The impacts of payments for watershed services in Ecuador

Emerging lessons from Pimampiro and Cuenca

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ENVIRONMENTAL ECONOMICS PROGRAMME

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Contents

1. Introduction

"Markets may be efficient, but nobody says they are fair. The question is: what do we owe the future?"

Robert Stavings, University of Harvard, in "The invisible green hand. A survey of the global environment", *Economist* 6 July 2002.

1.1 Background

As a reaction to the ineffectiveness of command and control environmental regulations, environmental policy makers have promoted market mechanisms to achieve ecological goals. In the past decade proposals to market the environmental services provided by forests have become a reality in a wide range of settings (Pagiola et al. 2002; Landell-Mills and Porras, 2002). A key area of interest is that of watershed services, for example, flow regulation, maintenance of water quality, control of soil erosion and sedimentation, and maintenance of the hydrological functions provided by forests. With this in mind, environmentalists and conservation-minded local authorities are proposing to pay landowners to protect forest cover and thus maintain or improve hydrological integrity. At present, the environmental effectiveness of these 'experiments' is still being evaluated (Johnson et al. 2001).

One of the questions that arises in relation to this issue is: what is the impact of 'environmental markets' on poverty? Through a worldwide study of green markets, the International Institute for Environment and Development (IIED) has found that in general it is assumed that the social impacts will be positive; however, these are rarely assessed (Landell-Mills and Porras 2002). The study examines 287 cases in which 'markets' are being developed for forestry services including carbon sequestration, wetlands, biodiversity protection and landscape beauty. "Markets" are deemed to exist where payment systems are set up such that beneficiaries of an environmental service compensate providers of that service. Payments may be in the form of financial or in-kind transfers. To this end, with the aim of undertaking a social assessment of environmental market mechanisms, research was carried out in several countries where markets are emerging or are already in existence (Ecuador, Costa Rica, the Philippines and Brazil), as means of extracting key lessons that could be applied in other countries.

Payments for environmental services are of great interest in Ecuador, particularly as a way to leverage funding for environmental protection. Payment systems are emerging, but because these experiences are recent little is known about their impacts on national or local well-being. Thus, the rationale for this research is to provide guidance in order to ensure that policies support payment systems that are beneficial to the poor, as well as the environment.

Two cases of payments for watershed services were selected for detailed analysis: Pimampiro and Cuenca. These two different cases were chosen to illustrate how municipalities are implementing or planning to implement payment systems to protect their watersheds. Pimampiro is a small town and provides an interesting pilot experience of paying landowners to protect their forest, the first such case in the country. Cuenca is a medium-sized city that has established an ambitious and integrated water resources management system and is interested in developing a payment system in the near future.

1.2 Project objectives and deliverables

The project set out to engage stakeholders in the evaluation of this emerging "market" for watershed services and its social impact.

The study consists of two documents that are separate but also complement each other. The first document, called *Markets or Metaphors? A Sustainable Livelihoods Approach to the Management of Environmental Services: two Cases from Ecuador*, written by Dr Joseph Vogel, is at the centre of the research. This document presents the results of the development of a methodology and its application in the field. It also includes an economic and legal analysis that demonstrates the importance of understanding and including social and cultural implications when developing a market for watershed services.

Vogel (2002) discusses the implications of "commodifying" the environment ("Does charging for water disrupt public order and moral conduct?"), presenting five key issues that should be considered by those interested in promoting water and watershed markets:

- access to common resources;
- the issue of private ownership;
- conflicts between upstream "sellers" and downstream "buyers";
- confusion between *de facto* control over the land and *de jure* right;
- water as a right versus water as a commodity.

The present document is descriptive in nature and provides a more detailed explanation of the Ecuadorian context and the "stories" behind the two cases. The project conclusions based on Dr Vogel's analysis and the opinions of the people interviewed are presented in order to present lessons for the future.

1.3 Data collection techniques

Ecodecisión, an Ecuadorian firm specialising in watershed environmental services and climate change mitigation, coordinated a research team from several institutions. Dr Joseph Vogel, Professor of Economics at FLACSO-Ecuador, was the Technical Director and directed the focus of the study, designed the methodology and analysed the data. Montserrat Albán, an economist from EcoCiencia, a national biodiversity research institution, was the research assistant in charge of the consultations and stakeholder interviews. Marta Echavarria, an environmental manager, acted as project coordinator.

To evaluate market mechanisms, Vogel (2002) developed a methodology that considers the impacts on the poor. Based on a critique of the Sustainable Livelihood Approach, Vogel recommends the use of *limits*, be they institutional, cultural or physical, as a guide for assessing impacts. Thus the methodology aims to "design a field instrument that can refine the researcher's subjective impressions as to what are the most relevant limits for the provision and consumption of environmental services".

The methodology is divided into the three areas, described below:

1. *The background preparation* entails the collection, synthesis and summary of all published and unpublished data in order to build on existing research and provide recommendations. Unpublished and published documents are identified and collected as

suggested by representatives from the different institutions participating in the studies, as well as other practitioners in academic, government and non-government organisations. A full list of the literature referred to is provided in the reference list. Key participants in the development of these cases, from implementing agencies or advisory bodies, were interviewed.

Subjective impressions should be identified and used to develop an instrument, which, unlike a survey, should consist of a list of statements in simple and jargon-free language. Those interviewed should not be asked open-ended questions but should be allowed to review bracketed phrases so they can choose the answer that best reflects their opinion.

Owing to possible literacy and numeracy problems, it may be necessary to reformulate the instrument into questions. As we all have opinions and biases, great care should be taken to avoid steering the interviewee towards an answer.

The content of the survey should be different for "buyers" (downstream water users) and "sellers" (upstream water suppliers).

2. *The field work* highlights the fact that "consultation with stakeholders", rather than "surveying" members of a community, is more conducive to collaboration given that in developing countries there is often mistrust of interviews. This is particularly true in settings in which payment systems are discussed and where people will answer strategically. It is important to allow sufficient time and space for people to reflect on the question and take their time to answer. It might be appropriate to offer some kind of compensation for people's time, but this will depend on the researcher. Only relevant and clearly defined data should be collected and the stakeholders' privacy should be respected.

   Based on the instrument designed by Vogel (2002), consultations took place in Pimampiro with 11 of the 20 members of the Nueva América Association who participate in the payment system, and 36 individuals from the town of Pimampiro; and in Cuenca with 24 people from the Yanuncay watershed and 49 ETAPA customers in the city of Cuenca. The tabulated results of these consultations can be found in the Annex 1.

3. *Analysis and recommendations* should be provided to all stakeholders after the statistical analysis is performed. Existing recommendations maybe reinforced or corrected after analysing the new data.

The time frame will vary according to the site and the stakeholders consulted.

1.4 Content of the report

Section 2 presents the national context relating to water resource management and describes the laws, policies and institutional organisation. This section also presents a summary of how watershed "services" are being discussed and developed nationally.

Sections 3 and 4 describe the features of the Pimampiro payment system and water resources management system of Cuenca's municipal water company, ETAPA. At the end of each

section, impacts are assessed and the recommendations derived from the economic analysis are presented.

Section 5 presents the main findings of the preliminary assessment of Pimampiro and Cuenca, the process of creating the payment mechanisms, and finally the project's conclusions.

2. Water in Ecuador

2.1 Water scarcity

The Andes mountain range crosses the whole country (Figure 2.1), dividing it into three distinct climatic regions: the *Sierra* or mountainous region, which is characterised by snow-covered peaks and high valleys; the eastern region, which is part of the Amazon basin; and the coastal region, which is influenced by the Pacific Ocean. With an estimated volume of 43,500 m^3 of water per person per year, the total rainfall per person in Ecuador is three times the world average of 10,800 m^3 (CNRH, 2002). However, this figure can be misleading as the water resources are not distributed evenly – either over the year, geographically, or throughout the population.

Figure 2.1 Physical map of Ecuador

Source: www.ciudadfutura.com/ecuador/fisico.com

Large areas of the country are subject to extreme climatic conditions, such as very dry summers and excessive rains in the rainy season. Floods are a common threat in some areas of Ecuador. In the coastal region, for example, the hot *El Niño* current from the north meets

the cold Humboldt current from the south, producing severe climatic conditions which can cause huge damage. In 1997-1998, *El Niño* produced flood damage of around 2.9 billion dollars, and this is considered to be one of the main reasons for the country's latest political and economic crisis.

A large proportion of the population does not have access to safe and reliable drinking water sources. Only 67 per cent of Ecuador's 13 million inhabitants, have access to drinking water, and these are predominantly in urban areas (CNRH, 2002). But this national average disguises the fact that there are areas where there is very low coverage, such as the coastal region where only 20 per cent of the population has access to water. Furthermore, the majority of the drinking water systems have serious operational and maintenance faults, such as inadequately funded installations, unaccounted-for water loss, shortage of water meters, poor water quality, erratic service, and low pressure (Lloret, 2002).

Irrigation activities account for most of the water consumption (82 per cent). Yet only 7 per cent (approximately 600,000 hectares) of the area under cultivation is irrigated. Eighty per cent of the irrigation systems are community- or privately-owned, and the remainder are public. Water losses are above 50 per cent (Andrade and Olazaval, 2002). Industrial demand is increasing and as the water sources close to populated areas are depleted, conflicts with agricultural uses occur (Lloret, 2002). Thus, given the country's dependency on agriculture, as the country becomes more urbanised conflicts over water will become more serious.

Finally, there is growing recognition that water quality is deteriorating. The majority of the country's rivers are polluted by domestic and industrial wastewater, and agricultural runoff. Only Cuenca, the third largest city in the country, has a treatment plant, and this only treats 9 per cent of the city's wastewater. In general, industrial wastes go untreated, although in some areas environmental regulations have recently been strengthened. The poor water quality is illustrated by the fact that during the worst cholera epidemic in the region in 1991 and 1992, Ecuador was second only to Peru in the number of cases registered. According to the Health Ministry a large percentage of genetic defects in newborn children can be attributed to chemical water pollution (Lloret, 2002), caused by agricultural runoff and industrial wastewater discharges.

2.2 Complexities and contradictions within the water regime

As in most Latin American countries, water is a public good, with a few exceptions made for certain indigenous communities with ancestral rights. The Agrarian Development Law of 1997 upholds the principle that water is a national good for public use and as such cannot be taken away (Article 45). The *right to use* can be formalised and registered in the property but it is clear that it does not mean ownership:

> "In short, the waters within Ecuadorian territory have one sole owner - the State - which grants individuals the right to use only" (Arias, 2002, p.3).

The Water Law of 1972 establishes a hierarchy of uses: a) provision for communities and wells; b) agriculture and cattle raising; c) energy, industry and mining; d) others (Article 34).

Box 2.1 Main water laws and regulations in Ecuador

1960 Irrigation and Soil Sanitation Law regulates irrigation systems.

1966 Decree 1551 creates the Ecuadorian Institute for Water Resources (Instituto Ecuatoriano de Recursos Hidráulicos - INERHI).

1971 Special Decree 188 (also known as the Health Code) regulates water services for human consumption.

1972 Water Law on the management of all marine, surface, ground and atmospheric waters in the country.

1973 Special Decree 40 regulates the 1972 law and establishes the responsibilities of the INERHI, composed of an Advisory Council and 13 Water Agencies, and defines its jurisdiction to cover the whole country.

1994 Special Decree 2224 on the centralised planning, administration and control functions in the National Water Resources Council (CNRH). It also includes decentralised implementation, operation and maintenance of irrigation systems and water infrastructure, water quality control and conservation of watersheds by regional development councils. It also authorises the transfer of irrigation systems to its consumers (UEP-PAT - Implementing Unit for Technical Assistance for Irrigation Projects.

1999 Environmental Management Law creates a decentralised environmental management system.

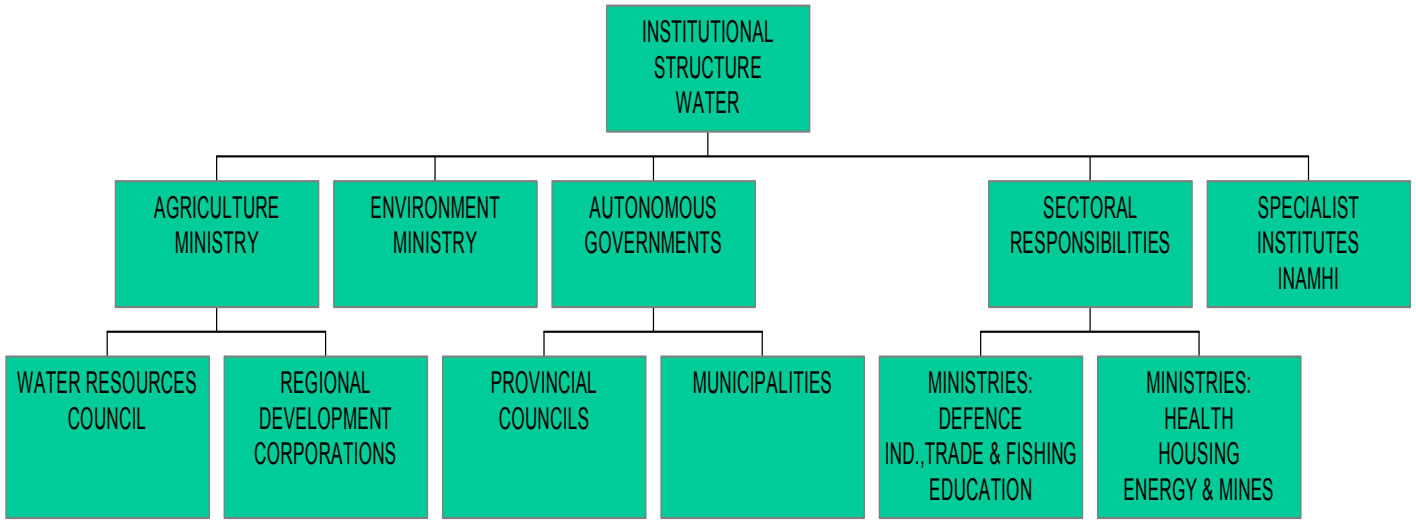
The institutional structure pertaining to water resources is complex and confusing, because of the multiplicity of institutions, regulations and jurisdictions involved. In a recent study a prominent environmental lawyer identified 25 laws and regulations as having direct relevance and 11 institutions as having direct or indirect jurisdiction over water resources (Arias, 2002). Box 2.1 simplifies the legal framework by highlighting the main laws and regulations. For example, provincial governments and regional development corporations have similar legal mandates with regard to watersheds and irrigation systems, yet they do not have a legal mandate to coordinate activities, nor do they attempt to prevent duplication of activities (Andrade y Olazaval, 2002).

The Special Decree 2224 of October 1994 attempted to modernise the 1972 Water Law by centralising planning, administration and control functions in the National Water Resources Council (CNRH). At the same time, implementation, operation and maintenance of irrigation systems and hydrological infrastructure, water quality and pollution control, and the conservation of watersheds were decentralised to nine regional development corporations (CORSINOR in the Northern Sierra; CORSICEN in the Central Sierra; CODELORO in El Oro Province; CODERECH in Chimborazo Province; CODERECO in Cotopaxi Province; CEDEGE in the Guayas watershed; CRM in Manabí Province; CREA and PREDESUR in the central and southern part of the country). Inspired by similar experiences being developed throughout Latin America, these regional development corporations were considered “motors of progress” that would build irrigation systems and thus modernise agricultural systems. They receive funding from the central government but the governing bodies are composed of national and regional representatives.

These corporations differ in terms of their jurisdiction, institutional structure, political power and resources, and have had differing degrees of success. Yet, their common focus has mainly been irrigation systems. They tend to work in isolation with few links to local and national decision-making processes.

This already confusing and dispersed system is exacerbated when we add to it interaction with the environmental authorities. The Environmental Law of 1999, which aims to strengthen the country's environmental management, created a decentralised environmental management system. This "system" is composed of all the institutions that have environmental jurisdiction, which includes ministries, municipalities and provinces. However, the latter two entities are legally defined in the Constitution as autonomous - Art. 228 (Llaguno, 2002 p.7-8). The challenge is how to coordinate these two, at times, overlapping bodies.

Figure 2.2 The institutional structure for water



Thus, as illustrated by Figure 2.2, water has been managed and administered on a sector-by-sector basis with no unity of focus towards integrated water resources management, but with a duplication of responsibilities. For example, water quality is a responsibility of the Water Resources Council but also of many other sectoral institutions: the Ministry of Agriculture for agricultural wastewater, environmental agencies for industrial discharge, the Ministry of Energy and Mines for hydrocarbon pollution. Although there are national water quality standards, their enforcement has been the responsibility of the municipalities since they are responsible for provision of drinking water.

The management and administration of water resources correspond to the geopolitical distribution of municipalities and provinces, which is not necessarily the most effective way to manage the resource. Watersheds are not used as management or planning units, although in theory their importance is recognised. Watersheds are the responsibility of the provincial governments, the forest service within the Ministry of Agriculture, and the regional development corporations. The constitution states that the provincial councils "must promote and carry out work within the provinces on roads, environment, irrigation and management of watersheds and sub-watersheds" (Article 228). Yet, in practice few activities are implemented at ministerial or provincial level and there is little or no coordination with the development corporations or municipalities to address watershed issues.

Regulations to enforce the 1972 Water Law establish that water tariffs are to be paid to the Council and that the tariff structure should be reviewed every three years. Drinking water and hydroelectricity are exempt from tariffs. Although the current irrigation tariffs are very low (just over $1.0 per hectare) few users actually pay (CNRH, 2002). The income does not cover the needs of the irrigation systems, let alone the administration of the resource. Most municipal water companies are in financial difficulty because of poor management and lack of funding from central government. Attempts have been made to reduce subsidies and move towards transparent pricing. However, there are arbitrary regulations that are deeply entrenched in the system, such as the 50 per cent discount for low level industrial use and for social and educational institutions.

Consumer participation is limited within the framework of the 1972 Water Law. Rather, the government regulates water use and does not make provision for consumers to participate in the decision-making process. The 1994 decree authorised the transfer of irrigation systems to its users as a national policy implemented through a department of the Ministry of Agriculture (Executive Unit for Technical Assistance on Irrigation Projects - UEP-PAT) funded by World Bank. Although this process is now underway and could empower consumers, experts consider that the transfer has been carried out in an ad-hoc fashion, without the necessary training and capacity building to ensure the long-term viability of the system (Andrade y Olazaval, 2002).

2.3 Watershed management: an unfulfilled goal

Watershed management has been a goal for many years, but results have been limited. One good example of watershed management is that of the Paute River watershed, which is important because it provides almost all of the country's electricity (Proyecto Plan Maestro para la Protección de la Biodiversidad Mediante el Fortalecimiento del SNAP, 1998). A more recent experience is the Carchi Consortium, which integrates private and public organisations from all sectors of society, using the "sub-watershed eco-region" of El Angel in

northern Ecuador as its planning unit. The Carchi Consortium takes a holistic approach in which water is the focus for the management of the area.

Although, in theory, there is a recognition of the importance of watershed management, there are few programmes, and most of those that do exist are developed through international cooperation and with short-term funding. According to Pablo Lloret, a water resources administrator "the majority of watershed experiences are linked to integrated watershed management studies, which generate a long list of projects, or to the construction phase of hydrological or other infrastructural works. They are sponsored by commissions or development corporations or by large water users, such as hydroenergy, irrigation and drinking water projects" (Lloret, 2002).

Unfortunately, there has been little continuity in the development of watershed programmes and little or no systematisation of the results.

Yet there have been increasing calls for a more integrated management of this vital resource. National environmental policies point to water resources as a key area for development and describe the state's role in defining the legal and institutional framework for integrated water management based on watersheds with the participation of local governments and communities (Políticas Básicas de la Estrategia Ambiental de Desarrollo Sostenible, 1999). At the time of writing, four different proposals were being discussed in Congress for reform of current water law and in these proposals watersheds are the geographical units around which management and administration of the resource are based. All of the proposals aim to establish a sound tariff structure, clear regulations for water use and concessions, control of wastewater discharge and protection of watersheds. The political sensitivity of water and the spectrum of ideological positions make it unlikely that a reform will be approved. The indigenous communities are very fearful of water privatisation, and multilateral agencies and commercial agricultural interests want to promote investment in irrigation systems and infrastructure development.

The Water Resources Council's proposal for the reorganisation of the water sector has been under discussion over the last year. It proposes the creation of nine watershed management units, each of which has a water administration authority or agency, to administer water use rights, develop management plans and monitor water quality. Each unit would also have a watershed council, which would include the active participation of the water users (CNRH, 2002). Unfortunately, this proposal does not seem to be on the current political agenda, and its implementation seems remote. The Council does not have the political leadership or influence to turn this debate among specialists into a national debate.

To add to this pessimistic panorama, there is growing public concern about the long-term sustainability of forests and in particular their ability to provide hydrological "services", such as maintaining quality and flow.

Although the 1981 Forestry Law prohibits the conversion of forests to other uses, forests are disappearing at an alarming rate. Different institutions present various statistics for deforestation, and there is no agreement as to the precise figure. However, the magnitude of the figures indicates the seriousness of the problem. Ecuador has the second highest deforestation rate in South America, estimated by FAO to be 1.6 per cent per year, which is higher than the world average for tropical biomes, which includes highlands, montane and lowland forests (Bruijzneel, 2001).

A recent study on the economics of deforestation in Ecuador considers the following to be the principal causes of deforestation (Wunder, 2000):

- the role of logging companies
- the fuelwood trap
- poverty and forest loss
- the impact of population growth
- land tenure and access
- extra-sectoral (non-forestry) policies

Wunder characterises the deforestation cycle in Ecuador as follows:

- *Phase 1:* timber and charcoal extraction (1-2 years).
- *Phase 2:* slash-and-burn agriculture (2-5 years):
  potatoes, beans (1-2 years)
  maize (1-2 years)
  wheat, barley (1-2 years)
- *Phase 3:* pasture for cattle ranching (7-10 years)
- *Phase 4:* fallow and bushland regeneration (1-5 years)
- *Phase 5:* slash-and-burn, agriculture, pasture, etc.

The scientific debate about the hydrological implications of deforestation is complex and at times counter-intuitive. Nevertheless, it is generally accepted that replacement of montane forests, particularly cloud forests, with agriculture and pasture, with little or no management, can reduce the stability of the soil, its capacity for infiltration and, in the case of cloud forests, interception of horizontal and net precipitation, thereby reducing water flow during the dry season (Bruijzneel 2001). Changes in forest cover might not affect local rainfall, but as mentioned by Bruce Aylward in his electronic newsletter, 'scientists are agreed that the loss of forest will adversely affect rainfall in vast continental basins (such as the Amazon basin, which is partially enclosed) and in cloud forest areas (due to loss of horizontal precipitation or fog drip)" (Flows, 2002). In a recent study in Costa Rica, Lawton et al. (2001) found that deforestation in lowlands could reduce cloud formation and increase cloud elevation during the dry season in higher altitudes, and thus reduce precipitation in cloud forests. The foregoing relates mainly to cloud forests, which are important in Ecuador, and in particular the case of Pimampiro as highlighted in section 3. Unfortunately, there are no hydrological studies from Ecuador that the authors were able to draw on, nor studies linking forests to water quality.

The main source of water for the country's population is the *páramo,* or high altitude grasslands. Unfortunately, there are no estimates for the percentage of useable water that comes from these ecosystems but it is clear that the majority of the country depends on the páramo for their water since the Andes provide the drainage for the whole country. The high humidity and low temperatures limit evaporation and decomposition of organic matter. Large volumes of water come from melting glaciers and snowfalls, abundant rainfall (>3,000 mm per year) and almost constant horizontal precipitation. All this humidity is stored in the organic soils and the vegetation which absorbs water like a sponge (Hofstede, 1997). Robert Hofstede, an expert on this type of ecosystem estimates that in the rainy season, the páramo soils contain between 1,000 and 6,000 cubic metres of water per hectare. About half of this volume is mobile.

Although the páramo only covers 5 per cent of the country's surface, it is of great social, economic and cultural importance because a large proportion of the country's population and economic activity depends upon it. The páramo is under threat from a variety of human activities, including burning, grazing, crop cultivation, reforestation with exotic species, and, to a lesser extent, plant, wood and soil extraction, hunting, and tourism (Hofstede, 2001). The páramo is protected by the state and is considered under the Environmental Management Law to be a "fragile ecosystem". As such, forestry regulations and sanctions can be enforced. Additionally, there is a special regulation which clarifies the legal status and the conservation of this ecosystem (Morales, 2001).

Ecuadorian public opinion holds that forests and páramos generate water. Although this assertion could be very useful for conservation efforts, it is a gross oversimplification; further scientific studies on this theme are required. Furthermore, it has not managed to change attitudes or ensure the protection of these ecosystems. In general, legal enforcement in the country is poor and even more so in the case of environmental laws. This situation is further exacerbated by the corruption that is rife in Ecuador.

2.4 Promoting payments for environmental services

Various national, local, public and private organisations interested in improving natural resource management are advocating the valuation of the services provided by ecosystems. The Ministry of Environment and many environmental organisations are interested in valuing watershed services. National environmental policies (Basic Policies for the Environmental Strategy for Sustainable Development) define the protection of water resources and the valuation of water as key responsibilities of the Ecuadorian State.

Ecuador's second Strategy for Sustainable Forest Development relates to the valuation of native forests and plantations. The strategy aims to:

"Create and promote the legal basis and mechanisms to allow the payment for environmental services provided by forests, so that their owners will receive a monthly payment in cash for the services they render. Society demands, among other things, the protection of soils and other infrastructure, regulation of water quality and quantity, protection of the biodiversity and maintenance of the scenic beauty provided by forests. However, in Ecuador, the mechanisms to internalise the cost of these services, and directly compensate the owners of these forests, have not yet been created".

Ecuador's National Biodiversity Policy considers markets for environmental services within Ecuador's ecosystems as a means of protecting these ecosystems (Ministerio del Ambiente, 2000), and thus the strategy recommends establishment of the following:

- a payment system for the protection of mountainsides, provision of water from forests and páramo, and protection of coasts;
- payment for environmental services on public and private lands (including in the National Protected Areas System), for the provision of water for hydroelectric plants, irrigation and human use; erosion control and global climate change services (for example carbon sequestration);
- an adequate compensation system to landowners, whether individuals or communities, for the lands that generate the services;

- investment in the protection and maintenance of lands in order to ensure the continuity and quality of the environmental service;
- investment in the social development of the communities within or around the lands in question (Llaguno, 2002 p.2).

The biodiversity policy explicitly defines páramo*s,* mangroves, flood plains and forests on hillsides as the priority ecosystems for the development of these market mechanisms.

In addition to declaring environmental services as a political aim, the Ministry of Environment is attempting to institutionalise them. Thus, a corporation (CORDELIM) was created to promote and market Ecuadorian climate change mitigation projects, to be presented to the Clean Development Mechanism created by the Kyoto Protocol. The creation of a biodiversity corporation (BioE) has also been proposed and is currently under discussion. A consultancy was recently contracted to define the institutional structure required to institutionalise environmental services. No decisions have yet been made; the policy documents define environmental services vaguely and do not clearly explain the way in which water, forestry and environmental regulations could be harmonised.

Despite the lack of clarity, local initiatives are being implemented at municipal level aiming to compensate landowners for the protection of water sources. As part of this project, the project team undertook a national review and identified seven initiatives in the country that implicitly and explicitly recognise the water quality and quantity benefits provided by forests and páramos.

Before evaluating and analysing these initiatives, a basic flaw must be highlighted. As Vogel (2002) explains, paying private landowners for the water services provided by their forests contradicts current legislation. Landowners are not permitted to deforest their land, and they do not own the water that flows from their property. They cannot sell something they do not control or own. Thus, in developing payments for environmental services in Ecuador, there is a need to clarify exactly what is being bought and sold in order not to subvert the current environmental laws and further weaken the credibility of the water regime. Legislation needs to be amended to make it more coherent.

Notwithstanding the legal issues above, the fact remains that payments for watershed services are emerging. It is therefore crucial that we understand the dynamics of these systems (e.g. the drivers and how they have arisen) and their impacts, so that we can formulate appropriate responses. To evaluate and analyse the socio-economic impacts of the payments, the project team selected Pimampiro and Cuenca. Although they are in the early stages, these cases can provide lessons about how the system of direct payments can work. The following two Sections (3 and 4) describe these two cases and how they came about, and outline the key findings relating to the drivers and their impacts.

3. Pimampiro: paying landowners to protect the forest

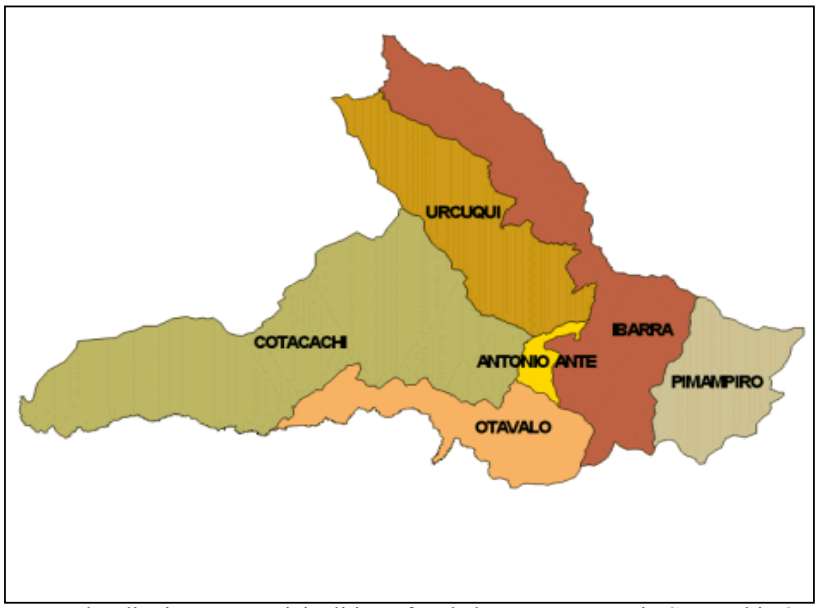
3.1 Location

San Pedro de Pimampiro is a municipality located in the north-eastern corner of the Imbabura province in Ecuador's Andean region (Figure 3.1). The province of Imbabura has an area of 4,560 km² and is located in the valley of the Chota River. The province is divided into six municipalities (Figure 3.2). The main economic sectors in the province are agricultural; principally dairy and livestock production, and bean, banana, corn and coffee cultivation.

Figure 3.1 Political map of Ecuador

Source: www.comunidadandina.org/quienes/map_ecu.htm

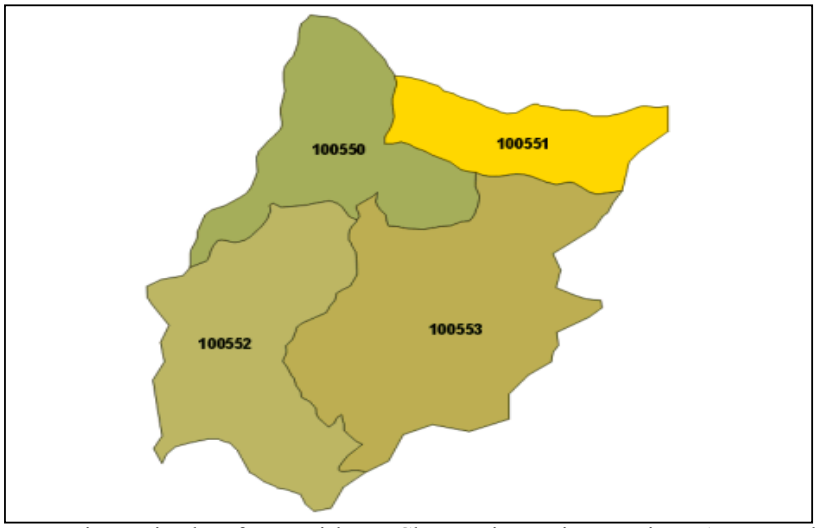
Figure 3.2 Political map of Imbabura



Note: The districts or municipalities of Imbabura are: Uruqui, Cotacachi, Otavalo, Antonio Ante, Ibarra and Pimampiro.
Source: www.ame.org.ec

The municipality of Pimampiro has four parishes: Pimampiro, Mariano Acosta, Chugá and San Francisco (Figure 3.3), and has a population of 17,285 (6,311 inhabitants reside in the urban zone while 10,974 live in the rural zone) (Municipalities of Ecuador, 2002). The municipality has a density of 39 people per km², ranging from 12 in the town of Pimampiro to 100 in San Francisco de Sigsipamba . The population has remained stable, with a growth rate of 0.17 per cent between 1982 and 1990 (EcoCiencia, 2002).

Figure 3.3 Political map of Pimampiro



Note: Pimampiro has four parishes: Chuga, Pimampiro, Mariano Acosta and San Francisco de Sigsipamba.
Source: www.ame.org.ec.

3.2 Water supply

3.2.1 Water quantity and quality

The municipality is subject to water shortages. Until 2001, domestic water users received a water service two days a week, for a period of two hours per day (CEDERENA, 2002). A quarter of the population had limited access to drinking water services (Guerrero, 2002). Water quality is also a problem as the water is affected by agriculture upstream. However, the main concern is still access, and for this reason, developing the appropriate infrastructure for increasing water flow has been a priority.

3.2.2 Vegetal cover

Pimampiro is located in the highlands at an altitude of between 1,600 and 4,000 metres above sea level. Owing to the altitudinal range, the area has four types of vegetation: lowland evergreen montane forest, cloud forest, highland evergreen montane forest, and herbaceous grassland or páramo (Sierra, 1999).

The evergreen lowland montane forest[1] covers the lowest part of Pimampiro. This forest is located between 1,300 and 1,800 metres above sea level and it extends from Colombia to the Girón-Paute valley. The highest trees in the forest reach 30 metres. In this montane forest most of the lowland tree species such as the Bombacaceae family are no longer found (Sierra, 1999).

Montane cloud forests extend from 1,800 to 3,000 metres above seal level. The tallest trees of the forest reach 25 metres and most of the trees are covered by moss. Epiphytes such as orchids, ferns and bromeliads are predominant. There is also a variety of bamboo plants in the cloud forest (Sierra, 1999).

The evergreen highland montane forest[2] of the western Andes extends from 3,000 to 3,400 metres above sea level. It contains the "Ceja Andina", which is in transition between highland montane forest and páramo. As in the montane forest, moss and epiphytes are present in the cloud forest. However, in the montane forest a dense layer of moss covers the soil and the trees grow irregularly. The trunks form branches from the base of the trees. The trees grow in a tilted, almost horizontal fashion (Sierra, 1999).

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[1] The characteristic flora of lowland evergreen montane forest are: *Anthurium ovatifolium, Anthurium spp.* (Araceae); *Ceroxylon alpinum, Socratea exhorriza* (Arecaceae); *Buddleja americana* (Budlejaceae); *Cecropia bullata, Cecropia monostachya* and *Cecropia spp*. (Cecropiaceae); *Cyathea spp* (Cyatheaceae); *Heliconia spp* (Heliconiaceae); *Hectandra membranacea* (Lauraceae); *Carapa guianensis* (Meliaceae); *Siparuna guajalitensis, Siparuna eggersii, Siparuna laurifolia, Siparuna spp.* (Monimiaceae); *Fuchsia macrostigma* (Onagraceae); *Piper spp* (Piperaceae); epiphyte species of *Ficus spp*. (Moraceae) (Sierra, 1999 pp. 82,83).

[2] The characteristic flora of the evergreen highland forest is: "*Gynoxys buxifolia* and *G. spp* (Asteraceae); *Berberis conferta* (Berberidaceae); *Tournefortia fulicinosa* (Boraginaceae); *Hedyosmum spp.* (Chloranthaceae); *Gunnera pilosa* (Gunneraceae); *Brachyotum ledifolium* (Melastomataceae); *Siphocampylus giganteus* (Campanulaceae); *Vallea stipularis* (Elaeocarpaceae); *Siparuna echinata* (Monimiaceae); *Myrcianthes rhopaloides* and *M. spp.* (Myrtaceae); *Piper spp.* (Piperaceae), *Hesperomeles lanuginosa* (Rosaceae); *Cervantesia tomentosa* (Santalaceae); *Freziera verrucosa, F. canescens y F. spp* (Theaceae). At higher altitudes, in the "Ceja Andina" (according to Diels 1937) shrubs are more common (for example, *Hypericum laricifolium*, *Brachyotum ledifolium*, *Lupinus spp.*), but there is an occasional presence of *Buddleja incana* (Budlejaceae), and *Miconia spp.* (Melastomataceae), and other species" (Sierra, 1999 pp.85).

All of these cloud and montane forests are part of the tropical montane cloud forest, and are characterised by the presence of clouds, low temperatures and humidity, which are important factors with regard to hydrological functions, in particular, increased surface runoff during the dry season, as discussed in Section 1.

The herbaceous páramo[3] is located between 3,400 and 4,000 metres above sea level. In its lower part lies the "Ceja Andina" and deforested fields for crop cultivation. The plants that dominate the páramo have crests and plumes, such as those of the genus *Calamagrostis* and *Festuca*. These plants are interspersed with small shrubs and other vegetation. Some species grow only in the páramo of the northern Andes, such as *Calamagrostis effusa* (Sierra 1999).

3.2.3 Hydrology

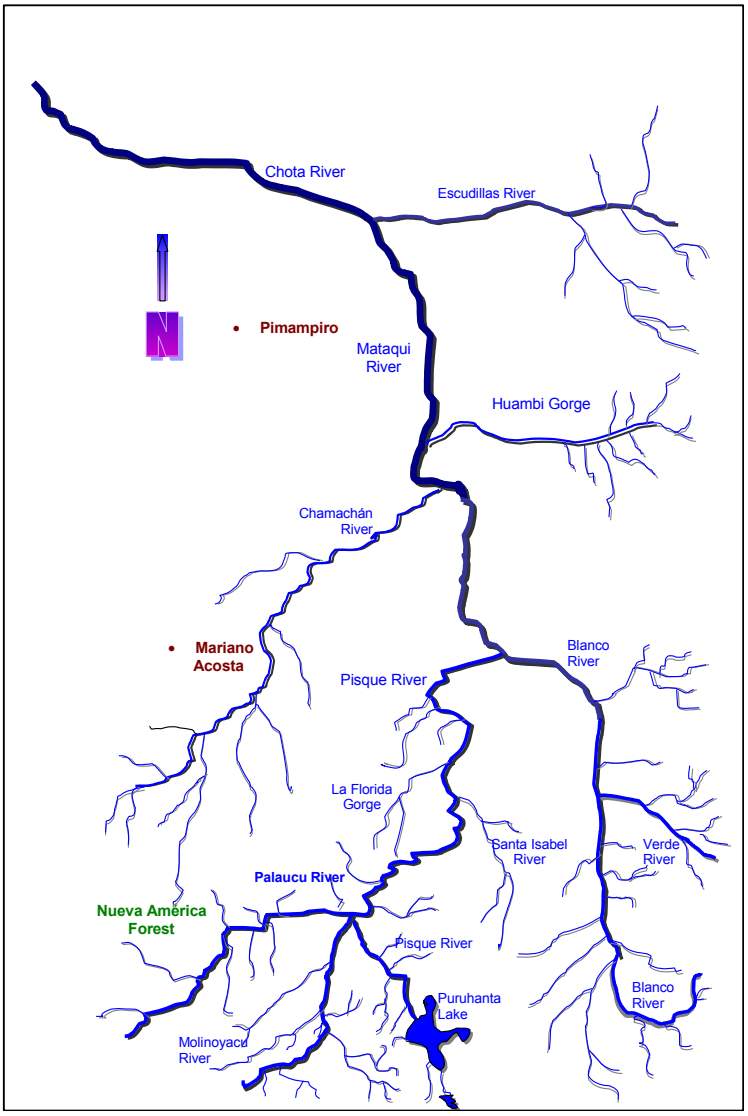
One of the largest rivers in the province of Imbabura is the Chota. This river forms the northern boundary between the province of Imbabura and the northern province of Carchi. It changes its name to river Mira when it passes Ibarra, the capital of Imbabura, and flows into the Pacific Ocean in Colombia. The Chota has four tributaries: the Escudillas, the Chamachán, the Blanco and the Pisque. The Pisque, in turn, has three tributaries: the Palaurco (also known as the Palaucu), the Molinoyacu and the Pisque (Figure3.4).

The town of Pimampiro is located on the river Pisque watershed, specifically in the Palaurco sub-watershed. Water from the Palaurco is used for irrigation and consumption in Pimampiro. The headwaters are in the Páramos de Angococha (IGM, 1990). Annual precipitation in the area is estimated to be 850 mm per year (Lascano, 2002).

Despite the lack of hydrological information, the common perception is that the forests ensure water supply, particularly during the dry season, and water quality, since the trees can prevent erosion.

[3] The characteristic flora of the páramo are: *Calamagrostis effusa, C. spp., Festuca spp*. (Poaceae); *Hypochaeris spp., Baccharis spp, Chuquiragua jussieui, Oritrophium peruvianum* (Asteraceae); *Gentiana sedifolia, Gentianella selaginifolia, G. cerastioides, Halenia spp.* (Gentianaceae); *Geranium sericeum, G. ecuadorense* (Geraniaceae); *Huperzia talpiphila* (Lycopodiaceae); *Lupinus smithianus, Lupinus spp*. (Fabaceae*); Ranunculus guzmanii, Ranunculus spp.* (Ranunculaceae); *Castilleja spp*. (Scrophulariaceae); *Valeriana rigida y V. spp* (Valerianaceae)" (Sierra 1999 pp.87).

Figure 3.4 Map of the Chota (or Mira) watershed



Notes: Chota River has four main tributaries: Escudillas, Chamachan, Pisque and Blanco. Data is not to scale. (Fernanda Meneses 2002).

3.2.4 The sellers: Nueva América Association

The Nueva América Autonomous Association for Agriculture and Livestock is located 32 kilometres south of the city of Pimampiro upstream, in the parish of Mariano Acosta and within the Palaurco watershed. It was created in 1985 with the aim of formalising the group's tenure of 502 hectares of land (Cayambe, July 2002). Between 1989 and 1997, the Association paid for a total of 638 hectares.[4] In 1991 the Ministry of Agriculture built the road that allows access to the Association's lands. The Association was originally formed of 40 members but some of them sold the land to other members of the association. At present the Nueva América Association has 24 members, of whom 20 are receiving payments for environmental services. All the members have individual title to their land. According to the

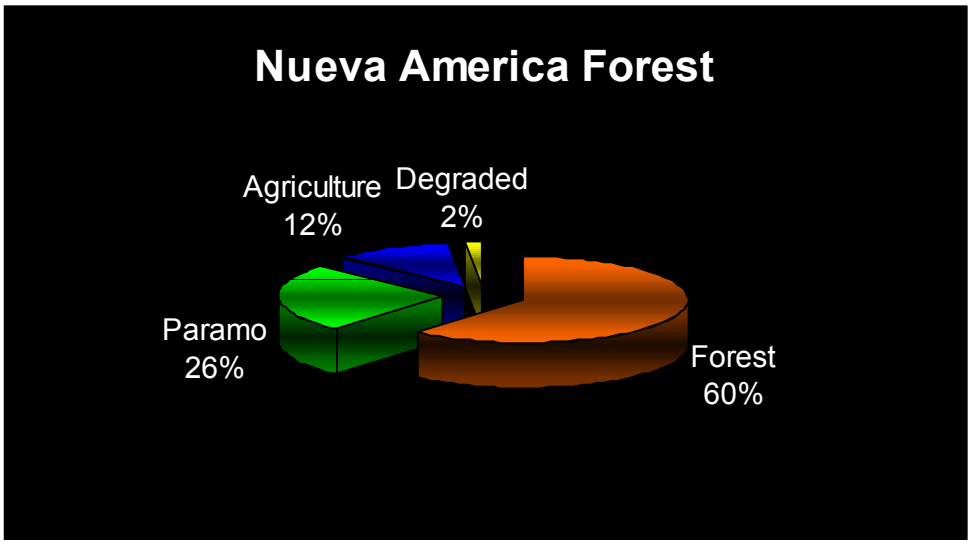
[4] These are approximate figures since there are discrepancies between the property titles, Cederena's evaluation and the national land institution (INDA).

11 members consulted, the size of properties varies from 12 to 119 hectares, with an average of 43 hectares per member.

Most of the members of the Association describe themselves as "colonos" which means that they have recently settled in that area. They are mestizos of Indian descent. There is an average of six children per family. Only four families of the Association live permanently in the forest, while the rest live in different settlements in the lowlands (such as Rumipamba and Mariano Acosta). The Association's land has no electricity supply or sewerage service, and drinking water is collected from a nearby stream. The children attend school in the nearby Mariano Acosta parish. The main source of energy for cooking is fuelwood.

The main economic activities of the families are agriculture and livestock production. Other sources of income are animal raising, wood extraction, and planting and harvesting crops on lowland farms. The latter activity pays US$2 to US$3 per day per person (Cayambe, 2002). Young adults work in larger cities like Ibarra or Quito (the capital of Ecuador), to help their families in Pimampiro. Most of the men in the Association completed third grade of school, while 30 per cent of the adult women are illiterate (CEDERENA, 2002).

Figure 3.5 Forest area in Nueva America



Notes: Nueva America owns 638 hectares, of which 60 per cent is forest, 26 per cent is páramo, 12 per cent is land for agriculture and 2 per cent is degraded land.
Source: CEDERENA 2002.

Of the 638 hectares the Nueva América Association owns, 390 hectares are forest, 163.3 hectares are páramo, 74.9 hectares are dedicated to agriculture and livestock, and the remaining 9.8 hectares are degraded land (3.5) (CEDERENA, 2002). The areas dedicated to agriculture and livestock have potato, beans and pasture crops and to a lesser extent local Andean vegetables (*melloco and ocas)* (CEDERENA, 2002). It is important to note that the community bought the land as a unit, and over time it has opened it up for agricultural production, moving from a communal title to individual plots.

Figure 3.6 Upper parts of the watershed: Nueva América

Photo: Ina T Porras

The forest is located in the buffer zone of the Cayambe Coca Ecological Reserve (RECAY), between 2,900 and 3,950 metres above sea level (CEDERENA, 2002). As mentioned previously, the forest is composed of páramo and evergreen montane forest. Forty-three per cent of the area is primary forest[5] and the remaining 57 per cent of the area is secondary forest, as the presence of the bamboo species "surro'' of the genus *Chusquea* indicates (CEDERENA. 2002). A part of this secondary forest has not been touched for approximately ten years.[6]

The Nueva America forest contains "sigse" *(Cortaderia nitida),* "surros" *(Chusquea* spp.*)* and Rosaceae (*Lachemilla orbiculata)*. The first two species are good indicators of water presence, and the third one grows in areas that have been under intensive pasture (Mena Vasconez and Medina, 2001). This indicates that even though the area has been affected by human activities, the forest still maintains its capacity to retain water.

The páramo appeared to have been well conserved. Three different genus of grasses or "paja", *Stipa*, *Calamagrostris* and *Festuca* predominate. The existence of certain species of flora and fauna, like the Andean or spectacled bear (*Tremarctos ornatus)* reflect the good

[5] Primary forest is characterized by tree species like "matache" (*Weimania pinnata*), "amarillo" (*Miconia sp*), "manzano" (*Rannhus sp*), "borracho" (*Hedyosmum sp*), "tupial" (*Myrsine dependenz*), "hoja blanca" (*Polymnia pyramidalis*), "puchinche" (*Cletra fimbriata*), "pumamaqui" (*Oreopanax sp*) and "aliso" (*Alnus acuminata*). The forest also has bromeliads, lichens, orchids and ferns (CEDERENA 2002).

[6] Secondary forest has tree species like "aliso" (*Alnus acuminata*) and "hoja blanca" (*Polymnia pyramidalis)*. The younger secondary forest has not been touched for about four years and has plant species like "hoja blanca" (*Polymnia pyramidalis*), "motilon", "cola de caballo" and "ortiga".

condition of the land. Other páramo plants are "echol" (*Gaiadendrum punctatum*) and "piñuela" (*Puya sp*). Access to this area is difficult and this is one of the reasons for the limited human presence in the area.

There are also areas of steep escarpments containing small, dense forest surrounded by tall coarse grass. Years ago, this páramo was forest, but the use of slash-and-burn practices for agricultural production transformed the original vegetation. This is why small patches of forest can be seen in the grasslands of Nueva América. These remnants of the original forest on the high slopes are viable for conservation since they are not suitable for pasture or agriculture.

This area has faced strong deforestation pressure for timber extraction, agriculture and cattle raising. The construction of a highway ten years ago also increased the rate of deforestation by facilitating the transportation of timber (CEDERENA, 2002). In 1985, Pimampiro had 19,000 hectares of primary forest. Today there are less than 7,000 hectares (Municipalidad de Pimampiro, 2002). However, there is no agreement as to the accuracy of these figures. According to a CEDERENA employee, around 40 hectares have been deforested within a monitored area of 550 hectares since 1986 (Silvia Ortega, 21 November 2002). This implies a lower rate of deforestation than that mentioned above. In general, the hydrological impacts anticipated because of land use change have not been measured or studied.

3.3 Water demand

The two main water consumers in the area are households, for domestic use, and farmers, for irrigation.

3.3.1 Drinking water

The Pimampiro water treatment plant started functioning in April 2001, funded by a loan from the State Bank. Before the plant came into existence, Pimampiro obtained its water from the Puetaquí canal, which is part of the Chamachán sub-watershed. This water was not treated, except for the addition of chlorine. Consequently, the service was deficient both in quantity (only two hours of water supply, twice a week) and in quality (the manual chlorination system). There are no statistics to illustrate these conditions.

The new plant is located 7 km from the town and has the capacity to treat 50 litres per second (l/s). Currently, the plant operates at 24 per cent of capacity, with an average flow of 12 litres per second. The two main sources of water for the plant are the Puetaqui stream (4 l/s) and the Del Pueblo irrigation canal (8 l/s), which comes from the Chamachán, a neighbouring watershed to the Pisque.

To fully satisfy the town's demand the system must increase flow to 20 l/s (Paspuel, 2002). No information on the distribution of the service was found.

A new 1 km tunnel which is being built (Nueva America Project) will add 60 l/s to the system, 20 l/s for the town of Pimampiro and the remaining 40 l/s for irrigation. This tunnel was due to be completed in 2003 and was funded by the provincial government.

3.3.2 Irrigation

Approximately 500 hectares are being irrigated from Del Pueblo[7] canal, is a 16-kilometre ditch which was built in colonial times. The water comes from a small stream called Tigre Rumi at an altitude of 3,030 metres in the parish of Mariano Acosta. There is a flow of 140 l/s which supplies water to the 375 families that hold water concessions granted by the water agency. The biggest consumer is Hacienda Jesús Miranda, which has an area of 400 hectares and has 25 per cent of the concessions, then after diverting to the city's water treatment plant, the farms in the lower part of the canal in Pimampiro, which hold 50 per cent of the concessions, are irrigated, followed by Santa Rosa, which holds 25 per cent of the concessions. It is estimated that the potential area to be irrigated is 1,500 hectares, which would require an additional flow of 248 l/s. The maximum capacity of the canal is 400 l/s (Lascano, 2002).

3.3.3 The buyers: the residents of Pimampiro

The city of Pimampiro consumes 12 l/s of water and 1,350 households have water meters (CEDERENA, 2002). The residential tariff was initially US$0.80 for 17 cubic metres of potable water (Paspuel, 2002). The tariff paid by industries or commercial establishments for the same volume of water was US$1.80. The tariffs were raised in 2001 to US$0.96 and US$2.16 respectively. Residents accepted the 20 per cent tariff increase because it coincided with the construction of the new plant, which improved the service considerably. Of the 36 people consulted, only six were not satisfied with the water service.

The total variable cost of water treatment in the plant, including labour costs, chemical agents and spare parts is US$0.21/m³ (Paspuel, 2002). Because of the system's inefficiency, only 60% of the water billed is collected, which means that the municipality is heavily subsidising the service. However, 35 of the 36 people consulted agreed that it was important to protect the watershed.

3.4 Linking supply and demand

3.4.1 The payment mechanism

This section describes the fund that was created to ensure that payments by domestic users are channelled to those people investing in the continued supply of water by maintaining forest cover.

The actors

This initiative has involved many actors, including:

- DFC, an FAO-funded project for community forest management,
- Cederena, an NGO which evolved from DFC

[7] The canal is managed by a board and the administrator has to establish an annual operating budget, on which the tariffs are based. It is interesting to note that the tariff is paid not by volume but by time. The current fee is US$3.80 per hour. There are sanctions ranging from US$0.50 to US$2.00 for unauthorized water collection. If a violation is repeated, the service can be cancelled indefinitely. As up to 50 per cent of the users are late in paying, the new rules establish that interest is to be charged or that the service is to be suspended until payment is made (Lascano 2002).

- The Inter-American Foundation, a US donor
- The municipality of Pimampiro

In 1994 DFC[8] worked with the Nueva América Association to develop a forest management plan for their land. The plan identified priority management activities such as agroforestry, soil management, selective exploitation and enrichment planting. In 1996 additional activities were established, such as commercial orchid cultivation, medicinal plant collection, soil conservation, environmental education, natural regeneration, and "aliso" (*Alnus acuminata)* management (CEDERENA, 2002). The development of a forest management plan helped the families of the Association obtain the titles to their land. From 1997 to 1999 DFC reduced their presence in the area, but continued its support to the municipality with the creation of UMAT (the Environment and Tourism Unit), which will be discussed later.

In 1997 several DFC technicians founded CEDERENA (the Ecological Corporation for the Development of Renewable Natural Resources) as a national non-profit organisation to facilitate community management of natural resources, local development, environmental services and institutional development (Yaguache, 2002). In 1999 CEDERENA continued with the work that DFC had started, opening offices where the DFC had worked in Quito, Ibarra, Pimampiro, Santo Domingo, Riobamba and Cuenca. The CEDERENA office in Pimampiro now has one coordinator, one administrator and four other employees. CEDERENA works on developing suitable forest management plans for the Nueva América Association and other communities.

The role of the municipality and the Environment and Tourism Unit

In accordance with Article 233 of the constitution Ecuador is undergoing an extensive decentralisation process (EcoCiencia and CEDA, 2001). A decentralisation and social participation law was passed in 1997 to promote local government action. It mandated municipalities to preserve and defend the environment by requiring environmental impact assessment studies and promoting local management of protected areas. This has made municipalities focus on environmental issues and develop the institutional and budgetary arrangements to do so.

The challenge that this legislation presented, coupled with the municipality's water shortage, led to the creation in 1998 of the Environment and Tourism Unit (UMAT) within the town's governance structure. The former mayor of Pimampiro, Edwin Lora, created the unit by ordinance (based on a study by DFC), in order to implement the municipality's

[8] The *Desarrollo Forestal Comunitario* (DFC) is a project within the Forest Action Plan for Ecuador (PAFE) implemented by the Food and Agriculture Organization (FAO). The DFC is part of the Participatory Forest Development Project in the Andes, started in 1989 with the aim of documenting social, economic, environmental and technological impacts of forestry experiences for communities in Bolivia, Colombia, Chile, Ecuador and Peru (DFC, 2002). In Ecuador, DFC has been working since 1993 in nine out of ten provinces in Ecuador's highlands. DFC has developed methodologies for natural resource management with a focus on participatory forest development, providing training and empowerment to indigenous communities and small farmers to carry out their own community forest plans (DFC 2002). The object is to improve the quality of life of the highland communities in Ecuador. In the province of Imbabura, DFC currently works with 20 small farming communities as part of a consortium of institutions. The institutions include CEDERENA, the municipality of Pimampiro, and the Red MACRENA (an NGO with a network of ex-DFC technicians for training in natural resources management), and they receive funding from the Inter-American Foundation (IAF), FAO and the Netherlands Government (Yaguache s/d).

environmental strategy. The strategy consists in an 11-point mandate covering four main programmes:

- pollution control activities
- environmental education
- ecotourism
- watershed management

UMAT is developing activities for watershed protection (including páramo and forest protection), irrigation and drinking water projects (Municipalidad de Pimampiro, 2001).

In 1999, CEDERENA signed an agreement with the municipality of Pimampiro to work on the project Sustainable Management of Pimampiro's Renewable Natural Resources for the Maintenance of Water Quantity and Quality. This project which was designed by CEDERENA and financed by the Inter-American Foundation (IAF)[9] (CEDERENA, 2002) and had two main objectives:

- natural resource conservation in Pimampiro
- strengthening Pimampiro's Environment and Tourism Unit (UMAT)

CEDERENA received $US326,200 from IAF for three years to implement a project to counteract environmental degradation and to help 450 small farmers in the application of soil conservation, organic farming, watershed recovery and sustainable forest management techniques (Inter-American Foundation, 2002).

As part of this project, and in particular the forest management plan in Nueva América, the UMAT implemented an environmental payment system in order to create incentives for the people who conserve the forest, and to penalise those who do not (CEDERENA et al. 2001). With the participation of the municipality and CEDERENA, the Nueva América Association reorganised their management plan into five programmes, which included an Environmental Service Programme, which has four projects: 1) Maintenance of forest capacity to regulate water quality and quantity; 2) Carbon sequestration; 3) Ecotourism; and 4) Biodiversity protection (CEDERENA, 2002).

This payment system is considered a pilot experience and thus was only implemented for Nueva America. However, DFC and CEDERENA have worked in other areas that could be potential beneficiaries of the payment mechanism.

The City Ordinance and creation of the fund

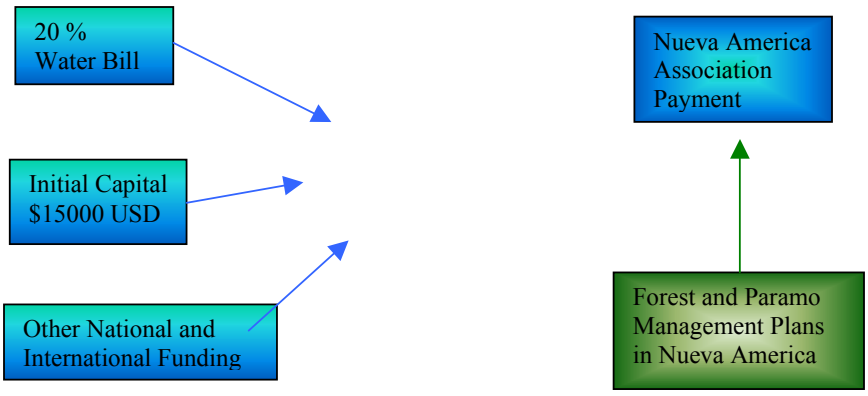
The municipality of San Pedro de Pimampiro considered the forest and páramo ecosystems of Nueva América important for the maintenance of water quality and quantity, and thus began the pilot experience. In the beginning of 2001, the municipality approved a new ordinance[10],

[9] The Inter-American Foundation is a United States Government foreign assistance agency. It works to promote equitable, responsive and participatory self-help development in Latin America and the Caribbean (Inter-American Foundation 2002).

[10] The ordinance by which the fund was established has 13 articles and covers the following issues: an introduction, the activities and rationale for the creation the fund, fund financing and management, ecosystem categories, payment candidates, and sanctions.

which established a Water Regulation for the Payment of Environmental Services for Forest and Páramo Conservation (CEDERENA, 2001). This became part of the UMAT's responsibilities.

Figure 3.7 Financing and payments of the fund



Source: CEDERENA 2002

The fund was created with an initial investment of US$15,000, of which US$10,000 came from the IAF (via CEDERENA) and the remaining US$5,000 came from the DFC Project. The fund also receives the 20 per cent increase on the drinking water tariff, which was calculated to amount to US$500 a month (Figure 3.7). The resources are managed in an account with the National Development Bank. Given that only 60% of the water billed is actually paid for, the municipality does not always manage to supply the agreed amount of money to the fund.

The committee that manages the fund is composed of the following representatives: the Mayor of Pimampiro, the municipality's Financial Director, the Director of the UMAT, the President of the municipality's Environmental Commission, and a representative of CEDERENA (Municipalidad de Pimampiro, 2002). Although the rules governing the Committee were are not formally approved at the time of writing, they include the following responsibilities:

- fund management;
- authorisation of quarterly payments based on UMAT's inspections;
- analysis of agreements with landowners and determining sanctions in the case of violations;
- analysis and approval of payment increases;
- approval of the incorporation of new beneficiaries;
- proposing of strategies for fund's sustainability;
- evaluation and control of the fund´s development.

The committee determines the amount to be paid to each family that owns lands in Nueva America, after verifying the property titles, measuring the holdings and inspecting the condition of the land.

Payment categories

CEDERENA classifies the land according to categories and measures each area. Monthly payments are determined based on the available resources, as shown in the table below.

Table 3.1 Payments by category

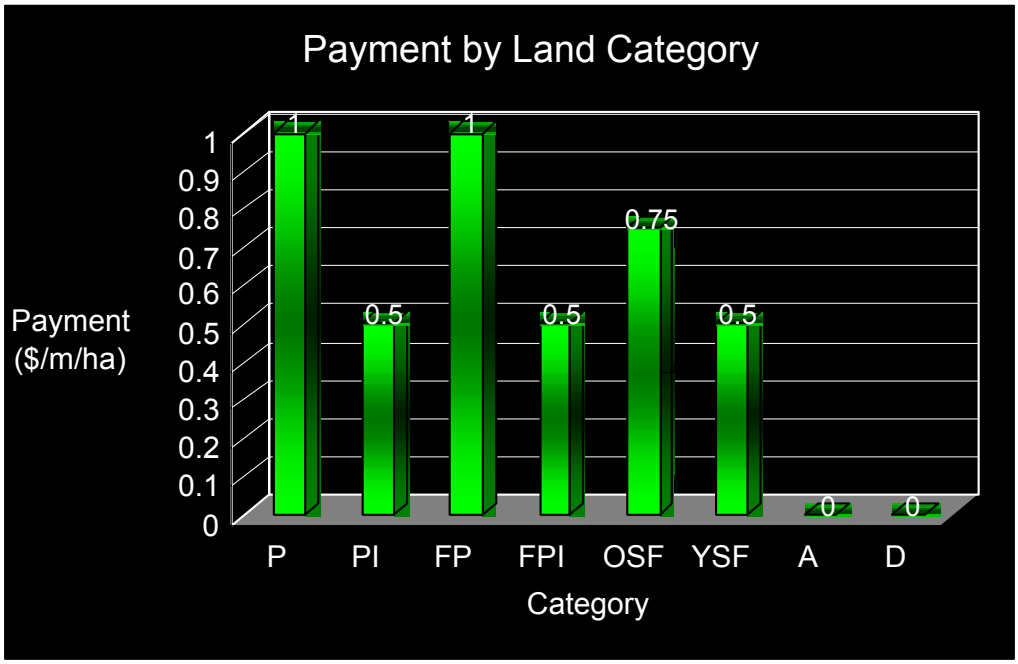
Abbreviation	Payment categories	Payment ($/month/ha)
P	Páramo where no human activity has taken place	1.00
PI	Páramo where human activity has taken place	0.50
FP	Primary forest	1.00
FPI	Primary forest where human activity has taken place	0.50
OSF	Mature secondary forest	0.75
YSF	Young secondary forest	0.50
A	Agriculture and livestock	0
D	Degraded land	0

These payments are a result of political negotiation rather than a technical analysis of the hydrology, water valuation, or the financial planning of the fund. CEDERENA initially proposed an increase in the water tariff of 40 per cent but the city council only approved a 20 per cent increase. However, these figures are considered to be only a start, and the tariffs may increase in the future as the market for watershed services develops and more resources are generated.

To receive payment, each member of the Nueva América Association must sign an agreement with the municipality of Pimampiro (CEDERENA, 2002). The agreement stipulates which areas are covered and determines payments in accordance with current land use, and establishes a land management plan for the property (this requirement has not been fulfilled).

Landowners who violate the forest conservation agreement after signing up to it have their payments suspended for one quarter. If the violation is repeated, the suspension lasts for two quarters, and if one more violation is committed, the participant is excluded from the payment system. UMAT has been reporting violations to the Ministry of Environment so that sanctions are imposed in accordance with the Forest Law. In the case of páramo, the law is more ambiguous (CEDERENA 2002).

Figure 3.8 Payment by land category



Notes: Landowners will be paid according to the vegetal cover of the land. The categories are paramo P, paramo with human activity PI, primary forest FP, primary forest with human activity FPI, old secondary forest OSF, young secondary forest YSF, agriculture A and degraded D. *Source*: CEDERENA 2002.

3.4.2 Drivers

The Pimampiro initiative appears to have been driven by supply and demand considerations. On the one hand, the DFC experience with landowners highlighted the importance of creating incentives to improve natural resource management. On the other hand, the town has been subject to serious water shortages, so decision-makers were concerned about protection of the water sources. In particular, the former mayor appears to have been an important promoter of UMAT and provided the leadership to mobilise the payment concept.

3.4.3 Payments to date

Payments began to be made in January 2001. They are made on a quarterly basis. The committee chooses four families at random and technicians from UMAT, CEDERENA and the municipality evaluate the condition of their land. The technicians write a report which is assessed by the committee before payment is made. The table below shows the payments effected to date.

Table 3.2 Payments made

Quarter	Total paid (US$)	Number of families with agreement	Observations
January – March 2001	1,067.70	27	
April – June 2001	1,100.19	27	3 violations prompted removal from system
July – September 2001	1,099.17	24	4 violations prompted removal from system
October – December 2001	952.02	22	2 families reinstated
TOTAL 2001	4,219.08		
January – March 2002	974.82	16	1 reinstated
April – June 2002	848,46	15	1 violation
July – September 2002	827.78	15	

Source: For 2001, CEDERENA 2002, for 2002, Municipality of Pimampiro.

3.4.4 Penalty system

The municipality of Pimampiro and CEDERENA have yet to develop a structured penalty system but are 'learning by doing'. Penalties have been imposed ranging from the cancellation of payments for one month to a total exclusion from the system. In the two years that the system has been in place, it is evident that sanctions are required. The most common violations are:

- Slash-and-burn practices. This has prompted immediate removal from the list of beneficiaries and action by the Ministry of Environment to impose penalties.
- Unauthorised selective timber extraction.
- Soil and undergrowth extraction.

3.5 Impact assessment

As stated previously, assessing socio-economic impacts is a difficult task. This is particularly so in rural communities, where there are often logistical problems. The task of conducting interviews with the Nueva America landowners in Pimampiro was not easy. After five separate visits by different organisations to Nueva America, 11 landowners were finally consulted, of a total of 24 association members of whom 20 who participate in the payment system. This difficulty may have been due to survey fatigue, since other studies have been carried out there recently, or because of incentives issue, as discussed below.

The small sample size does have the advantage of confidentiality. As not everybody participated, no one can assume what other people said. The sample indicates that there is a particular generational point of view. The average landowner is 51 years old.

The results of the consultation can be seen in Annex 1. The median holding size is 42 hectares. The level of education is low, with the highest grade of education attained being 6th grade, and seven of the 11 respondents reading a newspaper only once a year. All except one of the respondents live in the middle part of the watershed and move to the upper part, where the forest is located, whenever there are difficulties where they live, such as a bad harvest.

3.5.1 Social impacts

In situations where compensation is being discussed, it is difficult to ensure "honest" responses from those consulted. People often answer strategically to maximise their benefits. The average payments received were US$21.1 per month, which is less than half of the family's income. Monthly expenditure on food, medicines and schooling totalled an average of US$60.8. Therefore, the payments do appear to supplement the family income. It is worth highlighting that the legal minimum wage in Ecuador is US$114 per month. However, nine of the 11 consulted were motivated by the payments to conserve, five of them indicating that they were "somewhat" motivated.

Measuring issues of welfare (such as income, consumption, and well-being) effectively is difficult and can become speculative. Respondents indicated that the last payment was used for food and gas, while the next month's payment would be used for education. This response was influenced by the time at which the consultation took place, ie, near the beginning of the school year. Although it is impossible to verify effectively what the resources are used for, it appears that the payments are used to fulfil the families' short-term needs.

An interesting fact to bear in mind is that only one of the 11 respondents indicated that they cooked with gas. This is likely to be the person who lives in town. From discussing the issue with the CEDERENA staff, it appears that there is a cultural preference for cooking with firewood despite having to go out and fetch wood every day, and having to go a little further to fetch it each time. There is still a preference for the flavour that the firewood gives to the food and there is also the social significance of sitting around the stove in the family kitchen. Moreover, gas has to be paid for while firewood is still considered to be free. This is a challenging situation given that the need for firewood may be an added pressure on the forest. However, most families do have stoves and they use gas for heating things.

The average compensation received ranged from US$0.10 to US$1.00 per hectare. These variations are the result of differing information used to calculate payments (GPS measurements differ from those in the land titles) and of the difficulty in understanding the value of money, since the dollarisation of Ecuador's economy.

Meanwhile, the average amount suggested as a fair payment to protect the watershed was US$1-10 per hectare. For the citizens of Pimampiro, the majority (35 out of 36) agreed that it was necessary to protect the forest in order to guarantee water provision, and over half (22 out of 36) were willing to pay more for it. They considered US$3.70 per hectare to be a fair level of compensation to the landowners.

Therefore, the payment does not seem to meet expectations. However, following discussion with representatives of the municipality and CEDERENA, it was suggested that the participants were "never satisfied and always expected more". For example, when the system was being established, the Association wanted to be paid according to land values. The mayor

suggested that the situation had become unmanageable as landowners could "extort" payment from the municipality threatening to deforest if they were not paid (Lora 2002).

On the question of whether water is a right or a good, respondents from Nueva America seemed wary in answering – eight of the11 did not respond to the initial question of whether people have a right to water. On further clarification of the concept, the interviewer perceived that the cautious responses were because they thought that their answers might affect their level of compensation.

The payment does seem to improve awareness of environmental regulations. Nueva America respondents were conscious of the legal restrictions on deforestation. On the question regarding the use of the payments, 8 of the 11 responded that they were not able to change the land use. Only two of the 11 considered that the payments did not encourage conservation. This response contrasts to the answer of those consulted in Pimampiro where 18 of the 36 consulted stated that landowners could clear the land if they were not paid.

This awareness was also illustrated by the responses about having interest in alternative activities (seven were interested in medicinal plants, ten in ecotourism, five in sustainable agriculture), though their involvement in CEDERENA activities was not verified. Ecotourism seemed of greatest interest - ten of the 11 expressed interest. Yet, from the answer to the question of whether the payments encouraged participation in more sustainable activities, seven of the 11 claimed it did not. From discussions with CEDERENA, it appears that the move towards a more conservation-minded attitude is slow to take off. People still hope to be able to change their land use in the future.

The payment system does not seem to have strengthened the level of organisation; nine of the 11 respondents indicated that the Association is less organised than before the payment system was established. CEDERENA believes that this is a characteristic of this community in general which was not very well organised to begin with. Moreover, the change from communal ownership of the land to individual titles weakened the role of the Association. Yet, one of the benefits of the payment systems should be the strengthening of social organisation. Formerly, the group united to address land tenure issues, now there is an opportunity to unite to achieve common conservation goals, such as ecotourism.

There does not appear to be resentment or conflict among the Nueva America members, nor with the downstream users in Pimampiro. The consultation demonstrated that the creation of the fund and the increase in the tariff had not been well explained to the community.

3.5.2 Transaction costs

The development of any market or payment systems implies costs, be they for labour, infrastructure, research, etc. Thus, it is important to understand these costs in order to ensure the economic, political and social viability of the mechanism.

It is difficult to assess the transaction costs of the Pimampiro case. In addition to the sensitivity of this information, the fact that it is the first experience of its kind in the country has meant that other programmes or projects have heavily subsidised the process, and there are therefore hidden costs. The creation of the municipality's environmental unit was important for the payment mechanism, but it also provides additional benefits.

For the sake of discussion, we estimate the costs of the main components of the Pimampiro payment system as follows:

Table 3.3 Estimated costs of the Pimampiro payment system

COMPONENT	TIME	COST $	SPONSOR
Forest Management Plan	1996-2000 3 years		DFC, FAO, Cederena
IAF Project with Cederena, including: studies undertaken by Wilson (2001) and Lascano (2002)	3 years	30,000	10% of the project
Development of system: Collect information, Organise actors, Set prices, Negotiation, Organise payments	1 year: 1 month 1 month 1 month 1 month 1 months		Cederena Cederena -UMAT
Development of municipal ordinance	3 months		DFC, FAO, Cederena, UMAT, Tax Office
Seed money for the fund		15,000	IAF, DFC and users
Improvements in water infrastructure			Church, Provincial Council, BEDE loan
Administration of the system			UMAT, Cederena
Administrative costs for payments			Bank and municipality
TOTAL		> 45,000	

UMAT is responsible for monitoring the system, imposing penalties, collecting payments, and negotiating contracts.

It can be assumed that the transaction costs for the development of these mechanisms are high. A conservative estimate would be a cost of three times the amount paid in the first year of the payments, assuming an annual cost of $15,000.

3.5.3 Sustainability of the fund

Pagiola et al. (2002) describe the sustainability of a market mechanism as being dependent on a combination of demand, capacity to supply, and the institutional structure to maintain it. At present CEDERENA is working on a strategy to address supply and demand. The strategy aims to cover the costs of technical assistance and monitoring, activities which are currently subsidised by the CEDERENA project. The idea is to have an institutional arrangement where UMAT can regulate and control the payment system but an independent organisation is in charge of monitoring (Yaguache, 2002).

As part of this strategy, several valuation studies have been undertaken, including one quantifying the opportunity costs of habitat conservation (Wilson, 2001) and one estimating the total value of the water from the Del Pueblo irrigation canal (Lascano, 2002). According to Lascano (2002), the monthly collection of the 20 per cent tax ($US199.64) does not cover the payments, which amount to US$454.72. In order to protect all the water sources, an area of 4,200 hectares, the payments would have to increase to approximately US$4,000 per month. Therefore, the inclusion of the irrigation systems is vital to expand the demand for the service. However, no action has been taken to involve irrigation, and substantial lobbying

may be required in order to do so. One of the recommendations arising from this study is the possibility of involving agricultural producers through a property tax, which would also be collected by the municipality. Since the water tariffs are overseen by a different government body, the application of a tax or incentive based on water consumption could be interesting. However, the economic and political viability of this idea still needs to be assessed.

A significant gap that needs to be addressed in this area is the lack of hydrological data to demonstrate the link with the forest cover.

In addition, the institutional viability of the mechanism is not clear. The IAF funding is coming to an end and there seems to be no clear explanation about what will happen with the payment scheme. The municipality is looking for another partner such as Cederena. Cederena would like to develop a project that would create a more participatory institutional structure which would include other actors in addition to the municipality.

3.5.4 Recommendations

The following recommendations came out of Joseph Vogel´s economic analysis:

1. Change the title from "Payment for environmental services" to "Payment for protection of environmental services", and launch an educational campaign.

2. Raise $3,456 by setting progressive water tariffs, exempting the first 0-17 m^3 per month.

3. Raise $60,544 by liaising with the water boards to increase the water rates for irrigation. If the water boards are not agreeable, the municipality could levy an agricultural tax based on the volume of water used.

4. Prioritise areas to be protected according to the level of water produced. A hydrologist with experience in the region should be consulted.

5. Integrate into a Geographical Information System (GIS):
- costs of protection by habitat type and its situation with respect to the "edge effect";
- the hydrological productivity of each type of habitat;
- land titles in the watershed

6. Solicit funds from past international donors to refine the payment mechanism and to and extend the "payments for protection of environmental services" system to other landowners in the watershed.

7. The 27 families in Nueva America currently receiving "payments for environmental services" should continue to receive payments that are at least equivalent to those they received under the pilot scheme.

These recommendations were presented to the city council in November 2002.

4 Integrated water resources management in Cuenca

4.1 Background

Cuenca is located in the southern part of the Ecuadorian Andes. As Ecuador's third most populous city, it has a large industrial sector. Agricultural and livestock activities are important in the both the temperate and subtropical ecological zones surrounding the city (Wunder, 2000).

Cuenca's social and economic indicators are better than the national average. "Cuencanos" are noted for being dynamic and independent. The area has been affected by mass emigration of its inhabitants to the United States and Europe in search of work. Although this provides substantial income from remittances, it also aggravates social problems.

The city's population was reported to be approximately 277,000 in 2001 and the population of the entire municipality was 428,000 (both urban and rural communities) (INEC, 2002). Although 98 per cent of the city's population has access to drinking water, the municipality has become concerned about the future supply of water and the possibility that water quality and quantitiy will deteriorate in the long term. Thus, efforts have been made to prevent this. The local government utility that manages telecommunications, drinking water, sewerage and wastewater treatment (ETAPA) is considered exemplary within the region and the country because of its efforts to manage water resources in an integrated fashion.

4.2 Water supply

The city of Cuenca has four main watersheds: Machángara, Tarqui, Yanuncay and Tomebamba. These four rivers flow into the river Cuenca.

4.2.1 Vegetal cover

The southern Andes are geologically older than the northern Andes and do not have active volcanoes. The mountains tend to be lower than those of the northern Andes, so plant species are different from those in the north. In general, the land cover is categorised as humid montane thicket, dry montane, montane cloud forest, and herbaceous grasslands (Sierra, 1999).

Humid montane thicket covers all of the inter-Andean valleys located at altitudes of between 2,000 and 3,000 metres above sea level. Most of the original vegetation has been destroyed and has been replaced by crops and eucalyptus forest (*Eucalyptus globulus*). The remnants of the original vegetation are located on steep slopes (Sierra, 1999). The original species of thicket nourished the soil and generated humus while the introduced eucalyptus species dries the land and prevents other plants from growing.

The montane cloud forest is located between 1,500 and 2,900 above sea level. Most of the trees in the forest are covered with moss and there is a wide variety of epiphyte plants such as bromeliads, orchids and ferns. This cloud forest is one of the most diverse in terms of vegetation (Sierra, 1999). The plants that grow in this cloud forest are known for their water retention capacity and for their ornamental and medicinal uses.

Herbaceous grasslands begin at altitudes of 2,800 metres above sea level. It is dominated by grasses of the genus *Calamagrostis*, *Festuca* and *Stipa* (Sierra, 1999). These species are found growing among other smaller species that have adapted to the low temperatures the wind. This páramo has leguminous species like *Lupinus spp*, from the Fabaceae family, which add nitrogen to the soil. There are also Gentians, known for their beautiful flowers and their capacity to retain water.

4.2.2 Hydrology

The Macua Project, a river monitoring system, which was established with Inter-American Development Bank funding at the University of Cuenca to prevent floods and landslides, compiled the following hydrological data.

Table 4.1 General hydrologic information for Cuenca

Items	Unit	Tomebamba	Yanuncay	Tarqui	Machangara
Hydro meteorological					
Average rainfall	mm	1097.00	1132.00	840.00	1142.00
Average Flow	m^3/s	7.30	6.34	3.59	6.64
Maximum Flow	m^3/s	124.00	145.00	127.00	150.00
Minimum Flow	m^3/s	0.69	0.81	0.5	0.54
Flow	$l/s/km^2$	24.30	15.91	7.51	20.58
Physical					
Area	km^2	335.50	408.90	478.05	323.40
Perimeter	km	74.71	115.76	103.53	94.24
Length of river	km	23.00	42.50	48.00	40.00

Source: Macua Project. 2002

The four watersheds that supply water to the city form the Cuenca river which drains into the Paute River. This, in turn, drains into the Amazon, whose importance was discussed in Section 1.

A key feature of this area is the soil formed by a delicate layer of volcanic ash on top of old lava. This contrasts with the soil in the north of Ecuador, which is young and rich in volcanic matter, and has the ability to retain water (Medina y Mena, 2001). A large proportion of the soils in these watersheds have a high water retention capacity (Macua, 2002). The páramo is located on andosols, which are light very porous volcanic soils capable of storing large quantities of water (Buytaert et al., 2000).

The rainy season is from January to May. The most humid watershed is the Tomebamba watershed, due to rainfall and the presence of black soils in 65 per cent of the watershed (Macua Project, 2002).

The source of the above named rivers that flow into the Paute is the Cajas National Park. The park gets its name from the 230 lakes which are scattered throughout the park and look like *cajas* or boxes. The park is located at an altitude of between 3,150 and 4,300 metres above sea level. It has an area of 28,800 hectares and is mainly formed of páramo.

Of the area under production, the 70 per cent of the land in these watersheds is used for grazing and 30 per cent is used for agriculture (Dominguez, 2002b). Land tenure is divided as follows:

- Private individual land holdings:
  - large and small cattle ranches in the upper Yanuncay and Tomebamba watersheds;
  - small land holdings for potato and grain cultivation.

- Community land holdings for agricultural production, particularly corn and bean production in the lower Machángara watershed.

As areas are becoming deforested for cattle raising, the soils are rapidly deteriorating. There is growing concern about the impact on water flows, particularly in the dry season, and about soil erosion which produces sediment in the drinking water.

ETAPA has two water treatment plants: Tixán and El Cebollar, treating a water flow of 1,800 litres per second (Dominguez, 2001). At present, the two main watersheds, Machángara and Tomebamba provide 17.5 m^3/s to meet the city's demand (Tomebamba provides 40 per cent and Machángara 60 per cent) (Dominguez, 2002c). The city's treatment plants process 4 million cubic metres of water per day. Losses are estimated to be around 45 per cent. Payment collection has an 82 per cent efficiency rate (Dominguez, 2002b).

Despite the abundance of water, Lloret (2001) highlights a series of problems that have caused concern to ETAPA, including:

- *Water use*: more water has been assigned than is available, as shown in a study of the Machángara watershed carried out by the National Council for Water Resources.
- *Erosion:* sedimentation in the reservoirs creates problems for hydroelectricity generation, water treatment and irrigation.
- *Wastewater pollution*: contamination from abattoirs, plantations, and wastewater from rural communities seriously affects water quality.

4.3 Water demand

The four watersheds supply water for the following uses:

- drinking water for the municipality;

- irrigation for potato, grain and other cultivation;

- cattle raising for dairy production;

- recreational activities and local, national and international tourism such as fishing and thermal springs;

- Elecaustro, the electricity utility, which generates 50 per cent of the electricity for Cuenca city and the provinces of Cañar, and Morona Santiago from its Machángara plant;

- Cuenca's industrial park, which takes water directly from the river Machángara;
- trout farms.

The study does not quantify the different water uses, but focuses on the principal user, ETAPA.

ETAPA estimates that the drinking water system covers 99.1 per cent of the families in the urban area of Cuenca. Of the 59,712 homes in the payment system, 95 per cent have meters. The rural area has 139,064 users and the system covers only 61.8 per cent of the population (ETAPA, 2002b).

Table 4.2 Water consumption in Cuenca

	Consumption m^3	% Users	Payment US$ /m^3	Observation
RESIDENCIAL	0 – 20	45 %	0,20	All the users have to pay US$2 per month for the access to the service.
	21 - 40	35%	0,30	
	+ 40	20%	0,65	
COMMERCIAL/ INDUSTRIAL	0-50		0,70	The tariff for the access to the service is 4 US$ per month.
	+ 50		1,05	

Source: ETAPA, 2002b

4.4 Linking supply and demand

Urban drinking water users, who are usually located downstream, have an interest in receiving a stable and good quality service. This service can be affected by upstream landowners and water users so the latter should therefore be involved in the protection of water resources. ETAPA is a pioneer in Ecuador in linking upstream and downstream water uses and develops activities to ensure the long-term provision and protection of water resources. The following section will describe ETAPA´s initiatives, which have evolved over time. What began as a land acquisition programme developed into a programme of integrated management of water resources, which includes protection of watersheds, rational use of water and treatment of wastewater. The company hopes to apply payments for environmental services in the future.

This is an interesting contrast to the Pimampiro experience, and this study hopes to enable the two projects to learn from one another. The link between downstream water users and upstream landowners is being made in Pimampiro by the application of a payment system for protecting the forest. In the case of ETAPA in Cuenca, the link is being made through the Environmental Management Unit, which has a securely-funded consolidated watershed protection programme.

In the early 1980s, ETAPA developed a municipal master plan for water, which included three main strategies: water supply, rational water use and wastewater treatment. As the local water utility, ETAPA assumed responsibility for carrying out these strategies in accordance with environmental regulations that were directed towards reducing water pollution and decentralising environmental control responsibilities. ETAPA was charged by the Environment Ministry with enforcing pollution controls in the city. ETAPA's Environmental

Management Unit designed programmes which included control of industrial wastes and waste oils, limnology studies, environmental education, wastewater treatment, hydro meteorological networks, environmental laboratories, geographic information systems, air quality monitoring, and management of protected areas (ETAPA, 2002).

The growing awareness of the threats to water quality and quantity was a significant factor in the development of ETAPA's water enterprise. The main drivers of this project were Agustín Rengel, who provided leadership as ETAPA´s general manager in the 1980s, and the city's cultural heritage. In addition, ETAPA has historically been a very well run technical institution, whose technicians take a long-term view. Thus, their commitment to protecting the watersheds was taken seriously (Dominguez, 2002b).

To guarantee the conservation of key areas and reduce the pressure of local communities, ETAPA has implemented the following activities since the 1980s.

4.4.1 Acquisition and protection of land

Over the last two decades, the utility has bought land in critical areas around the Tomebamba watershed, as shown in the table below.

Table 4.3 Land bought by ETAPA in Tomebamba

YEAR	CUMULATIVE AREA (Hectares)	CONSERVATION AREA
1984	3,623	Mazán
1996	5,251	Llaviuco
1998	8,382	Hato Chocar
1999	8,759	Llulluchas

Source: Lloret, 2000.

In 1984, the company bought the Mazán forest. By the year 2002, 21 per cent of the Tomebamba watershed, which generates 30 per cent of the water for Cuenca was under ETAPA's protection. The company continued to buy land until 1999, by which time it owned a total of 8,759 hectares, composed of 7,253 hectares of páramo, 1,410 hectares of regenerated land, and 96 hectares of pasture (Lloret, 2000).

In 2000, as part of the Environment Ministry's effort to decentralise, ETAPA was granted a concession to manage Cajas National Park, which was the first concession granted of an area within the protected areas system. ETAPA will manage and protect the park with the oversight of the Ministry of Environment. The entrance fees will be managed by ETAPA with a percentage given to the Ministry of Environment to subsidise other areas of the park system. ETAPA is currently promoting Cajas National Park's status as a Ramsar Site and a UNESCO World Heritage Site (ETAPA, 2002b). ETAPA has also developed specific agreements with Cuenca University in relation to biological research in Cajas National Park.

Owing to these efforts, 11 per cent of the area of the municipality of Cuenca is now under protection (Dominguez, 2002b).

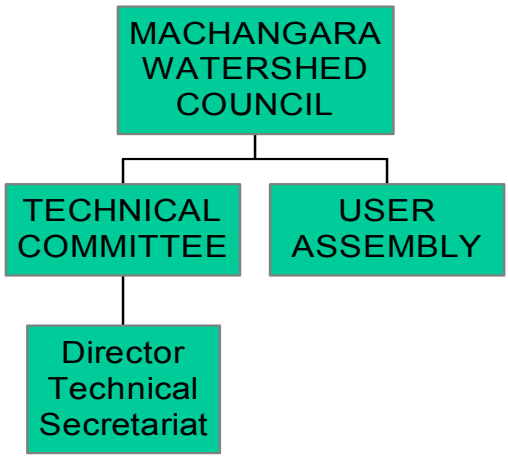
4.4.2 Machangara Watershed Council

Besides providing 50 per cent of the water for Cuenca, the Machángara watershed also serves 120 industries (50 per cent of city's industrial park), generates the region's electricity and provides water for cattle ranching and fish production activities.

In July 1998, led by ETAPA, the Watershed Council was created order to provide an adequate legal framework to guarantee the conservation of the resource with the participation of the water users (Lloret, 2000). This Council has nine member institutions: the electricity utility (Elecaustro), the Centre for the Economic Development of Azuay, Cañar and Morona Santiago (CREA), the National Water Council (CNRH), Cuenca University, the Azuay provincial government, the Environment Ministry, the water irrigation board of the Machángara river (which includes 4,500 families that use a major irrigation canal in the lower part of the watershed), the municipality's environmental council, and ETAPA.

The Council was formed with the objective of coordinating among the participating institutions and users the sustainable development of the watershed.

Figure 4.1 Council structure



The Council is the principal decision-making body and is composed of the most senior representative of each member institution and a representative of the User Assembly. Each of the council members nominates a technical representative to the Technical Committee. The Technical Committee has a permanent secretary who is the Technical Director of the Council and is responsible for preparing the plan of activities. The Technical Committee meets monthly and presents the plan of action for approval by the Council. The funding for all the activities is provided by the member institutions.

The following activities have taken place:

- studies to analyse and control the damage caused by landslides from the Soroche stream;
- water quality and soil studies in the watershed;
- installation of four meteorological stations, connected to the network in the Paute watershed;
- in conjunction with the National Water Resources Council, a comparative study of the available water versus the water designated for all users in the watershed;

- through a participatory process, the design of a Development Plan for the 110-member Board of Machangara Irrigators, which then evolved into the preparation of a Development Plan for Chiquintad, a small town of 3,000 people.
- technical assistance to a 55-member savings cooperative in Chiquintad for the development of an ecotourism operation in a native forest;
- development of a reforestation plan in three villages of the middle and upper part of the watershed with a total population of 6,00 people. One hundred and forty-four hectares were planted with 86,400 trees, which has greatly improved the relationship between the electricity utility and the community;
- creation of community nurseries with over 50,000 trees;
- training in the growing of native tree species;
- creation of 60 family gardens which, besides providing food for the household, enables some surplus to be sold locally;
- improvement of pastureland;
- establishment of a soil conservation programme;
- community training for pastures, family gardens, rational use of water, and beekeeping for adults and children;
- bee production with 18 women from the town of Sidcay;
- use of non-forest products.

All these activities have been designed and included within the yearly operational plan prepared with the participation of all the members.

4.4.3 Wastewater treatment

As mentioned previously, Cuenca was the first city in Ecuador to treat its wastewater. Initially wastewater collectors were built with a loan from the Interamerican Development Bank and as part of the city's water management plan. Then, as part of a second phase, the treatment plant was established. Currently, the city treats 95 per cent of its wastewater. ETAPA has also enforced industrial pollution control regulations.

4.4.4 Funding

ETAPA has developed an accounting system that incorporates the costs of watershed management. The company considers that its break-even point is 45 cents per cubic metre, which is composed of the costs outlined in Table 4.4.

Table 4.4 Costs per cubic metre of water

Activities	Investment (US$/m^3)	Operation and Maintenance (US$/m^3)	Total (US$/m^3)
Watershed management	0.01	0.04	0.05
Raw water uptake and transportation	0.04	0.00	0.04
Treatment and distribution	0.23	0.13	0.36
TOTAL	0.28	0.17	0.45

Source: ETAPA, 2002b

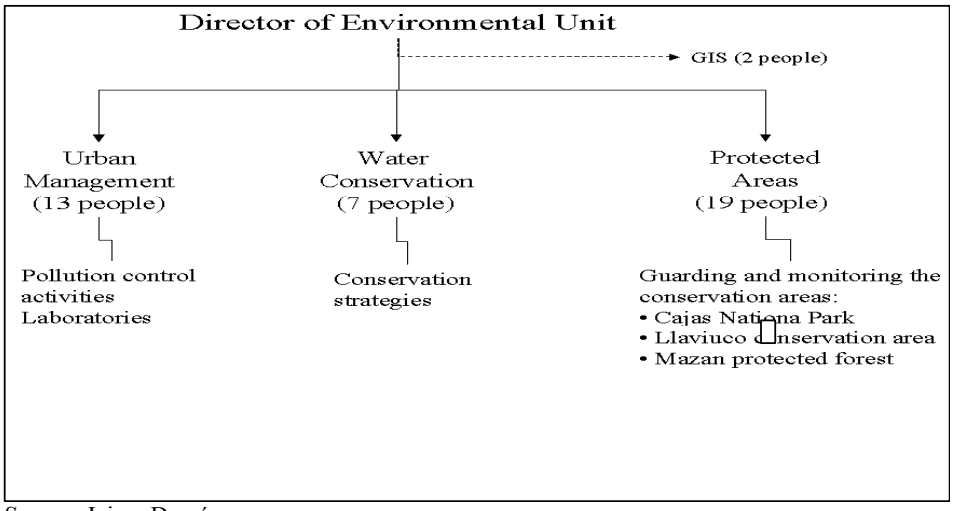
Water use is metered. At least 80 per cent of city's domestic water users receive a subsidy; users are not paying the real cost of the water service, which is still subsidised by the

ETAPA's communications business. Water users are unaware that they are paying for the protection of the watershed. Furthermore, wastewater treatment is currently not charged to the users, but is also subsidised by ETAPA's communications service. It is very interesting to see how ETAPA incorporates water treatment and the conservation of the water source into the structure of their business, which is unique in Ecuador, and indeed the region.

The Environmental Management Unit receives $0.05 for every cubic metre of water sold. Payments are directed to a specific account in the Unit's budget. The institutionalisation of this figure has been gradual but the figure has now been accepted by the company's board. For 2002, this meant a budget of US$1,089,000 (Dominguez, 2002b).

The Environmental Management Unit has a team of 42 people working in four different areas as shown in Figure 4.2.

Figure 4.2 Cuenca's Environmental Manage Unit



Source: Jaime Domínguez

ETAPA´s board is composed of the mayor, who presides over it, three members of the city council, a citizens' representative, a municipal government official, a representative from the professional colleges and a representative from producers' associations. Any decision regarding the tariff structure has to be ratified by the 14 member-city council. One would expect from this board composition that the decisions are very political. On the contrary, decisions are taken on a technical basis. In respect of the Environmental Management Unit, the board always considers the advice of the technicians and ensures that resources are allocated for environmental activities. The company is expecting to make a decision regarding a tariff to cover the costs of wastewater treatment, which is currently subsidised by ETAPA's communications business as mentioned above.

4.4.5 Payments for watershed services

ETAPA is planning to expand the drinking water system by taking water from the upper part of the Yanuncay river, near the settlement of Soldados, which is 27 kilometres from the city. This project is expected to begin operation in the year 2005 and add 31 per cent more water to the system. Given the fragile conditions of the basin and the fact that there are many private landholdings, ETAPA wants to develop a system that encourages the conservation of

the forest cover by establishing a direct payment system (Dominguez, 2002a). See Box 4.1 for a further description of the site.

Box 4.1 Potential sellers in the Yanuncay Watershed

The main economic activity of the families in the Yanuncay watershed is livestock production. A significant area of the watershed is under pasture, an economic activity that appears to be expanding. Even though the forestry law prohibits land use change, slash-and-burn practices are commonplace among local families. Some families are also involved in other economic activities such as commerce, or they work in other cities near Cuenca.

One of the main problems of the Yanuncay watershed is the threat of flooding at certain times of the year. The Inter-American Development (IDB)-funded Macua Project found that the population density, the very narrow river canyon, and the impact of local construction methods were some of the factors that make this watershed a priority area for conservation activities (Macua Project, 2002). This watershed is highly susceptible to floods and landslides. If the cattle ranching and agricultural activities persist, ETAPA fears there will be problems with water supply, erosion, and increased sedimentation in the Yanuncay river, which will affect the city's supply.

Besides cattle and agricultural activities, the watershed offers tourism opportunities as another source of income. Since part of the watershed is in the Cajas National Park and there is a road from Cuenca to the Park along the river, the communities have an interest in ecotourism. Thus, they have promoted reforestation in order to "green" some areas and also to reduce the pressure on the forest from charcoal extraction. Although most of the reforestation has taken place with exotic species, eucalyptus and pine, there are now nurseries of native species. A priest from one of the settlements and some landowners are developing a plan for a tourist corridor along the river and have received resources from a European Union programme to develop the idea. Tourism could involve 30 per cent of the population of the watershed (Durán, 2002).

It is difficult to compete with the economic benefits of cattle ranching activities in existing areas. Therefore, ETAPA is interested in developing a payment system, which would provide an incentive to the families who hold title to the land to conserve the forest.

Consultations took place in the Cuenca and Yanuncay watersheds in order to compare the situation with that of Pimampiro, where a payment system exists.

4.5 Impact assessment

The consultation results can be seen in Annex 2. Of the Yanuncay respondents, the property owned ranges in size from 2 to 300 hectares, with an average of 64 hectares. The highest level of education attained in the group is 6th grade, and the majority (20) read a newspaper once a year.

Monthly expenditure on food, medicines and schooling averaged US$108. Therefore, the payments would constitute less than half of total income. Meanwhile, the average amount considered to be a fair payment to protect the watershed was suggested as US$9 per hectare.

The main uses of the payments would be to buy food (6), to buy small animals (5) and improve irrigation (4).

The respondents from Yanuncay appeared to be unaware of the legal restrictions on deforestation. Twelve of 24 interviewed were aware that they could not clear the land. However, nine thought they *could* clear the land. In Cuenca, 19 of 49 interviewed were aware that they could not clear the land. This illustrates the level of public confusion on this matter.

In terms of the cultural preference regarding water as a right or a good, the Yanuncay respondents were clearer than those of Pimampiro in their responses: 24 of 24 said that provision of sufficient water to cover basic needs was a right. Twenty-three of the Cuenca respondents did not answer this question.

The responses from the Cuenca interviewees show their environmental awareness. Of the 49 consulted, 47 supported the conservation of the Yanuncay forests. Half (25 of 49) were willing to pay for it. It is important to highlight that the responses may be affected by the recent tariff increase, which was mentioned frequently during the consultations. The mean amount considered to be a fair payment for protecting the watershed was suggested as US$3.37 per hectare.

The demand side drivers such as a willingness to pay appear to be strong in Cuenca. There is a very solid and well developed institutional infrastructure within which to establish a payment system. In addition, the institutional capacity, the resources available and the interest in market mechanisms provide potential for applying a payment system. However, the success of a model depends on the socioeconomic context. For example, the opportunity costs of land and labour in and around Cuenca are different to those of Pimampiro. There is also a difference in the level of consumer surplus for the value of water for commercial and residential use. In addition, Cuenca and its surrounding areas might be subject to higher costs and values because of the boom in the remittances sent by emigrants. Paying landowners to protect the forest could have detrimental effects in that improved socioeconomic conditions could lead to conspicuous consumption, which could in turn aggravate deforestation pressures. A recent economic study (Wunder 2002) demonstrates that this is the case in Cuenca particularly because the deforestation cycle includes a cattle raising phase, an activity that owing to the high level of male migration in Azuay (the province where Cuenca is located) has become more attractive for the female population left behind.

4.5.1 Recommendations

Vogel (2002) provides some interesting recommendations for ETAPA should it apply a payment system:

1. Identify the areas that are most susceptible to urbanisation in the lower river basin (Sustag and San Joaquin) and inform landowners about the relevant laws. Monitor land use and impose sanctions when necessary.

2. Hire local people involved in the ecotourism corridor for infrastructure and public education activities.

3. Identify ownership of lands already forested in the upper river basin (Soldados) and inform landowners about relevant laws. Monitor land use and impose sanctions when necessary.

4. Offer to pay the opportunity costs of cattle in the areas adjacent to the forested or riparian lands or buy the title outright, whichever is most cost-effective.

5. Hire local people from the upper river basin to carry out reforestation and involve them in extractivist and agroforestry activities.

6. Revisit the water pricing policy, dispensing with the system of discounts for public institutions, but exempting charges for the minimum level of consumption (<20m^3), and establishing a progressive tariff system in order to finance the costs of Recommendations 1-5.

5. Project results

5.1 Major findings

The key findings of the research can be summarised as follows:

- When discussing markets, it is important to clarify the term "market" and the legal context in which it is operating. There is no market for watershed services in Ecuador at present. However, since monetary compensation is being paid, as in the case of Pimampiro, the term "market" should be thought of as a metaphor, and it might be more correct to say we are analysing a "mixed market". This is also true because there is imperfect information among the market participants regarding the service that is bought and sold (hydrological function – quality or quantity), the value of the service to the downstream buyers (consumer surplus), and the value to the upstream sellers (producer surplus).

- A key element to consider, which is often ignored by economists, is the legal context in which a market can operate. In Ecuador, as in most Latin American countries, land use change is regulated, and water is a public good. Therefore, payments for watershed services have to be consistent with the forest and water regimes in order not to subvert the authority of the state, and to prevent the mechanism from being misused (e.g., "rewards" for good behaviour or extortion by landowners). The research concludes that in Ecuador landowners should be paid for the costs they incur from protecting forests from incursions by third parties. They are paid for *protecting* the environmental services, rather than providing the services themselves.

- Misunderstanding the socioeconomic context in which a market operates can have contradictory effects. Land, labour and opportunity costs vary and can alter the conditions in which a particular environmental service has to operate, as is the case of Cuenca with the link between deforestation and the increase in remittances from abroad. There is also a cultural and political dimension to water, which is too important to be ignored when discussing the marketing of watershed services. Water should be viewed as both a right and a commodity. Sufficient water for human beings to satisfy their basic needs (e.g., approximately 10 litres per person per day in the developing world, according to the United Nations), should be considered a basic human right and should be available free of charge or at very low prices to everyone, especially the poor.

- Consumption in excess of the above level should be paid for progressively, such that as consumption increases, so does price. The price should reflect the natural limits required to maintain and regenerate water quality and volume, including the cost of watershed protection. Although the change must be gradual in order to improve social impacts, the price of drinking water should reflect environmental impacts.

- A payment system or market mechanism as seen in Pimampiro, can change cultural norms, creating a more "neoliberal" mentality, or reinforcing choices based on self-interest, as illustrated by the contrast in the Nueva America and Yanuncay responses (eight out of 11 interviewees did not respond in Nueva America, 24 out of 24 in Yanuncay stated that sufficient water to satisfy basic needs was a right). This could be a double-edged sword because:

- As markets for environmental services are promoted, there is a risk of commodifying water to a point where private rights are established, to the detriment of the basic right discussed above, which could have devastating effects on the rural poor. One extreme scenario could be the penetration of venture capital for the sale of environmental services, prompting the sale of lands. According to the economics of deforestation as discussed by Wunder (2002), the payments themselves or proceeds from land sales could end up being used for conspicuous consumption, which could lead to displacement of people from their homes and lifestyles.

- The pro-market view could argue that payments for environmental services could be a source of income or transfer of resources for the poor rural communities poor that are ignored or abandoned by the State. Paying for their labour to protect the forest or shifting their land use away from pasture could fulfil the environmental objectives of improved water quality and quantity, and at the same time improve their livelihoods. Yet for this scenario to occur, it is important to ensure that environmental services and in particular watershed services, are coherent with the existing forest, environment and water regulations, as well as, the cultural and socio-economic conditions.

- The case of Nueva America indicates that there is increased awareness of watershed services. It is not clear how far this awareness goes beyond the individual land holding or affects other aspects of people's behaviour. For example, all families in Nueva America still cook with firewood and if this is not done in a sustainable way it could put additional pressure on the forest.

- Although it may sound obvious, a clear understanding of what is being bought and sold is essential. If the payment mechanism is not based on technical information, people are paying for something they cannot see or measure. Therefore, the service must be explained in material terms to buyers and sellers.

- When there is a lack of hydrological information, payments for watershed services could actually be a form of insurance against land use change, and this could threaten water services. In this case people are buying an insurance policy, rather than improved water quality or quantity.

- Society should support public authorities in protecting the public's interests by establishing limits for the "market" for environmental services. This has been referred to as governance in the literature and is a major challenge in developing societies, where local authorities tend to be weak and under funded. Given the weak and confusing institutional structure of the water sector in many countries, public scrutiny is essential.

5.2 Setting up the payment system

Based on Pimampiro's experience, the development process can be described in the following ten steps, which may not be sequential:

1. *Identify a situation where there is a "seller" and "buyer" of a watershed service*. Whether it is water quality or flow regulation, it is important to understand the physical function in order to clearly define the "service" to be marketed.

2. *Create the institutional capacity to implement a market mec*hanism. This refers to the environmental unit or department in a municipality or a water company, which need to be established, and strengthened over time to be able to adapt and fine-tune the mechanism.

3. *Develop inter-institutional links.* Whether it is overseen by an international or local NGO, or a national or local government institution, a payment mechanism is complex and requires technical, legal, social, economic and political expertise. Different institutions can provide the different capacities required.

4. *Know what is going to be sold*. In the preliminary studies to design the mechanism, different types of information have to interact. The legal basis for the mechanism has to be clearly defined, and the hydrological benefits of the ecosystem to be protected must be quantified. These may be measured directly or based on secondary information. As discussed by Johnson et al. (2002), even though there is a limited amount of information, there are certain rules of thumb that could be used, for example, beginning with wetland and riparian protection, and protecting existing forest before undertaking reforestation. It is necessary to carry out economic and financial studies to validate the payment scheme. Valuation studies have become fashionable but they should not necessarily be the decision-making tool. As discussed in detail by Nazi et al., they are "an important tool for revealing the relevant incentive structures… rather than a tool for optimal land use." Payments should be realistic to ensure the financial sustainability of the mechanism and should be competitive in comparison with alternative non-conservationist land uses.

5. *Develop and implement a negotiation strategy with the political decision-makers*. Whether it is a city council or a regional board, the legal mandate for a payment scheme needs to be ensured.

6. *Develop environmental education projects for the communities upstream and downstream*. This could include creating awareness about the hydrological importance of the forest and natural habitats and/or rational use of water and the conservation of natural resources.

7. *Develop a formal and transparent organisational structure for decision-making and implementation.* The scheme should have a governing body including several stakeholder representative members (3-5) as a safeguard against arbitrary decisions. A clear and well-structured payment system should include a payment structure and schedule, payment agreements or contracts, sanctions, an appeal process, financial and environmental monitoring systems and an information system. Access to information for the public, especially participants, is vital for market development.

8. *Establish an appropriate payment system*. Ensure that payments are correct and made on time. Otherwise the system loses credibility and participants will be justified in not complying. Payments should be realistic, based both on ability to pay to ensure financial sustainability, and willingness to pay to ensure competitiveness with alternative land uses in the long term.

9. *Monitor and evaluate the process.* It is important to have an independent body to monitor progress and manage conflicts.

10. *Make corrections and reinforce successful measures*. Strengthening institutional capacity over time is fundamental. Payment systems are long-term mechanisms that have to deliver the benefits they were created for. Failure to so lead to buyers' unwillingness to pay for the service.

5.3 Project conclusions

- Hydrological benefits are assumed, not measured or monitored. There is a *de facto* belief that forests mean more and better water. Very limited local data is available to support this claim. Considering the global importance of water and the challenges facing the water sector in the coming years, it is very surprising how little information is available regarding the hydrological functions provided by particular ecosystems. There is a need for further understanding of this relationship and investment in research.

- Besides the need for further research on the hydrological impacts of land use change in general, this information is vital for setting a market clearing price. Buyers and sellers have little information and thus cannot make rational decisions as to what the watershed service is worth. Due to limited resources and high transaction costs, it is important to disseminate the available information regarding national and international experiences. The compilations prepared by Landell Mills and Porras (2002), and Pagiola et al. (2002), and the results from this project could be useful sources of information.

- The focus of most payment mechanisms has been on drinking water and hydropower generation because their economic value is clearly recognised and there is greater willingness to pay for these uses. In addition, the legal and institutional framework clearly identifies the municipal water authorities and hydroelectric plants as key actors in the development of these payment systems. The contrary is found with water for agricultural use. Yet, it is the main and most inefficient use of the resource. Irrigation should be included in the payment schemes, at least in the case of Ecuador. A possible way to do is through a property tax managed by the municipalities, which would be applied according to the volume of water consumed.

- Household surveys may not be the most effective way to gather information to evaluate the social impacts of a compensation mechanism, because people answer strategically. If surveys are used, questions must be cross-referenced in order to validate results.

- The implementation of payment systems can help create institutional capacity to further environmental management. The process in Pimampiro prompted the municipality to enforce environmental regulations (regarding deforestation), which in turn prompted the national authority to act. With the existence of an environmental unit, the municipality begins to address other environmental issues. This process takes time and the sustainability of the process is fundamental for effectively creating environmental management capacity.

- Payment mechanisms are limited for addressing issues of equity. Payments should improve people´s livelihoods, but how far can this be directed? People have to be given the freedom to decide how to spend the compensation received. All of the respondents answered that they would use the next month's compensation payment for basic expenses, such as food, agricultural production, education and health.

- Market mechanisms are not the solution to everything, and they cannot work in a vacuum. Markets for environmental services create incentives for particular stakeholders, but in order to solve environmental problems, they have to be complemented by other environmental policies. For example, there is a need for education on how to improve agricultural production, which would thus reduce pressure on the forest.

- ETAPA provides a useful example of municipal management of water resources that merits further study in order to document the results.

6. References

Andrade, N. and H. Olazaval. 2002. *El riego en el Ecuador*. Quito, Ecuador: Foro de los Recursos Hídricos. CAMAREN.

Anteproyecto de Ley Especial para el Desarrollo Forestal Sustentable del Ecuador. Government of Ecuador

Anteproyecto de Ley Especial para la Conservación y Uso Sustentable de la Biodiversidad en el Ecuador. Government of Ecuador.

Arias, M. V. 2002. *Marco Legal e Institucional de los Recursos Hídricos en el Ecuador.* Quito, Ecuador: Centro Ecuatoriano de Derecho Ambiental. Foro de los Recursos Hídricos. CAMAREN.

Bruijnzeel, L.A. 2001 "Hydrology of tropical montane cloud forests: A reassessment" *Land Use and Water Resources Research 1*. http://www.luwrr.com/.

Buytaert, W, B. De Bievre, J. Deckers and G. Dercon. 2000. "Influence of land use on the hydrological properties of volcanic soils: the case of catchments providing water to Andean cities". Land-Water Linkages in Rural Watersheds. FAO Electronic Workshop. Rome, Italy: Food and Agriculture Organization of the United Nations.

Cayambe, R. 2002. Personal communication, 28 July 2002.

CEDERENA 2002. *Pago por Servicios Ambientales. Una alternativa que contribuye al manejo y conservación de bosques y páramos*. Ibarra Ecuador: Editorial Almeida.

CEDERENA, *Municipio de Pimampiro y Fundación Interamericana 2001.* Boletín No. 1 Mayo. Ibarra, Ecuador: CEDERENA.

Ciudad Futura Web Page. 2002. www.ciudadfutura.com/ecuador

Comunidad Andina Web Page 2002. www.comunidadandina.org/quienes/map-ecu.htm

CNRH. 2002 *Gestión de los Recursos Hídricos del Ecuador – Políticas y Estrategias*. Documento Básico - Revisión 2 – Conceptos Adicionales. Ecuador: Consejo Nacional de Recursos Hídricos (CNRH).

Cuellar, J. C. and A. López. 2002. Informe de Moderación del Seminario Taller sobre Servicios Ambientales en el Ecuador con énfasis en el Recurso Agua. Ambuqui, Ecuador.

Cueva, P, C. Ajamil, V. Paspuel and R. Moscoso. 2001. *Manejo de los recursos hídricos: Estudio de prefactibilidad de un sistema de pago por servicios ambientales en la cuenca del Río Arenillas.* Ecuador: Ministerio del Ambiente.

Decreto Especial 2224 de octubre, 1994. Government of Ecuador.

Desarrollo Forestal Campesino (DFC) Web Page. 2002. www.ecuanex.net.ec/fao-dfc

Diario del Norte. 2002. “En obras de mejoramiento de sistemas de agua: CORSINOR invertirá 500000 USD este año”. 12 junio . Ibarra, Ecuador: Diario del Norte.

Domínguez J. 2001. “La Gestión de ETAPA y el Páramo” in Mena V., G. Medina and R. Hofstede (eds). 2001. *Los Páramos del Ecuador. Particularidades, Problemas y Perspectivas*. Quito, Ecuador: Abya Yala / Proyecto Páramo.

Domínguez, J. 2002. “La Gestión de la Empresa Pública Municipal de Telecomunicaciones, Agua Potable, Alcantarillado y Saneamiento del Canton Cuenca, ETAPA: Una visión integral del ciclo del agua en Cuenca, Ecuador”. Mayo-2002 en el II Foro Electrónico *Municipios Rurales y Gestión Local Participativa en zonas de Montaña* Ecuador: Consorcio para el Desarrollo Sostenible de la Ecorregión Andina (CONDESAN)..

Domínguez, J. 2002a. Personal communication May 2002.

Domínguez, J. 2002b. Personal communication August 2002.

Domínguez, J. 2002c. Personal communication October 2002.

Durán, Esteban. 2002. Personal communication, July 2002.

EcoCiencia and CEDA. 2001. *Biolegal*. Unpublished document. Ecuador: EcoCiencia Foundation and Ecuadorian Environmental Law Centre.

EcoCiencia. 2002. *Sistema de monitoreo socio ambiental*. Ecuador: EcoCiencia.

ETAPA. 2002a. *Ordenanza que regula la organización y funcionamiento de la Empresa Pública Municipal de Telecomunicaciones , Agua Potable, Alcantarillado y Saneamiento de Cuenca*. Cuenca, Ecuador: ETAPA.

ETAPA. 2002b. *Resumen Ejecutivo de los Servicios Integrales de Agua Potable y Alcantarillado.* Empresa Pública Municipal de Telecomunicaciones, Agua Potable, Alcantarillado y Saneamiento de Cuenca. Grenoble.

ETAPA. 2002c. Políticas Ambientales de Etapa en torno a la Visión Integral del Ciclo del Agua. Empresa Pública Municipal de Telecomunicaciones , Agua Potable, Alcantarillado y Saneamiento de Cuenca. Ucubamba.

Flows 4: “A foggy issue” 29 March 2002. http://test.bagus.org/resources/flowsserve/4.html.

Guerrero, A. 2002. Personal communication July 2002.

Hofstede, R. 1997. *La importancia Hídrica del Páramo y Aspectos de su Manejo*. Quito, Ecuador: EcoPar. Abya Yala/Proyecto Páramo.

Hofstede, R. 2001. “El Impacto de las Actividades Humanas en el Páramo” in Mena V., G. Medina and R. Hofstede (eds). 2001. *Los Páramos del Ecuador. Particularidades, Problemas y Perspectivas*. Quito, Ecuador: Abya Yala / Proyecto Páramo.

IGM (Instituto Geográfico Militar) and Geodetic Survey. 1990. "Pimampiro, Los Lagos and Mariano Acosta topographical maps". Esc 1:50000. Ecuador: IGM.

INEC. 2002. *26 Ciudades más pobladas del Ecuador*. Instituto Nacional de Estadísticas y Censos. www.inec.gov.ec.

Inter-American Foundation Web Page. 2002. URL: www.iaf.gov.

Johnson, Nels, Andy White and Daniéle Perrot-Maître. 2002. *Developing Markets for Water Services from Forests: Issues and Lessons for Innovators*. Washington DC, USA: Forests Trends.

Landell-Mills, N. and I. T. Porras. 2002. *Silver bullet or fools' gold? A global review of markets for forest environmental services and their impact on the poor.* Instruments for sustainable private sector forestry series. London, UK: International Institute for Environment and Development.

Larrea, Carlos et al. 1999. *Desarrollo social y gestión municipal en el Ecuador: Jerarquización y tipología.* Quito, Ecuador: Oficina de Planificación de la Presidencia, ODEPLAN.

Lascano, M. 2002. *Valoración económica del agua de la Acequia "Del Pueblo de Pimampiro"*. Quito, Ecuador: Corporación para el Desarrollo, CEDERENA-InterAmerican Foundation.

Lawton, R., U. Nair, R. Pielke, Sr., and R. Welch. 2001. "Climatic Impact of Tropical Lowland Deforestation on Nearby Montane Cloud Forests," *Science* **294**: 584-587.

Llaguno, D. 2002. *Aspectos Estratégicos, Legales e Institucionales sobre Servicios Ambientales en el Ecuador Foro de los Recursos Hídricos*. Quito, Ecuador: CAMAREN.

Lloret, Pablo. 2000. Conferencia evento COMAFORS sobre "La Valoración y el Pago por Servicios Ambientales" Servicios Ambientales. Quito, Ecuador: Corporación de Manejo Forestal Sustentable (COMAFORS).

Lloret, P. 2000. "Consejo de la Cuenca del Machángara". II Conferencia Electrónica sobre Usos Sostenibles y Conservación del Ecosistema Páramo en los Andes. Ecuador.

Lloret, P. 2000. *Problemática de los Recursos Hídricos en el Ecuador*. Quito, Ecuador: Foro de los Recursos Hídricos. CAMAREN.

Lloret Zamora, Pablo. 2001. *Estudio de Caso: Cuenca del Río Machangara, Cuenca, Ecuador*. Land and Water Development Division, FAO. Rome, Italy: Food and Agriculture Organization of the United Nations.

Lora, E. 2002. Personal communication 14 November 2002.

Macua Project. 2002. *Establecimiento de un plan de manejo de cuencas en ríos andinos.* Cuenca, Ecuador: FUNDACYT, Universidad de Cuenca.
http://rai.ucuenca.edu.ec/proyectos/margenes/webmar.htm.

Medina, G. and P. Mena. 2001. "Los Páramos en el Ecuador" in Mena V., P., G. Medina y R. Hofstede (eds.). 2001. *Los Páramos del Ecuador. Particularidades, Problemas y Perspectivas*. Quito, Ecuador: Abya Yala / Proyecto Páramo.

Mena V., P., G. Medina y R. Hofstede (Eds). 2001. *Los Páramos del Ecuador. Particularidades, Problemas y Perspectivas*. Quito, Ecuador: Abya Yala / Proyecto Páramo.

Ministerio del Ambiente. 2000a. *Estrategia Ambiental para el Desarrollo Sustentable del Ecuador.* Ecuador: Ministry of Environment.

Ministerio del Ambiente. 2000b. *Estrategia para el Desarrollo Forestal Sustentable del Ecuador.* Ecuador: Ministry of Environment.

Ministerio del Ambiente. 2001. *Política y Estrategia Nacional de Biodiversidad del Ecuador*. Ecuador: Ministry of Environment.

Morales, M. 2001. "Apuntes juridicos sobre los paramos" in Mena V., P., G. Medina y R. Hofstede (eds.). 2001. *Los Páramos del Ecuador. Particularidades, Problemas y Perspectivas*. . Quito, Ecuador: Abya Yala / Proyecto Páramo.

Municipalities of Ecuador Web Page. 2002. www.ame.org.ec

Municipalidad de Pimampiro 2001. *Convenio de Cooperación para Protección de Fuentes Hídricas y Pago por Servicio de Protección entre el Ilustre Municipio del Cantón Pimampiro y la Asociación Agrícola Ganadera Nueva América*. Pimampiro, Ecuador: Municipality of Pimampiro.

Municipalidad de Pimampiro 2001. *Ordenanza para la creación del "Fondo para el pago por servicios ambientales para la protección y conservación de bosques y páramos con fines de regulación de agu*". Pimampiro, Ecuador: Municipality of Pimampiro

Pagiola, S, J. Bishop and N. Landell-Mills (eds). 2002. *Selling Forest Environmental Services: Market-based mechanisms for conservation and development*. London, UK: Earthscan.

Paspuel, L. 2002. Personal communication, September 2002.

Proyecto Plan Maestro para la Proteccion de la Biodiversidad Mediante el Fortalecimiento del Sistema Nacional de Areas Protegidas. 1998. *Guia de Parques Nacionales y Reservas del Ecuador*. Quito, Ecuador: Proyecto INEFAN-GEF.

Quesada, Milton. 1993. "La Industria de la Provincia del Azuay" in IDIS, ILDIS and CREA. 1993 *Los Retos del Austro*. Cuenca, Ecuador: Banco del Azuay.

Reglamento de Aplicación de la Ley de Aguas de 1972, publicado en R.O. 425 de 3 de octubre de 2001. Government of Ecuador.

Sierra, R. (ed). 1999. *Propuesta Preliminar de un Sistema de Clasificación de Vegetación para el Ecuador Continental*. Quito, Ecuador: Proyecto INEFAN/GEF-BIRF y EcoCiencia.

Stavings, R. "The invisible green hand. A survey of the global environment" *Economist* 6 July 2002.

Tobar, M. 2000. *Estudio del Recurso Hídrico en Ecuador*. Ecuador: CEDA-UICN.

Vistazo. 2000. "El Ecuador del 2000". *Vistazo* ***6***, junio 15.

Voguel, Joseph. 2002. *Markets or Metaphors? A Sustainable Livelihoods Approach to the Management of Environmental Services: Two Cases from Ecuador*. London, UK: IIED/ Ecuador: Ecodecisión.

Yaguache, R. 2001. Project "Impactos del Desarrollo Forestal Comunal en la Calidad de vida de Familias Campesinas en Comunidades del Cantón Pimampiro", Ecuador: CEDERENA.

Yaguache, R. 2002. Personal communication 29 August 2002.

Wilson, S., C. Rodríquez, M. Cevallos, and G. Amaya. 2001. *Propuesta de Ampliación Sostenible del Pago de Servicios Ambientales (Fuentes de Recursos Hídricos) en el Cantón Pimampiro*. Ecuador.

Wunder, Sven. 2000. *The Economics of Deforestation. The Example of Ecuador*. UK: Palgrave Macmillan.

Interviews

- Ramiro Carrion, Cederena. 2 Julio 2002. 21 November 2002
- Rafael Cayambe, Yanuncay landowner. 28 July 2002.
- Jaime Dominguez, ETAPA. 29 Julio, 2002 and 30 Agosto 2002.
- Esteban Duran, 27 July, 2002
- Aurelio Guerrero. UMAT. 2 Julio 2002. 21 November 2002
- Silvia Ortega. Cederena. 23 Julio 2002. 21 November 2002
- Luis Paspuel, Pimampiro´s Water Treatment Plant. September, 2002.
- Robert Yaguache, Cederena, 29 Agosto 2002

ANNEX 1 Consultation Results in Pimampiro

Nueva America Consultation Results

1) *Number of Respondents:* 11

2) *Number of hectares owned:*
min (11.7) max (119) mean (42.8) sd (31)

3) *Amount received under the Payments for Environmental Services (PES):* min (5.33) max (68.5) mean (21.1) sd (18.2)

4) *The Payments constitute (less than half/half/more than half) of total income*:
Less than half (11)

5) *Expenditure on food per month*:
min (20) max (80) mean (41) st (19.5)

6) *Expenditure on medicine per month*:
min (0) max (33.3) mean (13.7) st (10.7)

7) *Expenditure on fuel per month:*
min (0) max (1.6) mean (0.2) st (0.6)

8) *School expenditure per month:*
min (0) max (25) mean (5.9) st (7.6) no response (1)

9) *Do you cook with firewood? Y/N Coal? Y/N Gas? Y/N*:
firewood (10) gas (1)

10) *The last payment was used for:*
food (4) gas tank(2) buy seed(1) save(1) tools (1) uniforms (1) no response (1)

11) *The next payment will be used for:*
school expenditure(3) clothes (1) food (3) savings(1) medicine (1) no response (2)

12) *Have you accessed credit since the Payments for Environmental Services (PES) began? Y/N:*
no (8) yes (2) no response (1)

13) *Did you report the PES in the credit application?*
no (1) yes (1) no response (9)

14) *The credit was for:*
buy cows (2) no response (9)

15) *Are you interested in the collection of medicinal plants? Y/N:*
no (3) yes (7) no response (1)

16) Are you interested in ecotourism? Y/N:
no (1) yes (10)

17) *Are you interested in sustainable agriculture? Y/N:*
no(4) yes(5) no response (2)

18) *Highest level of education attained*:
0 (1) 2nd (2) 3rd (3) 4th (2) 6th (3)

19) *Do you help your children with homework? Y/N:*
no(4) yes(2) no response (5)

20) *I read the newspaper Daily/Weekly/Monthly/Yearly:*
monthly (2) 6-monthly (1) yearly (7) no response (1)

21) *I listen to the radio Daily/Weekly/Monthly/Yearly:*
daily (4) monthly (2) 6-monthly (2) yearly (3)

22) *Do you believe families have a right to water? Y/N:*
Enough to cover basic needs (1) unlimited (2) no response (8)

23) *If it is a right, do you believe families have a right to water YES/NO:*
Yes (4) no response (7)

24) *If water is both a right and a good, at what point does it change from being a right to becoming a good (at a sufficient level for survival/twice sufficiency/thrice sufficiency/unlimited access):*
sufficient for survival (1) no response (10)

25) *In Nueva America, landowners of the watershed are receiving ($0.0 per month per ha/$0.1 per month per ha/ $1.0 per month per ha/$10 per month per ha/other):*
$0.1(1) $0.2(4) $0.25(2) $0.4(1) $1(3)

26) *The fair compensation for protecting the watershed is ($0.0 per month per ha/$0.1 per month per ha/ $1.0 per month per ha/$10 per month per ha.):*
$1(2) $2(2) $3(3) $4(1) $5(2) $10(1)

27) *This is because without payments, they: can clear the land and plant crops/still cannot clear the land and plant crops/are protecting the forest from outside incursions.*
Clear the land (8) cannot clear (3)

28) *Does PSE motivate conservation: not at all/somewhat/definitely.*
Not at all(2) somewhat(5) definitely(4)

29) *The association organises (more/the same as always/less) than before the PES.*
More(1) the same as always (1) less(9)

30) *The PES motivates/does not motivate the participation in more sustainable activities.*
Motivates(4) no motivates(7)

31) *The increase in the cost of water for Pimampiro (has/has not) resulted in ill feelings*.
No(8) yes(3)

32) *Pimampiro is being taken advantage by Nueva America (yes/no).*
no(5) yes(1) no response(5)

33) *It is/is not possible to resuscitate a communal system without payments*.
No(4) yes(2) no response(5)

34) *I am/am not worried that outsiders will buy the land of the watershed*.
No (4) yes (5) no response (2)

35) *Age:*
min (38) max (72) mean (50.9) st (9.8)

36) *Sex:*
male (8) female (3)

37) *Number of people in the family*:
min (2) max (12) mean (6.6) st (2.8)

38) *Place of Residence:*
Alisal (2) Mariano Acosta (1) Mirador (1) Nueva America (1) Peñaherrera (1) Pimampiro (1) Rumipamba (4)

Pimampiro Consultation Results

1) *Number of people interviewed*
(36)

2) *Do you have problems with water supply?*
no(30) yes(6)

3) *Willingness to pay: Do you think that conservation of forest is needed to guarantee water supply?*
no (1) yes(35)

4) *Are you willing to pay more in your water bill for forest conservation?*
no(14) yes(22)

5) *A fair level of compensation to the landowners for protecting the watershed is a)$0.0 month/ha b) $0.1 month/ha c) $1.0 month/ha d) $10 month/ha e)other*
min(0) max(10) mean(2.8) sd (3.7) no response (19)

6) *Without payments, they: can clear the land and plant crops/still cannot clear the land and plant crops/are protecting the forest from outside incursions*.
Clear(18) cannot clear(9) protect (9)

7) *Do you believe families have a right to water? (sufficien for survival/twice sufficiency/thrice sufficiency/unlimited access):*
   Sufficiency for survival (5) unlimited(4) no response (27)

8) *If it is a right, do you believe families have a right to water?*
   No(6) yes(5) no response (25)

9) *If water is both a right and a good, at what point does it change from being a right to being a good (a level of sufficiency for survival/twice sufficiency/thrice sufficiency/unlimited access):*
   sufficiency (16) unlimited (2) no response (18)

10) *Age:*
   min(17) max(82) mean (42) sd(17)

11) *Sex:*
   male (6) female (30)

12) *Number of family members*:
   min(1) max(10) mean(4.3) sd(2.1)

ANNEX 2 Consultation Results in Cuenca

Yanuncay Consultation Results

1) *Number of Respondents:* 24

2) *Number of hectares owned:*
   min(2) max(300) mean(41.2) sd(63.6)

3) *If you were to receive $ 1/ha-mo. for conservation of the forest on your property, this would constitute (less than half/half/more than half) of your total income:*
   Less than half(24)

4) *Expenditure in food per month*:
   min(45) max(400) mean(92.2) sd(69)

5) *Expenditure on medicine per month:*
   min(0) max(50) mean(8.6) sd(13.4)

6) *School expenditure per month:*
   min(0) max(25) mean(7.2) sd(6.7)

7) *You would use the payments for*:
   buy small animals (5) change paramo into pasture (2) improve irrigation canal(4) improve house (2) improve business (2) save (2) food (6) school expenses (1)

8) *And for :*
   buy small animals (2) food (3) improve irrigation (1) improve house (1) save (3) school expenses (1) no response (13)

9) *Highest level of education attained*:
   min(4) max(6) mean(5.5) sd(0.6)

10) *Do you assist your children in their homework*?
    No(18) yes(6)

11) *Do you read the newspaper Daily/Weekly/Monthly/Yearly*:
    yearly (20) twice yearly(4)

12) *Do you listen to the radio Daily/Weekly/Monthly/Yearly*:
    daily(24)

13) *Do you believe families have a right to water? (a level sufficient for survival/twice sufficiency/thrice sufficiency/unlimited access):*
    Sufficient(24)

14) *If it is a right, do you believe families have a right to water?*

Yes(24) no(0)

15) *If water is both a right and a good, at what point does it change from being a right to becoming a good (at a level sufficient for survival/twice sufficiency/thrice sufficiency/unlimited access):*
sufficient for survival(12) twice sufficiency (3) no response(9)

16) *A fair level of compensation for protecting the watershed is a)$0.0 month/ ha b)$0.1 month/ ha c) $1.0 month/ ha d)$10 month/ ha:* e) other? – how do you explain a max of $20?
min($0) max($20) mean($9) sd($4.46)

17) *This is because without payments, landowners: can clear the land and plant crops/still cannot clear the land and plant crops/are protecting the forest from outside incursions.* Clear the land (9) cannot clear the land(12) protecting from outside incursions(3)

18) *Age:*
min(24) max(65) mean(37) sd (12.15)

19) *Sex:*
male(9) female(15)

20) *Number of family members:*
min(19) max(65) mean(37 sd(12.15)

21) *Place of residence*:
Capuli(8) Soldados(8) Sustag(8)

Cuenca Consultation Results

1) *Number of respondant*s
(49)

2) *Do you have problems with your water service?*
No(36) yes(13)

3) *Besides the conservation activities of ETAPA in the Cajas National Park, do you think that the forests in the Yanuncay watershed should also be conserved in order to safeguard the water supply for the future?*
No(1) yes(47) no response (1)

4) *Willingness to pay: Are you willing to pay more in your water bill to conserve the Yanuncay Watershed?*
No(24) yes(25)

5) *A fair level of compensation to the landowners in the upper Yanuncay watershed for protecting their forest is ($ 0.0 per month per ha/$0.1 per month per ha/ $1.0 per month per ha/$10 per month per ha/other _____):*

min($0) max($10) mean($3.37) sd($3.8)

6) *Without payments, they: can clear the land and plant crops/still cannot clear the land and plant crops/are protecting the forest from outside incursions.*
   Clear the land(18) cannot clear (19) protect form outside incursions(10)
   no response (2)

7) *Do you believe families have a right to water? (sufficient for survival/twice sufficiency/thrice sufficiency/unlimited access):*
   sufficient (20) twice sufficiency(1) thrice sufficiency(1) unlimited (4)
   no response (23)

8) *If it is a right, do you believe families have a right to water?*
   No(2) yes (0) no response(47)

9) *If water is both a right and a good, the point where it goes from being a right to becoming a good is at a level (sufficient for survival/twice sufficiency/thrice sufficiency/unlimited access):*
   sufficient(25) twice sufficiency(1) no response(23)

10) *Age:*
   min (15) max(71) mean(43) sd(13)

11) *Sex:*
   male(14) female(35)

12) *Number of family members:*
   min(1) max(8) mean(4.4) sd(1.4)