

ARE PAYMENTS FOR ENVIRONMENTAL SERVICES (PES) AN OPPORTUNITY FOR RELIEVING COUNTRIES OF THE CONGO BASIN FROM POVERTY?

Fidoline N. Nonga

University of Yaounde II in Yaounde Cameroon

ABSTRACT:

The payment for environmental services (PES) have attracted increasing interest as a new market mechanism that translate external, non market values of the environment into real financial incentives for local populations and actors to provide environmental services. In this article, we try to evaluate the effectiveness of the PES of the forest in boosting the conservation of forest ecosystemic services and alleviating poverty in the Congo Basin. Many questions or worries exist, that limit the implementation of the PES in this sub-region. Our purpose is not to give answers to them. We are only interested on the organization of ES markets which mobilizes the beneficiaries and suppliers and on the price-fixing mechanisms. We start with a flashback on the socio-economic and environmental contexts and a discussion of PES definition. We proceed to the appreciate the capacity of the PES to lead to the socio-economic and environmental sustainability of the forest in the sub-region. Lastly, we examine an effective logic of compensating suppliers who renounce applying usage rights on the forest environmental services. Three main services are concerned: carbon storage, biodiversity conservation, and protection of side basins. In order to cause the changes required for forest conservation and poverty alleviation, PES systems in the Congo Basin must at the same time satisfy both the effectiveness and equity criteria. For this purpose, it is necessary to fix the payments beyond the opportunity costs of renouncing access to and usage of the forest and to organize these payments within a framework of sustainable development leading to the improvement of living conditions of all the populations in the areas concerned.

Keywords: Alleviation of Poverty; Congo Bassin; Economic Incentives; Forest Sustainable Management; Payment for Environmental Services, Opportunity Costs

INTRODUCTION

The Congo Basin refers to the hydrographic basin covering some 3.7 million square kilometers, including the Democratic Republic of Congo (DRC), as well as parts of the Republic of Congo, Cameroon, the Central African Republic, Equatorial Guinea, Gabon, Burundi, Tanzania, Zambia and Angola. It constitutes the second great forest in the world after the Amazon.

Despite the increased degradation here and there, this massif remains very rich and relatively protected. In terms of biological riches, the Congo basin occupies a remarkable place in the world. A huge part of the fauna and flora of the basin's forests is endemic. A complete group of land megafauna including elephants and apes is still found there. These riches are beneficial to

the local populations, and the national and world economies. However, the countries of the Congo Basin remain poor and underdeveloped of.

To take up these two challenges, the international financial community prescribed growth rates of about 8% per year to countries of the Congo Basin. The attainment of such a growth rate requires high rates of utilization of forest resources. The strategies to develop, like growth and employment strategy implemented in Cameroon since November 2009, requiring the mobilization of all the resources of the country. Either in a substitution logic or in a complimentary logic between resources, which compose the total capital (human, natural and manufacturing), the increase in the rate of utilization of forest resources has negative impacts on the sustainability of this capital.

Some people think, however, that, by taking forest functions into account as sources of financial revenue, the negative impacts on the forest are likely going to diminish. In fact, the forest is no longer only needed for wood or the land, which is for agropastoral activities and areas of human settlement, but also for environmental services which it provides and which can be traded on the markets. Concretely, can this increase in the valorization of forest resources lead to a sustainable and equitable growth without compounding the degradation of forest resources?

For the next twenty years, two important tools shall be highly mobilized to help in removing the sustainability constraints of the forest capital. This refers to protected areas which will probably remain the key of all biodiversity conservation strategies in the Congo Basin and payment for environmental services (PES). This last tool, which is the subject of our analysis, raises much hope in the mobilization of funds necessary for economic development and indirectly for the conservation of ecosystems in the countries of the South.

Appearing in the 1997 notably in the book “Nature’s Services” by Gretchen Daily, which is a collection of articles from about ten authors, the concept of environmental service (ES) (respective ecosystemic service) associated with the concept of PES was popularized by the Millennium Ecosystem Assessment (MEA) in 2005.

Environmental services are combined services such as: supply (food and fibre), regulation (regulation of floods and climate), cultural (spiritual and amusing benefits,) and support (cycles of nutritive elements). All these services also include material and non material benefits drawn from the ecosystems in their natural state or modified by human practices. These environmental services are public or collective goods, a very large part of which generally, is for free and utilized according to the “first come, first served” principle. Their degradation has considerable impact on the utilities of the populations at the local, national and world levels.

The PES is therefore a valorization mechanism for these environmental services. It allows for the integration (internalization) in the economic sphere of degradation and other risks of weakening or disappearance of environmental services. According to Mayrand and Paquin (2004), “The payment for environmental services (PES) is a mechanism (...) which aims at enhancing positive environmental external factors, thanks to the transfer of financial resources between the beneficiaries of

some ecological services and suppliers of services or managers of environmental resources.” The PES stems from a commercial transaction, organized in a competitive market, between suppliers (persons who renounce utilizing environmental goods and services at the present time) and buyers (those who pay for the protection of these guaranteed environmental services). The PES is a response to the weakness of the market by allowing the latent demand to be expressed in monetary terms to compensate for the supply of these services.

The suppliers in our region of interest are the populations and some forest stakeholders (some NGO), while the polluters and the populations within and without the Congo Basin are the main buyers. But are the suppliers capable of perpetuating the offer of ES? On which markets can these ES be exchanged? Will PES lead to a huge mobilization of funds necessary to induce the sustainable alleviation of poverty in the countries of the Congo Basin? What is the feasibility of PES leading to the sustainability of forest ES?

The objective of this article is to evaluate the effectiveness of the PES of the forest in boosting the conservation of forest ecosystemic services and alleviating poverty in the Congo Basin. In order to attain this objective, we are postulating that Cameroon largely represents countries of the Congo Basin. We shall support our analysis with data from this country where necessary. The evaluation of the effectiveness of the PES will depend on the possibilities of organizing “markets” and those of fixing compensation prices at the least costs for suppliers who renounce their “access and usage rights” presently. We shall demonstrate that the fixing of the price of forest environmental services at the level of the opportunity cost of renouncing the usages of the forest does not lead to the sustainability of forest capital. Consequently, obtaining this sustainability and the effectiveness of PES is based on the rapprochement between the socio-economic development need and potentialities in terms of the availability of “buyers” to pay in order to conserve forest ES.

OPERATIONAL CONTEXTS AND DEFINITION OF THE CONCEPT OF PES

The sustainability of development and forest conservation in central Africa go together in one package. The latter in general has enormous potentialities for economic growth and poverty alleviation.

Summary of Cameroon Socio-economic indicators

Cameroon, with its 20 million inhabitants, is classified among countries with a low level of human development. The population growth rate is 2.8%. In Cameroon, the forest and natural resources occupy a very important place. The economic growth rate in 2010 stands at 2.8%. The poverty level which was 533 CFAF in 1996 increased to 637 CFAF since 2001. Close to 17% of the population live on \$ 1 per day. The forest sector currently accounts for 6% of the GDP. The Cameroonian economy is based on agriculture (43%) of GDP, industry (15%) and service (42%). All agricultural, breeding, forestry activities and the production of 55% of raw materials for the industry are based on the forest. With 2.3 million cubic meters in 2007, Cameroon is the second producer of timber in the Congo Basin. The main species harvested being ayous, sappeli, tali, azobé and iroko. Agriculture and forest exploitation employ 60% of the population. The forestry sector directly employs more than 170 000 persons. Despite the high rate of urbanization of about 58.4 %, a large proportion of the population (rural and urban) practice itinerant agriculture through burning and collection of NLFP. Survival activities (food,

domestic energy, medicines) degrade the natural forest capital, depriving future generations of it. In fact, the demand of the population (food, housing, energy, revenue sources) lead it to “exploit” wild and degraded species thus increasing the risks of degrading protected species. Under these conditions, unless biodiversity conservation becomes economically competitive in relation to other uses of species, “there will always be an urge to parcel out and convert land around protected areas” (Byrne, Staubo, & Grootenhuis, 1996).

Table 1: Cameroon socio-economic indicators in 2010

Country	Population (in millions of inhabitants)	Population density	Life expectancy	Infant mortality (/1000)	HDI	GNR/inhabitant \$/inhabitant	Rate of urbanization %
Cameroon	20	39	51.7	82	0.460	2197	58.4

Source: UNDP, 2010

Population density/Region	ET	STH	AD	SW	FN	CE	LT	NW	NO	WT
Inhabitant/KM ²	7.5	12.5	12.6	67.8	85.5	90.7	105.2	112.5	145.6	151.7

SOURCE: NIS, 2009. Key: AD=Adamawa. SW=South West; FN=Far North; CE=Centre; LT=Littoral; WT=West; NW=North West.

Environmental indicators

According to Duveiller, Defourny, Desclée& Mayaux, 2008) and Hansen, Stehman, Potapov, Loveland, Townshend, DeFries, Pittman, Arunarwati, Stolle, teiningen, Carroll & DiMiceli (2008), the average rate of net deforestation (difference between the net rate of conversion of the dense forest into any other type of occupation of the ground and the rate of deforestation) is on the decline since 2000. This rate for Cameroon could have been 0.14% in 2008. Then, the deforestation phenomenon remains globally contained in the region. So is the forests degradation.

Overview of the biological riches

The forest biodiversity in central Africa comprises food (human and animal), fibre products and other extractable resources. From Kettunen and Ten Brink (2006) and the Millennium Ecosystem Assessment (2005), these products and biological services of the forest can be classified in five main categories (table 2).

Table 2: Categories of environmental services provided by the forest

Supply services	Support services	Cultural and scientific services	Indirect support services	Regulation services
<ul style="list-style-type: none"> - food products (NLFP, animal, water...) - fuel (wood) - construction material (wood lianas, leaves...) - ornamental products (hides/skins, wood, barks, liana...) - medicinal plants - genetic resources 	<ul style="list-style-type: none"> - habitats - agricultural, breeding and human settlement zones - monuments and other sites - tourism (consumption and non consumption) - protected areas - amusing sites 	<ul style="list-style-type: none"> - sources of artistic and cultural inspiration - sources of spirituality (initiations, cemeteries) - sources of scientific information 	<ul style="list-style-type: none"> - photosynthesis - primary production - soil training - cycle of nutritive substances 	<ul style="list-style-type: none"> - regulation <ul style="list-style-type: none"> ✓ of climate ✓ of floods ✓ of erosion - cycle and water quality (purification and other hydrologic services) - carbon sequestration - pollination, seed dispersal and soil fertility - biological protection against harmful organisms and onset of some diseases (malaria onchocercosis, other vector transmissible diseases...) - maintenance of biological diversity - recycling of wastes and organic matter.

Sources: From Ketumen and Ten Brinke (2006) and from the Millennium Ecosystem Assessment (2005)

According to the Costa Rican Law on forests, environmental services correspond to “services provided by forests and forest plantations which have an impact on the protection and improvement of the environment. Such services include the following: attenuating the emissions of greenhouse gases (fixing, reduction, sequestration, storage and absorption), protection of water for urban, rural and hydroelectric exploitation, protection of biodiversity with a view to a sustainable exploitation and for scientific and pharmaceutical purposes, study of genetic resources and their development, preservation of ecosystems, forms of life and beauty of natural landscapes for tourism and for scientific purposes” (Costa Rican Law on forests n° 7575, article 3, clause k, in ROSA, H. & coll, 2003).

These different services determine the biological riches of the forest. More than 90% of the inhabitants in the Congo Basin depend in various ways on forest resources. Ndoye (2005) says that the forest significantly contributes to the means of

subsistence. Even if the scientific information on the extent of forest riches remains scanty, a good part of NLFP (the NLFP are used in food, medicine, construction and trade. More than 18 000 plant species are currently identified, out of which several hundreds are used in the treatment of diseases) largely used by the population is known (Food Agricultural Organization, 2001). The same is true for the main ligneous species (ayous, sapelli, tali, ayobé, iroko, sipo, okoumé, movingui, ozigo, ilomba, okan, etc.), and large mammals. The forests of the Congo Basin are known for their exceptional mega fauna riches in the world. About 270 species of mammals are known. Of these species, the population consumes and/or commercializes practically 200 (including 120 species of large and average size and 80 of small rodent size, insects, caterpillars, crickets and birds inclusive). More than 700 fish species, 80% of which are endemic, constitute a very large part of the diet of the population (Stiassny, Teugels and Hopkins, 2007).

As far as regulation is concerned, the forests of the Congo Basin contribute to the absorption of large quantities of solar energy and show high rates of evaporation and transpiration. They constitute huge carbon reservoirs on the ground (trees, lianas, underwood vegetation litter and dead wood) as well as underground (roots, soil). Estimates made from existing global models, (Nasi, Brown, Wilkie, Bennett, Tutin, Van Tol & Christophersen,, 2008), put carbon quantities stocked in the Congo Basin at 46,016 billion tons. Per country and comparatively with other authors, Nasi, Brown, Wilkie, Bennett, Tutin, Van Tol & Christophersen (2008), estimate carbon quantities trapped in Cameroon and DRC between 3,454 and 6,138 and between 20,416 and 36,672 million tons, respectively.

At the ecosystemic level, the region offers a wide variability of ecosystems comprising mangroves, coastal Atlantic forests and reliefs, western Congolese forests, semi-deciduous forests, swampy and periodically inundated forests, submountainous and mountainous forests. Each of these forest formations is characterized by abiotic conditions as well as unique floristic and wildlife compositions.

The extent of biological riches justifies the wide expansion of protected areas since the nineteen sixties. In fact, since independence, the number, size and nature of protected areas have greatly increases. The expansion has mainly taken place over three decades, from the years of colonization to independence, from the nineteen sixties to the nineteen eighty-eights. Since 1988 in Cameroon, a certain number of additional protected areas have been created, notably Campo-Ma'an, Mbam and Djerem, Lobéké and Faro.

In the region, there are 341 protected areas of which 174 are in Cameroon, 73 in CAR, 50 in the DRC, 17 in Gabon, 14 in Congo and 13 in Equatorial Guinea, belonging to categories I to VI of the International Union for Conservation of Nature (IUCN) and covering 14% of the territory. The protection prevents the population from using protected areas. It induces national and world intertemporal benefits, but also opportunity costs and frustrations arising from the invasion of protected areas and from the over utilization of resources. Theoretically, in order to change this state of things, the PES by generating revenue from the non utilization of the forest, would push the current users to adopt behaviours conducive for the sustainable management of the forest.

DEFINITION OF THE CONCEPT OF PES

The ineffectiveness of legislative tools (laws, norms, regulations, etc.) while the destruction of the natural forest capital progresses, has led to the development of new economic tools of internalising the externalities based on market forces. The originality of PES systems stems from the fact that they are not exclusively conceived for the internalization of negative externalities. PES are capable of causing the production of positive external effects. They have a potential for effectiveness and cost-effectiveness greater than the constraining regulatory strategies.

However, there is no consensual definition of PES systems, but rather a series of classifications based on the type of environmental service, the geographical extent, the structure of markets or the type of payment used. This absence of definition or common classification testifies to the great diversity of existing models. It equally creates some confusion and lack of precision in the literature on the mechanisms that have to be considered as payments for environmental services.

The PES take several forms (money, compensatory projects, payment in kind, etc.). They are bilateral and/or international, public or private. According to Grieg-Gran, Porras, Wunder, (2005), there is a proliferation of PES initiatives ranging from competitive markets to environmental services promotion projects and regulatory approaches resorting to economic incentives. For the Congo Basin, three main services are concerned: carbon storage, biodiversity conservation and protection of side basins.

DIFFICULTY OF IMPLEMENTING THE CONCEPT OF PES FOR THE FOREST

The PES is an economic mechanism, which leads at the same time, to the internalization of negative externalities and the production of positive externalities. For neoclassical economists, this internalization depends on economic calculations and allows for environmental problems (pollutions, overexploitation of natural resources) to be solved and leads to the Pareto optimum. For environmental economists (who bring in human and ethical considerations into reflection), internalization also facilitates the valorization of environmental services a priori non merchant. This leads to decisions of sustainable management of natural resources, with a view to the collective well-being. Some authors like Pearce & Bello (1998), Chomitz & Kumari (1996), Brandon (1996), Stavins (2000), estimate that bargaining over ES, notably through the production of positive externalities and the valorization of carbon and forest functions, calls for a reconsideration of the relationships between the parties involved, for the financing of conservation and for the sustainability of natural capital.

The first reflections on the PES of the forest were carried out in Pretoria, South Africa, in 1996, during an international workshop organized by the United Nations Development Program (UNDP) and the intergovernmental Group on the forests. This Workshop has given rise to what is called “the Pretoria Declaration” in which it is recognized that “forest, including thin forests simultaneously provide a vast range of economic, social, environmental and cultural advantages at the local, national and world levels, and that it is in the collective interest to present and future generations to maintain in good state all types of existing forests in the world” (FAO, Unasyuva n°198).

In October 1999, the international forum on forests organized in the United Kingdom on the theme of sustainable financing of forests, continued the reflection that started in Pretoria. All the same, despite the elaboration of operational terms of the

PES, the results of this forum were meager. This caused Chipeta & Joshi (2001) to say that “Despite the preparatory Croydon workshop, the IFF was also unable to reach consensus on a few critical issues related to existing as well as proposed new mechanisms such as carbon offset functions of forests (under the Kyoto Protocol), the concept of compensating landowners for environmental services from their forests, and reviewing existing mechanisms, such as GEF to make full use of their potential to support SFM activities”.

This semi failure has led to a huge mobilization of scientists to demonstrate the interest of PES in reconciling conservation activities and poverty alleviation. Numerous colloquia and fora respectively organized by the OCDE and the World Bank in January 2001, the Association of Environmental and Resource Economists (AERE) of June 2001 on bargaining over forest services, and the Oslo Conference in 2001 have progressively opened the way for launching the effective implementation of PES. In an information memo by Pagiota and Platais (2004), the authors explicitly valorize the concept of “Payments for environmental services”.

However, although the interest of PES has been clearly demonstrated in two reference works published in 2002, (the first titled « Silver bullet or fool’s gold? A global review of markets for environmental services and their impacts on the poor » by Landill Mills and Porras, and the second is a collective work by Pagiola, Bishop and Landell-Mills entitled « selling environmental services: market-based mechanisms for conservation and development ».), it was still necessary to wait for the publication of the final report in 2005 of the MEA, for the effective implementation of the concept of PES. According to Wunder (2005), PES is “a voluntary transaction in which, a well defined environmental service (or use of the soil for even securizing this service) is “bought” by a (minimum) buyer of ES from a (minimum) supplier of ES if and only if the supplier of ES securizes the provision of this ES (conditionality)”.

As for the PES of the forest, it is during the Bali Conference that the parties agreed to include the deforestation and/or forest degradation in the negotiations. The field of the mechanism to be set up was defined during the Poznan Conference (2008). The market for forestry ES integrates all forest surfaces, and also takes into account changes in the use of the soil (emissions resulting from deforestation, absorptions linked to reforestation) as well as variations within the forest ecosystems (positive-increased carbon stocks or negative forest degradation).

The implementation of the concept of PES therefore marks some advancement, in the dynamism of the conservation of the forest and that of the relationships between tropical countries and the rest of the world. In fact, with the emergence of the rhetoric of payment for environmental services, forest tropical countries are rightly becoming “true” parties involved and no longer only “beneficiaries” of conservation projects and other integrated projects, mobilization of funds necessary for the intertemporal well-being of the populations. However, despite their launching more than ten years ago throughout the world, PES systems have remained timidly implemented in the Congo Basin. Thus the interest in examining their effectiveness in this sub-region.

EFFECTIVENESS OF PES SYSTEMS AND THE SOCIO-ECONOMIC AND ENVIRONMENTAL SUSTAINABILITY

In international exchange, the countries of the South, in general, and those of the Congo Basin, in particular, always suffer from the diktats of developed countries, their big companies and other brokers. The unequal exchange is at the origin of the over exploitation and over utilization of forest resources (Nonga, 2002). What will become of the exchanges involving “payment for the conservation of the forest”? Which PES lead to the socio-economic and environmental effectiveness?

There are many questions on the implementation of the PES. These questions revolve around the respect of the principles of additionality and losses of the Kyoto Protocol, the existence of solvable demands for biodiversity, the financing of opportunity costs, the monetary evaluation of environmental benefits, etc. For the time being, the state of science or the difficulties in the evaluation implies that most cases of PES are set up, but the results are neither measured nor measurable, thereby casting doubt on the very foundation of the concept since the original idea is that the beneficiary of the service pays the supplier (FAO, 2007).

Moreover, because of the existence of hardly controllable costs of transaction during the launching (scientific studies, consultations of land users and beneficiaries, evaluation of uses and current practices, conception of contracts, launching of a pilot phase and others) as well as for the functioning (surveillance, award of contracts, management of payments), there is a great difference within the PES systems between the quest for effectiveness, efficiency or equity. “In order to be effective, payments have to be optimized and targeted on high value lands; but that brings about higher costs of transaction and a risk of inequalities, because the management of targeted payment costs are dearer, and owners of high value lands are generally rich. On the other hand, to be efficient, PES systems have to reduce their cost of transactions, for example by using non-targeted payments and by concentrating their action on big forest exploiters, to the detriment of small users, who are often penniless and at the risk of reducing the effectiveness of PES systems. Lastly, PES systems will be more equitable (but less effective) if they use non-targeted payments. Besides, equity supposes the participation of many small users, which in turn leads to an increase in the costs of transaction (Mayrand and Paquin, 2004). Our subject is not to give answers to or all the above questions or worries. We are only interested on the organization of ES markets which mobilizes the beneficiaries and suppliers and on the price-fixing mechanisms.

ORGANIZATION OF PAYMENTS FOR FOREST ES

The creation of a PES market is only possible if there is a solvent demand for the ES. The identification of beneficiaries of environmental services and that of those who are disposed to pay for these services therefore constitutes a fundamental step. The same applies to the identification of environmental services concerned with “exchanges” and the evaluation of current demands of ES concerned with the negotiations.

In the Congo Basin, the nature of three services targeted above influence the organization of payments. In fact, if carbon and biodiversity are “world” public property, benefiting all of humanity, side basins are collective property, directly benefiting only exploiting companies and local populations and consumers. Hence, institutional differences exist in the implementation of PES remunerating these two types of properties.

MARKETS FOR THE CONSERVATION OF SIDE BASINS

The management of the degradation of side basins generally mobilizes a small number of stakeholders. Markets for hydrographic services are organized at the local level. The exchange therefore has to do with the financing of land uses which generates hydrographic advantages and not (necessarily) the quantity or quality of the water.

In this organization, the internalization of the degradation of the environmental service can take place within the framework of a coasian negotiation and result in agreements between suppliers (farmers, breeders, etc.) and buyers (water companies, urban communities, local councils, etc.). The PES in this case results in the protection of the interest of beneficiaries who may at the same time be suppliers. In this situation, the PES contributes at the same time to the conservation of the environment (insofar as it encourages the mobilization of relationships between man and resources) and to poverty alleviation, notably by perpetuating and improving access to potable water and by allowing suppliers to have the means (in kind, financial, educational) for their survival.

In the Congo Basin, the degradation of “water resources” is little known. In fact, if a small proportion of the population has access to potable water, the same is not true for access to the “water” resource which is not always a problem in the region. The difficulties of the region stem rather from the unavailability of statistical data and information on the relationships between forest ecosystems and water resources. These two constraints reduce the interest for these resources. For the moment, two PES pilot projects in Cameroon with WWF-CARPO for Lake Barombi-Mbo which is a great potable water reservoir for Kumba town and in Gabon with WCS for River Mbé which is at the same time a potable water reservoir and source of energy for the town of Libreville are still in the process of negotiation with possible buyers.

ORGANIZATION OF PAYMENT SYSTEMS FOR CARBON STORAGE

Launched about twenty years ago, carbon markets are extremely competitive at the world level and most transactions involve international buyers. Competition obliges providers of ES to produce economies of scale and to reduce their costs of transaction in order to remain in the market. According to Landell-Mills and Porras (2002) who have studied 75 examples of payments of carbon sequestration services in the world, the market is rapidly evolving towards multiple exchange areas and transactions are organized at various scales (national, regional and international).

Despite the weakness observed in the evaluation of quantities of carbon quantities i) stored in different wells (forests and ground) or ii) reduced by activities grouped in AFOLU (agriculture, forestry and other land uses), it is now accepted that the lost of the forest cover in the Congo Basin has repercussions on the climatic phenomena in all regions of the world.

According to Localli and Karsenty (2004), about 17% of the total carbon reserve of the land biosphere are found in the humid tropical forests, making them important carbon reservoirs.

About payment systems for carbon storage, three types of markets are to be considered:

- Restrictive commitment markets on which projects (afforestation and reforestation) are eligible for the Clean Development Mechanism (CDM) and for the Joint Implementation (JI) of the Kyoto Protocol;
- Voluntary markets (operating without regulatory commitments) which have progressively imposed themselves as a real and complementary alternative to the above-mentioned commitment markets. In these markets, transactions are based on contractual agreements, general concluded privately between project bearers and credit solicitors. Eligible activities, although unrecognized by the CCNUCC, are numerous and include afforestation and deforestation, forestry management and reduction of deforestation (REED) ;
- Compensatory markets governed by the mechanisms for the reduction of emissions from deforestation and degradation (REDD). Adopted by the Parties Conference 13 of Bali in 2007, the REED will enable poor countries to be encouraged to voluntarily reduce national rates of deforestation and carbon emissions there from which are below reference levels. Countries which show proof of such reductions could « sell » carbon credits to international markets and/or should be eligible for green funds set up in Cancun in 2010..

All types of carbon market are perceived as a great source of funding for the development (financial projects) and protection of the forest. Unfortunately, right up to 2010, the number of projects from tropical countries eligible for these mechanisms and the finances mobilized were still very small, despite the involvement, since the end of the twenties, of the World Bank through the Forest Carbon Partnership Fund (FCDF) and those of other multilateral funding bodies and international institutions United Nations Development Program, United Nations Environmental Program, Food Agricultural Organization, and African Development Bank.

On the contrary, the possibility of post-Kyoto agreements in 2012 or 2018 enhances the reflection. The above-mentioned funding bodies also finance capacity building, notably for the follow-up and the measurement of GES emissions and the organization of the preparatory phase (improvement of the understanding of the GES problem, drawing up national and regional strategies).

In the Congo Basin, carbon storage PES initiatives remain very timid. However, since 2006, under the impetus of the Central African Forests Interministerial Commission (CAFIC), all countries have drafted and submitted to the FCPF of World Bank R-PIN (Readiness Plan Idea Note) documents. Many project ideas are therefore under elaboration at the regional and national levels. The same holds true for biodiversity conservation projects.

PAYMENTS FOR BIODIVERSITY CONSERVATION

On the biodiversity preservation markets, it is difficult to identify the beneficiaries disposed to pay for the protection of ecosystems, species or biological diversities. So their organization is especially the work of international conservation

organizations and the World Environment Fund (WEF). In fact, the diversity of biodiversity preservation services brings about a multitude of exigencies which increase the complexity of payment mechanisms. Nevertheless, biodiversity PES systems have something in common either with carbon markets or hydrographic basins or with a mixture of both. Like hydrologic services, biodiversity preservation services are not sold directly: it is rather specific uses of land aimed at protecting species, ecosystems or biological diversity that are sold. Contrary to carbon PES, the markets for biodiversity conservation have been existing for some years in the Congo Basin. The PES in this sub-region take three main forms: the conservation of potentially exploitable areas including timber concessions (established on timber exploitation concessions. Their main objective is the protection of inhabitants and large mammals as apes and elephants. The loss of earnings is therefore paid by the manager of the conservation. There are therefore problems i) of evaluating this loss of earnings ii) of institutionalizing the PES), the labelling of merchantable goods (certified wood) produced according to precise environmental norms (Forest Stewardship Council and the ISO 14001 are the two systems of certification applied in the Congo Basin.) and the restriction of degrading activities around protected areas (for example, the ban on the fishing of turtle in the Campo Ma'an in Cameroon). A survey conducted by Tchiofo (2008) on 30 protected areas of the Congo Basin revealed that at the time, if all PA proposed indirect payments ranging from remuneration for denouncing poachers to compensation of victims of damages caused by wild animals, there were only five PES for the restriction of activities around protected areas.

Globally, the organization of payments for carbon and biodiversity at the world level involves suppliers of local services and a large number of consumers-beneficiaries, sometimes ignorant of their demands, for they are not directly payers. Payment in this case is carried out by States, multilateral and/or bilateral institutions, NGOs, etc. Because of the diversity of stakeholders and their large number, the coasian negotiation is not effective for internalizing external effects.

In these cases, production of positive external effects (internationalization of negative externalities respectively) shall include much institutional mediation between suppliers and beneficiaries. The payment pattern includes mediation structures (international markets, conservation funding bodies, NGOs), States, project elaboration and execution structures (who materialize and organize the payment of ES on the field). According to Karsenty, Sembrés, and Perrot-Maître (2009), “these mediations have many consequences on the control of the effectiveness of payments. The global character of the service does not allow for the direct verification of the effectiveness of the service supposed to be provided. A resumption of deforestation upstream generally has direct repercussions on the erosion and costs of production of an industrial unit downstream, but a transfer of the deforestation from a zone under PES contract to a zone not covered by the contract is not absolutely detectable in the global emissions. This implies not only the very high costs of surveillance, but equally weakens the environmental effectiveness of payments”.

FIXING OF ENVIRONMENTAL SERVICE PRICES AND SOCIO-ECONOMIC AND ENVIRONMENTAL EFFECTIVENESS

The principle of PES is also based on the capacity of providers of the ES to change their forest production (utilization) habits. But, the difficulties encountered in the environmental evaluation make it in such a way that in most cases, it remains very

difficult to know the link between the production function and the quantities/qualities of ES offered. The price of ES is not automatically ordered by the markets.

PARTICULARITIES OF BIODIVERSITY PAYMENTS

The concept of biodiversity PES remains vague. Popularized during the earth summit in Rio de Janeiro in 1992, biodiversity comprises three essential levels: the diversity of ecosystems, the diversity of species and the genetic diversity. Genetic diversity which describes the variability of genes inside the same species, that is the variability of the population of the same species. The diversity of species is the variety of species present within a given region. And the diversity of ecosystems refers to the variety of the milieu, their number and their distribution. But the diversity of the living also and especially refers to natural diversity that is to all attributes which condition the adaptation and survival of different populations within different milieus. Biodiversity includes the fauna, flora and ecosystems and allow for the maintenance of the main economical services.

If one removes the ambiguities between biodiversity and its components (forest goods and services for example), two other elements make the perception of biodiversity PES more complex. If there is a high international demand for protected areas known for their riches, the demand for the biodiversity of underutilized species runs the risk of not existing. In other words, insofar as these species are in any case used for the survival of the population and contribute to the well-being of the planet (industries, services, etc.), the continuation of these utilizations risks being preferred to conservation. Moreover, for these species, it will still be more difficult to respect the principles of additionality and that of losses of the Kyoto Protocol.

In order to perpetuate the PES, the existing demand must be solvable. This supposes that the one who pays has the means permitting him “to acquire” or to participate in the conservation of biodiversity service. “Such payments for biodiversity conservation can therefore come only from companies or the international community, the only solvable and politically acceptable “buyers” (Lescuyer and others, 2008).

PES AND OPPORTUNITY COSTS

To be effective in the economic logic, the fixing of ES payment should take into account three constraints:

- The environmental economic evaluation remains approximative. Estimations are always dependent on local contexts, analysis hypotheses, choice of calculation methods and variables and on the rate of interest and can only be extrapolated with difficulties.
- For the conservation of PAs, the populations and governments of the Congo Basin are already bearing the high opportunity costs of not using a good part of forest resources.
- While the prices of wood, NLFP and other agricultural and breeding productions increase regularly on the markets, while the cost of agricultural inputs and others increase, while the dynamics of modernizing rural and forest resources merchandizing zones are in full expansion (Ferraro, 2002; Wunder, 2006), while the standard of living of the population improves, the acceptance to conserve biodiversity and/or to improve carbon storage remains a marginal option (N. Nonga, 2010).

But these elements which affect biodiversity in the Congo Basin are neither considered in negotiations between suppliers and “buyers” nor in the existing proposals for payment of ES at less cost. In fact, in order to circumvent the scientific uncertainties of the functioning of environmental services and on the interrelationships between the latter, and in order to effectively encourage suppliers to give up using forest resources and services, several authors like Stern (2006), propose to fix the PES at the level of opportunity costs of the non usage of lands and ES. Wilkie and Carpenter (2001), by continuing a series of articles by Norton-Griffiths (Norton-Griffiths and Souley, 1995, Norton-Griffiths, 1997, Norton-Griffiths and Souley, 1995) are of the same opinion and estimate in the case of Kenya, that in order to make biodiversity protection (protected areas) economically competitive, in relation to other uses of the land, the opportunity cost of conserving the protected area in Maasai Mara was \$58.77/hectares /year. The same authors citing studies carried out in the case of Uganda, reveal that for protected areas (national parks, wildlife reserves and forest reserves of a total area of 32 414 square kilometers), when all tangible and intangible costs and benefits are considered, the government incurs a net loss of \$76.4 million annually (Bagri, Blockhus, Grey, & Vorhies 1998; Howard, 1995 cited by Wilkie and Carpenter (2001).

These two examples show that opportunity costs can be enormous (the opportunity costs can increase permanently, in situations where the scarcity of subsistence goods, harvested from the forest (therefore causing deforestation and/or degradation) leads to increase in prices. It is thus the opinion of Karsenty, Sembrés, and Perrot-Maître, (2009) when they criticize the analysis by Stern (2006) on the generalization of PES at the level of opportunity costs of agriculture and forestry in the tropical countries. In fact, according to Karsenty Sembrés, and Perrot-Maître (2009), it's seems difficult to obtain the reduction of tropical deforestation at less costs, but it is also delicate to generalize the evaluation of opportunity costs fixed for Costa Rica and Mexico at \$6/hectares to other tropical basins in general and to the Congo Basin in particular. In the latter, opportunity costs increase with the very high costs of transaction related to the classification of property rights, to the identification of international intermediaries who may have the confidence of the populations, to the management of systemic risks of embezzlement of funds and to the setting up of control mechanisms and credible follow-up contracts. These costs also include « the question of land insecurity and the cost of conflicts bound to stir up the perspective of « private income from conservation » in situations of uncertainty of rights where beneficiaries of the same land are numerous. Conflicts within « communities », generally less homogenous than are believed to be (especially in Africa), for the ownership of conservation income, will bring about costs of prevention and settlement of conflict (at the same time causing the necessity for political arbitrations on the distribution of land and consequently for real reforms) » (Karsenty, Sembrés, and Perrot-Maître, 2009).

While evacuating the difficulties in calculating opportunity costs and postulating that Congo Basin forests are comparable to those of the Amazon, at least two other groups of factors limit the effectiveness of forest PES calculated at the level of opportunity costs.

On the one hand, unless to target, like for protected areas, very rich and poorly deforested (degraded respectively) areas for which opportunity costs are negative or null, the effectiveness of compensatory mechanisms calculated on opportunity costs risks being a weak incentive to cause a change of behaviours of the farming and forest populations of the Congo Basin towards biodiversity and areas where their rights of usage are currently exercised.

On the other hand, short of targeting, like is the case for protected areas, very rich species and less deforested (degraded respectively) for which the opportunity costs are negative or not, it may be difficult using compensatory mechanisms, calculated on the opportunity costs, in order to encourage farmers and foresters of the Congo Basin to conserve the biodiversity and species where rights of usage are currently applied. On the other hand, insofar as Congo Basin countries and their peoples also have the right to development and well-being, the compensatory funds calculated on mobilized opportunity costs risk being insufficient, thus generating the problems of socio-economic effectiveness of PES mechanisms (For the time being, in poor tropical countries, the compensation of opportunity costs results in a low level of effectiveness. The real prices of these services (unknown but increasing with progressive scarcity of environmental services) are not paid, nor the price of reforms necessary to durably ward off the pressures on the ecosystems. It is being proposed that poor farmers be compensated by living them in misery, a situation that is neither just nor realistic.

Examples of existing calculations show that ridiculous values are arrived at, very insufficient to cause the improvement of living conditions. It is thus the case in the Democratic Republic of Congo for which the Woods Hole Research report propose to pay Congolese households between \$300/year and \$1000/year (estimated on the basis of opportunity costs). But if the PES is not equitable (involving a large number of small forest users), we arrive at prices which are neither encouraging for the reduction of deforestation (farmers whose needs are not satisfied are quickly going to renounce the agreements and go back to their practices) nor favourable to poverty alleviation. In fact, the perception of whatever payment for an ES requires from rural households, that they abandon their survival activities. But in case of discouraging PES, if there is no renunciation of the contract, the freezing of rights of usage on the forest, not only will the capabilities of the poor be limited, but the poverty situation will risk being aggravated.

According to Karsenty, Sembrés, and Perrot-Maître (2009), “the PES are trapped in a pincer movement between two dangers; where opportunity costs are high, the available sums are not often sufficient, but where the opportunity cost is low, the risk of non additionality is high. Correctly evaluating the risk of non additionality increases costs and is more of a challenge: if we can determine which forests are to be deforested, it is generally impossible to say when they will be insofar as we cannot foresee the trend of relative prices and notably against rural prices, which increase more and more with speculative world trends”.

The problem of fixing the ES price is and will be the topic of politics-scientific debates for some years. However, although uncertainties still exist in connection with relationships between deforestation and/or degradation and the world intergenerational well-being, given the negative effects of climate change, those of floods, hurricanes, storms and other tsunamis and the thawing of glaciers, and, given the persistent poverty in the Congo Basin, it is urgent to improve forest conservation. Thus, the necessity to reflect on a methodology of internalizing the effects of degradation and or deforestation which equally leads to the improvement of living conditions of the forest user populations.

CONCLUSION: ORGANIZING THE EFFECTIVENESS OF PES FOR FOREST CONSERVATION AND IMPROVEMENT OF LIVING CONDITIONS.

Inasmuch as it is necessary to rely on the scientific basis-be it approximative-for biodiversity and water, the opportunity cost of non-usage, increased by all costs of transaction including the costs of identifying speakers (legal and authoritative), representing suppliers of ES, should continue to be used for estimating the basis of compensation. From this basis of calculation, three main elements should be taken into account in fixing the price of ES: the right to development of Congo Basin countries, the respect of principles of additionality and losses and the value of all indirect opportunity costs.

These three elements determine the fixing of the PES which will vary depending on whether we are either on threatened lands, very rich in biodiversity including lands around protected areas) and on less threatened lands even if they are degraded, or on less threatened lands very rich in biodiversity and on degraded lands and on which there is still more pressure or depending on whether the suppliers are committed to deforestation.

The identification of suppliers of ES is therefore of capital importance in implementing PES systems. It is a question of expecting the characterization of suppliers. And the right of ownership does not seem to be the best criterion for this characterization. In fact, in Cameroon, like in other countries of the Basin, the provisions governing land rights remain poorly applied. There is an opposition on the field between the political discourse and reality. The family right continues to be applied on vast extents of land. These family groups (sometimes comprising several families) regulate the access thereto and the rights of usage. The family is generally numerous, extended to multiple ancestries and descendants in direct and collateral line. Each family controls access to a territory. All the members of one and the same family all have right of access, production harvest and/or control. They have the obligation to protect their territory from invasions by other families and to transfer it as inheritance to the descendants.

But beyond family and tribal ownership, the land (soil) belongs to the individuals as individual unit of production intended to ensure the survival of the home (household). Thus, the control of land in Cameroon is done through an ownership « that varies according to circumstances ». A multitude of specific rights may be recognized and superposed in the same lands (individual right, households, family law, right of succession, clan law, etc.). Even if customary law enhances social cohesion, it appears that ownership « according to circumstances has a main consequence that an individual rarely possesses in his own name exclusive, stable and transferable ownership rights (land certificate). However, the family is not “enclosed”. Strangers are admitted into it after long periods of observation. Once admitted, these strangers obtain the same rights as descendants.

Because of the overlapping of families between villages and the superposition of several rights on the same spaces, the PES can only be effective if they are integrated into a logic of centred integrated development, among other things, on the formal recognition of the rights of the local populations on the land, and on a perspective of investment. This recognition has as consequence the reduction of ownership based on the «first come, first served » principle imposed by land legislation. In fact, it is only through development (deforestation, cultivation, construction, etc.) that the legislation recognized the rights of usage of the local populations. The formal States – family lineages co-ownership of the forest and the PES can be the best bet

for the durability of land management, by notably reducing the illegal exploitation and encouraging the adoption of more productive and lasting usage practices (agricultural ; breeding, collection of NLFP and ligneous plants, fishing).

In this logic, given the inadequacy of the market and the State as classical regulatory institutions, the respect of the right of the populations to the well-being, being a key element in the change of habits of utilizing the forest, it shall be guaranteed by the State, the market and a multitude of private institutions. We thus agree with Stiglitz (2000), who estimates that “the key components of a workable sustainable development strategy are ownership and participating [...]. In order to obtain the desired ownership and transformation, the process of drawing up the strategy must be participative. The development should never be a question of negotiations between the funding bodies and the government: it must penetrate more deeply and be supported, in the civil society, on groups which contribute to the required funding of its collective competences, which are the spokespersons of often excluded social classes.

In other words, in order to cause the changes required for forest conservation and poverty alleviation, PES systems in the Congo Basin must at the same time satisfy both the effectiveness and equity criteria. For this purpose, it is necessary to fix the payments beyond the opportunity costs of renouncing access to and usage of the forest and to organize these payments within a framework of sustainable development leading to the improvement of living conditions of all the populations in the areas concerned.

Cameroon has already developed such a framework. The Growth and Employment Strategy Document is a very ambitious programme. PES could pertinently contribute to its realization, notably by allowing for the funding of investment in agricultural productivity (adoption of durable technical itineraries, implementation of accompanying programmes: professionalization, access to local funding, price policy for producers in order to enable them have revenues at the money with the other sectors of activity, road infrastructure and commercialization, etc.) and forest exploitation.

REFERENCES

- Bagri, A., Blockhus, J., Grey, F. & Vorhies, F. (Eds.) (1998). Economic values of protected areas: a guide for protected area managers. Draft report for the Economic Benefits of Protected Areas Task Force. World Commission in Protected Areas. Gland: IUCN.
- Brandon, K. (1996). Ecotourism and Conservation: A Review of Key Issues. Environment Department Paper No. 033. The World Bank, Washington.
- Byrne, P, V., Staubo, C., & Grootenhuis, J, G. (1996). The economics of living with wildlife in Kenya. In *The economics of wildlife: case studies from Ghana, Kenya, Namibia, and Zimbabwe*, (ed.) J. Bojo, pp. 39-78. World Bank, Washington, D.C.
- Chipeta, M, E., & Joshi, M. (2001). Financing sustainable forest management. Report of the International Workshop of Experts, 22-25 January 2001. Oslo, Norway. Center for International Forestry Research, Bogor, Indonesia, 109p.
- Chomitz, K., & Kumari, K. (1996). The Domestic Benefits of Tropical Forests: A Critical Review Emphasising Hydrological Functions. Policy Research Working Paper 1601. Washington DC: World Bank.

- Rosa, H. and coll (2003). Compensation for Environmental Services and Rural Communities. Lessons from the Americas and Key Issues for Strengthening Community Strategies, Fundación PRISMA, p. 19.
- Daily, G. (1997). Nature's services: societal dependence on natural ecosystems. Island Press, Washington D.C.
- Duveiller, G., Defourny, P., Desclée, B., Mayaux, P. (2008). Deforestation in Central Africa: Estimates at regional, national and landscape levels by advanced processing of systematicall - distributed Landsat extracts. *Remote Sensing of Environment*, 112 (5): 1969 - 1981.
- Food Agricultural Organization (2010). Situation des forêts du monde en 2010. FAO, Rome.
- Food Agricultural Organization (2007). The State of Food and Agriculture 2007. Paying farmers for environmental services.
- Ferraro, P, J. (2002). The local costs of establishing protected areas in low-income nations: Ranomafana National Park, Madagascar. *Ecological Economics* 43: 261 – 275.
- Grieg Gran M., Porrás I., Wunder S., (2005). How can market mechanisms for forest environmental services help the poor? Preliminary lessons from Latin America. *World Development* 33(9): 1511-1527.
- Hansen, M, C., Stehman, S, V., Potapov, P, V., Loveland, T, R., Townshend J, R, G., DeFries, R, S., Pittman, K, W., Arunarwati, B., Stolle, F., Steininger, M, K., Carroll, M., DiMiceli, C. (2008). Humid tropical forest clearing from 2000 to 2005 quantified by using multitemporal and multiresolution remotely sensed data. *PNAS*, 105 (27): 9439 - 9444.
- Institute National Statistique. (2009). Données statistiques du Cameroun.
- Howard, P. (1995). The economics of protected areas in Uganda: costs, benefits and policy issues. University of Edinburgh. Ph.D. Dissertation.
- Karsenty, A., Sembrés, TH., et Perrot-Maître, D. (2009). Paiements pour services environnementaux et pays du Sud : La conservation de la nature rattrapée par le développement ? 3èmes journées de recherches en sciences social. INRA SFER CIRAD 09, 10 & 11 décembre, Montpellier, France, 20P.
- Kettunen, M., and ten Brink, P (2006). Value of Biodiversity. Documenting EU examples where biodiversity loss has led to the loss of ecosystem services. Institute for European Environmental Policy.
- Landell-Mills, N., & Porrás, T. (2002). Silver bullet or fools' gold? A global review of markets for forest environmental services and their impact on the poor. Instruments for sustainable private sector forestry series. International Institute for Environment and Development, London.
- Locatelli, B., & Karsenty, A. (2004). Tropical forest dynamics and climate change. In: D. Babin (Ed.) Beyond tropical deforestation: from tropical deforestation to forest cover dynamics and forest development. UNESCO. Paris, pp.97-120.
- Mayrand, K., & Paquin, M. (2004). Payments for Environmental Services: A Survey and Assessment of Current Schemes. Unisfera International Centre for the Commission of Environmental Cooperation of North America, Montreal 67p.
- Millennium Ecosystem Assessment, (2003). Ecosystems and Human Well-being: A Framework for Assessment, Island Press, Washington DC.
- Nasi, R., Brown D., Wilkie, D., Bennett, E., Tutin C, E, G., Van Tol, G., Christophersen T. (2008). Conservation and use of wildlife-based resources: the bushmeat crisis. Secretariat of the Convention on Biological Diversity. Montreal, Center for International Forestry Research. Bogor Technical Series no. 33, 50 p.

- Ndoye, O. (2005). Commercial Issues Related to Non-Timber Forest Products. In J-L Pfund, J-L and P. Robinson (eds). Non - Timber Forest Products. Between poverty alleviation and market forces. InterCooperation, Berne. 50 p.
- Ngo Nonga, F. (2010). Problématique des performances des systèmes de production des exploitations familiales au Cameroun. 12 p.
- Ngo Nonga, F. (2002). Gestion soutenable de la forêt tropicale et développement intégré au Cameroun. Thèse de Doctorat d'État, Université de Yaoundé II-Soa, Yaoundé, 385p.
- Norton-Griffiths, M. (1995). Property rights and wildlife conservation options in Kenya. GEC 95-07, pp.1-23. East Anglia, UK: CSERGE.
- Norton-Griffiths, M. (1997). Economic incentives to develop the rangelands of the Serengeti: Implications for wildlife conservation. In Serengeti II: Research, management and conservation of an ecosystem, A.R.E. Sinclair & Arcese (eds), pp. 588-604. University of Chicago Press, Chicago.
- Norton-Griffiths, M., & Southey, C. (1995). The opportunity costs of biodiversity conservation in Kenya. *Ecological Economics* 12: 125-139.
- Pagiola, S., Platais, G. (2004). Payments for Environmental Services, Environment and Strategy Notes, n°3, World Bank, Washington DC.
- Pagiola, S., Bishop J., & Landell-Mills, N. (2002). Selling Forest Environmental Services. Market-based Mechanisms for Conservation and Development, London, Earthscan.
- Pearce, D., and Bello, T. (1998). Selling carbon storage: background paper for the Guyana forest partnership initiative.
- PNUD, (2010). Rapport sur le développement humain. La vraie richesse des nations : les chemins du développement humain. Ed. du 20^e anniversaire.
- Stavins, R. (2000). Experience with Market-Based Environmental Policy Instruments. In K. Maler and J. Vincent (eds.) *The Handbook of Environmental Economics*. Amsterdam: North-Holland/Elsevier Science.
- Stern, N. (2006). Stern Review on the economics of climate change. http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm
- Stiassny, M, L, J., Teugels, G, G., and Hopkins, C, D. (2007). The Fresh and Brackish Water Fishes of Lower Guinea, West - Central Africa. IRD, Éditions, Paris.
- Stiglitz, J. (2000). Discours prononcé à la CNUCED, octobre 1998, reproduit par *L'Economie politique*, n°5.
- Tchiofo, R. (2008). Potentialities of payment mechanisms for environmental services in the Congo Basin forests: the case of biodiversity conservation. Dissertation, University of Göttingen.
- Watson, R. T., Dixon, J. A., Hamburg, S. P., Janetos, A. C. and Moss, R. H. (1998). Protecting our planet securing our future: linkages among global environmental issues and human needs, World Bank,
- Wilkie, D.S. et Carpenter, J, F. (2001). Le sous-financement des aires protégées dans le bassin du Congo: Tant de parcs et si peu de volonté de payer. *Biological Conservation*. 27 p.
- Wunder, S. (2006). Are direct payments for environmental services spelling doom for sustainable forest management in the tropics? *Ecology and Society* 11(2): 23.
- Wunder, S. (2005). Payments for Environmental Services: Some Nuts and Boots, CIFOR Occasional Paper n°42, disponible sur : <http://www.cifor.cgiar.org/>