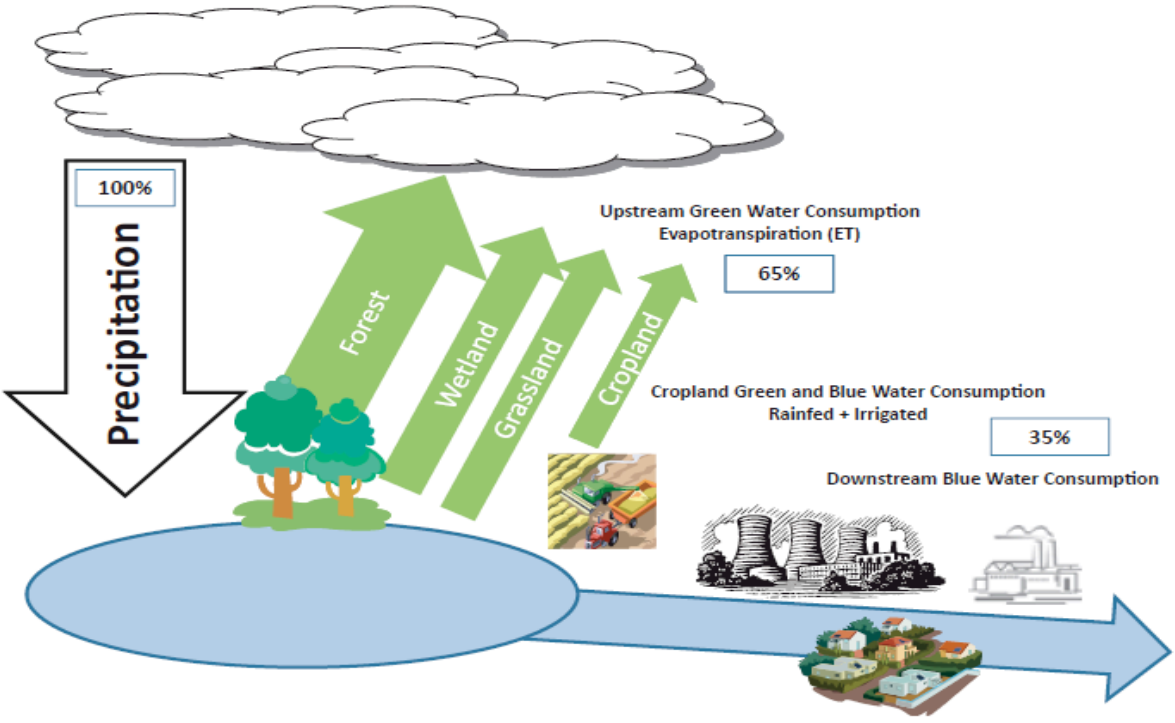

Figure 12: green and blue water flows, adapted from Falkenmark (2009)

One conclusion of the supply-side thinking school the Forest cover increases water supply at regional and global scales, in particular through intensification of the water cycle. Also the trans-boundary evapotranspiration can't be hidden from the analyses.

Globally, what has been noticed from the studies is that there are different contexts then different results. But mainly what has to be underlined is that the forest does have a hydrological impact on precipitation pattern, water cycle and water yield.

Going back to Kodagu and the research done, mainly with the CAFNET hydrological study outcomes, the water balance at a tree scale is represented as follow:

The outcomes of CAFNET studies point out that coffee and shade tree canopy intercepts 15-25% of the precipitation, more precisely coffee trees intercept more than shade trees. In parallel, coffee under native trees intercepts more precipitation than coffee under exotic trees. And finally, native trees intercept more precipitation than silver oak.

Regarding water runoff, it is more or less equal with native plots or exotic plots. There is a major infiltration with native plots than with exotic plots, especially where there is heavy rainfall.

Then, regarding the environmental prospective and the device based approach, it should be taken into consideration that forest ecosystem services, concerning water, provide a production of evapotranspiration and, as already indicated above, allow cross continental transport of moisture vapour. In addition, the impact on land conversions should be considered, forest and cropland in particular, with potential evaporation as well as the recovery cost for water provision

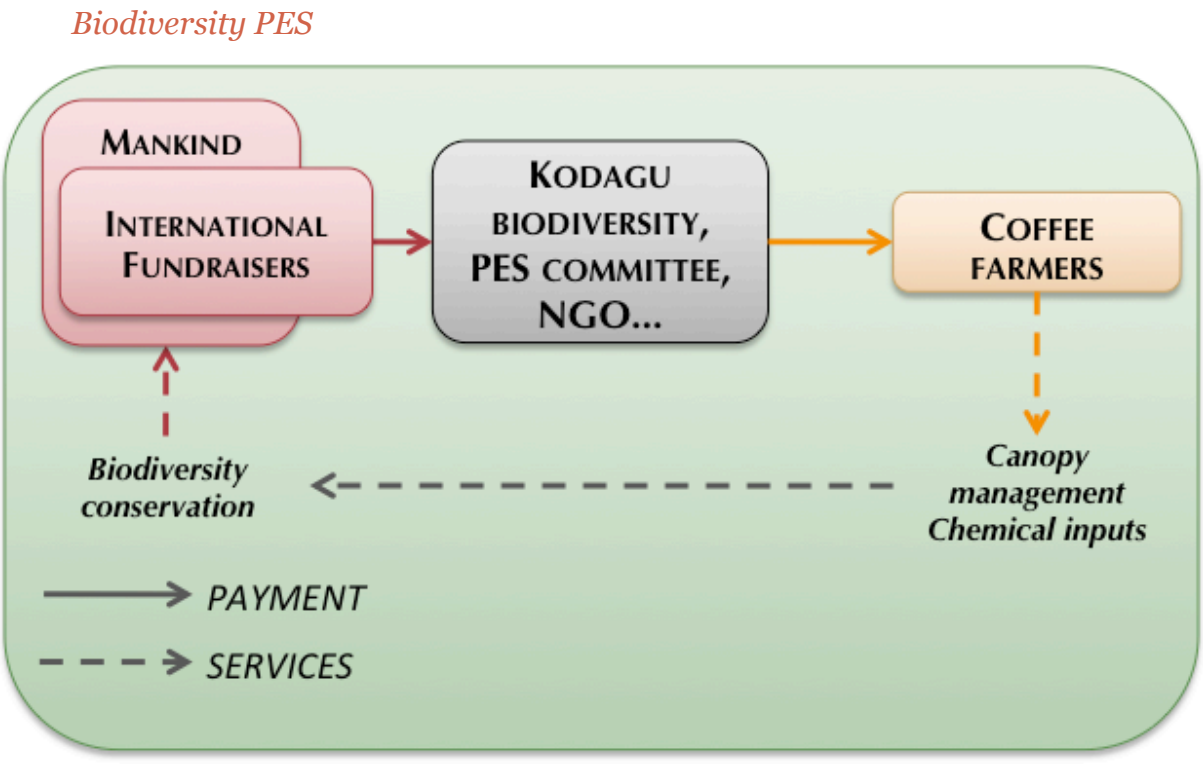

Figure 13: schematic representation of the biodiversity PES mechanism envisaged. Adapted from Laurens, Leménager et al.2011

The biodiversity PES Figure 13 works the same way as the water PES (Figure 14). Considering the hard-to-prove link between land use and hydrology for the water PES, the biodiversity PES would appear easier to implement. Several NGOs and international fundraisers should

be candidates to finance biodiversity conservation in Kodagu, but whether they will be ready to pay farmers for good environmental conservation or not remains the decisive issue.

Carbon PES

With this PES the coffee farmers would be funded by carbon investors through the voluntary carbon market in order prevent forest degradation, and carbon emissions (Figure 14). The amount of money given to the farmers fluctuates with the carbon market price.

It is estimated than an average increase of 10 Mg per Ha of carbon in the plantation would lead to an average loss of nearly 8000 INR per Ha per year. In some estates, these costs could be partially compensated by the introduction of Silver Oak that would certainly increase fertilizer costs but lead to higher pepper returns. But the given opportunity costs do not include transaction costs (monitoring, institutions, financial costs, etc, that can multiply the cost by 2 or 3. Indeed, there are currently no institutions in Coorg who are capable of supporting a programme such as REDD (Vignault, 2009).

Moreover considering the relatively low price of the carbon tons, there is no perceivable incentive to preserve biodiversity in the area.

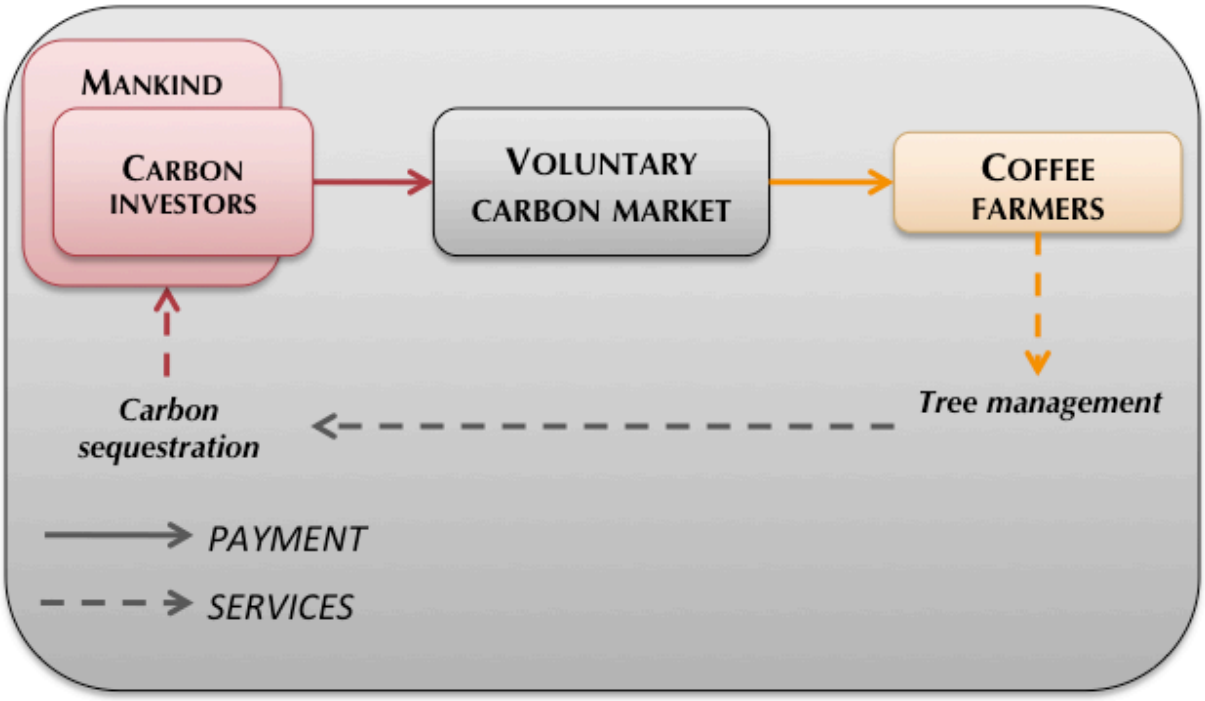

Figure 14: schematic representation of the carbon PES mechanism envisaged. Adapted from Laurens, Leménager et al.2011

Taxes and subsidies

The National Water policy advocates that the principle of “polluter pays” should be applied in the management of polluted water. A device of this kind applied to the agriculture action system would consist of the taxation of chemical inputs. The money collected could be used

as subsidies for organic inputs. The government would play the role of the principal fund manager in this case.

There already exists a tax system for industries called the CESS Act. According to some critics the quantum of payment is so low that there is no incentive or disincentive for industry to reduce wastewater discharge and hence water use (Ministry of Water Resources, 2010). For agricultural use, a tax perception done directly on products would minimise the need of control.

However, if the Ministry of Water and the MoEF decide to support such a policy, it would need the collaboration of the Ministry of Agriculture who are already subsidising chemical inputs.

It's a simple device that can be very efficient but which requires collaboration between ministries, and an efficient monitoring system.

Infrastructures development action system

We have seen earlier in the description of actual management, that infrastructures can cause several types of degradation to the environment: fragmentation, soil pollution, water pollution…

To prevent this degradation, some organisations actively oppose these projects. First, we will analyse the current processes used by Environmental NGOs in opposing infrastructure projects. Then, we will consider which regulations and devices could be effective in preventing this degradation in a sustainable manner.

Environmental NGO action on private investments: an example

A local-environmental ONG is working at the grass-roots level with the aim of stopping major projects which are liable to cause an environmental imbalance. Since its creation in 2004, it has blocked over a hundred projects of all types: major hydrological projects, mining and quarrying projects, high tension line projects etc. The strategy it uses to oppose environment-threatening projects can be summarized in the Figure 15 below.

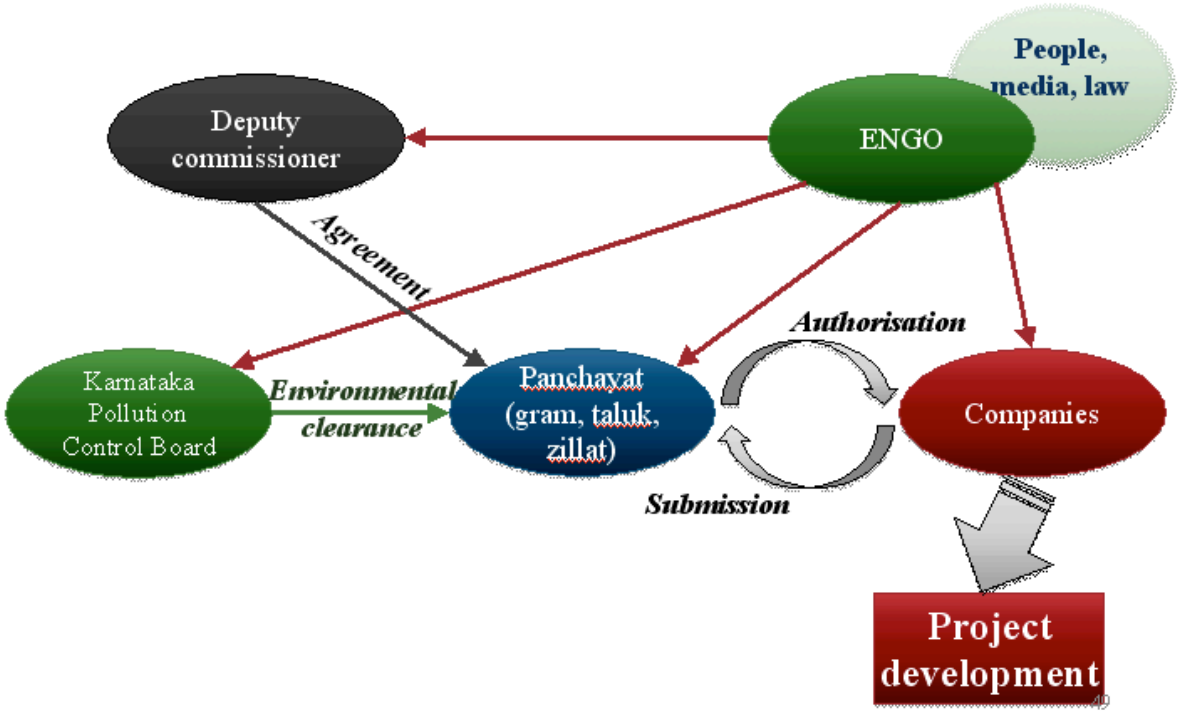

Figure 15: strategy and resources engaged in the ENGO opposition process

If, through press and other media sources, the ONG gets to know about a particular infrastructure project, its first actions will be to get close to the village people who are concerned by this project, in order to mobilise them and instigate the opposition. There are very few permanent employees working for this ONG. As such, the only staff are the villagers recruited in each case.

A process of information collection begins and all the details are gathered in order to build a detailed report. This report will be given to the Deputy Commissioner as a memorandum to convince him/her to stop the project. A negotiation then begins between the project opponents and the deputy commissioner who has the power of decision. The media are informed throughout this phase in order to put pressure on the commissioner and to build public awareness of the environmental impacts of the project.

If the deputy commissioner decides to maintain the project despite the opposition, the ENGO will engage in a protest in collaboration with the media, again to increase public awareness: walking protests, public speeches…

If the protest isn't enough, the ENGO will instruct their lawyers to go to court and stop the project. If the project is built on government land for example, the ENGO will plead the non-respect of property rules.(which ones?)

Eco Sensitive Zone/Area (ESZ/ESA)

The current situation resembles a case-by-case battle between NGOs and infrastructure project holders. This situation is quite unstable as it necessitates restarting from scratch each time a project is planned.

In order to establish a more sustainable situation, some Environmental NGOs are campaigning for the implementation of Eco-Sensitive-Zones (ESZ).

An Eco Sensitive Zone/area is a law that sets some restrictions on a given territory. In case of an Eco Sensitive Zone (Figure 16), the territory is a delimited zone up to 10 km around the eco-sensitive area (ex: wildlife sanctuary, national park). In the case of an Eco Sensitive Area, a whole area can be selected (ex: whole Kodagu district).

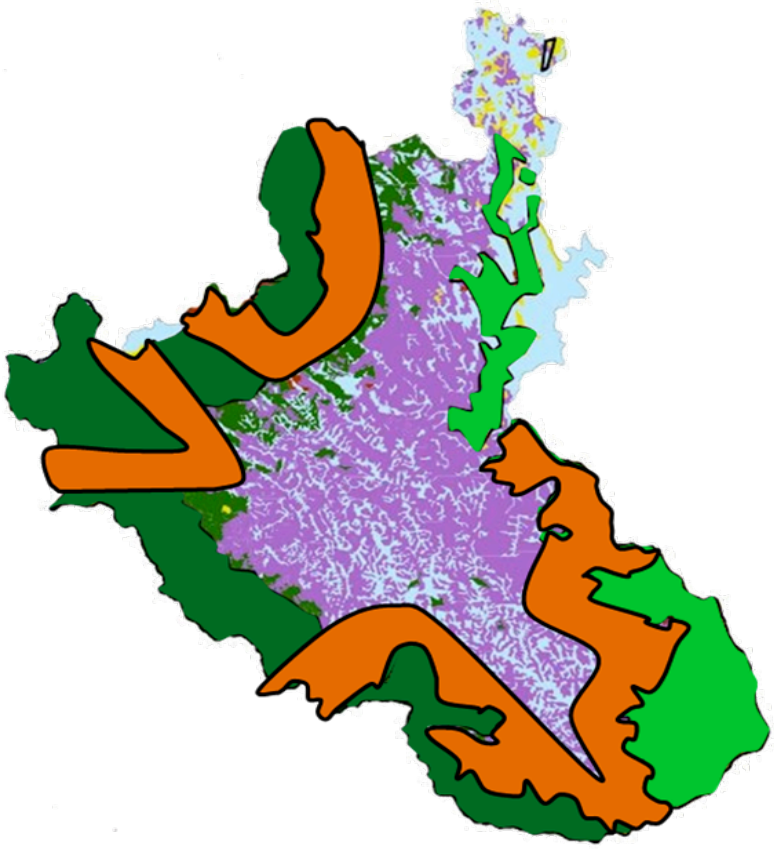

Figure 16: Example of an application of the ESZ in Kodagu district

There are 3 kinds of restrictions concerning different practices:

- *Prohibited practices*: mining, quarrying, industrial activity, commercial hotels and tourism, saw mills, major hydroelectric projects, high tension cables, railways...
- *Regulated practices*: land conversion, commercial use of water resources...
- *Authorised practices*: some practices are tolerated in some areas of the zone and not tolerated in other zones.(which practices?)

Since 1998, several parks and wildlife sanctuaries have been surrounded by an Eco Sensitive Zone in India(MoEF, 2012).

The Karnataka forest department has been supporting the ESZ project until recently but seems to have abandoned it at present. Several Environmental NGOs are now supporting the establishment of an ESZ/ESA in Coorg, but other actors who see their freedom being limited by ESZ/ESA legislation are clearly opposing it.

Environmental Impact Assessment (EIA)

This device already exists in India but several ENGO have described it as inefficient. By describing the process of delivery of an EIA in the case of a resort building (Figure 17), we can identify its weak points and how it could be improved.

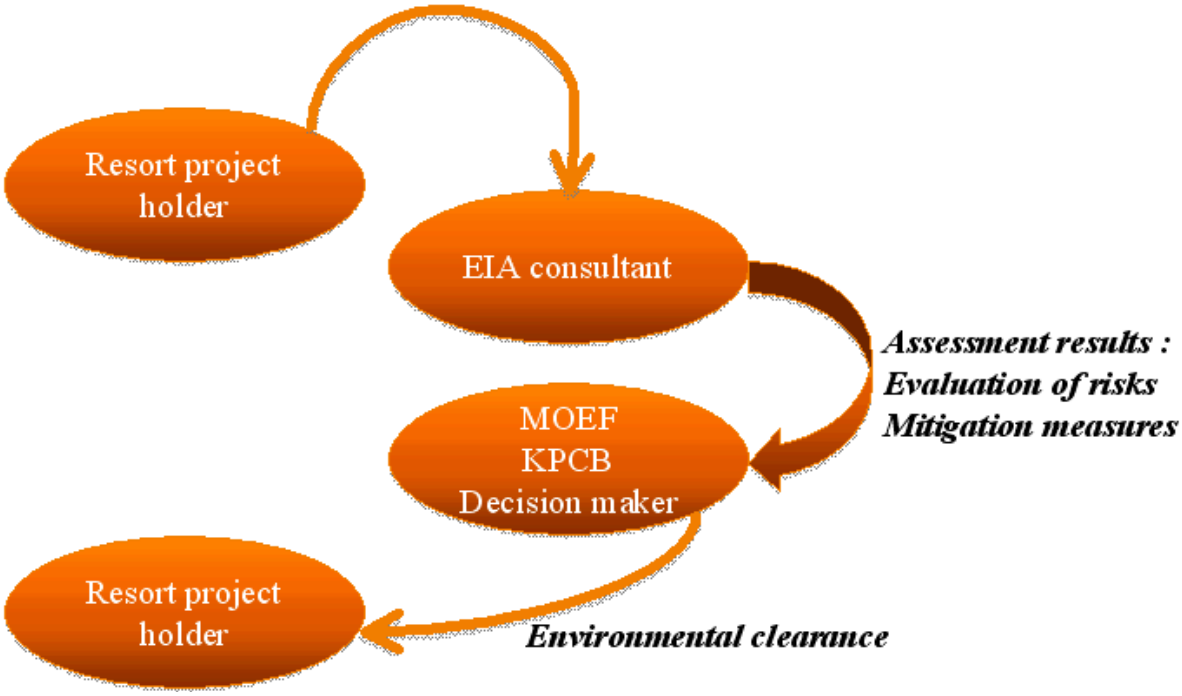

Figure 17: an example of an Environmental Impact Assessment process

The EIA process is a device meant to evaluate and measure the risks of a project on the environment. It communicates and recommends mitigation measures to the project holder. However those are recommendations and therefore they are optional and the project holder is not constrained by them.

Moreover, the project holders choose the consultant companies they want to carry out the EIA. As there is no accreditation of EIA consultants, they can be more easily influenced by the companies contracting them.

As far as we've understood it, EIAs rarely block any projects, and they are carried out in a relatively random fashion. Furthermore, no monitoring seems to be done during, or after the project realisation.

In the future, we could only imagine EIAs to be effective if they become capable of constraining companies and blocking those projects which damage the environment. This would certainly necessitate the modification of the law and therefore, considerable legislative and administrative work and investigation.

The Forest Rights Act implementation action system

The Relocation Scheme

As mentioned before, the Karnataka Forest Department shows great prudence in the implementation of the Forest Rights Act in the Kodagu district. Considering the misuses and abuses that could be implied by a strict FRA implementation and the actual human encroachment into the forest surrounding the hamlet(s) that has been observed, the Karnataka Forest Department has only given its approval for individual forest rights in reserve forests. In the Protected Areas – Wildlife Sanctuaries and the Nagarahole National Park, no IFRs have been given yet. The CFRs, which concern wider areas for minor forest products collection, are regarded by the Forest Department as dangerous for wildlife conservation. Until February 2012, no CFRs were planned inside the Nagarahole area, despite large parts of the area being concerned by the act, in particular the Jenu Kurba settlements.

To avoid potential damage to the most eco-sensitive areas, the Forest Department's strategy relies mainly on a voluntary relocation scheme designed by the Ministry of the Environment and Forests to ensure the absolute protection of the Core/Critical Tiger Habitats as defined in the Wildlife Protection Act, 1972. The Tiger Reserves are divided in two distinct areas: the Core/Critical Tiger Habitat (CTH), where no human activity should occur, and the buffer areas, where a lesser degree of protection might be enough to ensure the security of wandering tigers(Government of India, 2011).

This relocation Scheme, originally created in 1999 as the Beneficiary Oriented Tribal Development Scheme (BOTDS), relocated tribal families out of the Tiger Reserves, and in exchange they were remunerated with 1 Lakh Rupees in money or a small house and a plot of land to cultivate inside Reserve Forests. This scheme was implemented by the State Forest Department and funded by the National Tiger Conservation Authority (NTCA) at federal level. The FRA the WPA, and the MoEF revised the relocation scheme in 2008 and raised the compensation to 10 lakhs Rupees. If the volunteer family choose the house and land instead of the money, this amount is divided as shown in Table 1.

Table 1: Repartition of the Relocation Scheme's 10 lakhs Rupees per family package(Government of India, 2011)

Agricultural land procurement (2 ha.) and development	35% of total	3,5 lakhs
Settlement of rights	30% of total	3 lakhs
Homestead land and house construction	20% of total	2 lakhs
Incentive	5% of total	0,5 lakh
Community facilities (access road, irrigation, drinking water, sanitation, electricity, telecommunication, community centre, places of worship, cremation ground)	1% of total	0,1 lakh

For Nagarahole, the relocation scheme is supervised by a District Level Committee presided by the Deputy Commissioner of Mysore. The Forest conservation officer of Nagarahole is the secretary of this Committee. The relocation process is divided into the following steps:

- The Committee selects land inside reserve forests
- After MoEF clearance, a new settlement ("block") of 150 houses is built and equipped with facilities
- A Forest district officer is appointed whose specific task is to "motivate" tribal families to relocate, and to make a list of volunteers/participants.
- A lottery for lands and houses attribution is organised by the officer. Revenue Transfer Certificates are given to the beneficiaries.

When resettled outside the Park, tribal families can benefit from the Tribal sub-plan, a part of the MoTA Integrated Tribal Development Plan designed to bring agricultural support to relocated families. This sub-plan completes the ITDP basic action, which is to ensure that healthcare and education are also provided to all tribal people. This managed by theTribal Welfare Department.

From 1999 to December 2011, 491 families out of the 1550 living inside Nagarahole NP were relocated this way, reducing the number of hadis from circa 45 to 21. The new settlements are located in the Mysore district, in the following locations:

- Nagapura: 6 blocks
- Sollepura: 1 block
- Shattihalli Lakhkhapatna: 2 blocks (one remaining to fill)

From the Forest Departments point of view, the relocation scheme is efficient and really incentive, even though the process takes time. The incentive also shows itself to be limited: during the last campaign, 7 houses found no volunteers.

In addition to the MoEF and MoTA institutional support, the Relocation scheme benefits from the support of civil society organizations. Two local NGOs are actively involved in the Nagarahole National Park Relocation Scheme: Wildlife First and LIFT.

Wildlife First was created in 1995 under the name "Nagarahole Wildlife Conservation Education Programme" by Mr. Chinnappa, the former Forest Department's Range Forest

Officer. The association works mainly on building public awareness for wildlife conservation, and promotes a unique vision of wildlife through educational events in schools. Wildlife First support the Relocation Scheme and the de-population of Protected Areas by seeking evidence of tiger presence, and by strong lobbying action to have new Tiger Reserves established.

LIFT (Living Inspiration For Tribal people) has been working since 1997 to integrate the tribal families of Nagarahole into the countrys mainstream population. LIFTs action takes place upstream with the Forest Department to "motivate" the tribal population, and downstream with the Tribal Welfare Department to supervise the development of new settlements. The TWD provide the settlements with free education and healthcare material, resource management advice (organization of self-help groups, fixed bank deposits to secure the principal while the interest are perceived monthly, etc.), and birth control (finance of sterilization operations). LIFT benefits from the support of diverse institutions, including the Lion's Club, Rotary International and the World Conservation Society.

The following diagram (Figure 18) shows a summary of the action system involved in the relocation schemes implementation. One can notice the crucial position of LIFT, which not only benefits from external finance from independent fundraisers, but also creates a connection between the Forest Department and the Tribal Welfare Department that might have worked independently elsewhere.

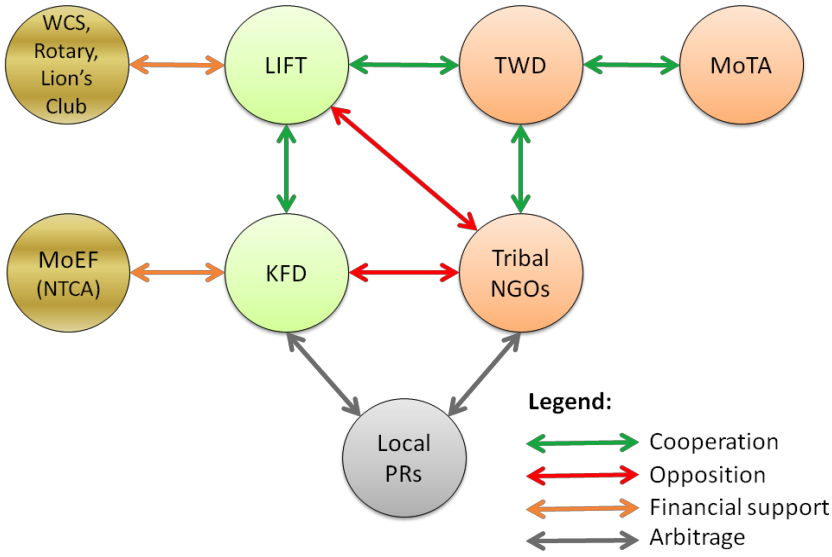

Figure 18: Summary of the action system involved in the Relocation Scheme implementation

An alternative vision for Tribal development inside the forests

As a response to the negative vision of tribal populations impacts on forests carried by the Forest Department, tribal organizations such as VGKK, BKS and CORD oppose the idea that *Adivasi* groups have lived in the forests for centuries without threatening wildlife. They see themselves as the best possible forest managers and claim Community Forest Rights even

inside the protected areas. The vision they carry relies on a culturally specific way of life inside the forest which respects the wildlife and the ecological balance.

An example of this vision implemented in the field can be found in B.R. Hills Wildlife sanctuary (Chamarajanagar district), where the NGO Vivekananda Girijana Kalyana Kendra (VGKK) is particularly active with the Soliga community. After the CFR have been given, VGKK promoted the development of healthcare and education facilities, while ecotourism facilities have been built to generate extra income and employment opportunities for the people.

At the same time, scientific and technical support was given to the tribal community in order to help them to manage forest resources and agriculture in a sustainable way and to organize handiwork in order to supply the ecotourism shops. VGKK also tries to rehabilitate traditional practices and institutions to preserve Soliga culture from being totally assimilated, despite the fact it considers that the evolution toward the mainstream society is inevitable. Its position is that Tribal peoples should at least maintain a link with their tribal identity. All these actions are supported by the IUCN, which finances VGKK.

Even though this model seems to have proven its potential, their initiatives seem to be quite isolated. If the FRA is more strictly implemented in the future, with CFR being given more often, this approach could constitute a new and viable forestry management philosophy, contrasting with the rigid preservation model inherited from the colonial administration.

To achieve this, VGKK promotes a “joint venture” organization that involves a collaboration between the Forest Department, the tribal NGOs, the research institutes and the Social Welfare Department. Working together, these actors are able to combine their knowledge, powers and legitimacy in order to implement the best management practices. The following diagram (Figure 19) shows the intended action system that could result from such cooperation:

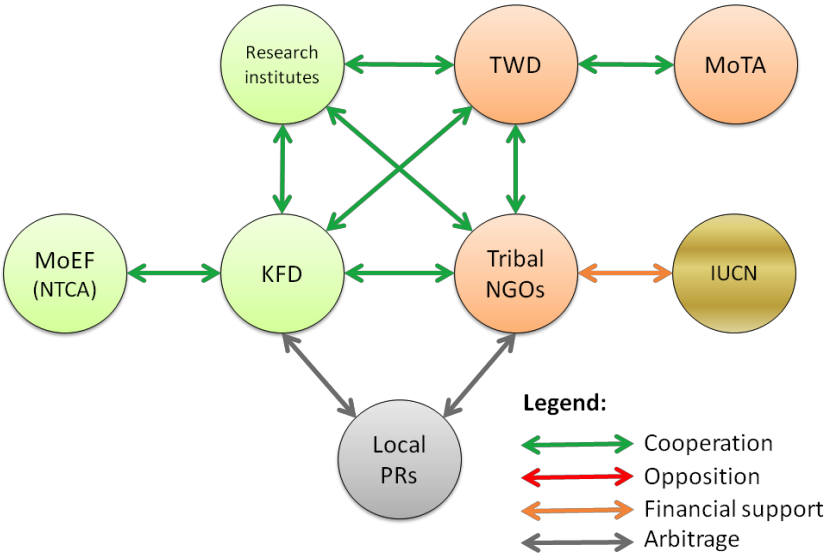

Figure 19: diagram for a joint venture forest management ideal action system (VGKK vision)

Given the current opposition between the KFD and Tribal NGOs, this multilateral cooperation scheme relies on the strong hypotheses that both institutional groups will be able to change reconciliate their discourses and positions. The second critical uncertainty concerns whether the NGOs have the legitimacy to carry out this kind of development model. Beyond the ideological discourses, one must ask whether tribal people really have the will to remain in the forests.

Even though a few tribal family heads of Nagarahole actually work inside the forests as rangers for the Forest Department, the bulk of them are hired in coffee plantations. Out of 25 tribal children interviewed in Nagarahole School in February 2012, 9 wanted to become policemen, 11 wanted to become teachers, 4 wanted to become doctors or nurses and 1 an engineer. All of them said they would like to to stay in Nagarahole, but they all agreed that if moving was necessary for them to achieve their dreams, they would move.

As modest as this result may be, it entails the tribal NGOs common argumentation, that a significant number of educated young tribal people will return to their forest homeland ?

Prospective

Building scenarios

Building scenarios aims at raising debates on possible futures and the involvement of the actors. In no case do these scenarios propose a mechanist view of what will happen. They aim at but showing the plausible evolution of a given situation, according to the knowledge and data that was gathered upstream.

Defining actual management dynamics

The first step of scenario building is thus to have a clear view of the actual dynamics that a given system is submitted to. This was the main objective pursued in the "actual management" part of the diagnosis presented above. Understanding how different stakeholders interact with each other and with the environment allows us to define action systems' structures. Understanding the social, institutional, economic and physical universe in which these action systems evolve means finding out the main trends and uncertainties that may transform them and modify their actual practices.

These dynamics are relatively autonomous, in that they don't depend on the action systems' intentional management of environmental issues. This doesn't mean that the actors are systematically helpless in front of them (for instance, the giving of tree rights to coffee planters may result of a strong lobbying action), but that their action is not primarily motivated by environmental issues. In some other cases, and particularly when it comes to market or demographic trends, the uncertainties are totally independent from actors' actions.

The last points to clarify here are that the action systems' dynamics may not impact each individual group of actors inside the action system in the same way, and that they are neither mutually exclusive nor binary in their effects: there is a broad range of blends and gradations among them.

Hence, these dynamics are numerous and complex. An important part of the work is thus to reduce this complexity by selecting contrasted and easy to read trends. But one must not forget that these trends are artificially forced, even if they reflect the reality as faithfully as possible.

Defining intentional management dynamics

The second step is to analyse the intentional management dynamics: once the devices and objectives contained inside each action system are understood, their own dynamics are outlined. The autonomy of intentional management dynamics is a little more complex to comprehend, as intentional management is by definition highly dependent on the actions of each individual group inside the different systems studied. Intentional management has

nevertheless its own trajectories, mostly independent from the actual practices implemented on the field.

The same precautions taken with actual management dynamics also apply to intentional management dynamics: they are neither mutually exclusive nor binary in their effects, and they don't concern all the actors in a homogenous way. And from the infinite complexity and variety of the future scenarios, contrasted possibilities of evolution have been selected for the use of prospective methods.

Finding a path through multiple combinations

Even though all the possible futures of both actual and intentional management have been reduced and simplified, there are still a lot of possible combinations among them. Building scenarios consists of selecting a small number of these combinations to tell inspiring stories. But to catch the readers attention on the focus points that seem of major importance, these stories have to be (i) plausible (ii) coherent and (iii) make sense for people. This last point implies that these combinations must reflect the projects and ambitions of the stakeholders, and that the tipping points of their projects must be identified.

For a given scenario, the first thing to define is therefore its main objectives, i.e. the precise issues to explore and the reasons why it seemed important to focus on them. Once this is done, the basic hypotheses can be specified, by selecting a precise set of actual and intentional management dynamics that will be assumed to occur. These combinations are selected for their relevance to the issues to be explored, but also for the probability that they could happen together. For instance, PES mechanisms are more likely to happen with market deregulation than with environmental law being more strictly enforced. All scenarios are thus easy to identify with simple and distinctive features, which their names reflect.

Storytelling

The last step of the prospective work is the storytelling itself, giving rhythm and drama to the scenarios. Some attempts might fail, others could succeed. Some groups of actors may succeed and obtain their goals; others may be subjected to the trends without having any power over them. Things happen in a given order, following specific events. The idea here is to describe things as they may come, and to explain why they arise.

Of course, a certain amount of imagination is needed. However this imagination is not pure fantasy, and it is important to emphasise that the choices made when writing the scenarios rely on documented data, and on the real appreciations of the persons interviewed. Scenarios are not predictions: a given device could fail in the story and succeed in reality. But if the diagnosis shows weak points such as indifference or reluctance from the decision makers or a lack of legitimacy of the project carriers, or anything that is considered unfavourable, then in a good scenario the project will not be implemented.

"Carbon coffee"

Why this scenario?

The College of Forestry of Ponnampet is currently thinking about how to implement a Payment for Ecosystem Services on Carbon in Kodagu. The CAFNET project has already produced a study on carbon sequestration. It was focused on the effects on carbon sequestration of the composition of shade trees and of the coffee management. Considering the global market competition there is an incentive to intensify the CAFS in several ways as explained below. This scenario shows the possible trends to cope with this environmental threat.

Hypotheses

As a starting point, let us assume that the Tree Rights are provided by the KFD to planters. Thus the KFD will focus on setting up a strict conservation programme concerning national parks and wildlife sanctuaries.

A second hypothesis regards the evolution in the next few years of the Rainforest Alliance certification standards, which will be based on local indicators, and which is currently under discussion (CAFNET, 2011).

The scenario

First step 2015 to 2025

There is increased logging activity in Coffee Agro Forest Systems. The tree Rights allow coffee planters to cut trees and sell them immediately to an intermediary or at the local market. The market for fuel wood, building timber, and pulpwood is developing. The opening of the canopy is accompanied by a general intensification of CAFS cultivation: the increasing need for water (due to the opening of the canopy) leads to the development of irrigation, increased use of fertilizer, the replacement of the last indemic, jungle tree varieties by exotic trees such as Silver Oak.

Meanwhile, national and international initiatives lead to the establishment of a higher standard of coffee certification encouraged by global objectives on biodiversity conservation. The higher standards focus on the tree diversity and they impose a maximum authorized quantity of fertilizer. On the international market, niches do exist that allow the commercialization of certified coffee. At this time, premium certification is the best way to reduce environmental impacts and to provide benefits to farmers. Unfortunately, after ten years, premium certification does not benefit coffee planters enough; it is insufficiently developed because the financial premium available from the market for certified coffee is not enough to compensate planters for complying with the standard. For Kodagus people

interested in biodiversity conservation, there is thus a need to find other mechanisms to regulate people's practices.

At the global scale, trading on carbon markets is fast developing. Among the different Payment for Ecosystem Services (PES) schemes, a PES on Carbon is favoured as it seems to be the simplest and the most accurate to provide significant incomes to coffee planters. The implementation of carbon PES leads to the development of projects aiming at producing carbon credits that can be sold on the international voluntary market. Coffee planters have first to find funders or investors who are willing to finance projects such as tree planting in coffee estates. They organise themselves in a Carbon PES committee in order to do this.

Then, they have to choose a standard to certify carbon credit production. Several standards are internationally recognized, among which two are discussed in Kodagu: the CCBS & the VCS. The CCBS standard regards carbon sequestration plus co-benefits, as biodiversity conservation and community capacity building but it does not allocate certified carbon credits. Since its main goal is to provide an incentive to store carbon, the VCS standard allocates certified carbon credits, without much regard to other co-benefits.

The PES carbon committee organizes several public consultations to choose between these two standards; through this consultation, the VCS standard finally becomes adopted. Consequently, not much attention is paid to biodiversity conservation in CAFS. Planters, however derive a better income. Through time, native species have disappeared from Kodagu, massively replaced by the fast growing — and thus, fast carbon-storing — species Silver Oak.

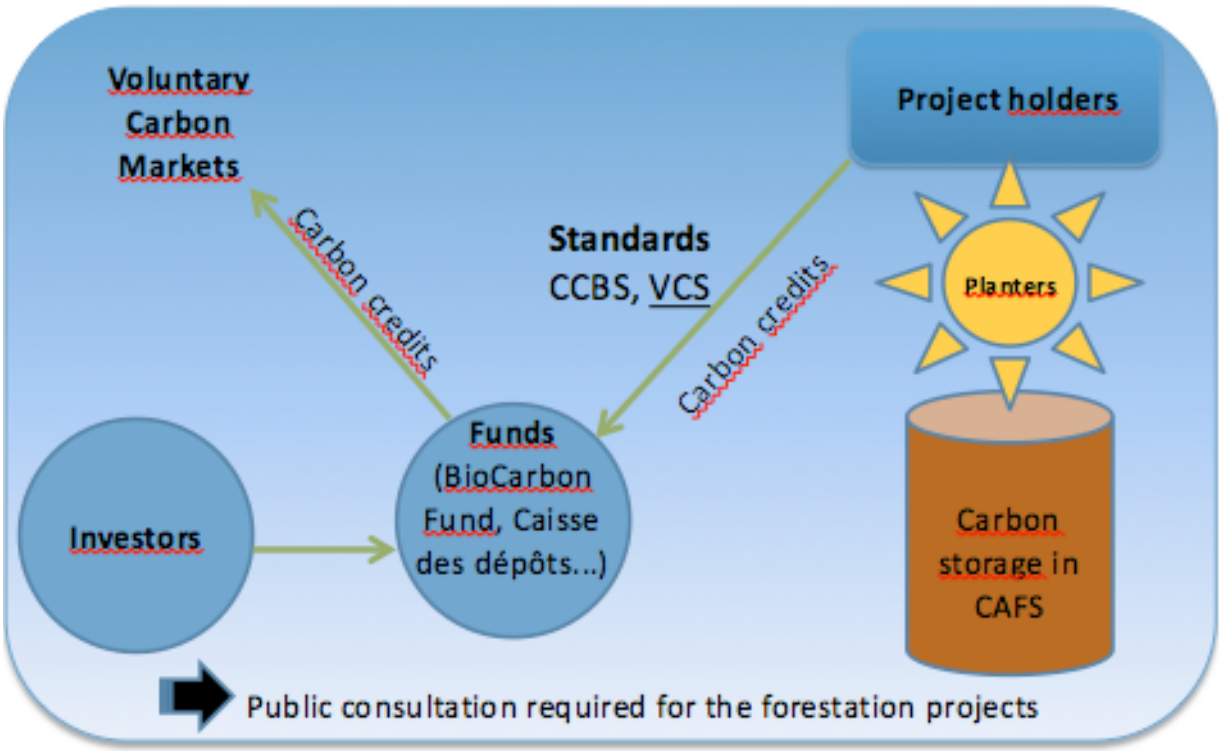

Figure 20: possible organisation of a future carbon PES

Second step 2025 to 2035

The evolution of the scenario reveals a change in the landscape of the CAFS throughout the phase of implementation of the PES between 2025 and 2035.

The first major driver of landscape modification is the KFD, which focuses on protected areas and reserved forests. In protected areas, much is done to promote the relocation scheme. In the western reserved forests, new modes of sylviculture are developed and logging resumes after being stopped for more than 20 years.

Biodiversity conservation actions are undertaken but local communities are not really implicated. Community Forest Rights are granted in eastern reserved forests. Newly available lands attract outside investors; these investments are the second major driver of change in Kodagu. The development of tourism leads to an increasing number of guesthouses in rural and remote areas, the development of tourist resorts, and the construction of large scale infrastructure.

A dam project is planned in the southern part of the district along with other important infrastructures i.e. railway network, roads, electricity.

Environmental impacts

Eventually the main impacts on the Kodagu territory are felt in three dimensions: ecologic, sociologic and demographic. Ecological impacts are that exotic trees like Silver Oak are extensively planted despite of the carbon PES. Because of population growth and tourism development, drinking water, sewage systems and pollution issues are resolved by the appropriate infrastructure. The increased logging in agroforestry systems would lead to a reduction in terms of canopy diversity.

“Kodagreen”

Why this scenario?

Twenty years after the Earth Summit in Rio in 1992, the UN are this year organizing a new international summit in Rio. Two priorities were identified: the green economy as part of poverty eradication and global governance for sustainable development.

Hypotheses

UN Agencies and governments will make a serious attempt at Rio+20 to accelerate an “evergreen revolution” supported by the Professor M.S. Swaminathan in India. This revolution will meet the growing global food demand while protecting soils, water and biodiversity.

With the strong position of the BRIC (Brazil-Russia-India-China group at the UN) in RIO+20 negotiations, India could succeed in pointing out the importance of its biodiversity and obtain international subsidies in order to protect its hotspots. The green economy in India will start to get market recognition.

Public financial institutions, development banks, fiduciary funds, as well as some pension funds and insurance funds would be encouraged to finance the international green economy through the protection of biodiversity and natural resources.

The scenario

Certification

The increasing demand from urban upper class for certified coffee leads the planters to be certified. But the premium remains economically unprofitable and the certification doesn’t become adopted.

Water PES

With the limited development of the certification, the PES becomes a priority. Project holders want to use the ecosystem services of CAFS for water regulation. The planters could be remunerated for their good practices.

They create a planters committee with the participation of a local ENGO to look for companies interested in the project. Their funds are used for the creation of a steering committee with planters, scientists and engineers. After the realization of scientific studies, project holders try to implicate the government with a tax system, and the Bangalore city to finance a water PES project.

But the studies show that agroforests don’t have a strong impact on water flow variation and the project holders can’t justify the PES project. Moreover, Bangalore has other priorities, such as the improvement of its water management efficiency, and new facilities

for the water network and sewage treatment. Furthermore, the dam in the Coorg controls the flow of the Kavery and allows water to be pumped through a pipeline to Bangalore. So the water flow regulation by the agroforests doesn't interest anyone. And at national level, the government has more pressing priorities in others districts suffering drought problems.

Biodiversity PES

After the failure of the water PES, project holders turn their attention to biodiversity PES. With the new trend of the green economy, international fiduciary funds invest in a biodiversity PES with state funding. There is strong lobbying from International ENGO, national ENGO like the Ashoka Trust for Ecology and the Environment (ATREE) to find funds. A consortium with local politicians and a voluntary planters association is implemented in the interim. Voluntary planters receive payment for maintaing good practices. Standards are created with the conservation of the native trees, the conservation of cover tree and the low chemical input.

With the success of the first experiences, the biodiversity PES is spreading in the Coorg. The PES committee appeals to other international fiduciary funds in order to find new partners.

Community Forest Rights

In parallel, the relocation scheme is completed. Most tribal people have left the forest and some of them remained. Pushed by the tribal associations, the Community Forest Rights becomes implemented. The CFR is regularly monitored and evaluated and the results show that tribal people don't have any serious impact on the biodiversity.

Ecosensitive Zone

In order to avoid the uncontrolled development of infrastructures with the implementation of Community Forest Rights, the State implements the Ecosensitive Zones programme. Also the government wants to control urbanisation caused by the development of tourism. The new strategy for the acceptance of this project consists of more communication and more involvement of local politics and planters regarding the content of the project and its implementation. The State wants a win-win strategy. Planters see in these Ecosensitive Zones the continuance of the biodiversity PES. Local politicians agree to it as well because it allows the development of green tourism in the Coorg. The State implements regular monitoring and yearly evaluation of the eco sensitive zone.

Indigenous land

Based on the success of other countries experiences like in Brazil, and after the positive results of the Community Forest Right implementation, the Indigenous Lands lobby is ready to take over the land rights. The government recognizes their land rights and creates indigenous territories in the Reserved Forest. A Socio-environmentalist coalition with local and international NGOs is created in order to maintain a high degree of conservation

compared to the others forest areas in the district. This implementation allows the recognition of the role of tribal people as protectors of the forest.

Environmental impact

The Kodagreen scenario is a conservationist one…

Biodiversity PES implementation has a positive impact on the conservation of the biodiversity in the CAFS. The standards created permit the conservation of the diversity of native trees and of the forest cover. Silver oak doesn't proliferate in plantations and problems of soil fertility and soil erosion are reduced. Chemical inputs are reduced and the water quality is conserved at the local scale.

The Ecosensitive Zones constitute a buffer zone for large mammal populations. It limits human encroachment around protected areas caused by urbanisation in the Coorg and the development of the middle class. The risk of infrastructure development is therefore reduced by the implementation of the Community Forest Rights and the Indigenous Lands.

Tribal people who stay in the forest ensure a good management of the diversity of species and limit the urban encroachment. The conversion of agricultural lands and growth of villages is limited and the large mammal populations can slowly increase.

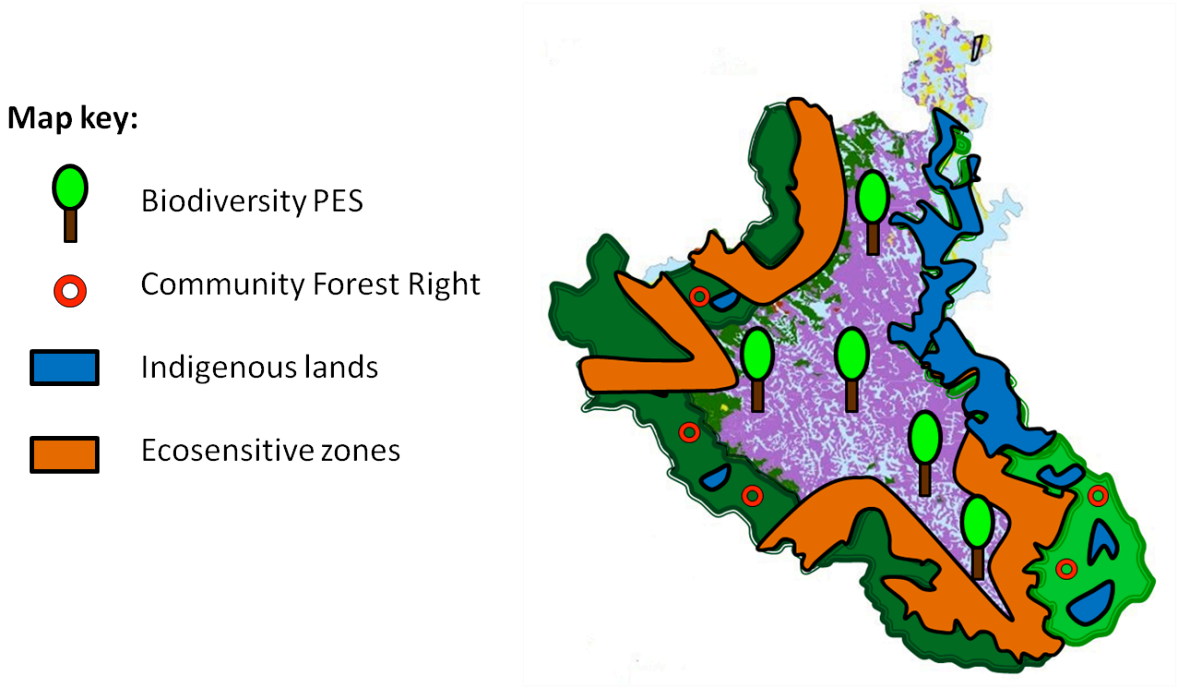

Figure 21: hypothetic map of "Kodagreen" after all device are implemented

"Let's regulate"

Why this scenario?

Today in Kodagu, the two main drivers of economic growth are the coffee sector and the tourist industry. Their impacts on the environment are being assessed and mitigating them could be achieved by the implementation of voluntary, market-based, devices such as eco-certification and Payments for Ecosystem Services (PES). However, uncertainties remain regarding the efficiency of the premium gained from certification and the relevance and demand for PES.

From the Authorities' point of view, economic growth is an opportunity to gradually achieve better living standards and reduce social inequalities. Therefore it would be the State's mission to share the benefits of growth. For instance, electrification and household water connections could be made more widely available. Furthermore, due to these investments, the necessity for public management and regulation of environmentally impacting activities could also emerge.

This scenario is therefore considering a possible series of legal actions that could be undertaken to address this issue: How to combine an objective of human development with the regulation and mitigation of environmental impacts?

It draws from today's situation, where public policies are not coordinated towards an environmental goal, although some of them are supporting this perspective. This scenario was thus imagined to stress the possible role of public policies in the regulation of environmental impacts and as environmental devices or incentives.

Hypotheses

The two main hypotheses in this scenario are the following:

- The sustained economic growth will keep on being a major driver of change in Kodagu, with public infrastructures and private investments causing environmental impacts.
- The environmental devices that are being considered seem to be difficult to implement, and when they are not, it seems they are not able to bring about a significant reduction in environmental impacts. This is the case with a low-standard and unattractive certification such as the Rainforest Alliance label in Kodagu and optional EIAs, as well as the difficulty in setting up PES schemes due to the lack of data and the complexity of implementing them.

The scenario

From now until 2020: the situation

The scenario is based on the idea that the voluntary, contract-based, devices such as certification and PES would still not be attractive enough for coffee growers to maintain environmentally friendly practices. The premium for organic and certified coffee made it uncompetitive compared to the price for regular, uncertified coffee. Intensification would thus continue together with a declining tree cover density and diversity. Similarly, no buyer would be found for water and biodiversity PES schemes, due to the lack of solid data and the inherent complexity of these devices.

This lack of incentives for these environmental devices and the lack of data regarding the role of paddies for water services would cause them to be progressively abandoned. To get extra income from these lands, the paddies would then be declared suitable for conversion into homestays, with the development of tourism.

Finally, regarding the STs and OFDs, the Relocation Scheme would reach its limit, with no more volunteers willing to move out of the Protected Areas. Some small communities would thus remain in their original areas and ask for CFRs.

From now until 2020: Public policies

Today, the multitude of policies governing agricultural practices, water management, and forest exploitation, do not appear to be coordinated with an environmental perspective in mind. They address a range of issues causing diverse impacts.

This scenario is that this would continue for the next ten years. For instance, while the Ministry of Tribal Affairs together with local Indigenous NGOs would still be promoting the implementation of CFRs in application of the FRA, the KFD's priority would still be to limit this dynamic and relocate people via the Relocation Scheme.

In the same way, regarding agricultural practices and water use, diverging policies allow farmers to get subsidies for both organic agriculture as well as chemical inputs. Increasing silver oak plantation for additional income has a negative impact on soil fertility compared to conserving native trees. To compensate, coffee growers need more and more fertilisers which, subsidised by the public authorities, consequently cause increased water and soil pollution.

The use of water for agriculture is also virtually unrestricted whereas industry pays a (water) tax (CESS Act). The KDF is managing the trees in CAFS but little is done to enhance regeneration.

Finally the environmental impact assessment would remain optional and limited to larger companies with Corporate social responsibility programmes.

2020: a tipping point

The consequences of such a situation would be that, ten years from now, the environmental impacts would increase. It is thus likely that this degradation would cause public pressure on the authorities for a change in these diverging policies towards a more environmentally focused action. This might as well be part of the Government's priority, following the Green India programme, and would be made possible by the increasing public budget due to sustained economic growth.

It is thus likely that, after 2020 up until about 2035, policies would be reoriented towards a more integrated approach with environmental regulation and impact regulation as a core issue.

From 2035 onwards: environmental policies

First of all, the EIA could become mandatory for larger projects. Given that it is not a constraining device, it could easily be implemented and would create valuable data on biodiversity, water, and possible impacts.

In the Protected areas, where some forest dwellers' communities remain, the KFD and the MoTA could both support eco-development initiatives around nature conservation and local ecological knowledge regarding biodiversity management.

Last but not least, regarding the agricultural activities, policies enforced through the Agricultural Department, the Water Resource Department and the KFD would all prioritise organic practices and native trees regeneration. This would be achieved through subsidies for organic inputs and native trees' saplings, a native tree regeneration managed by the KFD instead of the farmers, a stronger regulation of water use for irrigation with the extension of the CESS Act to irrigation purposes, and taxes on chemical inputs.

Impacts on environment

The first harmonisation of public policies toward a common environmental goal would occur about ten years from now. Consequently, the impacts on the environment today would continue and worsen, given that development and capital investment are major drivers.

Thus, by 2020, only one third of the CAFS would have more than 70% of native trees as tree cover, and the use of chemical fertilisers would have caused growing concerns regarding soil and water pollution.

Between 2020 and 2035, more integrated public policies would allow for a change in these practices. Native tree cover regeneration would be managed by the KFD. Subsidies would be limited to organic inputs only, combined with taxes on chemicals and on irrigation, in order to encourage a thicker native tree cover. Similarly, soil and water pollution would gradually decrease after reaching a peak around 2020.

In the Protected Areas however, the impacts caused by the forest dwellers would be low. The volunteers having left with the Relocation Scheme, only small communities would remain and once granted CFRs, their eco-development projects and their daily use of forest products would not cause significant forest fragmentation.

Finally, the mandatory EIA for larger projects, although not constraining, would at least emphasise the importance of environmental issues and possible mitigation measures, as well as produce data.

This scenario thus imagines contrasting impacts depending on the time needed for the policies to integrate common environmental goals. If these devices, such as taxes and subsidies are to be legally enforced, their implementation therefore supposes strong governance, as today only 17% of the farmers pay the taxes they owe.

Invest!

Why this scenario?

India is one of the fastest growing countries in the world. In this context, pressure is put on the government to let market play on more and more fields. We elaborated this scenario to imagine what would be the impacts on the environment in the case of partial deregulation in Kodagu district.

Hypotheses

- Economic growth continues in India and the presence of a nearby major city, Bangalore, causes the development of Tourism.
- The growth of the middle class in the major cities adds to the demand for certified coffee.
- Recent laws facilitate access to land. There is an appropriation of the land in Kodagu by the upper class of the cities.
- Labour is increasingly rare, and becomes ever more expensive. Rice cultivation is no longer profitable. Some paddy fields are converted. Others are abandoned because the law doesn't allow them to be bought by non-agricultural people.

The scenario

This scenario is a succession of three phases (Figure 22): first the coffee and tourism sectors become developed. These sectors are then deregulated in order to accelerate inward investment. Eventually, water is privatised in order to solve the recurring conflicts caused by an increase in overall consumption.

Figure 22: chronology of the *Invest!* scenario

Deregulation and fast growing industries

In order to stimulate economic activity in the region, the government suppresses restrictive laws to help develop tourism and coffee production. The government waives the obligation to possess agricultural land before buying a paddy field. Many resorts are built on those paddy lands.

On the other hand, the government gives the rights on trees to coffee planters in order to increase their revenues and to improve mechanisation. These rights cause the intensification of coffee cultivation and the loss of tree cover. Silver Oaks replace a big part of the native trees (Vendé, 2010, CAFNET, 2011). A huge amount of irrigation becomes neccessary to compensate the loss of tree cover.

Boosted by the market, certification spreads throughout most of the plantations. By imposing a minimum number of tree species per hectare, it prevents the conversion of CAFS to monocultures. However, it is insufficient to stop the intensified coffee production leading to biodiversity losses and excessive water consumption.

Because of the slackening of regulation, many projects emerge: coffee-industries (pulping, roasting...), big infrastructures (train, roads, highways, high tension lines...), mining, quarrying... These activities create jobs and slow the migration toward cities.

KFD and Adivasis

In the reserved forest, some of the Adivasis are developing agriculture with the use of individual land rights. Others are employed in the agro-industries nearby. Basic infrastructures are constructed: hospitals, schools, electricity, roads... This fragmentation of the forest is accelerated by the demographic growth in these communities: the population doubles in 30 years.

Seeing the rapid biodiversity degradation in Kodagu, the Forest Department supported by ENGOs succeed in improving environmental protection in the protected areas. Adivasi communities living in the wildlife sanctuaries and in the National Parks are relocated into the Reserved Forests. Some (biodiversity hot)spots in the protected areas are reserved for adventure tourism.

The demise of ENGOs and Environmental impact assessment

ENGOs try to resist this industrialisation of the district but they can't oppose the numerous projects being planned. Village people are being recruited into the fast growing industry (tourism, construction, coffee plantations...) and their attitudes change. At the same time, new investors coming from big cities don't feel as concerned by environmental issues as the Kodava people used to be. The ENGOs also suffer from a weakened regulation and therefore they have less legitimacy to oppose.

However, ENGOs obtain the imposition by government of a mandatory Environmental Impact Assessment on all infrastructure projects. A business of consultancy develops in Karnataka. Results from these assessments are imposed on project holders moderately reducing environmental degradation. However, they don't cause any major reduction in the expansion of infrastructures.

Water management by private companies

Despite the rise of impacting practises on water, no devices are implemented. No stakeholder wants to finance conservation projects because studies reveal no tangible link between activities in the upper part of the Kavery and the water pollution in the lower part.

A conflict emerges on water resource sharing. Water is not shared equitably between domestic use, irrigation for agriculture and tourism.

The government decides to delegate water management to a private stakeholder. Access to water then becomes a problem for certain categories of the population.

The population becomes more and more contrasted between:

- The richest, who are the new investors coming from big cities. This minority owns a growing percentage of the land.
- The Kodava planters who continue living on their traditional coffee plantations.
- The workers employed in tourism, coffee plantation and other industries...

Impacts on the environment

Impacts on forests are limited to adventure tourism

Due to a reinforcement of the KFD control, the Adivasis are relocated outside the protected areas. KFD can concentrate on these areas because they don't have to worry about tree rights and protection of reserved forest. A very small eco-friendly community practices the adventure tourism that develops in those areas.

Agro-forest degradation

The adoption of the certification that imposes a species diversity of 15 species per hectare (RainForest Alliance, 2010) is insufficient to stop the severe degradation of the original agro-forest cover diversity.

In addition to that, the intensification of Silver Oaks planting affects the fertility of the soil due to its acidification and lack of foliage.

Allocation of water resources.

Water is reserved for the most profitable activities like tourism and industry. Therefore, the population has frequent water shortages.

Ground water is jeopardised

The majority of the paddy fields are converted. The water percolation decreases and the ground water resources are jeopardised. There are also more risks of floods because the paddy fields used to regulate the water circulation, and now they can't.

Discussion

The scenarios detailed above were presented to stakeholders for discussion two debating sessions. These debates are the specific goal of the prospective method as they act both as an arena for strategic discussion and as a moment where stumbling blocks between stakeholders are openly discussed. The two discussions have lead to some very different outcomes that reveal interesting insights into stakeholders' reactions as well as their vision of the research method. As opposed to last year however, discussions on precise aspects of the scenarios were limited. The problem of water PES, the tribal context, and the methodological choices have been more powerful triggers for debate than the scenarios *per se*. This might be due to the fact that all scenarios were quite complex, whereas there were more fundamental, transversal issues needing to be discussed, directly concerning the people attending. The scenarios have however appeared plausible, but also interesting because they represent a foreign understanding that can display unexpected views for the local attendants.

The first presentation: an open forum for a tribal community & the problem of water PES

The first debate was held at the College of Forestry of Ponnampet. Last year, certain representatives of the tribal community took the floor to stress their role as sustainable forest managers. The same happened this year. One tribal representative declared the Adivasis as being the only true managers of the forests, stating the example of teak plantations as proof that the KFD does not take care of biodiversity. As a consequence, in this vision, the Relocation Scheme appears pointless and even counter-productive. However, the possibility of developing some infrastructure and facilities within the forest communities lead to a more subtle discussion. If some tribal representatives do not seek development in the way it is proposed by the KFD – which is their integration into mainstream society, they are nevertheless aware of the fact that the younger generation might have different views and might want to get jobs in nearby cities and follow a lifestyle different from their parents'. In response to that, they stress the fact that these young people, in the future, might want to stay in touch with their heritage, even on a temporary basis, and thus they should still have the possibility to do so. This remains uncertain and important insights could be gained by research in this direction as it could constitute an important driver of change within the forest dwellers population.

The fact that the tribal representatives did orient the larger part of the discussion towards their concerns for the second year in a row is being commented upon. These discussions seem to be an arena where tribal people can express their views not only to people linked to the KFD, but also in front of foreign scholars. It seems opportunities are rare for them to participate in open discussions related to environmental issues and the role of tribal communities in the management of forest resources. This criticism they produce can be

interpreted as an opportunity to score some points in the public sphere as understood by Habermas. Indeed, for critics this is the place to express themselves in an attempt to create a “permanent siege” (Habermas, 1996) and to change the actual views and dynamics set by the dominant authorities, or at least to gain publicity. Given that the tribal communities are supported by certain NGO’s and the Ministry of Tribal Afairs, it would be interesting to see how often their representatives have the opportunity to express themselves in such a way, so that their situation can be understood within the public sphere.

The discussion also focused on water PES as none of the scenarios imagines its implementation. This decision was supported by the fact that when the people and the administrations met in Bangalore to deal with the State of Karnatakas water issues, they clearly seemed to disregard the water PES in Kodagu as a possible way to address the current issues they face at the Karntaka State level.

Moreover, the dam on the Kavery River located upstream, in the Mysore district might also form a buffer against the environmental impacts caused in the Kodagu district. Water PES being however a major project for local stakeholders at the College of Forestry, the discussion was lively. The CoF representatives stressed the fact that people in Bangalore do consider water PES as a relevant device, and particularly at the national level. They did acknowledge the fact that this water PES project would need strong scientific data to clearly evaluate the link between agricultural practices and quantity, quality and timing of water availability, because this would be the only way to convince potential buyers. But they are confident such a scheme could be implemented in the future, and this would thus have been missed by the scenarios.

Second presentation:

The second presentation took place at the University of Agricultural Sciences in Bangalore and the discussion that followed concentrated on the issues of the Water PES, but also pointed out interesting aspects regarding the importance of the socio-cultural context.

The water PES discussion continued from the one after the first presentation, although the critics regarding the absence of this PES in the scenarios were now from Bangalore, and thus presenting diverging views. According to them, water PES could be an important device at the State level, as it could be the first step toward integrated policies on water management including taxes on water use. It was however unclear how this would happen and how such taxes would help maintaining good agricultural practices upstream, which is the principle of PES, as the taxes envisioned in the discussion were addressing downstream misuses. The lack of data available and of time dedicated to a deeper understanding of water resources as well as the absence of interviewees that had lead to the abandonment of water PES in the scenarios prevented a more challenging discussion. However, this discussion also leads to the point that governance was a major issue regarding the implementation of water-related devices and on a more general basis. The fact that regulation exists but is not thoroughly

implemented appears to be a major concern influencing the feasibility and impact of mandatory devices.

The other main topic of the discussion was that the study as a whole pays little attention to the socio-cultural context of Kodagu. Its sociological perspectives are indeed limited to action systems, their inner dynamics and their competing strategies toward environmental change. This is an intrinsic characteristic of the Strategic Environmental Management Analysis approach, as its normative framework is primarily based on environmental issues, with the hypothesis that these issues are produced and addressed by the stakeholders' action systems through the actual and intentional management. As such, it does not encompass broader social issues or an understanding of the underlying principles organizing the action systems. The critic that was formulated thus implied that these other dimensions should also be taken into account in order to understand environmental issues, so as not to limit the scope of social dynamics to action systems. Ideally, these are not excluding approaches and when time allows doing so, such a deeper exploration of the social and cultural context do add valuable information regarding the action systems, the actual situation and the way the intentional management intends to address it. Setting *a priori* an environmental normative framework can be seen as an ethnocentric rationale related to growing environmental concerns in academic spheres especially in western countries, where poverty and inequalities are not a priority that is as much stressed as it can be in India. However, this strategic environmental analysis does not claim to address these issues and focusing on socio-technical relations and the way they evolve is indeed providing insights on a given situation and on how it might evolve. Besides, the prospective step is a further approach aiming at contextualizing the analysis through debates. The idea of mixing foreign and local students for the next fieldwork could however greatly improve the subtlety of the analysis.

Conclusion

This study chose to focus on multiple environmental devices that are considered in Kodagu as being able to tackle transverse impacts: biodiversity decrease in the CAFS, forest fragmentation and water resources related issues. The first two points were already well documented thanks to the CAFNET research programme and last year's study. The latter had identified water resources as an aspect that should be taken into account, and this year's study is an attempt to do so. This is a very broad and complex issue, and although it was not possible in a couple of weeks to identify and quantify all practices and threats, the information that was gained on this topic has broadened the initial scope of the study and allows to contextualize Kodagus issues within the State of Karnataka and India. Moreover, as local stakeholders are researching the feasibility of water PES, this theme has also appeared as being a powerful debate trigger and has stressed the need for further research on water management and the potential ecosystem services associated with it. Despite this particular case of water PES that requires a specific research programme on its own, the devices studied, after the discussions with stakeholders, all appear quite plausible in the near future and could help mitigating targeted impacts. The Relocation Scheme however is a controversial device and studies in other countries show that Indigenous Lands might very well be an environmental advantage.

The important number of devices taken into account has permitted an omnidirectional exploration on various topics all around the Kodagu. Systematically, stakeholders have been met and interviewed in the three Taluks. This was possible thanks to the detailed study completed last year that, although it focused much more on Virajpet in a sectoral approach, produced a valuable insight in the action systems to be analysed again.

The devices here presented and researched thus offer the opportunity to consider many environmental impacts with transverse axes. But one of the main conclusions of this study is that that the action systems promoting these devices are rarely linked together and often focus only on separate aspects of the landscape. Indeed, no clear relation could be found between the management practices and strategies occurring in the agroforests and those occurring in the forests. Although these areas are interwoven in a single landscape and despite the fact that there are transverse stakes and stakeholders, it appears that the landscape itself is not dealt with as a whole. It is suggested that landscape labelling could initiate such a dynamic, but this concept is not widespread. This issue of landscape segmentation was a major difficulty when building the scenarios as the lack of sustained relationships between action systems, although they do relate to common issues, makes is difficult to set them in motion. This might be due to the methodological will to encompass environmental issues as a common framework when this environmental link might not be what is structuring the stakeholders' sphere. In return, it bears a meaning regarding the feasibility of environmental devices in the landscape. Similarly to what is going on with non-cooperative policies, non-cooperative action systems, despite having common interests,

might also limit the implementation of devices. The methodological will of associating diverse axes thus acts as a revelatory process, allowing a further understanding of the heterogeneity of the situation through a common glance.

The Strategic Analysis of Environmental Management methodological approach, although conducted in a very short period of time, has directed the search for information in an efficient way, so that it was possible not only to map and understand action systems with relative confidence, but also to imagine how the actual situation could evolve with various scenarios for the future, all stressing different aspects. It is a very flexible approach that, although choosing a narrow environmental focus, relies on powerful hypothesis regarding the dynamics of stakeholders' managements in a given landscape. This leads to the production of cognitive models of relationships that illustrate the strategies, motivations and resources needed by the groups of actors to initiate a change in a given situation. Valuable knowledge regarding the rationale and meanings pertaining to each action system could undoubtedly be gained through a more detailed diagnosis including broader sociology, economics or anthropology and a more informed way of identifying key stakeholders. This could indeed address some underlying socio-cultural dynamics that, although affecting the environmental situation indirectly at first sight, might be fundamental issues to research, such as the labour problem and the rural migration problem.

Finally, the above conclusions and the discussion of the scenarios show that it is essential for future environmental research in Kodagu to pay careful attention to water-related issues and data, to the possible links that might occur between the action systems, and to the evolution of governance efficiency. The lack of water-related data makes it difficult to envision possible evolution. Indeed, the link between land use and water availability and the link between water quality and the regulation of irrigation or the subsidies for specific practices are not well documented but constitute crucial elements that would influence future environmental decisions. Similarly, many stakeholders belong to various social networks, (clubs, planters or environmental NGOs...) and it would be very interesting to understand how these networks convey the promotion of devices or of environmental ideas throughout the society, thus linking the action systems to each other. Third, the governance is also to be specifically looked at. Its efficiency is a key factor to some devices' success, and the Government of India, through its National Mission for a Green India and other environmental action plans is also affirming a strong environmental stand that might generate more efficient environmental governance.

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