CHAPTER 2

FIRST ARTICLE: PAYMENTS FOR ECOSYSTEM SERVICES IN A DOMINICAN WATERSHED: ARE THEY ENOUGH TO 'TIP THE SCALE' TOWARD FOREST CONSERVATION?

2. Introduction

Tropical forests provide multiple goods and services that benefit individuals at various spatial scales. Some are market goods that provide benefits at the local level, such as timber and food products, while others are nonmarket services, such as water regulation, storm protection and biodiversity that provide public good benefits at the local, regional and global level (Gluck, 2002). Despite the different inherent characteristics of ecosystem goods and services, they are all critical to human well-being (Daily, 1997).

A study by Costanza et al. (1997) estimated the average value of tropical forest to be US $2,007 per hectare. However, farmers in developing countries often choose to convert tropical forest to agricultural land for profits that are much smaller—farmers in Paragominas, Brazil for example have been shown to convert forest to cropland for average annual profits of $33/ha/yr. (Almeida and Uhl, 1995) . Why is this?

One reason is that most of the Total Economic Value (TEV) of tropical forests comes from the provision of non-excludable goods and services, meaning that no one can be prevented from using that particular good or service (World bank, 2004). When resources or the services they provide are non-excludable, no one can prevent another from consuming the good or service in question, whether or not they pay. As a result there is little incentive to pay, and therefore little incentive for the market to provide the resource.

Forest ecosystems can provide both non-excludable goods and services, which have distinct characteristics. We define a good as a structural component of an ecosystem which can alternatively serve as a raw material input into the human economy. Georgescu-Roegen (1971) refers to these goods as stock-flows. Stock-flows are physically transformed into what they produce, can be consumed at the rate of our choosing (subject to harvest costs), and can be stockpiled if desired. All stock-flows are rival in consumption, which means to say that consumption by one person precludes consumption by another (Daly and Farley, 2004). Hardin (1968), Clark (1990) and many others have explained how non-excludable and rival goods are subject to over-consumption. Hardin (1968) popularized the problem as the 'tragedy of the commons' , but Bromley (1991) and Ostrom (1990) point out that such resources are not common property, but rather unowned by anyone, and best defined as open-access regimes . Non-excludable resources in general are subject to free-riding, which refers to people benefiting from an ecosystem good or service without paying for its provision. The outcome is generally sub-optimal levels of provision (Ostrom, 1990). In many cases, it is possible to create property rights to stock-flow resources, in which case they become excludable. Rival and excludable resources meet the necessary criteria for efficient market allocation (Randall, 1993).

Forest ecosystem services have fundamentally different characteristics than forest goods. An ecosystem service is an ecosystem function that has value to humans (Daily, 1997; Costanza, 1997). These ecosystem functions are the result of interactions between abiotic (chemical and physical) and biotic (living organisms) components that are provided by ecosystem structure – (see de Groot (2002) for a comprehensive review).

Functions are what Georgescu-Roegen (1971) refers to as fund-flux resources. Fund-fluxes result from a particular configuration of stock-flows; they are not physically transformed into what they produce, they are provided at specific rate over time, and they cannot be stockpiled. While all elements of ecosystem structure are rival and could potentially be made excludable, most ecosystem services such as storm protection or biodiversity are purely non-rival and non-excludable public goods. By assigning individual property rights to elements of ecosystem structure one runs the risk of sacrificing ecosystem services, because they are not valued by the market economy (Pearce, 2001), albeit just as important to human well-being (Daily, 1997).

Markets fail when resources are non-excludable, and they are inefficient when resources are non-rival. The latter statement deserves elaboration. The use of a non-rival resource by one person does not leave less for another person to use. Markets use prices to ration resource use, but if there are no costs imposed by additional use, then it is inefficient to ration use. In other words, market provision of non-excludable goods leads to under-production, while market provision of non-rival goods leads to under-consumption (Daly and Farley, 2004). Economists generally agree that government intervention is necessary to manage pure public goods by subsidizing their supply (Hardin, 1968; Ostrom, 1990) and ensuring their availability to the user at zero cost, which meets the efficiency criteria of marginal benefit equal to marginal cost (Daly and Farley, 2004).

A limited number of ecosystem services such as waste absorption capacity, and recreation can be made excludable, which makes it possible to create a market. Water flows from water regulation services can also be made excludable. Water flows and waste absorption capacity are rival (if a forest absorbs phosphorous runoff from my farm, it has less capacity absorb the runoff from yours), and recreation is congestible, meaning that it becomes rival at high levels of use, so markets might also be efficient. It is important to recognize though that a market in waste absorption capacity is fundamentally different than a market in clean water or clean air—while markets can allow polluters to decide how much to pollute, individuals cannot decide how much pollution they will endure.

In summary, forests are both stock flows of market goods (convertible to farmland that produces market goods) and fund-fluxes of non-marketable public good ecosystem services. The landowner logically prefers the private benefits of clearing the forest to the public benefits of preserving it. In its role as the provider of public goods, the government could potentially address this problem regulating land use or otherwise restricting forest loss. There are at least three major complications with this approach, however.

First, governments in developing countries often lack the economic or human resources to enforce rules on the beneficiaries of forest goods (Gibson and Beck, 2000). As a result, the top-down management approach in many developing countries has caused severe environmental degradation (Dietz, 2003). This is especially relevant to the country of the Dominican Republic, where in the last seven decades natural resources have been managed by a highly centralized government (Peter, 2004). Conservation policies, such as the 1967 forest law that prohibits logging, have been developed at the national level without considering the economic, social and ecological conditions at the local level and consequently, have been ignored by local communities (Kustodia, 1998).

Second, command and control regulations are often inefficient, in that they typically demand the same level of activity from all landowners. Market based mechanisms in contrast typically allow landowners to weigh the marginal costs of a particular activity against the marginal benefits. Such micro-level flexibility in achieving macro-level goals has been shown to be more cost effective in many cases (Daly and Farley, 2004).

Third, many governments do not recognize the importance of sustaining vital ecosystem services. For example, there are many cases in which the economic goals of the Dominican Republic's government have been pursued at the expense of ecological sustainability. Incentives for activities that degrade ecosystem services are known as perverse subsidies (Pearce, 2001) and in the Dominican Republic primarily take the form of government financing for the production of root crops on steep hillsides.

Having lost 34% of its original forest cover in the Dominican Republic since the 1950s (USAID, 2001) has forced policymakers and practitioners to seek alternative solutions. One such strategy, which has emerged as a popular approach to solving environmental problems in Latin America and the Caribbean, is providing economic incentives to landowners for the provision of public goods (Landell-Mills and Porras, 2002; Echavarria and Lochman, no date; Echavarria et al., 2004; Pagiola and Ruthenberg, 2002).

This concept is known as Payments for Ecosystem Services (PES) (also referred to as Payments for Environmental Services). The logic behind PES schemes is rather simple: "those who provide the environmental services should be compensated for doing so, and those who receive the service should pay for their provision" (Pagiola and Platais, 2002 as in Hartmann and Peterson, 2004: p.5). The majority of PES transactions to date have been for water supply, mainly because of the decline in water quality and quantity in developing countries and the ease with which beneficiaries can be identified (Pagiola et al., 2004). PES schemes in Ecuador, Costs Rica and Mexico have developed a conservation fund by charging a fee to water users (Echavarria, Vogel, Alban and Menesses, 2004; Echavarria and Lochman, no date). While there are several different methods PES schemes employ (i.e. eco-labeling, entrance fee to parks and water user fees) the main idea is generally the same: to internalize the positive externalities of resource conservation.

This approach is being considered by a non-governmental organization (NGO) *Sociedad para el Desarrollo Integral del Nordeste (SODIN)* for achieving sustainable land management in the *Loma Guaconejo* Scientific Reserve, which is located in the northeast corner of the Dominican Republic. Research suggests that sustainable land management depends largely on the rural poor being compensated for the benefits they provide to society as a whole (World Resources, 2005; Farley, 1999). SODIN seeks to accomplish this by shifting conservation tactics from command and control policies to Payments for Ecosystem Services (Tepper and Base, 2002). While as a market based approach PES systems may be more cost effective than command and control, they also suffer from several major problems.

First, the local beneficiaries of forest services may have inadequate resources to compensate for their provision. As many of the services are regional and global in distribution, local payments should be supplemented by regional and global ones, but there are few existing institutions that appear willing to shoulder this responsibility.

Related to this issue is the second problem of transaction costs: When there are many beneficiaries of forest services and many potential providers, it can be very expensive to work out payment schemes. Such costs are aggravated for transboundary benefits.

The objective of this paper is to assess the feasibility of incentive-based mechanisms in achieving the desirable ends of sustainable land management and adequate provision of forest ecosystem services in the Loma Guaconejo Scientific Reserve. Primarily, we seek to answer the following fundamental questions: Are there a sufficient number of beneficiaries at the local level to pay the full costs (opportunity, transaction and implementation) of forest conservation in Loma Guaconejo? If not, would it be possible to expand PES schemes to regional and global beneficiaries of forest services, and would the combined contributions from these beneficiaries be adequate to cover the full costs of the scheme? What ecosystem services could be marketed at these broader spatial scales? What are the obstacles to developing such an extended scheme, and how can they be overcome? Understanding the effectiveness of current PES schemes and identifying the feasibility for future PES schemes is important for local NGOs to implement a sustainable watershed management plan in Loma Guaconejo.

Figure 2.1: Location of Loma Guaconejo Study Site

2.2 Case Study

The Dr. Miguel Lazaro (*Loma Guaconejo)* Scientific Reserve is in the Provinces of Maria Trinidad Sanchez and Duarte, which are located in the eastern part of the northern mountain range (*Cordillera Septentrional)* of the Dominican Republic (see figure 1). The climate is subtropical, receiving approximately 2,000 mm of annual rainfall and the highest elevation is just over 400 meters. The total area within the reserve is 75 km^2, of which 22 km^2 is the "government owned" nucleus. The remaining 53 km^2 is the *zona amortiquamiento* (buffer zone with communities) where farmers have usufruct to *parcelas (*plots) privately owned by farmers.

There are fifteen communities that exist in the buffer zone; residents are *campesinos* who practice slash-and-burn agriculture to plant root crops, often on steep hillsides. These slash-and-burn plots are referred to as c*onucos* (Kustodia, 1998). Many of the campesinos also have small plots (1-2 hectares) of agroforestry systems (AFS); these are multi-layered crop production systems of cacao, coconut and other fruit trees. These communities in the buffer zone differ in respect to their socio-economic conditions. Community populations range from as small as 9 households to as large as 78 households. Three of the fifteen communities have electricity and direct access to a road (Tepper and Base, 2002).

Loma Guaconejo was designated a conservation area by the government in 1996, because of its high ecological value at the local, regional and global scale (SODIN, 2002). It provides both private goods, such as perennials (cacao and other fruit trees) and annual root crops (yucca and ginger) and pure public goods, such as erosion control and biodiversity. The local goods benefit over two-thousand inhabitants in the buffer zone;

the majority of which rely on the forest's goods and services for building material, water, subsistence agriculture, cash crops and medicinal uses (Adam Paredes, personal communication). Loma Guaconejo also contributes to human well-being at the regional level. It is the source of the Nagua and Boba rivers, which provides drinking water to the municipality (SODIN, 2002).

The flora and fauna in Loma Guaconejo have an exceptionally high rate of endemism and diversity, which means it provides a pure public good that has significant importance at the national and global level (SODIN, 2002). The broad leaf forest also provides an excellent wintering habitat for migratory birds from North America (Rimmer and McFarland, 2001). The fact that the Dominican Republic has been ranked the highest importance for bird-protection priorities (Latta et al., 2006) and is categorized as a bio-diversity hotspot (Conservation International, 2003), suggests Loma Guaconejo should be a priority conservation area.

Although these forest ecosystems provide important global benefits and the country depends on its ecosystem functions for food, water and economic sustainability, forest degradation continues – approximately 85% of upper watersheds in the Dominican are degraded (UNDP, 2002).

2.2.1 Project Background

Faced with an increasing demand on water supply from population growth in the municipality of Nagua and decreasing water quality and quantity from forest conversion in the Loma Guaconejo watershed, international development agencies collaborated with a local NGO, SODIN, to support initiatives that shifted conservation tactics from command and control policies to Payments for Ecosystem Services (Tepper and Base, 2002). These PES initiatives were part of an umbrella project called "Integrated Management of Loma Guaconejo Scientific Reserve". The main objective of the project was to provide local institutions with the autonomy to manage natural resources through community-based conservation.[1]

The objective of this paper is to examine the suitability of PES schemes by: (1) examining pilot PES schemes that have been implemented in Loma Guaconejo; and (2) identifying the potential for other PES schemes to take place in Loma Guaconejo from various spatial scales. Although there were several other projects that focused on community-based conservation, for the purpose of this paper, I will focus on two projects that are considered traditional PES schemes.

2.2.2 Existing Payments for Ecosystem Service Projects

The first PES scheme was an organic certification project with small-scale cacao growers that was funded by a USAID Small Project Assistance (SPA) grant and administered by the Peace Corps. Grant money was used to organically certify 18 small-scale cacao farmers in the communities of Blanco, Amarrillo, and Naranja. While biodiversity is typically not valued in the market-place, eco-labeling can demand a premium by guaranteeing the product was harvested and processed using environmentally friendly behavior (Nunes and Riyanto, 2005). Organic shade grown certifications can play on a consumer's willingness to pay for a good they may not experience directly experience, but knows it exists. Payments for eco-labeling are

[1] The Presidential decree #249-04 that was signed in 2001 made it possible for local institutions to co-manage protected areas with the Secretariat for Environment and Natural Resources.

different than other PES schemes, such as water supply, because the consumer does not actually pay for the direct consumption of the good. In fact, eco-labeling generally relies on a consumer's willingness to pay for a public good such as biodiversity. According to conventional economic theory, individuals are rational and self-interested, and will not pay for public goods, but numerous studies have shown that many individuals are in fact willing to do so (Henrich at al., 2005). In many cases, it is unclear whether consumers pay a premium for the organic seal for health reasons or for environmental causes.

Whether the willingness to pay for eco-labeling is for health reasons or environmental causes, the reality is that eco-labeling provides a niche market for farmers in Loma Guaconejo that compensates them for practicing sustainable agriculture.

Labeling allows farmers to add value to their product by differentiating it from others and controlling the price and demand, as opposed to commodities that are supply driven and easily substituted (Goad, 2001). Figure 2.2 illustrates the theory behind the price elasticity of demand for organic chocolate and commodity chocolate. When cacao has an organic seal like in graph A it has an inelastic demand curve, which means a 1% increase in price would result in a less than 1% decrease in quantity demanded. On the other hand, graph B demonstrates that commodity chocolate has an elastic demand, which means it has a larger substitution effect than Graph A.

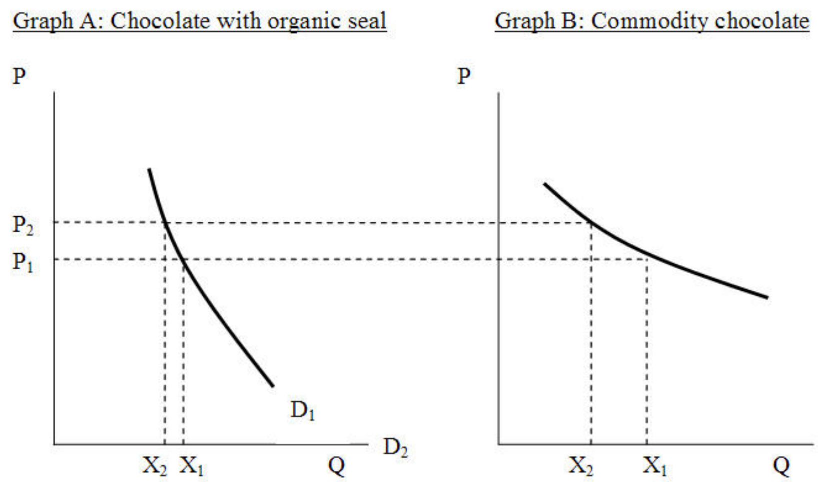

Figure 2.2: Price Elasticity of Demand for Cacao

The second PES scheme was an ecotourism project in the community of Verde. In 2004, the Ford Foundation in conjunction with SODIN provided funds to build an eco-lodge. The idea behind ecotourism projects is that by making a traditionally non-excludable ecosystem service (recreation) excludable, people will pay for the right to use it, providing incentives to ensure its provision. This service was made excludable by charging an entrance fee to tourists and educational groups. Community members earn additional income serving as guides and selling food and drinks to tourists. It is important to note that while we were conducting research in Loma Guaconejo, the eco-lodge was still being constructed, therefore it is too early to quantify any impacts it may have on the community and surrounding environ. While we expect this project to provide some incentives for conservation, we do not believe that it alone will lead to the socially optimal provision of ecosystem services. We therefore turn our attention to other PES schemes that would complement the two described here.

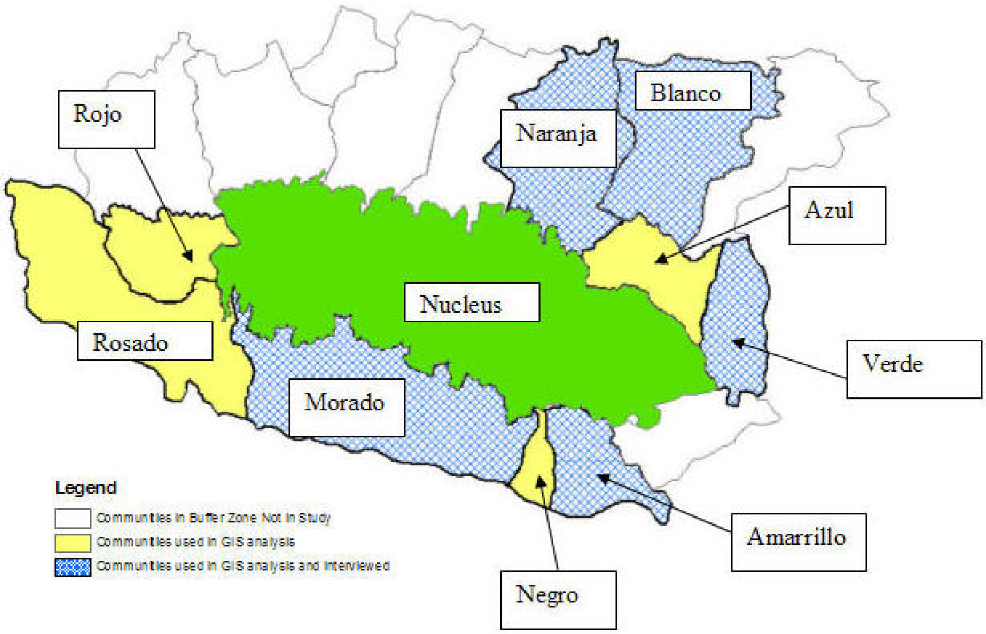

Figure 2.3: Loma Guaconejo Research Site

<u>2.3. Methods</u>

This study employs a mixed-methods approach to accessing the feasibility of PES schemes in meeting the desirable ends of sustainable land management in Loma Guaconejo. Both Geographic Information Systems (GIS) technology and interviews with Loma Guaconejo residents are used to assess the specific service that are or could be provided, to whom, by whom and at what cost. The over-arching method of this study is a case study. We use a case study approach because it is widely accepted by scholars as the best way to understand the relationship between communities and forest resources (Gibson et al., 2000). Dietz et al., (2003) claims that although sound science is important, failure to manage the commons has resulted from research ignoring local conditions and local knowledge.

Interviews are conducted with forest users in Loma Guaconejo to answer three fundamental questions: (1) How effective were the pilot PES schemes in providing an incentive for forest conservation; (2) Do beneficiaries recognize they benefit from the enhanced provision of ecosystem services? (3) Are they willing to contribute toward a conservation fund? Studies have shown that local users who depend on forest resources often have knowledge about the environmental conditions, land use patterns, and extraction rates of those resources, but they often do not recognize the value of pure public goods, such as erosion control and biodiversity (Silvano, Udvardy, Ceroni and Farley, 2005). Thus, by comparing farmers' knowledge of forest ecosystems with scientific assessments of Loma Guaconejo's ecological integrity using GIS analysis, we can better predict the feasibility of a market transaction for a service. If the beneficiaries (demand side) recognize that they benefit from the enhanced provision of hydrological services, than they will be more likely to participate in PES scheme (Conservation Guide, 2006) On the other hand, if beneficiaries feel they do not benefit from the protection or enhancement of an ecosystem service, than they will not pay for the service, and a market mechanism will not be created.

We conducted interviews with eighteen landowners in Loma Guaconejo between May-June 2005 in the communities of Naranja, Blanco, Amarillo and Verde. Surveys were conducted at participants' homes and lasted between thirty minutes and one hour. In order to gather data about the effectiveness of PES schemes I needed to interview project participants, which means I had to use purposive sampling to select interviewees.

In purposive sampling each sample element is selected for a purpose (Schmutt, 1999). This means that I select the criteria for my sample. And while purposive sampling is not representative of the population, it is exactly what I needed for a case study approach. In an effort to obtain the most diverse sample possible I stratified the interviews to two communities to the north, one to the east and one to the south (see figure 2).

Spatially explicit analysis is used as a quantitative method to identify: the landowners who provide ecosystem services; and the beneficiaries of those services. In addition, using GIS technology to identify land use land cover (LULC) provides us with valuable information as to the costs and value of ecosystem services within each community.

The primary unit of analysis is land that is classified as subsistence agriculture. Since slash and burn agriculture and conversion of forests to pasture lands contributes to soil erosion, poor water quality and global warming (Ewel et al., 1981) land use patterns are thought to be a good indicator of the overall ecological integrity of Loma Guaconejo. Land Use Land Cover (LULC) is digitized from aerial photos taken in 2000 that have a scale of 1:20,000 with a resolution of .5 meters. Raw data layers were provided by SODIN and Thomas Oberfrank of DED.

One of the challenges with creating a PES for a specific ecosystem service is that one ecosystem can provide numerous services. Payments from beneficiaries of one service might not justify the adoption of sustainable land management. However, paying for the suite of them may be sufficient enough to 'tip the scale' towards forest conservation. Therefore, by identifying single forest services may under-estimate the "full value" of the forest and consequently may not justify the adoption of sustainable land management.

At the same time, the success of any PES scheme depends on whether the beneficiary of a watershed service is convinced that the economic contribution he makes is improving or maintaining the quality of the service (Conservation Finance Guide, 2003). In other words, if we don't identify the direct linkage between providers and beneficiaries of water supply, payments by one person may go towards enhancing the provision of water for another beneficiary in a different watershed. As a result, the beneficiary will not directly benefit from his financial contribution and the PES scheme will fail (Landell-Mills and Porras, 2002).

It is important to note that to protect the confidentiality of survey participants, the names of interviewees and communities have been changed in this paper.

2.4. Results

Descriptive statistics were used to assess the ecological integrity of Loma Guaconejo. As illustrated in table 2.1, 34% (2,580) of land is used for subsistence agriculture, which indicates there has been significant deforestation. Over half (1349 hectares) the land under state owned property is primary forest compared to only 6% (320 hectares) under the private property regime. Likewise, 81% (2077 hectares) of total subsistence agriculture has taken place in private land.

Table 2.1: Land Use Land Cover in Loma Guaconejo

Table 3: Land Use Land Cover and Property Regimes in Loma Guaconejo

Land use	Total	State land	Private land
Agroforestry	1756 (23%)	134 (6%)	1622 (31%)
Primary forest	1669 (22%)	1349 (57%)	320 (6%)
Secondary Forest	1171 (15%)	303 (13%)	868 (17%)
Riparian Buffer	419 (6%)	80 (3%)	339 (6%)
Slash/Burn or Pasture	2580 (34%)	503 (21%)	2077 (40%)
Total	**7595 (100%)**	**2369 (100%)**	**5226 (100%)**

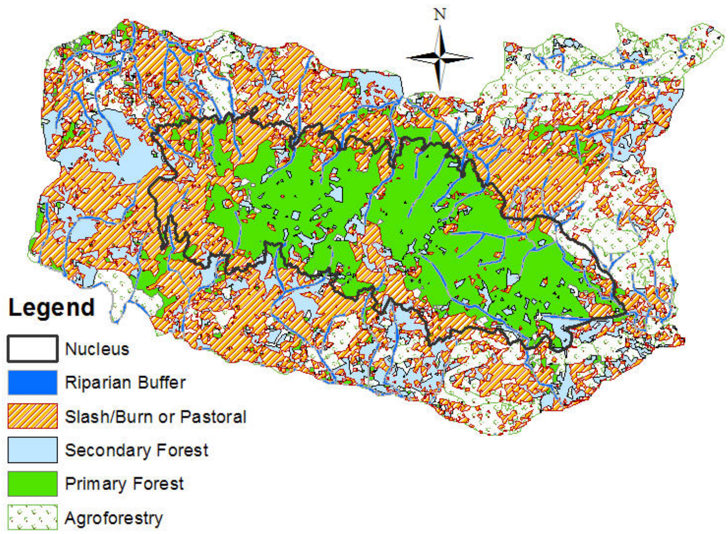

Figure 2.4: Map of Land Use Land Cover in Loma Guaconejo

Descriptive statistics were used to assess the interviewees' socio-demographic characteristics. Table 2.2 indicates that all 18 interviewees were male. This can be explained by the *machismo* (macho) stereotypes in the Dominican culture where the division of labor (especially in rural communities *)* is based on gender roles. The average respondent is 53 years old, has 6 years of education, 5 individuals living in the household and owns 70.3 tareas of land (4.5 hectares). Just over half of the respondents have a title to their land. However, land without a title is still considered private property. Land can be sold or inherited, thus it is considered *de facto* land tenure. Average household income is US $237 per month.

Table 2.2: Socio-Economic Descriptive Statistics of Interviewees

Variable Name	Description	Mean	S. D.
AGE	Age	52.9	12.6
GENDER	Male=1 Female=0	1.0	0.0
EDUC	Years of education	5.9	2.85
HOUSE	Number of people in the house	4.9	2.16
TITLE	Has title to land=1	0.61	0.5
LETRINE	Has a latrine=1	1.0	0.0
LAND	Quantity of land*	70.53	54.75
FOOD	Amount spent on food a month**	163.35	76.34
MEDICINE	Amount spent on medicine a month**	9.4	4.8
TRAVEL	Amount spent on travel a month**	25.6	24.5
SCHOOL	Amount spent on school a month**	39.06	25.67

N=18

*Indicates value is in US dollars

Water supply provided by community aqueducts in Loma Guaconejo must be considered open-access regimes, where the goods non-excludability means the beneficiaries will receive the water whether or not they pay. Poor upstream land management (clearing of riparian zones, planting of root crops with little erosion control, and so on) threaten both the quality and quantity of water transported by the aqueduct.

Potentially, downstream beneficiaries of the aqueduct could pay upstream land users to restore or maintain degraded riparian zones, and to reduce practices that cause erosion. Upstream land use practices that reduce land degradation generally incur significant opportunity costs in the form of lower profits, at least in the short run. Ecological restoration might be the most effective way to restore water quality and quantity, but incurs significant implementation costs. An adequate payment scheme would also have to cover transaction costs of creating and monitoring the market for ecosystem services. Table 2.3 shows that none of the 17 water users contribute towards a fund that pays landowners for the provision of water. As a result, there is little incentive for the landowner to maintain forest cover in the riparian zone upstream.

Table 2.3: Water Quality and Users Willingness to Contribute To a Fund

	Yes	No	DK	Refused
Water quality				
Do you have potable water?	17	1		
If yes, Is it gravity feed?	17			
Does it meet your daily needs?	17	1		
Is there a problem with the water?	1	17		
Do you pay for water?	3	14		
(If pays for water) Does it go to the owner of the land where the water is sourced?		3		
Would you pay the landowner for protecting your water source?	15	2		
How much would you pay? (table below)				
Do you think you should pay the landowner for the agricultural production lost in protecting the water source with trees?	12	3	2	

N=18

Table 2.4 shows that all eighteen community members recognized the importance of forest cover for the conservation of water, suggesting they understand that they depend on it. Additionally, in table 2.3, fifteen of seventeen interviewees said they would be willing to pay a farmer to protect their water source. Their willingness to pay suggests that they also view water as scarce.

Table 2.4: Knowledge of Ecosystem Services and Their Functions

	Yes	No	DK	Refused
Forests				
Do you have trees on your land?	18			
In your opinion are trees good?	16	1	1	
If you had the option would you have more trees on your land?	14	3	1	
If yes, would you plant more wood species?	11	3		
If yes, would you plant more fruit trees?	14			
Is the forest necessary for the conservation of water?	18			

2.4.1 Who Provides the Service and How Much Should be Paid?

Determining how much should be paid for an ecosystem service is important in developing a payment level that is sufficient to induce the desired changes between current and improved practices (Pagiola, et al., 2004). Calculating the minimum amount a conservation fund must generate, to pay a landowner not to engage in inappropriate land use practices, is a supply-side valuation. This can be done by estimating the opportunity cost, implementation cost and transaction cost. The opportunity cost is defined as, "the cost of a good or service measured by the alternative uses that are forgone by producing the good or service" (Nicholson, 2000: p.17).

If beneficiaries of the watershed services wanted the farmer to implement Best Management Practices (BMP) they would also have to pay him for implementation costs. This may include costs for planting riparian buffers, terracing the land or implementing other BMP strategies. In addition, there are transaction costs for setting up the payment.

Using farm financial data from 11 project participants in a project called *Planes de Finca* (farm plan) we were able to determine the opportunity cost of slash-and-burn agriculture. The "farm plan" project, funded by UNDP in May, 2003, had collected detailed farm financial data as part of an overall farm plan for project participants to improve farm profitability. We calculate the average sales from planting root crops at US$ 833/hectare/year with the average expenses at US $729/hectare/year. Thus, the net revenue from subsistence agriculture in Loma Guaconejo is US $104/hectare/ year. The amount US $104 estimated from the study is the opportunity cost for the farmer to leave the land fallow. As mentioned earlier, this does not include implementation or transaction costs.

The master watershed plan (figure 2.5) includes a 30 meter riparian buffer zone. Private land has a total of 339 hectares that fall within this 30 meter riparian zone. The total value of a 30 meter riparian buffer, using the opportunity cost calculated in this study, is US$ 35,256 annually.

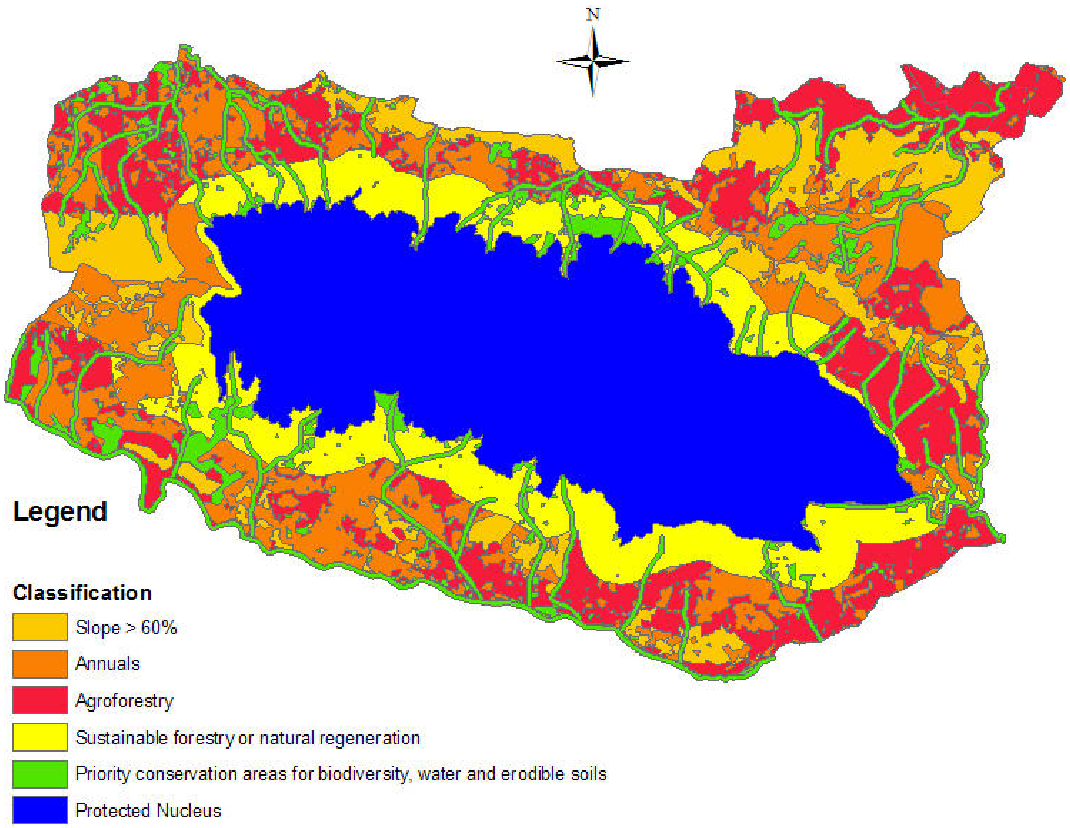

Figure 2.5: Loma Guaconejo Sustainable Land Management Plan

<u>2.4.2 Who are the Beneficiaries and How Much Will they Pay?</u>

Now that we have a benchmark for the cost of enhancing the provision of the watershed service, we look to see if the amount the beneficiaries are willing to pay will match it. This is a demand side valuation and it is often useful to, first, identify local beneficiaries who have a direct linkage with the service. In this case the local beneficiaries are the Loma Guaconejo residents.

During the interviews, respondents were asked how much they would be willing to pay a landowner to protect their water source. Interviewees were asked their willingness to pay with a dichotomous format, where they were given follow up questions that increased by increments of DR $20 pesos.

Table 2.5: Respondents' Willingness to Pay for the Provision of Water

*Willingness to Pay for the Provision of Water Monthly	Yes	No
Would you be willing to pay a landowner to protect your water source?	15	2
$20	12	3
$40	10	5
$60	8	7
$80	3	12
>$80	2	13

* Amount in Dominican Pesos

The median willingness to pay was DR $50 a month, which is equal to US $1.60 dollars a month per family. There are approximately 400 families that live in Loma Guaconejo's 15 communities. If every family was willing to contribute towards a conservation fund, then the yearly contribution of Loma Guaconejo residents would be US $7,872, which would not cover the opportunity costs of restoring riparian buffer zones.

Considering there are not sufficient funds to cover the opportunity cost for maintaining a forest cover for a thirty meter riparian zone on private land, the next logical step is to identify beneficiaries of water supply at the regional level. As displayed in figure 2.6 creating micro-watersheds can help identify the linkage between landowners who provide watershed services and those who benefit. The micro-watersheds labeled "2" are tributaries to *Rio Nagua* and micro-watersheds labeled "1" are tributaries to *Rio Boba*. Rio Boba provides potable water to residents of the municipality of Nagua and rice farmers in el *el Bajo Yuna* . Rio Nagua provides potable water to the residents of El Factor.

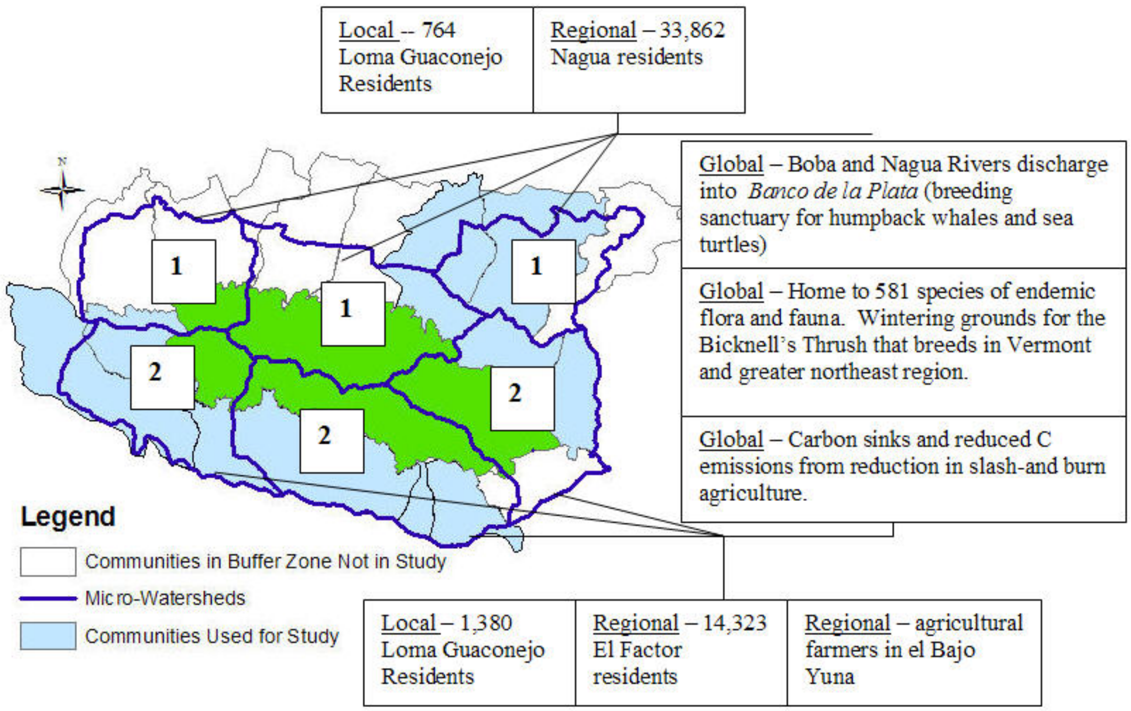

Figure 2.6 :Spatial Distribution of Loma Guaconejo Watershed Services

If the WTP, from beneficiaries of water supply in Nagua and El Factor, was the same as Loma Guaconejo's resident than they could add approximately US $ 183,000 a year to the conservation fund. By combining the beneficiaries of potable water at the local and regional level than there are sufficient funds to cover the opportunity costs for maintaining a 30 meter riparian buffer for all the rivers on privately owned land. The excess of approximately US $148,000, between beneficiaries WTP and opportunity costs, could be used to cover transaction costs, implementation costs and monitoring costs. Collecting funds from agricultural users in el Bajo Yuna would also help contribute toward these costs.

Conversion of forests to agricultural land also has environmental implications at the global level. The Rio Nagua and Rio Boba feed into the *Banco de la Plata*, which is a breeding sanctuary for endangered humpback whales and sea turtles. Banco de la Plata was declared a Marine Mammal Sanctuary in 1986 to protect the breeding area for Humpback whales who travel from the Northern Atlantic Ocean yearly, between January and April. However, soil erosion has caused sedimentation of waterways and the use of agri-chemicals have polluted the breeding sanctuary. A recent report of water quality tests in a one area of the breeding sanctuary indicates there are high levels of mercury, bio-accumulating pesticides and organic compound, such as DDT (UNDP, 2000). The Dominican Republic has the highest whale watcher expenditure than any other country, contributing to US $5.2 million dollars a year toward the eco-tourism sector (Hoyt and Hvengaard, 2002). Contributing some of these funds to landowners in the upper watersheds of Loma Guaconejo to practice sustainable land management may improve water quality in the sanctuary.

Developing a conservation fund for protecting waterways is an important step for ensuring the sustainable provision of water. However, other PES schemes are also needed for sustainable land management to be adopted in areas outside the riparian zone.

2.4.3 Other Loma Guaconejo Ecosystem Services and Their Beneficiaries

Biodiversity is one of the most important global benefits provided by Loma Guaconejo (SODIN, 2002). One PES scheme that has improved biodiversity in Loma Guaconejo is the organic cacao certification scheme. Premiums received for producing organic cacao, along with improved production methods from fermenting beans, have raised the value of cacao to a net revenue of US $169 per hectare. This is US $44 above the net revenue from commodity cacao, which is US $125 per hectare (Reynosa, personal communication). Figure 2.7 demonstrates the prices for different types of cacao.

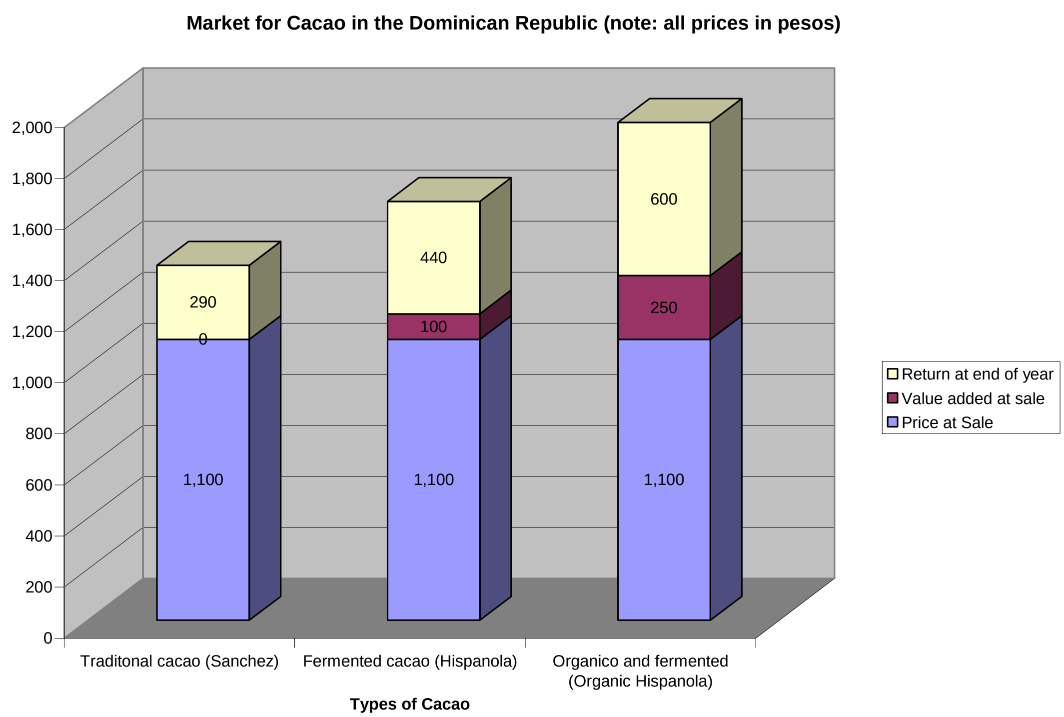

Figure 2.7: Market for Cacao in the Dominican Republic

Note: prices per 100 pounds of cacao for June- 2005: prices fluctuate daily

Results from interviews with 18 forest users suggest this economic incentive has been effective in mitigating inappropriate land use practices. Eight interviewees said they have changed land use practices, from slash-and-burn agriculture, to more sustainable methods. In three years, this project grew from eighteen organic certified farmers to one hundred thirty-five. A cooperative called La RED (the network), which was developed to reduce transaction costs, now produces over 250,000 pounds of organic cacao a year. Table 2.6 demonstrates that the majority of respondents thought the organic certification project generated the most income for the communities.

Table 2.6: Farmers' Perception of the Projects

	Org. cacao cert.	Demon. plots	Tree Nurseries	Ecotourism
What project improved environmental conditions the most ?	4	4	9	1
What project generated the most income for the community?	10	5		3

There is one other PES that appears to have the potential to provide funds for biodiversity conservation. A project titled *Hispaniolan Bird Conservation Fund* has been developed by the Vermont Institute for Natural Sciences (VINS) with funds from the White Face Ski resort in New York (Wildlife Conservation Society, website). This project takes the polluter pays approach, where those who degrade a ecosystem service – and thus degrade the common resource of forest services – are responsible for the costs.

Expansion of the White Face Ski Resort in New York will threaten the fragile breeding habitat for the Bicknell's Thrush (*Catharus bicknelli*), which ranks as the Neotropical migrant bird of the highest conservation priority for the Northeast U.S. (Audubon, website). As a reconciliation from the White Face ski resort expanding into the Bicknell's Thrush breeding ground, White Face is are paying for the conservation of the Bicknell's Thrush wintering grounds on the island of Hispaniola. This bird has been found to use Loma Guaconejo's forests for its wintering grounds (VINS, personal communication). Using funds to purchase land that could be managed as communal property would most likely result in the sustainable provision of biodiversity. Many case studies have shown that when communities depend on a resource, common property may lead to the desirable ands of ecological sustainability (Bromley, 1992; Agrawal, 2000; McKean, 2000; and Gibson, 2001).

2.4.4 Carbon Sequestration

Carbon sequestration also provides another unique opportunity for Loma Guaconejo forest users to capitalize on markets for ecosystem services. One study has shown that secondary tropical forests can sequester 10 tonnes of carbon per ha a year (Pagiola et al., 2004). Another study by Redondo-Brenes and Montagnini (2006) in Costa Rica found that mixed tropical forests have the potential to sequester 13 tonnes of carbon per ha. Using these values, Loma Guaconejo would be eligible for between 5,030 tonnes and 6,539 tonnes of carbon credits for reforesting 503 ha of deforested land in the nucleus. If the Clean Development Mechanism (CDM) was designed to compensate landowners for conserving intact forest ecosystems, Loma Guaconejo would have the potential to sequester between 23,690 tonnes and 30,797 tonnes of carbon a year within its nucleus.

2.5. Discussion

2.5.1 Agroforestry and Market Failure

Results from interviews indicate the organic cacao certification project has been successful in improving the overall integrity of Loma Guaconejo. Agroforestry systems

(AFS) have been widely accepted as a potential way of improving socioeconomic and environmental sustainability in the tropics. Multi-layered AFS provides a mix of market goods, such as food and timber, and nonmarket goods such as biodiversity, soil conservation, and improved air and water quality (Martin and Sherman, 1992; Alvalapati et al., 2004). The problem is that AFS provides what is known as 'private profitability' to the landowner and 'social profitability' to society. If markets for root crops pay more than sustainable forestry, the farmer must make a choice between making the greatest individual profit or providing a greater benefit to society. The farmer is then stuck in what is called a 'social trap'. A 'social trap' refers to when the short-term individual profitability does not fall in line with the best interests of the individual or society as a whole in the long-term (Costanza, Farber and Maxwell, 1989). If he keeps the land forested, communities downstream in Loma Guaconejo will benefit from clean water and storm protection, but he will foregо any potential profit from working the land. When forced to choose between working the land to feed his family or providing a pure public good and bearing the full cost, he invariably goes with the former.

2.5.2. Challenges in Organic Cacao Production

This study shows that both AFS with and without organic certification pays more than the opportunity cost of slash-and-burn agriculture. Considering this scenario one may assume that since sustainable agriculture pays more there may not be a need to develop other PES schemes. Organic certification will increase the net revenue per ha from AFS production and will, in turn, increase the adoption rate of sustainable land management. However, despite the benefits of AFS there are several socioeconomic barriers that prevent it from being adopted at a scale large enough ensure the sustainable provision of forest goods and services. Thus, it is critical to identify the potential of other PES schemes to meet the desirable ends.

First, the optimal foraging theory that suggests individuals will “maximize their net rate of return of energy per unit of foraging time” (Schweik, 2000: p.108). This means that forest users will seek to reduce the amount of energy exerted by planting labor-intensive crops closer to their homes and markets (roads). Farmers in Loma Guaconejo exert more energy with agroforestry systems, such as cacao parcels than they do with slash-and-burn agriculture. Cacao production is extremely labor intensive and requires significantly more energy to maintain weeds, prune limbs and harvest fruit.

As Feliciano in the community Blanco expressed in the interview with him:

> “Organic production does not work in the mountains because it is very far from where I live. For me to sell organic cacao I can not spray chemicals... so I will need to visit *la parcela* every few weeks to maintain the weeds. Especially, in the first few years of planting the field there will be no shade and the weeds will grow *como Diablo* (like the devil). It takes a minimum of 3 or 4 years for cacao to produce after you plant it, so I will not have any income. I need to have a *conuco* because that is how I eat”.

Feliciano touches on another important barrier to AFS adoption. Remote communities tend to practice subsistence agriculture because they lack access to finances and resources. Organic agroforestry systems typically entail high start up costs. There is also considerable lag time before systems can produce (Pagiola et al, 2004). Communities that are closer to roads tend to have a higher standard of living (SODIN, 2002). They have better access to education, water, electricity, healthcare and income streams. As a result, farmers in upstream communities that are further away from roads tend to practice migratory agriculture that maximizes their yield in the short-term, with little consideration for the negative externalities created for downstream beneficiaries.

In addition, if demand for organic cacao is indeed inelastic, then an increase in quantity might lead to even larger decrease in price, so that the total revenue received by the farmers could actually decline.

Finally, the third barrier to adoption of AFS has to do with the discontinuity of policies that are developed at the national level and ignore the needs of local users, which typically results in a game of “cops and robbers” between outside authorities and local users (Ostrom, 1999). This game of “cops and robbers” has been a long standing tradition in Loma Guaconejo. At the sight of La Floresta, it is common practice for community members to run to the hills to inform farmers of the authority’s presence. Thus, until policies at the national level consider the needs of local users, sustainable land management will be difficult to achieve.

2.5.3. Feasibility for Payments for Water Supply

Findings indicate that developing payments for water supply at the local and regional level should be a major priority for conservation efforts. The results from GIS analysis show that forty percent of private land is being used for subsistence agriculture. Further, while conducting research in Loma Guaconejo we observed severe degradation of riparian zones next to aqueduct intakes. This may significantly reduce water flow during the dry season, cause sedimentation and inhibit the ability to filter agri-chemicals that pollute waterways, potentially leading to serious health problems.

Forest conversion in riparian zones may be explained by the fact that water users in Loma Guaconejo do not pay landowners for protecting the resource. This scenario has lead to what is known as the ‘tragedy of the commons’. When water supply is open-access (non-excludable) individuals will “free ride” on the conservation of others and benefit form the depletion of the good without paying for any of the costs of its provision (Ostrom, 1990). The solution to this tragedy is making the service excludable by charging a user fee that pays the landowner for the cost of enhancing or protecting the watershed service (Echavarria et al., 2004; Echavarria and Lochman, no date). Based on this analysis, we find that several important conditions are met for a PES scheme to occur for watershed services.

In assessing the feasibility for creating a market for watershed services we find that Loma Guaconejo residents recognize they both depend on watershed services and find it scarce. These are two necessary conditions that local institutions must meet in managing common-pool resources (Gibson, 2001; Ostrom, 1990; and Agrawal, 2002). Having met these two conditions indicates that there is much potential for a PES scheme for water supply to take place between the beneficiaries and landowners in upper watersheds. However, we also find that in order to cover the opportunity cost from slash-and-burn agriculture regional beneficiaries of water supply, in Nagua and El Factor, are needed to contribute toward the payments. Thus, there are several barriers to overcome before a successful PES can be implemented.

The first challenge is organizing all the beneficiaries of water supply in Loma Guaconejo, Nagua and El Factor in a cost-effective manner. This may prove to be challenging because it would require uniting the beneficiaries across political boundaries, which often entails high transaction costs. Transaction costs tend to increase at broader spatial scales because there are usually more beneficiaries. Moreover, it is often difficult to convince beneficiaries, who are further away from the watershed service, that their financial contribution is improving or maintaining the quality of a service (Conservation Finance Guide, 2006).

Also, considerable effort must be made to minimize transaction costs so they do not exceed the total benefits of the service (U.S. House, 2002). One way to reduce the transaction costs is to identify one main beneficiary. The Water Treatment Facilities in Nagua and El Factor could act as the main beneficiary of the good, which would dramatically reduce the transaction cost.

Other times farmers' cooperatives can also be effective in organizing beneficiaries of ecosystem services and reducing the transaction cost. In Columbia, a cooperative of agricultural users have made payments to upstream landowners for the provision of watershed services (Pagiola et al., 2004). In the Dominican Republic, irrigation management has proven to be much more efficient when management is transferred from national control to local agricultural water users associations or *Juntas* (Rodriquez, 2001). A recent study suggests that recuperation of water fees under Juntas' management is between 60-85%, where under systems still under centralized management receive 15%. Giving *Juntas* the autonomy to manage their resource has improved water efficiency, mainly through technology (USAID, 2001).

<u>2.5.4.La RED – Transaction Costs, Direct Markets and Social Capital</u>

The farmers' cacao cooperative – La Red – has provided a unique opportunity for farmers in Loma Guaconejo who are marginalized geographically, economically and socially to a fair share of the products' market value. Farmers are spatially spread out, which makes it difficult for them to organize. They have few resources to cover the initial start up costs and many times lack the necessary social capital needed to analyze problems and create solutions. As a result, they generally have few market options, which make them a price taker rather than a price maker.

However, with the farmers' cooperative they have strength in numbers. They have a considerable amount of members and produce a significant quantity of cacao, which enables them to access a direct market in the U.S and Europe. They no longer have to go through intermediaries, who take a considerable portion of the profit. La RED plays a vital role in the organic certification process by reducing transaction costs with the adoption of an internal inspection program certified by the Institute for Market Ecology (IMO). La RED reduces transaction costs by certifying the farmers, provides them with a higher price by accessing a niche market and also fosters a democratic process that is socially equitable.

This has increased forest user's social capital. The World Bank (2000) recognizes the role of social capital as a key factor to the success of a PES scheme. Social capital is critical, because it improves the ability of local organizations to analyze problems and develop solutions, which affects the PES scheme as a whole. If there is poor social capital then local communities or institutions will not be able to effectively manage their resources for the present or for the future. The democratic process allows farmers to take part in the decision-making process and provides forest users with a sense of community.

2.6. Conclusion

While the organic certification scheme may have improved the overall ecological integrity of Loma Guaconejo, GIS analysis suggests priority conservation areas of riparian zones continue to be extracted at unsustainable rates. This has occurred primarily as a result of the non-excludability of water supply. When landowners in the upper watershed are forced to pay the full cost of water provision, they often opt to incorporate inappropriate land use practices for short-term economic gain despite the negative externalities generated to downstream beneficiaries.

This open-access resource has provided a unique opportunity for a PES scheme at the local and regional level for water supply. Water users in Loma Guaconejo meet the conditions for a PES transaction – they value water and view the resource as scarce. However, payments from local beneficiaries are not enough to cover the opportunity cost for a thirty meter riparian buffer on private lands. Since payments are needed from water users at the regional level, future research should focus on determining how much residents in El Factor and Nagua are willing to contribute toward a water conservation fund. Having a Water Treatment Plant in Nagua and El Factor should reduce transaction costs by serving as the main beneficiary, which can facilitate market transactions between upstream landowners and downstream beneficiaries.

We conclude that the key to sustainable land management in Loma Guaconejo depends on providing local people with access to a fair share of the products' market value. This finding is supported by Sarukhan and Larson (2001) who found the sustainability of Mexico relies on global markets valuing low-input communal and small property systems that reward sustainable extraction of resources.

The creation of the farmers' cooperative (LA RED) is one such entity that is being rewarded for adopting such practices. They have been vital in reducing the transaction cost of organic certification, accessing direct markets and improving social capital. The organic cacao certification scheme has enhanced the provision of pure public goods, such as biodiversity with the AFS. However, sustainable land management in Loma Guaconejo depends on developing PES schemes from the local, regional and global level.

Specifically, unless there are payments from regional and global beneficiaries (i.e. potable water, irrigation water, clean water in the humpback whale breeding sanctuary, U.S. Northeast migratory birds wintering grounds, carbon sequestration and biodiversity) forest conditions in Loma Guaconejo will remain sub-optimal. Sustainable land management depends on farmers receiving more of the Total Economic Value (TEV) of tropical forests. Payments for Loma Guaconejo's services have the potential to do this and 'tip the scale' toward forest conservation.

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