Land-Water Linkages in Rural Watersheds Case Study Series

Cooperation between a small private hydropower producer and a conservation NGO for forest protection: The case of La Esperanza, Costa Rica

Manrique Rojas
Author for correspondence
Eco Asesores Integrados S.A., P.O. Box 72-4400
Ciudad Quesada, Costa Rica
Email: manrique@racsa.co.cr

Bruce Aylward
Independent Consultant
6935 Birch Street, Falls Church, VA 22046 USA
Email: bruce@radel.com

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Abstract

This Case Study focuses on a cooperation mechanism developed in Costa Rica between La Esperanza Hydropower Project (downstream water user) and the Monteverde Conservation League, a conservation NGO that owns most of the hydropower plant's upper catchment. The objective of the mechanism is to ensure the conservation of forest cover where it already exists, since forests are perceived to provide a range of downstream hydrological services for which the hydropower producer is willing to pay. The mechanism is centered on a private contract between two parties, where the hydropower producer commits to paying the forest owner in exchange of the latter's commitment to maintain the forest cover on its property. The payment increases through the first five years of the contract from US$ 3 to US$ 10/ha/yr, and from the fifth year onwards US$ 10/ha/yr is used as a reference value in a formula that factors in power produced and the tariff at which the power is sold. Under the agreement, the hydropower producer makes payments to 3 000 ha in the watershed, which is equivalent to 88 percent of the total area. The contract was signed for 99 years. This payment for environmental services (PES) scheme represents a considerable increase in the O&M costs of the power plant (approximately a 21 percent increase) and is a significant contribution to the annual budget of the conservation NGO (approximately 10-25 percent of the annual budget).

Introduction

This Case Study focuses on a cooperation mechanism developed in Costa Rica between a hydropower producer (downstream water user) and a landowner in its upper catchment. The objective of the mechanism has been to ensure the conservation of forest cover where it already exists. Forests are perceived to provide a range of downstream hydrological services for which the hydropower producer is willing to pay. The mechanism is centered on a private contract between two parties, where one party commits to paying the other in exchange of the latter's commitment to maintain a specific land use on its property.

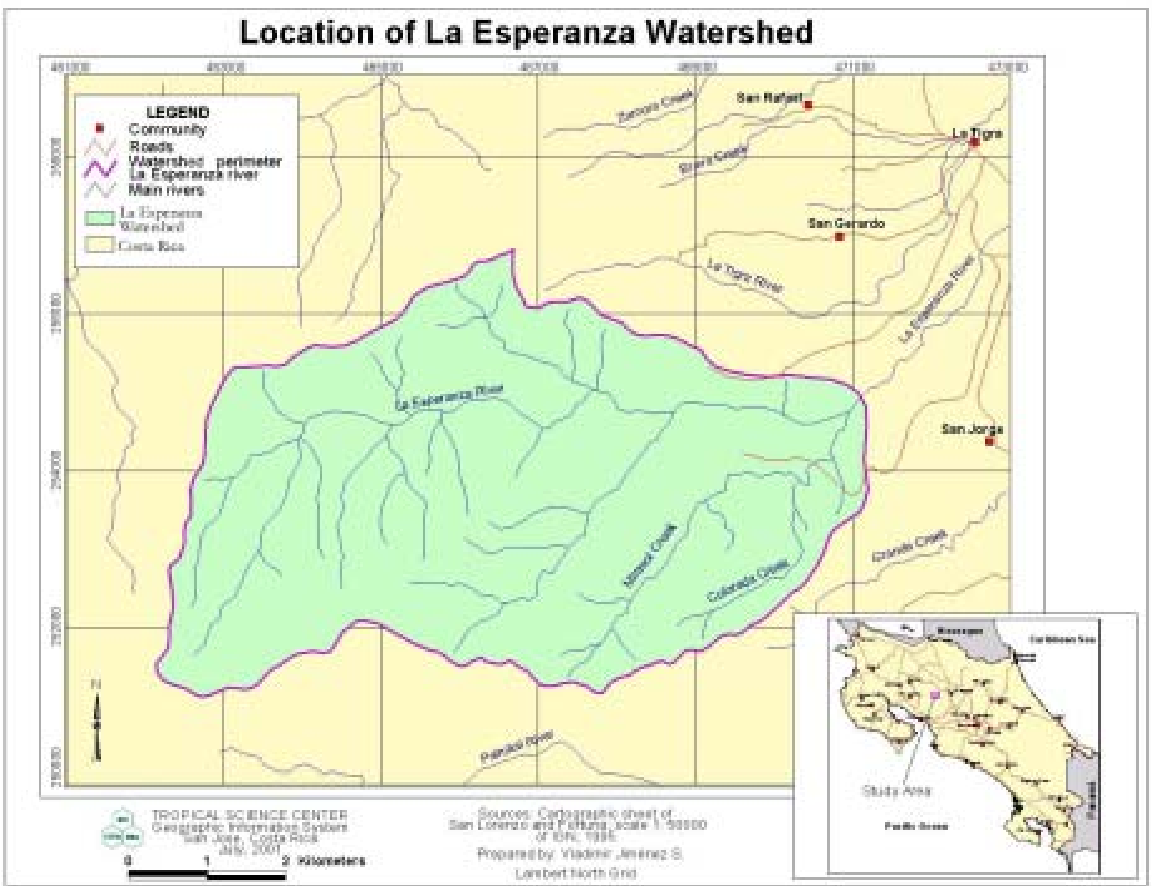
The paper is centered on describing the mechanism and its background. It is mostly based on interviews, as there is almost no published information about the specific case. The paper begins with a description of the context in which the cooperation mechanism was developed. Then, the mechanism itself and its background are detailed. Conclusions follow, including a summary of findings and an analysis of key aspects of the Case Study.

The setting: background information on the study area

Location of the Study Area

The study area is the watershed of La Esperanza River, which supplies water to La Esperanza Hydropower Project (LEHP). A majority of it lies within La Tigra district of San Carlos County and Angeles district of San Ramon County; both in the Province of Alajuela. The watershed is located on the Atlantic slopes of the mountains in northern Costa Rica (see Figure 2), and is very close to the highly visited tourist destinations of Arenal Volcano and the Monteverde Cloud Forest Preserve. Most of the watershed is within the Children's Eternal Rain Forest, owned by the Monteverde Conservation League (MCL).

Figure 1: Location of the La Esperanza watershed



La Esperanza Hydropower Project

In 1990, the government of Costa Rica partially opened the market of electricity generation to the private sector. Under these provisions, La Manguera S.A. developed a small hydropower plant named La Esperanza (LEHP) with a powerhouse of 6 MW installed capacity. The run-of-river project takes up to 5.5 m^3/s of water from a 12 meter-high rockfill dam on La Esperanza River (Morales, 2001; Rojas, 2001). Elevation at the dam site is 412 meters above sea level, from where water is transported through a 700 meter-long tunnel and a 1,600 meter-long open canal to a daily storage reservoir of 1 ha in size and 60 000 m^3 live storage capacity.

LEHP was designed to generate an average of 29 GWh per year. Seasonal variation in power production was forecasted to range from 24 GWh in a dry year to 34 GWh in a wet year (Bel Ingenieria, 1994). LEHP is a peaking-plant, designed to accumulate water throughout the day in order to produce electricity during the hours of highest energy consumption in the country. All power is sold to the Costa Rican Electric Power Institute (ICE) and delivered through the national grid.

Biophysical Characteristics of the Watershed

The headwaters of La Esperanza River are located at 1,700 meters above sea level (m.a.s.l.) in the Tilarán Cordillera, close to the continental divide. It is a tributary of the San Lorenzo River, which in turn flows into the San Carlos River before feeding into the large San Juan River that drains into the Caribbean Sea; along the border with Nicaragua. The dam of LEHP is situated on the upper La Esperanza River above the town of La Tigra. The watershed above the dam site has an area of 34 km^2 (see Figure 2).

The steep and irregular topography of the watershed, with slopes greater than 50 percent, makes La Esperanza a fast-flowing white-water river. Located in an area of high orographic precipitation, average annual rainfall in the watershed is approximately 4 500 mm. Intense rains combined with storm events, chemical alteration of the soils, and the volcanic material of low resistance, have given form to the landscape by carving deep river canyons. Natural landslides are relatively frequent in the upper catchment. The terrain is characteristic of the Monteverde geological formation in the Tilaran Cordillera, with some plateaus formed by lava flows and relict strato-volcanoes that have been deeply dissected by erosion (Tournon & Alvarado, 1997).

Along the river channel, fast-flowing areas through narrow canyons alternate with pools, where the velocity of water slows down. Pools have substrates composed of large stones, gravel, and sand. This combination provides a diversity of habitats used both by aquatic and terrestrial organisms.

Historical hydrological data is not available for the small watershed of LEHP, but measurements from nearby hydrometeorological stations allowed for extrapolations to be made before building the hydropower project (Rojas, 2001; Morales, 2001). In Costa Rica there are generally two seasons marked by the difference in monthly rainfall, making for a dry and a wet season. Although La Esperanza River is located in a very moist watershed, it is marked by significant seasonal variation in streamflow (Figure 2), resulting from changes in precipitation patterns.

Average annual streamflow was estimated using a twenty-year series as 4.8 m^3/s. The average annual streamflow for a dry year, which can be used as an approximation for dry season base flow, was calculated as 0.97 m^3/s. A wet year was estimated to yield an average annual streamflow of 6.07 m^3/s (Bel Ingenieria, 1994).

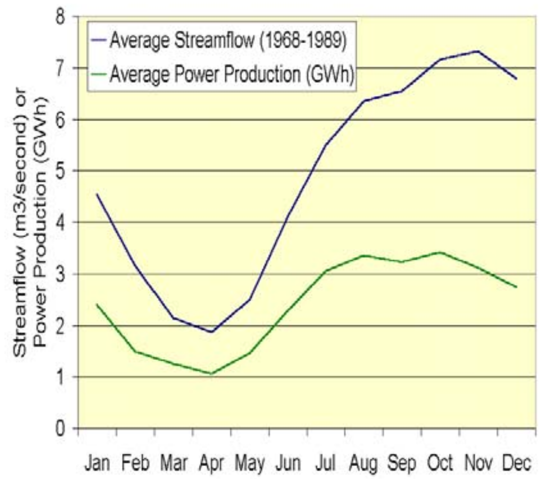


Figure 2: Average annual hydrograph of La Esperanza River & energy production at LEHP. Bel Ing., 1994.

As a run-of-river facility with limited storage capacity, seasonal variations in streamflow are of great importance to LEHP. During the dry season, water becomes the limiting factor for power production, while in the wet season there is often excess water available (Figure 2).

Design flood flows were estimated based on available hydrometeorological information. Table 1 describes the projected flood flows, including their recurrence intervals, which is a statistical probability of the frequency of such events. Due to the high volumes of precipitation and the steep terrain in the watershed, flood flows can be considerable, surpassing the average annual streamflow by 78 times its volume in the 100-year floods.

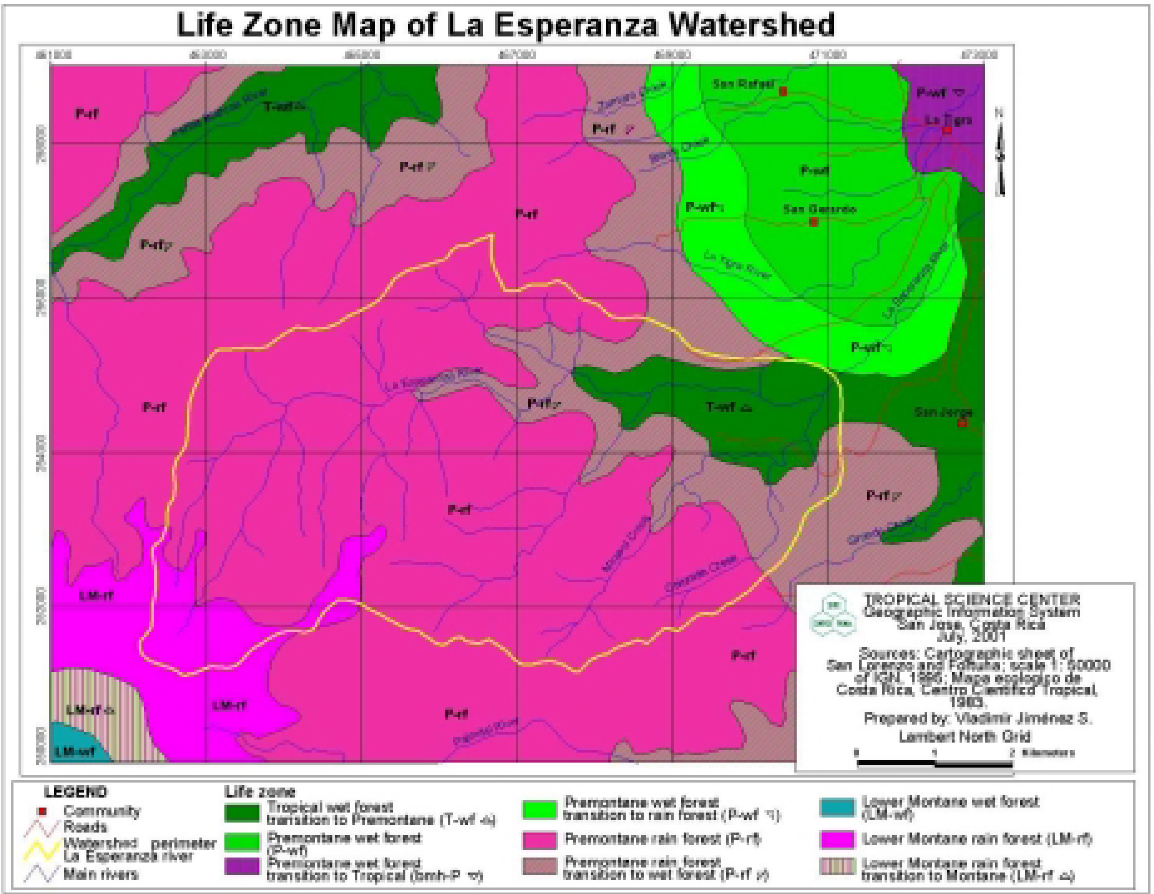
Table 1: Flood Flows and their recurrence intervals for La Esperanza River watershed. Source: Bel Ingenieria, 1994.

Recurrence Interval (years)	Design Flood Flows (m^3/s)
5	190
10	235
20	278
50	334
100	376

There are four different Life Zones[1] (as per Holdridge, 1967) in the watershed of LEHP (Figure 3). Premontane Rain Forest is the dominant Life Zone, found in 71 percent of the watershed. A second forest type, Lower Montane Rain Forest, covers 6 percent of the watershed and is found in the uppermost sections. The remaining 23 percent of the watershed is covered by two transitional Life Zones (Figure 3) that are found in the lower slopes of the watershed, where the transition into lowland forests begins.

[1] Holdridge's (1967) Life Zones is a system for classifying vegetation types. It is widely used in Costa Rica.

Figure 3: Holdridge Life Zones in the La Esperanza watershed]



Socio-economic setting

Small rural towns in the area are sparsely populated, the main one being La Tigra (Figure 2). Within a radius of 5 km from the project, other communities are San Jorge, San Isidro, Esperanza, and Bajo Rodriguez (Bel Ingenieria, 1994; Figure 2). A paved road crosses through the region along the base of the mountains outside of the watershed, connecting these small communities to the major populated towns in San Carlos and San Ramon. Basic services like education, health care, water, and electricity, are available to the communities.

Economic activities in the region are mostly centered around agricultural and cattle activities. Crops like coffee and fruit trees, double-purpose cattle (beef & dairy) and, more recently, ornamental plants for export are among the principal economic modes of production (Bel Ingenieria, 1994). Some individuals exploit forest resources illegally, such as hunting wildlife and extracting ornamental plants like orchids and bromeliads. These activities are sporadic and do not represent the mode of life of communities, instead they are complimentary activities.

There are no communities or households inside the watershed of LEHP, only a few individual homes along its periphery (Rosales, 2001; Rojas, 2001). Topographic conditions constrain the development of large agricultural areas and access within the watershed is limited to a dirt road that goes into the watershed for a distance of approximately 2 km. But the main reason why 98 percent of the watershed is still forested (Figure 4) has been the conservation efforts of the Monteverde Conservation League (MCL), a not-for-profit non-governmental organization (NGO) created in 1986.

The MCL has 167 members and currently owns over 22,000 ha of forestland in the Tilarán Cordillera. It was created by a group of scientists, activists, and community members with the goal of purchasing sections of the remaining forestland in the surroundings of Monteverde for conservation purposes. Their most successful campaign began in 1987, when children's groups in Europe started a fundraising campaign that allowed for the purchase of the Children's Eternal Rain Forest, the largest private preserve in Costa Rica.

Table 1: Current land use in the watershed of La Esperanza Hydropower Project

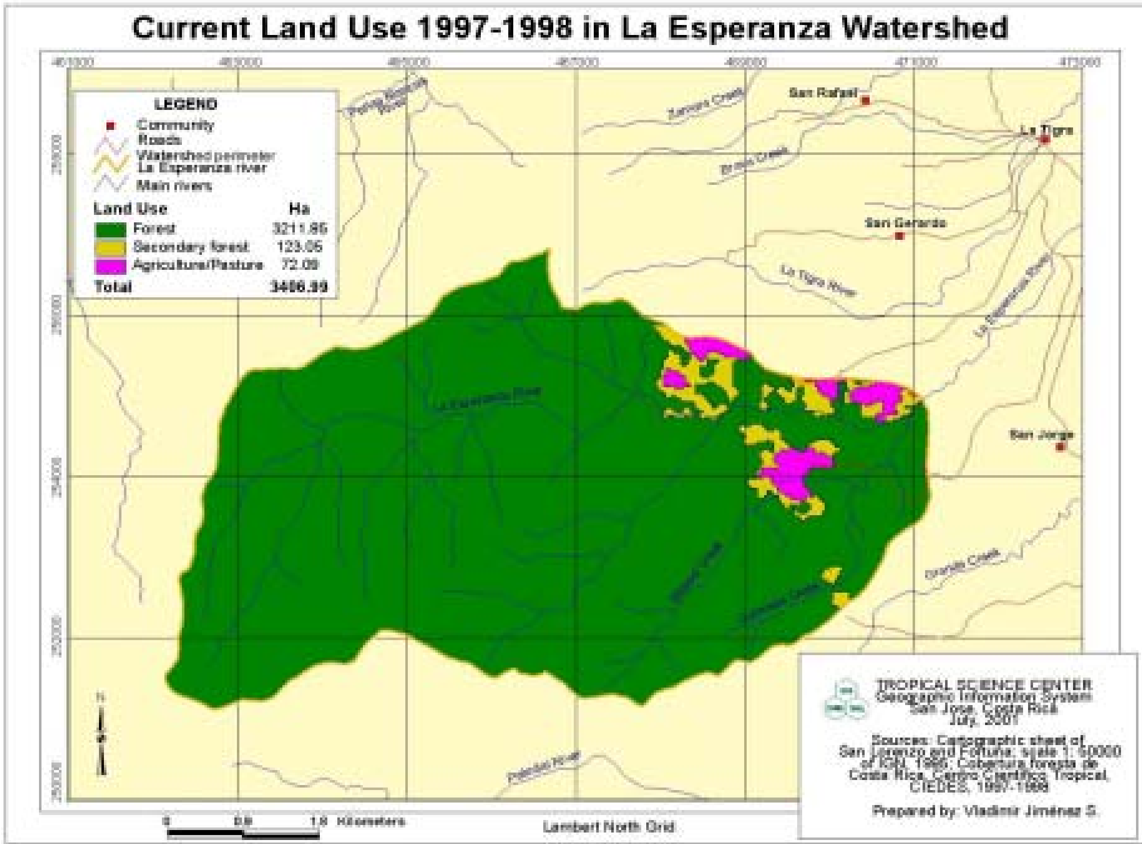
Land Use	Area (ha)	% of total area
Forest	3 212	94
Secondary Forest	123	4
Agriculture/Pasture	72	2
Total	3 407	100

Source: Figure 4

A land use map (Figure 4) prepared for this study by the Tropical Science Center indicated that 94 percent of the watershed is covered by mature natural forest, 4 percent is recovering secondary forests, and 2 percent has cleared areas of crops or pasture (Table 2). Most of the watershed terrain belongs to the MCL with the exception of a small area of approximately 300 ha.

Within the watershed, water is only used to produce hydropower. Water in the periphery of LEHP is mostly used to supply aqueducts for household consumption and dairy farms. Downstream it is used for recreation purposes, and for cattle that drink directly from the watercourse of streams and rivers.

Figure 4: Current land use in the La Esperanza watershed



A series of institutions and regulations deal with the management of land and water resources in the watershed of LEHP (Table 3). The key institution that manages land resources in the watershed is the MCL, which owns most of the land and patrols its forests to ensure its conservation and prevent any possible change in land use. To a lesser extent, the Ministry of Environment plays a role to ensure the conservation of forest cover, and is in charge of imposing fines or taking legal action for violations to the Forestry Law of 1996. Other laws impose restrictions on land use in areas close to springs and river courses, to preserve forest cover and avoid pollution (Table 3).

Table 3: Main institutions and regulations that deal with the management of land and water resources in the watershed of LEHP

Institution	Role / Responsibility
Monteverde Conservation League	Patrols its forestland to ensure its conservation and avoid any possible change in land use
Municipal Government/ Water Management Association	Are in charge of managing local rural aqueducts
Ministry of Environment	Is responsible for approving and assigning water concessions to hydropower producers. Oversees any violation to prohibitions to clear forests and assigns permits to cut trees.
Regulation	**Role / Responsibility**
Water Law of 1942	Assigns priority of water use over any other use to aqueducts for human consumption. Prohibits clearing trees close to springs
Land Use, Management, & Conservation Law of 1998	Promotes the sustainable use of land resources through appropriate planning.
Forestry Law of 1996	Prohibits changing land use in areas covered by forest. Restricts land use in forested areas close to watercourses, recharge areas, and springs.
Environment Law of 1995	Indicates that the government has an active role to ensure the protection of ecosystems that regulate water resources. Specifies the limitations of land use within protected areas, private or public.

The Ministry of Environment is responsible for the water concession of the hydropower project. In addition, local entities (Water Associations and/or the Municipality) are in charge of local aqueducts. According to the Water Law of 1942, water for human consumption has priority over any other water use, and supercedes any other right, or concession (Aguilar et al., 2001).

Contractual arrangement for upstream-downstream cooperation

The incentive mechanism that is the central subject of this Case Study is a contract signed between La Esperanza Hydropower Project, the downstream water user, and the Monteverde Conservation League, the landowner of the watershed. This contract establishes payments from the downstream water user to the forest owner for hydrological services of the forest. The conceptual framework of the contract is different but was modeled on the general concept of the payment for environmental services (PES) scheme developed in Costa Rica in 1996.

The La Esperanza contract in the context of Payments for Environmental Services in Costa Rica

During the 1980's and 1990's, the government of Costa Rica developed a series of economic incentives for the forestry sector, most of which focused on reforestation activities. In the mid-1990's, new incentives were developed to promote the conservation of forests outside Protected Areas. Shortly thereafter, external pressure (mostly from the International Monetary Fund) to eliminate government subsidies, led the country to the search for new options to promote the conservation of forests in private lands (Watson et al., 1998). With the approval of the new Forestry Law of 1996 a shift in the mechanism used to encourage forest conservation occurred with a switch from 'subsidies' for forest conservation to payments made for the 'environmental services' (PES) that forests provide.

The PES scheme was intended to create a market to internalize the costs of providing the goods and services from forestlands. It was assumed that without monetary compensation, deforestation would continue in private lands because "private decisions to convert forests fail to account for the value of the services that those forests provide to others" (Chomitz et al., 1998: 3). Therefore, the conceptual framework of the Forestry Law indicated that "forest cover could be maintained only if there were mechanisms to allow…beneficiaries to compensate landholders for the benefits they produce" (Chomitz et al., 1998: 5).

To operationalize the PES scheme, a formal mechanism was established in 1997. The National Forestry Fund (FONAFIFO), a department within the Ministry of Environment created in 1991 to distribute subsidies to the forestry sector, was designated as the government entity that seeks funds and redistributes them to providers of environmental services. A majority (>95 percent) of the funds distributed by FONAFIFO come from a tax on fuel that aims to provide economic resources to compensate the effects of burning fossil fuel on climate change (Sanchez, 2001). In the past, other resources have come from donations of foreign governments who have purchased greenhouse gas offsets. But overall, the conceptual structure of the PES scheme has not allowed for a clear linkage between providers and users of environmental services due to the leading role of the intermediary government agency.

The only cases where there has been a linkage between users and providers of environmental services has been where hydropower projects have made payments to FONAFIFO in exchange for having FONAFIFO give economic incentives to forest owners in the project's watershed. The first agreement involving a private hydropower producer (Energia Global de Costa Rica) was approved under the FONAFIFO PES scheme in 1997 as a voluntary commitment for a 5-year period. Two other hydropower companies (Hidroelectrica Platanar, Compañia Nacional de Fuerza y Luz) have joined the voluntary scheme since then.

FONAFIFO set US$ 40/ha/yr as the standard payment for a bundle of four environmental services: mitigation of greenhouse gas emissions, watershed protection, biodiversity protection, and natural scenic beauty. The US$ 40 figure came from a previous government subsidy for forest conservation that was eliminated when the PES scheme was developed. For the voluntary agreements with hydropower companies, they are only expected to make a retribution for only one of the four environmental services.

The FONAFIFO scheme for PES has laid out the background and conceptual framework for environmental service transactions in Costa Rica. Additionally it has provided certain standards such as the categories and the market value of environmental services. However, it has not been the only means to achieve the same goal of compensating forest owners for the services their land use provides to others. In the case of watershed protection, LEHP opted for a fully private contract between the project and forest owners in its catchment. The private agreement between LEHP and the MCL used the FONAFIFO PES scheme as a basis to define the value of the hydrological services per ha. It builds on this base value with additional innovations and is completely separate from the governments' PES program.

Perceived linkages between land use and water resources

It is reasonable to assume that in order to develop a contract or a market to pay for the hydrological services of forests, there must be a clear understanding about the linkages between land use and hydrology, as well as the economic consequences of these linkages for the parties involved. This understanding is needed to:

- identify and quantify the specific services that forests provide,
- identify and quantify how these services are translated into benefits for downstream water users, and
- assign an economic value to the services.

Such knowledge was not available in Costa Rica when the official PES scheme originated. Instead, the mechanism developed under a set of assumptions or "common knowledge" regarding the relationship between forest cover and hydrological functions. In the contract signed between LEHP and MCL, environmental services were defined as:

"those goods or services that in a direct or indirect fashion, are obtained due to the existence of an ecosystem such as natural forest. The forest provides the environmental service of capturing and retaining water, and avoids landslides and soil erosion, particularly in terrain with steep slopes." (translated by author).

The definition outlines several ecosystem functions that are perceived as beneficial to the downstream hydropower project. Although there has not been quantitative evidence to support the attributes ascribed to forests, the public generally accepts that forestland is the best land use to protect watersheds. An interpretation of the authors of what people perceive to be the hydrological functions of forests, and how these functions translate into downstream benefits, is given in Table 4.

In the LEHP-MCL case, the purchaser of hydrological services (LEHP) was willing to pay for the maintenance of a stable streamflow during the dry season, reduced peak-flows when the project can not use the additional water because of its small storage capacity, and a lower overall sediment yield (Rojas, 2001). Even though LEHP managers recognize that extreme weather events will keep occurring, regardless of land use, they believe that if land use were changed, the frequency of these events would increase (Rojas, 2001). On average, 4-8 events a year cause high streamflows in La Esperanza River that bring elevated sediment loads. During those events, the water intake gates are closed to avoid siltation of the reservoir, which means that power production can suffer since no water is flowing into the reservoir.

In the watershed of LEHP there is no formal monitoring process for hydrological variables or how they relate to land use. The only hydrological variable that is quantified indirectly, is the volume of water used by the hydropower project, which can be derived from the total amount of electricity produced (Morales, 2001). Instead, forest cover is used as an indicator of change in the watershed that is assumed to affect hydrological variables (Sanchez, 2001; Ortiz, 2001). The FONAFIFO PES scheme uses Geographic Information Systems (GIS) as a tool to quantify changes in forest cover through time. The MCL has GIS capabilities, but has not yet implemented a formal monitoring system of forest cover.

Smyle (1999) has suggested that avoiding changes in land use in the watershed of a hydropower project can be a means to reduce risk, even where the links between land use and hydrology have not been quantified. In other words, by preserving the current land use in the watershed of the project, the risk of changes in hydrology due to human induced modifications to the land use patterns is minimized. Such a risk minimization approach has been implicitly chosen by LEHP, who has opted to invest in keeping their watershed with 98 percent forest cover. Those interviewed agreed that investing in a PES scheme is worth it even though there is no clear quantified linkage between land use and hydrology (Castro, 2001; Rojas, 2001; Rosales, 2001; Sanchez, 2001; Ortiz, 2001). Kaimowitz (2000) provides a good summary of the reasoning behind this perspective:

> "While we still don't know enough about the effects of land use changes on climate, water flows, and sedimentation, the simple fact that economic activities have altered the existing ecological balances poses inherent risks, and the precautionary principle makes it incumbent upon us to seriously address those risks." (Kaimowitz, 2000)

For the LEHP-MCL case we can then conclude that there has been no quantification of the relationship between land use and hydrology. The agreement is based on a set of assumptions and perceptions about the role of forests on hydrological variables. From the company's perspective, it could be viewed as a means to reduce uncertainty and therefore the risk to which an investment is exposed.

Table 4: Author's interpretation of people's perception about the hydrological functions of forests and the expected benefits for downstream run-of-river hydropower projects

Perceived Hydrological Functions & Services of Forests	Expected Benefits for a Downstream, Run-of-River, Hydropower Project
• Forests have lower surface runoff rates, making for higher **infiltration** capacity than other land uses	The root network of trees and low soil compaction rates allow more water to go into the soil as opposed to flowing quickly over the surface and into the streams. This higher infiltration capacity is a key function to increase the water retention time in the watershed.
• The higher infiltration capacity allows for a longer water **retention** in the soil	Water that infiltrates into the ground will be released slowly into the stream, either as sub-surface flow through the soil, or as baseflow from groundwater sources. This makes for a more even distribution of water throughout the year and it evens out the pattern of streamflow, reducing abrupt peak flows during rain events.
• The higher infiltration and retention rates of forests make for a more **even distribution** of streamflow throughout the year, ameliorating the differences between dry and wet season flows	The hydropower project has a very small storage capacity, and mostly depends on the water that is available in the stream. If water can be stored in the catchment and is then slowly released as baseflow, then the project will have a more reliable and constant source of water to produce power. This is considerably more important during the dry season, when streamflow is the constraint for power production. It must be noted that power generated during the dry season has a higher price than that produced during the wet season.
• **Erosion rates** are lower in forests than in other land uses, making for stream flows with lower sediment concentrations	High sediment concentrations in streamflow has two negative consequences for small hydropower projects. One is that it silts up the small daily storage reservoir. Silt removal is expensive not only because of the machinery, but also because it requires stopping electricity production during the clean-up. The second negative consequence is the abrasive effects of sand and suspended particles on the machinery, particularly the blades inside the turbine.
• Some types of forest can actually have higher water yields in the dry season by collecting **horizontal precipitation**	By condensing fog, cloud forests can contribute to a greater streamflow in the dry season, which is greatly beneficial to run-of-river projects that have greater water needs in the dry season.

Description of the contractual arrangement

On October 28th 1998, the MCL and La Manguera S.A. signed a contract[2], which included the mechanism of cooperation that is the subject of this Case Study. The mechanism is a fully private contract between two private entities: a not-for-profit conservation NGO and a private hydropower company. It focuses specifically on preserving forest cover as the desired land use and has a duration of 99 years. There was no mediation between the two parts, nor was there any government involvement, which are key differences with the FONAFIFO PES scheme. As there was only one landowner in the watershed, negotiations were direct and the transaction costs were relatively low. At the time it was believed that there were no other providers of

[2] An English version of the entire contract is available in Janzen (1999).

environmental services in the watershed, which makes the MCL the only landowner involved in the agreement.

The cooperation mechanism is the byproduct of a land ownership dispute between the two parties that revolved around an area of half a ha. This area was vital for the hydropower project, as the dam and water intake were to be built there. The conflict arose because of an overlap in two different official land entitlements, in which both entities appeared to own the same parcel of land. Such conflicts can happen due to mistakes in topographical work at the time of inscribing a property in the land registry, resulting in two neighboring properties having a claim over the same piece of land. Usually the party that has possession of the land at the time of the conflict gets to keep it unless the other party can demonstrate the validity of its claim, which can take several years. In this case, the MCL held possession of the land at the time of the dispute, which made direct negotiations a speedier process for LEHP than having to go through the legal system.

The contract resolved the land dispute by granting surface rights to LEHP, which means that the MCL retained full ownership of the land but it allowed LEHP to build and utilize the land autonomously for a period of 99 years. At the end of this period, the surface right will expire and the infrastructure will become the exclusive property of the MCL. Although the contract states that the payment for environmental services is explicitly independent of the surface right, it is clearly an end product of the negotiations initiated because of the land dispute. In fact, the contract states that if LEHP is delayed and has not made a PES one month after it was due, the MCL will immediately recover the surface right to the land and all infrastructure on it. It is doubtful if the PES scheme would have taken place had there not been a land conflict and one could argue that MCL is leasing the land to LEHP in return for a share of LEHPs profits. The land itself and the infrastructure is the collateral.

The cooperation mechanism consists of the payment for the environmental services produced by the forests of the MCL, services that are received downstream by LEHP. A definition of environmental services as understood in the contract is given in section 3.2 of this document. Although in the contract the watershed size was overestimated at 3 800 ha, negotiations yielded that LEHP would make payments for environmental services only in an area of 3 000 ha.

In 1997, the first agreement involving a private hydropower producer (Energia Global de Costa Rica) was approved under the FONAFIFO PES scheme. The contract between the MCL and LEHP came a year later, which allowed the parties to learn from the general concept of the existing official scheme. Since FONAFIFO paid landowners approximately US$ 40 per ha per year during a 5-year period for four environmental services, their agreement with Energia Global de Costa Rica established that the hydropower producer should only pay for one environmental service, namely watershed protection. The US$ 40 were divided equally among the four services so that Energia Global de Costa Rica would pay for US$ 10 per ha per year. This amount was established independently from the service itself, as it was not quantified in any way, but having no better data available, it set the standard for comparison in the MCL-LEHP case. As mentioned earlier, FONAFIFO obtained the US$ 40 figure from a previous subsidy for forest conservation.

Instead of fixing payment for the duration of the entire contract, the MCL-LEHP contract introduces different amounts to be paid at different stages of the project. It starts out with a payment of US$ 3/ha/yr during the construction phase of the hydro project, and is gradually raised to US$ 10/ha/yr on the third and fourth years of operations (Table 5). All payments up to the fifth year are to be made in advance, at the beginning of every year. After that, payment is made retroactively every six months.

Table 5: Amount paid* for environmental services to the MCL

Period of Payment	Payment** (USUS$ /ha/year)
During Construction	3
1st Year of Operations	8
2nd Year of Operations	9
3rd & 4th Year of Operations	10
5th Year & onwards	Based on a formula, adjusted every 6 months

*All payments up to the fifth year are made up front at the beginning of each period. From the fifth year onwards, they are paid at the end of every six-month period. ** The amounts are paid for a total area of 3,000 ha

From the fifth year onwards, the amount to be paid is variable, calculated every six months using the formula:

$$\mathbf{PES = US\$\ 10 * (G_r/G_f) * (T_{avg}/T_{beg})}$$

Where:
US$ 10, is the reference value of the services per ha per year
G_r, is the real energy (GWh) generated during the time period
G_f, is the forecasted energy (GWh) production for the time period
T_{avg}, is the average power tariff (USUS$) paid throughout the time period
T_{beg}, is the tariff (USUS$) paid for the energy generated on the first day of the time period

The innovative aspect of the formula is that it links the payment to power production and inflation. If the power plant produces more or less power, it will proportionately affect the total amount paid to the MCL. Also, because the power tariff changes through time, it allows for adjustments to be made accordingly. Therefore, if the power plant produces more power, the MCL receives more than US$ 10/ha/yr. Similarly, if the electricity tariff increases, so does the payment to MCL. The US$ 10/ha/yr were defined solely on the negotiations between the two parties, using the case of Energia Global de Costa Rica as a reference (Rosales, 2001; Rojas, 2001) and reflecting the willingness to pay of LEHP and the willingness to accept on behalf of the MCL.

In exchange for the payment for hydrological services made by LEHP, the MCL commits to:

1. Conserving and protecting the existing forests in the watershed of LEHP
2. Watching for and rejecting land invasions that might take place in the watershed
3. Managing the forest area and the forest rangers who protect it
4. Attaining the economic means to fulfill its conservation commitment

In the contract there is no control mechanism for these services.

LEHP began its operations in January 1998, so it will not be until the year 2002 that the formula will be implemented for the PES. With regards to enforcing compliance of LEHP in making the payments to the MCL, a contractual clause states that in such case, the difference is to be resolved through the Rule of Arbitration of the Center of Reconciliation and Arbitration of the Chamber of Commerce of Costa Rica. In case the arbitration process determines there was fault on behalf of LEHP, the MCL will get to keep the infrastructure built on its property, and the surface right given to LEHP will be extinguished. There is no specification in the contract about measures in case of non-compliance on behalf of the MCL.

Financial cost implications of the PES for LEHP

Compared to the other PES contracts that have been implemented with private hydropower producers in Costa Rica, all of which are voluntary and use the FONAFIFO PES scheme, LEHP makes a far greater investment in its watershed (Table 6). This is determined by adding the total investment in PES per year and dividing it by the power production capacity of each project, which is used here as a standard of project size. The method allows for an even comparison of dollars invested in PES per unit of power generating capacity of the projects. LEHP invests US$ 5/kW/yr, while all others invest less than US$ 1.50/kW/yr (Table 6).

There are two reasons that explain the difference. The first is that LEHP protects a greater percentage (88 percent) of its watershed than all other projects (62 percent on average). Second, LEHP has a much higher watershed to installed capacity index (0.57) than other projects (0.2 on average), which means that it has a larger watershed in proportion to its power capacity (Table 6). If LEHP operated under similar conditions as the other projects (0.2 ha of watershed per installed kW, and PES to 62 percent of the total watershed area), its investment in PES per installed capacity would be US$ 1.24/kW/yr, which is comparable to the other private projects.

Table 6: Comparison between the PES scheme of LEHP & other private hydropower projects

Hydropower Project	Installed Capacity (MW)	Area of Watershed (ha)[a]	Area Receiving PES (ha)[a]	Percent of w'shed receiving PES	Annual PES (US$/ha)[a]	Investment (US$/kWh[b])	W'shed area per kWh[c]
Don Pedro	14	2 403	1 818	76	10	1.30	0.17
Volcan	17	3 458	2 493	72	10	1.47	0.20
Platanar	15	3 567	1 400	39	15	1.40	0.24
L. Esperanza	**6**	**3 400**	**3 000**	**88**	**10[d]**	**5.00**	**0.57**

PES = payment for environmental services
a - information for all projects except La Esperanza taken from Cruz Rios & Navarrete Chacon, 2000
b - Total Investment in PES Proportional to Installed Capacity (US$ / kW/yr)
c - Index of watershed area per installed capacity (ha/KW)
d - US$ 10 is used as an average PES per ha per year

As PES are made on an annual basis, and in this case due to the formula they are proportional to power production, they can be considered as Operation & Management (O&M) costs. CT Energia (2000) estimated average annual O&M costs for large government owned hydropower plants in Costa Rica at US$ 2.50/MWh. This means that on an average year, O&M costs at LEHP would be US$ 72 000. However, this is a very low estimate, given that small hydro projects have a series of fixed costs that makes their O&M much higher than that of larger projects. The real O&M costs are more likely to be twice the estimated value for large power projects (Chavez, 2001), approaching an annual cost of US$ 140 000. Assuming an average PES of US$ 10/ha/yr, LEHP must pay US$ 30 000 in environmental services every year. The PES scheme at LEHP is therefore a considerable additional cost for the hydropower project, representing a 21 percent increase in annual O&M costs.

Findings & Conclusion

This paper has presented a detailed description of the context of the La Esperanza Hydropower Project and the agreement between the project owner, La Manguera and the upstream landowner, the Monteverde Conservation League. This level of detail is necessary in order to go beyond the level of generalities all too often observed in a new field such as that of markets for environmental services and understand the conditions under which the mechanism was developed with a view towards replicating or adapting the experience to other circumstances.

Reviewing the experience of the MCL-LEHP agreement to date suggests a series of potential responses to key questions as to how to go about developing markets for environmental services, and in particular hydrological services (Johnson, White & Perot-Maitre, 2001). While these findings are only formative given the small sample from which they are derived they may be of use in the assessment and development (or revision) of new, market-based arrangements for ecosystem management and the provision of hydrological services. The following points summarize the findings regarding the agreement on payment for environmental services between the MCL and LEHP:

The hydrological impacts of different land uses were not assessed. A series of complications made it difficult to quantify the environmental services attributed to forests. A major constraint was the absence of historical hydrometeorological data for the watershed of LEHP. There are monitoring stations downstream and in the surrounding areas, that could have been used via extrapolation, as was done in the hydrological study prior to constructing LEHP. But extrapolation brings an additional factor of potential error that makes it difficult to segregate the impact of land use from other variables that also influence hydrology, such as long-term climate patterns. Even further, the lack of land use change or experimental studies in the target area would have required the application of existing predictive models and the calibration of their parameters to La Esperanza watershed.

*The financial payment or incentive is not based on the value of the service provided***.** Given the lack of a quantitative basis for determining the hydrological service provided by the current land use, it was not possible to develop estimates of the economic value of the services. However, the lack of hydrological or economic information did not constraint the negotiations, instead both parties negotiated based on a series of assumptions about the biophysical interactions and with reference to the established precedent of the price set by the national PES scheme. It is likely that there were other benefits on both sides such as the land right that, added to the assumptions, made the deal acceptable to all. For the purchaser of the services, the public image of financially contributing to conserve tropical rain forest was well worth it, particularly as the negotiations took place during a period where communities in Costa Rica were very vocal about their opposition to private hydropower projects.

Forest cover is used as an indicator of guaranteeing hydrological services i.e. augmentation of dry-season flow, attenuation of peak flow and erosion rate, even though its effectiveness is uncertain. The cost of data collection effectively constrains the monitoring the environmental services throughout the duration of the contract. As Aylward (1999) has suggested:

"contracts may be established for the means to the end rather than the end itself. In other words, contracts may sidestep the measurement problem by specifying specific actions to be undertaken by landowners in terms of changes in land use or land management. The contract then becomes verifiable, even if the exact result remains unverifiable."

The arrangement is largely aimed at avoiding perceived risks by land use change. Due to the lack of information and the costs of obtaining that information, the decision of the hydropower project to invest in conserving forest as the preferred land use can be interpreted as a strategy to minimize risk. Any change in land use, whether it be deforestation or reforestation, could result in greater uncertainty for the investment, making the for a riskier venture. Preserving existing land use in the watershed at the time the investment is made minimizes such risks.

LEHP chose to invest in PES even though the land use was unlikely to change. The land in the watershed was already forested. It had been purchased by the MCL with the explicit purpose of keeping it that way. Therefore the land use in the watershed would have been forest with or without the PES scheme. The PES cover an important percentage of the MCLs annual operating costs (between 10 percent and 25 percent, Rosales, 2001), which makes for a more effective conservation effort. It helps guarantee the conservation of land use in the long-term, as the cash inflow from donations on which the MCL depends is variable and unpredictable. In a sense, this situation makes valid the argument that:

"While the immediate hope is that such [cooperation] mechanisms will ensure the continued provision of such [environmental] services, the motivation is perhaps more accurately described as a subset of the larger effort to conserve natural ecosystems." (Aylward, 1999)

Setting aside the issue of the merits and worth of the hydrological services a series of additional findings emerge from this paper regarding the application of market-based incentive mechanisms to hydrological services.

A land ownership conflict was solved through the implementation of the PES scheme. The PES contract served the purpose of solving a land dispute by granting surface rights to LEHP to a parcel of land claimed by both parties but of which the MCL held possession. This condition gave considerable bargaining power to the MCL. Although the contract states that the payment for environmental services is explicitly independent of the surface right, it is clearly an end product of the land dispute negotiations. Whereas other PES schemes in Costa Rica that involve private hydropower producers are voluntary contracts, the contract between LEHP and the MCL can be interpreted as a lease agreement that was necessary to execute the power project. At the same time, project managers explicitly state their preference of forest as the land use of choice in the project's watershed, for which they are willing to pay through the PES scheme. It is therefore difficult to desegregate what portion of the total payment made by LEHP goes to cover the leasing cost versus how much is used to cover the perceived environmental services provided by forests.

Voluntary contractual arrangements are a viable form of market-based incentive mechanism for the internalization of hydrological services. Previous PES schemes in Costa Rica have relied on a centralized approach using an official intermediary between buyers and sellers in the effort to develop market-based mechanisms to compensate owners for beneficial externalities of forests. The LEHP-MCL agreement mechanism demonstrates that voluntary contractual agreements or Coasean Bargains involving the negotiation of a direct payment by the consumer of the service to its producer are also a viable alternative[3].

Voluntary contractual arrangements are feasible where transaction costs are low, i.e. where numbers of participants and watershed scale are limited. The small scale of the watershed area concerned and the existence of a sole upstream provider of watershed services and sole downstream user clearly lowered transaction costs of negotiating a contractual arrangement. Similarly, the more landowners involved in a scheme and the larger the watershed the more difficult the monitoring and enforcement of compliance.

There are two possible observations that can be derived from this experience. First, this case suggests that in order to establish the contractual arrangement there was no need to quantify in biophysical or economic terms the land use impacts on hydrology. However, at the same time the paper demonstrates that the cost to the hydropower project of paying for these services are likely to be a significant portion of annual O&M costs. Even further the paper shows that in comparison to other small private hydropower projects in the country, including those that are also paying for these services, the investment represented by these payments reduces the relative profitability of the LEHP.

The second cautionary observation made is that to the extent that the payments are significant cost components and not just a mix of corporate social responsibility or 'reputational' investments the widespread application of hydrological service payments is likely to rest with the ability to demonstrate convincingly their contribution to shareholder value. Clearly, at present there is a large gap between what is known in scientific and economic terms about the value of these services and the manner in which these services are 'traded.' Much remains, therefore, in the area of price discovery.

Different incentive mechanisms may be used to achieve the same outcome. A narrow-minded focus on a particular institutional arrangement and incentive mechanism should therefore be avoided, and experimentation with different arrangements and mechanisms encouraged. In Costa Rica, the only other PES scheme where hydropower producers have entered into a contract to compensate landowners upstream is the official FONAFIFO scheme. The LEHP-MCL contract demonstrates that the FONAFIFO scheme is not the only option available to reach the same end result. Depending on the preferences of those involved and the transaction costs of the alternative schemes, one scheme might prove more attractive than the other one.

Clearly the development of a contractual arrangement in the LEHP-MCL case was favored by the low transaction cost due to the direct negotiation and lack of intermediaries. In this case the presence of a central intermediary that does not play any role in producing or consuming the services was superfluous. What remains to be evaluated more fully is to what extent these factors are crucial determinants of the

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[3] "the negotiation and agreement of a contract for the exchange of a resource, function or ecosystem between the producer of an environmental function and the consumer of related services, otherwise known as a Coasean Bargain" (Aylward, 1999).

feasibility or relative attractiveness of different incentive mechanisms. In a more complex watershed it may be that the established institutional capacity, framework, and bureaucracy of the FONAFIFO scheme lends itself better to establishing payments ‘for hydrological services’ than an independent contractual arrangement.

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