

VALUATION OF HYDROLOGICAL SERVICES PROVIDED BY FORESTS IN COSTA RICA

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In 1996, the government of Costa Rica created Forest Law 7575 in order to accomplish new strategies in support of the development of the forestry sector. This forest law evolved from a period of three decades of forest policies and introduces paying owners of forested property, or property in the process of reforestation, to compensate for the environmental services provided by their activities to society in general. The acknowledged environmental services include regulation of hydrological cycles, scenic beauty, carbon sequestration, and biodiversity conservation. How to value and pay for these environmental services is a process of evolution, which also corresponds to a set of innovations in the forestry sector as briefly explained in this paper.

1. PAYMENT OF ENVIRONMENTAL SERVICES

Nowadays, the actors involved in the forest sector are more dynamic and pro-active than ever before, and the range of marketed goods and services from the forest has broadened. It is now widely accepted that forests are ecosystems, which besides producing timber, seeds and a few other marketable non-wood products, also produce ecological services that provide benefits to society in general and the economic sub-system in particular. These “new” services, described in Table 1, can only be maintained and further developed on the condition that plans for sustainable forest management and conservation are implemented.

The novelty of these forest services lies in their introduction into the economic sub-system. New opportunities are emerging for the development of the forest sector and for nature conservation, to be pursued in interaction with other societal goals. Until recently, these services were not considered as part of the national economy of any country, nor as elements of the learning economy⁴. As indicated in Table 1, some of the services are entering the economic sphere of society either through the market or through public investment and consumption.

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⁴ The concept of learning economy is based on the idea that learning and innovation are interactive, cumulative processes, which depend on the structure and change of the institutional set-up of the economy (Johnson, 1992). This also applies to the forest sector in Central America, as described by Segura (2000).

Forest environmental services may also be divided into market and non-market services. As the name indicates, the latter services are not valued monetarily, but may be of high ethical, biological or economic value. The problem is that the topic of the internalisation of forest environmental services is being debated nationally and internationally, but the process of coming to an agreement is expected to take a long time. Therefore, Costa Rica is taking the lead by incorporating four forest services in the market through different policies based on the Forest Law. Some of these services are becoming “products” or marketable services at the international level sooner than others are, as is the case for carbon sequestration by forests⁵.

Table 1 Markets for goods and services provided by forests in Costa Rica

Forest goods and services	Development of markets
1. Timber	++
2. Non-timber forest products	+
3. Carbon sequestration	+
4. Regulation of the water cycle, flood control	+/-
5. Control of erosion and sedimentation	+/-
6. Regulation of micro-climate	-
7. Wind and noise control	-
8. Maintenance of resilience	-
9. Landscape amenities, scenery	-
10. Recreation and ecotourism	+
11. Cultural and religious services	-
12. Information for bioprospecting	+/-
13. Preservation of the ecosystem and biodiversity	+/-

Explanation of symbols: ++ : well developed; + : existing; +/- : incipient; - : absent.
Source: modified after Segura et al., 1997.

The implementation of the principles of the Forest Law through a program of Payment of Environmental Services (PES) comprises two types of mechanisms. Firstly, it includes monetary compensation by Costa Rican society to private landowners either for maintenance of primary forest, establishment of forestry plantations, or forest management. Secondly, different types of voluntary agreement were established with hydropower companies and a brewery company, which also bottles water. Negotiations with several hotels and tourism agencies are taking place.

From 1997 to end of 2000, the PES program included 251,226 ha of private landowners (4.9% of Costa Rican territory). Of these, 212,333 ha correspond to forest protection, 15,202 ha to forestry plantations and 23,691 ha to forest management. The forest owners receive payment from the National Forestry Fund FONAFIFO that counts with funds provided by the national government. Of the taxes collected from fossil fuels, 3.5% goes to FONAFIFO, which allows the compensation to private landowners. In addition, the existing voluntary agreements also provide financial resources, resulting in the payment of 17,611 ha.

⁵ It is estimated that forests and forest plantations in Costa Rica sequester 28.2 tons of CO₂ ha⁻¹ yr⁻¹ on average, equivalent to 7.7 metric tons of carbon.

2. RESEARCH IN SUPPORT OF PES

FONAFIFO needs a solid basis for negotiation of voluntary agreements. Both the Forestry Law (1996) and Biodiversity Law (1998) define the criteria for payment of environmental services but do not define the type of financial instrument nor the monetary amount that should be paid. FONAFIFO should establish these mechanisms on the basis of scientific studies, of which the following is an example.

The research project on “Parameters for the economic valuation of the hydrological services provided by forest and forestry plantations in Costa Rica” was recently developed by CINPE. This study reviews the Costa Rican experience in the establishment of PES agreements for hydrological services and develops economic valuation tools in order to create or renegotiate settlements with private or governmental organisations.

3. VOLUNTARY AGREEMENTS

The review of PES agreements for payment of hydrological services showed that voluntary agreements can be classified into two categories. On one hand, there are private agreements established between an NGO and a private company. An example is the agreement since 1998 between the hydropower company La Esperanza and the conservation organisation Asociación Conservacionista Monteverde, where the company pays 10 US\$/ha per year to the NGO for hydrological services of forests in the Peñas Blancas watershed.

On the other hand, FONAFIFO⁶ established agreements with private companies. The following are three examples of this kind of settlements:

- Energía Global has two hydropower plants in the Volcán and San Fernando watersheds and pays 10 US\$/ha per year during five years since 1997.
- The Empresa Eléctrica Platanar located in San Carlos has recognised an expenditure of 15 US\$/ha per year during five years. In addition, this company signed an extension in 2000 that includes payment of 30 US\$/ha per year to landowners, including those without official land titles, for a period of 10 years.
- The Compañía Nacional de Fuerza y Luz signed an agreement in 2000, where 47 US\$/ha per year is compensated to landowners with or without land title during 10 years in three watersheds.

4. FEE ON DRINKING WATER

Another interesting case is the hydrological fee established in the year 2000 by the drinking water Company of Heredia in three minor watersheds in the Central Valley of Costa Rica. There is no institutional agreement with FONAFIFO nor the Ministry of Environment. The company collects 0.0057 US\$/m³ for consumed water, to be reinvested in forest conservation and reforestation within the same region.

⁶ FONAFIFO (National Forestry Fund) is operationally independent of the government and has legal identity and recognition; however, the board of directors has three members appointed by different governmental offices, namely the Ministry of Agriculture (MAG), Ministry of Environment and Energy (MINAE) and the Central Bank (BCCR), plus two private sector representatives.

5. ECONOMIC VALUATION

The valuation study focuses on hydropower and domestic consumption, and aims to estimate the value of the hydrological services provided by forests in four watersheds: Peñas Blancas, Reventazón, Savegre and Pejibaye. The first two rivers drain to the Atlantic coast and the other two to the Pacific coast of Costa Rica. In these watersheds are located important communities, which live from coffee production, double-purpose and dairy cattle ranching, forestry, and cultivation of flowers and ornamental plants. The hydrological criteria evaluated include the increase or decrease of runoff, flow regulation and maintenance of water quality. Furthermore, the feasibility of setting up new hydropower plants is being evaluated for all four rivers.

The hydrological results in relation to runoff show that an increase of 1% of forest cover implies a minor decrease in runoff (0.07%). This result is congruent to findings of different recent studies as cited in the literature. There was no significant effect of forest cover on flow regulation, probably because it was masked by influences of the El Niño - Southern Oscillation (ENSO, El Niño y La Niña events). Finally, for none of the watersheds it was possible to show significant changes in the production of sediments in relation to changes in forest cover. Due to the interaction of multiple variables and their variation in time and space (different watersheds), the regulatory functions of the forest could not be isolated in the statistical analysis, especially since sufficient information to control for these variables was lacking. Impacts of changes in forest cover may take a long time before they can be measured, for example in terms of the production of sediments. These findings do not prove, nor reject the beneficial effects of forest cover on hydrological processes, which leads the authors to recommend the application of the Precautionary Principle.

The study considers social, biophysical and economic aspects of valuation of environmental services. In order to estimate the economic value of the ecological services provided by forests, the costs of changing from the main agriculture activity to forest were assessed, and the costs of maintenance of forest cover. The opportunity costs include the costs and benefits of forestry activities and environmental education. Market prices were used as these are based on available and reliable data.

6. VALUATION RESULTS

A range of values has been estimated for the overall ecological services provided by forests in the four watersheds. Based on replacement and maintenance cost, these values⁷ are estimated at 100 US\$/ha per year for Peñas Blancas, 133 US\$/ha per year for Reventazón, 138 US\$/ha per year for Savegre, and 176 US\$/ha per year for the Pejibaye watershed. This implies that if forest cover is preferred in relation to the provision of hydrological services and is to be guaranteed in the long term, the landowners would have to receive at least 100 US\$/ha per year in terms of additional income in order to protect forest cover or commit themselves to reforestation activities.

Hydropower companies of course would be willing to pay only for the hydrological services related to hydropower generation. If other forest ecological services would also be paid for, by means of benefits from ecotourism, carbon sequestration or biodiversity conservation, the

⁷ Note: the values correspond to the present value of the net benefits (discount rate 9.8%).

amount could increase to meet the opportunity cost. However, in the case of Pejibaye watershed for instance, it should be questioned whether the internalisation of benefits from forest cover could form a competitive alternative to the current highly profitable coffee cultivation activities. There, it seems worthwhile to explore the possibilities of adaptation of the existing land use (e.g. by changing to coffee with shade trees).

7. PERSPECTIVES AND CONCLUSIONS

The research resulted in the description of proper mechanisms for implementation of PES in relation to hydrological services. This provides tools in support of policy mechanisms that will encourage FONAFIFO negotiations with private and governmental organisations that consume water. The Precautionary Principle was in this case applied for calculations of the value of the hydrological services. The outcomes provide policy makers with a point of departure, in order to generate policies and set up prices, not necessarily equal to the value calculations.

Future studies should pay more attention paid to hydrological information and the impacts of different land use systems on the hydrological cycle, rather than focussing on different methodological approaches in economic valuation. More studies of this kind are needed, especially considering different watersheds in the country.

The research also recognises the emergence of a change in the forest sector towards virtuous circles, including positive externalities and generating new sets of values attached to the forest. This fact may introduce innovations and improve the sustainability and competitiveness of the sector. The valuation of forests in a more integral manner, including not only the value of hydrological services, but also of biodiversity and bioprospecting activities, carbon sequestration and natural scenic beauty, which are considered in the Forest Law, will probably not only permit the possibility of maintaining the resource base in the long run, but also create a stimulus for the provision and marketing of new forest goods and services. Forest engineers, consultant firms, universities, research centres, insurance companies and other groups are now becoming more actively involved in the forest sector precisely due to the changes just described.

In Costa Rica, change in institutional development towards more environmental considerations has been slowly introduced, through policies, regulations, subsidies and other economic and non-economic instruments. The correct application of these new economic instruments seems fundamental to motivate the rural population to take a more active role in reforestation, forest management and conservation.

In a broader sense, an important recommendation to policy makers of Costa Rica and other countries involved in the development of financing instruments in support of local and national forestry strategies, is to seriously consider the payment of environmental services and to continue investing time and resources in making comparable valuations of these services.

8. REFERENCES

- Johnson, B.-A. (1992). Interactive learning. In: B.A. Lundvall (ed.) *National systems of innovation - Towards a theory of innovation and interactive learning*. Pinter Publishers, London.
- Segura, O. (2000). *Sustainable systems of innovation: The forest sector in Central America*. Sudesca Research papers No. 24. Department of Business Studies, Aalborg University, Denmark.
- Segura, O., Kaimowitz, D. and Rodríguez J. (eds.) (1997). *Políticas forestales en Centro América: Análisis de las restricciones para el desarrollo del sector*. I.I.C.A., San Salvador, El Salvador.