Payments for Environmental Services: A Peruvian Case Study

Teresa Rojas Lara

Land Use Economics in the Tropics and Subtropics Group

University of Hohenheim, Germany

Poster prepared for presentation at the International Association of Agricultural Economists (IAAE) 2012 Triennial Conference, Foz do Iguaçu, Brazil
18- 24 August 2012

Payments for Environmental Services: A Peruvian Case Study

Teresa Rojas Lara[1]
Land Use Economics in the Tropics and Subtropics Group, University of Hohenheim, Germany

Abstract. Globally, land use changes and deforestation contribute with around 20% of the green house gases emissions. Payments for Environmental Services (PES) schemes constitute a way to cope with these problems and promote the conservation of natural resources using market-based incentives. Through empirical evidence from Peru, this study assesses the impact of payments for carbon reductions and analyzes factors which can contribute to the adoption of these projects. Household behavior is analyzed with a linear programming model. The preliminary results indicate that carbon payments would increase the income of the farmers, thus could contribute to increase the adoption of these projects.

Keywords: Climate Change, Peru, Payments for Environmental Services (PES), Mathematical Programming

1. Introduction

Projects to protect or increment carbon stocks receive high development relevance in many tropical countries, as the payments have the potential to generate significant revenue, contribute to alleviate poverty and preserve ecosystem services (Baker, 2010).

Peru has 54 percent of its territory covered with forests while around 40 percent of the population lives in poverty (FAO, 2009; INEI, 2011). The rate of deforestation reaches approximately 150,000 hectares per year (Velarde, et al., 2010). Deforestation and land use changes causes around 50 percent of Peru's greenhouse gas emissions (MINAM, 2009). Most of its deforestation is the result of subsistence agriculture (slash-and-burn agriculture), which is attributed to the migration of farmers from the highlands, as well as development activities (Velarde, et al., 2010). Moreover, forest areas are also confronted with the problem of illegal coca cultivation, where many farmers are attracted by the high revenues which provide an attractive option in the light of often scarce alternative economic opportunities (UNOCD, 2011). Payments for Environmental Services (PES) could constitute a way to cope with these problems and contribute to creating sustainable land use management projects. It is important to emphasize that the conservation of forest ecosystems in the tropics will be difficult, unless people are compensated for the environmental services of their forests.

At present, efforts to mitigate greenhouse gas effects trough establishment of forest based systems are in process in Peru. Most of them directly involve poor rural communities, but it is necessary to determine the potential of these projects to alleviate poverty and increase farmers' income. In order to achieve this objective, the potential impacts of PES on the economies of rural households are analyzed. Furthermore, the institutional settings which are likely to facilitate an adoption and enhance the dissemination of projects involving PES are identified.

[1] This contribution is partly based on the chapter "Carbon Sequestration Projects in Peruvian Tropical Forest" of the forthcoming book entitled "Governing the provision of ecosystem services".

Based on a theoretical framework from institutional economics, the present paper presents analyses of data obtained from surveys carried out in two regions: the Peruvian Amazon and Peru's Pacific coast. A mathematical linear programming model is applied to assess the impacts of PES on the economic situation of households involved in PES schemes. An analysis of the institutional context in which PES schemes are implemented in Peru is presented, as well as a discussion about householders' perception of PES projects and their possible implementation.

The paper develops as follows: Section 2 describes the theoretical framework to analyze PES, providing a definition of PES, as well as a link between PES schemes and poverty reduction. Theoretical concepts from institutional economics are presented along with a discussion of the implications of the presence of transaction costs for these schemes. Section 3 gives a description of the research context and describes the current legal and institutional framework for PES schemes in Peru. In section 4, the methodology is explained, focusing on household modeling with a mathematical linear programming model. Section 5 presents a set of preliminary results and section 6 deals with conclusions which can be drawn from the results obtained.

2. Theoretical Framework

Externalities are costs or benefits arising from an economic activity, in most of the cases attributed to human activities, than affect somebody other than the people engaged in the economic activity and are not fully reflected in prices (Perman, Yue und Common 2003). Externalities represent an important class of market failures in the field of environmental and resource economics and in most cases, they can be attributed to human activities (Woerdman, 2004). Sometimes, they are caused consciously, whereas in other instances they are unintentional side-effects. Different policy instruments such as taxation, subsidies, tradable permits or charges are possible solutions to overcome these market failures (Perman, Yue, & Common, 2003). Payments for Environmental Services (PES) belong to the group of market based mechanisms and have been promoted as an environmental policy instrument for climate mitigation (Wunder, 2005). Frequently, institutions of society exist, which shape the use and the regulation of environmental services. In PES schemes these institutions often provide a framework for management and regulation. As PES schemes entail the participation of various stakeholders, especially those who pay for the project and those who deliver the service (Corbera et al. 2008; Wunder 2005), factors such as transaction costs might provide a barrier to entry for some of them (Scherr, Milder, & Bracer, 2007). This is reflected in the theory of institutions of which the transaction cost theory constitutes an important component (North, 1990).

This study focuses on payments for carbon sequestration as a policy which creates market-based incentives for positive externalities. Since these schemes often involve high transaction costs, the nature of institutional arrangements will be described and their implications for the management of natural resources.

2.1. Payments for Environmental Services (PES)

Wunder (2005, p.3) defines PES as "[...] a voluntary transaction where a well defined environmental service (ES) is being bought by a (minimum one) ES buyer and from a (minimum one) ES provider if and only if the ES provider secures ES provision (conditionality)".

PES are used as tools for financing conservation in developing countries. Through the internalization of positive environmental externalities, they help to "get the price right". PES help to create a market via which economic actors can at least cover the opportunity cost of the changes to land management necessary for providing environmental services (Pascual, Muradian, Rodriguez, & Duraiappah, 2010; Wunder, 2005). The four main environmental services that have been addressed by PES up to present are watershed services, carbon sequestration, landscape beauty, and biodiversity conservation with some overlaps between them (Landell & Porras, 2002).

Currently, the majority of PES schemes are local level arrangements, whereas large PES schemes tend to be driven by governments. These schemes can also involve regulated PES markets, such as carbon markets created by the Kyoto Protocol on Climate Change (Landell & Porras, 2002). A number of studies show that PES has a positive impact on the conservation of the environment and on the welfare of the rural poor (Wunder & Albán, 2008; Pagiola, Arcenas, & Platais, 2005; Cacho, Graham, & Milne, 2003; Rosa & Dimas, 2003). When they are implemented in an enabling economic and institutional environment, these schemes have the potential to contribute to poverty alleviation programs and can play a role in solving social conflicts (Pagiola, Arcenas, & Platais, 2005; Wunder & Albán, 2008). Nevertheless, impacts of PES programs on poverty may not always be positive. Their impacts depend on whether the poor can benefit from markets for environmental services. Poor smallholders in developing countries often confront constraints related to market access, in particular environmental markets (Scherr, Milder, & Bracer, 2007).

A considerable amount of research shows that institutional factors play an important role in that poor people can be involved in and benefit from these schemes (Smith & Scherr, 2003; Bracer, Scherr, Molnar, Sekher, Ochieng, & Sriskanthan, 2007), where transaction costs associated with PES schemes seem to be very a crucial factor (Wunder, 2008).

2.2. Institutional Economics

As mentioned above, PES schemes often involve different parties and transaction costs may arise. In neoclassical economics, transaction costs are often neglected. New Institutional Economics, in turn, focus on understanding the role of human made institutions for the reduction of transaction costs (North, 1990). According to North, transaction costs are all costs linked to the exchange of property rights. In case of PES schemes, they are associated with costs of drawing attention to potential buyers, costs of working with project partners and costs of ensuring parties accomplish their obligations (Bracer, Scherr, Molnar, Sekher, Ochieng, & Sriskanthan, 2007). Bearing this in mind, the reduction of transaction costs is an important key for increase the potential of PES to deliver new sources of income to rural communities (North, 1990; Woerdman, 2004). Participation of local communities in these

markets for environmental services can contribute to a reduction in transaction costs, specifically of monitoring and compliance activities (Smith & Scherr, 2003; Ostrom, 1990).

2.3. Forest Based Projects

Land-use changes are responsible for around 20 percent of anthropogenic CO_2 emissions and thereby constitute the second largest source, after fossil fuel use (IPCC, 2007). It is mainly dominated by deforestation, with contributions from agricultural practices. Therefore, when deforestation and land-use change decrease and natural systems are restored, opportunities are provided to decrease carbon emissions (UNFCCC, 2003). Some of these activities can have the additional benefit of increasing the CO2 uptake, protecting biodiversity and watersheds, as well as restoring natural systems. Forestry activities are important sources of mitigating GHG emissions because CO2 is removed through photosynthesis. Under the agreements reached at the 7th Conference of the Parties (COP7) in Marrakesh in 2001, the rules for sink projects in the Clean Development Mechanism (CDM) were established. In non-Annex I countries only projects implemented for afforestation and reforestation (A/R) activities are considered. The exchange units are carbon credits or CER, which is a measure of the amount of CO2 kept from the atmosphere either by avoiding an emission or creating a sink (Woerdman, 2004). The forestry sector is quite restricted on the Kyoto Market, under the rules of the CDM, providing just 1 percent of all activities among all CDM projects. By June 2012, only 67 A/R projects had achieved registration from a total of 8584 CDM projects (UNEP Risoe, 2012).

In the voluntary markets, forestry projects have been became the primary source of demand for carbon credits. A growing number of project developers, mainly in developing countries, are implementing projects to create offset credits for the non-Kyoto markets. Forestry has the additional comparative advantage of being a “charismatic” project type as it has public appeal (Linacre, Kossoy, & Ambrosi, 2011). Corporate responsibility and public relations are the most common motivations behind carbon offset purchases, together with considerations such as additionality, certification, reputation and environmental and social benefits (Hamilton, Sjardin, Marcello, & Xu, 2008).

3. Research context and the Case Studies

3.1. Peru

Peru is a country in western South America, facing socio-economic and environmental challenges. According to the World Bank, the economy of Peru is classified as upper middle income and is the 42nd largest in the world (World Bank 2011). Peru is a market oriented economy with a high level of foreign trade. Although exports have provided significant revenue, an egalitarian distribution of income has not been achieved. Thirty nine percent of the Peruvian population lives below the national poverty line, of this 13.7 percent live in extreme poverty. Although the country ranks 80 of 180 countries (HDI, 2009), it characterizes for its stark disparities reflected in a Gini coefficient of 0.48 (1 indicating complete inequality). Moreover, 42 percent of the population cannot cover the minimum required caloric intake (2100 kcal)

(World Bank, 2011; United Nations Development Programme, 2009; INEI, Instituto Nacional de Estadística e Información, 2011).

Fifty four percent of Peru's territory is covered by forest however the contribution of the forestry sector to the Peruvian GDP is only 1 percent (FAO 2009). Furthermore, deforestation and forest degradation from subsistence agriculture and development activities are significant threats to forest estate in Peru.

In order to overcome these problems, Peru has tried to implement an environmental management framework. Different entities and legal instruments have been developed to address specific issues, ranging from forests and biodiversity to the regulation of sectorial activities and the consolidation and integration of policy and institutions involved with natural resource

3.1.1. Peruvian Legal Framework for PES

Governments have an important function in establishing the legal framework that defines the institutional arrangements, responsibilities, requirements, contracts, and mechanisms for resolving conflicts or disputes (FAO and ITTO, 2010, Capella and Sandova,l 2010; Bracer, 2007). While there are many individual cases of PES operating without a formal legal framework, the scaling up of PES to operate with significant impacts for either ecosystem service provision or local benefits requires clear legal frameworks (Smith 2007; Bracer 2007).

Many international agreements and treaties signed by Peru have a potential role in the implementation of PES and REDD schemes[2]. These agreements are in accordance with the Peruvian Constitution and will be implemented through different regulations.

Peru has subscribed the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol and participates in the international debate on the implementation of a new binding agreement on climate change (MINAM, 2009). The Peruvian Government has expressed its intention to reduce to zero its greenhouse gas emissions originating from deforestation activities, which will be reached in 10 years[3] (MINAM, 2009). It is, however, not been backed by a broader political consensus.

In Peru the state has the ownership rights to natural resources, including forests. The most important laws that could contribute to the implementation of forest-based PES schemes include, the Environmental and Natural Resources Code (Legislative Decree No. 613), the Natural Protected Areas Law (Law No. 26834), the Forestry and Wildlife Law (Law

[2] Peru has signed the Biodiversity Convention, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the ILO C 169 Indigenous and Tribal Peoples Convention.

[3] In Peru, the Ministry of Environment (MINAM) is promoting REDD schemes, due to the high amount of tropical forest (Amazon) and the lower cost of conserving forest as compared to afforestation and reforestation activities (Capella et al. 2010). MINAM is interested in implementing PES through a national protected areas network, including schemes to fund indigenous communities to preserve standing forest like the "Programa Conservando Juntos" and "Programa de Bosques".

No. 27308), the National System for Environmental Impact Evaluation Law (Law No. 27446), the National Environmental Management System Framework Law (Law No. 28245) , the General Law of the Environment (Law No. 28611) and the Organic Law for Sustainable Use of Natural Resources (Law No. 26821) (Capella and Sandoval 2010, USAID 2010).

The Peruvian Ministry of Environment (MINAM) has already submitted a proposal to create an Environmental Services Law, which is currently being discussed by the Peruvian Congress. This bill aims to establish a legal framework for natural resources and biodiversity.

Even though, there is a consensus about the importance of regulation and policies, the Peruvian forestry governance still lacks an effective mechanism to implement these rules, as well as appropriate control systems.

3.1.2. Peruvian Institutions for PES

Although institutions and organizations have different meanings, they are often understood as being the same. Organizations are material entities and include political, economic, social and educational bodies. Institutions can be defined as the humanly entities that devise constraints that structure political, economic and social interactions. Institutions achieve their objectives through informal rules (e.g. traditions, cultural values) and/or through formal rules (e.g. legal rules) which govern individual behaviour and structure social interactions, and thereby provide an institutional framework (Woerdman 2004, North 1990).

Peru has undertaken some efforts to consolidate an organizational structure that can respond to the country´s environmental necessities. The Ministry of Agriculture (MINAG), through its General Directorate for Forestry and Wildlife (DGFS), establishes national policies related to the promotion, management, monitoring and evaluation of forest resources and coordinate with their regional counterparts the implementation of these policies (Capella & Sandoval, 2010). The Ministry of Environment (MINAM), established in 2008, has the administrative authority for the national environmental policies, and promotes the evaluation, design and establishment of PES schemes (Capella and Sandoval 2010; USAID 2010)

There are public-private partnerships providing financial support through projects oriented to promote conservation or sustainable forest management. The National Environmental Fund (FONAM) is Peru´s focal point for the World Bank Carbon Finance Unit, whereas the National Fund for Natural Protected Areas (PROFONANPE) is working in 46 of the currently 63 natural protected areas (Capella and Sandoval 2010; USAID 2010).

The Public Ministry, the National Policy and the Peru's national ombudsman program are institutions dealing with environmental offences, whereas the Supervision Office of Wood Forest Concessions (OSINFOR) supervises forest concessions rights over state forests (Capella & Sandoval, 2010).

Currently, the central government is transferring forestry management functions to regional governments. Therefore, regional governments are responsible for granting rights over their forest resources, approving management plans and exerting control over the rights granted. They are able to develop and implement programs for sale environmental services in forest regions or protected areas (Velarde, et al. 2010; USAID 2010). The Regional Agricultural Directorates are working also at the regional level, granting property titles to indigenous and peasant communities.

The civil society and the private sector are actively involved in these schemes. NGOs have promoted at least 17 carbon-based projects in the country (Baker et al. 2010), while private enterprises have advocated at least 5 projects in the country. NGOs are also working on the legal and institutional framework for REDD schemes at the country level.

At the local level, several rural communities are carrying out sustainable management activities that help maintain or produce environmental services. Some are organized in Rural Patrols and Forest Management Committees, which are working in conservation and sustainable forest management activities and control of illegal logging (Capella and Sandoval 2010; Velarde, et al. 2010). However, little government support is provided to their activities.

At the same time, some institutions and policies could negatively impact the establishment of PES schemes. Regarding to property titles, there is a small percentage of forestry land with land-tenure rights granted by the State. The Ministry of Housing, Construction and Sanitation, through the Agency for Formalizing Informal Property (COFOPRI) is in charge of the national program for property´s formalization. In Amazonian, COFOPRI has a negative performance in the forest conservation. The procedures for granting titles are based on land use changes to agriculture activities[4], which have encouraged deforestation activities[5] (Velarde, et al. 2010).

The Ministry of Energy and Mining is giving rights for the exploitation and exploration of non-renewable natural resources (hydrocarbons and minerals). This situation is creating overlaps in the use of land[6], generating enormous pressure on forest areas, including

[4] See the law of Private Investment in the Development of Economic Activities in the lands of the National Territory and of Rural and Indigenous Communities (Law No. 26505) and Legislative Decree of Investment Promotion Law in the Agricultural Sector (Legislative Decree 653) (Velarde, et al., 2010).

[5] During the data collection carried out for the present study in the Peruvian Amazon, the Campo Verde Beekeeper Association, for example, mentioned its desire to conserve 600 has of primary forest, which is not recognized by COFOPRI as suitable land for entitled.

[6] There are 64 active oil and gas blocks under contract with multinational companies in the Peruvian Amazon, covering an area of two thirds of the Peruvian Amazon. Of them, 20 blocks overlap Communal Reserves and Reserve Zones, 58 overly lands titled to indigenous peoples and 17 blocks overlap areas that have proposed or creased reserves for indigenous groups in voluntary isolation (Finer, Jenkins, Pimm, Keane, & Ross, 2008). During the data collection in Campo Verde, one native community received an official visit from an oil company, which will begin its exploration in the area.

In San Lorenzo - Piura, a fruit growing region, close to the research area, the Peruvian government granted three blocks of Land to Manhattan Minerals of Canada in 2000. In San Lorenzo, agricultural production creates about US$2 billion in annual revenues and permanently employs roughly 15,000 people, and more during the harvest. In 2001, the local population held a referendum and the result was an overwhelming rejection of the proposed mining project, (Earthworks, 2008). The proposed mining project was abandoned in 2009.

natural protected areas and indigenous community lands. Although coordination between stakeholders and relevant actors is mandatory, in practice this is not done effectively (USAID 2010). The Ministry of Economy and Finance and the Ministry of Transportation and Communications are expanding the road infrastructure in forest areas, where dramatic changes in ecosystems over the years are observed and/or predicted.

Biofuel production is promoted in Peru as a mitigation option for climate change. In 2007, the government promulgated a legislation determining a mandatory blending of 5 percent biodiesel in diesel by 2011 and 7.8 percent of ethanol in gasoline by 2010. In order to accomplish this goal, an increment of crop areas of oil palm, jatropha, canola and sugar cane is necessary. By encouraging changes in land use, this policy is seen as a potential threat to forest areas (Velarde, et al., 2010).

3.2. The Case Studies

The present study involves two case studies of forest-based projects oriented to timber production and carbon markets in Peru.

The first case study involves the project *"Ignacio Tavara Dry Forest Reforestation, Sustainable Production and Carbon Sequestration",* which was established on 8989 ha of the communal land of the Ignacio Tavara Pasapera Community. It is located in Chulucanas District, department of Piura. The project was registered in 2009 with the Clean Development Mechanism (CDM) of the UNFCCC and it employs native species from the dry tropical forest, such as algarrobo (*Prosopis pallida*), zapote (*Capparis scabrida*) and overo (*Cordia lutea*). The stakeholders involved are the Ignacio Tavara community, the AIDER NGO (technical support) and the National Environmental Fund (FONAM). The community has 8589 inhabitants and encompasses a total of 52269 ha divided in 16 villages. The land tenure system is based on the right of the members of the community to access communal lands. Farms are oriented to subsistence that includes both livestock and crop production. Livestock depends on algarroba production and seasonal pastures for their maintenance, whereas agricultural activities take place over small areas, only during the rainy season (January – April). Beans are the most important staple crop that is sold for cash, while maize and watermelon are grown for self consumption. Forestry activities are restricted, timber harvesting is not allowed without an approved management plan (Aider 2010). Nevertheless, evidence of illegal logging practices was founded during the data collection.

The second case involves the project *"Reforestation of Degraded Areas in Campo Verde with Native Species"*, which is located in the district of Campo Verde, department of Ucayali in the Peruvian Amazon. In this area, deforestation is caused mainly by the increase of the agricultural frontier (slash-and-burn agriculture), forest substitution for illegal coca cultivation and the conversion of secondary forest into grasslands (Ramos, 2009; Velarde, et al., 2010). The carbon project belongs to a private enterprise which owns 16000 ha of degraded land, of which 2600 hectares have been reforested with mahogany (*Switenia macrophylla*), tornillo (*Cedrelinga catanaeformis*), marupa (*Simarouba amara*) and guaba (*Inga edulis*). This project has sold already some Voluntary Emissions Reductions (VERs) to voluntary markets. The stakeholders involved in the project are SFM-BAM enterprise, several

communities, AIDER NGO and FONAM. The project area is surrounded by 15 rural communities. In the area under consideration, illegal coca cultivation is widespread; therefore the government is doing efforts to control these activities, ranging from military interventions to introduction of productive projects[7].

4. Methodology

4.1. Data Collection and Research Design

The data collection has been carried out in 2010, using a combination of qualitative and quantitative research design. The qualitative research concentrated on the institutional setting for natural resource management. For this purpose, in-depth and key interviews have been undertaken. For the quantitative research, 163 household interviews have been carried out using a detailed structured questionnaire. For each individual household all the necessary data for household modeling was collected in this survey. Secondary data provided by the NGO AIDER and SFM BAM enterprise was employed in order to quantify the amount of carbon sequestrated for each project.

The household surveys carried out in the Ignacio Tavara Community (Piura) and in Cerro Verde (Ucayali) took the form of random samples of 90 households in 16 villages in Piura, and 73 households Campo Verde. The information gathered focused on general aspects of the household and farm characteristics, availability of land resources and their use, agricultural production activities, forest use, carbon projects, assets and savings, credit and institutional embeddedness, as well as the households' perception of the forest and its functions.

4.2. Mathematical Programming

Mathematical programming (MP) is applied to evaluate the behavior of the farmers and their resource allocation. MP is a simulation approach for achieve the best outcome, such as maximize profit or minimize costs (Hazell and Norton 1986). It has been favorably used to assess the potential smallholder´s adoption of forestry technologies, taking into account socioeconomic characteristics and the influence of policy activities, such as in this case carbon payments (Bellow et.al. 2008; Vosti et. al. 2002). Nevertheless, it is important to be aware that, as with all methods, there are some limitations, which are not capture in the present model, like the assumption of certain values and preferences when specifying the objective function, the possibility of non-linearity and feedback between variables, as well as the dynamics of systems.

As an input for the model, the gross margins for the main cropping activities maize, beans (Piura) and cassava, maize and rice (Ucayali) is calculated. In Ucayali, perennial crops also play an important role; therefore cacao, oil palm and fruit trees as a component of the gross

[7] A Cacao Program is carried out with the support of United States Agency for International Development (USAID) through the Alternative Development Program (ADP), providing technical and financial support (fertilizers and pesticides) during the first three years of the plantation. Ucayali´s regional government is implementing the Palm Oil Program in the area, working in the same way as the Cacao Program.

margin are considered. As livestock activities are very important in both regions, they are included in gross margins calculations. The model is designed to maximize the total gross margin of the farm by finding the optimal set of the different agricultural activities under the respective restrictions such as farm size, suitability of the land for various crops, credit limit, and family work force. The credit limit is the maximum amount of credit that a household expects to be able to borrow from formal and informal sources. We also consider that the farmer has information about alternative production activities and input and output prices; therefore risk is not accounted in the model (Vosti et. al. 2002). The model allows off-farm labor activities, but it does not incorporate nonagricultural investment (for example schooling). The time horizon in simulations is 20 years in Piura and 30 years in Ucayali.

4.3. Carbon Accounting

In order to account for the amounts of sequestrated carbon the UNFCCC methodology AR-AM003 is applied: "Afforestation and reforestation of degraded lands through tree planting, assisted regeneration and control of animal grazing" (UNFCCC, 2006). This methodology is approved under the Clean Development Mechanism by the UNFCCC for forest projects. There are five carbon pools: living biomass (above and below ground), dead biomass (dead wood and litter) and soil carbon. For the purpose of this study, only living biomass is considered. The calculation of carbon sequestrated in living biomass was done using different allometric equations for the different species in both study areas. These equations are mathematical functions that relate oven-dry biomass per tree as a function of a single or a combination of three dimensions (Chave, et al., 2005). For this research, the field inventory data was provided by the NGO AIDER. The biomass can be converted to carbon using a conversion factor of 0.5 g for 1 g of biomass. All carbon measurements for above and below-ground are added up to obtain an estimate of the total carbon per hectare. Finally, this amount is converted to CO2e, which is the basis to calculate the amount of certificates to be obtained for the different forestry systems. This is translated later into monetary terms, using the Certified Emission Reductions (CER´s) and Verified Emission Reductions (VER´s) values with a discount rate of 10 percent. For the linear programming model the net present values are converted to annuities, in order to show the annual payments which the farmer would receive from a 20 and 30 years sequestration project.

5. PRELIMINARY RESULTS

5.1. Carbon Sequestration Potential

In Piura the project removes approximately 498,675 ton CO2e in 20 years or 2.8 ton CO2e per ha/per year. Payments for carbon sequestration in turn depend on the CER and VER prices, which vary considerably on carbon markets. A price of US$ 5 per tCO2e is comparable to the lowest price, whereas US$ 30 represents the trading prices in the European Climate Exchange for 2011 – 2012 allowances. At low carbon prices of US$ 5 tCO2e this would amount to an annuity payment of US$ 200,000, at a price of 15 USD tCO2e to US$ 600,000 and at 30 US$ tCO2 to 1200,000 for a 20 year project. In Campo Verde 531,888 ton CO2e will be removed during 30 years of project, which means an annually removal of 6.8 ton CO2e per ha. At a low carbon price of USD 5 tCO2e represents approximately an annuity payment of US$ 49,000, at a price of 15 US$ tCO2e to US$ 149,000 and at 30 US$ tCO2e to 290,000.

5.2. Farm Households

In this section the farm households of the research areas are described, using a mathematical programming model. A first look on the data obtained from the household surveys reveals some basic characteristics of the households. Furthermore, in parts substantial differences between the households in the two research areas become evident (Table 5.2.1.).

Table 5.2.1. Characteristics of Different Households

	Jose Ignacio Tavara Community	Campo Verde
Total Land (ha)	2.5	39.9
Cultivated Land (ha)	1.82	7.8
Grassland (ha)	0.78	13.8
Forest (ha)	0.06	19.3
Family Size (members)	5.2	4.47
Age (years)	29.8	28.3
Analphabetism	40%	20%
% migrant households	3%	44%
Family labor days per month	68.9	58.8
Credit Limit (USD)	925	2750

Source: Own data

As the table shows, households in Piura have the lowest credit limits and substantially lower land areas at their disposal. Differences also occur with respect to land use. In Piura, more than 95 percent of the agricultural area is allotted to annual crops, mainly cowpeas and beans, watermelon and maize. Cowpea is the major cash crop destined to local markets, whereas the other crops are used for home consumption. In Campo Verde a mere 20 percent of the land is dedicated to agriculture activities. 34 percent of the land is grasslands, leaving the major part to be covered by forest. The most important cash crops are cassava, palm oil and cacao, citrus and to a lesser degree pepper. Cassava and banana are the most important food staples in the area.

While family sizes and age structure are similar, striking differences between the two areas again occur with respect to human capital and migration. In Piura, the rate of analphabetism of 40 percent is twice as high as in Campo Verde. The shares of households which have migrated to the respective areas, however, are substantially higher in Campo Verde, with 44 percent against 3 percent in case of Piura. This latter aspect reflects the high importance of immigration from other parts of the country to Peru's Amazon regions.

The baseline of the Total Gross Margins of the main farm activities were calculated (table 5.2.2.). The gross margins increase with the carbon payments. However, farmers in the region do not only employ crops with the highest gross margin. There are some factors for crop choice by the farmers, which are not reflected in the model, such as traditional land use practices and cultural preferences, which could play potentially important roles in the household´s decisions with respect to forestry projects.

Table 5.2.2. Total Gross Margins for Household for Different Carbon Payments Scenarios

	Jose Ignacio Tavara Community	Campo Verde
Baseline	790	1253
Scenario 1 (USD 5)	808	N.C.
Scenario 2 (USD 15)	843	N.C.
Scenario 3 (USD 30)	895	N.C.

N.C. = Not calculated

Source: Own data

In the Ignacio Tavara community (Piura), the median annual income of a household is US$ 790, whereas in Campo Verde (Ucayali) is 1250 US$. Median was chosen instead of the average income because is considered by many statisticians as a better indicator as it is not dramatically affected by unusually high or low values (Bureu, 2003). Agriculture activities provide 60 percent of the gross income of the householders in the Jose Ignacio Tavara community, while in Campo Verde the contribution is at around 76 percent.

In order to evaluate the potential impact of carbon payments, three scenarios are tested. In these scenarios new activities are introduced into the baseline model. In Piura, 2000 families could benefit for an increment of their total gross margin between 2 and 13 percent, when US$ 5, 15 and 30 carbon payments are introduced. Forestry projects aims to produce timber, which is extracted from forest during logging operations. The time of harvesting depends on the forest rotation management system, which entitled long periods, thus carbon payments could sustain families during the long waits between harvest.

In Campo Verde, as the project belongs to a private enterprise, villagers benefit mainly from the generation of employment, which is more than 200 wages per day, reached 500 at the peak season. This can increase their gross margin up to 30 percent in some cases. Employment opportunities may additionally reduce the need of poorest households to open up further land at the forest border and practice migratory agriculture.

Results shows that in the Ignacio Tavara community, the median income per day is 2.1 US$, which is below to the poverty line in Peru (3 US$ per day). Among the respondents, 43 percent are living under extreme poverty (1.5 US$), whereas 26.6 percent are living under poverty. In Campo Verde, the median income per day is 3.4 US$. In this area, 23.3 percent of the

responders are below to the extreme poverty and 20.5 percent under poverty line. As the introduction of carbon payments appears to have a positive impact on household income, PES can contribute to the reduction of poverty. In the case of the community in Piura, with payments of US$ 5 extreme poverty could be decreased by 5 percent, whereas with 15 US$ and US$ 30 scenarios, extreme poverty could be decreased by around 11 and 13 percent.

5.3. Impacts and Incentives for Forest-Based Projects

The potential impacts and incentives for adopt forest-based projects are described in this section. In both areas, it was identified that forests play a considerable role in household´s livelihood. In the quantitative survey about their perception of PES, farmers considered that individual payments in cash or in kind could act as incentives for diffuse forest projects in the communities. Among village payments, were found differences between both areas. While in the Ignacio Tavara´s community, which has a strong social organization, 55 percent of the respondents agree with communal payments, in Campo Verde only 28 percent of responders concur. Some concerns are arising about whether communal projects will be carried out according to their objectives and funds could be handled efficiently and distributed fairly. In Campo Verde, a few respondents had concerns about land tenure and potentially, the loss of their land. In Piura, where there is a main problem of land scarcity, associated with the need pass on land to the villagers' children; some had concerns that not enough land will be available for their children. Although these concerns are raised, forest projects are considered as a source of employment for most of the farmers, as well as their contribution for reduce deforestation and protect the remaining forest. Regarding to the incentives for forest based-projects, farmers believe that financial support is the most important incentive, followed by training and strengthened social organization. About enforcement and incentive measures to stop villagers deforestation, most of them considered that payments is the best solution, following by individual payments of penalty and physical punishment. Although, the last one is not sanctioned by Peruvian law, these kind of informal arrangements are common in many rural communities in Peru.

5.4. Institutional Arrangements for Carbon Sequestration Projects

The two cases studies are looking into the institutional arrangements and searched if they can provide a framework for active involvement of stakeholders in the project.

Although in Campo Verde, we did not found communal organizations dealing with carbon projects, some local organizations are working in agricultural activities like Campo Verde Beekeeper Association and the Organic Farming Producers. In one village, a rural patrol is working effectively against illegal logging activities. According to local authorities, villagers are interested in forest-based projects.

In Piura, the Ignacio Tavara community was involved in the project´s formulation and holds the rights to the sequestered carbon. The stakeholders signed a formal agreement, where they commit themselves to use the revenues from CERs to cover operational costs, as well as fund social projects. As mentioned in Section 2, transaction costs of carbon projects could be reduced with communal agreements, where monitoring and enforcement are key issues for the success of

these projects. It was founded that the Representative Board[8], the Board of Directors[9] and the Rural Patrol (Ronderos) are performing successfully these activities in the area, but that more support is necessary to back up their efforts.

These results allow some judgments as to whether the institutional arrangement of the community could benefit the carbon sequestration project. It was founded that the regulatory framework established on the basis of the traditional customary institution, provides an important groundwork for the implementation of a PES project, including a REDD projects. Thus, for a PES or forest carbon sequestration project, the participation of all those affected by it can be guaranteed by the present institutional arrangement of the community, but a better improve is necessary. For an internationally financed REDD project, monitoring activities have to strengthen through financial support, associate with a more transparent organizational structure, where the objectives and responsibilities have to be clearly defined.

In the case of the Amazon, compensation payments can be used as an incentive for deforestation reduction, which ultimately leads to avoided greenhouse gas emissions. In some areas, villagers are interesting to protect remain primary forest.

6. Preliminary Conclusions

Both case studies show that carbon payments could increase the income of the farmers and the adoption of these projects. The degree of participation would depend on the price of carbon and other factors such as transaction costs and economic conditions. With low carbon prices of US$ 5 tCO2e, the increment in the gross margin is low. However, with upper certificate prices, householders could increase their gross margins by 13 percent with the introduction of carbon payments.

Although, in Campo Verde no community agreements related to forest-based carbon projects have been encountered, some local organizations could be used as a starting point.

In Piura, the actual institutional arrangement of the community could provide a framework for the carbon project implementation and further PES projects, based on their traditional rules and regulations. There is some evidence that extractive activities have declined since the establishment of rural patrols and environmental awareness has increased, albeit not homogeneously in all villages. Thus, for a potential REDD project, the institutional framework needs to be strengthened and community participation in the conservation activities fostered, where the institutional framework needs to be strengthened and the information flows have to be improved. Negotiations can be done much more efficiently when contractual arrangements are made with the community rather than with individuals. This can substantially decrease transaction costs, and has the advantage that using known institutional arrangements can ensure familiarity for the participants as they have trust in these established institutions.

Although Peru has ratified important agreements at the international level, at the country level, the Peruvian forestry governance lacks on an effective mechanism to implement environmental policies and appropriate control systems. Verification is needed for important changes in how Peruvian are using their forest resources. In Peru, negotiations have emphasized the need to

[8] For every 50 locals, one representative is elected.
[9] The Board of Directors is elected with the votes of all members of the community

establish clear national mechanisms for accounting, recording and monitoring carbon sinks and REDD projects. It is clear, that only with a strong national system working efficiently with their regional counterparts this requirement could be reached.

There are several overlaps in Peru´s institutional framework for PES schemes. Despite several institutions could contribute to the implementation of these mechanisms, such as the Ministry of Environment and the Forestry authority (national and regional); others could contradict and can undermine PES efforts such as COFOPRI and the Palm Oil Program, which is inducing farmers to change their land use practices. An arrangement of the existing institutional framework, in line with competencies or functions designated in the international agreement, is necessary. Thus it is imperative to formulate and approve measures to carry out inter-agency coordination between the competent authorities that grant rights over renewable and non-renewable natural resources, as well as a coordination of policies related with natural resources.

During this research, overly high expectations about the benefits from carbon market credits have been found among smallholder farms. An information campaign to address this point is particularly necessary, as well as promotion of financial mechanisms for carbon sales that are inclusive and not exclusive.

7. Acknowledges

The author is grateful to the support for field data collection to NGO AIDER (Jaime Nalvarte, Mario Palomares, Pio Puertas), SFM-BAM enterprise (Jorge Torres), the Ignacio Tavara Community (Frank Castillo, Luis Espinoza, Eulogio Castillo) and the Beekeeping Association in Campo Verde (Luis Alba, Hugo Garcia). The author acknowledges funding for this PhD study from Heinrich Boell Foundation.

8. Bibliography

AIDER (2010). Informa Interno del Proyecto de Reforestación de la Comunidad Campesina Ignacio Távara. Lima.

Baker T., Jones J., Rendón O., Román R., del Castillo D. Chan I., Torres J. & J. Healey. (2010). How Can Ecologists Help Realise the Potential of Payments for Carbon in Tropical Forest Countries? Journal of Applied Ecology, 47 (6) 1159-1165.

Ballet, J., Sirven, N., & Requiers-Desjardins, M. (2007). Social Capital and Natural Resource Management: A Critical Perspective. *The Journal of Environment and Development , 16, 355-374.*

Bayon, R., Hawn, A., & Hamilton, K. (2009). Voluntary Carbon Markets. An International Business Guide to What They are and How they Work. Earthscan.

Bellow, J., Hudson, R., & Nair, P. (2008). Adopton potential of Fruit-tree based Agroforestry on Small Farms in the .Subtropical Highlands. *Agroforestry Systems , 73 (1), 23-36.*

Bracer, C., Scherr, S., Molnar, A., Sekher, M., Ochieng, B., & Sriskanthan, G. (2007). *Organization and Governance for Fostering Pro-Poor Compensation for Environmental Services: CES Scopping Study.* Nairobi: World Agroforestry Center (ICRAF).

Cacho, O., Graham, R., & Milne, M. (2003). *Smallholder Agroforestry Projects: Potential for Carbon Sequestration and Poverty Alleviation.* Rome, Italy: The Food and Agriculture Organization of the United Nations (FAO).

Capella, J., & Sandoval, M. (2010). *REDD in Peru: Legal Consideraciones Legales para su Implementación*. Lima: Sociedad Peruana de Derecho Ambiental (SPDA).

Chave, J., Andalo, C., Brown, S., Cairns, M., Chambers, J., Eamus, D., et al. (2005). Tree Allometry and Improved Estimation of Carbon Stocks and Balance in Tropical Forests. *Oecologia , 145, 87-99.*

Corbera, E., González, C., & Brown, K. (2009). Institutional dimensions of Payments for Ecosystem Services: An Analysis of Mexico´s carbon forestry programme. *Ecological Economics , 68, 743-761.*

Engel, S., Pagiola, S., & Wunder, S. (2008). Designing Payments for Environmental Services in Theory and Practice: An Overview of the Issues. *Ecological Economics , 65, 663-674.*

FAO. (2009). *State of the World`s Forest 2009.* Rome.

FAO & ITTO. (2010). *Forest Governance and Climate Change Mitigation*. Policy Brief. Retrieved from http://www.fao.org/forestry/19488-0a2b1be34bcc2f24f780036ed0c5f9d69.pdf

Finer M, Jenkins CN, Pimm SL, Keane B & Ross C (2008) Oil and Gas Projects in the Western Amazon: Threats to Wilderness, Biodiversity, and Indigenous Peoples. PLoS ONE 3(8): e2932.

Hazell, P., & Norton, R. (1986). *Mathematical Programming for Economic Analysis in Agriculture.* New York: McMillian Publishing Company.

INEI. (2009). *Anuario de Estadísticas Ambientales. Dirección Técnica de Demografía e Indicadores Sociales.* Lima: INEI.

Landell, M., & Porras, I. (2002). *Silver bullet of fool´s gold? A global review of markets for forest environmental services and their impact on the poor*. London: IIED.

Linacre, N., Kossoy, A., & Ambrosi, P. (2011). State and Trends of the Carbon Market 2011. Washington DC: World Bank.

MINAM. (2009). Informe de reuniones de la Convención Marco de las Naciones Unidas sobre Cambio Climático y su Protocolo de Kioto. Copenhague, 7 al 18 de diciembre del 2009. http://www.minam.gob.pe/

No Dirty Gold. www. user survey (n.d.). Retrieved May 8, from http://www.nodirtygold.org/tambogrande_peru.cfm

North, D. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge and New York: Cambridge University Press.

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.

Pagiola, S., Arcenas, A., & Platais, G. (2005). Can Payments for Environmental Services Help Reduce Poverty? An Exploration of the Issues and the Evidence to Date from Latin America. *World Development , 33 (2), 237-253.*

Pascual, U., Muradian, R., Rodriguez, L., & Duraiappah, A. (2010). Exploring the links between equity and efficiency in payments for environmental services: A conceptual approach. *Ecological Economics , 69 (6), 1237 - 1244.*

Perman, R., Yue, M., & Common, M. (2003). *Natural Resource and Environmental Economics.* Munich: Pearson.

Ramos, R. (2009). Impacto de la Producción Forestal Maderable en la Economía de la Región Ucayali, Perú. Master Thesis, National Agrarian University

Rosa, S., & Dimas, L. (2003). *Compensation for Environmental Services and Rural Communities*. San Salvador: PRISMA.

Scherr, S., Milder, J., & Bracer, C. (2007). *How important will different types of CRES be in shaping poverty & ecosystem services across Africa, Asia & Latin America over the next two decades?* Nairobi: World Agroforestry Centre (ICRAF).

SFMBAM. (2010). Reporte Interno de Avance del Proyecto de Reforestación con Especies Nativas Campo Verde. Pucallpa.

Smith, J., & Scherr, S. (2003). Capturing the Value of Forest Carbon for Local Livelihoods. *World Development , 31 (12), 2143-216.*

UNODC. (2011). *Monitoreo de Cultivos de Coca en el Perú 2010*. Lima, Perú : UNODC.

UNDP. (2009) Human Development Report. United Nations Development Programme

UNFCCC. (2006). *AR-AM003: Afforestation and Reforestation of Degraded Land Through Tree Planting, Assisted Natural Regeneration and Control of Animal Grazing*. UNFCCC. Retrieved from http://cdm.unfccc.int/methodologies/DB/U3WW9YEC2X333WW8CPVQ6CGVY6IBPJ/view.html

USAID. (2010). Country Profile: Peru. Land Tenure and Property Rigths Portal. Retrieved February 28, 2011, from: http://usaidlandtenure.net/usaidltprproducts/county-profiles/peru

U.S. Census Bureau (2003). *Net Worth and Asset Ownership of Households: 1998 and 2000*. Department of Commerce.

Velarde, S., Ugarte-Guerra, J., Rügnitz Tito, M., Capella, J., Sandoval, M. & Hyman, G (2010). *Reducing Emissions from All Land Uses in Peru.* Final Report. Nairobi. 142 p.: ASB Partnership for the Tropical Forest Margins.

Vosti, S., Witcover, J., & Carpentier, C. (2002). *Agricultural Instensification by Smallholders in the Western Brazilian Amazon*. Washington D.C.: IFPRI.

Woerdman, E. (2004). *The Institutional Economics of Market-Based Climate Policy. Developments in Environmental Economics*. Elsevier.

World Bank. 2007. *Republic of Peru Environmental Sustainability: A Key to Poverty Reduction in Peru.* Country Environmental Analysis. Report N°40190-PE.

World Bank. 2011. Peru. Retrieved November 10 from http://data.worldbank.org/country/peru.

Wunder, S. (2005). *Payments for Environmental Services:Some Nuts and Bolds*. Bogor: Centre for International Forestry Research (CIFOR).