

What are we learning from experiences with markets for environmental services in Costa Rica?

A review and critique of the literature

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ENVIRONMENTAL ECONOMICS PROGRAMME

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International Institute for Environment and Development (IIED)

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Note from the authors

This paper aimed to analyze the growing body of literature on markets for environmental services in Costa Rica. Most of the collecting of references, analysis, and writing took place in 2001 and early 2002. Given the dynamic nature of the topic we had to stop gathering new references at some point in order to be able to complete the paper. We chose March 2002 as a cut off date, with some exceptions.

Trying to document an evolving subject was a challenging task. As we were writing, new ideas and references were emerging. This is a reflection of Costa Rica, which has been a prolific laboratory of experiences in the environmental field during the last twenty years. There is no doubt that by the time this paper is published the reality in Costa Rica will be different from what we describe here. Nonetheless, we consider the paper can provide a useful analysis of the period ending in 2001.

Although we tried to limit our sources to published materials as much as possible, including grey literature, for some information we had to rely on interviews, phone calls, and correspondence. We would like to acknowledge all those people who kindly offered their time and shared their views with us. We are also thankful to everyone who contributed to the process of amassing the reference materials, especially Ronald Mejias. We would like to thank in particular staff at FONAFIFO, Alexandra Saenz, Oscar Sanchez, and Edgar Ortiz, for sharing information, documents, and their views, on several occasions. IIED provided guidance throughout the process. Joshua Bishop provided the initial impetus for the paper and Ina Porras provided useful feedback on an earlier draft.

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1 Introduction

The use of markets and payments for environmental services is a topic gaining increasing attention amongst policy-makers and environment and development practitioners around the globe. Simply put, the term ‘environmental services’ can be taken to refer to the overall concept of natural systems providing a continuous flow of valuable goods and services to society. This is in contrast to similar services provided by man-made physical infrastructure and technological capital (i.e. water treatment, artificial fertilization, genetic modification) for which these environmental services are a substitute. The use of market mechanisms as a means of incorporating the economic value of these environmental services into the financial decision-making of producers and consumers is an additional tool that can be employed to resolve longstanding market failures that lead to less than desirable economic outcomes – i.e. having fewer environmental services and paying more for their man-made substitutes.

In the developing world, Costa Rica has led efforts to experiment with the application of these mechanisms, many of which were simply ideas on paper just a few years ago. A survey of markets for environmental services by IIED highlights the formative role Costa Rica has played and provides a rich characterization of the economics of these initiatives in a global context (Landell-Mills and Porras 2002). As a complementary effort, this paper digs deeper into the literature regarding the Costa Rica experience in an effort to see what we are learning from the experience: how has technical, scientific and economic information on environmental services fed into these initiatives? To what extent are these initial experiences being monitored and evaluated? Is there a feedback loop that connects these experiences with learning about environment and development issues, particularly in the local context of policy-making within the country?

The principal objective of the literature review is to identify and review documents and other material that address the following:

1. the local origins of the concept of payments and markets for environmental services and how they have developed over time, particularly in relation to the broader international development of the concept and local necessities/realities (historical and trend analysis);
2. the types of existing initiatives related to markets for environmental services, and who is participating in such initiatives (descriptive work);
3. the knowledge base that underpins market development, i.e. the extent to which markets are based on specific scientific and technical knowledge regarding the biophysical, economic and social relationships involved as opposed to general views on the subject (critical assessment);
4. the initiatives undertaken and underway to date with respect to the monitoring and evaluation of the experience with payments and markets for environmental services and to what extent (and with what results) the literature assesses these initiatives in terms of economic efficiency, environmental effectiveness, and social equity and/or poverty reduction.

Where written material is not available or does not provide comprehensive coverage, interviews with those involved in these initiatives were used to supplement the documentary

evidence. Given that IIED has undertaken a thorough review of the global literature on this topic and identified the examples emerging from Costa Rica, objectives 1 and 2 draw heavily on the existing IIED work by attempting to cross-check, confirm and, where possible, expand the coverage (in number and depth) of existing cases of markets and payments. The added value of the literature review will be in the deepening of the knowledge base and analysis of its content with respect to objectives 3 and 4. This in turn provides a basis for charting a way forward.

The paper is organized to cover the objectives one by one. In the first chapter the local origins of the concept of markets and payments for environmental services in Costa Rica is explored. The paper then turns to the experiences (or market cases) gained so far in the country, providing in each of the succeeding chapters a description and review of each of the cases, an assessment of the role of knowledge in the development and formulation of the initiatives and a report on monitoring and evaluation underway to date. The paper concludes by drawing out some of the lessons learned and making recommendations regarding practical steps that other countries, researchers and financing organizations might take to improve the process of launching such initiatives in the future.

1.1 References (Chapter 1)

Landell-Mills, N., and I. Porras. 2002. *Silver bullet or fools' gold: A global review of markets for forest environmental services and their impacts on the poor*. London: International Institute for Environment and Development (IIED).

2 Local origins of payments and markets for environmental services

Pagos por servicios ambientales or ‘payments for environmental services’ (PES) as set forth and defined in the Forestry Law of 1996 defines new terminology for Costa Rica. It also marks an important international milestone with respect to the development of policies that promote efforts to convert the economic value of environmental services as received and perceived by consumers into financial incentives targeted to the producers of these services. However, viewed in historical context it can be seen as a result of an evolving national concept of how to use markets and payments to ensure the provision of the products and services that ecosystems – not just forest ecosystems – provide to human society. In this section the origins and precedents in this regard are explored, focusing primarily on a number of key ingredients that have led not only to an established legal definition of the term PES, but also to a more unconstrained exploration of the concept in the context of forests, environmental services, and biodiversity.

Indeed, in drawing lessons from the Costa Rican experience it is important not to fall into the trap of believing that the system of PES now in place either represents the totality of the Costa Rican experience with the larger concept of markets for environmental services, or that the legal definition of environmental services is one that should automatically be replicated elsewhere. Thus throughout the paper an effort is made to distinguish between the legally established confines of the PES term and the larger conceptual ambit of the concept of markets for environmental services. While markets for environmental services is in itself an ambiguous and difficult term, it is taken to refer to the larger effort to employ market mechanisms to resolve externality problems with respect to the provision of environmental services (Aylward 2002).

2.1 Environmental services and the evolution of markets for their provision

Environmental services have been recognized for a long time in Costa Rica, although clearly the attention they have received, both locally and internationally, has increased in the last 20 years. The environmental service that has the longest history of formal recognition is the service of watershed protection. One of the earliest official acknowledgements dates back to 1888, when a decree was passed declaring a 2-km wide strip on the sides of Barva Volcano as state-owned land, which could not be appropriated by any individual. The area was considered of public interest because the streams and springs that supplied drinking water to the towns of Alajuela and Heredia had their headwaters on the slopes of the volcano (Watson et al. 1998).

Although some protected areas were instituted in the early 1900s,¹ recognition of biodiversity and scenic landscapes is a more recent development, beginning in the 1970s with the establishment of the country’s system of national parks, biological reserves and other protected areas. By 1999, the 120 protected areas in the country covered 1.2 million hectares, which represented 24.8 per cent of the national territory (see Table 2.1). In the early stages,

¹ “Poas Volcano entered the system in 1913, and the summits of all volcanoes were declared national parks in 1955” (de Camino et al. 2000).

Costa Rica closely followed the institutional model of the United States, in which separate institutions manage wildlife, forestry, and national parks. During the 1980s and 1990s the system of protected areas evolved as the main mechanism to preserve biodiversity. In 1995 the entire country was divided into ‘conservation areas’, 11 in all, effectively uniting these protected areas with surrounding multiple use areas in recognition of the interlinkages in terms of environmental services provided to economic activities in surrounding areas.² The three services – wildlife, forestry and parks – were then merged and operations decentralized to these conservation areas. Changes to the areas under protection, by category, during the 1990s are shown in Table 2.2.

Table 2.1. Historical evolution of protected areas in Costa Rica, 1955 to present

Year	Percentage of National Territory in Protected Areas
1955	0.05%
1990	16.8%
1997	23.8%
1999	24.8%

Source: Adapted from de Camino et al. (2000)

Table 2.2. Changes in the number and area of protected areas in Costa Rica, 1991-1997

Type of Protected Area	1991		1993		1997	
	No. of sites	Area (Ha)	No. of sites	Area (Ha)	No. of sites	Area (Ha)
National Park	14	465,698	20	505,484	24	541,576
Biological Reserve	7	17,653	8	30,482	9	39,644
National Monument	1	217	1	217	1	217
Forestry Reserve	13	No data	9	312,930	12	291,513
Protected Zone	21	No data	27	188,350	31	178,677
Wildlife Refuge	9	No data	9	117,483	39	181,018
Wetland	0	No data	0	0	14	50,465
Total	65	1,094,413	74	1,154,945	132	1,284,543

Source: MINAE (http://www.minae.go.cr/estrategia/Inf_Pais/labor_art8_al.htm)

By the early 1990s tourism had surpassed coffee and bananas as the country’s number one earner of foreign exchange, the National Biodiversity Institute (INBio) had signed its famous \$1 million contract for biochemical prospecting with Merck, Sharpe and Dohme, Inc. and ‘green’ product certification efforts were well underway by the Rainforest Alliance and other actors. In 1994 the government raised the entrance fee to national parks for foreigners to \$15 (from \$1), again reflecting Costa Rica’s position as an early adopter of the concept of creating markets for environmental services and applying the principle of ‘user pays.’ During this same period Costa Rica had taken a leading role in the field of Activities Implemented Jointly, which allowed the country to capture funds from developed countries to invest in actions within Costa Rica that would contribute to the reduction of atmospheric greenhouse gases. By 1994 Costa Rica had established the Costa Rican Joint Implementation Office

² Executive Decree No. 24652-MIRENEM established the framework for the operations of the National System of Conservation Areas (SINAC).

(OCIC), a government office responsible for climate change negotiations and the government counterpart for potential projects, shortly thereafter developing a series of climate change mitigation projects in the fields of energy and land use.

So, by the mid-1990s there was in Costa Rica an increasingly widespread appreciation of the linkages between environmental services and the economy, particularly among a growing clique of environmental policy-makers and entrepreneurs. The adoption, experimentation and nationalization of these concepts emerged from a familiarity with international ‘best practice’ in the application of economic tools to the environment, as well as from Costa Rica’s own growing empirical database of valuation studies. In Section 4 the question of the precise role of empirical work and, in particular, economic valuation in this evolution is taken up again. For the moment it is sufficient to stress that prior to the advent of the term PES as coined in the Forestry Law of 1996, the concept of markets and payments for environmental services was well known – even if it was not referred to as such.

Still, the proximate forces that drove the development of the term PES in the Forestry Law of 1996 came from the forestry sector and these are reviewed in more detail below. Indeed, it could be said that the majority of the early initiatives focused on providing new sources of financial flows to officially designated protected areas (prospecting activities, entrance fees, carbon sales for locking up forest in protected areas) and that the migration and transformation of the general concept to the forestry sector, where land is privately managed, was a natural and inevitable extension of the concept to new and fertile ground.

2.2 Incentives for the forest sector

Economic incentives for the reforestation sector were first established in the original Forestry Law of Costa Rica. The law was passed in 1969 but the incentives entered into operation only in 1979. Initially the incentive was intended as a means to promote tree planting through credits that would benefit medium and small size landowners (Camacho et al., 2000). However, the government opted for actions that would give tax credits to those who pay income taxes, which excludes many if not most of rural landholders. A fixed amount of 16,000 colones per hectare (equivalent to US\$2,000) was set as the income tax credit (Camacho et al., 2000). This amount was expected to compensate for the expenses incurred in establishing and maintaining a forestry plantation. The incentive was later modified in 1979, 1984 and 1985, mostly by increasing the amount of the income tax credit.³

The 1980s saw the development of additional economic incentives, all aimed at promoting reforestation activities. These included:

- Soft credits, established in 1983. The credits had an 8 per cent interest rate⁴, a 10-year grace period and repayment periods of up to 30 years.
- Certificate of Forestry Payment (CAF), established with the second forestry law (No.7032) in 1986. The CAFs were tax-exempt, transferable state bonds that could be

³ Decrees No.10521-AH of September 1979; No.15308-MAG-H of February 1984; and No.16640-MAG-H of September 1985.

⁴ As a comparison, in 1983 credits (in colones) for agriculture, coffee, and silvicultural activities had an annual interest rate of 28.5% (Banco Central de Costa Rica, 2002).

used to pay any tax obligation to the government. In order to access the CAF a landowner would be required to make an up front investment in the plantation before receiving any financial compensation.

- Certificate of Advanced Forestry Payment (CAFA), was also established in 1986 by the second forestry law. The difference between the CAF and the CAFA was that the CAFA was aimed at landowners who could not cover the entire up front investment in a plantation. In order to qualify for the CAFA, the landowner was expected to be part of a farmer cooperative, reside where the plantation was to be developed, and be farming a parcel of less than 25 hectares.
- Fund for Municipalities and Organizations, set up in 1986 was intended to support the establishment of reforestation projects and nurseries.
- A reduction in the taxes on capital goods was another tax break incentive.

Needless to say, landowners preferred the subsidies, such as the CAF and CAFA, to the soft credits as the latter had to be repaid.

In the 1990s a second set of subsidies and incentives aimed at managing natural forests for timber production or conserving them were developed. These included:

- Certificate of Payment for Natural Forest Management (CAFMA), approved in 1994, was a subsidy for extracting timber from natural forests. A management plan was required.
- Certificate of Forest Protection (CPB), approved in 1995, was a subsidy to conserve natural forests on private lands.

These incentives were in effect for only a short period when they were superseded by those introduced under the third forestry law.

The incentives listed above are well documented in the literature (Segura and Solorzano 1995; Watson et al. 1998; Chomitz et al. 1998; de Camino et al. 2000; Camacho et al. 2000; Cruz and Navarrete 2000; Mejias et al. 2000a; Mejias et al. 2000b). Analysis of the effectiveness of these subsidies and their social, environmental and economic impacts is however limited. Many of these documents simply focus on comprehensively describing the different incentives and on documenting the coverage attained by these programmes. Conclusions on the utility of these programmes are, therefore, typically drawn on first principles and received wisdom rather than any substantive empirical analysis. No evidence of any formal survey work with those participating (or not participating) in the programmes appears in the papers reviewed, with the exception of Camacho et al. (2001). This is a point that is worth re-emphasizing later in this paper.

2.3 Payments for forest environmental services

In 1996 the third (No.7575) and most recent forestry law was approved in Costa Rica. International pressure for Costa Rica to eliminate the existing subsidies – particularly from the International Monetary Fund – had been mounting since the early 1990s (Watson et al., 1998). At the time the new forestry law was passed, the government was negotiating the structural adjustment programme with the World Bank, which required the elimination of subsidies to the productive sectors, including the forestry sector (Camacho et al. 2000).

However, 17 years of subsidies to the forestry sector had allowed room for the creation of an influential institutional framework to support and lobby in favour of the forestry sector's interests. These groups exerted pressure and opposed the complete elimination of forestry subsidies.

These proximate variables, including

- the development of forestry incentives in Costa Rica,
- the transition to give subsidies to forest conservation in addition to reforestation,
- the pressure from international financial institutions to eliminate subsidies,
- the internal pressure to keep the forestry subsidies,

when combined with the broader expectations for market opportunities associated with INBio, climate change, ecotourism and certification all served as a basis for the legal definition of Payments for Environmental Services (PES) that emerged in the Forestry Law of 1996. The law creates a financial mechanism and the institutional structure to compensate private forest owners for the services provided by forest as a land use. According to von Platen (1999: 24,27), with the forestry law's definition of environmental services:

“Costa Rica directly and legally recognizes that forests produce benefits (services) other than the traditionally traded forest products (timber and other traded items). Indirectly, the Law recognizes as well that those benefits are enjoyed by people other than the forest owners, like urban and rural water consumers, scientists, tourists, and those who do business in tourism, and mankind as a whole by mitigating the negative effects of greenhouse gases”

The law recognizes four services provided by forests: watershed protection, scenic beauty, carbon fixation/sequestration, and biodiversity conservation. The official PES scheme is a system that pays forest owners, in effect, for producing this bundle of four environmental services.

According to Camacho et al. (2000) it was argued that private forest lands provide beneficial externalities to society, and those costs should be internalized through the PES. This is a fairly straightforward interpretation of environmental economic theory, one that has not always easily found an application in policy and law. Clearly in this case, theory dovetailed quite well with the forces of political economy shaping the relationship between the forest sector – which was alarmed at the possibility of losing access to the existing set of subsidies – and politicians.

Although the PES scheme of the National Forestry Financing Fund (FONAFIFO) is the official attempt to create a market for environmental services, there have been other efforts to buy and sell environmental services, or simply to invest in preserving ecosystems to maintain their services in the long run. Many of these alternatives employ economic, market or financing mechanisms, which differ in form and nature from the PES approach. These include grass roots level actions such as cases where communities have purchased forestland to protect a natural spring, i.e. land purchase as a tool to vertical integration. Others, like the voluntary contract between La Esperanza hydropower project and the Monteverde Conservation League (Rojas and Aylward 2001), are fully private agreements that explicitly mention the economic compensation for environmental services. Thus, while the PES scheme clearly is very instructive, the general trend towards experimentation has encouraged a series

of complementary approaches to developing markets and payments for environmental services.

2.4 References (Chapter 2)

Aylward, B. 2002. *Market Mechanisms and Environmental Services: A Conceptual Approach and Review of International Experience. Report for the project on the Integrated Management of Natural Resources and the Environment in the Western Highlands of Guatemala (MIRNA)*. Guatemala City, Guatemala.

Banco Central de Costa Rica. 2002. *Tasas de interés que los bancos aplican en las operaciones activas de todos sus departamentos (porcentajes a diciembre de cada año): 1973-1985*. Table provided by the Central Bank of Costa Rica via email on April 17, 2002.

Camacho, María Antonieta, Olman Segura, Virginia Reyes, Alejandra Aguilar. 2000. *Pago por Servicios Ambientales, Punto Focal: Costa Rica*. Proyecto PRISMA-FORD, preparado por CAMBIOS (Cambio Social, Biodiversidad y Sostenibilidad) y CINPE (Centro Internacional de Política Económica para el Desarrollo Sostenible). San José, Costa Rica.

Camacho, María Antonieta, Olman Segura, Virginia Reyes, Miriam Miranda. 2001. *Gestión local y participación en torno al pago por servicios ambientales: Estudios de caso en Costa Rica*. Proyecto PRISMA-FORD, preparado por CAMBIOS (Cambio Social, Biodiversidad y Sostenibilidad) y CINPE (Centro Internacional de Política Económica para el Desarrollo Sostenible), San Jose, Costa Rica.

Chomitz, K., E. Brenes and L. Constantino. *Financing Environmental Services: The Costa Rican Experience*. The World Bank, Latin America and Caribbean Region, Central America Country Management Unit. Economic Notes. Washington DC: World Bank.

Cruz, Ginette and Gilmar Navarrete. 2000. *Los bosques y el servicio ambiental de protección del recurso hídrico en Costa Rica*. San Jose, Costa Rica: FONAFIFO.

de Camino, Ronnie, Olman Segura, Luis Guillermo Arias and Isaac Pérez. 2000. *Forest Policy and the Evolution of Land Use: An Evaluation of Costa Rica's Forest Development and World Bank Assistance*. Operations Evaluation Department. Washington DC: World Bank.

Mejías, Ronald, Edwin Alpízar, Vicente Watson, Raúl Solórzano, and Jaime Echeverría. 2000b. *Análisis Beneficio-Costo de los Servicios Ambientales en Costa Rica: Tres Estudios de Caso*, preparado para el Proyecto Ecomercados. San José, Costa Rica: Centro Científico Tropical.

Mejías, Ronald, Jaime Echeverría, and Raúl Solórzano. 2000a. *Incentivos para la Conservación de Tierras Privadas en Centroamerica*. San Jose, Costa Rica: Programa de Economía Ambiental, Centro Científico Tropical (CCT) y CEDARENA.

Rojas, Manrique and Bruce Aylward. 2002. *The Case of La Esperanza: a Small, Private, Hydropower Producer and a Conservation NGO in Costa Rica*. FAO's Land Water Linkages in Rural Watersheds Case Study Series. www.fao.org/landandwater/watershed.

Segura, O. and R. Solórzano. 1995. *Instrumentos Económicos para la Protección de Cuencas Hidrográficas: El Caso de Costa Rica*. CREED Costa Rica Notas Técnicas No. 3. San José: Centro Científico Tropical.

Von Platen, Henning. 1999. "Payments for environmental services: a new slogan for old incentives or a new economic concept?" *GFA (Gesellschaft für Agrarprojekte) Natural Resources Management between Economic Development and Nature Conservation: Experiences from Development Projects in Asia, Latin America and Africa*. Wissenschaftsverlag Vauk Kiel KG. p. 21-30. GFA-Studien (Germany), no. 4.

Watson, Vicente, Sonia Cervantes, Cesar Castro, Leonardo Mora, Magda Solis, Ina T. Porras and Beatriz Cornejo. 1998. *Making Space for Better Forestry: Costa Rica Country Study*. Policy that Works for Forests and People Series No: 6. London: International Institute for Environment and Development.

3 Review and summary of Costa Rican market initiatives

The cases of market initiatives for environmental services developed in Costa Rica can be grouped in a number of ways. One option is to group experiences by the type of economic mechanisms employed (Aylward 2002; Bayon et al. 2000; Landell-Mills and Porras 2002; Panayotou 1995; Powell et al. 2002; Spergel 2001; WCPA and IUCN 2000). Another option is to group the cases by the type of environmental (or ecosystem) service involved, for which there are also a number of classification options – one being the definition of environmental service proffered by the Costa Rican Forestry Law and another that proposed for use under the Millennium Ecosystem Assessment (Law No.7575; Millennium Ecosystem Assessment (MA) 2002). Aylward (2002) reviews the Costa Rican classification, as well as that proposed by the MA, and concludes that neither is fully up to the task of categorizing the environmental services that are subject to market failure. The MA approach builds on previous categorizations offered by natural scientists (Daily 1997; de Groot 2002; Costanza et al. 1997). As a consequence it is an extensive list that focuses on a functional grouping of ecosystem services rather than on the economic aspects of these services. Thus, it may not be a useful structure to group the lesser number of services that have significant economic value subject to market failure and, are therefore being approached from an economic and behavioural perspective.

The Costa Rican approach is more intuitive, with the exception of the scenic beauty category, which can be confusing – given that the economic activity associated with scenery, is tourism and recreation. Some aspects of scenic beauty are clearly landscape or geological features rather than of biological or ecological origin, and have little to do with the concept of environmental services subject to market failure. Where the attraction of scenic beauty that draws visitors is biologically based it often has to do with biodiversity, which is already defined as having species and ecosystem levels. So a tourist that enjoys visiting Costa Rica because it has 13 different life zones all in a small geographic space could be said to be enjoying the scenic beauty of the diversity of ecosystems that the country possesses. Thus, if scenic beauty is left out (or incorporated under biodiversity) then the Costa Rican classification is effectively reduced to hydrological services, climate change services and biodiversity. This provides a fairly useful way to group the initiatives underway in Costa Rica and dovetails quite well with the framework proposed by Aylward (see Table 3.1). As the discussion here revolves around forest environmental services and does not include the issue of environmental services from agroecological landscapes, the categories of biological resources and soil fertility are less relevant for the purposes of this paper. The exception is the use of non-timber forest products (NTFPs). Market failure issues regarding the commercial exploitation of NTFPs or their subsistence use are less prevalent in Costa Rica given its very small forest-dwelling population and its status as a post-frontier economy. Thus, the initiatives are grouped according to whether they involve biodiversity, climate change services, hydrological services, or represent a bundling of a number of services across these categories. As noted earlier there have been other initiatives aimed at preserving ecosystems for the functions they provide. However, many of these are not “market” initiatives but regulatory measures – such as the creation of protected areas – and are therefore not included here.

Table 3.1 Environmental functions and services of forests

Environmental Functions	Environmental Services
<ul style="list-style-type: none">• Primary production	<ul style="list-style-type: none">• Biological resources (i.e. goods or “provisioning services”)
<ul style="list-style-type: none">• Nutrient (biogeochemical) cycle	<ul style="list-style-type: none">• Soil fertility
<ul style="list-style-type: none">• Hydrological cycle	<ul style="list-style-type: none">• Hydrological services
<ul style="list-style-type: none">• Atmospheric regulation	<ul style="list-style-type: none">• Climate change, ozone
Biological and Cultural Diversity	Diversity Products, services and attributes
<ul style="list-style-type: none">• Genetic diversity	<ul style="list-style-type: none">• Bioprospecting
<ul style="list-style-type: none">• Flora, fauna and natural landscapes	<ul style="list-style-type: none">• Tourism, Recreation, Scenic Beauty, Existence Values
<ul style="list-style-type: none">• Ecosystem diversity	<ul style="list-style-type: none">• Ecological services, such as pollination or filtration services

Source: Aylward (2002)

3.1 Biodiversity⁵

As indicated above, efforts to conserve biodiversity in Costa Rica date back to the late 1960s when the first Forestry Law was passed, followed in the 1970s by the introduction of formally protected areas. In 1989 the creation of the National Institute of Biodiversity (INBio) expanded the notion of biodiversity protection to one of conservation, defined by INBio as “studying, knowing and using biodiversity”. Table 3.2 summarizes the initiatives with respect to the market for payments for forest environmental services identified through the review of the literature. A brief description and summary of each initiative is provided below.

⁵ Defined by the 1996 Forestry Law as “Biodiversity protection to conserve and use it sustainably for scientific, pharmaceutical, research, genetic improvement, and ecosystem protection purposes.”

Table 3.2 Markets and Payments for Biodiversity in Costa Rica

Project/commodity	Status	Reference
1. Bioprospecting		
A. Bioprospecting contracts:		
(i) National Biodiversity Institute (INBio)	Implemented beginning in 1991	Aylward et al (1993), Aylward (1993); Espinoza et al. (1999); Onaga (2001); Mulholland and Wilman, (1997); Reid et al. (1993); Sittenfeld et al (1999); Sittenfeld and Lovejoy (1999) and many more
2. Tourism, Recreation and Scenic Beauty		
A. Differentiated entrance fees:		
(i) SPN: public protected areas	Implemented in 1994	Baldares and Laarman (1991), Aylward et al. (1996), Chase (1995); Lindberg and Aylward (1999)
(ii) private reserves (e.g. Monteverde)	Implemented since at least early 1990s	Aylward (1996)
B. Transfer payments for scenic beauty: Pro Rios	Suspended proposal	Aguilar (2001)
3. Ecological Services		
A. Transfer payments for forest pest and disease control services		
(i) Del Oro	Proposed in 1998 – cancelled in 1999	Janzen (1999), Rainforest Alliance (1998), Araya (1997), Pizkulich (1999),
4. Bundled Biodiversity Services		
A. ODA and GEF funding:		
(1) Ecomarkets project	Approved in 2000	World Bank (2000a), www4.worldbank.org/sprojects/project.asp?pid=P05 2009

3.1.1 Bioprospecting Contracts: National Institute of Biodiversity (INBio)⁶

INBio is a not-for-profit research organization created by a group of Costa Rican and foreign scientists. According to Mulholland and Wilman (1997), "... initially their goals were to conserve and catalogue all of the genetic resources located in the country." There was, however, more than this to the work. In 1991 INBio signed a highly publicized bioprospecting agreement with Merck, Sharpe and Dohme, Inc., a major US pharmaceutical company, setting an important precedent for developing countries interested in financing biodiversity conservation.

As suggested by Chapela (1997) the "INBio-Merck agreement has been the subject of intense scrutiny and is hailed by many as the benchmark of modern bioprospecting." In the early to mid-1990s a large body of literature emerged on the INBio case. Much of the work was descriptive as analysts attempted to understand the INBio "model" and determine its replicability. The work included papers by foreigners as well as Costa Ricans. In the latter

⁶ Bioprospecting is the use of biodiversity in the search for commercial genetic resources and chemical compounds.

case a number of key players in the early years at INBio produced overview papers in an effort to educate and promote (and correct misinterpretations regarding) the INBio experience in response to demand from international institutions and other biodiverse tropical countries (Sittenfeld et al. 1999; Janzen 1999; Onaga 2001). A smaller subset of the literature examined the value of bioprospecting as a market mechanism for generating resources for conservation, both in the case of INBio and more generally. This literature is taken up in Chapter 4. While INBio’s activities in capturing the value of biodiversity are related below, it is important to stress that the bulk of the literature concerns the early years. A comprehensive set of information on INBio’s activities in prospecting is not generally available and was not provided by INBio when requested as part of this study. This is justified because of the confidentiality of the bioprospecting agreements. Cevallos (2000) reports that by the end of 2000, INBio had signed 12 bioprospecting agreements. Camacho et al. (2000) provide similar numbers. In the absence of a current account from INBio itself the cited sources are used in compiling the summary of INBio’s bioprospecting agreements and activities provided in Table 3.3.

Table 3.3 Bioprospecting agreements at INBio

Partners and Projects	Activity
Merck, Sharp and Dohme, Inc	screening of plants, insects and microbiological samples for biochemical activity
ICDG	chemical prospecting in a conservation area
Givaudan Roure	fragrance and aroma extraction
Btg-Ecos-La Pacifica	development of a nematocide
Chagas Project	research
Strathclyde University	search for compounds with pharmaceutical application
Phytera Inc	plant cell culture
Diversa	search for enzymes from extremophylic organisms
University Of Massachusetts	search for potential insecticides
CRUSA Foundation	validation of promising plants
Indena S.P.A.	search for natural products with pharmaceutical and agricultural applications
Eli Lilly	search for natural products with pharmaceutical and agricultural applications
Akkadix	search for proteins with nematocide properties

Source: Camacho et al. (2000) and INBio Annual Reports

The INBio-Merck agreement called for INBio to provide Merck with plant, insect and microbiological samples that could be tested for biological activity against Merck’s proprietary screens. The extent of INBio’s involvement varied with the type of sample. In the case of plants, INBio collected, identified and catalogued the species and, received from Merck the equipment to process the samples into extracts. In the case of microbiological samples, Merck scientists undertook the collection directly (simply the collection of soil samples). From Merck’s end the arrangement included up-front payments to INBio for samples, training opportunities for Costa Rican scientists at Merck facilities and through collaborative projects with Costa Rican universities, transfer of processing technologies to INBio, and royalty arrangements developed in the event of marketable pharmaceuticals resulting from the collaboration. For its part, INBio undertook the collection, taxonomy and processing of samples to Merck’s specifications. INBio also collaborated with other scientific institutions in the country to take advantage of the capacity-building provisions of the agreement.

There were hiccups of course (as when the National Museum withdrew its offer to locate the national plant collection at INBio, requiring INBio to develop its own plant reference collection), but in general the INBio-Merck deal emerged as a full-blown example that covered most elements, and as a result immediately became known as best practice in the field of bioprospecting – a field that saw a rapid re-emergence in the early 1990s (Reid et al. 1993).

INBio's experience is probably the first successful case in the context of a developing country where a significant financial return to biodiversity has been implemented through bioprospecting contracts. This has given INBio a very high profile internationally. INBio received approximately \$1.3 million in support of its infrastructure in the first two-year contract with Merck. Approximately 10 per cent of this sum (US\$100,000) was channelled to the Environment Ministry and the National Park Service under a formal agreement developed between INBio and the Environment Ministry. This agreement also stipulated that 50 per cent of any royalties earned from eventual commercial products would be shared with the Park Service as well. Clearly the INBio-Merck agreement played a large role in shaping INBio's policies and future agreements on bioprospecting. As stated by Sittenfeld and Lovejoy (1999):

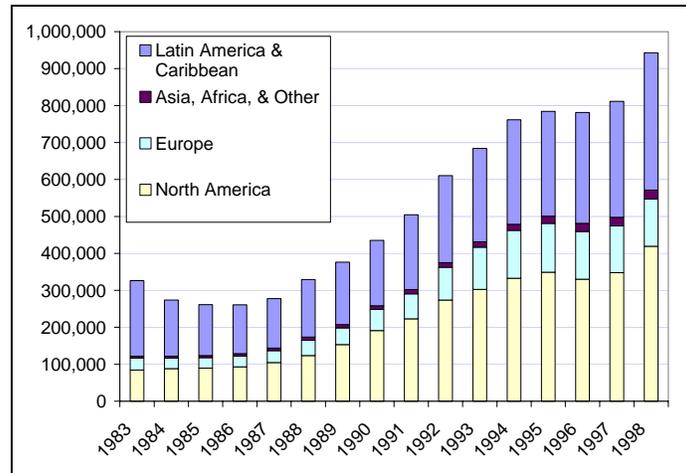
“The set of criteria used by INBio to define its research agreements includes access, equity, transfer of technology, and training. Agreements stipulate that 10 per cent of research budgets and 50 per cent of any future royalties be awarded to MINAE for investment in conservation.”

The precise percentage of the agreed-upon royalty for commercial products resulting from the agreement was kept confidential. The bulletin GRAIN (1999) reported a value of 5 per cent, but sources inside and outside of INBio state that this would be far beyond established bounds for the proportion of value added by INBio. As the royalties will naturally be specific to an individual contract and depend on the contribution to the overall R&D effort made by INBio, these royalty rates are likely to vary from one agreement to the next.

3.1.2 Site entrance fees: flora, fauna and natural landscapes

Over the years Costa Rica has developed a large and varied system of protected areas. While many of the principal attractions for tourists and recreationalists are the parks and reserves managed by the public sector, there is also a significant number of (smaller) private reserves that, in many cases, subsist on the tourist trade. De Camino et al. (2000) suggests that the network of private reserves that has developed in the country may total 250,000 hectares in area, or some 5 per cent of the national territory. As “ecotourism” grew in the late 1980s and into the 1990s (see Figure 3.1), increasing interest in policy circles centred around capturing more of the tourists' supposed willingness-to-pay through entrance fees – as a means of providing finance for conservation of these same areas.

Figure 3.1 Foreign tourists visiting Costa Rica 1983-1998 by region of origin



Source: Instituto Nacional de Estadística y Censos (www.inec.go.cr)

As elsewhere, national park funding levels in Costa Rica have not always kept up with increases in the number of parks or visitors, and entrance fees have been increased partly in response to these financial pressures. The first fees to be charged were instituted in 1972 and, at around \$0.10, represented little more than a token inconvenience to the tourist (see Table 3.4 for entrance fee levels over time). Baldares and Laarman (1991) report that a working group was formed by the National Parks Service of Costa Rica in 1989 to revise entrance fees. At the time, fees for both residents and non-residents (foreign tourists) were just 25 colones or from \$0.20 to \$0.30 at exchange rates prevailing in the late 1980s. Subsequently rates for foreigners were raised to 100 colones (\$1.18) in 1990. Steady devaluation of the colón in the 1990s gradually reduced the dollar equivalent of entrance fees, resulting in a doubling of the fee to 200 colones in 1992.

Nevertheless, when a new government took office in May of 1994 the dollar value of the entrance fee was just \$1.28. As part of that administration's plan to promote sustainable development in Costa Rica, non-resident fees for entry to all the protected areas were raised to \$15 on September 1, 1994. The resulting backlash from the industry, media, local communities and tourists led to two concessions. The first concession was that tourists could purchase entrance in advance (for specific parks) for the reduced fee of \$10. This concession had little effect as it required tourists to find their way to the National Park Service headquarters in downtown San José, a not inconsequential task. The tourist industry also succeeded in obtaining a reduced price of \$5 for tourists on package tours. This exception was intended to be temporary, and was designed to provide agencies with time to raise package prices. However, as noted in Chase et al. (1998), a black market developed in these \$5 tickets, such that their use was not confined to visitors on tours.

Table 3.4 Entrance Fees to Costa Rican National Parks 1972 to 1997

Beginning	Residents		Non-Residents	
	Colones	US\$	Colones	US\$
1972	1	0.11	1	0.11
1978	2	0.23	2	0.23
1982	5	0.13	5	0.13
1984	10	0.21	10	0.21
1985	20	0.39	20	0.39
1986	25	0.44	25	0.44
1990 (April)	50	0.59	100	1.18
1991 (August)	100	0.80	100	0.80
1992 (August)	200	1.57	200	1.57
1994 (September)	200	1.27		At gate: 15 Advanced purchase: 10 Travel agencies: 5
1995 (July)	200	1.12		At gate: 15 Advanced purchase: 5, 7, or 10 Travel agencies: 5 4-entry pass: 29
1996 (April)	200	0.98		6

Source: Lindberg and Aylward (1999) as developed from Chase et al. (1998); MINAE (1998). Also checked against Reyes and Cordoba, 1999.

In 1995, a pass was created that allowed visits to four parks for \$29. In July 1995, the fee was further revised and included differential pricing across parks, based on visitation levels, for advance purchase tickets (the three case study parks were all in the most expensive group, at \$10). However, that fee structure was changed again in April 1996, to a daily fee for foreigners of \$6 applied at all parks. Fees have remained at this level since that time.

In the private sector, each reserve maintains its own fee schedules, depending on various factors including its clientele, location, services and attractions. While there is no comprehensive listing of these fees, the experience at one of Costa Rica's most frequently visited destinations – the Monteverde Cloud Forest Reserve – provides an indication of the opportunities that exist for charging differentiated “user” fees at well-managed private protected areas that offer a true natural history experience (Aylward 1996). At Monteverde prices are reviewed regularly and adjusted as necessary. Table 3.5 reports on pricing at the reserve in recent years showing that some time before the parks system introduced its price hikes, foreigners were paying substantially higher prices at Monteverde than locals. For non-students prices have ranged from \$8 to \$16 depending on whether the tourists arrive independently or as part of a package tour.

Table 3.5 Entrance fees at Monteverde Cloud Forest Reserve, 1992-2000

	Foreigners: Package Tour		Foreigners: Self-Drive		Foreign Students		Residents		Resident Students	
	colones	US\$	colones	US\$	colones	US\$	Colones	US\$	colones	US\$
1992	1100	7.98	1100	7.98	550	3.99	250	1.81	125	0.91
1993	1100	7.70	1100	7.70	550	3.85	250	1.75	125	0.88
1994		16.00	1200	7.74	600	3.87	250	1.61	125	0.81
1996		16.00		8.00		4.00	250		125	
1997		16.00		8.00		4.00		3.00		1.50
1998		16.00		8.00		4.00		3.00		1.50
1999 (Jan)		11.00		8.50		4.50		3.25		1.75
1999 (June)		11.25		8.75		4.75		3.25		1.75
2000		11.25		8.75		4.75		3.25		1.75

Source: CCT unpublished data gathered by the authors

3.1.3 Transfer payments for scenic beauty: ProRios

In another initiative a non-profit association named ProRios, formed by a number of rafting companies, explored the possibility of signing a contract with FONAFIFO to develop PES contracts for forest conservation with landholders along the riverbanks where whitewater rafting tours take place. This was because it was expected that rafters would prefer to take trips down a river surrounded by “jungle” instead of cropland. However, no agreement was reached. The main drawback may have been the difficulty with cooperation between companies, as no one rafting company can hold an exclusive concession on the river. Therefore, other companies – or new entrants – could free-ride on payments made by ProRios.

One of the companies leading the initiative, Rios Tropicales, subsequently created its own foundation and began purchasing land along the margins of the Pacuare River. A portion of this land was subsequently put into the PES scheme in order to provide a return to the land, as well as to the rafting (Aguilar 2002). The land is also used for a lodge where tourists stop over to have lunch or spend the night during the whitewater rafting tours. To date, Rios Tropicales has acquired over 1,000 acres of land in six different properties, a majority of it (> 90 per cent) covered by forest (Esquivel 2002). The areas that were cleared have been reforested using native tree species. Of the six properties that were purchased, only three are used for the lodge, while the rest were purchased exclusively for conserving the forest cover on the margins of the river. Some of the properties have been purchased by Rios Tropicales, while others have been purchased by Rios Tropicales in conjunction with national and foreign investors interested in forest conservation (Esquivel 2002).

3.1.4 Ecological services contracts: Del Oro – Guanacaste Conservation Area

On August 24, 1998, the Minister of Environment of Costa Rica signed a contract with Del Oro Group, an agricultural concern belonging to the CDC (Commonwealth Development Corporation) of the United Kingdom. Del Oro owns and operates citrus plantations and a citrus juice plant in north western Costa Rica. Through the contract, Del Oro agreed to purchase environmental services from a government-owned protected area for a period of 20 years. The payments, which would amount to \$480,000, were to be made in kind to the Guanacaste Conservation Area (ACG), which is located on lands adjacent to the 2,000 hectares of citrus plantations belonging to Del Oro. The contract involved the transfer of

remnants of forestland on Del Oro's properties to ACG. The total forestland to be transferred was 1,200 hectares, valued at \$400 per hectare.

Del Oro explicitly stated that they were willing to pay for the environmental services of the ACG, including biological pest control, water supply, and natural decomposition of citrus peels from the juice plant. Each component was given a specific value as follows (Rainforest Alliance, 1998; Contract between Del Oro and the ACG, 1998 in Janzen 1999):

1. Biological control agents coming from the ACG forests (primarily parasitic wasps and flies of importance to Integrated Pest Control): \$1/ha per year for the 1,685 ha of adjacent Del Oro citrus plantations. For the 20 years of the contract, the total would be \$1,685/year.
2. Technical services of the ACG: \$500/day for international consultants and \$200/day for national consultants. Del Oro would pay for a minimum of three days and ten days, respectively, per year, for the 20 years of this contract, for a minimum of \$3,500 of consultant services, irrespective of whether Del Oro uses these services or not. Additional days would be charged at these same rates.
3. Provision of water to the Del Oro farms: \$5/ha/year for the 1,169 ha of the drainage basin of the Rio Mena that lies in the ACG, for a total of \$5,885/year for the 20 years of this contract. Other minor water sources draining from the ACG into the Del Oro farms at no cost were not included in this valuation.
4. Biodegradation of orange peels from Del Oro on ACG lands: \$11.93/truckload, for a minimum payment of 1,000 truckloads per year, whether used or not, for a minimum of \$11,930/year for the 20 years of the contract. The ACG would design a 20 ha Biodiversity Processing Ground (BPG) to the east of Del Oro, at some point in Sector El Hacha to receive the orange peels. The ACG would select another 20 adjacent hectares for the peels in the next year, and continue doing this in four-year rotation cycles for a given PBG. Del Oro agreed to maintain the access road and its bridges to the BPGs for this 20-year period. Del Oro also agreed to maintain a registry of the number of truckloads of peel that are deposited at a PBG each year.
5. Rent of a hectare of old pasture within the ACG wildlands far from any orange plantation or other citrus trees: \$1,000/year. The objective was that Del Oro would plant an arboretum of citrus trees free of diseases, from which they could obtain material for grafts. The environmental service provided to Del Oro is protection from pests via isolation. Del Oro would pay for and continue any maintenance associated with this hectare for protection against any kind of threat. Del Oro agreed to avoid any pesticide or chemical applications that are toxic to biodiversity in the specified hectare without first having written permission from the ACG. The ACG had full authority to deny such permission without affecting the agreement.
6. The biodiversity services and ecosystem services described above are worth $\$1,685 + \$3,500 + \$5,885 + \$11,930 + \$1,000 = \$24,000$ /year. The 1,200 ha are worth \$480,000. This means that the land that the ACG would receive permanently from Del Oro is worth 20 years of environmental services.

At the time, supporters of the agreement hailed it as the beginning of a new era of contracts between farming companies and protected areas that provide services to them, such as

pollination. Since most protected areas in Costa Rica are surrounded by farmland, it was believed that the Del Oro-ACG contract could serve as a model in other conservation areas (Rainforest Alliance, 1998). However, a fierce publicity campaign, initiated by another citrus processing plant in Costa Rica, questioned the Del Oro-ACG contract. The “competing orange juice firm, TicoFrut, complained that Del Oro had created a garbage dump in a national park” (Ellison 2001). The objections to the contract included the potential threat to public health, pollution to nearby streams through leakage of liquid waste, and damage caused to the Guanacaste National Park caused by decomposing citrus peelings. The publicity campaign also appealed to nationalistic sentiments by emphasizing the fact that Del Oro was owned by the British government, who was “dumping its waste in the Guanacaste National Park” (La Nación, December 5, 1998, publicity paid by Tico Frut). Promoters of the contract, on the other hand, argued that the decomposing peelings served as a natural fertilizer for abandoned pastures in the park, and would help speed up the natural regeneration of forest.

The government cancelled the contract in August 1999 (Ellison 2001), following several months of controversy and successful legal objections to the project presented to the Constitutional Court (La Nación, March 26, 1999 and September 5, 1999).

3.1.5 Overseas development assistance and GEF funding: Ecomarkets Project

The Ecomarkets Project is a financial assistance package from the World Bank and Global Environment Facility (GEF) to the government of Costa Rica to support its Payment for Environmental Services (PES) scheme. The objective of the project, approved in June 2000, is to “increase forest conservation in Costa Rica by supporting the development of markets and private sector providers for environmental services supplied by privately owned forests” (World Bank 2000b). The main focus of the project is to support biodiversity conservation by targeting resources to priority areas within the Mesoamerican Biological Corridor. The five-and-a-half-year project is financed by a World Bank loan of \$32.6 million to the government of Costa Rica, a GEF grant of \$8 million to the National Forestry Financing Fund (FONAFIFO), plus counterpart funding of \$8.6 million from the government of Costa Rica (World Bank, 2000a).

Of the \$49 million to be invested in the project, US\$14 million will be destined to support PES contracts already programmed by FONAFIFO, \$23.3 million will be for new PES contracts through FONAFIFO, and \$0.4 million will be to support the development of FONAFIFO’s revenue capture mechanisms (World Bank, 2000a). Therefore 77 per cent of all funds will be used to finance the purchase of environmental services, while the remaining funds are for strengthening the administration and field supervision of FONAFIFO’s PES programme.

Although the project’s funding will be used to strengthen the overall PES scheme, which means paying for a bundle of four environmental services, the explicit interest is on the service of biodiversity conservation in specific geographic locations. In practice this objective is realized by prioritizing lands for biodiversity conservation and offering FONAFIFO to cover \$10 of the \$40/year payment made to landholders in these areas. This cost sharing makes conservation of these areas relatively less expensive for FONAFIFO providing an additional incentive to target lands important for biodiversity conservation.

The PES contracts that can receive Ecomarkets funding are only those that fall within the priorities established by the project. For the programmed contracts (1995-1999), priority areas include 1) forest ecosystems in buffer zones of national parks and biological reserves, 2) forest ecosystems within the Mesoamerican Biological Corridor, 3) forest ecosystems

which provide critical hydrological services, 4) degraded forests or those at high risk of fire, 5) wildlife refuges, and 6) priority areas for recuperating forest ecosystems. For new contracts beginning 2000/2001, priorities are given to 1) conservation easements in Tortuguero, La Amistad-Caribe, and Osa Conservation Areas, 2) conservation easements in areas of high biological importance as identified in the 1996 GRUAS report outside of Tortuguero, La Amistad-Caribe, and Osa Conservation Areas, 3) additional areas outside of the GRUAS report areas based on the priorities established by the Ministry of Environment (World Bank 2000b). Within each of the Conservation Areas mentioned, Ecomarkets has identified specific areas that deserve special attention and should be targeted with new PES contracts.

3.2 Greenhouse gas mitigation⁷

At the 1992 Earth Summit in Rio de Janeiro, 155 countries signed the United Nations Framework Convention on Climate Change (UNFCCC), an agreement to seek the stabilization of the enhanced greenhouse effect. Its objective was to reduce the concentration of GHGs in the atmosphere to levels below those that could cause severe climate change. The UNFCCC entered into force on 21 March 1994, after the receipt of the 50th ratification. Prior to the UNFCCC, there were two World Climate Conferences in 1979 and 1990 that laid out many of the issues addressed by the UNFCCC.

A series of policy level events regarding climate change have taken place since the ratification of the UNFCCC, at meetings of the Conferences of the Parties (COP) to the UNFCCC. One of the major results from these international conferences was the Kyoto Protocol, in which industrial nations committed themselves to reduce their GHG emissions by 5.2 per cent from 1990 levels by 2008-2012. In addition, there are three “Kyoto Flexibility Mechanisms” in the Protocol that are intended to help the global reduction of emissions in a cooperative fashion. In other words, the Kyoto Protocol defines assigned amounts of GHG emissions for Annex B countries (developed countries and countries with transition economies) and authorizes cooperative emission reduction methods under which portions of the assigned amounts may be shared or re-allocated. The Kyoto Mechanisms are International Emission Trading (IET), Joint Implementation (JI), and the Clean Development Mechanism (CDM).

Prior to the Kyoto Protocol, there was a series of initiatives aimed at creating mechanisms to reduce GHGs, which later served as experiences to develop the Kyoto Flexibility Mechanisms. In 1993, the United States announced the US Initiative on Joint Implementation (USIJI), a voluntary pilot programme designed to contribute to the international knowledge base through projects that would demonstrate a range of approaches to reduce or sequester greenhouse gas emissions in different geographic regions. The programme encouraged private sector investment in international partnerships to reduce GHGs. Thus, USIJI became the first programme set up by a developed country to promote Joint Implementation. Costa Rica had a leading role in the early stages of USIJI, and benefited from having seven projects approved through the USIJI portfolio from 1995 to 1999 (USIJI 1999).

⁷ Defined by the 1996 Forestry Law as mitigation of greenhouse gas emissions or reducing, sequestering, storing, and absorbing greenhouse gases.

After the first COP meeting, which took place in Berlin in 1995, the concept of Joint Implementation was rearranged so that instead of full projects with carbon credits as initially conceived under the USJI framework, there would be an experimental period to develop pilot projects. This new concept was called Activities Implemented Jointly (AIJ).

Also prior to the Kyoto Protocol, Costa Rica developed an innovative financial instrument, called "Certifiable Tradable Offsets" (CTOs) as a means to facilitate the development of AIJ projects. A CTO was defined as a specific amount of greenhouse gas emissions, expressed in carbon equivalent units, reduced or sequestered, or to be reduced or sequestered by AIJ actions, in which all phases have already been completed. Each CTO was to be certified, fully transferable and guaranteed for a specific period of years, according to the project lifetime. It gave the bearer the right to claim the offsets. The idea was that CTOs would resemble bonds, with 20 yearly coupons, that could be sold through brokers. During the guarantee period any CTO declared invalid by the monitoring and/or independent third party verification would be replaced (www.cinde.or.cr).

However, the CTOs were soon replaced at the international level by the Certified Emission Reductions (CERs) embodied in the Kyoto Protocol, which very closely resembled the CTO concept as conceived in Costa Rica. Therefore, CTOs were only used for one transaction - that between the Governments of Norway and Costa Rica (Alpizar 2001).

AIJ projects in Costa Rica preceded the Kyoto Protocol and were among the first project proposals globally designed to mitigate climate change through innovative mechanisms. The AIJ projects were initiated in Costa Rica in 1994, when it signed along with the United States, the first AIJ agreement in the Western Hemisphere. In 1995, Costa Rica set up OCIC (Costa Rican Joint Implementation Office) as the official national counterpart for climate change projects and negotiations. It was through OCIC that Costa Rica then developed the concept of CTOs.

The forestry projects that were approved under the Costa Rica AIJ programme are listed in Table 3.6 and discussed more fully below. There were AIJ proposals outside of the forestry sector, and therefore are not addressed in this paper.

Table 3.6 Markets and payments for carbon in Costa Rica

Project/commodity	Status	Reference
1. Activities Implemented Jointly		USJI (1999)
(i) Ecoland	Implemented	http://unfccc.int/program/aij/aijproj.html
(ii) Klinki	In progress	Barres (2002)
(iii) Costa Rica / Norway Reforestation and Forest Conservation AIJ Pilot Project	In progress	http://unfccc.int/program/aij/aijproj.html
(iv) Territorial and Financial Consolidation of Costa Rican National Parks and Biological Reserves	Did not receive any funding from the sale of Carbon Credits	Http://unfccc.int/program/aij/aijproj.html
(v) EARTH	Implemented	Russo (2001), Russo (2002)

3.2.1 Activities Implemented Jointly

With OCIC in place, and reforms in the institutional, legal, and administrative structure, Costa Rica was able to develop 11 project proposals under the AIJ framework during the period 1995-1999:

- five forestry projects (US\$158 million total investment),
- five energy projects (US\$135 million total investment), and
- one agricultural project (US\$1 million total investment).

Of these, one forestry project and one energy project were funded through the Norwegian Government. A second forestry project, and the agricultural project, were funded through the Dutch Government. All other projects were to be funded through the USIJI initiative (Manso 1998). Detailed descriptions of the forestry projects are given in Table 3.7 below. The intention was that the projects within the AIJ portfolio would have a climate change component that would credit them with a given quantity of CTOs. These could then be sold to investors or companies in developed countries as a means to fulfill their commitments to reduce that country's GHG emissions. Income received from the sale of CTOs would make the projects more attractive in financial terms as they would have an additional source of income.

Table 3.7 Forestry sector projects developed in Costa Rica under the AIJ scheme

Project Title	Type of Activity	Project Lifetime (yrs)	Area (ha)	Total Project Cost (US\$ millions)	GHG Impact (CO2 equivalent in metric tons)
ECOLAND: Piedras Blancas National Park	Conservation Regeneration	16	2,500	\$1.1	1,342,733
Territorial and Financial Consolidation of Costa Rican National Parks and Biological Reserves	Conservation Regeneration	25	422,800 (Manso 1998) 555,000 (Busch et al. 2000)	\$157	57,467,271 (UNFCCC 2001) 66,000,000 (Manso 1998)
Klinki Forestry Project	Reforestation	46	6,000	\$3.8	7,216,000
Costa Rica-Norway Reforestation and Forest Conservation AIJ Pilot Project *	Conservation Regeneration Reforestation	25	4,000	\$3.3	230,842 (UNFCCC 2001) 1,150,139 (Manso 1998)
EARTH	Reforestation	na	121	\$0.33	16,474
TOTAL			542,461	\$158.4	75,650,393

Sources: Adapted from Manso 1998, www.cinde.or.cr, Busch et al. 2000, and UNFCCC 2001.

Unfortunately, a majority of projects under the AIJ portfolio in Costa Rica never received the expected level of income from the sale of CTOs, and some did not receive any funding at all from carbon offsets. Despite the availability of carbon credits to sell the demand has not been significant, and the only forestry projects that received significant funding from carbon offsets were the Ecoland and the Costa Rica-Norway projects. The Protected Areas Project (PAP) was able to consolidate one million tons of carbon that were certified by the Société Generale de Surveillance (SGS), but these CTOs were never sold. A brief description of each approved forestry project is given below.

ECOLAND – Piedras Blancas National Park

The ECOLAND Project's objective was to preserve tropical forest through the purchase of approximately 2,500 hectares of privately-owned forest in the Piedras Blancas National Park (formerly named the Esquinas National Park), in south western Costa Rica. The purchased land was to be passed to the Costa Rican system of conservation areas for permanent protection. GHG benefits accrue from conservation of existing carbon stocks in the park that would have otherwise been deforested (USIJI, 1999).

The 12,500-hectare Esquinas Forest was declared a national park by the Government of Costa Rica in 1993, but almost all of the land within the park was privately-owned. Some landowners held logging concessions, a number of which were active at the time, and many owners faced economic pressures that encouraged deforestation. Under Costa Rican law, the government cannot restrict land-use decisions of private landowners, thus the government had to purchase the land it wished to protect. The ECOLAND Project was intended to bring nearly 20 per cent of the park's land under protection. At the time, approximately 2,150 ha of the total land to be purchased was forested. The remaining 350 ha had already been cleared, but forest regeneration was expected to occur once the area became protected (USIJI 1999). All 2,500 ha of land were purchased through the project and have been passed to the Costa Rican National Park Service for permanent protection.

The ECOLAND project was one of the few AIJ projects to be fully funded through carbon credits. The total project cost was \$1.1 million, of which \$150,000 was used for project development and representation, \$40,000 was used as an endowment to cover annual costs, and the remaining \$910,000 was used for land purchases (UNFCCC, 2001). The funding sources for the carbon component of the project are given in Table .

Table 3.8 Co-financing for the Ecoland Project

Funding Source	Country of Funding Source	Amount (\$US)
Tenaska	U.S.A.	650,000
Rainforests of Austria	Austria	200,000
National Fish and Wildlife Foundation	U.S.A.	250,000
Total		1,100,000

Source: Adapted from USIJI 1999 and UNFCCC 2001

Territorial and Financial Consolidation of Costa Rican National Parks and Biological Reserves (Protected Areas Project)⁸

The primary objective of the Territorial and Financial Consolidation of Costa Rican National Parks and Biological Reserves Project, also known as the Protected Areas Project (PAP), was the acquisition of 555,000 ha of land in 27 National Parks and Biological Reserves in Costa Rica - land that was still in the hands of its original owners after they were declared protected areas (Busch et al. 2000). With this objective the project would facilitate the consolidation of national parks through land purchases financed through the sale of carbon savings. The

⁸ Protected Area Project, or PAP, is a shorter name also used for this project.

project included all of the unregistered national parks and biological reserves in Costa Rica (UNFCCC 2001).

At the time, the land to be purchased was being deforested at an average rate of 2-3 per cent per year, releasing approximately 1.5 mt C/yr. Therefore, the GHG benefits of the project would accrue from the preservation of carbon stocks in the primary forest and from biomass growth (i.e., carbon sequestration) in the secondary forest and pasture. This project was the result of combining two earlier USIJI projects, Project BIODIVERSIFIX and the protected area component of Project CARFIX: Sustainable Forest Management (USIJI 1999).

The project was to be funded through an initial contribution of \$376,241 from the Earth Council Foundation and the Costa Rican National Parks Foundation, plus an estimated \$156.7 million to be generated through the sale of carbon offsets (UNFCCC 2001). However, only approximately 6 per cent of the PAP project was executed, and it did not receive any funds from the sale of carbon credits. With the first 35,000 ha the project purchased, it consolidated one million tons of carbon, all of which was certified by SGS. Another 16,000 ha were later purchased in Guanacaste, but again, it did not receive any carbon credits. The only external funds received were \$50,000 which was donated by the Earth Council to consolidate the first 35,000 hectares (Manso 2002).

Klinki Forestry Project

The aim of the Klinki Forestry Project was to convert pastures and marginal farmland to commercial tree plantations by promoting the planting of 6,000 ha of private farms with mixtures of selected fast-growing tree species in a matrix, with the Klinki (*Araucaria hunsteinii*) tree as the major component for carbon sequestration. The trees would be harvested periodically for use in long-life lumber products (such as utility poles) or left standing.

The project would include small, medium, and large farms, educational pilot projects, and investor farms. Farmers would be given incentives for planting in return for the rights to the sequestered carbon. The objective of the project was to foster the involvement of the farmer in carbon sequestration as an economic activity using the latest tree farming technology while providing GHG, wood production, and conservation benefits (USIJI, 1999).

By early 2002, 47 hectares had been reforested under the Klinki project in five participating farms. Funds have come from 36 greenhouse gas emitters in the United States. The project does not deal in carbon credits because the funding required for long-term commitments has not been found. Thus, the project is structured on donations that are used to carry out the reforestation projects. On average, the project offsets 6.4 tons of CO₂ per hectare per year (Barres 2002).

It is expected that an additional 40 to 160 hectares will be planted in the short term. Negotiations are underway with two potential donors in the USA who are interested in offsetting their greenhouse gas emissions. One potential donor wants to mitigate the emissions from the use of fuel cells (Barres 2002).

Costa Rica-Norway Reforestation and Forest Conservation AIJ Pilot Project

The objective of the project is to conserve and rehabilitate four thousand hectares of forests in the upper Virilla river basin, to produce among other environmental benefits, the reduction of atmospheric GHG emissions through biomass growth and avoidance of future emissions. One thousand ha will be reforested and 3,000 ha of existing forestland will be conserved - 2,000 ha in a natural primary forest area and 1,000 ha in a secondary forest area. The implementation period will be ten years in successive and overlapping stages covering the micro-basins in the zone. The estimated life of the project is 25 years.

The forestry activities are expected to improve the existing hydrological resources of the watershed (increased output), increasing the efficiency of the hydroelectric plants and therefore enhancing the displacement of fossil fuel use in the national electricity system (UNFCCC 2001). This is of relevance for the various hydroelectric projects located on the Virilla River.

This project is part of the "Private Forestry Project" (PFP), a national forestry project designed to use AIJ foreign investments to compensate farmers for their conservation and reforestation efforts. The project will therefore be developed within the legal and institutional framework of Costa Rica's Payments for Environmental Services (PES) programme. Legislation authorizes the Ministry of Environment to find international partners for the PES programme so that the cost of producing global environmental services like CO₂ reduction can be shared with the international community (UNFCCC 2001). To make use of external AIJ investments a Specific Fund for the Conservation and Development of Greenhouse Gas Sinks and Deposits was established through Executive Decree N° 25067-MINAE.

Within the project OCIC is responsible for collecting the contributions and disbursing these funds to FONAFIFO upon proof of successful sequestration or avoidance of CO₂ emissions through the PES programme. In addition, OCIC issues the CTOs to foreign AIJ investors as proof of the offsets. Each CTO issued is guaranteed against CO₂ offsets that have already taken place through the PES programme. These CTOs are transferred by OCIC to the Norwegian investors in return for their financial contributions to the project.

FONAFIFO is responsible for carrying out the financial administration of the PES Programme by signing legally binding contracts with individual farmers, through which the farmers receive annual payments in return for proof of effective forest conservation reforestation activities.

The Compañía Nacional de Fuerza y Luz (CNFL), a public utility, and MINAE are responsible for the technical promotion and implementation of the PES programme in the upper Virilla river basin for 1,000 ha of reforestation, 2,000 ha of natural forest conservation, and 1,000 ha of natural forest regeneration.

The total cost of the project is US\$3,395,243. In accordance with the Costa Rican legal framework for AIJ forestry projects, the investment capital contribution from the Norwegian partners, equivalent to 200,000 metric tons of carbon, is US\$2 million. The price per CTO was determined by OCIC as US\$10/mt of C. (UNFCCC 2001). National matching funds of \$1.39 million are provided by CNFL.

The Costa Rica-Norway AIJ Pilot Project was the first international financing initiative for the PES programme. In February 1997, through OCIC, the Government of Costa Rica issued CTOs to Norwegian AIJ investors in exchange for the first disbursement of US\$1 million corresponding to the first tranche of 100,000 mt of C. In 1997, the final disbursement of US\$1 million was channelled to FONAFIFO in exchange for the second tranche of 100,000 mt of C.

During the period 1996 to 1999, a total of 2,387 ha in the upper Virilla river basin were incorporated into the PES programme. This area is equivalent to about 60 per cent of the total 4,000 ha referred to in the project agreement (UNFCCC 2001).

EARTH

A commercial reforestation project on land belonging to the EARTH (Agricultural College for the Humid Tropics) was the core component of this project. EARTH received funds from the municipality of Rotterdam in the Netherlands. A total of 121 ha were planted with native timber species in abandoned banana plantations currently covered by pasture land. Carbon credits for 5,000 mt of C during the lifetime of the project (20 years) were sold for \$400,000 to the municipality of Rotterdam.⁹ This payment gave an average value of \$20 for every ton of carbon be sequestered (Alpizar 2001).

Through the agreement, the municipality of Rotterdam could partially mitigate its CO₂ emissions resulting from the expansion of the port of Rotterdam and industrial activities in the Rijnmond area (Russo, 2001). However, no carbon certificates were issued for this project (Russo 2002), thus the Netherlands could not use them to fulfill their commitments under the Kyoto Protocol (Russo 2001). Although no certificates were issued, the contract states that EARTH cannot sell the carbon credits to anyone else.

The project was implemented in three years, and planting of trees was completed in November 2001. EARTH's commitment is to manage and maintain the plantation for a period of 20 years (Russo 2002). It is likely that some blocks of the plantation will not be harvested within 20 years of planting, since the rotation cycle for some species is much longer than 20 years.

Monitoring of the project is carried out by EARTH while OCIC is responsible for verification through annual progress reports. Every year EARTH presents a progress report, and a final report will be prepared in 2005. In addition to the income from the sale of carbon credits, EARTH expects that the project will also provide additional benefits through educational and knowledge transfer opportunities from the different courses it offers to its students (Russo, 2001).

3.3 Hydrological services¹⁰

The environmental service that has been formally recognized for the longest time in Costa Rica is watershed protection (or hydrological services). One of the earliest official

⁹ Banana was eradicated from the area several years earlier due to the marginal condition of the soils (Russo, 2001).

¹⁰ Defined by the 1996 Forestry Law as water protection for urban, rural, and hydroelectric use of water.

acknowledgements of this service dates back to 1888, when a decree was passed declaring a 2-km wide strip on the sides of Barva Volcano as state-owned land, which could not be appropriated by any individual. The area was considered of public interest because the streams and springs that supplied drinking water to the towns of Alajuela and Heredia had their headwaters on the slopes of the volcano (Watson et al. 1998). However, the first case that more closely resembles a market based transaction did not take place until 1997, when a private hydropower company signed an agreement to pay landowners in its watershed who would ensure conservation of existing forest on their land.

A summary of the market cases covered in more detail in this section is provided in the table below.

Table 3.9 Markets and payments for hydrological services in Costa Rica

Service/Mechanism/Case	Status (Dec. 2001)	Reference
1. Hydrological Services to Hydropower Production		
A. Transfer Payments: FONAFIFO and Hydropower Companies		
(i) Energía Global and FUNDECOR (2)–Don Pedro and Rio Volcan HEP	Implemented and coming to a close, likely to be renewed	Cruz and Navarrete (2000); Benavides (2001)
(ii) Hidroeléctrica Platanar (1)	Ongoing implementation	Cruz and Navarrete (2000)
(iii) Compañía Nacional de Fuerza y Luz (3) – Aranjuez, Balsa and Cote	Ongoing implementation	Cruz and Navarrete (2000)
B. Voluntary Contracts		
(i) La Esperanza HEP and Monteverde Conservation League	Ongoing implementation	Rojas and Aylward (2001)
2. Hydrological Services to Water Supply		
A. Transfer Payments: FONAFIFO and Industry		
(i) Costa Rican Brewery	Agreed	Echeverría (2001); Mejias (2001); Mejias and Segura (2001)
(ii) Melia Playa Conchal Hotel	Proposal	Melia Conchal (2001)
B. Water Use Charges		
(i) Heredia Public Water Supply Company	Charges levied to water consumers, payments to forest owners pending	Barrantes and Castro (1999b); Cordero (2001)

Note: HEP refers to hydroelectric power project

3.3.1 Transfer payments for environmental services: FONAFIFO-hydropower companies

Arrangements made between FONAFIFO and Energía Global, Hidroeléctrica Platanar, and Compañía Nacional de Fuerza y Luz are described below.

Energía Global

Energía Global de Costa Rica, a private power producer, owns and operates two small run-of-river hydropower plants in northern Costa Rica; Don Pedro (14 MW) and Rio Volcan (17 MW). The projects began producing hydropower in November 1996 and December 1997,

respectively. In late 1997, Energía Global signed a five-year agreement with FUNDECOR (Foundation for the Development of the Central Volcanic Range) to promote forest conservation in the watersheds of both projects. Through the agreement, the company has offered landowners in its watersheds a \$10 per hectare annual payment in order to maintain or restore forest cover on their plots. Energía Global covers a quarter of the \$40/ha/yr that FONAFIFO pays forest owners because the hydropower company is only interested in one of four environmental services, namely watershed protection. FONAFIFO therefore has to fundraise the remaining \$30/ha/yr from other sources.

The payments are made to FONAFIFO through FUNDECOR, which has a separate agreement, and the funds are used to finance the official PES scheme. As in the case of the Ecomarkets scheme, FONAFIFO in turn prioritizes payments to the watersheds of Energía Global's projects under the official PES scheme. The landowner contracts and conservation commitments are for five years. Landowners can also participate in reforestation or forest management activities as established by FONAFIFO.

At the time the two hydropower projects were built, more than 75 per cent of the watersheds were covered by forest (Table 3.10). However, using a model developed by FUNDECOR to predict changes in land use FUNDECOR forecasted that 46 per cent and 15 per cent of the watersheds of Rio Volcan and Don Pedro hydropower projects, respectively, were at high risk of deforestation (FUNDECOR and Energía Global, undated).¹¹ These predictions were an incentive for the hydropower company to invest in the PES scheme and therefore minimize the perceived threat posed by deforestation (Benavides 2001).

Table 3.10 Land use in the watersheds of Don Pedro and Rio Volcan watersheds, 1996

Land Use	Don Pedro	As % of watershed	Rio Volcan	As % of watershed
Forest	2,076	87%	2,603	76%
Crops/Pasture	240	10%	757	22%
Reforestation	48	2%	60	2%
Other*	13	1%	9	0%
Total	2,377		3,429	

Note: *Other includes clouds and water.

Source: (FUNDECOR and Energía Global, undated)

During the first year of the contract, Energía Global made payments of \$18,180 for Don Pedro and US\$24,870 for Rio Volcan (for the allocation of these funds see Table 3.11).

¹¹ The model predicts changes on a one-hectare plot basis and takes into account such variables as distance to nearby human populations and agricultural lands, access roads, and topography of the terrain

Table 3.11 Allocation of payments made by Energía Global in the first year of the PES contract

Allocation	Don Pedro HEP	Rio Volcan HEP
1. To compensate FONAFIFO for land already reforested through the PES scheme (\$10/ha)	\$4,000 (400 ha)	\$3,000 (300 ha)
2. To cover FUNDECOR's expenses in promoting conservation and sustainable forest use in the watershed	\$7,090	\$10,935
3. To cover expenses of the ACCVC in protecting natural resources	\$7,090	\$10,935
Total	\$18,180	\$24,870

Source: Adapted from Reyes and Cordoba 1999

After the first year, Energía Global committed to paying up to \$29,540/year for Rio Volcan's watershed and \$23,800/year for Don Pedro's watershed (Reyes and Cordoba 1999). By 2000, 72 per cent of Rio Volcan's watershed and 75 per cent of Don Pedro's watersheds had been incorporated into the PES scheme (Cruz and Navarrete 2000).

In addition to overseeing the funds directly received from Energía Global, FUNDECOR is responsible for executing the forest conservation activities, and carries out the legal and administrative procedures for the PES on behalf of landowners. For this service, they charge a fee to landowners that is deducted from the payment they receive from FONAFIFO.

The Energía Global–FUNDECOR–FONAFIFO model was later adopted and modified by two other hydropower companies: Hidroeléctrica Platanar and CNFL (Compañía Nacional de Fuerza y Luz).

Hidroeléctrica Platanar

Hidroeléctrica Platanar, a private power producer, owns a 15 MW run-of-river hydropower project in northern Costa Rica, which began operations in 1995. In 1999 Platanar signed an agreement for PES in its catchment similar to that of Energía Global–FUNDECOR, but instead of paying \$10/ha/yr, Platanar contributes \$15/ha to the annual PES payment to landholders. In addition, Platanar has a separate agreement for properties that do not have a formal land title deed, for which the hydropower company contributes \$30/ha/yr. In these cases Platanar makes the full payments directly and the landowners do not receive any funds from the official PES scheme. In both cases Hidroeléctrica Platanar works with FUNDECOR and CODEFORSA, the intermediary NGOs responsible for preparing the forest management plan. The cost of this is covered by a fee charged directly to landowners, approximately equivalent to 18 per cent of the payment amount (Pérez 2002).

Approximately 35 per cent of the 3,655-hectare watershed of Platanar was forested in 1996, and it is these areas that are the main target of Platanar's PES efforts. In early 2002 there were already 555 hectares incorporated into the PES scheme, which represents 45 per cent of the forested area in the watershed (Table 3.12). The initiative of the hydropower company is complemented by other local forestry agents that independently promote the incorporation of forested areas into the national PES scheme. These forestry agents act as intermediaries between landowners and FONAFIFO, and the benefit they receive is a fee paid by landowners. If activities continue as planned, the hydropower project expects to incorporate 90 per cent of the forested area in the watershed into a PES scheme in the short term (Table 3.12).

Table 3.12 Breakdown of forested area in the watershed of Hidroeléctrica Platanar and the forested area participating in the PES scheme

(Information as of 24 January, 2002)	Area (hectares)	% of forested area (in 1996)
Total Watershed Area	3,655	-
Total Forested Area (in 1996)	1,226	34% (of total watershed)
Area Currently Receiving PES	556	45%
Area in Process of Applying for PES	464	38%
Area that was approached but did not join the PES scheme	100	8%
Area where landowners are in the process of deciding whether or not to join the PES scheme	85	7%
Total forested area in the watershed expected to be incorporated into PES scheme	1,105	90%

Source: Chacon (2002)

There are currently 14 landowners receiving benefits through the PES scheme in Platanar's watershed (Table 3.13). By the time the project reaches its intended target it is likely that 28 landowners will benefit from the scheme. Land use in the catchment is mixed, composed mostly of dairy farms and some forest patches. Sections of Ciudad Quesada, an urban area with a population of 36,000, also lie within Platanar's watershed. The beneficiaries of the PES scheme are, for the most part, farm owners. In the uppermost section of the watershed, there is also a forested section that lies within the borders of the Juan Castro Blanco National Park. However, the park lands have not been expropriated, and are still held by private land owners.

Table 3.13 Landowners, area, and status of PES scheme in the watershed of Hidroeléctrica Platanar

No. of Land-owners	Area (ha)	Status of PES
8	399	Have signed contract through the FONAFIFO-Fundecor-Platanar scheme
6	157	Have signed contract through Platanar scheme (the company makes 100 per cent of payment (\$30/ha))
4	75	Have completed technical studies to apply for PES
4	85	Have expressed an interest to participate in the scheme
6	389	In process of application to the national PES scheme through other agents (APAIFO)
4	540	Properties adjacent to but located outside the watershed (participate as a result of the promotion of the PES scheme that is part of the FONAFIFO-Fundecor-Platanar agreement)

Source: Chacon (2002)

National Power and Lighting Company¹² (CNFL)

CNFL is a private company majority-owned by the Costa Rican Institute of Electricity (ICE), the state utility. In November 1998 CNFL signed an agreement with FONAFIFO and MINAE for the purchase and sale of environmental services in three watersheds of interest to CNFL where it plans to develop hydropower projects. As in the Energía Global case, the

¹² Compañía Nacional de Fuerza y Luz in Spanish.

agreement is aimed at promoting forest conservation and management as well as reforestation, which are believed to contribute to the protection of water resources.

Under the CNFL-FONAFIFO scheme, the forest owner receives \$40/ha/year from FONAFIFO under a ten-year contract. CNFL in turn pays FONAFIFO \$47/ha/year, with the exception of the first year, when it pays \$53/ha/yr in order to cover the expenses of the management plan at the beginning of the contract. There are important differences between the CNFL-FONAFIFO scheme and the Energía Global scheme:

- the CNFL-FONAFIFO scheme does not require a land title, accepting established rights of possession (*derechos posesorios*) as sufficient indication of tenure;
- the contracts are for ten years instead of five;
- CNFL pays for all four environmental services plus an additional amount to cover FONAFIFO's promotion costs;
- the hydropower projects are yet to be built;
- there is no intermediary between the utility and FONAFIFO.

Table 3.14 Land to be incorporated under the CNFL PES agreement

Watershed	Area of Watershed (ha)	Percentage of the watershed to be incorporated into the PES scheme
Aranjuez HEP	9,516	53%
Balsa HEP	18,926	32%
Cote HEP	1,458	62%

Source: Cruz and Navarrete (2000)

In all cases, the hydropower companies enter into the agreements with FONAFIFO/FUNDECOR voluntarily and on their own initiative. However, implementation of the agreements, that is finding willing sellers, is largely up to FONAFIFO and FUNDECOR.

3.3.2 Voluntary contracts: La Esperanza Hydropower Project and Monteverde Conservation League

La Esperanza Hydropower Project (LEHP) is a 6MW run-of-river power project located in northern Costa Rica. Most of the 3,400-hectare watershed used by the project is located within the Children's Eternal Rainforest, owned by the Monteverde Conservation League (MCL). MCL is a not-for-profit non-governmental organization created in 1986, and currently owns over 22,000 ha of forestland in the Tilarán Cordillera. MCL 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.

On October 28th 1998, MCL and LEHP signed a private contract through which LEHP would make payments to the MCL for the environmental services its forests provide. The 99-year contract focuses on preserving forest cover as the desired land use in the watershed. The contract also resolved a land ownership dispute between the two parties relating to an area of half a hectare. This area was vital for the hydropower project, as the dam and water intake were to be built there. The conflict arose because two different official land titles stated that both entities owned the same parcel of land.

The contract grants surface rights to LEHP, while the MCL retains full ownership of the land. This arrangement 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 an end product of the negotiations initiated because of the land dispute. In fact, the contract states that if LEHP delays payment of a PES by more than one month after it is due, the MCL will immediately recover the surface right to the land and all infrastructure on it.

Through the agreement, LEHP commits to paying for environmental services provided by the 3,000 hectares of forest located in the watershed. 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 \$3/ha/yr during the construction phase of the hydro project. This is gradually raised to \$10/ha/yr on the third and fourth years of operations (Table 3.15). 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 3.15 Contracted amounts paid for environmental services to the MCL

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

Notes: 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

Source: Contract between MCL and LEHP

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

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

Where:

\$10, is the reference value of the services per hectare 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 (US\$) paid throughout the time period

T_{beg} , is the tariff (US\$) 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 \$10/ha/yr. Similarly, if the electricity tariff increases, so does the payment to MCL.

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

- conserve and protect the existing forests in the watershed of LEHP;
- watch for and repel land invasions that might take place in the watershed;
- manage the forest area and the forest rangers who protect it;
- attain the economic means to fulfill its conservation commitment.

3.3.3 Transfer payments and water use charges for water supply services: FONAFIFO and industry

Experimentation in the development of markets for hydrological services in Costa Rica extends beyond hydropower to the services provided by intact forests to industries that use water for water supply. The industries involved to date include those that use clean water as an input to water treatment for municipal water supply or as an input in the production of retail and service products such as beer and lodgings.

Cervecería Costa Rica and FONAFIFO

Florida Ice & Farm, owners of Cervecería Costa Rica (CCR), the largest brewery in the country, uses groundwater in the production of beer, bottled water, and fruit juices. However, there has been concern that groundwater sources in the Central Valley, where CCR is located, are being affected by reduction in the recharge zone due to land conversion and pollution. In October 2001, CCR signed an agreement with FONAFIFO to promote forest conservation and regeneration through the PES scheme (Echeverría 2001; Mejías 2001). The goal is to promote forest conservation or regeneration in the recharge areas of the aquifer used by CCR.

- CCR will pay FONAFIFO a total of \$225,000 distributed over seven years, equivalent to US\$45/ha/yr for 1,000 ha located in the upper part of Rio Segundo Watershed. Landowners will subscribe contracts with FONAFIFO for five years.
- CCR will pay FONAFIFO US\$1,500/month for 12 months to contract FUNDECOR as the intermediary and programme promoter.
- CCR will pay FONAFIFO a lump sum of US\$15 for each new hectare entering the project. These funds will be used by FUNDECOR for technical and legal advice for the proprietors.
- CCR will pay FONAFIFO a lump sum of US\$14 for each new hectare entering the project. These funds will cover administrative expenses by FONAFIFO.
- The total amount of funds for the project is US\$272,727 (equivalent to 90 million colones).

Melia Playa Conchal Hotel and FONAFIFO

The Melia Playa Conchal is a tourism development project in Guanacaste province owned by the Melia hotel group. The project has already built a first phase including a beach resort and golf course. The entire complex will be finished within 15 years. The project currently has its own water supply from ground water wells, but as the project expands it will require additional water. A potential source has already been identified as the Nimboyores River. Melia has contacted FONAFIFO to explore the option of developing a management plan for

the watershed of the Nimboyores River in order to ensure the protection of the water source in the long term. Although the available supply (>1,000 l/s) far exceeds the forecasted demand (180 l/s), the hotel group believes such a plan would be beneficial for the area. The objective would be to conserve existing forests or allow regeneration/reforestation in unproductive land within the watershed. FONAFIFO would be responsible for implementing the project while the hotel would provide the financial resources to execute it. This proposed watershed conservation scheme is currently being negotiated between Melia and FONAFIFO (Melia Conchal 2001).

Empresa de Servicios Públicos de Heredia and water use charges

The Empresa de Servicios Públicos de Heredia (ESPH) is a utility owned by three municipalities in the province of Heredia, where it provides electricity, potable water, public lighting and sewerage services. In 1999 ESPH made a proposal to ARESEP (Regulating Authority for Public Services) to raise the potable water tariff in order to compensate forest owners for the services their land use provides to water users. ARESEP approved a tariff increase of $\text{¢}1.90/\text{m}^3$ in 1999 to cover the environmental services component. ESPH has been collecting the funds and has designed a project, Procuencas, to implement the environmental services component in the watersheds of the Ciruelas, Segundo, Bermudez, and Tibas rivers. The objective is to protect groundwater sources through forest conservation where forests already exist, and restore forest cover through reforestation or natural regeneration in some denuded areas. ESPH is the only water company in the country that has included an environmental component in its water tariff to invest in its watersheds.

Originally the ESPH scheme was envisaged as independent from the official PES scheme. Funds would be collected directly by ESPH via water tariffs, and the amount charged for watershed protection would be channelled to an independent fund administered by ESPH. During the development of this scheme, it was unclear what role other key players would have, particularly the Ministry of Environment (MINAE). MINAE insisted on participating in the decision-making, and eventually, it was decided that the funds collected by ESPH would be transferred to FONAFIFO, who would implement the PES scheme in the areas of interest to ESPH as part of the overall PES programme. Therefore, what was originally conceived as an independent PES programme ended up being incorporated into the national PES scheme.

3.4 Bundles of environmental services

In many cases either the buyer or the seller of environmental services wishes to make a single transaction that includes a number of or all of the environmental services provided by a parcel of land. In such cases, services are “bundled” either at the buying end or from both ends of the transaction. Land purchases, conservation easements, forest certification and transfer payments are approaches to transacting bundles of services that have been widely applied in developed countries. As can be seen in Table 3.16 and the ensuing discussion, efforts have been made to employ all four methods in the Costa Rican context, and these approaches have met with varying degrees of success.

Table 3.16 Markets and payments for bundles of environmental services in Costa Rica

Service/Mechanism/Case	Status	Reference
1. Voluntary Contributions: Land Purchase		
(i) Children's Eternal Rainforest, Monteverde	Implemented	www.acmonteverde.com/ibosque.html
(ii) FAMAAR, Zarcero	Implemented	Blanco (1999)
2. Tradable Development Rights: Conservation Easements		
(i) CEDARENA Land Trust	Implemented	www.cedarena.org/landtrust , Chacon and Meza (2001)
3. Product Labeling and Certification: Forest Certification		
(i) Various certified operations	Implemented	www.smartwood.org
4. Transfer Payments and Market Based Instruments: Official PES Scheme		
(i) FONAFIFO Payment Programme	Implemented	Chomitz et al. (1998); Camacho et al. (2000); Cruz and Navarrete (2000); Landell-Mills and Porras (2002); Rodríguez (2002);
(ii) Tax on Petrol	Implemented	Ortiz, (2002); Rodríguez, (2002)

3.4.1 Land purchases

Probably the most traditional means to ensure that the environmental services of forests are provided in the long term has been purchasing and conserving the land where the forests are found. This is how the national system of protected areas was created. Conservation organizations have also used land purchase to set aside land. The Tropical Science Center and the Monteverde Conservation League, each of which was referred to earlier with reference to the Monteverde Cloud Forest Reserve and the Children's Eternal Rainforest, respectively, protected these lands by purchasing more than 54,000 hectares (www.acmonteverde.com/ibosque.html). Much of this money came from overseas, though some was sourced locally, principally through voluntary contributions.

Recently, grassroots organizations and private sector interests have opted for land purchases as a means to ensure forest conservation and the provision of desired environmental services in their areas of interest (such as water supply, existence values, tourism and recreation). This includes, for example, a local organization in Zarcero, FAMAAR, which purchased over 200 ha of forest with funds raised from community members. The objective of purchasing the forestland was to protect the natural springs from where the drinking water for the town comes. The idea sprang from local dairy farmers who were concerned about water quality for their aqueducts (Blanco 1999). Although the organization did not have any legally recognized status, community members began to give money to the association, which has purchased the land under the name of one of its members. Given that Zarcero is a small and close-knit community, there is a high level of public accountability among the association members. Other communities that have made similar land purchases include the towns of San Ramon, and Hojancha. There are, no doubt, other similar initiatives, but they are unlikely to be documented or included in literature related to environmental services.

While land purchase is clearly a market transaction and one that can be motivated by interest in securing environmental services it can be differentiated from many of the other market mechanisms by its degree of permanency, unlike schemes where users of services make regular payments linked to usage of the provided services. In other words, land purchase represents an investment in environmental services rather than a payment for environmental services.

3.4.2 Conservation easements

The CEDARENA Land Trust was created in 1999 by the Environmental and Natural Resources Law Center (CEDARENA) of Costa Rica for the purpose of promoting biodiversity conservation in private lands within the Mesoamerican Biological Corridor. This was the first land trust created in Latin America (Chacon and Meza 2001). CEDARENA provides technical and legal assistance to landowners interested in conserving their forests. The preferred mechanism to promote conservation in the long term is a voluntary contractual agreement between the landowner and the Land Trust. This conservation easement is recorded in the National Register and is a limitation imposed on the property regardless of the landowner. CEDARENA monitors and verifies that land use is not changed on those properties that have a contract.

Since 1992, 50 conservation easement contracts have been established in Costa Rica (Chacon and Meza 2001). In the Talamanca-Caribe Biological Corridor (CBTC), the CEDARENA Land Trust has already established 28 conservation easements, protecting 1,200 ha of forestland in perpetuity. The work has been carried out in coordination with the Nature Conservancy, and the Association of Organizations in the CBTC (www.cedarena.org). Land purchase and easements often go hand in hand. Such initiatives are limited in Costa Rica, probably due to the lack of incentive for landowners to enter into such agreements, unless they purchased land primarily for their environmental services in the first place. Chacon and Meza (2001) consider that another major limitation to expanding the conservation easements programme is the legal structure of easements under Costa Rican law, which requires that an easement be conceived in terms of land and not individuals or organizations, ie, it is a property that gives an easement to another property, not the landowner. The limitation is that it does not allow conservation organizations to be the beneficiaries of the easement. Some countries have modified their legislation to allow easements to be transferred to conservation organizations or the government (Chacon and Meza 2001).

During the period 2001-2005 CEDARENA is focusing its efforts in four biological corridors considered a priority for conservation purposes. These are: Paso de la Danta, Osa, San Juan-La Selva, and the Pacific drainage of the Monteverde biological corridor.

3.4.3 Forest certification

Forest Certification is another means by which forest owners can be “paid” for the forest environment services they provide, in this case by the eventual purchasers of certified products. By the late 1990s Costa Rica already had six of Central America’s eight certified projects (De Camino and Alfaro 1997). In 2002 there were 11 Smartwood certified operations in Costa Rica, though most are for timber plantations of exotic tree species (Table 3.17). The impact of certification on natural forests appears to be minimal, since only one or two certified operations extract timber from forests. This is likely to be reduced given the policy of the current government to halt timber extraction from natural forests.

Table 3.17 Smartwood certified plantation and forest management operations in Costa Rica (as of 20 April, 2002)

Company / Organization	Products	Species (common names)
1. Balsatica, S.A.	Lumber (kiln-dried)	Teak
2. Brinkman & Asociados Reforestadores de Centro América, S.A. (BARCA, S.A.)	Logs	Teak, Cocobolo, Cristobal, Ron ron
3. ECODIRECTA, S.A. (EXCLUSIVE)	N/A	Teak, Melina
4. ECO CAPITAL S.A.	N/A	N/A
5. Expomaderas S.A.	Lumber	Teak
6. Flor y Fauna S.A.	Cabinets, ceilings, custom millwork, doors, flooring, furniture - household, furniture - outdoor /garden, moldings, veneer, window components, lumber (tropical woods)	Teak
7. Forestales International BV	N/A	Teak
8. Fundación Tuva: Reservas Extractivas de Madera Caida de Osa	Furniture – Household	Ajo, Cedro bateo, Chiricano, Cristobal, Manglillo, Manu, Mora, Nispero, Reseco, Santa maria, Tamarindo, Zapatero
9. Germano-Costarricense, S.A.	N/A	Teak
10. Reforestadora Buen Precio S.A.	Furniture parts, Lumber (kiln-dried)	Teak, Laurel Negro
11. Reforestation Group International, S.A	N/A	Teak

Source: Smartwood list of certified operations, 2002

3.4.4 Official PES scheme

The Forestry Law of 1996 brought a change in the mechanism used to encourage forest conservation in Costa Rica, with a switch from subsidies and incentives for forest conservation to payments made for the ‘environmental services’ (PES) that forests provide. The PES scheme 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).

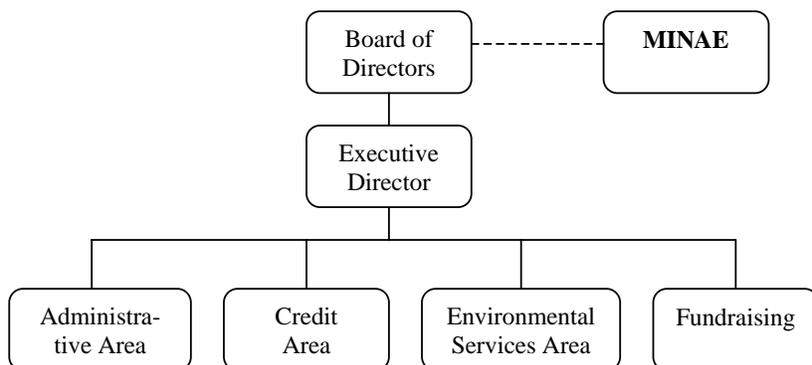
The FONAFIFO scheme for PES has set out the background and conceptual framework for environmental service transactions in Costa Rica. Additionally, it has provided certain standards such as the categories and the reference values of environmental services. A brief overview of the institutional arrangements, activities, payment scheme and financing situation of the PES/FONAFIFO programme is provided below. The level of its empirical underpinning and its performance are covered in subsequent chapters.

Institutional arrangements

To implement the PES scheme, a formal mechanism was established in 1997 that designated the National Forestry Financing Fund (FONAFIFO) as the administrator of the national PES programme. FONAFIFO is a relatively autonomous government agency that forms part of the State Forestry Administration (Administración Forestal Estatal) within the Ministry of Environment. It was created in 1991 to distribute subsidies to the forestry sector and is responsible for managing the funds and making the payments for environmental services. Due to its role in managing subsidies to the forestry sector, by the mid 1990s FONAFIFO had accumulated experience in distributing funds to private landholders for forestry activities. This role was probably facilitated by the administrative model followed. The intention was to provide a single national broker in the market for forest environmental service payments:

“Costa Rica’s new approach to forestry de-links the provision of environmental services from the financing of these services. The Government acts as an intermediary in the sale of services. It sells forest services such as carbon sequestration and watershed protection to domestic and international buyers. Funds from these sales – and from a fuel tax – are used to finance the services.” (Chomitz et al. 1998:6).

FONAFIFO has a board of directors that oversees the work of the agency, and is composed of representatives from the public and private sectors. An Executive Director is responsible for running the day-to-day operations and four departments are responsible for executing the projects and the mandate of FONAFIFO.



A series of other government agencies, NGOs, donors, and private companies have different types of relationship with FONAFIFO (Table 3.18). For simplicity’s sake the role of these organizations can be grouped functionally as funding, mediation, and implementation. FONAFIFO’s funding comes mainly from a tax on fuel. Costa Rican petrol consumers are therefore the main financiers of the PES scheme.¹³ Two additional sources of funding are donors (such as the Global Environment Facility) and private or public companies. Companies usually make payments for PES in a specific area of their interest. A third source of funds is an extra tariff charged in utility bills. However, only one utility in the country (ESPH) has implemented this alternative (see section 3.3.3 above).

FUNDECOR is a foundation that acts as an intermediary between the companies and FONAFIFO. It has signed agreements with private hydropower producers. FUNDECOR

¹³ Originally FONAFIFO was supposed to receive 5% from every fuel sale. However the National Treasury did not pay the entire amount. In 2001 the law was reformed and FONAFIFO now receives 3.5% from every fuel sale. Overall FONAFIFO will receive more funds from the 3.5% than from the portion of the 5% it received before the reform (Ortiz, pers. comm. 2002).

plays a role in promoting the PES scheme in the watershed, where it also acts as an intermediary between forest owners and FONAFIFO. OCIC is the government agency that certifies projects for mitigating climate change. In exchange for the PES, landowners transfer their credits for carbon mitigation to FONAFIFO, who in turn transfers them to OCIC to seek international purchasers (often the carbon purchaser is identified prior to initiating the project). Another intermediary is RECOPE, the Government monopoly on imports of oil and fuel. RECOPE sells petrol to distributors and collects taxes on the sales.¹⁴ Taxes collected are transferred to the National Treasury, which then disburses a percentage to FONAFIFO.

The two main actors with regard to implementation are SINAC and professional foresters. SINAC coordinates every year with FONAFIFO on prioritizing areas to receive PES. In addition SINAC is responsible for overseeing compliance with the PES contracts in their area of influence. Landowners who enter into the PES scheme are required to have a management plan, which must be drawn up by a professional forester. In addition, a forester must be assigned to each project to oversee the implementation of the scheme. The foresters charge a fee for these services. They may work independently, or for an NGO or a consortium of foresters that provides professional services to forest owners.

¹⁴ Distributors pass this cost onto consumers.

Table 3.18 Institutions that have a relationship with FONAFIFO and their roles.
(In=Intermediary, Im=Implementing, F=Funding, O=Other)

Institution	Role	Description
OCIC	In	OCIC is the official government agency that endorses climate change mitigation projects. It certifies the credits for carbon offsets. OCIC also verifies compliance. By signing up for PES, forest owners cede their carbon offset credits to FONAFIFO, which in turn transfers them to OCIC, which markets them to potential international or domestic buyers.
RECOPE	In	The government monopoly on oil/fuel imports sells petrol to distributors and collects taxes on the sales. Distributors pass this cost onto consumers. Taxes collected are transferred to the National Treasury, which then disburses a proportion to FONAFIFO.
ARESEP	O	This is the national authority that regulates all tariffs for public services, including aqueducts and electricity. If utilities are to incorporate a fee into their tariffs, this must be approved by ARESEP
Public Utilities	F	Only one utility (CNFL) currently transfers funds to FONAFIFO for PES. This is a voluntary agreement. The initial goal of the PES scheme was that all public utilities would incorporate a PES into their tariffs, as approved by the regulating authority (ARESEP). ESPH is the only utility that has incorporated a fee for PES directly into their fees structure for consumers. However, ESPH does not route their funds through FONAFIFO.
Private Hydropower Companies	F	Two hydropower companies have entered into voluntary agreements with FUNDECOR, who in turn has an agreement with FONAFIFO. The companies pay FONAFIFO, through FUNDECOR, for PES invested in the watersheds of their hydropower projects.
FUNDECOR	In/Im	The agreements with private hydropower producers include funds destined to FUNDECOR for promotional activities. FUNDECOR also acts as an intermediary between forest owners/re-foresters and FONAFIFO. It fulfills the role of professional forester, for which it charges a fee.
Professional Foresters	Im	By law all land receiving government funds from the PES scheme (reforestation, forest management, or forest conservation) must have a management plan drafted by a professional forester (duly accredited by the relevant national body). In addition, a forester supervises the project's compliance with all relevant legislation and requirements. Independent foresters, or foresters grouped in organizations like FUNDECOR or CODERFORSA, fulfill this role.
SINAC	Im	FONAFIFO and SINAC coordinate the process of setting annual priorities for distributing the available funds for the PES scheme. SINAC is also responsible for enforcing contracts between landowners and FONAFIFO.
Donors/ Companies	F	Donors or companies that want to enter into an agreement with FONAFIFO to fund the PES scheme can do so through a contract. Funds can go through the national treasury, as in the case of the Ecomarkets project, or directly into FONAFIFO's trust fund. FONAFIFO has sufficient autonomy to be flexible.

Activities and payment scheme

The 1996 Forestry Law established PES for three activities: reforestation, forest management for timber production, and forest preservation. These follow very closely, if not exactly, the system of subsidies established for the forestry sector in the 1980s and 1990s, where there was a subsidy for reforestation (CAF and CAFA), forest management (CAFMA) and forest

conservation (CPB/CCB). The payment levels and eligible areas for these contracts were established in February 1997, and have since then been adjusted for inflation (Table 3.19).

Table 3.19 Amounts assigned per hectare for the PES programme according to the type of activity, 1997-2001. Values are in current colones or US\$.

Activity	Currency	1997	1998	1999	2000	2001
Reforestation	colones	¢132,000	¢154,000	¢154,000	¢169,000	¢185,900
	US\$	\$566	\$596	\$539	\$548	\$566
Forest Conservation	colones	¢50,000	¢60,000	¢60,000	¢66,000	¢72,600
	US\$	\$215	\$232	\$210	\$214	\$221
Forest Management	colones	¢80,225	¢94,000	¢94,000	-	¢113,300
	US\$	\$344	\$364	\$329	-	\$345

Source: Adapted from Mejías and Segura (2001). Average annual exchange rates were used for each year by the authors to convert from colones to US dollars.

In all cases the payments are made over a five-year period according to a fixed schedule (Table 3.20). However, the landowner commits to manage forestry plantations for a period of 20 years (five in the case of forest conservation). This obligation is noted in the public land register and applies to future purchasers of the land. The landholder must establish a management plan for the property and it must be drawn up by a professional forester. The management plan becomes an integral part of the contract.

Table 3.20 Distribution of annual payments for environmental services

Activity	Year 1	Year 2	Year 3	Year 4	Year 5
Reforestation	50%	20%	15%	10%	5%
Forest Management	20%	20%	20%	20%	20%
Forest conservation	20%	20%	20%	20%	20%

Source: FONAFIFO (1998) in de Camino et al. (2000)

The annual per hectare payment is paid as compensation to landholders for the bundle of all four services, and no distinction is made between ecosystems or any of the individual environmental services. Landholders receive a different payment if they intend to conserve forest (~\$40/ha/yr) or reforest a parcel of land (~\$100/ha/yr). A minimum of 1 ha is required to receive a PES for plantations while the minimum for forest conservation is 2 ha. The maximum area that can receive PES is 300 ha, except in the case of Indian reservations which can have a maximum of 600 ha. In the case of a group of landholders that apply together as a package, the maximum limit is 50 ha per landowner (Camacho et al. 2000).

Financing

As indicated earlier, the PES scheme merely plays a brokerage role and therefore must find not only willing sellers but also willing buyers. When the PES scheme was officially initiated in 1997, \$14 million was invested in reforesting 6,500 ha, managing 10,000 ha of natural forest for timber production, and protecting 79,000 ha of forests, including secondary forests. The sale of carbon credits in that year through the Norwegian Government generated approximately 20 per cent of the required investments in PES (Espinoza et al. 1999). However, through 2001 a majority (>95 per cent, Sanchez 2001) of the financing of

FONAFIFO came from a national fuel tax. All other sources of finance are service-specific and, therefore, were mentioned earlier in this chapter. These include other carbon sales, the Ecomercados project, financing of biodiversity components of conservation payments, and the contracts developed for hydrological services between FONAFIFO and hydropower producers.

The 1996 Forestry Law allocates one-third of the revenues from the fossil fuels tax to the PES scheme (Chomitz et al. 1998), but the allocation promised has not been delivered (Table 3.21). Theoretically, the tax could yield up to \$19.8 million annually. However, the Ministry of Finance negotiated the amount of these payments with forest owner associations and arrived at a figure of only \$6.5 million to \$7 million (de Camino et al. 2000).

Table 3.21 Discrepancies between the financial resources allocated to FONAFIFO and disbursements made by the Government

Year	Amount that should have been transferred to FONAFIFO from Fuel Tax (millions of colones)	Amount transferred to FONAFIFO (millions of colones)	Amount transferred to CAF Programme (millions of colones)
1997	8,959	1,786	1,581
1998	8,700	1,269	2,381
1999	9,625	2,406	1,590

Source: Camacho et al. (2000)

This situation has caused an imbalance between supply and demand for PES, where demand for the incentives far outstrips available resources and each conservation area competes for a share of available funds (Barborak 2000). The imbalance is aggravated by the fact that if the programme is to increase the total area under PES, annual commitments will need to be raised continuously, as the payments for additional hectares has to be added to commitments from previous years. For example, in 2001, of 2,345 million colones destined for the PES programme, only 304 million (~13 per cent of the total funds) were allocated to incorporating new land (FONAFIFO 2002).

Apart from internal financing from the fuel tax, difficulties experienced in operationalizing the Kyoto Protocol, and the fact that INBio has directly managed the bioprospecting agreements, has meant that international funding available for the PES scheme has been limited in recent years. The situation has led FONAFIFO and the Government to seek additional sources of internal funding. FONAFIFO is seeking to sign more contracts with private sector companies that are targeted as key consumers of environmental services, such as those reviewed above.

As part of its search for innovative ways to raise additional funds for the PES scheme, FONAFIFO recently established the Environmental Services Certificate (CSA). This new mechanism, officially launched in March 2002, is a means of giving flexibility to the existing PES scheme. The CSA is a certificate issued by FONAFIFO, which can be purchased by individuals or organizations interested in paying for the environmental services of forests. The purchaser can choose to allow FONAFIFO to allocate the funds to an area it selects, or can indicate a specific area that FONAFIFO must target to invest the resources collected through that particular CSA. Although the CSA is not a financial instrument in that it does not commit FONAFIFO to any financial compensation (i.e. interest rate or return of capital), the CSA can be deducted from gross income tax. CSAs are certified by a third party to guarantee to the purchasers that the process is transparent and that all the technical, legal, and

administrative requirements have been fulfilled. FONAFIFO hopes that CSAs will be tradable at some point, which will allow the market to establish the value of environmental services (FONAFIFO 2002). It is important to note that CSAs are not intended as a mechanism to compensate for environmental damage caused by the purchaser. This means that the CSA is not a form of environmental mitigation.

In 2001 the legislature abolished the obligation for the Ministry of Finance to pass on the entire revenues collected by the tax to FONAFIFO. This implied that the Ministry of Finance would determine how much money would be allocated to FONAFIFO every year. However, in late 2001, a new law for tax simplification replaced the source of income for FONAFIFO. Instead of assigning a third of the “impuesto selectivo de consumo” on fuel, the new law assigned 3.5 per cent of the “impuesto único” on fuel. It is estimated that with this new scheme FONAFIFO should expect to receive on average 3,500 million colones per year for the PES programme (Mejías and Segura 2001). Although the previous tax assigned more than twice that amount, the reality is that if the 3,500 million colones are transferred to FONAFIFO, it will be a significant increase in the funds available to the PES scheme (Mejías 2001; Ortiz 2002). This tax will most probably continue to be FONAFIFO’s major source of funds for the foreseeable future.

3.5 References (Chapter 3)

Aguilar, Grethel. 2001. Former head of ProRios. Personal communication.

Alpizar, William. 2001. OCIC. Personal Communication on September 2001.

Araya, Mónica. 1997. *Economía de Áreas Protegidas, Empresa y Ambiente: El Caso del Área de Conservación Guanacaste y la Empresa Del Oro*. Tesis para Maestría en Política Económica, Universidad Nacional, Heredia, Costa Rica.

Aylward, B. 1993. *The Economic Value of Pharmaceutical Prospecting and its Role in Biodiversity Conservation*. LEEC Discussion Paper No. 93-05. London: International Institute for Environment and Development.

Aylward, B. 2002. *Markets Mechanisms and Environmental Services: A Conceptual Approach and Review of International Experience. Report for the Project on the Integrated Management of Natural Resources and the Environmental in the Western Highlands of Guatemala (MIRNA)*. Guatemala City, Guatemala.

Aylward, B., J. Echeverría, L. Fendt, E. Barbier. *The Economic Value of Species Information and its Role in Biodiversity Conservation: Costa Rica's National Biodiversity Institute*. LEEC Discussion Paper Series No. 93-06. London: International Institute for Environment and Development.

Aylward, B., K. Allen, J Echeverría, and J. Tosi. 1996. “Sustainable Ecotourism in Costa Rica: the Monteverde Cloud Forest Preserve”. *Biodiversity and Conservation* 5:315-343.

Baldares, M.J., and J.G. Laarman. 1991. “User Fees at Protected Areas in Costa Rica” in J. R. Vincent, E. W. Crawford and J. P. Hoehn (eds) *Valuing Environmental Benefits in Developing Countries*, East Lansing, MI: Michigan State University. 87-108.

- Barborak, James. 2000. *Update: Innovative funding in Costa Rica*. <http://www.biodiversityeconomics.org/incentives/topics-303-36.htm>.
- Barrantes, G. and E. Castro. 1999a. *Estructura Tarifaria Hídrica Ambientalmente Ajustada: Internalización del Valor de Variables Ambientales*. Heredia, Costa Rica: Empresa de Servicios Públicos de Heredia, S.A.
- Barres, Hester. 2002. Reforest the Tropics Inc. Personal Communication.
- Bayon, R., J. S. Lovink, and W.J. Veening. 2000. *Financing Biodiversity Conservation*. ENV-134. Washington DC: Inter-American Development Bank.
- Benavides, Jose. 2001. General Manager of Energía Global de Costa Rica. Personal Communication.
- Blanco, Hernan. 1999. Member of FAMAAR. Personal Communication.
- Busch, Christopher B., Jayant A. Sathaye and G. Arturo Sanchez-Azofeifa. 2000. *Estimating the Greenhouse Gas Benefits of Forestry Projects: A Costa Rican Case Study*. Energy Analysis Department, Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory. Prepared for the U.S. Environmental Protection Agency, Climate Policy and Programme Division.
- Camacho, María Antonieta, Olman Segura, Virginia Reyes, Alejandra Aguilar. 2000. *Pago por Servicios Ambientales, Punto Focal: Costa Rica*. Proyecto PRISMA-FORD, preparado por CAMBIOS (Cambio Social, Biodiversidad y Sostenibilidad) y CINPE (Centro Internacional de Política Económica para el Desarrollo Sostenible), San Jose, Costa Rica.
- Cevallos, Diego. 2000. *'Bioprospecting' agreements abandoned*. Tierramerica. www.tierramerica.net.
- Chacón, Carlos Manuel and Andrea Meza. 2001 *Servidumbres ecológicas y la conservación de recursos naturales en tierras privadas en Costa Rica*. Costa Rica: CEDARENA. Unpublished.
- Chacón, Xinia. 2002. "Hidroeléctrica Platanar". Communication by email.
- Chapela, Ignacio. 1997. "Bioprospecting: Myths, Realities and Potential Impacts on Sustainable Development" in M. Palm and I. Chapela (eds) *Mycology in sustainable development: Expanding Concepts, Vanishing Borders*. Boone, North Carolina: Parkway Publishers Inc.
- Chase, L. 1995. *Cuotas de Entrada a los Parques Nacionales en Costa Rica: Resultado de una Encuesta sobre el incremento de las cuotas para turistas extranjeros*. New York: Cornell University.
- Costanza, R., R. D'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neil, J. Paruelo, R.G. Raskin, P. Sutton and M. van den Belt. 1997. "The Value of the World's Ecosystem Services and Natural Capital". *Nature* **387** (6630): 253-260.
- Cordero, Doris. 2001. Environmental Officer, ESPH. Personal Communication.

Cruz, Ginette and Gilmar Navarrete. 2000. *Los bosques y el servicio ambiental de protección del recurso hídrico en Costa Rica*. San Jose, Costa Rica: FONAFIFO.

Daily, G.C. 1997. "Introduction: What are Ecosystem Services" in G. C. Daily (ed.) *Nature's Services: Societal Dependence on Natural Ecosystems*. Washington DC: Island Press, pp. 1-10.

de Camino, Ronnie, and Marielos Alfaro. 1997. Certification in Latin America: Experience to date. Network paper, Rural Development Forestry Network. London: Overseas Development Institute.

de Camino, Ronnie, Olman Segura, Luis Guillermo Arias and Isaac Pérez. 2000. *Forest Policy and the Evolution of Land Use: An Evaluation of Costa Rica's Forest Development and World Bank Assistance*. Operations Evaluation Department. Washington DC: World Bank.

de Groot, R., M. Wilson and R. Boumans. 2002. "A Typology for the Description, Classification and Valuation of Ecosystem Functions, Goods and Services". *Ecological Economics* **41** (3): 393-408.

Echeverría, Jaime. 2001. Independent Consultant. Personal Communication.

Ellison, Katherine. 2001. "Estimated Prophet" *Latin Trade Magazine* July 2001. <http://www.latintrade.com/newsite/content/archives.cfm?TopicID=9&StoryID=1348>

Espinoza, N., J. Gatica and J. Smyle. 1999. *El Pago de Servicios Ambientales y el Desarrollo Sostenible en el Medio Rural*. RUTA, IICA, San José.

Esquivel, Fernando. 2002. President, Rios Tropicales. Phone interview on April 3, 2002.

FONAFIFO. 2002. "Certificados de Servicios Ambientales" (CSA). San Jose, Costa Rica: FONAFIFO, MINAE.

FUNDECOR and Energía Global de Costa Rica S.A. No date. *Watershed Protection and Hydroelectric Energy: A New Approach to Rain Forest Conservation*. San Jose, Costa Rica: FUNDECOR.

GRAIN (Genetic Resources Action International). 1999. "Bacteria become big business". www.grain.org/publications/mar991-en.cfm.

Janzen, D.H. 1999. "Gardenification of Tropical Conserved Wildlands: Multitasking, multicropping, and multiusers". *PNAS (Proceedings of the National Academy of Sciences of the United States of America)* **96** (11): 5987-5994.

Landell-Mills, N., and I. Porras. 2002. *Silver bullet or fools' gold: a global review of markets for forest environmental services and their impacts on the Poor*. London: International Institute for Environment and Development (IIED).

Lindberg, K. and B. Aylward. 1999. "Price Responsiveness in the Developing Country Nature Tourism Context: Review and Costa Rican Case Study". *Journal of Leisure Research* **31** (3): 281-299.

- Manso, Paulo. 1998. *Energía, Cambio Climático y Actividades de Implementación Conjunta*. San Jose, Costa Rica: OCIC.
- Manso, Paulo. 2002. OCIC. Personal communication by email.
- Mejías, Ronald and Olman Segura. 2001. *Situación Actual del Pago de Servicios Ambientales en Centroamérica*. Documento borrador, preparado para World Resources Institute. Heredia, Costa Rica: Centro Internacional de Política Económica para el Desarrollo Sostenible (CINPE).
- Mejias, Ronald. 2001. Independent Consultant. Personal Communication.
- Melia Conchal. 2001. Personal communication by telephone.
- Millennium Ecosystem Assessment. 2002. *People and Ecosystems: A Framework for Assessment*. Penang: Millennium Ecosystem Assessment.
- MINAE. 1998. Data from National Parks Service. San Jose, Costa Rica: MINAE.
- Mulholland, Denise, and Elizabeth Wilman. 1997. *Bioprospecting and Biodiversity Contracts*, prepared for the Seventh Annual Conference, Canadian Resource and Environmental Economics Study Group/Septième Réunion Annuelle Groupe d'Etudes Canadien sur les Ressources et l'Environnement - Natural Resources in an Era of Deregulation. Hamilton, Ontario, Canada: McMaster University.
- Onaga, Lisa. 2001. "Cashing in on nature's pharmacy". *EMBO Reports* 21(41): 263-265.
- Ortiz, Edgar. 2002. FONAFIFO. Personal communication.
- Panayotou, T. 1995. "Innovative Economic and Fiscal Instruments". Paper presented at *Servicing Innovative Financing of Environmentally Sustainable Development, 2-3 October 1995*. Washington DC: World Bank.
- Perez, Luis Fernando. 2001. Forester at CODEFORSA. Information provided to Ina Porras of IIED in an interview.
- Pizkulich, Z. 1999. *Incentivos para la Conservación de Tierras Privadas en América Latina*. The Nature Conservancy. Región de América Latina y el Caribe, Programa de Políticas y Finanzas para la Conservación.
- Powell, I., A. White and N. Landell-Mills. 2002. *Developing Markets for the Ecosystem Services of Forests*. Washington DC: Forest Trends.
- Rainforest Alliance. 1998. "Costa Rica Firma un Contrato Innovativo de Servicios Ambientales". www.rainforest-alliance.org/news/archives/news/news8-s.html.
- Reid W. V, S.A. Laird, C.A. Meyer, R. Gamez, A. Sittenfeld, D.H. Janzen, M.A. Gollin, and C. Juma. 1993. *Biodiversity prospecting: using genetic resources for sustainable development*. San Jose, Costa Rica: World Resources Institute.
- Reyes Gatjens, Virginia, and Cynthia Córdoba Serrano. 1999. *Valoración económica del bosque y su relación con el recurso hídrico para su uso eléctrico en la microcuenca del río*

Volcán. Masters Thesis. Facultad de Ciencias Sociales, Universidad Nacional, Heredia, Costa Rica.

Rodríguez, Jorge Mario. 2002. Presentation at Seminario Internacional Servicios Hidrológicos de los Ecosistemas Forestales, 30-31 May, 2002, San Jose, Costa Rica: FONAFIFO.

Rojas, Manrique and Bruce Aylward. 2002. *The Case of La Esperanza: a Small, Private, Hydropower Producer and a Conservation NGO in Costa Rica*. FAO's Land Water Linkages in Rural Watersheds Case Study Series. www.fao.org/landandwater/watershed.

Russo, Ricardo. 2001. Summary of EARTH (Costa Rica) - Rotterdam (The Netherlands) Project. Costa Rica: EARTH University. Unpublished.

Russo, Ricardo. 2002. Professor, EARTH University. Telephone conversation on April 12, 2002.

Sanchez, Oscar. 2001. Head of PES at FONAFIFO. Personal Communication.

Simpson, R.D. 2001. *Bioprospecting as a conservation and development policy: overview and insights from three cases*. Prepared for an international workshop of the OECD Working Group on the Economic Aspects of Biodiversity. Paris: OECD.

Sittenfeld, Ana, and Annie Lovejoy. 1999. "Managing bioprospecting and biotechnology for conservation and sustainable use of biological diversity" in J.I. Cohen (ed) *Managing agricultural biotechnology – Addressing research program needs and policy implications*. Wallingford, UK: CAB International.

Sittenfeld, Ana, Ana Mercedes Espinoza, Miguel Muñoz and Alejandro Zamora. 1999b. *Costa Rica: Challenges and Opportunities in Biotechnology and Biodiversity*. Centro de Investigación en Biología Celular y Molecular (CIBCM) Universidad de Costa Rica, San José, Costa Rica. CGIAR / NAS Biotechnology Conference - October 21-22, 1999.

Spergel, B. 2001. *Raising Revenues for Protected Areas: A Menu of Options*. Washington DC: World Wildlife Fund.

UNFCCC. 2001. "Activities Implemented Jointly – Link to AIJ Interactive Project Search". <http://unfccc.int/program/aij/aijproj.html> (Updated 06 December 2001).

USIJI. 1999. *Activities Implemented Jointly: Fourth Report to the Secretariat of the United Nations Framework Convention on Climate Change - Accomplishments and Descriptions of Projects Accepted Under the U.S. Initiative on Joint Implementation*. USA: USIJI.

Watson, Vicente; Sonia Cervantes; Cesar Castro; Leonardo Mora; Magda Solis; Ina T. Porras; and Beatriz Cornejo. 1998. Making Space for Better Forestry: Costa Rica Country Study. Series editor: James Mayer. Policy that Works for Forests and People Series No: 6. IIED, London.

WCPA (Financing Protected Areas Task Force) and IUCN (Economics Unit), and Economics Unit of IUCN (eds). 2000. *Financing Protected Areas: Guidelines for Protected Area Managers*. Edited by A. Phillips. Vol. 5, *WCPA Best Practice Protected Area Guidelines Series*. Gland: IUCN.

World Bank. 2000 b. Project Information Document (PID). Report No. PID8876. Environmentally and Socially Sustainable Development, Latin America and the Caribbean Regional Office. www4.worldbank.org/sprojects/project.asp?pid=P052009.

World Bank. 2000a. Project Appraisal Document. Report No. 20434-CR. Environmentally and Socially Sustainable Development, Latin America and the Caribbean Regional Office.

4 Knowledge base that underpins markets and payments

This chapter explores the scientific and economic basis for the market and payment schemes reviewed above. The intention is to offer a critical assessment of the extent to which markets and payments for environmental services in Costa Rica are based on a sound underpinning regarding the biophysical, economic and social relationships involved – as opposed to demonstrably incorrect, unreliable or merely generalized views on the subject. In particular this assessment focuses on what was known or what was assumed about the economic value of the services being provided. Where such information is available, the accuracy and reliability of any associated biophysical and social analyses is then assessed.

The review suggests that the degree to which there is a sound and site-specific knowledge base that underpins the development of market mechanisms to pay for the environmental services of forests varies considerably. Some of the mechanisms are based on a series of studies that serve as the technical justification for the payment or the market. At the same time, many other cases do not appear to be based on solid knowledge that can be used to quantify the environmental service being provided or the economic value of that service. Where there are perceived gaps, limitations or errors in the knowledge base they will be identified and indicated as such.

Clearly development of markets and payments systems that are based on sound underpinnings stand the greatest chance of thriving and being replicated, followed by those that rely on facts as generally accepted (conventional wisdom), even if lacking specific technical support. Where markets and payments are developed on demonstrably false or inherently unreliable estimates of the importance of environmental services, not only is there potential for failure and disenchantment of those involved, but eventually for the larger process of market development and, indeed, the larger environmental agenda to be discredited.

In organizing the relevant literature, the same categories of services and market cases developed in Chapter 3 will be employed. Table 4.1 provides an overview of the references and how they contribute to the basis for the different services. It is important to stress that the emphasis in the presentation is on the chronological sequence of the knowledge base, in order to try to relate the progress over time in understanding of the economic value of these services to the efforts to develop markets and payments for these services. As will become clear, it is also the case that for some services a reliance on non-Costa Rican estimates of values have (or should have) played a role. It is equally true that the broader literature on the value of these services in Costa Rica has been (or should have been) of relevance, even where the sites or values studied are not those that are incorporated into specific cases. Thus, the table below and the ensuing text refer to “generic” studies and to studies undertaken of the specific market cases reviewed earlier.

Generic studies are ones that while not specific to a particular case of Costa Rican market or payment development have (or should have) influenced the development of these cases. As can be seen the mix of these generic and specific studies are generally related to the extent to which economic valuation is likely to be site specific or not. Thus, in the cases of bioprospecting and carbon for example, many of the generic studies that are cited are studies not specific to a given country but rather global estimates. However, in the case of hydrological services the non-transferability of value figures from other regions is often

recognized and, thus, the generic studies consist of national estimates from watersheds other than those in which the services are developed.

Where they are of central importance, the generic studies are described. However, a full review of the literature on bioprospecting or carbon values, for example, goes beyond the remit of this paper. Thus, an attempt is made to provide a flavour of the generic literature, including a rough assessment of its merits. The bulk of the literature review, however, focuses on the studies that have supported specific cases of market development or have been undertaken within Costa Rica.

Table 4.1 Summary of economic studies of environmental services in Costa Rica

Services	Classification of studies (i.e. as economic valuation or cost estimate)	Reference
1. Biodiversity		
A. Bioprospecting		
(i) Generic	Value of a species or sample	Farnsworth and Soejarto (1985); Principe (1989); McAllister (1991); Ruitenbeek (1989); Pearce and Puroshothaman (1992); Reid et al. (1993); Artuso (1994); Simpson, Sedjo and Reid (1995)
(ii) INBio-Merck	Value of a species or sample, versus cost of protection	Aylward (1993); Harvard Business School (1992)
B. Tourism, Recreation and Scenic Beauty		
(i) Park Entrance Fees	a) Willingness-to-pay for entrance fees; b) WTP for conservation of protected areas; c) econometric estimation of elasticities of demand	a) Tobias and Mendelsohn (1991); Echeverría et al. (1997); Baldares and Laarman (1991); Chase (1995); Schultz et al. (1998) b) Echeverría et al. (1995) c) Chase et al. (1998); Lindberg and Aylward (1999)
(ii) Scenic Beauty	Assessment of factors underlying value of scenic beauty	Watson and Fallas (2000)
C: Ecological Services		
(i) Del Oro	Cost of services provided	Janzen (1999)
D. Bundled Biodiversity Services	Total economic value or contribution to GDP	Barrantes and Castro (1999a)
2. Carbon		
A. Generic	Damage costs of climate change	Tol (1999)
B. Costa Rica	Costs and benefits of sequestering and storing carbon	Echeverría et al. (1997), Aylward et al. (1998); Ramírez and Gomez (1999); Otarola and Venegas (1999); Ramírez et al. (1999)
3. Hydrological Services		
(i) Generic	Methodologies, literature review, and some specific value estimates from case studies	Echavarria (1999); Castro and Barrantes (1998); CT Energia (2000); Cruz and Navarrete (2000); CINPE (2001)
(ii) Non-PES cases/watersheds	Value, opportunity cost or cost estimates of watershed protection	a) Solórzano et al. (1995) b) Aylward et al. (1998); Aylward (1998); Castro and Barrantes (1998); Chakravorty and Chen (2000) c) Quesada-Mateo (1979); Rodriguez (1989); Otarola and Venegas (1999)
a) Ecological-Economic Values of Treated Water		
b) Arenal		
c) Rio Macho		
(ii) PES cases/watersheds	Valuation or opportunity cost of services in different future land use scenarios	a) Reyes and Cordoba (1999) b) Barrantes and Castro (1999b); Castro and Salazar (2000)
a) Rio Volcan and Don Pedro HEP		

Services	Classification of studies (i.e. as economic valuation or cost estimate)	Reference
b) ESPH Heredia c) La Esperanza HEP		c) Rojas and Aylward (2002)
4. Bundles of Services		
(i) Generic – Costa Rica	Value aggregations	a) Carranza et al. (1996); Espinoza et al. (1999); Ortiz (1999); Otarola and Venegas (1999); Sage and Otarola (2000)

4.1 Biodiversity protection

When paying private forest owners for protecting the biodiversity their forests sustain, it is vital to understand which species are to be protected and which habitats they are found in. This knowledge allows for the prioritization of resources allocated to biodiversity protection. In addition to species taxonomy, it is important to have an understanding of the life history of the species in order to ensure the protection of a viable minimum population that can be self-sustaining in the long term (Shafer 1990). This is particularly important for migratory animals that rely on several habitat types at different times of the year. In the case of Costa Rica, it is also important to have an understanding of the biodiversity conserved in the national system of protected areas and how it can best be complemented by promoting biodiversity protection in private lands.

In comparison with other tropical countries, Costa Rica has made rapid strides in identifying and cataloguing the diversity contained in its ecosystems. Since the late 1960s and early 1970s a global, systematic effort by scientists to improve the knowledge base of tropical forests was undertaken, and Costa Rica proved to be a very appropriate site to host such work because of its small size, high biodiversity, and its economic and political stability. Many researchers from developed countries have used the country as a laboratory to further the understanding of tropical ecology and, over time, this has fostered a correspondingly large group of local scientists that have played an important role in the development of this knowledge base.

The creation of the National Institute of Biodiversity (INBio) in 1989 was a pivotal development for the taxonomic classification of the country's biological diversity, though their work has mainly focused on protected areas. The government has developed a National Strategy for the Conservation and Sustainable use of Biodiversity. The GRUAS project also helped identify key forest patches outside protected areas that serve the function of biological corridors. These developments have enabled the country to have a clear idea of which areas must be given priority to receive funds for the conservation of biological diversity. It has also guided the Ministry of Environment in designating new protected areas and supporting the development of private forest reserves.

This technical knowledge is accompanied by a growing understanding of the economics of the sustainable use of biodiversity in the country. As the services offered by biodiversity have often benefited people from far away from the original site there has been a relationship between the national knowledge base and the international literature. In this section this knowledge base is reviewed, in an attempt to define the role that valuation has played in the

four services described earlier: bioprospecting; tourism, recreation and scenic beauty; ecological services; and bundled biodiversity services.

4.1.1 Bioprospecting

Bioprospecting includes a range of different activities, all of which involve the derivation of new products from the biochemical and genetic reservoir of information inherent in the diversity of organisms on the planet. As shown in Table 4.2, pharmaceutical applications are by far the largest of these markets in terms of revenue. Indeed, as recounted above, the original INBio-Merck deal (1991) and many of INBio's subsequent deals have targeted pharmaceutical products. The generic and specific literature is assessed below in chronological order as it relates to the INBio experience. Much of the material on developments prior to 1993 is based on Aylward (1993), which provides a thorough review of the literature available on valuing pharmaceutical prospecting at that time. Subsequent papers are also referenced although it is fair to say that most of the interest in the valuation of bioprospecting occurred in the first half of the 1990s.

Table 4.2 Estimates of market size for products that can be derived from bioprospecting

Type of Product	Revenue (in US\$ billion)
Pharmaceuticals (worldwide, 1998, estimated growth of 6% per year through 2001)	300
Nutraceuticals (dietary supplements, functional and medical foods) (USA) (estimated for 1998, varies according to definition)	86
Seeds (worldwide) (1994), including commercial seed (\$15bn), farm saved seed, and seed from government institutions	45
Agbiotech crop and food products (estimates for 2010)	40
Pesticides (worldwide) (1996)	31.2
Cosmetics and toiletries (USA) (1998)	25.6
Animal health products (worldwide) (1995)	14.4
Top selling herbs (Europe, Asia, North America) (1996) (average growth rate 12- 15% per year)	12.9
Soap and detergent ingredients (USA) (1996)	9
Herbal remedies (Europe) (1998)	8
Enzymes (1996)	2.5
2.5% natural cosmetics	0.6
Detergent enzymes (USA) (1996)	0.16

Source: Sittenfeld and Lovejoy, 1999

It is quite probable that no single estimate of the potential value of engaging in pharmaceutical prospecting motivated INBio's efforts, as much as did the conviction held by many of the scientists involved in INBio's establishment that this was an unexploited and untapped market. INBio's emergence was indeed timely. After decades of inactivity, the late 1980s and early 1990s saw a revival of the idea that new drugs could be found by investigating biodiversity, particularly of the highly biodiverse tropical forests. This resurgence was illustrated by the numbers that turned out for an international conference sponsored by the Rainforest Alliance's "Periwinkle Project" in 1992, which brought together many people from industry, academia and conservation to share their nascent experiences in pharmaceutical prospecting.

In the early days of the resurgence certain “global” studies of the economic value of pharmaceutical prospecting were oft-cited (see those from 1991 or before in Table 2.4). Many of these values were severely exaggerated and represented poor application of economic valuation methodologies (for a full critique see Aylward 1993). Estimates casually bandied about that species were worth millions of dollars were substantiated by some of these studies. In fact, it was only following the INBio-Merck deal that these estimates began to move on from estimating the potential value of the products actually produced by prospecting to the expected returns that prospectors could earn from royalties in a competitive market. A series of studies that were linked more or less directly to INBio and tried to respond to the need for more realistic calculations subsequently emerged (Harvard Business School 1992; Aylward 1993; Artuso 1994; Reid et al. 1993; Simpson et al. 1995; Barbier and Aylward 1996).

The most straightforward methods were calculations of expected royalty returns based on expected hit ratios, royalty rates, expected sales and other industry parameters (Harvard Business School 1992; Aylward 1993; Reid et al. 1993; Artuso 1994; Barbier and Aylward 1996). These studies suggested figures in the order of \$50 to \$50,000 per untested species, with the studies by IIED (Aylward 1993; Barbier and Aylward 1996) and Harvard Business School suggesting a best estimate of approximately \$250 per species or per sample. Artuso’s (1994) royalty model suggested a figure of \$500 per extract tested. Simpson et al. (1995) employed a more complex “lottery” model to estimate the value of the marginal species. Their results are very sensitive (as are all the models) to the probability that a given species yields a hit, and they cite combinations of parameters that result in values for marginal species of from \$2 to \$10,000, with a value of \$67 where the probability of a hit is 1 in 25,000, which approaches the values used by the other researchers.

However, it is difficult to arrive at an exact comparison of these figures as the authors are discussing variously returns per species, per sample and per extract. How to extrapolate these figures to actual screening programmes is also not always clear, given that the same species, sample or extract may be submitted to various screening programmes over time. For example, the analysis by Simpson et al. (1995) assumes that once a species yields a hit it is not employed in further testing. However, reality suggests that a “hot” extract will often be exactly the one that will demonstrate activity in other screens. As pointed out by Aylward (1993), for the purposes of pharmaceutical prospecting, biodiversity is effectively a renewable resource since diseases (and, at a much slower rate, organisms) evolve over time and, thus, a scenario of continually testing species extracts against evolving disease targets is feasible.

From a practical point of view, much of the discussion of the value of individual species in pharmaceutical prospecting needs to be weighted against the larger objective of conserving biodiversity. It is clear that initial expectations regarding the potential contribution of prospecting to biodiversity were exaggerated based on the early “valuation” studies. These same claims also drove much of the Convention on Biological Diversity, which in turn supported efforts to “nationalize” the biodiversity asset for this purpose.

Perhaps the first comparison of this nature appeared in a working paper by Aylward (1993) and was later published in Barbier and Aylward (1996). Using figures for the costs of biodiversity protection on 600,000 hectares of Costa Rican national parks and a generous set of assumptions about annual turnover for screening, loosely based on the INBio-Merck experience, Barbier and Aylward (1996) calculated that the INBio model of allocating up-front and royalty payments (10 per cent and 50 per cent respectively to protected area

management) would lead to a present value financial return to protected area management of around \$2 million. When these returns are set against the full present value of the costs of protecting these areas of \$245 million it becomes clear that pharmaceutical prospecting will only be a minor contributor to the costs of biodiversity conservation. Simpson et al. (1995) reach the same conclusion, applying their estimates to eighteen biodiversity hot spots around the world. The results suggest values of \$1 to \$20 per hectare. The results from Costa Rica fit nicely within that range at a present value of just over \$3/ha.

In conclusion, it is probably worth reiterating that INBio did not depend on these value estimates to generate business, yet the early, high numbers did provide a secure backdrop for selling prospecting as a valuable activity. The \$1 million from Merck only served to heighten this sense of anticipation. However, the valuation studies that were then produced urged caution, and indeed the initial expectations of large flows of money for conservation derived from prospecting have not materialized. Still, it is worth emphasizing as many authors have, that pharmaceutical prospecting remains a potentially profitable venture, and one that is yielding important technical and scientific benefits to countries that invest in it - in terms of improving human capacity and knowledge in the areas of medical research and biodiversity inventories (Aylward 1993; Laird and ten Kate 2002).

Table 4.3 Summary of the literature on the pharmaceutical value of biodiversity

Reference	Farnsworth and Soejarto (1985)	Principe (1989)	McAllister (1991)	Principe (1989)	Ruitenbeek (1989)	Harvard Business School (1992)	Pearce and Puroshothaman (1992)	Reid <i>et al.</i> (1993)
Biodiversity valued	plants	plants	trees	plants	Cameroonian species	Costa Rican species	rainforest plants	biotic samples
Scope of values	US	OECD	global	OECD	not specified	not specified	OECD	not specified
Type of data	drug sales	drug sales	drug sales	value of a life saved	patent renewal costs	royalties on drug sales	drug sales and value of life saved	royalties on drug sales
Type of value	annual	annual	annual	annual	annual	net present value	annual	net present value
Value per item	\$200m	\$200m US \$600m OECD	\$250,000	\$37.5b	\$7,500	\$253,000	\$1.95m - \$350m	not specified
Success rate for discovery of new drugs	1:125	1:2,000	3:100	1:5,000	not specified (10:500)	1:10,000	1:1,000 or 1:10,000	1:40,000
Annual value per untested species (1990 dollars)	\$2.58m	\$474,000	\$7,500	\$23.7m	\$15.00 - \$150.00	na	\$585.00 - \$1.05m	na
Net present value per untested species (1990 dollars)*	\$27.8m	\$5.11m	\$80,800	\$255m	\$162.00 - \$1,620	\$253.00	\$6,310 - \$11.3m	\$52.50 - \$46,000

Notes: *Due to the different methods used in calculating values, the figures are not, strictly speaking, comparable. Net present values for studies presenting only annual values are calculated over a 40-year term with a 10 per cent discount rate. na = not applicable, m = millions, b = billions.

Source: Aylward (1993)

4.1.2 Tourism and recreation

Costa Rica is one of the world's most biodiverse countries and, with more than two dozen parks and other protected areas, has preserved more than ten per cent of the country's primary forests. The country has also experienced rapid growth in international tourism arrivals, due in large part to these national parks. In 1993, tourism became Costa Rica's largest single source of foreign exchange, and 65 per cent of tourists from the US, Canada, and Europe visited national parks during their holidays in Costa Rica.

Naturally, attempts to estimate the economic value of ecotourism, through examination of tourists' willingness-to-pay for visits to protected areas, and for conservation more generally, have proliferated over the years in Costa Rica. A summary of some of the more notable and widely cited papers is provided in Table 4.4.

Table 4.4 Valuation studies of ecotourism in Costa Rica

Survey		Method	Value Measured	Willingness-to-pay		Study
Year	Site			Residents	Foreigners	
1988	Monteverde	TCM	Entrance fee	\$35	-	Tobias and Mendelsohn (1991)
1989	National Parks	CVM	Appropriate entrance fee	\$0.60	\$1.30	Baldares and Laarman (1991)
1989	Monteverde	CVM	Appropriate entrance fee	\$1.50	\$4.20	Baldares and Laarman (1991)
1991/92	Monteverde	CVM	Total economic value	\$137	\$119	Echeverría et al. (1995)
1995	National Parks	CVM	Appropriate entrance fee	\$1.40	\$6.80	Chase (1995)
1995	National Parks	CVM	Entrance fee	\$4.78	\$22.76	Chase (1995)
1995	Manuel Antonio NP	CVM	Entrance fee with improved services	\$13	\$14	Schultz et al. (1998)
1995	Poás NP	CVM	Entrance fee with improved services	\$11	\$23	Schultz et al. (1998)

Notes: TCM is the travel cost method and CVM is the contingent valuation method

The first survey was of resident visitors at the Monteverde Cloud Forest Reserve in 1988. The study employed the travel cost method and suggested willingness-to-pay figures in the order of \$35. As part of a 1989 initiative by the National Parks Service to review entrance fees, Baldares and Laarman (1991) asked visitors to report what they felt 'appropriate' fee levels would be at National Parks and at Monteverde. A similar survey was undertaken in 1995 by Chase (1995) at three national parks (Irazú, Poás and Manuel Antonio). While there was some variation in the results for foreigners, the figures suggested by residents were all less than \$2.00, similar to the fee levels at the time. Baldares and Laarman found foreigners suggesting a higher fee (\$4.20) at Monteverde than at National Parks (\$1.30). Almost six years later, Chase (1995) found that foreigners felt that \$6.80 was a 'fair' entrance fee for national parks. Chase (1995) also examined the willingness-to-pay of visitors for entrance fees at the same parks. The resulting figures were substantially higher than those for 'appropriate' fee levels. Residents were willing to pay over \$10 to visit the parks and

foreigners even more (up to \$23) depending on the park. A later paper from surveys also undertaken in 1995 suggested higher figures (over \$10) for the willingness-to-pay of residents and found similar figures of \$14 to \$23 for foreigners (Schultz et al 1998).

All of these figures pale before those elicited from tourists at Monteverde for their full willingness-to-pay for conserving the entire reserve. Echeverría et al. (1995) suggest figures in the region of \$120 for both residents and foreigners. Unfortunately, there is no direct and comparable survey of willingness-to-pay entrance fees at Monteverde. However, the earlier studies at Monteverde and those at other parks suggest that a good \$100 of this willingness-to-pay is related to existence values apart from those derived from personal enjoyment of the actual visit (as this would be reflected in the willingness to pay entrance fees).

It is interesting to note that the surveyed values have increased over time, sometimes substantially. The exact cause is not clear, but one could speculate that the increasing popularity of Costa Rica as an ecotourism destination and the accompanying rise in the public perception of the importance of natural assets in this regard may well have influenced visitors' sense of value. These changes were clearly visible within the country and the policy-making community during the 1990s. While it is not clear whether these valuation studies drove policy or merely confirmed common knowledge and expectation regarding the worth of the ecotourism experience, it is clear that they very much had an effect on policy.

Indeed, the Chase (1995) study was conducted in conjunction with the National Parks Service, and early results may well have had an influence on the decision taken in September, 1994 to increase entrance fees significantly for foreigners at national parks. It is also noteworthy that when the fees were lowered substantially in April 1996, they were lowered to \$6, which was approximately what Chase (1995) had reported as a fee that foreigners felt was 'appropriate'.

The difficulty of applying sophisticated contingent valuation approaches in developing countries and the problems that are encountered with many such studies should not be discounted (Whittington 2002). Nevertheless, many of these studies were carried out by competent local/international teams of researchers and published in academic journals. The figures for Costa Ricans probably show more unexplained variability. Indeed, many of the later studies tend to have small sample sizes for residents (around 50) as researchers focused more on foreigners and, thus, these figures may be largely discounted. Sample sizes for foreigners, however, were often between 150 and 300 people, enabling a greater degree of confidence in the transferability of the estimated means to the larger population of visitors.

Nevertheless, basing policy decisions regarding pricing on estimates of mean willingness-to-pay remains a crude endeavour. Much more useful is basing such decisions on the expected elasticities of demand. Elasticities provide the means to assess how visits and revenues will respond as prices are changed. They can also be used to find the optimum point for generating revenue. In the case of Costa Rica, two studies of this nature were published following the raising and lowering of prices. Chase et al. (1998) employed the original survey data from the 1995 publication to estimate own and cross price elasticities for foreigners for the three national parks included in the survey. Lindberg and Aylward (1999) examined actual visits to these same parks before, during and after the price hikes of the mid-1990s.

The two studies provide vastly different results. As shown in Table 4.5, Chase et al. (1998) found that visits were relatively inelastic (elasticities of less than negative one). In other

words, visits would drop off just as fast if not faster in percentage terms as the price was raised. In this case the prognosis would have been to avoid a drastic price hike, such as that of 1994, in the expectation that visits would drop off dramatically. Whether or not this study or drafts of the study had an influence on pricing policy and the decision to lower the fee to \$6 for foreigners is not known.

Table 4.5 Elasticities of demand in three National Parks

Park	Chase et al. (1998)	Lindberg and Aylward (1999)		
		at \$5	at \$10	at \$20
Poás	-2.9	-0.051	-0.053	-0.055
Irazú	-1.05	-0.296	-0.366	-0.485
M. Antonio	-0.96	-0.238	-0.281	-0.345

Source: Chase et al. (1998)

Notes: Elasticities represent the percentage change in quantity (visits in this case) associated with a percentage change in price (entrance fees in this case)

Lindberg and Aylward (1999) employed time series data on prices and visits to Poás, Irazú and Manuel Antonio parks and found that demand was, in fact, elastic. That is, a significant gain in revenue from foreign tourists could be expected due to the price hikes, given that the percentage drop in visits fell off at less than the percentage increase in entrance fees. In the case of Poás national park, the figure of -2.9 derived by Chase et al. (1998) was far off the mark, as actual experience showed demand to be very inelastic at -0.05 (across a range of relevant fee levels). Lindberg and Aylward (1999) found less of a difference in the case of Manuel Antonio where the observed elasticity was around -0.3 while the stated preference figure was close to -1.

Figure 4.1 and Figure 4.2 reveal how differently foreigners responded to the large price rise in September 1994. The third arrow from the left in each figure shows the point at which the increase came into effect. The subsequent drop in visits to Manuel Antonio was considerable, with visits dropping by up to 50 per cent in response to the 1,500 per cent price rise. Even with half as many foreign tourists arriving, however, revenues were bound to increase. In the case of Poás, the drop in visits was much less severe. The difference in elasticity is easily explained. In the case of Manuel Antonio, a small coastal park featuring lowland rainforest, some of the key attractions are the beautiful forest-ringed white sand beaches. However, similar sand and waves are available just outside the park on public beaches. Tourists arriving and faced with a \$15 entrance fee were thus more likely to pass up the opportunity to visit the park than tourists were to forgo their visit in the case of Poás national park. The latter is an active volcano surrounded by cloud forest and is at least a half-day trip an hour outside the capital city of San José – and usually figures in the average tourist’s itinerary.

Figure 4.1 Response of actual and seasonally adjusted visits to price changes at Manuel Antonio National Park

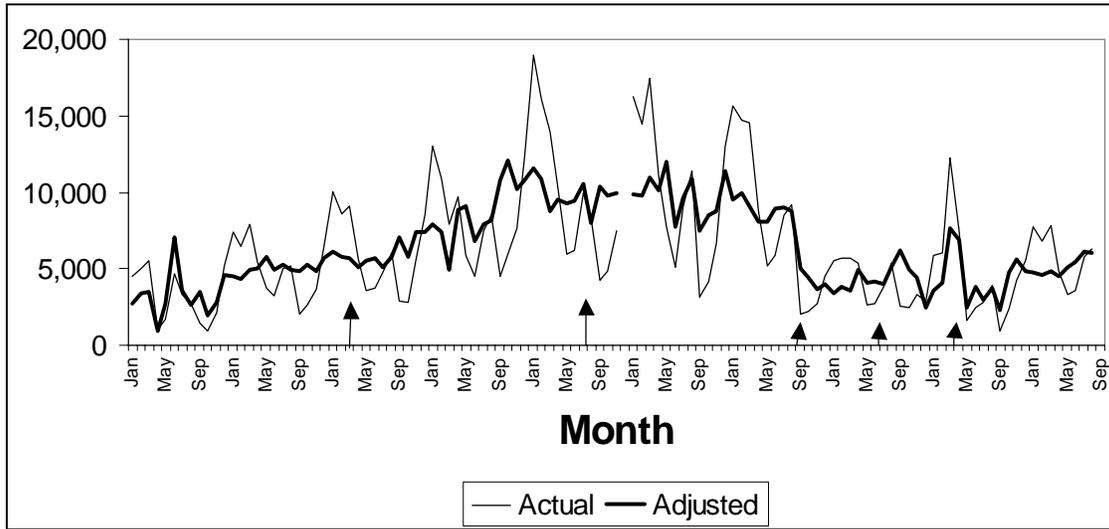
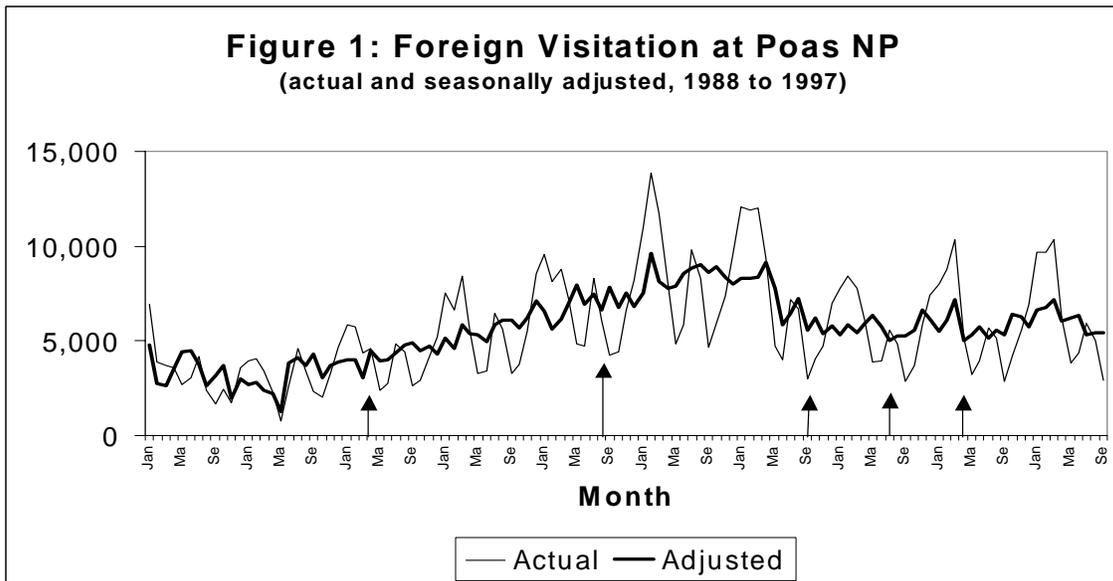


Figure 4.2 Response of actual and seasonally adjusted visits to price changes at Poás National Park



4.1.3 Natural scenic beauty

Only one publication was found that specifically addressed issues related to the knowledge base underpinning the environmental service of scenic beauty (Watson and Fallas 2000). The report, which was prepared for the Ecomarkets project, attempted to develop a methodology to quantify the benefits of forests to scenic beauty. For this, the authors reviewed available

literature, interviewed a wide range of individuals, and developed a GIS based model that included variables such as angle of visibility, land use, etc. For the model, the variables enabled different sites to be ranked according to their “index of complexity” and a measure of uniqueness. Another map was created that included the sensory perception, with variables such as sound, aroma, social surroundings, and texture. The scenery was calculated by optimal land use (versus current land use), ruggedness of the terrain, and a measure for visibility. The final variable included the distance of the scenery from the viewing points, which was calculated by 250-metre wide rings along the roads.

The authors concluded that the methodology could be applied in watersheds to model scenic beauty using GIS. For watersheds that do not have forests, the major contribution to scenic beauty is the recuperation of secondary forests.

4.1.4 Ecological services

Apart from rough estimates derived for the purposes of national statistics (as discussed in the next sub-section), little or no empirical work on the value of ecological services has been conducted in Costa Rica. The Del Oro contract referred to earlier was based largely on estimates of what it would cost for the various parties to the deal to undertake their part of the agreement, i.e. payments for technical assistance, rent, processing, etc. To conclude that the estimate of these costs is an estimate of the value of the ecological services is incorrect. It is simply an estimate of the cost of providing these services and says nothing about whether in economic terms the benefits are worth incurring these costs. This confusion between costs and benefits is a repeated theme in the literature on environmental services, stemming largely from the misuse of the “replacement cost” approach to valuation. Ellis and Fisher (1987) provide a clear discussion of why this approach can yield potentially erroneous conclusions on the value of environmental services.

4.1.5 Biodiversity bundles

A question often posed as part of the larger, international processes related to biodiversity conservation is ‘what is the value of biodiversity?’ An accompanying question relates to determining the economic contribution to the economy or GNP of biodiversity. Such questions and efforts to address them typically emerge from national level processes, often those driven by international initiatives for biodiversity conservation, such as the Biodiversity Convention. Under the convention, countries must engage in various national level strategies and assessments that often include issues of valuation of biodiversity. Such efforts are linked in a way to the issue of environmental services, in the sense that they reflect efforts to take a holistic view of biodiversity as a service bundle.

Unfortunately, efforts to value ‘biodiversity’ are beset by problems of a conceptual, theoretical, methodological and practical nature. Principal among these is arriving at a consistent and useful definition of biodiversity. This can be illustrated by a brief review of some of the initiatives in this regard in Costa Rica.

Castro and Barrantes (1999) review several issues underlying the creation of a market for biodiversity services, including a description of the values and revenues from the biodiversity sector. The approximate revenue/year from some biodiversity products in Costa Rica are estimated as (1996 US\$):

- Ecotourism \$686.2 million (based on average expenditure per visitor to national parks);

- export of cocoons from butterfly farms \$0.1 million, water based transport \$2 million (Nicoya Gulf ferry revenues);
- genetic material for livestock \$448.8 million, and agriculture \$169.2 million (scientific advances in "produced" biodiversity);
- wood-based crafts for export \$6.7 million;
- pharmaceutical nurseries \$5.0 million (exports of plants like raicilla and ipecacuana);
- carbon regulation \$1.0 million (revenues accrued from the Costa Rica-Norway AII project);
- biodiversity research \$0.4 million (funds obtained to support research in biodiversity, as recorded by FUNDECOOPERACION, GTZ, PNUD, and BID);
- bioprospecting \$0.6 million (funds obtained by INBio);
- demand for water from forests \$68.8 million;
- scenic beauty \$9.5 million (this figure relates to entrance to parks whose main attraction is their natural beauty);
- fisheries \$56.3 million (relates to the fish extracted from the oceans); biological control \$603.8 million (no reference to origin of this figure);
- pollination \$235.1 million (the authors estimate this figure is based on studies for the USA).

From the framework put forward in this paper it is clear that biodiversity quickly becomes confused with environmental services more broadly in efforts to calculate the "total economic value" of biodiversity. That said, the example above should reinforce the breadth of opportunity for biodiversity to contribute to a national economy. While bioprospecting, tourism and scenic beauty are potentially valuable aspects of biodiversity, there is a range of other benefits that are less well understood and studied.

4.2 Greenhouse gas mitigation

Costa Rica was one of the first countries to enter into the pilot phase of Activities Implemented Jointly. These activities included developing the knowledge required as a basis for financial transactions to buy and sell carbon offsets. Since this paper is focused on environmental services, this section will only refer to climate change issues related to the forestry sector.

Key knowledge necessary for developing a carbon market and greenhouse gas mitigation projects includes understanding:

- how much carbon is already stored (in existing forests and soils),
- what are the carbon sequestration rates of regenerating natural forests or plantations,
- how much of the carbon is additional (i.e. would not have been sequestered without the mitigation project), and
- how much of the carbon could not be taken into consideration due to leakage.

Due to Costa Rica's early entry into the carbon market a number of Costa Rican organizations have amassed considerable experience and skill in these areas (including the Tropical Science Center, CATIE, and Fundecor). Early on the Tropical Science Center developed an approach to carbon flux estimation based on the Life Zone Ecology approach. Drawing on extensive knowledge and sampling of forests by life zone and association, and

employing standard conversions from biomass to carbon the Center played a pivotal role in the initial inventories of carbon stored in standing forests and estimates of the potential for secondary regrowth. Meanwhile, in developing a number of market proposals for Guanacaste National Park, estimates of carbon sequestration rates were developed. These figures and approaches were then used and reused as studies of carbon potential or market proposals were developed at sites throughout the country.

In terms of the potential above-ground storage of carbon in forests, the figures vary widely depending on the location or life zone. An example of calculations of above-ground carbon stored in forests of different types is provided below for a range of sites initially surveyed by Holdridge as part of the development of the life zone methodology. Figures in Table 4.6 suggest that in per hectare terms stored carbon values might vary by a factor of four. If the range is expanded somewhat the range is from 50 tons/ha to 300 tons/ha. In terms of carbon sequestration, estimates of the rate of sequestration of carbon in regrowth can be used to calculate expected sequestration over time. An example from work in Guanacaste National Park is provided in

Table 4.7. Note that approximately 70 per cent of the potential carbon of a site is expected to accumulate in the first 50 years of regrowth.

Table 4.6 Calculation of biomass and carbon storage for Holdridge sites

Site	Life Zone	Basal Area (m ² /ha)	Length of stem (m) ¹	Total Volume (m ³ /ha)	Average Density (gr/cm ³)	Biomass (ton/ha)	Carbon (ton/ha)
1B	bs - T	40.5	8.2	222.5	0.553	196.8	88.6
20A	bh - T	53.4	14.4	515.2	0.625	515.2	231.8
4	bmh-T	43.8	16.3	478.3	0.515	394.1	177.4
21	bh - P	32.8	11.5	252.7	0.709	286.7	129.0
16	bmh - P	49.0	16.4	538.4	0.615	529.8	238.4

Source: Echeverría et al. (1997)

Table 4.7 Sequestration of carbon by life zones over 50 years

Life Zones	Potential carbon (tons/ha)	Proportion of Total Potential Carbon Stored					Total in 50 years 70%
		10% (years 0-10)	15% (11-20)	20% (21-30)	15% (31-40)	10% (41-50)	
bs-T, bh-Pv	88.59	8.86	13.29	17.72	13.29	8.86	62.01
bh-T	231.84	23.18	34.78	46.37	34.78	23.18	162.28
bmh-T	177.37	17.74	26.61	35.47	26.61	17.74	124.15
bh-P	129.01	12.90	19.35	25.80	19.35	12.90	90.30
bmh-P	238.41	23.84	35.76	47.68	35.76	23.84	166.88
bp-P	74.19	7.42	11.13	14.84	11.13	7.42	51.93
bp-MB	84.03	8.40	12.60	16.81	12.60	8.40	58.82

Source: Echeverría et al. (1997)

As an example of an attempt to calculate national values, Ramírez and Gomez (1999) examined carbon sequestration on plantations in Costa Rica. The authors estimate that an average hectare in a plantation can sequester on average 28.2 metric tons of carbon dioxide

per year, equivalent to 7.7 tons of carbon sequestered in the wood. The 142,600 hectares planted with forestry species in the country up to 1997 can therefore be expected to have sequestered approximately 6.3 million tons of carbon, of which the authors expect some 1.5 million remained sequestered (i.e. not harvested). If the same plantation lands are continually replanted, Ramírez and Gomez (1999) also project that an additional 9.8 million tons of carbon will be sequestered in the next twenty years.

The biophysical baseline information provided by methods and studies such as those cited above is often used in assigning a total value to the carbon stored as part of economic studies or in deriving market prices and proposals for specific mitigation projects. Three broad approaches are found in the literature and proposals to deriving values and prices for the carbon outputs of these studies or mitigation projects:

- estimating the total costs of undertaking the mitigation project and deriving a per unit of carbon sales price to offer in the market;
- taking per unit estimates of the global economic impact of climate change and applying these to the carbon fluxes produced by the project in order to arrive at the economic benefits of the project;
- taking estimates of market values (as observed or projected) and applying these to carbon fluxes.

Early in the 1990s as the initial prospects of a carbon market caught on in Costa Rica a number of proposals for USIJI projects were developed. Lacking any real precedent in terms of valuation and, in any event, needing to correctly price their projects in the anticipated market, most of these initial projects simply estimated the costs of storage or sequestration. Using estimates of the rate at which stored carbon would be emitted as carbon dioxide (forest protection projects) or at which carbon would be sequestered (plantation or secondary regrowth projects) to arrive at net carbon fluxes for the projects, unit costs were derived. These varied considerably with the first three projects approved by USIJI varying from \$37 to \$58 per ton of carbon (for carbon dioxide values divide by 3.66).

As with the AIJ projects (and others) that followed, this approach is one that effectively emphasizes cost-effectiveness. If the costs are too high relative to the outputs then the project is expensive relative to other projects in the ‘marketplace’ and the buyer may go elsewhere. Indeed, the costs of the Costa Rican projects may well be one reason for the lack of examples of converting the carbon market into deals within the country. However, the fact that projects were “offered” at such prices does indicate that there was a presumption that Costa Rica would be a cost-competitive country in the carbon market – and that buyers would be willing to pay such amounts.

In part this may be due to the proliferation of estimates using the other two approaches. These are more research-related approaches, which attempt to assess the worth of mitigation projects for planning (or other) purposes, including that of examining the value of environmental services for the purpose of designing payment schemes. Loosely speaking, studies that use market values examine the financial worth of mitigation projects and those employing global economic figures are used to portray the global economic importance of such projects. There are many examples of these calculations as once the carbon figures are available these calculations are relatively straightforward.

At the macro level, for example, Ramírez and Gomez (1999) estimate that the additional 9.8 million tons of carbon that are forecasted to be sequestered by plantations in the next 20 years are valued between US\$98 and US\$196 million.

The potential range for per unit values is quite large from one study to the next. This problem is magnified by the occasional confusion between dollar values per ton of CO₂ and per ton of C or carbon (the latter being 3.6 times the comparable value for CO₂). As a consequence, the results of such calculations in per hectare terms also have a wide range. This applies to financial and economic studies. For financial values, at the lower end the price paid for a forestry mitigation project in Bolivia was around \$1. At the upper end some early market studies predicted market prices up to \$100/ton of carbon in the future. With respect to economic impact studies (marginal costs of emissions or cost-benefit studies) the range found in the literature varied substantially as well: from \$5 to \$35 depending on models and assumptions (Tol 1999).

Add to this range the confusion between the financial and economic concepts, annual vs. present value figures, storage vs. sequestration values, the lack of clear details about the calculations, and the overall picture on per hectare values or potentials in Costa Rica is not clear. Pearce (1989) first suggested per hectare carbon values in the order of \$2,000/ha based on 100 tons per hectare and a \$20 price. From this point onwards in Costa Rica any number of values can be derived from the literature. Kishor and Constantino (1993) suggest annual values of \$60 to \$120 for sequestration purposes. Echeverría et al. (1997) arrive at \$131/ha present value for carbon sequestered and \$262/ha for stored carbon in Guanacaste National Park. Aylward et al. (1998) suggest \$200 to \$300/ha for natural regeneration in Arenal. Otarola and Venegas (1999) estimate the economic benefits provided by forests for carbon sequestration of \$11/ha/yr, and for carbon storage from \$31 to \$34/ha/yr. Carranza et al. (1996) take this to the extreme and generate a set of values from \$4/ha/yr to \$334/ha/yr for different combinations of price assumptions and life zone carbon potential.

A full assessment of the empirical work on this topic would be an exhausting task indeed. It is unlikely that such an effort would actually be informative with respect to the question of what the value of the greenhouse gas mitigation service of Costa Rican forests is – either in economic or market (financial) terms. It would be more likely to provide data for a sociological study of the consistency, or lack thereof, of assumptions employed by economists and quasi-economists in this field. However, this review does suggest that estimates of the value of such projects were not out of line with the projects being developed in the country. Thus, the valuation work may have played a role in supporting such efforts to capture the value of the carbon market. Unfortunately, it appears that while the projects Costa Rica had to offer were to the upper end of the valuation range, the actual willingness-to-pay of market speculators in those early years were at the lower end of the range. This may explain the lack of carbon deals noted in Chapter 3 above.

4.3 Watershed protection

Hydrological services are some of the most complicated environmental services to understand and quantify, in which very little field empirical biophysical work has been done in Costa Rica. It is assumed that in order for a downstream water user to pay for upstream forest conservation, there needs to be an understanding of how conserving forest translates into benefits for water users. Economic valuation of these services requires knowledge

regarding the linkages between land use and forest hydrology, hydrological functions and consumption/production activities, and the marginal values of water to these activities.

A complicating factor is that a given watershed may have many different users of water, each with their own requirements in terms of hydrological services. Domestic water supply, irrigation, hydropower, navigation, fisheries and ecosystem maintenance are just a few of these uses, each with its own requirements in terms of water quantity and water quality. Even within one sector the hydrological service that is most desired may vary. For example, a run-of-river hydropower plant is interested in maximizing water retention in the watershed and providing as regular a water inflow as possible throughout the day. Peaking hydropower plants with daily storage facilities are more concerned with maximizing daily inflows during the dry season. Meanwhile an inter-annual storage reservoir is most interested in maximizing total annual water inflow given its ability to store water across seasons. These objectives require different strategies of land use management in the watershed, in which forests play different roles.

4.3.1 Biophysical knowledge base

Hydrological services can be divided into water quantity (volume and rate and its distribution in the system in space and time) and water quality (physical, chemical, or biological characteristics with reference to a particular use). Very little fieldwork has been carried out in Costa Rica to understand the relationship between forests and water quantity and quality. Paired catchment experiments, which provide the opportunity to rigorously assess factors such as evapotranspiration, infiltration, and suspended sediment yields, are largely unheard of in Costa Rica, and indeed in Central America as a whole. Thus, most of the experiences in Costa Rica aimed at developing markets for watershed services have either relied on conventional wisdom on the direction and magnitude of these linkages or they have been based on an understanding derived from secondary sources. A number of these sources are often cited (Hamilton and Pearce 1986, Bruijnzeel 1990, Stadtmuller 1994) as the basis for general trends about the relationship between forests and water, which are then used as the justification to promote forest conservation. However, as the conventional wisdom on the direction and magnitude of these impacts differs from scientific knowledge – particularly in the case of water quantity – the degree to which the local literature correctly cites these international sources varies considerably.

In recent years, three locally produced literature reviews have sought to summarize the knowledge on forest hydrology. These include a review carried out for the CREED project by the Tropical Science Center (Mouraille et al. 1996), a background section in a CATIE thesis by Otarola and Venegas (1999), and a summary in a publication by FONAFIFO (Cruz and Navarrete 2000). All synthesize the basics of the current understanding about the relationship between forests and hydrology. It is interesting to note that even though these reviews are balanced in terms of reflecting the mixed nature of forests in providing hydrological services, they have subsequently been used as a basis for the watershed protection service, stating that there will be higher water yields from forestland even when they indicate that the scientific literature suggests that the opposite is expected.

A more recent review of experience in Costa Rica with markets for watershed services by Pagiola et al. (2002) also comments on the biophysical information base and briefly reviews a few of the valuation studies covered below. Pagiola et al.'s major conclusion is that the use of the PES system in Costa Rica to promote watershed management is limited by the lack of reliable and precise information on forest/water linkages.

In addition to the literature reviews, there have been some field studies and statistical analyses that have attempted to examine the impact of land use and vegetation cover on water quantity. A few of these are worth mentioning to provide a flavour of the work undertaken to date. A study by Fallas (1996), carried out as part of the CREED project, measured the contribution of horizontal precipitation in primary and secondary forests. The study found that high primary forests have a net loss of 9.7 per cent, while strips of remnant forest have a net contribution of between 13.9 per cent (remnant primary forest) and 7.9 per cent (remnant secondary forest). Low primary forests have a net contribution of 5.9 per cent. The study concludes that while significant capture of cloud moisture is observed in all cases, the unfortunate reality is that intact cloud forests appear to capture less precipitation than fragmented forests.

At the same time a recent publication by Lawton et al. (2001) suggests that deforestation in the Atlantic lowlands of Costa Rica may lead to reduced cloud formation and increased cloud heights – each of which can have negative effects on the precipitation (horizontal and vertical) in the upland areas along the continental divide. In particular, elevated levels for clouds may lead to reduced fog stripping by cloud forests, which as shown by Fallas (1996) can be an important dry season input to the hydrological cycle. Thus, there may even be important interconnections between geographically distinct forest areas in terms of their hydrological services.

In addition to these studies, there have been a series of initiatives to assess the economic value of hydrological services (or watershed protection). Some of these are undertaken in the areas that are engaged in markets or payments for watershed services and others are not. Many of the studies are based on outdated and overly generalized assumptions about the biophysical linkages between land use and downstream hydrology. In some cases the studies do not even value the resource but rather calculate what the opportunity cost would be of returning cleared land to forest cover and proceed to claim that this “value” is somehow informative with respect to the value of hydrological services. In addition, there are a few studies that make an explicit attempt to develop a model of land use and hydrology interactions.

4.3.2 Background: generic studies of the economic value of hydrological services in Costa Rica

Before turning to examine the biophysical and economic basis for each of the market cases identified in Chapter 3, a review of other studies of hydrological externalities in Costa Rica provides background on the nature of the general information available to those developing market deals. These are loosely grouped by the focus of such studies – either by watershed or service area, while still trying to preserve some of the chronological sequencing of the studies in order to assess the extent to which the studies reveal ‘learning-by-doing’.

Ecological-economic valuation of treated water supply. In 1995, as part of a larger initiative aimed at natural resource accounting, the Tropical Science Center (CCT) and the International Center for Economic Policy for Sustainable Development (CINPE) of the National University of Heredia collaborated on an “ecological-economic valuation” of water as a first step towards the internalization of the ecological-economic costs of water supply (Solorzano et al. 1995). The study appeared only as a working paper and contains a number of conceptual, methodological and numerical errors. However, as it was indeed the first step in a process of developing markets – one that continues to the present day as seen below – it is worth at least a partial review. It is interesting for the information that it presents, but it

does not fully assess the issue of incentives to provide watershed protection as a means of guaranteeing hydrological services.

Working backwards it appears that the authors propose three ways of estimating the ecological-economic value of hydrological services as reflected in industrial, urban and rural piped water supply. The analysis includes seven components:

1. a watershed “production cost” which reflects the cost of providing clean water through ensuring forest cover (by conservation and management of existing forest, forest management and reforestation) – this is calculated by assessing the annual and net present value of 20 years of costs of these activities;
2. a conventional “production cost” reflecting the cost of abstracting, treating and delivering water to customers – based on costs of the national water and sewerage company AyA;
3. an “economic value” of consumer willingness-to-pay for clean water for a permanent and quality water supply – calculated through a contingent valuation survey of the willingness-to-pay of three rural communities;
4. an “economic-ecological” value reflecting consumer willingness-to-pay for water as in (3) but that includes the concept of paying for watershed protection to guarantee sustainability of supply – measured by an additional question on the survey mentioned under (3) above;
5. a conventional “sanitation” cost that reflects the cost of treating water discharge from municipal systems – calculated as 18 per cent of the conventional production cost;
6. a cost reflecting the “exhaustion” of the water supply (the word in Spanish is *agotamiento* so perhaps the idea related to “user cost” although the concept is not explained well) – measured as the incremental usage of water that would be consumed due to population growth over the next 25 years multiplied by the cost of production (unfortunately it is not clear which cost of production is meant, as the figure for this value (11.49 colones) does not appear elsewhere in the document).

The authors then propose three ways of combining this data to arrive at different measures of cost and value:

- an estimate of the real costs of the system which includes (1), (2), (5) and (6);
- an estimate of the “social” value which includes (1), (3) and (6);
- an estimate of the value in perpetuity which includes (4), (5) and (6).

The results are shown in Table 4.8 for metropolitan areas (the figures for (4) are cited incorrectly in the document for urban and rural uses) in order to provide an indication of orders of magnitude. In recalculating the costs and values the production cost figure presented in the paper is reduced by a factor of 20 to account for the paper’s attribution of the production of only a single year’s water (m^3) against the present value costs of production over 20 years.¹⁵ The paper thus demonstrates that consumers are willing to pay more than the

¹⁵ The paper also slightly underestimates these net present values by using the annual cost of protection in the calculation of present value costs of protection, reforestation and forest management. However, as it is likely

real costs in order to provide a permanent and environmentally sustainable source of water. Of course this result is based on a survey of three rural communities, hence the additional surveys that have been conducted since (Table 4.8).

Table 4.8 Ecological-economic values of water

	Cited Cost	Corrected Values		Real Costs		Social Value		Sustainable Value	
	Col/m ³	Col/m ³	\$/m ³	Col/m ₃	%	Col/m ³	%	Col/m ³	%
1. Watershed production cost	9.96	0.50	\$0.003	0.50	0.7%	0.5	0.4%	-	-
2. Conventional production cost	60	60	\$0.400	60.00	84.2%	-	-	-	-
3. WTP for clean water	106.5	106.5	\$0.710	-	-	106.5	90.4%	-	-
4. WTP for clean water from protected watersheds	132.6	132.6	\$0.884	-	-	-	na	132.6	92.5%
5. Water sanitation costs	10.8	10.8	\$0.072	10.80	15.1%	10.8	9.2%	10.8	7.5%
6. Water “exhaustion” costs	0.072	na	na	na	na	na	na	na	na
Total				71.30	100%	117.80	100%	143.40	100%

Source: Solorzano et al. (1995)

Another conclusion that can be drawn, however, is that the watershed production cost is a relatively insignificant cost relative to conventional production costs. While this might seem surprising, it is actually confirmed by an interesting calculation that appears in the study (which does not enter into the calculations of costs and values). The authors calculate the material costs of treating water in two watersheds, one that is forested and one that is deforested. As expected, the costs of treating water (per m³) are higher in the deforested watershed, but only by 0.04 colones/m³. At the applicable exchange rate, that value comes to about US\$ 0.0003/m³. The paper states that 90 per cent of households consume less than 40 m³ per month. In other words, the extra monthly costs that are incurred in cleaning up “dirty” water from the intake in the deforested watershed would come to \$0.01/month. The real question, however, is what incentive does this contribute to the decision to manage, or not, Costa Rican watersheds. Returning to the calculation of watershed production costs as defined by Solorzano et al. (1995), these are seen to be around 0.50 colones/m³. Thus, the extra costs of providing clean water through water treatment represents just 8 per cent of the costs of protecting the watersheds. If the original figures for watershed production costs are used, then the costs savings of producing water from forested watersheds would be insignificant. In other words, in purely economic terms, the other benefits from maintaining or restoring forest cover would need to play an important role in justifying watershed protection.

that the figure of \$1,000 per year for the opportunity cost of land that is to be protected is exaggerated and it is unclear why figures for reforestation and forest management would not already have accounted for any required protection costs, these figures are left as is.

These figures and, indeed the conclusions derived therefrom, should be treated with caution given the problems in the paper by Solorzano et al. (1995). And, indeed, the costs of water treatment may be underestimated; for example, there may be additional labour or administrative costs alongside the increased costs of treatment chemicals when intake water is “dirty”. However, the main point is that in an effort to advance an argument for raising tariffs to provide for the environmental services component, an opportunity was missed in assessing the underlying economic justification for taking such action.

Arenal Watershed. Lake Arenal was impounded in 1979 by the construction of a large dam. Water from the reservoir is diverted from the Atlantic to the Pacific drainage in order to produce electricity in a cascade system with three power plants, and the water is then used for an irrigation project. The Arenal watershed, thus, effectively provides an inter-basin water transfer to the country’s largest hydropower complex (21 per cent of installed capacity in the year 2000) and the largest irrigation project (60,000 ha originally planned, 20,000 ha of which have been developed). As noted earlier, at present, no market is being developed for hydrological services in the Arenal watershed. However, in the mid-1990s the Costa Rican Electricity Institute (ICE) developed plans to try to obtain double carbon credits for reforestation activities in the watershed. The first credit would be for the fixation of carbon in the trees, and the second for the increased flow of water to the hydropower complex that was presumed to result from reforestation, thereby offsetting thermal power generation from other plants on the national grid. Although this idea came to nothing, the hydrological importance of this watershed is illustrated by the number of initiatives to value its hydrological services, all of which were developed with the intention of promoting restoration of forest cover in the large areas of pasture within the watershed.

Valuation initiatives in Arenal go as far back as the original environmental impact study of the dam conducted by the Tropical Science Center, which attempted to calculate the cost of importing extra oil due to deforestation and subsequent sedimentation of the reservoir (Duisberg 1980; and see review in Aylward et al. 1998). More recently, three different studies of the hydrological services in the watershed have been undertaken: a study by the Tropical Science Center and IIED as part of the CREED project (Aylward 1998; Aylward and Echeverría 1999), a study by Castro and Barrantes (1998) aimed at promoting the establishment of markets for services in the watershed, and a third study undertaken as part of a World Bank Environment Department examination of indicators for sustainable development in the Arenal-Tempisque Basin (Chakravorty and Chen 2001).

In the CREED study the present value of the cost of sedimentation from pasture (as opposed to reforestation) in terms of lost hydroelectric production ranged from \$35 to \$75/ha. The study employed a formal model of the impact of sedimentation on both the dead and live storage areas of the reservoir, enabling it to separate out the different effects on these areas. Given the large dead storage relative to sediment inflow for this particular reservoir, the effect of sedimentation on dead storage produced benefits, not costs, in the case of Arenal, as the sediment effectively displaces water upwards into the live storage during dry periods. Arenal is an inter-annual regulation reservoir and thus during a series of dry years in which the reservoir does not fill but is gradually drawn down, the sediment occupying the dead storage effectively makes additional water available for power generation.

With respect to water quantity, the CREED study showed that annual water yield losses due to reforestation of pasture areas could lead to large efficiency losses in downstream hydroelectric power production. The externalities associated with water yield effects were calculated to be one order of magnitude greater than those associated with the sedimentation

costs (as already referred to above). Best estimates for both cloud and non-cloud forest areas suggested positive present values in the range of \$250 to \$1,100/ha for pasture. Sensitivity analysis showed that the values would be reduced to two-thirds of these figures with higher discount rates and in the event that all the water yield gain under pasture were to arrive during the wet season (instead of being received proportionately across wet and dry seasons). The values may also rise to almost \$5,000/ha if dry periods lengthen or occur early in the 70-year simulation period. Further sensitivity analysis examined what would be the economic outcome if reforestation resulted in net gains in dry season flow, in spite of the expected overall losses in total annual water yield. A switching value (where the value of total hydrological externalities go to zero) was obtained only when all of the annual water yield gain *and* an amount equal to an additional 50 per cent of this amount was redistributed to arrive during the wet season (when water is less valuable for power generation). When the analysis of livestock productivity was incorporated into a cost-benefit analysis of land use options, strong synergies between livestock production and hydroelectric power generation in the catchment were demonstrated (Aylward and Echeverría 2001).

Castro and Barrantes (1998) also conducted a study aimed at quantifying in physical and monetary terms the water potential of the Arenal basin. The economic value of the services provided by the watershed has three components: water capture by forests (0.62 colones per m³), protection and maintenance of the watershed (0.044 colones per m³), and the value of the water resource as an input to production (2.13 colones per m³). As with the author's earlier analysis in the case of Heredia (see below), the authors focus primarily on the costs of providing forest cover rather than on the actual marginal value of water as an input into water usage for production or consumption.

The section provided by Chakravorty and Chen (2001) as part of the World Bank report on monitoring attempts to model some of the externalities in the Arenal Tempisque watersheds. However, the paper seems disjointed – on the one hand, clearly having access to prior work in the area yet, on the other, largely ignoring this work and citing unrelated pieces of work. The authors ignore earlier work in Arenal and do not explicitly model water flows but instead assert that water quality is a major problem in Arenal. Unfortunately the authors do not recognize that the relative size of the land area in the watershed and the size of the reservoir when combined with the simple agricultural practices employed make water quality a non-starter as a major problem.

With respect to water quality in Arenal, the authors claim forests have important effects on water quality, based on two reports and a single comparison of forest and agricultural land. All the references are from the United States and two of them were published in the 1970s. In the case of sedimentation rates, the authors cite the figures used in Aylward et al. (1998), which contains a thorough review of a series of erosion and sedimentation studies carried out in Arenal. Arenal, being by far the largest hydropower reservoir in the country, has been the subject of the most extensive studies on this topic, yet the authors then state there is no reliable information on sediment rates for different types of land use, and cite a publication from IFPRI on Honduras that states that erosion is more severe on slopes of 25 per cent or more and that it may be 5 tons/ha in areas with modest slopes. Since the authors then take 5 tons/ha as their model parameter (despite the watershed having extremely steep slopes), the extent to which the authors are really familiar with the area they are modelling is unclear.

Chakravorty and Chen (2001) end up modelling the impact of sedimentation not on Lake Arenal but the small Santa Rosa reservoir (in series with Lake Arenal). The authors assume that 10 per cent of the sediment would make its way downstream to this third reservoir and

that this would alter the use of the three power plants (which are in series). This is despite their acknowledgement that ICE might be able to dredge the reservoir at a reasonable cost. The authors argue that dairy farming in the Arenal watershed is inefficient as it causes \$703 million in externalities. The logic and construction of the model is hard to follow. In particular it is hard to justify the large externality costs, given that in a reservoir the size of Arenal one would expect almost all of the sediment to be trapped in the reservoir. Furthermore, with a \$703 million loss in power production at stake, it is hard to imagine that the Santa Rosa reservoir would not be dredged. Given that Santa Rosa has a volume of 0.1 million cubic metres there would be at least \$7,000 available to cover the dredging of each cubic metre of sediment. The results are therefore largely meaningless.

Talamanca – Rio Macho. Rio Macho is the site of one of the older hydropower facilities in the country, the Cachi HEP. In a Ph.D. thesis for Colorado State University, Quesada-Mateo (1979) develops a deterministic simulation model that enables the user to determine the maximum amount of firm (reliable) power that could be produced from the Cachi hydroelectric reservoir. What makes the model interesting is that it explicitly incorporates the effect of the accumulation of sediment in the live storage, as well as a change in stormflow regime. The author assumes that the removal of forest cover will lead to an increase in peak flow during the wet season and a decrease in base flow during the dry season. While the first assumption is likely to be correct, the latter does not necessarily follow.

In a master's thesis for CATIE, Rodriguez (1989) examines the effect of erosion and subsequent sedimentation in the Rio Macho watershed on the production of the Cachí HEP and subsequent dredging costs. The study suggests that degradation of 16,600 ha in the Rio Macho watershed has caused an increase in maintenance costs of \$16.54/ha/yr (in 1989 US dollars or 22.5 million colones). While a useful and informative, the paper sticks to a narrow interpretation of hydrological services.

In a master's thesis for the National University of Heredia, Otarola and Venegas (1999) developed a proposal for a compensation system for the environmental services provided by the oak forests of the Talamanca Cordillera, specifically within the Rio Macho Forest Reserve. They calculated the economic benefits received by two downstream hydropower plants (Cachí and Río Macho) to be \$14.40/ha/yr and the benefits received by a downstream water treatment plant (Planta de Tratamiento de Tres Ríos) to be \$10.40/ha/yr. Values for the hydropower projects were calculated based on the cost increase data for Cachi during the period 1970-1986, when a portion of its watershed was deforested. These numbers were used as the future scenario for cost increases if deforestation were to take place in Rio Macho's basin. In the case of hydropower plants, the expected benefits from PES are preventing the loss of power production (preventing storage loss) and reducing the maintenance costs for hydraulic machinery. Values for the water treatment plant were calculated by comparing the water treatment costs at the Tres Rios plant with another plant that has a deforested watershed. The water treatment plant is expected to receive benefits through a reduction in the costs of water treatment (reduction in costs of chemicals used) and a reduction in the costs of cleaning sediments from infrastructure and filters. As with the previous study the focus is exclusively on water quality impacts and does not consider water quantity impacts associated with forest maintenance.

4.3.3 Valuation in watersheds containing market initiatives in hydrological services

Energía Global and FUNDECOR – Don Pedro and Río Volcan HEP. According to Chomitz et al. (1998) the rationale for Energía Global to enter into watershed payments was its desire to maintain forest cover in order to smooth out streamflow over time. This enables output and revenue to be maximized as both hydropower plants have tiny reservoirs, able to store only five hours of water. Chomitz et al (1998:16) go on to point out that:

“When streamflow exceeds the plant's capacity for more than five hours, the excess water must be spilled. Each lost cubic metre of water translates approximately to a lost kWh of output, or about US \$0.065 in lost revenue (with price depending on time of day and year). While no in-depth hydrological analysis has been performed, the company's investment will pay off if it succeeds in capturing an extra 460,000 cubic metres per year for generation.”

However, no assessment of the likelihood of this occurring is available or was employed in reaching the decision to go ahead with the watershed payments.

In a master's thesis for the Universidad Nacional, Reyes and Cordoba (1999) valued the environmental service of forests in relation to water resources for the Volcan River Watershed. Two land use scenarios were considered for a 15-year simulation period in which land is either deforested or reforested to form the existing land use pattern. The former option is more profitable from a private (landowner's) perspective since the net present value was \$1,533/ha (all figures cited for 10 per cent discount rate) per hectare as compared to \$1,241/ha for engaging in reforestation. However, taking environmental externalities (carbon sequestration and water quality) into account, the authors suggest that profitability of the “with forest” scenario is higher since the NPV is \$1,198 and the NPV for without forest is \$834 (10 per cent).

In terms of the methodologies applied, Reyes and Cordoba (1999) is one of the best studies reviewed here. Not only does it actually calculate the change in productivity associated with a change in land use, but it also explicitly models the erosion, sediment and consequent impacts on small hydro in terms of plant outages and penalty costs (due to power purchaser when agreed targets are not reached).

Conceptually, however, the study suffers from a series of flaws. First, as noted above there is cause to expect that the effect of land use change on small hydro will be related to water quantity and not just water quality. Not only is this not attempted in the paper, but the authors seem unaware that the effect of reforestation could potentially be a reduction in production instead of an increase, if dry season base flow is reduced.

The second difficulty of the study relates to the way the scenarios are constructed and consequently, the way the results are interpreted. The private scenarios appear logical – in the reforestation option the farmers obtain the environmental services payments and pay the associated costs. However, in the social comparison the financial value of the payments are left in as benefits under the reforestation option and the “income” from the sale of captured carbon and the costs of poor water quality (albeit reduced in this scenario) are added in. The first oversight here is that in the social scenario the valuation figures should be included but not the payments. If both are included then this represents double counting of benefits. It is not possible to enter the payment schemes and separately sell carbon. Entering the programme implies ceding the farmer's rights of any sequestered carbon to FONAFIFO. Similarly, the payments also implicitly include a payment for the “value” of the hydrological

services. Thus, the results for the social scenario as cited are invalid. If the incentive payments (but not the costs of reforestation) are excluded and the valuation efforts left in the analysis then the comparable results for the reforestation option under the social scenario drop to \$311. Given that the social benefits of deforesting are \$834 this remains the optimal land use from an economic perspective (i.e. the farmers could compensate the global community for the carbon consumed and the hydropower producer for his losses). A perverse result perhaps, but interpreted correctly this is what the study suggests.

Finally, the study does not actually provide an indication of the cost of the loss of hydrological services due to deforestation instead of reforestation. If the two streams of costs (one under reforestation and one under deforestation) are compared and the net present value calculated per hectare of land affected (either by reforestation or deforestation), the pure external cost of deforestation imposed on the hydropower producer would be \$54/ha. Note that the combination of two differing land use projections in each of the options (i.e. deforestation of 1,652 ha and reforestation of 826 ha) and the lack of a baseline for comparison make this figure difficult to interpret. Presumably the per hectare costs attributable to deforestation would be higher than this given that the figure also incorporates the benefits of reforestation in terms of gains in water quality. The accuracy of the response of production figures to the change in erosion cannot be judged for a variety of reasons. One reason is that the exact method for converting erosion into sediment accumulated in the reservoir is not clear. Indeed, the number of tons of sediment deposited in year one under the two options is different and so are the cost figures, despite having the same land use patterns in the start year. The other reason is whether the USLE method yields accurate estimates of erosion under the conditions in the watershed.

Difficulties notwithstanding, the contribution made by the study is to actually estimate the change in revenues associated with a decline in small hydropower production due to sedimentation. If the resulting figures are reliable it certainly implies that these costs are significant when viewed on a per hectare basis. However, when mixed in with the costs and benefits of the productive activities on the land and the potential carbon gains and losses the paradoxical end result is that reforestation and the prevention of deforestation is a losing proposition in economic terms even when the value of carbon and hydrological services is included.

Heredia - ESPH. As part of the initiative to increase monthly tariffs to reflect the internalization of environmental services in the watersheds where ESPH obtains its potable water supplies the ESPH contracted a local consultancy, SEED, to produce an initial economic study in 1998. In order to quantify the value of watershed services Barrantes and Castro (1999b) disaggregated the concept into three components and calculated a value for each. The components and estimated values of the adjusted tariff include the capture value (\$0.01/m³), watershed protection and recovery value (\$0.02/m³), and water as production input (\$0.04/m³). From these values Castro and Barrantes (1999b) calculated that the tariff would have to be raised from \$0.27/m³ (¢68.47/m³) to \$0.31/m³ (¢77.20/m³). The increase was less than the value determined from a willingness-to-pay survey that showed people were willing to pay approximately \$0.06/m³ for the environmental adjustment over the amount they currently pay.

The authors estimated the compensation value to landowners as \$133/ha for capture value of forests, and \$180/ha for protection value. These amounts compensate for the opportunity cost of livestock activities and recognize the better water quality from forests.

In a follow-up study on the “Economic Value of the Hydrological Environmental Service at the Forest-Gate: A Supply Analysis,” Castro and Salazar (2000) returned to the watershed and asked farmers what they were willing to accept as payment for conserving existing forest, engaging in natural regeneration and undertaking reforestation. This study simply continues the conceptual confusion evidenced in the earlier SEED and CCT/CINPE studies by suggesting that estimates of the opportunity costs of land under alternative uses can be used to infer the benefits of forest hydrological services. As such, the results of the study are also left to the section in which the size of the FONAFIFO payments is discussed. Interestingly, at one point in the document Castro and Salazar (2000: 9) suggest that the “producers of environmental services [i.e. farmers] could conscientiously calculate the value of each environmental service that is produced by a hectare of forest.” However, the authors themselves do not attempt to cite such a value in the document.

To their credit Castro and Salazar (2000:11) are explicit about their justification for payments for hydrological services, stating that “Costa Rican society positively correlates the presence of forest with the supply of hydrological services.” As evidence of this the authors cite one respondent’s statement regarding the importance of forests in water regulation:

“I left the forest to regenerate around one of the springs that I have on the farm and with the increase in forest cover in that area the quantity of water available increased” (Castro and Salazar 2000:16).

This only serves to underscore the gap that exists between local perceptions and scientific knowledge on these issues. While theory and experience are not inconsistent, the bulk of the scientific evidence at small catchment scales does not support such statements. While this may be a deficiency in the experimental process of paired catchment assessments, it may just as easily be the product of conditioned thinking on the part of those who for years have been told that forests produce water.

La Esperanza HEP-Monteverde Conservation League (MCL). Rojas and Aylward (2002) provide a detailed review of the origins and implementation of this landmark voluntary agreement between La Esperanza HEP and the MCL. No formal studies of a biophysical or economic nature underlie the agreement. In fact, there are no hydro-meteorological gauges within the 3,000 ha that lie above the dam site so the hydrological parameters for the site are inferred from downstream gauges. However, as the watershed is largely comprised of intact primary forest the intention of the agreement is merely to keep this land use constant, rather than (as in some of the other market cases) one of trying to increase forest cover with the aim of improving hydrological conditions. Indeed, the negotiations appear to have revolved as much around the lease of land on which the plant is sited as on the expected nature and magnitude of the environmental services that were contracted (Rojas and Aylward 2002).

4.3.4 General guidance provided to FONAFIFO and ECOMERCADOS

Cross-sectional analysis and hypothetical extrapolation by CT Energía

In a study by CT Energía (2000) for the World Bank/MINAE Ecomarkets project, a statistical analysis was undertaken for the purpose of quantifying the hydrological benefits that forests provide to run-of-river hydropower projects downstream. The overall goal was to devise a formula that could be used to determine and quantify the economic benefits that hydropower producers receive from forest cover in its watersheds. This methodology was to be the basis

on which the official PES scheme could quantify the charges that would be made to hydropower producers for the watershed environmental services of forests.

As part of the study it was necessary to develop a quantitative relationship between forest cover and hydrological services. The study compared how land use had changed in six specific watersheds during the period 1979-1992, and attempted to draw statistically significant correlations between land use change and: 1) dry season stream flow and 2) sediment load. It must be noted, however, that the study mixed a wide range of watersheds. Some are in the dry Pacific slopes, others in the moist Atlantic, some have degraded watersheds, some have pristine forested watersheds. This wide range makes for a better statistical fit because of the inherent distortions within the various contexts.

For the period studied, the rates in land use change of the watersheds ranged from 2.7 per cent annual deforestation to 0.7 per cent reforestation. Empirical formulas were developed that related forest cover with sediment load such that:

$$Y = -2.7X + 311 \quad (R^2 = 0.60),$$

where Y is the sediment load (tons/km²/year) and X is the percentage of forest cover in the watershed.

For dry season (January-April) stream flow, the empirical formula is:

$$Y = 0.11X + 4.99 \quad (R^2 = 0.94),$$

where Y is equal to the dry season flow as a percentage of annual stream flow (dry season flow/ annual stream flow), and X is the percentage of forest cover in the watershed.

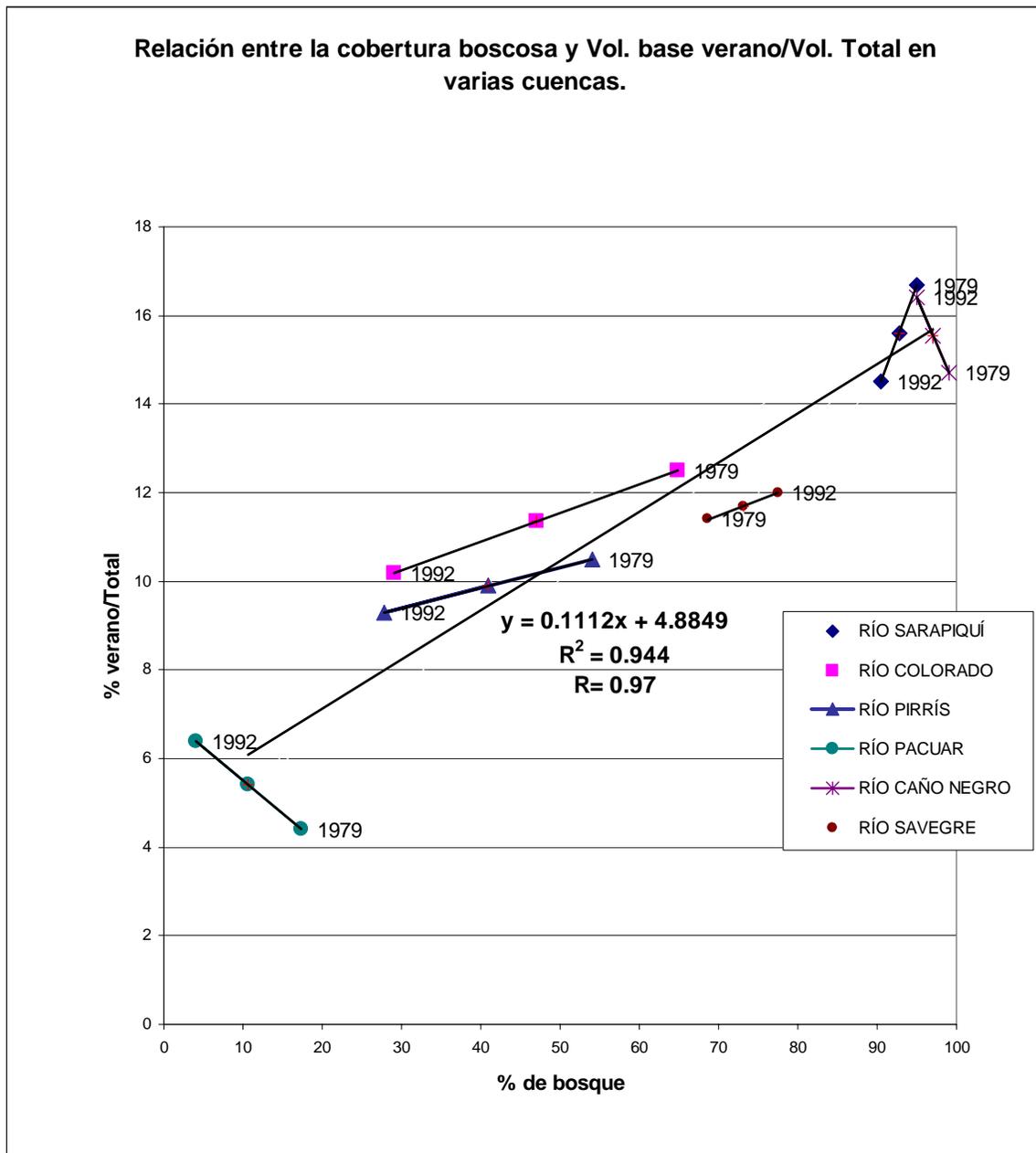
The notion that sediment discharge is related to forest cover is not particularly controversial. It is worth noting, however, that the estimation subsumes into one equation what effectively are two functions of forest cover or land use more generally: the effect of forest in preventing erosion and in detaining sediment transport. The dry season formula purports to show that forest is positively related to dry season stream flow. This is a recurring theme in Central America and one that proceeds without much firm evidence to support it (Aylward forthcoming). This analysis does little in this direction as the rather high power to explain the relationship evinced by the equation ($R^2=0.94$) is a mere artifice of a mistaken theoretical model and a limited sample size. It requires more than empirical evidence from a sample of six data points to overturn well-established scientific knowledge.

Effectively what the authors do is plot two points for each watershed representing 1979 and 1992 data for percentage of forest cover and percentage of total annual stream flow accruing in the dry season. The authors then use the mean of these points for each watershed as their sample for the analysis. The graph is reproduced below to show that the authors simply connect the dots across watersheds, when quite obviously the more relevant analysis would be a time series assessment of each watershed (Figure 4.3). As can be noted, for example, the Rio Pacuar is the watershed with the lowest percentage of forest and the lowest percentage of rainfall that accrues in the dry season. Quite clearly, this is a feature of the watershed and its hydro-meteorological conditions, but the authors use this point to anchor their positively sloped relationship between forest and dry season flow. Needless to say the data as presented for Rio Pacuar actually show that between 1979 and 1992 forest cover dropped from 17.4 per cent to 4 per cent. For the rather arbitrary two-year sample selected, the percentage of

rainfall accruing in the dry season increased with deforestation from 4.4 per cent to 6.4 per cent.

As indicated by Bruijnzeel (2002) “simply comparing streamflow totals for catchments with contrasting land-use types may produce misleading results because of the possibility of geologically determined differences in catchment groundwater reserves or deep leakage”. Bruijnzeel’s general observation applies to the results of the CT Energía (2000) study, limiting their practical import.

Figure 4.3 Relationship between forest cover and dry season flow/annual stream flow in various watersheds



The economic component of the study by CT Energía (2000) is based on the assumption that downstream hydropower producers benefit from having a high dry season stream flow and small sediment loads. Using this assumption plus the aforementioned formula for the relationship between land use and water flows, the authors determine a formula that can be applied to any hydropower project to determine the annual benefit for the project for every forested hectare in the watershed. A theoretical example is given in the paper to illustrate the method. An 11MW hydropower plant that produces 84.7GW per year, has a head of 100m, and a watershed of 38 km² that is 70 per cent deforested, should make annual payments of \$19/ha for the remaining forestland.

The overall conclusion from the study was that, on average, hydro projects receive benefits of \$20/hectare/year. This, CT Energía (2000) believes, should be evenly shared by the forest owner and the hydro project, therefore arriving at an estimate of \$10/ha/yr, which is what a downstream hydropower project should pay the upstream forest owner.

The average value of benefits (reduced sedimentation and increased generation) provided by forested watersheds to run-of-river hydropower producers was calculated as \$24/ha/yr for existing projects and \$15.7/ha/yr for future projects. The average of both values is \$20/ha/yr, with a standard deviation of \$12.7, a coefficient of variation of 0.63, and a range between \$7.3 and \$32.7/ha/yr.

The authors consider that the cost of benefits should be split 50:50 between forest owners and hydropower projects, therefore the calculated average value of the payment of environmental service that should be paid by hydropower producers to forest owners upstream is \$10/ha/yr. This is a convenient result given that at the time of writing this was already the established payment amount.

4.3.5 Conclusions

This review of the literature on valuation of hydrological services reveals a series of deficiencies in the approach taken by those involved in this field, which consequently severely constrains the utility of much of the quantitative work undertaken to date.

Most of the valuation literature appears to be familiar with the basic concepts and terms of forest hydrology, such as evapotranspiration, infiltration, and water balance. However, a significant part of this literature relies on conventional wisdom regarding the relationship between land use and hydrological responses, effectively ignoring the international scientific literature on the topic. Another smaller set of literature refers to the scientific literature and acknowledges at least a few of the inconvenient facts and theories that emerge from the literature, i.e. the inverse relationship between forest cover and water quantity. Some of these papers gloss over the implications of this literature preferring to rely on the conventional wisdom, which produces results that are at odds with the knowledge they cite in the paper.

With regard to the literature on the economic valuation of hydrological services, most of the papers cite at most a few of the locally produced studies from Costa Rica. Many of the studies seem to proceed in the absence of any connection to the literature and, indeed, only a very few make the connection to the global literature. The large majority of the “valuation” case studies make little effort to actually examine the economic benefits of hydrological services. Many of these supposed “valuations” merely tot up the cost to farmers of turning their land to forestry – either as their stated willingness to accept such a change, the direct costs of forest alternatives or the opportunity costs of lost agricultural or livestock production.

What is remarkable is that the recent production of a series of case studies and overviews on this topic – much of it related to the issue of payments and charges for environmental services – has mushroomed in such a manner that a number of publications fall into the vicious cycle of citing the local literature, without taking a critical view of it. The result is a series of assumptions, invalid methodologies and erroneous results and conclusions being cited over and over again, all of which seemingly builds a basis on which further market development is based.

Effectively then, market development proceeds based on conventional wisdom, so that should there be a need to actually rely on the “supporting” literature to demonstrate the value of hydrological services the inconvenient realization would emerge that there is no such support from a scientific or an economic standpoint. This is not to say that the deals that have been developed will not lead to the services for which the payments are made, but rather to emphasize that should this happen this will be more by chance than by design. As pointed out by one of the most cited authors on tropical forest hydrology, an author well-cited in the local literature that has concerned itself with the larger body of science on this issue, L.A. Bruijnzeel, in advocating a proposal to conduct basic hydrological research on this topic in Costa Rica:

“... in the absence of sound quantitative information on the hydrological role of montane (cloud) forest/pasture, any payment scheme in which downstream beneficiaries compensate upland people/forest managers for sustainable land and forest stewardship will have to be considered arbitrary.”

What is interesting is that there is a qualified base of forest hydrologists in the country and indeed Bruijnzeel has found excellent local partners at the Tropical Science Center and the National University. However, it is likewise clear that within policy circles and amongst economists working on the subject there has either been a basic failure to understand the biophysical bases of the services provided or, the knowledge in this regard has simply been too inconvenient and too at odds with popular, received wisdom – including that exercised by those making policy. Thus, this failure to conduct good background research and valuation reveals a learning process amongst government officials, NGOs, consultants and academics that is only loosely linked to scientific method. Those few cases that do not fit the trend largely consist of either analyses undertaken by relative outsiders to the daily machinery associated with environmental services work – i.e. foreign-funded researchers and their partners, or students working on theses. Somewhat predictably this latter literature has achieved little attention in the policy world in which market development occurs.

4.4 Bundles of environmental services

The official PES scheme is in many ways a continuation of the previous systems of forestry incentives and as such was based largely on existing assumptions, expectations and context. It should, however, be noted that there was an attempt to revisit the values of environmental services as part of the process of designing the new system. In 1996, with funds from the UK’s Department for International Development, the Ministry of Environment commissioned the Tropical Science Center to conduct a review of value estimates for environmental services. Carranza et al. (1996) recommended payments for all four environmental services, and distinguished between primary and secondary forests, departing from the assumption that secondary forests provide fewer environmental services than natural forests. The review of values of environmental services from Carranza et al. is summarized in Table 4.9.

Table 4.9 Estimates of the value of environmental services

Environmental Service (US dollars/ha/yr).	Primary Forest	Secondary Forest
Carbon sequestration	\$38	\$29.3
Water conservation	\$5	\$2.5
Biodiversity	\$10	\$7.5
Natural beauty	\$5	\$2.5
Total	\$58	\$41.8

Source: Carranza et al. 1996

Although studies by the World Bank and the Tropical Science Center suggested fixing a value per hectare and year, or a single payment for one full rotation or cutting cycle, MINAE fixed a payment for environmental services for a period of five years and as a percentage of the costs of establishing and managing different kinds of forests. This decision would compensate all four environmental services, and avoid disrupting existing incentives to the forestry sector (de Camino et al. 2000). In the case of forest preservation, FONAFIFO's \$40/ha/yr figure was set as the standard payment, based on the existing government subsidy for forest conservation (CPB). This figure was approximately confirmed in the study by Carranza et al. (1996) which suggested a value of \$58 per year for primary forest. However, it can be argued that the process undertaken by Carranza et al. (1996) was heavily influenced by MINAE and the lead consultant had little incentive to arrive at a final value estimate that differed significantly from the existing set of payments.

A number of the other studies reviewed here provide additional summary estimates of the value of environmental services or make recommendations regarding the size of the payment for environmental services:

- Otarola and Venegas (1999) used the opportunity cost approach to finally quantify a range for the PES for oak forests in Talamanca as \$32.9-\$145/ha/yr
- Espinoza et al. (1999) suggest values of between \$23 and \$53/ha/yr based on tourism values of \$12-25/ha/yr, water protection services of \$10-20/year/hectare and biodiversity services of US\$0.15-8.81 per hectare.

Ortiz (1999) presents survey results from the initial stages of a choice experiment applied to Costa Rican Fuel Tax Payment Allocation among four different services provided by protected, managed and planted forests. Those interviewed considered that the PES should be re-distributed among ecosystem types. Payments (over five years) for managed forests should stay at current levels (\$320/ha), protected forests should receive a higher PES (\$525/ha), while plantations should only receive \$207/ha.

In a paper for FONAFIFO, Sage and Otarola (2000) examined whether the current payment levels (under the PES programme) were sufficiently attractive to rural producers. Using the opportunity cost for the best soil types for permanent crops, it was determined that if the cost of capital is 14 per cent, at least \$246/ha/yr is needed to induce landowners to plant teak (best forestry use) instead of orange orchards (best agricultural use). Teak plantations without PES are a competitive land use compared with the best agricultural land use. In marginal sites for agricultural activities, the authors conclude that the current PES are sufficient to induce land owners to carry out management and conservation. Lower value

timber species such as Gmelina will obviously require greater contributions from PES to compete with agricultural activities in the best soil types.

4.5 References (Chapter 4)

Araya, Mónica. 1997. *Economía de Áreas Protegidas, Empresa y Ambiente: El Caso del Área de Conservación Guanacaste y la Empresa Del Oro*. Tesis para Maestría en Política Económica, Universidad Nacional. Heredia, Costa Rica.

Artuso, A. 1994. *An Economic and Policy Analysis of Biochemical Prospecting*. Ph.D. dissertation, Department of Economics. Ithaca: Cornell University

Aylward, B. 1993. *The Economic Value of Pharmaceutical Prospecting and its Role in Biodiversity Conservation*. LEEC Discussion Paper No. 93-05. London: International Institute for Environment and Development.

Aylward, B. 1998. *Economic Valuation of the Downstream Hydrological Effects of Land Use Change: Large Hydroelectric Reservoirs*. Ph.D. dissertation. Medford, MA: Fletcher School of Law and Diplomacy.

Aylward, B. Forthcoming. "Land Use, Hydrological Function and Economic Valuation" in M. Bonnell and L. A. Bruijnzeel (eds) *Forest-Water-People in the Humid Tropics*. Cambridge: Cambridge University Press.

Aylward, B., and J. Echeverría. 2001. "Synergies between Livestock Production and Hydrological Function in Arenal, Costa Rica". *Environment and Development Economics* 6 (3): 359-382.

Aylward, B., J. Echeverría, K. Allen, R. Mejías, and I.T. Porras. 1999. *Market and Policy Incentives for Livestock Production and Watershed Protection in Arenal, Costa Rica*. CREED Working Paper 25. London: International Institute for Environment and Development.

Aylward, B., J. Echeverría, A. Fernández González, I.T. Porras, K. Allen, and R. Mejías. 1998. *Economic Incentives for Watershed Protection: A Case Study of Lake Arenal, Costa Rica*. CREED Final Report. London: International Institute for Environment and Development.

Baldares, M.J., and J.G. Laarman. 1991. "User Fees at Protected Areas in Costa Rica" in J. R. Vincent, E. W. Crawford and J. P. Hoehn (eds) *Valuing Environmental Benefits in Developing Countries*. East Lansing, MI: Michigan State University, pp. 87-108.

Barbier, E.B., and B. Aylward. 1996. "Capturing the Value of Pharmaceutical Prospecting in a Developing Country". *Environmental and Resource Economics* 8:157-181.

Barrantes, G., and E. Castro. 1999a. *Aportes de la Biodiversidad Silvestre de las Areas de Conservación a la Economía Nacional*. Document prepared for INBio. Costa Rica: SEED.

Barrantes, G., and E. Castro. 1999b. *Estructura Tarifaria Hídrica Ambientalmente Ajustada: Internalización del Valor de Variables Ambientales*. Heredia, Costa Rica: Empresa de Servicios Públicos de Heredia, S.A.

Bruijnzeel, L.A. 1990. *Hydrology of moist tropical forest and effects of conversion: a state of knowledge review*. UNESCO-Free University Amsterdam.

Bruijnzeel, L.A. 2002. *Tropical forests and environmental services: not seeing the soil for the trees? Agricultural Ecosystems and Environment* (in press).

Carranza, C.F., B. Aylward, J. Echeverria, J.A. Tosi, and R. Mejías. 1996. *Valoracion de los servicios ambientales de los bosques de Costa Rica*. San Jose, Costa Rica: Centro Científico Tropical (CCT).

Castro, Edmundo, and Gerardo Barrantes. 1998. *Valoración Económico Ecológico del Recurso Hídrico en la Cuenca Arenal: El Agua un Flujo Permanente de Ingreso*. Heredia, Costa Rica: Area de Conservación Arenal (ACA) - Ministerio de Ambiente y Energía (MINAE).

Castro, Edmundo, and Gerardo Barrantes. 1999. *Generación de Ingresos Mediante el Uso Sostenible de los Servicios Ambientales de la Biodiversidad en Costa Rica*. Costa Rica: Instituto Nacional de Biodiversidad (INBio).

Castro, Edmundo, and Marino Marozzi. 2001. *Valoración económico ecológica de los activos naturales del ecosistema en sucesión de la Hacienda Matambú*. Costa Rica: Fundación Neotrópica/CRESEE.

Castro, Edmundo, Gerardo Barrantes, J.R. De Saxo, and Luis Monestel. 1998. *Capturando y Reinvertiendo los Beneficios Económicos de los Servicios Ambientales y las Áreas Protegidas*. San José, Costa Rica: Ministerio del Ambiente y Energía and Washington DC: World Bank.

Castro, Edmundo, and Sergio Salazar. 2000. *Valor economico del servicio ambiental hídrico a la salida del bosque: analisis de oferta*. Document prepared for Empresa de Servicios Publicos de Heredia S.A. Costa Rica: SEED.

CEPAL (Comisión Económica para América Latina y el Caribe). 2001. *Istmo Centroamericano: Estadísticas del Subsector Eléctrico (Datos actualizados a 2000)*, LC/MEX/L.487.

Chakravorty, U., and Y. Chen. 2001. "An Economic Model of the Arenal-Tempisque Watershed" in P. Hazell, U. Chakravorty, J. Dixon and R. Celis (eds) *Monitoring Systems for Managing Natural Resources: Economics, Indicators and Environmental Externalities in a Costa Rican Watershed*. Washington DC: World Bank.

Chase, L. 1995. *Cuotas de Entrada a los Parques Nacionales en Costa Rica: Resultado de una Encuesta sobre el incremento de las cuotas para turistas extranjeros*. New York: Cornell University.

Chase, L.C., D.R. Lee, W.D. Schulze, and D.J. Anderson. 1998. "Ecotourism Demand and Differential Pricing of National Park Access in Costa Rica". *Land Economics* 74:466-482.

Chomitz, K., E. Brenes, and L. Constantino. 1998. *Financing Environmental Services: The Costa Rican Experience*. The World Bank, Latin America and Caribbean Region, Central America Country Management Unit. Economic Notes. Washington DC: World Bank.

CINPE (Centro Internacional de Política Económica para el Desarrollo Sostenible). 2001. *Informe Metodológico para discusión: Definición de Parámetros Hídricos para la Valoración del Servicio Ambiental de Protección del Recurso Hídrico Brindado por los Bosques y Plantaciones de Costa Rica*. Document prepared for Fondo Nacional de Financiamiento Forestal (FONAFIFO), Costa Rica.

Coto, Marvin. 2001. "El Proyecto de Riego Arenal Tempisque" in Jorge Jiménez and Eugenio Gonzalez (eds) *La Cuenca del Rio Tempisque: Perspectivas para un Manejo Integrado*. Organización para Estudios Tropicales. San Jose, Costa Rica, pp. 73-82.

Cruz, Ginette, and Gilmar Navarrete. 2000. *Los bosques y el servicio ambiental de protección del recurso hídrico en Costa Rica*. San Jose, Costa Rica: Fondo Nacional de Financiamiento Forestal (FONAFIFO).

CT Energia S.A. 2000. *Análisis del impacto de la conservación de bosques en la generación hidroeléctrica*. Proyecto Ecomercados. San Jose, Costa Rica: CT Energia S.A.

de Camino, Ronnie, Olman Segura, Luis Guillermo Arias, and Isaac Pérez. 2000. *Forest Policy and the Evolution of Land Use: An Evaluation of Costa Rica's Forest Development and World Bank Assistance*. Operations Evaluation Department. Washington DC: World Bank.

Duisberg, P. 1980. "Erosión y Conservación de Suelos" in CCT (ed.) *Estudio Ecológico Integral de las Zonas de Afectación del Proyecto Arenal*. San José: Centro Científico Tropical (CCT), Anexo 2:1-65.

Echavarría, Marta. 1999. *Agua: valoración del servicio ambiental que prestan las áreas protegidas*. Arlington, Virginia: The Nature Conservancy.

Echeverría, J., B. Aylward, I. Porras, E. Alpízar, R. Mejías and S. Meijer. 1997. *Valoración Económica de los Beneficios del Area Conservación Guanacaste*. Programa de las Naciones Unidas para el Desarrollo. San José: Centro Científico Tropical (CCT).

Echeverría, J., M. Hanrahan, and R. Solórzano. 1995. "Valuation of Non-Price Amenities Provided by the Biologic Resources within the Monteverde Cloud Forest Preserve, Costa Rica". *Ecological Economics* **13** (1): 43-52.

Ellis, G.M., and A.C. Fishe. 1987. "Valuing the Environment as Input". *Journal of Environmental Management* **25**:149-156.

Espinoza, N., J. Gatica and J. Smyle. 1999. *El Pago de Servicios Ambientales y el Desarrollo Sostenible en el Medio Rural*. San José: RUTA, IICA.

Fallas, Jorge. 1996. *Cuantificación de la interceptación en un bosque nuboso: Monte de los Olivos, Cuenca del Rio Chiquito, Guanacaste, Costa Rica*. CREED Costa Rica, Notas Técnicas No. 6. San Jose, Costa Rica: CCT.

Farnsworth, N., and D. Soejarto. 1985. "Potential Consequences of Plant Extinction in the United States on the Current and Future Availability of Prescription Drugs." *Economic Botany* **39** (3): 231-240.

Hamilton, L., and A. Pearce. 1986. "Biophysical aspects in watershed management" in Easter, Dixon and Hufschmidt. *Watershed Resources Management: An integrated framework with studies from Asia and The Pacific. Studies in water policy and management no.10.* Boulder and London: Westview Press, pps 33-49.

Harvard Business School (HBS). 1992. *INBio/Merck Agreement: Pioneers in Sustainable Development.* NI-593-015. Boston: HBS.

Janzen, D.H. 1999. "Gardenification of Tropical Conserved Wildlands: Multitasking, multicropping, and multiusers". *PNAS (Proceedings of the National Academy of Sciences of the United States of America)* **96** (11): 5987-5994.

Kishor, N., and L.F. Constantino. 1993. *Forest Management and Competing Land Uses: An Economic Analysis for Costa Rica.* LATEN Dissemination Note No. 7. Washington DC: World Bank.

Laird, S.A., and K. ten Kate. 2002. "Linking Biodiversity Prospecting and Forest Conservation" in S. Pagiola, J. Bishop and N. Landell-Mills (eds) *Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development.* London: Earthscan.

Lawton, Robert et al. 2001. "Climatic Impact of Tropical Lowland Deforestation on Nearby Montane Cloud Forests". *Science* **294** (Oct. 19): 584.

Lindberg, K., and B. Aylward. 1999. "Price Responsiveness in the Developing Country Nature Tourism Context: Review and Costa Rican Case Study". *Journal of Leisure Research* **31** (3): 281-299.

McAllister, D.E. 1991. "Estimating the Pharmaceutical Values of Forests, Canadian and Tropical." *Canadian Biodiversity* **1** (3): 16-25.

Mejias, Ronald, and Olman Segura. 2001. *Situación Actual del Pago de Servicios Ambientales en Centroamérica.* Documento Borrado, preparado para World Resources Institute. Heredia, Costa Rica: Centro Internacional de Política Económica para el Desarrollo Sostenible (CINPE).

Mejías, Ronald, Edwin Alpízar, Vicente Watson, Raúl Solórzano, and Jaime Echeverría. 2000b. *Análisis Beneficio-Costo de los Servicios Ambientales en Costa Rica: Tres Estudios de Caso.* San José, Costa Rica: Centro Científico Tropical, preparado para el Proyecto Ecomercados.

Mouraille, Consuelo, Ina Porras, and Bruce Aylward. 1996. *La Protección de Cuencas Hidrográficas: Una Bibliografía Anotada de Hidrología, Valorización Económica e Incentivos Económicos.* CREED Costa Rica Notas Técnicas no. 2. San Jose, Costa Rica: CCT.

Ortiz Valverde, Rosalba. 1999. *Aplicación de experimentos de escogencia múltiple en la distribución del pago por servicios ambientales en bosques de Costa Rica.* Serie Técnica-Reuniones Técnicas CATIE No.5. Logros de la investigación para el nuevo milenio. Actas de la 4ta Semana Científica, 6-9 Abr 1999. Turrialba, Costa Rica: CATIE, Programa de Investigación p. 375-378.

- Otárola Guerrero, M., and I. Venegas Gamboa. 1999. *Propuesta de un sistema de compensación de servicios ambientales para los robledales de la cordillera de Talamanca, Costa Rica*. Thesis. Escuela de Ciencias Ambientales, Universidad Nacional, Heredia, Costa Rica.
- Pagiola, S. 2002. "Paying for Water Services in Central America: Learning from Costa Rica" in S. Pagiola, J. Bishop, and N. Landell-Mills (eds) *Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development*. London: Earthscan.
- Pearce, D., and S. Puroshothaman. 1992. *Protecting Biological Diversity: The Economic Value of Pharmaceutical Plants*. Discussion Paper 92-27. London: CSERGE.
- Principe, P. 1989. "The Economic Significance of Plants and their Constituents as Drugs" in H. Wagner, H. Hikino and N. Farnsworth (eds) *Economic and Medicinal Plant Research* Vol. 3: 655-6. London: Academic Press.
- Quesada-Mateo, C.A. 1979. *Effect of Reservoir Sedimentation and Stream Flow Modification on Firm Power Generation*. Ph.D. dissertation. Fort Collins, CO: Colorado State University.
- Ramírez, O.A., and M. Gómez. 1999. "Estimación y valoración económica del almacenamiento de carbono". *Revista Forestal Centroamericana (CATIE)* 27: 17-22.
- Ramírez, O.A., L. Rodríguez, B. Finegan, and M. Gómez. 1999. "Implicaciones económicas del secuestro del CO₂ en bosques naturales". *Revista Forestal Centroamericana (CATIE)* 27: 10-16.
- Reid, W.V., S.A. Laird, C.A. Meyer, R. Gamez, A. Sittenfeld, D.H. Janzen, M.A. Gollin, and C. -Juma. 1993. *Biodiversity Prospecting: Using Genetic Resources for Sustainable Development*. Washington DC: World Resources Institute.
- Reyes Gatjens, V., and C. Córdoba Serrano. 2000. *Valoración económica del bosque y su relación con el recurso hídrico para su uso eléctrico en la microcuenca del río Volcán*. Masters Thesis. Heredia, Costa Rica: Facultad de Ciencias Sociales, Universidad Nacional.
- Rodríguez, Higinia, F. Valerio, and D. Vindas. 2000. *La Valoración como Proceso Fundamental de los Servicios Ambientales*. Tesis. Heredia, Costa Rica: Escuela de Ciencias Ambientales, Facultad de Ciencias de la Tierra y el Mar, Universidad Nacional.
- Rodríguez, R. 1989. *Impactos del Uso de la Tierra en la Alteración del Régimen de Caudales, la Erosión y Sedimentación de la Cuenca Superior del río Reventazón y los Efectos Económicos en el Proyecto Hidroeléctrico de Cachí, Costa Rica*. MSc thesis. Turrialba: Centro Agronómico Tropical de Investigación y Eneñanza.
- Rojas, Manrique, and Bruce Aylward. 2002. *The Case of La Esperanza: a Small, Private, Hydropower Producer and a Conservation NGO in Costa Rica*. FAO's Land Water Linkages in Rural Watersheds Case Study Series. www.fao.org/landandwater/watershed.
- Ruitenbeek, H.J. 1989. *Social Cost-Benefit Analysis of the Korup Project, Cameroon*. Paper prepared for the World Wide Fund for Nature and the Republic of Cameroon.

- Sage Mora, L.D., and M. Otarola Guerrero. 2000. *Análisis financiero del proyecto: Mitigación de gases de efecto invernadero por medio de la actividad forestal en terrenos de propiedad privada en Costa Rica*. San Jose, Costa Rica: Proyecto Ecomercados.
- Segura, M.A. 1999. *Valoración del servicio de fijación y almacenamiento de carbono en bosques privados en el Area de Conservación Cordillera Volcánica Central, Costa Rica*. Tesis. Turrialba, Costa Rica: CATIE.
- Shafer, Craig. 1990. *Nature Reserves: Island Theory and Conservation Practice*. Washington D.C: Smithsonian Institution Press.
- Shultz, S., J. Pinazzo, and M. Cifuentes. 1998. "Opportunities and Limitations of Contingent Valuation Surveys to Determine National Park Entrance Fees: Evidence from Costa Rica". *Environment and Development Economics* 3 (1) :131-149.
- Simpson, R.D. 1992. *Transactional Arrangements and the Commercialization of Tropical Biodiversity*. ENR Discussion Paper 92-11. Washington DC: Resources for the Future.
- Simpson, R.D., R.A. Sedjo, and J.W. Reid. 1995. "Valuing Biodiversity for use in Pharmaceutical Research". *Journal of Political Economy* 104:1548-1570.
- Sittenfeld, Ana, and Annie Lovejoy. 1999. "Managing bioprospecting and biotechnology for conservation and sustainable use of biological diversity" in J.I. Cohen (ed.) *Managing agricultural biotechnology – Addressing research program needs and policy implications*. Wallingford, UK: CAB International.
- Solórzano, Raúl, Olman Segura, Joseph Tosi, Juan Carlos Burgos, Edmundo Castro, and Marino Marozzi. 1995. *Valoración económica ecológica del agua: primera aproximación para la interiorización de costos*. San José, Costa Rica: Centro Científico Tropical (CCT) y Centro Internacional de Política Económica para el Desarrollo Sostenible (CINPE).
- Stadtmuller, Thomas. 1994. *Impacto hidrológico del manejo forestal de bosques naturales tropicales, medidas para mitigarlo*. CATIE Informe Técnico No. 10. Turrialba, Costa Rica: CATIE.
- Tobias, D., and R. Mendelsohn. 1991. *Valuing Ecotourism in a Tropical Rain-Forest Reserve*. *Ambio* 20 (2):91-93.
- Tol, R.S.J. 1999. "The Marginal Costs of Greenhouse Gas Emissions". *The Energy Journal* 20 (1): 61-81.
- Watson, Vicente, and Jorge Fallas. 2000. *Propuesta para la Cuantificación de la Belleza Escénica en Costa Rica*. Centro Científico Tropical. San José, Costa Rica: Proyecto de Ecomercados.
- Watson, Vicente, Sonia Cervantes, Cesar Castro, Leonardo Mora, Magda Solis, Ina T. Porras, and Beatriz Cornejo. 1998. *Making Space for Better Forestry: Costa Rica Country Study*. Policy that Works for Forests and People Series No: 6. London: International Institute for Environment and Development.
- Whittington, D. 2002. "Improving the Performance of Contingent Valuation Studies in Developing Countries". *Environmental and Resource Economics* 22 (1-2): 323-367.

5 Monitoring and evaluation

In response to the question of what has been achieved with respect to markets for forest environmental services in Costa Rica, this chapter reviews the available literature on the monitoring and evaluation (M&E) of the market cases presented earlier in the paper. Given that many of these initiatives remain ideas or work in progress, it is not surprising that there is little available literature on this topic. However, reviewing what is available against the base of relevant experience can yield an idea of the extent to which monitoring and evaluation are being undertaken and what the coverage of this work is.

The most explicit M&E documents found are the biannual audits that FONAFIFO carries out of its programme. Probably because the PES system in Costa Rica was seen as innovative throughout the late 1990s, most documents do not evaluate or analyze the scheme, but instead focus on the description of how the system works. There are regular monitoring processes in place for certain PES projects, mostly for those in which government institutions are involved, such as OCIC and FONAFIFO, but those reports are not published. NGOs like Fundecor and INBio also have periodic reviews and other internal processes of analysis, but they are not published either. Table 5.1 sets out the ongoing cases of MES in Costa Rica and includes references found that represent either official or unofficial attempts at monitoring and evaluation.

Table 5.1 Markets for environmental services cases and monitoring and evaluation found in the literature

Market Case	Monitoring	Evaluation
Biodiversity		
INBio	INBio Annual Reports	Occasional Donor Evaluations Camacho et al. (2000); Sittenfeld et al. (1999); Sittenfeld and Lovejoy (1999); ten Kate and Laird (2002)
Site Entrance Fees		Aylward et al. (1996); Lindberg and Aylward (1999)
Carbon		
	none found	none found
Hydrological Services		
All	none found	Calvo (2002), Fallas (2002), Rojas (2002), Tattenbach (2002), Pagiola (2002)
Bundles of Services		
PES-FONAFIFO	Reports by forest managers	Chomitz et al. (1998), CECADE (1999), Camacho et al. (2000), Camacho et al. (2001)

5.1 Biodiversity

5.1.1 INBio

INBio is the most prominent example of an organization raising funds for biodiversity conservation in Costa Rica, specifically through bioprospecting. However, thorough evaluations of the INBio case are not readily available due to the confidential nature of the contracts between INBio, pharmaceutical companies and research groups, and this makes it very difficult to obtain accurate estimates and details of the transactions. For example, it is publicly known that a percentage of the funds received by INBio from bioprospecting contracts goes to the system of protected areas (SINAC) for conservation purposes, the public universities for research, and the Ministry of Environment (MINAE), and the remainder is used by INBio's research programme. According to Sittenfeld and Lovejoy (1999) "in 1992-97 INBio has conducted bioprospecting agreements worth over \$6 million: \$3.5 for investments and research expenses at INBio and \$2.5 million for MINAE, the conservation areas, and the universities." Camacho et al. (2000) give a figure of \$2,635,611 received by INBio in the period 1991-1997, of which 30 per cent was distributed to SINAC, 29 per cent to INBio's research programme, 27 per cent to the public universities, and 14 per cent to MINAE (Table 5.2). It appears that the total value of \$2.6 million quoted by Camacho et al. (2000) refers to the \$2.5 million mentioned by Sittenfeld and Lovejoy (1999). However, it is not clear how the \$3.5 million destined for investments and research differs from the \$740,800 allocated to INBio's research programme out of the remaining \$2.5 million. If the \$3.5 million is added to the \$740,800, the proportion of funds allocated to INBio's programme jumps from 29 per cent to 71 per cent of the total.

Table 5.2 Allocation of bioprospecting resources captured by INBio in the period 1991-1997

Institution	1991-1993*	1994	1995	1996	1997	Total
MINAE	110,040	43,400	66,670	51,092	95,196	366,398
SINAC	86,102	203,135	153,555	192,035	126,243	761,070
Public Universities	460,409	126,006	46,962	31,265	34,694	699,336
INBIO	228,161	92,830	118,292	172,591	129,008	740,882
Total	884,712	465,371	385,479	446,983	385,141	2,567,686

Source: Adapted from Camacho et al. 2000

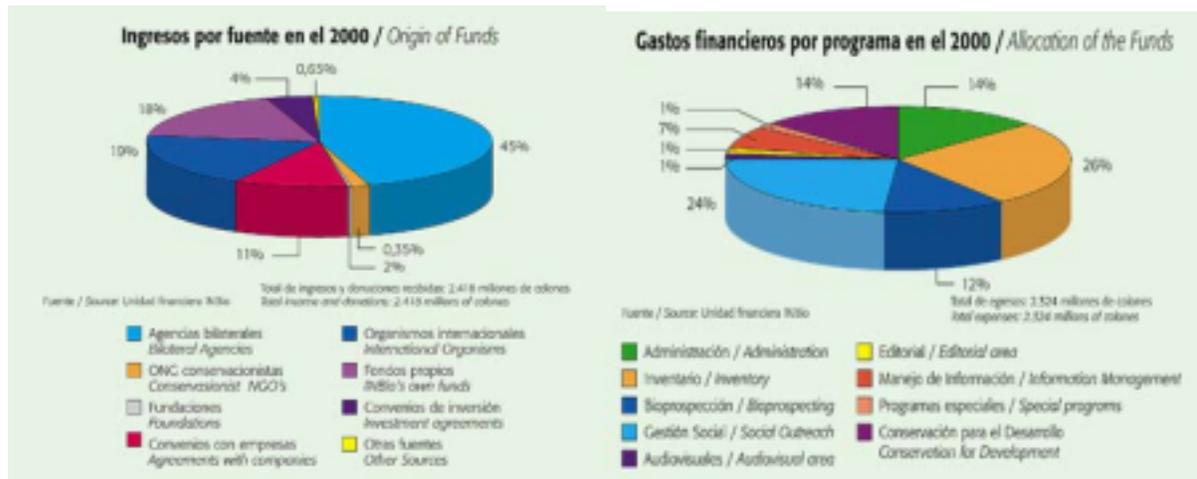
INBio's 2000 Annual Report indicates that for fiscal year 2000, only 15 per cent (equivalent to 355 million colones) of the institution's budget came from agreements with pharmaceutical companies and research institutions. Over 66 percent of the budget for that year came from bilateral donor agencies, foundations, and international aid agencies. Through its activities, INBio was able to generate income to cover 18 per cent of its budget (INBio 2001). These figures indicate that even though INBio is one of the most successful examples of income generation through bioprospecting agreements, in the year 2000 these contracts provided only a small percentage of the overall financial resources required to run the institution and its programmes (see Figure 5.). The value of the resources is significant, though other sources of income are much more important for the institution than bioprospecting contracts.

Camacho et al. (2000) have questioned whether INBio's bioprospecting agreements should be considered a form of PES. Instead they suggest that INBio's pioneering work is part of the groundwork that preceded and enabled the establishment of a national PES programme by allowing access to biodiversity resources that have a commercial value (Camacho et al.

2000). This coincides with a more general statement by Laird and ten Kate (2002), who say that “while in most cases biodiversity prospecting payments per hectare of forest would prove negligible... the direct and indirect benefits for conservation can be significant.” Similarly, Sittenfeld et al. (1999) suggest that it is difficult to assign a value to the benefits of bioprospecting “given the inherent complexities of assigning value to accumulated knowledge of biodiversity, the transfer of know-how and technology, and enhanced capacity building”.

However, in the same article Sittenfeld et al. (1999) suggest that even though the valuation of benefits from INBio is difficult, and the samples processed have not reached the market place to generate revenues from the sale of pharmaceuticals, “it is important to take into consideration that the figure of over US\$2.5 million for conservation and biotechnology development is significant for a country the size of Costa Rica, with a GNP of only US\$9 billion for 1997”. It is difficult to determine the significance of INBio’s contribution given that much of the information about INBio is not available to the public and given the difficulty in valuing non-tangible benefits. Whether US\$2.5 million in a nine-year period is a significant contribution to a country with a GNP of US\$9 billion (in 1997) is totally subjective. For example, the significance of \$761,000 allocated to SINAC in a seven-year period, which in 2000 had a budget of approximately \$30 million (Estado de la Nación, 2001), is debatable. In this respect the financial resources received by MINAE and SINAC are not significant. These conclusions are similar to a study carried out early on by Aylward et al. (1993), who “examined the economic value of species information and its role in biodiversity conservation and... found the sums negligible, and argued that as long as demand for biotic samples remains low, the returns from pharmaceutical prospecting cannot be expected to generate a market solution to the biodiversity crisis” (Laird and ten Kate, 2002). Nine years later the conclusions of Aylward (1993) remain valid.

Figure 5.1 INBio’s income and expenses during fiscal year 2000



Source: INBio Annual Report 2000.

Looking beyond the economic aspects of the INBio case, the institutional aspects of the development of INBio are of interest. Chapela (1997) analyzed the INBio process and pointed out key institutional features that allowed for the success of this particular case:

“The signing of the INBio-Merck agreement was the culmination of years of preparation. During that time, a presidential decree had to be produced to develop the institutional

framework that enables INBio to operate at times as a governmental agency and at times as a private enterprise. A ministerial-level commission was created to give legality and rationale to INBio's operation as a national project. First-rate scientists were enrolled to provide credibility and functionality to INBio. This institutional framework worked in conjunction with the vast international network of connections between politicians, scientists and citizens with an interest in Costa Rica. In other words, the transaction costs necessary to enable the signing of the Merck-INBio agreement were extremely high, and extended over a long period of time.”

There is no doubt that INBio can be considered a success story in many ways. The institution has been a leader in the field of bioprospecting for ten years, its programmes have grown, and it is now able to generate revenue to cover a portion of its annual budget. Benefits such as the taxonomic inventory for Costa Rica are considerable, and far more advanced than most tropical developing countries. INBio, working with other local institutions, has described on average 104 new species per year since 1989, and in 2000 alone described 331 new species, of which 279 are endemic (Estado de la Nación 2001). However the fundamental question that must be asked in light of this analysis is whether INBio is a case of a market that pays for the environmental services of forests. The information available in the literature indicates that this function is relatively limited.

5.1.2 Site entrance fees

Data on site visits and entrance fees is maintained by MINAE, but little in the way of formal monitoring or evaluation of this experience or “experiment” was conducted by the authorities. However, in an econometric analysis of the rise and fall in park visits that accompanied the price hike in 1994, Lindberg and Aylward (1999) confirm that demand for park visits was relatively inelastic. In other words, the decline in number of visits was moderate when compared to the level to which the price was raised. All of which suggests that the parks could have raised significantly more money by keeping the fees higher rather than lowering them.

Table 5.3 Expected visits and revenue under different pricing scenarios in Poás, Irazú and Manuel Antonio National Parks

Price	Expected Foreign Visits			Expected Revenue		
	Poás	Irazú	M.A.	Poás	Irazú	M.A.
1	6,900	3,900	7,400	83,000	47,000	88,000
5	6,500	2,900	5,600	389,000	175,000	336,000
10	6,300	2,500	4,800	756,000	299,000	581,000
15	6,200	2,200	4,400	1,115,000	405,000	792,000
20	6,100	2,100	4,100	1,468,000	498,000	981,000
Gain in increasing fees from \$1 to \$15				1,032,000	358,000	704,000

Source: Lindberg and Aylward (1999)

There is a series of additional impacts of raising fees that must be incorporated into any evaluation of such action. First and foremost is the issue of access and equity. Fees for resident visitors were left unchanged. This reflects the feeling that parks are national patrimony and that access should not be regulated by prices. Of course, this is a largely illusory argument given that the travel costs of visiting a protected area are often excessive for many developing country residents. However, it remains a politically powerful argument

to dissuade policy-makers from raising fees for locals. At \$15 per person and with little in the way of discounts, certain groups of foreigners such as backpackers and families would probably alter their itinerary and visit fewer parks based on their ability to pay.

Aylward et al. (1996) also suggest that the policy will not necessarily fulfil another of its stated objectives, that of increasing the profitability of private reserves. Falls in visits were observed at the Monteverde Cloud Forest Reserve in 1994-95 when it might otherwise have been expected that visitors would actually visit the reserve more, given the higher fees in the state-run parks. But this effect may have as much to do with substitution outside of Costa Rica as between the national parks and private reserves. Thus, changes in pricing policy at the national level may need to take into account not simply the microeconomic argument for extracting fees from tourists for reinvestment in the parks, but also subsequent economic impacts on a country's ability to maintain its competitiveness as an ecotourism destination.

It is unfortunate that the rather crude and drastic change in the pricing policy for the national parks failed to take account of the history of pricing policy and fee structure management at the Monteverde Cloud Forest Reserve, where a series of differentiated, but graduated fees had been implemented over a number of years prior to the hike in park entrances fees in 1994. While some suggest that the end result was worth the turmoil and confusion – i.e. that a \$6 fee is in itself a significant achievement in terms of differentiating fees – this view is not shared by everybody. If the eventual objective of good governance is a reasoned, balanced and participatory approach to policy-making then the Costa Rican experience was not a positive one. The fact that prices have not shifted since 1996 is an indication that the momentum that might have been generated by gradually raising prices has been lost. Despite the evidence that much-needed finance for biodiversity conservation could be generated in this way, too much political capital was lost for this route to be tried again.

5.2 Carbon

There is a series of reports that are required as part of the deals in which carbon credits are traded. These include monitoring and evaluation of commitments, as well as reporting to the international trading institutions. However no independent empirical evaluations of the overall market experiences with carbon in Costa Rica were found in the literature. Most documents on the topic are descriptive presentations of specific carbon schemes or technical documents such as methodologies to quantify carbon content. Documents such as those used to report progress of projects to the UNFCCC mention the status of individual projects, but do not assess their effectiveness.

A review of Costa Rica's experience with carbon would be very opportune, given that it was one of the first developing countries to enter into schemes for trading carbon offsets. An analysis of expected versus received benefits from carbon deals would shed light on the success of the first set of transactions. In the energy field, for example, the fact that there were no international buyers for carbon offsets has affected the expected rate of return of one wind power project (Gallegos 2001). It would be interesting to ascertain whether that has also happened in the case of forestry projects. Another important aspect that an evaluation could clarify is the impact that the failure to approve the Kyoto Protocol within the expected timeline has had on the Costa Rican projects. Many of the expectations for carbon deals were centred around the commitments imposed on developed countries, however, without Kyoto many companies have lost the incentive to purchase carbon offsets. This could be reversed through the Clean Development Mechanism, but it is still too early to judge.

5.3 Hydrological services

No formal evaluations of the hydrological component of payments for environmental services have been conducted. In many cases, even the hydrological data necessary to perform an ex-post evaluation is not being monitored due to the cost of installing the necessary equipment.

The issue is not being ignored, however. FONAFIFO organized a seminar in May 2002 that examined these issues and served as the closest to an evaluation of hydrological services yet undertaken in the country. The proceedings of the seminar and the discussions that took place are thus instructive. The seminar focused on the hydrological services that forests provide, and the implications these have for the PES scheme. Presentations by Rojas (2002), Calvo (2002), and Fallas (2002) all analyzed and questioned some of the perceptions that exist in Costa Rica about the relationship between forests and the hydrological services they provide. Rojas (2002) indicated that hydropower projects currently paying for the watershed services of forests do not know if in return for their payment they are getting more or less water, or water of a different quality. The only indicator used for the effectiveness of the payment for watershed services is the change in forest cover in the specified watershed. In Costa Rica it is widely assumed that forests are the best possible land use for hydrological services and therefore forest cover is used as an indirect means of verification.

Tattenbach (2002) presented data that shows a reduced rate of deforestation in watersheds that receive PES. However, he failed to provide data that quantifies how a reduced rate of land use change from forests to something else translates into hydrological services for hydropower projects. Calvo (2002) summarized the results from the international literature on this topic, and clearly stated that some perceptions in Costa Rica contradict the scientific evidence for other tropical countries. An international review of the hydrological literature and the implications it has for environmental services (Bruijnzeel 2002) is likely to shed more light on this debated topic. Fallas (2002) presented an analysis of evidence gathered from the Costa Rican context, and demonstrated that there is a high degree of uncertainty, which is complicated by the data sources available in the country.

Overall, presentations in the FONAFIFO seminar questioned the assumption that forests and timber plantations are by default the optimal land use for water users and therefore that forests do in fact provide the benefits claimed by the PES proponents. Presenters concluded that there would be variations on what services are or are not provided, depending on what the water is used for and the specific conditions of each watershed. This echoes the conclusions drawn by Pagiola (2003) in an independent review.

Symptomatic of this problem, Rojas and Aylward (2002) mention the lack of evidence to justify the PES scheme with regard to the hydrological services of forests in a review of a specific case where a hydropower project is paying for forest conservation upstream. In that particular case, the evaluation indicated that the agreement is based on assumptions and is solely the result of negotiations between two parties, basically centred on how much one part is willing to pay and the other willing to receive. The general feedback at the FONAFIFO seminar indicated that due to the lack of information it is important to have a precautionary approach to changes in land use in watersheds (Fallas 2002; Rojas 2002). However, there were also presenters who argued against the international literature as valid evidence for the local context, and emphasized that the assumed environmental services do exist (Segura 2002).

FONAFIFO and MINAE are currently placing a high importance on the hydrological services of forests (Solorzano 2002; Rodriguez 2002). It is thus advisable to initiate an evaluation of what the data for Costa Rica shows. Unfortunately, much of the hydrological information has been collected by ICE, and is not freely accessible by the general public. One alternative would be to commission a joint analysis of the hydrology-forest relationship with ICE, MINAE, other local experts and international reviewers.

5.4 Bundled services

Of the initiatives for PES that include a bundle of environmental services, monitoring and evaluation are available only for the FONAFIFO scheme. Most local initiatives have not even been documented and the land easements programme has not been reviewed.

Since FONAFIFO does not have field staff, it delegates the responsibility for permanent monitoring of projects to professional foresters. These foresters are accredited professionals whose reports are legally binding. They work for the forest owners, but legally they are expected to be impartial evaluators of forest management practices. Foresters must submit reports to FONAFIFO at least once a year. In addition to the work done by foresters, FONAFIFO also subcontracts periodical monitoring of land cover using GIS, through which they determine if there has been any loss in forest cover in areas receiving PES (Ansmann 2001). Finally, FONAFIFO carries out periodic external evaluations and audits, including a bi-annual technical review of its PES programme (Ansmann 2001). As of 2002, FONAFIFO had contracted two external evaluations of its PES programme, one in 1999 (CECADE 1999) and the most recent one in 2001. These are, however, fairly narrow audits, focused on the direct performance of the programme in terms of expenditure and lands incorporated into the programme.

Achievements during the period 1997-2000 are indicated in Table 5.4. A total of 256,520 ha were entered into the PES scheme, a majority (85 per cent) under the forest conservation modality. The PES programme has benefited 3,978 beneficiaries.

Table 5.4 Land incorporated into the PES scheme 1997-2000

Year	Forest Conservation (hectares)	Forest Management (hectares)	Reforestation/ Plantations (hectares)	Total (hectares)	No. of Beneficiaries
1997	88,830	9,325	4,629	102,784	1,531
1998	47,804	7,620	4,492	59,916	1,021
1999	55,776	5,125	3,880	64,781	925
2000	26,583	-	2,457	29,040	501
Total	218,993	22,070	15,458	256,520	3,978

Source: Estado de la Nación (2001)

According to the Costa Rican Chamber of Forestry, most of the private primary forest in Costa Rica is held in properties between 20 and 150 ha in size (Camacho et al. 2000). During the period 1997-2000, more than 80 per cent of the PES contracts were directed to parcels of under 80 hectares in size (Estado de la Nación 2001). As a reference for scale, FONAFIFO considers as small producers to be those with a parcel of land of 1-50 ha in area, while medium sized producers are those with properties of 50-300 ha in area.

The limitations of the programme can be summarized as relating to their conservation rather than service-specific nature and the single, centralized approach to the establishment of payment levels. Given the variations in soil and forest type, local land uses, downstream infrastructure, and socioeconomic conditions, it would clearly be more efficient not to package all four services into a single payment which obscures the variation in individual service levels across the country and the potential variations and tradeoffs between the different services. With regard to carbon offsets it would be particularly interesting to assess the possibilities for developing internal, national marketable permit systems as these have clear advantages over conservation transfer payment schemes.

An interesting question is whether there might not be better institutional arrangements and financial mechanisms for fulfilling the central role of providing for financial transfers to these smallholders. In the Costa Rican case, existing legislation complicates the issue as the new Forestry Law effectively expropriated land use rights on private land by forbidding any change in land use on lands with forest cover. As a result the PES are frequently regarded as a compensatory payment for this expropriation rather than an incentive or compensation per se.

In addition to the internal efforts at monitoring and evaluation, there have been three independent reviews of the PES programme. A very early summary and review by Chomitz et al. (1998) for the World Bank aimed primarily to draw lessons and generate recommendations for the programme. The authors emphasized the importance of improving the cost efficiency of the programme with respect to price setting and prioritization by using a spatial approach to supply price and environmental services. Two later efforts by Camacho et al. (2000) and Camacho et al. (2001) to compile existing information on PES included an emphasis on participation and social impacts. These efforts have since sparked off initiatives on behalf of a number of local and international organizations in conducting empirical field studies aimed at assessing the environmental and social impacts of the PES programmes.

5.5 References (Chapter 5)

Ansmann, Till. 2001. *El sistema de pago por los servicios ambientales (PSA) en Costa Rica: Estado actual, experiencias y perspectivas*. Heredia, Costa Rica: Centro Internacional de Política Económica, GTZ.

Aylward, B. 1993. *The Economic Value of Pharmaceutical Prospecting and its Role in Biodiversity Conservation*. LEEC Discussion Paper No. 93-05. London: International Institute for Environment and Development.

Aylward, B., K. Allen, J. Echeverría, and J. Tosi. 1996. "Sustainable Ecotourism in Costa Rica: the Monteverde Cloud Forest Preserve". *Biodiversity and Conservation* 5: 315-343.

Aylward, B., J. Echeverría, L. Fendt, and E.B. Barbier. 1993. *The Economic Value of Species Information and its Role in Biodiversity Conservation: Costa Rica's National Biodiversity Institute*. LEEC Discussion Paper 93-06. London: International Institute for Environment and Development.

Calvo, Julio. 2002. *Monitoreo del Impacto de los Ecosistemas Forestales en el Régimen Hidrológico de una Cuenca*. Presentation prepared for FONAFIFO and presented at the Seminario Internacional Servicios Hidrológicos de los Ecosistemas Forestales, 30-31 May, 2002. San Jose, Costa Rica.

Camacho, María Antonieta, Olman Segura, Virginia Reyes and Alejandra Aguilar. 2000. *Pago por Servicios Ambientales, Punto Focal: Costa Rica*. Proyecto PRISMA-FORD, preparado por CAMBIOS (Cambio Social, Biodiversidad y Sostenibilidad) y CINPE (Centro Internacional de Política Económica para el Desarrollo Sostenible), San Jose, Costa Rica.

Camacho, María Antonieta, Olman Segura, Virginia Reyes, Miriam Miranda. 2001. *Gestión local y participación en torno al pago por servicios ambientales: Estudios de caso en Costa Rica*. Proyecto PRISMA-FORD, preparado por CAMBIOS (Cambio Social, Biodiversidad y Sostenibilidad) y CINPE (Centro Internacional de Política Económica para el Desarrollo Sostenible), San Jose, Costa Rica.

CECADE. 1999. *Pago de Servicios Ambientales. Informe Final de Evaluación*. San José, Costa Rica: Fondo Nacional de Financiamiento Forestal.

Chapela, Ignacio. 1997. "Bioprospecting: Myths, Realities and Potential Impacts on Sustainable Development" in M. Palm and I. Chapela (eds) *Myecology in sustainable development: Expanding Concepts, Vanishing Borders*. Boone, North Carolina: Parkway Publishers Inc.

Chomitz, K., E. Brenes, and L. Constantino. 1998. *Financing Environmental Services: The Costa Rican Experience*. The World Bank, Latin America and Caribbean Region, Central America Country Management Unit. Economic Notes. Washington DC: World Bank.

Estado de La Nación, proyecto. 2001. *Estado de la Nación en Desarrollo Humano Sostenible: un análisis amplio y objetivo sobre la Costa Rica que tenemos a partir de los indicadores mas actuales (2000) Vol 7*. San José, Costa Rica: Proyecto Estado de la Nación, PNUD.

Fallas, Jorge. 2002. *Agua, bosques, y servicios ambientales*. Presentation prepared for FONAFIFO and presented at the Seminario Internacional Servicios Hidrológicos de los Ecosistemas Forestales, 30-31 May, 2002, San Jose, Costa Rica.

Fallas, Jorge. 1996. *Cuantificación de la interceptación en un bosque nuboso: Monte de los Olivos, Cuenca del Rio Chiquito, Guanacaste, Costa Rica*. CREED Costa Rica, Notas Técnicas No. 6. CCT: San Jose, Costa Rica.

Gallegos. 2001. Personal communication.

INBio. 2000 and 2001. *Annual Report*. Heredia, Costa Rica: INBio.

Laird, S.A., and K. ten Kate. 2002. "Linking Biodiversity Prospecting and Forest Conservation" in S. Pagiola, J. Bishop and N. Landell-Mills (eds) *Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development*. London: Earthscan.

Lindberg, K., and B. Aylward. 1999. "Price Responsiveness in the Developing Country Nature Tourism Context: Review and Costa Rican Case Study". *Journal of Leisure Research* 31 (3): 281-299.

Rodríguez, Jorge Mario. 2002. Presentation at Seminario Internacional Servicios Hidrológicos de los Ecosistemas Forestales, 30-31 May, 2002, San Jose, Costa Rica: FONAFIFO.

Rojas, Manrique and Bruce Aylward. 2002. *The Case of La Esperanza: a Small, Private, Hydropower Producer and a Conservation NGO in Costa Rica*. FAO's Land Water Linkages in Rural Watersheds Case Study Series. www.fao.org/landandwater/watershed.

Rojas, Manrique. 2002. *El Sistema de Pago por Servicios Ambientales en Costa Rica: Algunas Implicaciones para Pequeños Proyectos Hidroeléctricos*. Paper prepared for FONAFIFO and presented at the Seminario Internacional Servicios Hidrológicos de los Ecosistemas Forestales, 30-31 May, 2002, San Jose, Costa Rica.

Segura. 2002. Presentation at Seminario Internacional Servicios Hidrológicos de los Ecosistemas Forestales, 30-31 May, 2002. San Jose, Costa Rica: FONAFIFO.

Sittenfeld, Ana, and Annie Lovejoy. 1999. "Managing bioprospecting and biotechnology for conservation and sustainable use of biological diversity" in J.I. Cohen (ed.) *Managing agricultural biotechnology – Addressing research program needs and policy implications*. Wallingford, UK: CAB International.

Sittenfeld, Ana, Ana Mercedes Espinoza, Miguel Muñoz, and Alejandro Zamora. 1999b. *Costa Rica: Challenges and Opportunities in Biotechnology and Biodiversity*. CGIAR/NAS Biotechnology Conference, October 21-22, 1999. San José, Costa Rica: Centro de Investigación en Biología Celular y Molecular (CIBCM) Universidad de Costa Rica.

Solorzano, R. 2002. Presentation at Seminario Internacional Servicios Hidrológicos de los Ecosistemas Forestales, 30-31 May, 2002. San Jose, Costa Rica: FONAFIFO.

Tattenbach. 2002. Presentation at Seminario Internacional Servicios Hidrológicos de los Ecosistemas Forestales, 30-31 May, 2002. San Jose, Costa Rica: FONAFIFO.

6 Conclusion: lessons, findings and analysis

6.1 The current conceptual framework: is it too narrow, and skewed towards forests?

- The focus of PES is mainly on forests, but what about other ecosystems? There are several benefits and services provided by ecosystems other than forests, such as wetlands. If there is a market for the services of forests, should there be a market for the services provided by other ecosystems? The focus in Costa Rica has been on forests probably because the PES scheme represents an evolution from previous incentives to the forestry sector. Other institutional and market examples do include non-forest ecosystems, such as INBio and ecotourism. For example, INBio carries out bioprospecting on species that inhabit wetland, aquatic, and marine ecosystems. But the bottom line is that if the goal of the PES system is to internalize the costs of beneficial externalities of ecosystems, then the system will need to evolve to incorporate non-forest ecosystems.
- The focus of Law No.7575 is only on four environmental services, but what about the rest? There are other services provided by forests, such as flood mitigation, erosion control, storm protection (particularly mangrove forests), provision of nutrients for downstream ecosystems (i.e. fisheries), pollination of crops, pest control, etc. Some of these are implicitly included in the four services recognized in Costa Rica, such as erosion in hydrological services and pollination in biodiversity. But some are not included at all. Whether or not additional services should be considered will depend on the context. However, if all services are considered, it is more likely that a buyer of the services will be found. This would maximize the opportunity of obtaining economic compensation for conserving ecosystems even if not all services can be sold in every case.
- Ecological functions and services are not exclusive to natural ecosystems. This is implicitly recognized when timber plantations are included in Costa Rica's forestry law as providers of environmental services. For example, a citrus orchard or coffee plantation contributes to carbon sequestration, albeit with lower volumes than a fast growing timber tree species. Should citrus and coffee farmers be paid for the environmental services their crops provide? Once the thin line between natural ecosystems and other land uses is crossed the justification for payments becomes more complicated. An extreme scenario would be where a homeowner requests economic compensation for some trees on his or her backyard! Therefore, there may be a need to maintain the distinction between natural ecosystems and other land uses. This does not mean, however, that other land uses cannot be promoted for the benefits they provide. They may still be preferred to the alternative when both productive and environmental benefits are considered. Depending on the objectives, a mixture of strategies and land uses might be the best alternative, which may or may not include PES mechanisms.

6.2 Does the PES scheme really offer a new concept or is it simply a repackaged subsidy?

- The PES concept in Costa Rica emerged because of the increasing need to find sustainable sources of funding for forest conservation and forestry sector activities. This dual goal is the result of the development of two separate but parallel trends in Costa Rica over the last thirty years: the creation of the protected areas system with its associated conservation approach, and the creation of a subsidized forestry sector. It also forms part of the development of financing mechanisms for conservation activities. Therefore, it would appear that for forest conservation, the PES is in fact an innovative new market-based approach. However, making payments for environmental services to commercial timber plantations only seems to be a continuation of the subsidy scheme to the forestry sector.
- Law 7575 prohibited changing land use in areas of natural forests, and the penalty for this was imprisonment. One could then ask, why give an economic incentive to prevent landowners from breaking the law? One argument is that the PES scheme can be viewed as an alternative to ease the transition process from incentives to clear forests to a regime that prohibits deforestation. A law cannot achieve such a drastic change in a short time. Strong enforcement would have been necessary to make the transition - something that would have had a very high economic cost for the government. Therefore, it is feasible to view the PES scheme as an economic incentive to ease the transition. The big challenge, however, is that if the PES is to be a transitional incentive until the new law can fully be enforced, then it must end at some point.
- There has been no evaluation or study that examines the distinction (if any) between the current PES scheme and the previous subsidy system to the forestry sector. As noted in this paper, the amounts of the payments closely resemble those offered as part of the earlier incentives schemes. This supports the contention that the PES was a means to justify the continuation of subsidies to the forestry sector by capturing external funds from climate change and bioprospecting activities. In fact, the justification for the PES scheme was to internalize the costs of the services provided by forests on private lands. While payments and subsidies are different concepts, it is possible that this was not recognized by those involved in the process. This does not mean that the concepts are the same, even if conceptual confusion led to the establishment of similar amounts for the same result.
- How will the Government finance the conservation of forests in areas that do not have any major users of environmental services? This is very important, particularly for remote and rural areas that might have high conservation values. It is important to remember that the PES scheme is a tool that is to be combined with many other tools in order to reach a single goal: conservation of forests and biodiversity. PES is but one alternative mechanism to finance conservation. There must be complementary alternatives for public conservation areas. PES does not necessarily replace the need for command and control measures.

6.3 INBio's success story with bioprospecting: is it a replicable model?

- Even though the example of INBio is viewed as an ideal case for bioprospecting it is not really suitable as a general model. Conditions within Costa Rica at the time of its development were very specific and favoured INBio's success. As recognized by Aventis, an important pharmaceutical company¹⁶: "even before INBio, nature conservation was held in high regard throughout the country. Furthermore, there is no argument about who receives the share of the profits. In Costa Rica there are no indigenous peoples whose knowledge INBio might expropriate. This means that here, unlike many other places, consideration does not have to be given to the question of who should benefit from any profits among the indigenous population that brought a given plant to a researcher's attention." This is also supported by Onaga (2001), who states that: "INBio already had a high level of understanding of its biological resources and a stable country infrastructure when Merck began to set up its scientific programme in Costa Rica. It is, unfortunately, a situation that doesn't exist in most countries... Indeed, the Merck-INBio agreement raised the expectations of immediate benefits in many developing countries unrealistically...". The main lesson is that not all the successful experiences are easily replicable, and new innovations will still be required to promote conservation in different contexts.
- An aspect that forms part of the appeal of bioprospecting schemes is the sharing of revenues from the sale of 'blockbuster' drugs. However, as Onaga (2001) indicates: "So far... the Merck-INBio agreement... has [not] produced any major revenue-producing drug that benefits both the pharmaceutical industry and the environment. Scale remains a major obstacle. The chance of a successful hit is one in 10,000 for synthetic compounds, while the rate for natural products is as low as one in 30,000 or 40,000. In addition, difficulties in purifying extracts and the low number of non-microbial specimens pose major obstacles, and drugs can take ten, even 20 years to pass clinical trials." This situation could be due to the short time frame between the first signed agreements and today, and is likely to change in the future. However, this also means that "... it has become clear that the illusion of easy gains is gone... But to say that the deals between big pharmaceutical companies and poor countries have not worked is unfair... because the total number of natural samples that have been tested so far is less than the calculated sample volume needed to get a 'hit'." (Onaga, 2001). What can be learned from the flow of revenues expected by INBio is that sustainability requires short- and long-term sources of funding. Because the business of drug development takes a long time, bioprospecting contracts need to be considered carefully and with a long-term horizon. Moreover, it is important to include a variety of clauses into bioprospecting contracts, as INBio has done, in order to ensure some short-term flows of capital.
- There has been a great deal of hype surrounding the INBio case, and key aspects and constraints are not always explicitly mentioned. As Vogel (1996) stated: "Bioprospecting has received disproportionate attention in the popular press as a means to finance habitat preservation. Of the six values that can generate revenues in the short-run, bioprospecting occupies the last place. One predicts low returns for a fairly simple reason: many of the chemicals of interest to biotechnology firms do not exist in one country or even in one species but are diffused across both countries and species. This economic prediction has been confirmed by experience. A price war is emerging among supplying countries as

¹⁶ http://212.38.30.154/forum/fut0003/3_2000_healing_powers_7.htm

each offers its biological diversity at lower and lower prices: royalties in some contracts have been reported as low as 0.2%.” Another aspect “seldom mentioned in the press coverage is the fact that most of the biological diversity of Costa Rica is not endemic to Costa Rica” (Vogel, 1996). This is important because since “secondary compounds are diffused across international boundaries and taxa, a bioprospecting institution such as INBio is granting access not just to the biological diversity of the home country... but also to the biological diversity of the entire region” (Vogel, 1996). These concepts are “key to understanding why INBio or any other successful institution cannot be viewed as a model to replicate in the quest to internalize the value of biological diversity for bioprospecting” (Vogel, 1996).

- As with the PES scheme in Costa Rica, “... the economic impact of bioprospecting should not be overestimated. Bioprospecting can only complement other activities designed to advance human development and therefore cannot solve conservation and development issues in and by itself. It is an instrument that, complemented by science and technology, can work together with other tools to improve national capacities, support economic growth and generate financial income to conservation activities” (Sittenfeld and Lovejoy 1999).

6.4 Were carbon offsets over-promoted or is it still a matter of time?

- There has been no review of what happened to the carbon projects developed in Costa Rica, but it is clear that carbon has not delivered the benefits expected by the potential beneficiaries. The central question is: is this the result of delays in international negotiations about the Kyoto Protocol or is it because of the local context? For fairness sake it must be clarified that the projects developed in Costa Rica under AIJ were not really market transactions, but instead part of a pilot phase to develop experience. In this regard, the scheme was very successful in developing local experience in carbon projects. It is clear that they were not market transactions as most of the money that came in during that phase was in the form of donations. At the time “the Costa Rican Office for Joint Implementation (OCIC) believes that JI is the most important potential financing instrument for environmental services. A functioning administrative structure is already in place, it has enormous funding potential, and it involves financially strong international beneficiaries. However, the future of JI is uncertain” (de Camino et al. 2000). This clearly shows that even though the local context was ready, several internal changes were made, and an efficient local institutional framework was developed, uncertainty was crystallized due to the delays in the ratification of the Kyoto Protocol. Therefore, it is evident that the constraints that the carbon projects have faced are the result of an international process that is beyond the control of Costa Rica. Assuming that the Kyoto process moves forwards, and restrictions in developed countries create a market for carbon offset projects, it could well be a matter of time before the Costa Rican projects receive economic compensation for the services they provide.
- The AIJ carbon projects in Costa Rica were developed before there were buyers. The objective at the time was to develop an institutional framework and gather experience. That is why it was a pilot phase. There is already evidence that this is changing. An example of this change is the package of projects OCIC is negotiating with the Prototype Carbon Fund of the World Bank, where projects are being developed after the buyer for the carbon credits is identified. A similar situation is taking place in the negotiations

underway with the Dutch Government through Carboncredits.nl, though all projects in the pipeline are in the energy sector.

6.5 Watershed protection: are downstream users getting what they pay for?

- There are a handful of hydropower producers that are making payments for environmental services. However, they do not know if they are getting what they pay for. Measuring the expected benefits would be prohibitively expensive for individual small companies. Until now the payments of hydro producers have been voluntary, but there have been proposals to make such payments mandatory. If there is uncertainty as to the benefits that forests might provide to hydropower producers, then there should be more caution in trying to "sell" the idea of PES or attempting to make it a mandatory payment. By making it mandatory the purpose of market driven mechanisms is defeated. Given Costa Rica's heavy reliance on hydropower, it could be worthwhile for the national utility (ICE) to invest in applied practical research into this matter. Otherwise, companies considering investing in PES should carefully weigh the pros and cons under the high level of uncertainty that exists today.
- Watershed management does not equal PES for watershed services. Although this sounds like a very basic concept, both ideas appear to be confused in the literature. The concept of a watershed is very narrowly believed to mean the upper catchments. This means that other important environmental services and users of those services are seldom taken into account. This is the case for nutrient removal by wetlands, navigation in lowland rivers, and flood mitigation by floodplains. More important, water users who make payments should not be exempt by simply making those payments. Land cover is simply one component of ensuring a set of hydrological properties. Adequate watershed management is likely to require investment additional to PES.

6.6 Is there really a market for environmental services?

- The Government's PES programme does not demonstrate the existence of a market for environmental services since most of the funding comes from a fuel tax and not from a free and willing transaction. It can even be argued that a majority of fuel buyers do not relate their purchase with a payment for environmental mitigation. What the PES programme does demonstrate is the possibilities of developing a programme of payments for environmental services. In other words, it demonstrates a worked-out approach to using market approaches to allocated funding for environmental services. In this regard, the Costa Rican case, with its institutional development, is worthy of further study and analysis. To date, little effort has been made to monitor and evaluate the programme. The few studies that have been undertaken or are underway tend to focus on either traditional project monitoring or on examining the distributional implications of the programme. In other words, no study of the supposed intention, i.e. an efficient and low-cost allocation of conservation monies, has been undertaken.
- Supply far exceeds demand (only 25-33 per cent of demand for PES can be met). If it was left to the market, the payments for environmental services are likely to be even lower than current rates. This situation could lend itself to considering auctions for PES. By auctioning to the lowest bidder, a higher area could be conserved. However, this might not target the key priority areas, where a higher price might be required. The main point, though, is that the system could allow for a variable price. The problem here is that

management would be much more complicated. For simplicity sake, and to allow for a system that works, it might be preferable to keep the existing fixed price. However, in the future the "market", if there is such a thing, could evolve into a more complex array of options to make deals that further promote the conservation of natural ecosystems.

6.7 Were PES developed based on sound information on the economic value of the planned activities?

- Costa Rica has been the subject of a multitude of studies examining the economic value and costs associated with environmental services. In comparison with its neighboring countries, Costa Rica has an abundance of such studies. How useful the studies are and what impact they have had is variable. In many instances (bioprospecting and ecotourism) the value of the activity was promoted and realized largely independently of economic studies. Still, the studies have often provided political cover under which new initiatives and projects can be launched. Thus, it is difficult to conclude precisely how instrumental the valuation studies have been in decision-making. However, they have played a role in advertising and promoting the larger concept of markets/payments for environmental services.
- Valuation studies undertaken locally have often served as much to confuse the truth as to provide useful information. In the case of hydrological services, considerable confusion and controversy remains over the exact linkage between the natural function and the human, social and economic functions. Many valuation studies (bioprospecting and hydrological services) have produced erroneous and wildly misleading figures thus adding to the general confusion over environmental services.