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REVIEW ARTICLE

# Can payments for ecosystem services contribute to sustainable development in the Brazilian Amazon?

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## Abstract

The Brazilian Amazon supplies the world with several forests ecosystem services, many of which are essential to sustain human life on earth. Nevertheless, the Amazon is threatened by deforestation and degradation implying in reductions on the provision of these.

According to economic theory, as ecosystem services are positive externalities and public goods, agents do not take into consideration the costs and benefits of their consumption and production of ecosystem services into their economic decisions. To address this problem payment for ecosystem services – PES – emerged, aiming to provide a source of income to the poor people living in forest areas, stimulating them not to deforest, and making agents who are indebted with the nature pay for their overconsumption of ecosystem services.

There is still controversy about possible impacts of the instrument. This article accesses the potentials of PES to contribute to sustainable development in the Brazilian Amazon using the three goals related to sustainable development proposed by the ecological economics theory: efficient allocation, fair distribution, and sustainable scale.

The study shows that PES as a pure market approach is unlikely to solve neither the scale nor the distribution problems. Therefore, for PES to achieve sustainable development, markets for ecosystem services should first be constrained by a maximum sustainable scale. Then, measures should ensure fair distribution in second place. Only after these questions have been tackled, it is desirable that agents interact in the ecosystem services markets to lead to an efficient allocation of resources.

## Key words

Brazilian Amazon, forest ecosystem services, ecological economics, sustainable development

## Introduction

The Amazon forests are considered to have a high importance for the humanity due to the ecosystem services it provides. Despite this relevance attributed to them, these forests are facing high rates of deforestation and degradation, posing a threat to the ecosystem service provision. The payment for ecosystem services – PES – is advocated as a tool to slow down deforestation at the same time it would provide the local poor people, living in these forests and lacking alternatives of life with extra income. In this context, this article aims to

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analyze the potential contributions and limitations of PES to promote sustainable development in the Brazilian Amazon.

The originality of this article is that few authors have analyzed the potential of PES to achieve not only efficient allocation and fair distribution, but also a sustainable scale. This article applies some ecological economics concepts created by Daly (1992) in the context of pollution trading permits to the case of the payments for ecosystems services. Daly argues that ecological economic policies should have three distinct objectives: efficient allocation, fair distribution, and sustainable scale. This article tries to assess the qualities and problems of PES in these three perspectives together. It is considered that an environmental policy will only be completely successful for sustainable development if it can address these three aspects jointly.

Another contribution of this article is to situate the PES instrument in the economic theory and analyze the stage of these markets relative to the internalization of the externalities suggested by Coase (both for consumers and producers).

This article suggests that PES as a theoretical approach have a high potential to contribute to sustainable development in the sense that once competitive markets for ecosystem services are created, they will lead to an efficient allocation, ensuring the provision of ecosystem services at the lowest social costs.

It suggests, however, that for PES to contribute to sustainable development, before allowing the trading in the markets, the scale should be determined, i.e. the total amount of ecosystem services that should be provided. Therefore, international agreements should be achieved. After it, property rights for the ecosystem services – which are still positive externalities not considered in economic decisions – should be assigned to both consumers and producers. In other words, it must be defined what exactly are ecosystem services, how they are produced and who is going to produce them and pay for them. The way this definition of the rights is made may be decisive to achieve the fair distribution with inter and intra-generational and international fairness. Such a market is called by Daly (1999) not of a free market, but of a free market constrained by social, ecological and ethical decisions.

This article is structured in six chapters including this introduction. Chapter two provides an overview about the importance of the Brazilian Amazon with regard to the provision of ecosystem services to the humanity and the social, ecological and economic challenges it faces to achieve sustainable development. Chapter three introduces the definitions of ecosystem services, PES and the criteria for sustainable development which will be used in the analysis of the PES instrument. Chapter four provides an overview about the methods used to write this article. Chapter five provides the results and discussion regarding the potentials of PES to contribute to sustainable development in tropical forest regions. Chapter six provides the conclusions and recommendations.

## Ecosystem services, the Brazilian Amazon, and the challenge of sustainable development

### Ecosystem services and the Brazilian Amazon

Tropical forests play an outstanding role in providing ecosystem services to the humanity and the Amazon biome, as the largest area of tropical rain forests is key in providing ecosystem services to the humanity. The biome expands across 6.4 million km$^2$ (Lentini *et al*, 2005), accounting for approximately one third of the tropical forests worldwide. 63% of the whole Amazon Biome is in the Brazilian territory (Fig. 1). In Brazil, the Amazon biome extends through an area of 4 million km$^2$. The federal states which contain Amazon forest in them form the political region "Legal Amazon". This article refers to the Legal Amazon, whenever the Amazon is mentioned.

Despite the high importance of the Brazilian Amazon forests, the region faces the threat of deforestation and degradation which is occurring at an alarmingly pace. The most part of the deforestation occurs in the Amazon region especially in the southern and eastern edges, which is known as the "deforestation arc". Large scale deforestation began in the 1960s and today 17% of the whole biome has been depleted (Lentini *et al*. 2005). This loss of natural capital has consequences for the provision of ecosystem services at the local, national, and global levels.

First, deforestation and degradation cause biodiversity loss. Biodiversity is essential to ensure tropical forests resiliency, being important for pest control, pollination, propagation of seeds, among other (Burger 1980, 1991). Biodiversity provide landscape beauty and is the basis for medicine. Moreover, is widely defended to have value per se, even if it does not provide any benefit to humans. According to the Convention on Biodiversity, Brazil is one of 17 megadiverse countries in the world containing about 70% of the world's catalogued animal and plant species. The process of forest loss occurring in the Amazon causes huge impacts to biodiversity.

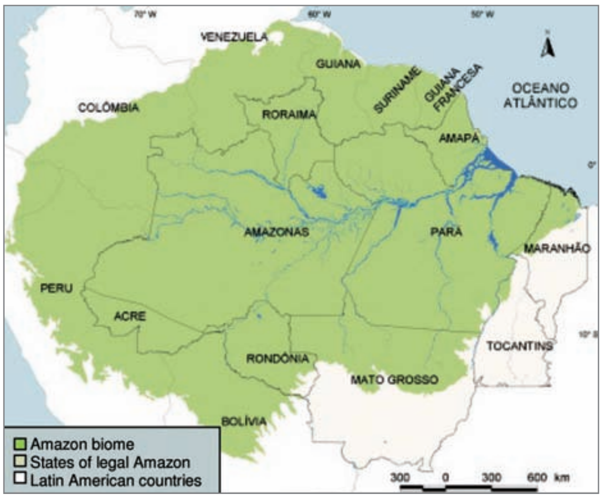


Fig. 1. The Amazon Biome (Lentini *et al.* 2005)

Second, the closed and dense Amazon forest plays a key role in the water cycles of the Amazon region and of several other regions as well. Half of the rainfall in the Amazon is likely to be recycled through the trees (Fearnside 2003). This vapor recycled in the Amazon is also transported to South and South-central Brazil, to Paraguay, Uruguay, and Argentina, and some crosses the Atlantic to Southern Africa (Fearnside 2005). These watershed functions are expected to be lost in great part when forests are converted into uses such as pasture (Fearnside 2005). The results of forest losses taking place in the Amazon, in addition to site related consequences for rainfall, might incur drastic changes in precipitation in other parts of the continent and even in other continents.

Third, a characteristic of tropical forests is that they store carbon mainly within biomass instead of in the soil (FAO 2007). Hence deforestation and forest degradation causes the emission of greenhouse gases to the atmosphere, especially when the forests are burned in order to convert the land into pastures or other types of agricultural land. The deforestation and land use changes taking place in the tropics are the second main source of $CO_2$ emissions which are contributing to the acceleration of the greenhouse effect, coming right after the emissions from fossil fuels. In Brazil, the major cause of $CO_2$ emissions is land use change, due to the deforestation and burning of forest areas. This phenomenon is responsible for not less than 75% of Brazil's total emissions in the period 1990-1994 (MCT 2007). The Amazon biome was responsible in the period for 59% of all net emissions due to land use changes in Brazil at the time (MCT 2007).

Fourth, tropical forests are essential for protecting the soils from erosion, which occurs when the multilayered forests do not protect the soils from heavy rainfalls and sun exposure. Forests on river banks protect the rivers from being destroyed by sedimentation. Moreover, Amazonian soils, similarly to other tropical soils, are very dependent on forests to keep the fertility of the soil intact, as the soils in the region are up to 75% acid soils with low fertility and have very little capacity to store nutrients (Burger 2006).

Lastly, the Amazon forest is highly appreciated due to its characteristically beauty. The composition of tropical forests, huge and small rivers, and a mixture of populations and cultures makes the area an attraction for tourists from all over the world.

Because of these many functions, the tropical forest ecosystem encountered in the Amazon is highly important to the well being of humans at the local, regional, and international levels. The broad process of devastation of these forests might incur impacts for global communities. However, despite consensus on the importance of the Amazon forests, other forces of economic and social characters induce the destruction of the forest with consequences for the ecosystem services it provides.

## Social reality of the people living in the Amazon

In addition to the ecological problems, the Amazon region faces as well economic and social problems. In 2004, 22.5 million people lived in the Legal Amazon, corresponding to 12% of Brazil's population. The development stage of the Amazon region lags behind the development of the other regions in Brazil, with the only exception of the Northeast region, the Amazonian GDP corresponding in 2004 to 64% of the Brazilian mean (Calentano and Veríssimo 2007). The overall Human Development Index (HDI)[1], which has income, health, and education as components, is also lower than that of other Brazilian regions with the exception of the Northeast. While the HDI of a developed country should vary between 0.8 and 1[2], and the mean HDI in Brazil in 2000 corresponds 0.766, the HDI in the Legal Amazon accounts for 0.705 (Calentano and Veríssimo 2007), which is much lower than the Brazilian mean. This HDI characterizes the region as a mid-developed area in comparison to world standards (UNDP 2006). This index, however, does not capture the disparities of the development within the region. Two thirds of the population is urban and the HDI of these areas is higher than in the rural areas, where the stage of underdevelopment is higher.

The World Bank forest strategy recognizes that over 90% of the 1.2 billion people living in extreme poverty depend on forests for some part of their livelihood (World Bank 2004). These people are extremely prevalent within tropical forest regions. This is also the case in the Amazon. In this region the poverty rates are quite high, much higher than other regions in Brazil, with the exception of the Northeastern region.

The Amazon is characterized by a generalized lack of infrastructure: health, education, transports, etc, whereas rural areas are especially affected. The people there lack alternative occupations, access to markets, appropriate educational system, appropriate transportation system, and healthcare systems. The remoteness and lack of infrastructure tend to be strongly related to extreme poverty (Chomitz 2007).

[1] "HDI provides a composite measure of three dimensions of human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and enrolment at the primary, secondary and tertiary level) and having a decent standard of living (measured by purchasing power parity, PPP, income)" (UNDP 2006).

[2] The HDI ranges from 0 to 1. HDI from 0-0.499 characterizes an area as underdeveloped. HDI from 0.5-0.799 characterizes an area as middle developed. HDI from 0.8-1 characterizes an area as developed (UNDP 2006).

Although since the 90s there is no longer any official colonization plan anymore, deforestation continues. In addition to the remaining subsidies (Burger 2006), a new dynamic is driving it. One of the main problems that cause a barrier to sustainable development in the region is the land tenure (Burger 2006). According to Lentini *et al*, from 1996 to 2005 the land property rights were defined as follows: 33% were protected areas, 10% were special areas (military land, land of traditional communities, rural settlements and environment protection areas – *APAs*); 24% were private land; and 33% are land without land title (*terras devolutas*) (Fig. 2). In this last type of land tenure, the Estate has the right of disposal. However, any stakeholder can occupy the land (*posse*) and, after years of use, can request the land title, which can then afterwards be sold (Burger 2006).

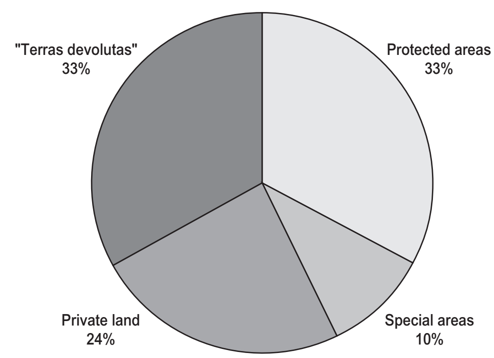


Fig. 2. Land tenure (Lentini *et al*. 2005)

## Current deforestation drivers

There are four main forces driving deforestation, which happen mainly (though not only) on the land without title – *terras devolutas*. First of all, conventional logging (mainly unsustainable and illegal) causes much degradation to the forests. However, in contrast to commonly held beliefs, it is not the main cause of deforestation. In the logging process, only about 20% of the wood is made up of commercial species and utilized for timber production. The rest of the vegetation is left, constituting secondary forests. The problem of the logging is the damage it causes. Logging activities impoverish the forests by extracting the valuable timber from it and by degrading the surrounding areas where logging took place. The results of logging are damaged and impoverished forests and roads. The opened roads build by the loggers open the way for other deforestation actors.

Both roads left behind by the loggers, as well as roads that are built and asphalted as a result of governmental infrastructure projects, enable the access to previously unreachable forests by other outsiders. This explains why small farmers have wider possibilities of advancing the agriculture frontier. Some of the wood that is still available is extracted from the forests and the areas are then burnt in a cheap and easy process for cleaning the land with almost no need of labor input. After that, farmers start agriculture based mainly on slash and burn practices for the cultivation of subsistence products in small areas. The non-consumed part of the production is sold to contribute to the family income. While the areas used for slash and burn agriculture are mainly small (mainly up to 3 ha), the shifting of the cultivated area poses a deforestation threat if population density is high.

Another typical activity which has spread very much in the last two decades is the cattle ranching activity. Cattle ranching is established either in an area where agriculture has been conducted or forests are converted directly into cattle ranching pastures. Many small farmers[3], as well as big farmers, conduct cattle ranching activities in their properties. This activity, however, offers alternative motivation for its use when compared to slash and burn agriculture. The cattle ranching activities are highly profitable (Margulis 2003) and they bring gains which arise from land speculation (Romeiro 1999, Fearnside 2005). Deforestation and the establishment of cattle pasture is a cheap way to enable claims to public lands (Fearnside 2005).

There is also the combination of slash and burn with small scale cattle pasture, which has been specially endorsed by the Constitutional Fund for the Development of the North – FNO – and credits from the Amazon Bank – Basa – in the 1990s (Costa 2005, Burger 2006).

Moreover there is the conversion of forests, independently of the logging activities, directly for the establishment of industrial agriculture, specifically soy in the southern frontier of the state of Mato Grosso. This has been the main cause of deforestation pressure in the last years. Furthermore, there are also other pressures due to mining activities, plantation forestry, plantations for production of biodiesel, etc.

## Deforestation vs. sustainable economic and social development: boom-collapse

The damages to the natural resources involved with deforestation do not lead to a sustainable social and economic development. A study from Calentano and Veríssimo (2007) confirms the *boom-collapse* hypoarticle, first proposed by Schneider *et al.* (2000), which illustrates how the model of occupation in the Amazon based on natural resource degradation leads to rapid economic growth and enhancement of education and health indicators in the short term, but, in the long run is nonetheless unsustainable. The study shows how degrading activities promote neither economic nor social development in the long run apart from the damage it causes to the environment and the welfare loss caused by the falling of the provision of the ecosystem services.

## Economic importance of the Amazon

The Brazilian Amazon is an area rich in forest and other natural and mineral resources, which gives it very high economic importance for the local, as well regional and national, society. It has large reservoirs of mining resources, water, is a source of raw materials and can be a source of land for the expansion of agriculture production to supply to other regions in Brazil, or for exportation. Soy, which has been expanding especially in the state of Mato Grosso (causing deforestation), is Brazil's most important export product, playing a key role for the stabilization of Brazilians' external trade accounts (Becker 2005). Despite of this, the contribution the region makes to the national GDP is very low. The Amazon, despite accounting for more than 50% of the total country's land area, only contributes to 8% of the national GDP (Calentano and Veríssimo 2007).

For the local economy, particularly in rural colonies and native settlements, forests play a crucial role, fur-

[3] Small farmers in the Amazon are defined according to the Brazilian Forest Code as familiar properties of up to 150 hectares.

nishing the main source of the populations' livelihood, including food, water, housing materials, other forest products, and land for agriculture.

Although the illegal activities occurring in the area incur a loss of tax revenues as enunciated by the World Bank (2004), the conservation choices might also be very costly to the nation. Monitoring and enforcing the law in the region is extremely costly and difficult to ensure. In addition to the difficulty posed by the vast land area, illegal groups acting in the area such as illegal loggers, big land speculation actors, and mining companies have much power, expressed by the high violence rates in the region (Calentano and Veríssimo 2007).

Apart from the direct costs of monitoring and enforcing, conservation may incur opportunity costs related to the use of the natural resources (timber, mining resources, water resources) or the land for economic activities, such as agriculture and cattle ranching. Therefore, it is likely that the region will not be conserved unless the maintenance of the forests evolves to be economically attractive. According to Joao Paulo Capobianco, executive secretary of the Ministry of the Environment, it is the lack of economic alternatives which lead to deforestation and degradation (Estado de Sao Paulo, 15/08/2007). For him, sustainable development for the Amazon means finding ways of using the forests sustainably and providing economic gains through conservation choices, so that the development in the region is not inhibited.

## The challenge of a sustainable development strategy for the Amazon

The Brazilian Amazon is in critical need of a sustainable development strategy that will enhance the economic gains in the region and nation, while at the same time provide social development for its population and avoid the devastation of the forests and the existing natural capital, which provide ecosystem services for the whole humanity.

The old policies in the region composed mainly by fiscal incentives and subsidized credits, beneficiated the expansion of industrial agriculture and cattle ranching. These policies had a homogenization character (Becker 2005). It did not consider the region's socio-economic and ecologic diversity and did not provide development alternatives and long term benefits for the weak and the poor. Moreover, they contributed to deforestation and degradation of the tropical forests, and the multitude of consequences that they had on the global communities.

During the 90s the necessity of promoting a sustainable development which would be more adequate in the context of the region was recognized. Programs such as the Pilot Program for the Protection of the Tropical Forests implemented many alternatives for land use which would be ecologically and socially more appropriate in the context of the region. However, it is still necessary to spread these ideas and to try to guarantee independence from financial donor support.

Today, there is a broad consensus about the high value of the Amazon. Special attention is paid to the importance of the service that the tropical forest's ecosystem provides. Therefore, it is important to find a strategy capable of maintaining the forest functions in the long-term and of avoiding irreversible losses. The ecosystem services of tropical forests, including the Amazon, should be protected. Now comes the challenge of how to make that happen.

It is unlikely that the vast resources available in the region will be protected if the costs of doing so are higher than the benefits. Thus, it is necessary to find alternatives which would provide economic gains on the respective scale of every economic actor involved in decision-making regarding the use of the land, so that they actually choose to use the forests and natural resources in a sustainable way. The benefits of preserving the forests should overweigh the costs (direct costs of protecting the forest plus the opportunity costs) at all levels of the decision making (Kremen *et al*. 2000).

The instruments used to conserve the forests until today were mainly based on command and control. These, used isolated, have shown to be insufficient in ensuring the sustainable use of the forest and natural resources (May 2005).

The challenge is therefore how to combine preservation of ecological integrity with social development, while at the same time finding ways of using the economic potentials of the region in a sustainable way, and thus considering the three pillars of sustainable development.

## The payment for ecosystem services as tool for sustainable development

In this context, much attention has been given to economic instrument payment for ecosystem services for its use in tropical forest regions. The instrument aims rewarding the local populations who deal with the land and natural resources in a more sustainable way by changing their land use towards more sustainable patterns, by acknowledging such populations as providers of environmental services. The buyers of the services should be the consumers of ecosystem services either directly or indirectly. In this sense, markets for the services would be created.

The idea is that the income flows enhance the value of the forest assets and thus encourage its conservation (ITTO 2004). In the Amazon this would mean that the local populations, who lack economic alternatives, have an extra incentive to adopt more sustainable land use practices. This would, on the one hand, provide the rural populations in the Amazon, who currently conduct slash and burn and cattle ranging activities, competitive alternatives for land use, and, on the other hand, provide extractives communities a complement to their restricted income as reward for their sustainable land use patterns.

In Brazil in the year 2000, the social movement elaborated a proposal called Proambiente, a program with the goal of rewarding small rural farmers that changed their patterns of production to more environmentally friendly systems than the current methods, which are causing environmental harm in the Amazon. For instance, agro-forestry systems, agriculture without the use of fire, second forest enrichment, forest margins reforestation, are among others which are known to provide ecosystem services to the society. The idea of Proambiente is to make available economic alternatives to the rural people simultaneously enhancing the ecological values of the secondary forests and avoiding primary forests from being deforested for slash and burn or cattle pasture establishment. This program aspires stimulating the adoption of low-impact land uses by small farmers in the Amazon region and reward the farmers for the provision of environmental services.

In the next section some definitions will be introduced and the economic problem related to the ecosystem services will be explained based on economic theory. Then, the instrument PES and its features will be introduced as a basis for the discussion of the results.

## Research objective and theoretical framework

### Research objective

The research objective is to understand the possible contribution of PES to sustainable development in the Brazilian Amazon. The research objective is intended to be reached by answering two distinct research questions. 1. Can PES contribute to sustainable development in tropical forest regions? 2. Can Proambiente's PES contribute to sustainable development in the Pole Rio Capim of Proambiente? This article focuses on the results related to the first research question.

In attempting to answer the questions posed, three broad economic goals related to sustainable development proposed by the ecological economics theory will be used. They are: 1. efficient allocation; 2. fair distribution; 3. sustainable scale (Daly, 1992). In this regard, the research will try to access first, whether PES is capable to promote an efficient allocation of economic and natural resources amongst economic actors providing aggregate maximum welfare economic and environmental gains in a society. Second, whether PES distributes the gains and losses in a fair manner between the actors, if it beneficiates weaker actors such as small farmers, extractives communities, and indigenous communities. Last, whether PES is an effective contribution to finding the sustainable scale of the economic system.

In the next section, the necessary ecological economics background theory will be highlighted as well as the background definitions, which are considered necessary for the discussion of the results.

### Theoretical framework

#### Ecosystem services and the role of tropical forests

An ecosystem is the functional unit where natural processes, i.e. the dynamic complex of interactions between plant, animal, and microorganism communities and the nonliving environment, take place (MEA 2005). The natural processes as well as biotic and abiotic components of ecosystems have the capacity of providing goods and services which satisfy human needs, either directly or indirectly. Based on the definition proposed by de Groot and others (2002), these capabilities are classified as ecosystem functions.

Once ecosystem functions are known and the contribution of these functions to the society can be accessed, they are reconceptualized as ecosystem goods and services. In other words, ecosystem services are the ecosystem functions when human values are implied, being therefore an anthropocentric concept (de Groot *et al*. 2002).

There are different types of ecosystem services which can be divided, according to the Millennium Ecosystem Assessment (2005), in four categories: provisioning, regulating, cultural, and supporting services. Provisioning relates to the capacity of providing goods such as water, food, and timber. Regulating services are the natural processes that regulate the environmental conditions that sustain human life such as water cycles, flood control, and climate regulation. Cultural services relates to the importance of the ecosystems in offering recreational, aesthetic, and spiritual benefitis. Finally, supporting services are those which are necessary for the other services to exist, such as nutrient cycling, soil formation, and photosynarticle (MEA 2005).

### Ecosystem services from tropical forests

Forest ecosystems as the largest terrestrial ecosystem (FAO 2005) play a key role in providing ecosystem services to meet human needs. They regulate air quality, water flows, and climate. Moreover, they can store carbon, protect soils from erosion and landslides, provide habitat for animal species, and are a source of landscape beauty (MEA 2005).

Tropical forests ecosystems play an outstanding role in providing ecosystem services. This relies on the peculiarities related to the ecology of these systems. First of all, they are the most biodiverse ecosystems in the world, providing habitat for a large variety of plant and animal species. Moreover, apart from the beauty they provide, they are an important carbon sink storing large amounts of carbon in the biomass; they protect the soils from erosion; and have watershed functions.

Not only primary forests are capable to provide ecosystem services. Forest ecosystem services can also be provided by trees within more complex landscapes (Landell-Mills and Porras 2002). The levels of the provision of ecosystem services are directly related to the land uses or forest management practices conducted in forest land.

While the conversion of forests into agricultural land or pasture becomes for instance a source of carbon dioxide and loss of biodiversity, afforestations and reforestations have the potential to store carbon in the biomass and complex agro-forestry systems can provide shelter for fauna therefore protecting biodiversity, and also maintain nutrient cycles similarly to that of a tropical forest, thus protect the soil fertility in the long run. Hence, not only forest protection but also sustainable forest management, agro forestry systems, and enrichment of secondary forests, contributes to maintaining or providing ecosystem services.

## The paradigm of sustainable development

The sustainable development paradigm has been signed by 178 countries during the United Nations Conference on the Environment and Development (UNCED) in 1992 held in Rio. While the paradigm does not provide a concrete development path with concrete measures to be undertaken, it is essential for guidance in the decision processes with development patterns to be adopted by providing orientation principles. These orientation principles should guide the actions of the actors in order to achieve sustainable development. These principles are 1. Economic efficiency; 2. Social fairness, and; 3. Prudent use of resources (Burger 2005). In this master article, based on ecological economics theory, the paradigm of sustainable development will be translated into three broad economic goals: efficient allocation, fair distribution, and sustainable scale (Daly 1992). Below these economic goals and their relation with the ecosystem services from forests will be explained.

### Efficient allocation

Firstly, efficient allocation means the ability of allocating resources between demand and supply to maximize the social gain in the economy. Regarding ecosystem services, it means to provide the expected levels of ecosystem services demanded by society at the lowest social costs.

Theoretically, the best instrument to achieve an efficient allocation is a competitive market. However, markets fail to allocate the ecosystem services adequately, causing a tendency towards the undersupply of ecosystem services, thus, resulting in welfare losses. This is due to the nature of ecosystem services as externalities and public goods and will be discussed below.

#### Fair distribution

Secondly, fair distribution refers to a distribution which reduces the degree of inequality amongst the division of resources to certain levels considered acceptable in the society. Following Daly (1999) and the principles of the Rio declaration, signed in 1992, a fair distribution is based on three pillars: inter-generational fairness, intra-generational fairness, and international fairness (Daly 1999).

According to the Brundtland Report and the consensus achieved at the UNCED held in Rio, inter-generational fairness means that the use of natural resources today should not diminish the next generations' access to resources. Inter-generational fairness in the forestry field, for instance, is expressed by the sustainable forestry yield concept, which was traditionally defended by foresters, of using yearly only so much from the forests as the yearly incremental growth, therefore maintaining the stock.

Intra-generational fairness means an overall lower inequality in not only the division of material, but also of information and capability resources between the contemporary generations. Therefore it is necessary as a first step, to address the poverty issue which has been emphasized in the Rio conference by the Principle Five of the Rio Declaration on Environment and Development:

"All states and all people shall cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development, in order to decrease the disparities in standards of living and better meet the needs of the majority of the people of the world".

In the forestry field, for instance, it has been identified that forests are an essential source of food, shelter, medicine, raw materials, and well being for many poor people in the world. According to the World Bank Forest Strategy 2004, forest resources contribute directly to the livelihood of up to 90% of the 1,2 billion extremely poor people in the world. If their use leads often to the depletion of natural resources it is often due to lack of alternatives. Thus, to reduce poverty would mean for them to expand their alternatives, their life chances as defended by Sen (Hauptmeier 2006)[4].

Regarding the environmental resources, intra-generational fairness refer to a lower inequality in the division of the use of natural resources or ecosystem functions, in other words the inequality in the division of the quantity of damage to the environment one person can make.

International fairness refers to the fairness between nations. In Rio the historical responsibility of industrialized countries towards natural resources depletion, their higher capabilities and, disposal of funds and technologies in order to address the environmental problems have been recognized. As a consequence, industrialized countries should provide the leadership and make available to developing countries financial and technological resources, besides assuming more commitments in natural resources recovering because of their historical responsibilities and bigger share of environmental damage they cause to the environment. This is the rationale behind the Principle Seven of the Rio Declaration on Environment & Development where it is accepted that the countries have "common but differentiated responsibilities":

"States shall cooperate in the spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environment degradation, states have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command" (University for Peace 2002).

[4] Following Sen.'s concept, to reduce poverty and provide development requires transforming the available resources in freedoms, which could expand people's life chances. The most important freedoms are to run a long and healthy life, to have access to education, and to have some appropriate life standards.

### Sustainable scale

Scale is the size of the economic system and might be thought as the product of the population times the per capita resource use (Daly 1992). A sustainable scale is one in which the total volume of resource flow is not higher than what natural ecosystems can regenerate and recycle. In other words, a sustainable scale is one that maintains the carrying capacity of the ecosystems over time, thus considering the intergenerational fairness, and avoids irreversible losses.

Important to point out is scale was not recognized officially in economic mainstream theory (Daly 1992). It considers that the economic system should not be restricted by ecological limits. It is expected that technology and trade is able to expand carrying capacity infinitely (Rees 1996).

Alternatively, ecological economics recognize that humans remain in a "state of 'obligate dependence' on the productivity and life support services of the ecosphere" (Rees 1990 cited in Rees 1996). Therefore, the maintenance of the productivity of ecosystems, which in turn provide many life support services, here ecosystem services, is fundamental for life on earth (Rees 1996).

While it is not possible to determine the exact figure about what is the carrying capacity of the earth, a didac-

Tab. 1. Biocapacity by component (Global Footprint Network 2007)

| | Population | Total Biocapacity | Biocapacity by ecosystem | | | | |
|---|---|---|---|---|---|---|---|
| | | | Cropland | Grazing land | Forest | Fishing grounds | Forests (% of total biocapacity) |
| | (millions) | (global ha/ person) | (global ha/ person) | (global ha/ person) | (global ha/ person) | (global ha/ person) | |
| World | 6.301,5 | 1,8 | 0,53 | 0,27 | 0,78 | 0,14 | 44% |
| High income countries* | 955,6 | 3,3 | 1,10 | 0,19 | 1,48 | 0,31 | 45% |
| Middle income countries** | 3.011,7 | 2,1 | 0,50 | 0,31 | 1,05 | 0,15 | 51% |
| Low income countries*** | 2.303,1 | 0,7 | 0,31 | 0,17 | 0,12 | 0,05 | 17% |
| Africa | 846,8 | 1,3 | 0,37 | 0,51 | 0,27 | 0,08 | 21% |
| Asia-Pacific | 3.489,4 | 0,7 | 0,34 | 0,08 | 0,17 | 0,11 | 22% |
| Latin America | 535,2 | 5,4 | 0,70 | 0,96 | 3,46 | 0,21 | 64% |
| Middle East and Central Asia | 346,8 | 1,0 | 0,46 | 0,27 | 0,11 | 0,08 | 11% |
| North America | 325,6 | 5,7 | 1,87 | 0,28 | 2,68 | 0,43 | 47% |
| European Union (EU25) | 454,4 | 2,2 | 0,82 | 0,08 | 1,02 | 0,12 | 46% |
| Rest of Europe | 272,2 | 4,6 | 0,98 | 0,25 | 3,02 | 0,26 | 66% |

* High Income Countries: Australia, Austria, Belgium & Luxembourg, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea Republic, Kuwait, Malta, Netherlands, New Zealand, Norway, Portugal, Saudi Arabia, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States of America

** Middle-Income Countries: Albania, Algeria, Angola, Argentina, Armenia, Azerbaijan, Belarus, Bolivia, Bosnia Herzegovina, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Czech Republic, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Gabon, Georgia, Guatemala, Honduras, Hungary, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Latvia, Lebanon, Libya, Lithuania, Macedonia, Malaysia, Mauritius, Mexico, Morocco, Namibia, Panama, Paraguay, Peru, Philippines,, Poland, Romania, Russia (and USSR in 1975), Serbia and Montenegro, Slovakia, South Africa, Sri Lanka, Swaziland, Syria, Thailand, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Ukraine, Uruguay, Venezuela

*** Low Income Countries: Afghanistan, Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Rep, Chad, Congo, Congo Dem Rep, Côte d'Ivoire, Eritrea, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Haiti, India, Kenya, Korea DPRP, Kyrgyzstan, Laos, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Moldova Republic, Mongolia, Mozambique, Myanmar, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Papua New Guinea, Rwanda, Senegal, Sierra Leone, Somalia, Sudan, Tajikistan, Tanzania, Togo, Uganda, Uzbekistan, Vietnam, Yemen, Zambia, Zimbabwe tic calculation is provided by the Ecological Footprint Network, called biocapacity. **According to this definition, biocapacity is**

"… the capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies. "Useful biological materials" are defined as those used by the human economy (…). The biocapacity of an area is calculated by multiplying the actual physical area by the yield factor and the appropriate equivalence factor. Biocapacity is usually expressed in units of global hectares" (Global Footprint Network, 2007).

Following, biocapacity can be defined for the purpose of this article as the area of ecosystems which provide needed ecosystems goods and services for humans considering the current levels of technology available.

The Ecological Footprint Network also estimated the availability of biocapacity per capita in the world and determined the components that contribute to this biocapacity (Tab. 1). Forest ecosystems account to a large amount of this biocapacity level. Considering the world mean, it responds to 0.78 hectares of the 1.8 hectares (or 43%) available per person. In Latin America forests have even a more important role responding to 64% of the biocapacity available.

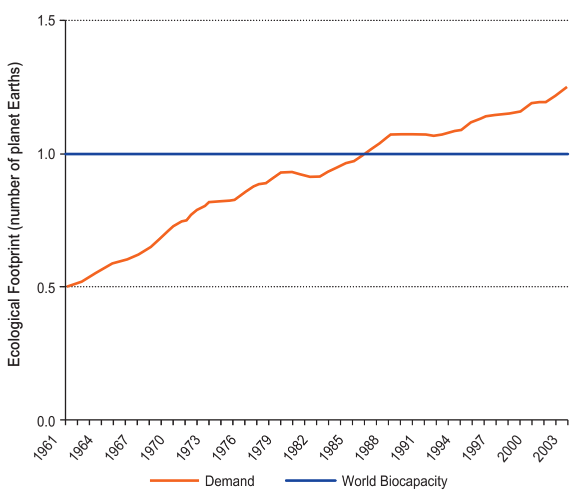


Fig. 3. Demand versus biocapacity (Global Footprint Network 2007)

Following, the area of productive land required to produce the resources consumed and to assimilate the wastes produced is called in this sense the ecological footprint.

Figure 3 shows how the world population under the current consumption patterns is using more than the carrying capacity, the biocapacity.

## Forest values and ecosystem services values

### Forests' total economic value

The concept of the total economic value aims to access the contribution of forest ecosystems to human economic welfare systematizing the economic value of the marketed, as well as the non-marketed values a forest ecosystem provides to humans. It thus expresses the aggregate value of benefits the forest provides to humans, hence the ecosystem goods and services from the forests.

The total economic value of a forest is the sum of its instrumental and the non-use values[5] as intrinsic values cannot be captured in monetary units. Instrumental values consist of direct, indirect, and option values. On the one hand, direct use values are those from which agents benefit directly through the direct use in the form of goods, such as timber and non-timber forest products, and services, such as landscape beauty for tourisms activities and recreation. On the other hand, indirect use values are functions of the forests which people use or beneficiate of indirectly, for example climate regulation, carbon storage, maintenance of water cycles. Option values relates to the value given to leave an option open to use the forests in the future (Oesten and Roeder 2002). An example is the value given to conserve the biodiversity in the expectation that it can be used for medicinal purposes in the future.

The non-use values are values given by an agent, even though he is not taking part of the use himself. They are divided in two categories: existence and bequest values. The existence value is the value given by humans for something to exist, independently of the direct use of it. Examples are the importance given by

[5] For a detailed explanation about the forest value types, see Oesten and Roeder (2002).

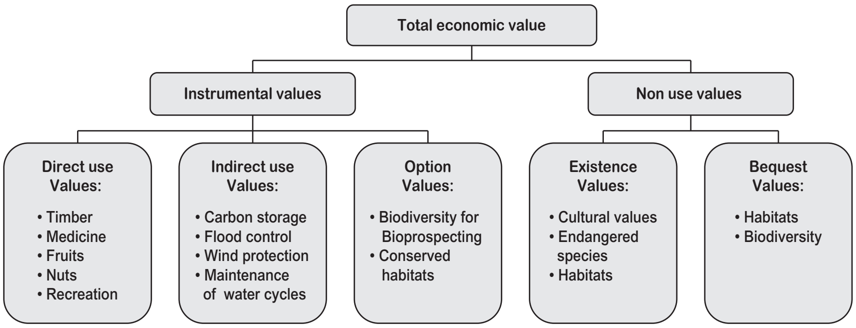


Fig. 4. Concept of the forests' total economic value (Oesten and Roeder 2002, Landell-Mills and Porras 2002)

people to know that a cultural memorial or a seldom biotope is conserved, even if they know they will never go there. Bequest values relate to the wish to keep the forests values so that next generations can profit from it (Oesten and Roeder 2002) (Fig. 4).

## The economic value of forests' ecosystem services and the Amazon

To quantify the total economic value of all forest ecosystems is a complicated task, especially with regard to the valuation of the non-marketed forest values. Such a research has several limitations and therefore, few studies have attempted to do it. Here one of these studies will be introduced to give a first estimation about the economic contribution of the ecosystem services to the humanity.

Costanza and other authors (1997) reviewed a number of nature's services valuations and estimated, based on some additional own calculations, the minimum economic flow values of important general ecosystem goods and services, including marketed as non-marketed, which are provided to humans. One of the ecosystems assessed was the forests, which were divided in temperate and tropical forests. Such a calculation, similar to models, is based on many assumptions and the power of the numbers is limited.

The calculations are based mainly on direct or indirect willingness to pay valuations. It considered values such as direct use values (food production, raw materials, recreation, and cultural), indirect use values (climate regulation, erosion control, nutrient cycling, waste treatment, etc.), option values (genetic resources, and habitat/ refugia), existence values (cultural, and habitat refugia), among others.

According to this estimate, the entire biosphere provides the humanity from US$ (1994 prices) 16 to 54 trillion ($10^{12}$) in ecosystem goods and services per year, or on average US$ 33 trillion. This was almost two times the global gross national product at the time of the study, calculated at US$ 18 trillion. The average economic value of ecosystem services corresponded to 1.8 times the global gross national product.

The economic value of forest ecosystems goods and services accounted, according to their estimations, for US$ 4.7 trillion (1994 prices). From this total, ecosystem goods and services from tropical forests were valued as US$ 3.8 trillion, 81% of the total value of all goods and services provided by forests worldwide considered in the study. The estimation of the value produced by a tropical forest per hectare corresponded on average to US$ 2000 per year. Excluding the goods, the economic value of only services corresponds to US$ 1652 per year per hectare. Multiplied by the global area of tropical forests ecosystems the services provided annually by tropical forests can be estimated in US$ 3.1 trillion. For the majority of these services there are no markets.

The research emphasizes that, due to the limitations of the study, this should be considered minimum estimations as there is still data for services missing and improvement is still needed in the valuation of various non-marketed goods and services.

In this context, if tropical forests are so important to the humans, why are these ecosystems under threat? The problem relies on the fact that several benefits the forests provide to humans in form of ecosystem goods and services are not considered in economic decisions. This relies on the fact that many goods, especially the forest ecosystem services, do not find markets, and therefore do not have a price determined by the demand and offer dynamic. For instance the existence value, the option value, many of the indirect values and even some of the direct values (such as landscape beauty) do not have a price in the markets. Consequently, the benefits they provide are often not considered in economic decisions. This lack of consideration happens even when many of the ecosystem services are essential to human life on the planet. This often leads to the depletion of the natural capital and consequently to the ecosystems services loss, causing huge harm to the world society. The next section will present the theoretical economic explanation for this problem.

## Supply tendency of forest ecosystem services through economists glasses

Above it has been highlighted how forest ecosystems provide quite a few economic benefits in form of ecosystem goods and services for the whole humanity and that tropical forests are especially valuable with respect to ecosystem services. The provision of forest ecosystem services is directly related to the forest management activities adopted. If, on the one hand, sustainable forest management activities, agro forestry systems and forest protection ensure the provision of ecosystem services, on the other hand, deforestation, degradation, and conversion of forests turn to be a negative provider of these services.

But if tropical forest ecosystem services are so valuable for the humanity, why are these ecosystems, the ones capable of providing the services, under threat? If more sustainable forest management regimes provide humans with more welfare, why do unsustainable systems remain and cause pressure of destruction of forests? This section will show the reasons why this happens.

### Economic profitability of sustainable forest management activities

The income sources of sustainable forest management activities still rely strongly on the marketed direct use values of the forests, mainly on timber selling. The problem here relates to the long term characteristic of the activity, contrasting with the peoples preferences for present satisfaction. The impacts for forestry of this tendency of people to value more present than future consumption has already been demonstrated by Pigou (1920).

"A number of other large undertakings, such as works of afforestation or water supply, the return to which is distant, are similarly handicapped by the slackness of desire towards distant satisfactions. This same slackness of desire towards the future is also responsible for a tendency to wasteful exploitation of Nature's gifts. Sometimes people will win what they require by methods that destroy, as against the future, much more than they themselves obtain." (Pigou, 1920).

This preference for the present satisfaction against the future satisfaction is also the basis for the discounting, which is used to calculate the profits of forestry activities. Samuelson (1976), in his analysis of the famous Faustmann formula of 1849, showed how from an economic perspective, at positive realistic interest rates, there should be no sustained forest yield in native forests, and no sustainable forest management as defended by foresters. Because of the long rotation periods for timber production and the compound interest applied in the economy, the forest activities which depends mainly on timber selling are not competitive in comparison to other economic activities. He concludes that in a *laissez-faire* economy, the low profitable forest activity will not exist, unless government keeps the responsibility to manage or protect them for the society's welfare.

"We have seen that the rotation age in the virgin forest is greater than what competitive enterprise will countenance. Indeed, where it not that, so to speak by accident, historical governments own much timber land, there would be even fewer trees in North America today. Our analysis warns that applying what is sound commercial practice to government's own utilization of public forests, or what the same thing, renting out public land to private lumbering interests at the maximum auction rent competition will establish – this is a sure prescription for future chopping down trees" (Samuelson 1976).

Thus although activities such as forest protection, sustainable forest management and forest enrichment ensure the provision of ecosystem services from forests which are highly valued by the society, non-sustainable land uses remain. From an economic perspective, these is due to the lack of consideration of several values (especially indirect use values, the option, existence and bequest values) in the calculus of decision agents. Below, it will be explained why these indirect effects of a forest sustainable activity are not taken into consideration in the economic agents valuations.

### Externalities, public goods, and market failure

Many of the ecosystem services forests provided to the society do not find a market. Thus these benefits for the society do not become financial benefits for the providers of the services and these, in taking their decision about which land use to adopt, do not consider these benefits in the valuation they conduct in the decision process about land use alternatives. The reason for this problem is explained below.

Forest ecosystem services are characterized from an economic perspective as positive externalities (Landell-Mills and Porras 2002; Campos *et al.* 2005). Externalities are non-intentional effects that arise from the production or consumption choice of an economic agent. They can be either negative, such as the effluents released as a by-product from a chemical company's production, or positive, such as the ecosystem services that are provided through the sustainable management of a forest or its protection.

In addition, forest ecosystem services have the nature of public goods, being a special class of externalities. These are identified by its non-excludability and non-rivalry properties. The first property denotes the impossibility (or for the prohibitively expensive possibility) of excluding someone from benefiting from ecosystem services. The second refers to the absence of competition in the consumption of the services. Due to these characteristics there is an absence of property rights to the ecosystem services (Fig. 5).

Accordingly, a free-rider dilemma arises. Although agents enjoy and value the consumption of the ecosystem services, since they cannot be excluded from enjoying the service and in addition the competition do not diminish the benefits they obtain from the services, individuals do not have an incentive to pay for them. They expect others to pay for the services and that they can consume them anyway.

Consequently, the willingness to pay tends to zero (Landell-Mills and Porras 2002). As market prices are the market signals that drive the economic decisions of producers and consumers in an economy, if the prices do not reflect the scarcity of the goods and services, there is thus a disturbance in the market systems (Pigou 1920, cited after Costanza *et al*. 2001: 45). There is though a failure in the caption of financial benefits of providing ecosystem services by forest owners and producers (ITTO 2004). In the case of the ecosystem services from forests, this disturbance causes the tendency for undersupply of the services. As a result, despite the high economic value of the forest ecosystem services contributing to the societies' welfare, the existing demand for the services is not reflected in the existence of a market and in the price system.

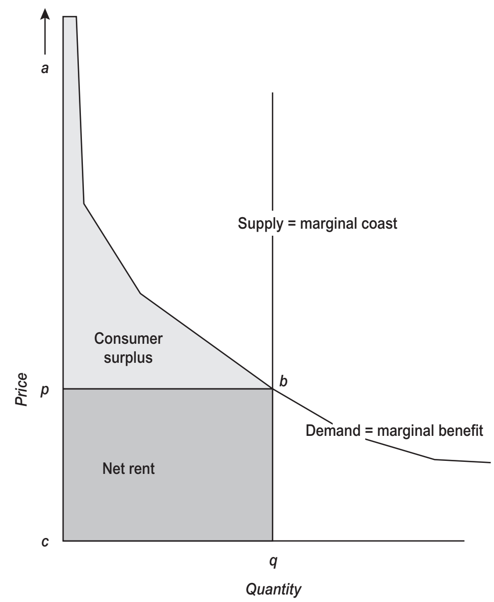


Fig. 5. Demand curve for ecosystem services (Costanza *et al.* 1997)

All in all, consumers benefit from the provision but do not pay for the consumption. And producers do not get paid and do not have incentives to produce more ecosystem services. As a result, unsustainable land uses have a competitive advantage against sustainable land uses. Thus, individuals do not have incentives to invest in protection, establishment and sustainable management of forests, with the aim to produce ecosystems services, which consequently leads to a lack of ecosystem services supply. This consists in a market failure where markets do not allocate forest goods and services in an efficient way. It is thus necessary that governments intervene in the markets so as to avoid overuse of the forests and undersupply of forest ecosystem services.

## Dealing with the market failure related to the ecosystem services

To solve the market failure related to the tendency of undersupply of ecosystem services, instruments of environmental policy emerge. There are two main groups of instruments which governments can use: command and control and economic instruments.

Command and control are regulatory instruments which determine the technical parameter for the economic activities in order to achieve the expected goals of the policy (Seroa da Motta 2005). Examples of command and control instruments are rules and laws that establish the level of pollutant gases companies are allowed to emit and laws restrict deforestation, such as the law from the Brazilian Forestry Code that only authorizes properties in the Brazilian Amazon biome to clear a maximum of 20% of forest cover to undertake other activities. The other 80% should be preserved as legal reserve (reserva legal) and cannot be used unless there is a forest management plan approved by the state. Generally each economic actor should achieve the same targets posed by command and control instruments, independently of their level of costs to do so (Seroa da Motta 2005). The non-fulfillment of the rules leads to sanctions.

To implement command and control instruments it is necessary to have a well established state apparatus. Moreover, it is argued that the implementation is often costly to monitor and to enforce. In combating air pollution in the USA, regulatory methods showed to be on average six times more expensive for the State to implement than economic instruments as to achieve the same goals of the environmental policy (Tientenberg 1990, cited after Barde and Smith 1997). In a world where States face financial budget constraints, there is a tendency to search for less costly instruments (ITTO 2004).

Alternatively, economic instruments modify the structure of costs and benefits of alternative actions open to economic agents (OECD 1994). They aim to change the relative profitability of the diverse economic activities in order to influence decision-making and behavior with regards to the environmental impact so as to achieve the policy goal. In comparison to the command and control instruments, they are more flexible in the sense that they allow agents some freedom in deciding how to respond to certain stimulus in a way that it is more beneficial for them (OECD 1994). Hence, they are more efficient and generate a better allocation among agents.

This is based on the concept of internalization of the externalities. This means that economic agents should incorporate either costs or, in the case of ecosystem services, the benefits of activities with environmental impacts to their decisions. Two main alternative approaches to internalizing externalities can be distinguished, the "pigouvian" and the "coasean" (Daly 1999).

On the one side, the Pigouvian approach suggests the imposition of taxes or subsidies so as to compensate the environmental cost or the benefit (Pigouvian Tax). This tax should correct the gap between social cost (or benefit) and private cost (or benefit) (Daly 1999).

On the other side, Coase advocates for definition or redefinition of property rights to the externalities so that later bargaining among private citizens will lead to the incorporation of formerly external costs in decisions (Daly 1999). Through this concept, for example, a pollutant chemical company would need to consider the costs for cleaning the water before releasing it to the water flows to the price of its products, thus internalizing negative externalities of the chemical industry activity, whereas a sustainable timber company could add the benefits that arise from the sustainable forest management to its timber selling prices or would sell directly the ecosystem services resultant from the sustainable forest management activities. In undertaking this, they internalize the positive externalities of the forest management activity. In both cases, property rights are conferred to the environmental costs or benefits (cited after Costanza *et al.* 2001).

Case advocates that the definition of property rights to externalities should make consumers pay for the consumption of them and producers to receive for the production of them. Once this supply and demand appears, ecosystem services' consumers (in the example, the chemical company) and suppliers (the sustainable timber company) come together and ecosystem services are traded and a market for ecosystem services is established. Thus, since markets are considered the most efficient institutions for allocating resources, one would expect the outcome of the market transactions to maximize the aggregate social gain in a society – achievement of the environmental goal at the lowest possible costs (Felder 2001).

In the case of the ecosystem services from forests this would mean defining property rights to these, consequently creating markets for them and letting the services to be traded. In the production side, assigning property rights in this context mean defining ecosystem services to be produced and defining rules of production for them. On the demand side, it means defining that consumers should pay for the services they consume and how they should do it.

A hypothetical example could occur in the case of carbon sequestration. Regulation could define that a certain area of forest binds certain amounts of carbon. A family living in a forest area and which makes sure this area is preserved instead of burnt could arise as supplier of carbon credits and should get paid for it. On the other side of the chain, a company which emits carbon as by product of its production may have to buy the sequestration of carbon if it exceeds the emission levels allowed by a certain regulation. The company would be the buyer of the ecosystem services[6]. This approach has been discussed in the last few years as the most efficient solution to address the problem of the provision of ecosystem services. This is the background of the idea of the payment for ecosystem services.

## Payments for ecosystem services

Payment for Ecosystem Services – PES – aims to address the market failure regarding ecosystem services, characterized by the lack of interest in sustainable forest and land use management activities and hence the tendency for undersupply of ecosystem services from forests due to lack of economic incentives to provide these positive externalities. PES expects to change the structure of incentives so as to influence the relative profitability of these economic activities by rewarding the producers which provide ecological benefits for the society (Campos *et al*, 2005). This way it should ensure the provision of ecosystem services in the society and provide the providers of sustainable land use activities with extra income, following the principle of the "protector receiver" (Born and Talocchi 2005).

### Background for PES

In the past, economic instruments of environmental policy have been mainly used to achieve reduction on the levels of pollution, effluents or environmental damage, thus implemented in order to diminish the environmental bad following the *polluter pays principle* (Seroa da Motta 2005). Through this concept polluters should bear the costs of pollution by implementing technologies with fewer environmental impacts, or by paying the government in form of taxes or charges for them to solve the environmental problem. Economic instruments offered often the possibility for the pollution permits to be traded. Thus, polluters could buy permits from other economic agents who could reduce environmental damage at lower costs.

Another type of instruments followed the *principle of the common burden* (Seroa da Motta 2005). Through governmental subsidies a strategic activity with essential environmental benefits was financed or the costs of handling environmental costs were taken by the government in order to achieve the goal of the environmental policy.

Today, especially in dealing with topics where the costs to revert an environmental damage might be too high, as expected for climate change, or the risks are too high, as in dealing with the biodiversity loss, a new approach emerges. The Rio Declaration on Environment and Development calls the *precautionary principle*, in order to avoid irreversible losses. New approaches arise, aiming to beneficiate and support the environmental good following a new principle of the "protector receiver" (Born and Talocchi 2005). The new idea is to reward providers and protectors of ecosystem services, paying for them to ensure the supply of ecosystem services for the society.

Considering the fact that people living in forest areas are often poor, the instrument also aim to promote better living standards for the rural and poor people, thus contributing to the sustainable development of rural forest areas.

[6] Note: this is still a hypothetical example, as there are no markets for carbon coming from avoided deforestation yet.

This is the rationale behind the payment for ecosystem services and it follows the proposal of the Coase Theorem of assigning property rights to the externalities to solve the market failure (Felder 2001).

## PES definition

Until this date, there is no established definition of PES, due to the initial stage of the schemes around the world and the high diversity of the experiences (Landell-Mills and Porras, 2002; Campos *et al*. 2005, Wunder 2005). In this article the definition proposed by Wunder (2005) will be used. According to it, PES is described as:

1. "a voluntary transaction where
2. a well-defined ES (or a land-use likely to secure that service)
3. is being 'bought' by a (minimum one) ES buyer
4. from a (minimum one) ES provider
5. if and only if the ES provider secures ES provision (conditionality)"

Wunder (2005) recognizes that in the PES schemes around the world, there are very few ones which accomplish all criteria and the schemes can thus be seen more as PES-like schemes. Nonetheless, the definition is useful in order to differentiate the instrument from other instruments of environmental policy.

The voluntarily characteristic of PES differentiates it from command and control instruments (Campos *et al*. 2005) and presupposes that the suppliers have alternative land use choices (Wunder 2007).

Moreover, in a PES scheme, the ecosystem service has to be well defined. There must be a "product" than can be traded. In that case, the product need to be identified and should be able to be measured, for instance an additional ton of carbon stored. It can alternatively be a land use which is likely to provide the product, for instance a piece of tropical forest conservation protects the habitat for a specific animal. The definition of this product is necessary so that trading can take place. Landell-mills and Porras (2002) call these products the "commodities". To define the commodity and bring it to the markets is one of the most challenging aspects of market creation (Landell-Mills and Porras 2002). Today, there are quite a few different commodities to commercialize the environmental services. Often they were created by regulatory frameworks such as the Kyoto Protocol and carbon credits. In addition, there must be buyers and suppliers for the services. In order to overcome the free-rider dilemma, regulatory frameworks, agreements are necessary, although there are also volunteer contracts happening in the world.

The last characteristic of the PES scheme is that the payment for the ecosystem service should be contingent to the provision of the service.

## Existing markets for ecosystem services and their drivers

In a review of 287 cases, Landell Mill and Porras (2002) identified four types forest environmental services (here ecosystem services) which are being traded: 1. Landscape beauty; 2. Biodiversity protection; 3. Watershed protection; 4. Carbon sequestration and storage. Moreover, bundled services are also being traded.

The demand may be formed through private preferences, such as the demand for landscape beauty or watershed protection, or public preferences such as for species protection (Wunder 2007). Demand may also be formed by regulations and agreements such as in the case of the carbon markets formed by the Kyoto Protocol. In contrast, the supply depends on the actors willingness to manage forests in a sustainable way, establish afforestations or reforestations, agro-forestry systems, and second forests enrichment so as to provide ecosystem services from forests.

## PES schemes

PES schemes can assume different forms. There are three main categories which Wunder (2005) suggests in categorizing them: 1. area vs. product based schemes; 2. public vs. private schemes; 3. use-restricting vs. asset building schemes. First, area based contracts rewards an area with a certain land use type capable of providing ecosystem services while product based schemes relies on a "green" price premium for products or services which are certified to have environmental friendly production patterns (organic fruit production) or which minimizes environmental damages (certified timber from reduced impact logging, tourism).

Second, public schemes are described as those which the State coordinate the payment to the sellers of the ecosystem services being responsible to raise the funding to realize the payments. The State is an intermediary body which coordinates the mechanism. In contrast, in private schemes buyers and sellers of the ecosystem service have a contract directly.

Lastly, use restricting PES schemes, pay service providers for not undertaking usual activity with environmentally damaging impacts. Examples are suggested payments for avoided deforestation, where it is suggested that communities living in forest areas which, for instance, forego their traditional slash and burn land use patterns are paid for the restriction to their possibilities of land use towards the protection of the ecosystem services. Alternatively, asset building schemes pay for ecosystem services sellers in order that they enhance an ecosystem so that it provides a specific ecosystem services. Examples are payments for forest communities to enrich second forests with native timber species. While in the first case payments are mainly based on the opportunity costs a family incur in, it is paid for the net environmental benefit (Garcia *et al.* 2004).

### Payment methods

The payment for ecosystem services can occur either through cash or non-cash. The non-cash payments can be made, for instance in form of development projects, technical assistance, building of infra-structure, etc. (Wunder 2005). Non-cash payment could be adequate in scenarios where local capacities for savings, investment, and entrepreneurship are limited.

## Methods

The research objective of the master article is to provide an overview about the contribution possibilities of the PES for the sustainable development in the Brazilian Amazon and will be accessed through a literature review. The analysis of the PES schemes is made under the optic of the ecological economics theory, complemented by a current literature review of the existing PES initiatives in the tropical forests.

## Results and discussion

### Can PES contribute to sustainable development in tropical forest regions?

Payments for ecosystem services have been implemented in diverse tropical forest regions in the world. It is expected that PES can be a tool to promote development in poor tropical forest areas at the same time that it conserve these high valued forests.

Based on the theoretical background provided above, this section provides some reflections about the literature regarding the potentials of the PES to contribute to sustainable development in tropical forest regions. PES will be analyzed with regards to the three economic goals related to sustainable development proposed above of efficient allocation, fair distribution, and sustainable scale.

Although PES schemes in implementation are not pure market instruments, this analysis will be based on the theoretical concept of PES as a market oriented approach to access the potentials and limitations of such an instrument.

### Allocation

Coase (1960, cited after Felder 2002) advocates that defining property rights to externalities and thus creating a market for them and let them to be allocated by the markets is the most efficient alternative to solve the externalities problem. The relative prices determined by supply and demand on competitive markets will lead to an efficient allocation. According to the Coase theorem, under the assumption of no transaction costs, this mechanism allocates the property rights efficiently leading to maximum welfare gains, independently of the distribution of the property rights.

Here it is argued that, similarly to the trading pollution permits, PES could provide a tool to reduce the costs to achieve the environmental goal through assigning the property rights to the ecosystem services. Once there is a market for ecosystem services, the markets would allocate efficiently bringing those actors to produce the ecosystem services which have lower costs to do so.

Tietenberg (1993) shows the advantages of the application of this approach to combat air pollution in the USA. There a cap for air pollution has been set and the firms were given pollution permits which could be traded. This policy made industries which could control their emissions cheaply change their production patterns to adopt new technologies and reduce emissions and sold their emissions credits. Other plants, which had higher costs to change their technologies to reduce their emissions did not change their patterns and bought pollution permits from other companies. Thus, with a limited number of emission permits, the emissions stayed under the level expected and achieved the goal at lower costs.

Chomitz (2007) shows how the carbon markets could achieve higher emission reductions at lower costs if the avoidance of deforestation would be considered in the carbon markets. He shows how already at modest carbon prices of USD 10 per ton, would make deforestation unprofitable in many land use systems in the tropics and could deter the conversion of 1 to 2 millions of $Km^2$ of forests by 2050, preventing the release of 8-15 billions of tons of $CO_2$. He reminds that any action that keeps a ton of carbon out of the atmosphere has the same effect towards mitigating climate change, independently of where it is done. If this policy would bring on the one hand benefits for tropical countries with the consequent financial flow, with the lower prices related to the higher offer of carbon, countries could than have higher reduction targets at the same price.

It is here argued that PES schemes follow the same approach as proposed by Coase. Therefore, it should be expected that the PES can be a good tool to ensure ecosystem services supply through defining property rights to the ecosystem services, consequently creating markets for them, and letting them to be traded. This would lead the maximum welfare gains in the society by produce the expected level of ecosystem services at the lowest costs. Through the markets, once the price for the ecosystem services is determined, only those agents who have ecosystem services production costs lower than the market prices will produce, reducing the costs for the production of the environmental goal.

The current markets for ecosystem services from forests are though very incipient (Landell-Mills and Porras 2002). The definition of property rights require though first, that it becomes clear to what the property rights are being assigned, how many property rights, and to whom these shall be distributed. Differently than the carbon markets and the air pollution trading cited above, the definition of the property rights in the PES schemes lays far behind the above mentioned examples.

First, there are still uncertainties regarding the relation between the forests and the levels of all ecosystem services it provides, regarding which land uses and forest management types provide which ecosystem services. Moreover, it is still not clear who should confer the property rights to the actors. It is necessary to advance in this field for the markets to develop.

In addition, the markets for ecosystem services from forests are driven by the buyers of the ecosystem services, mainly governments, private companies, and NGOs (Landell-Mills and Porras 2002). The prices in the markets are mainly determined by the willingness to pay of these actors. This does not solve the free riders problem related to the ecosystem services and the prices do not reflect the marginal benefit provided by the ecosystem services. It is still necessary to create demand to the ecosystem services and regulatory instruments might be needed such as happened in the Kyoto Protocol, where emission reduction targets were set.

Last, it is necessary to know how much of the ecosystem services are needed for human welfare. This question will be handled under the scale topic.

Important to consider is that market success may depend on the support from a range of local hierarchical and cooperative institutions such as regulatory agencies, trading platforms, certifiers and insurers among other institutions (Chomitz 2007). These constitute some of the transaction costs existent in establishing such a market. Coase advocates that, in a world with transaction costs, the welfare gains will depend on the distribution of the property rights (Coase 1960, cited after Felder 2002). In this case, Coase argues that governments should be the best instance to assign property rights in order to achieve the maximum gains form the markets.

In conclusion, PES schemes have a high potential to provide an efficient allocation of ecosystem services. The efficiency depends however on the assignment of the property rights to the ecosystem services. PES schemes in forestry are still very incipient and should develop in this field thorough a higher understanding about the benefits forests provides to humans, the economic benefits, through determining who are the consumers of ecosystem services, and the quantity of ecosystems services necessary for human well being.

### Distribution

Beyond the goal of efficient allocation, for PES to contribute to sustainable development, it is necessary that it contributes to social fairness. Following the concept above, PES have potential to provide allocation benefits, however this does not mean that these benefits will be fairly distributed. The welfare enhancement mentioned by Coase is the result of the social benefits minus the costs, independently of if some actors have a greater share from the benefits and other from the costs. Therefore, although assigning property rights to the forest environmental benefits and letting them to be traded will according to his theory enhance the aggregate well being in a society, the distribution of costs and benefits is not considered (Felder 2001, Daly 1999). Thus, while the approach is capable of maximizing the social gains, it is unclear if it is socially fair. It becomes clear that allocation and distribution are two different problems that have to be tackled by two different instruments (Daly 1999). It should therefore not be expected from PES that it will bring a fair distribution as an obvious outcome. Below the potential of PES to contribute to social fairness is separated in: intergenerational, intragenerational, and international fairness.

### Intergenerational fairness

The intergenerational fairness will depend on the ecological sustainability provided by PES, in other words, if the instrument is capable of maintaining a level of ecosystem services for the actual generation without implying in a lack of ecosystem services for the next generations. It depends therefore more on the ecological impacts of the instrument than on the social fairness issue and thus will be discussed below under the scale topic.

### Intragenerational fairness

In the last years, several scientists analyzed the potential impacts of PES systems with regard to the intragenerational fairness, especially with regard to poverty reduction. Especially tropical forest regions were a concern because many poor people live there.

The theory which advocates the definition of property rights for the externalities already brought up the issue that the markets, although highly efficient to allocate the property rights so as to maximize the aggregate welfare gains in a society is not the adequate instrument to ensure that the division of the gains and losses are fair. This problem was raised by Coase (1960) and Daly (1999) in an analysis about pollution trading permits.

Studies about PES schemes being implemented prove this reality. They suggest that it is very unlikely that those PES schemes which are focused on efficiency as primer goal will beneficiate poor and weaker actors instead of more powerful and richer actors (Landell-Mills and Porras 2002, Wunder 2005, Alix-Garcia *et al.* 2004).

In their study about three types of PES schemes in Mexican common property forests, Alix-Garcia *et al.* (2004) demonstrate how the most egalitarian PES scheme is also the less efficient in terms of environmental benefits per dollar paid. On the contrary, the scheme which aims to maximize the environmental benefits per dollar paid, in other words, the most efficient allocation, is the less egalitarian scheme. In designing a PES instrument, it should be clear that a trade-off between efficiency and distribution may exist as suggested by Alix-Garcia *et al.* (2004) and that to balance between these goals is necessary.

Studies pose the risks involved once the ecosystem services production turn to be an interesting economic activity, powerful groups can start to claim land of the poor to receive the payment for ecosystem services. This risk is especially high in tropics, where landownership is usually not formalized, (ITTO 2004, Landell-Mills and Porras 2002).

Moreover, ecosystem services markets pose other risks to poor people living in forest areas. Reminding that 90% of the poorest people depend on forests for their livelihoods, there is the risk that the PES restrictions endanger their food security and safety net (ITTO 2004). Poor people may face also other constraints such as the lack of access to markets or the lack of capabilities to deal with the emerging bureaucracy which these markets may require (ITTO 2004, Wunder 2005). Other complementary policies might be necessary in order to guarantee that the poor will beneficiate from the markets might be necessary such as enhancing capabilities, providing supportive institutions (Landell-Mills and Porras 2002).

According to Chomitz (2007), it is the assignment of rights which will determine who wins and who loses. The solution to the deforestation and poverty issue in this case will revolve on the allocation and enforcement of rights. He suggests that "strong, equitable institutions" are necessary to deal with the social fairness problems.

The issue regarding the distribution of property rights had already been raised by Daly (1992, 1999). According to him, PES in the sense of markets cannot solve the distribution problems per definition. However, it could beneficiate or not the weaker actors depending on the initial distribution of ownership of the new assets.

Governments need in this case to ensure the equity by providing the regulatory framework but especially by ensuring property rights of the poor so that the PES benefits the weaker actors more than the stronger (Landell-Mills and Porras 2002, Chomitz 2007).

### International fairness

Fairness is also a problem in talking about wealthier and poorer nations. While interest for the PES systems surged also because of their potential to promote a financial flow from the high income countries, mainly the ecosystem services consumers, to several middle and low income countries which are ecosystem services providers, it is still not clear whether the instrument will beneficiate the poorer more than richer countries.

Table 2 shows how high income countries consume per capita more than three times as much biocapacity as middle income countries and eight times as much biocapacity than lower income countries. Figure 6 shows the proportion each country is using from its national biocapacity and if the country is a biocapacity debtor or creditor. It shows that the main debtors of biocapacity in a national scale are mainly the higher income countries, the Middle East, China and India.

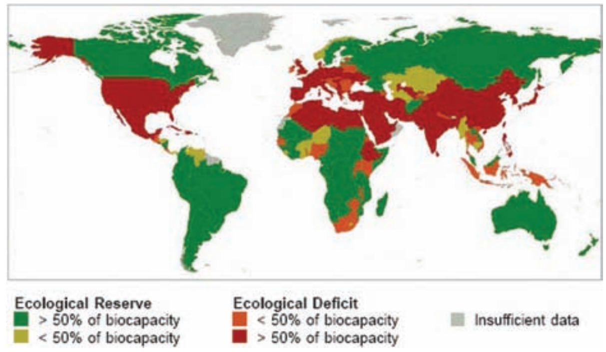


Fig. 6. Ecological creditors and debtors (Global Footprint Network 2007)

The national use of the biocapacity is the relation between the average levels of per capita consume of biocapacity multiplied by the population and the country's total available biocapacity (Global Footprint Network 2007). Most of the European countries and the USA are consumers of biocapacity, consuming more than 50% beyond of what they have available. Canada, Australia, and Finland, despite having high levels of per capita

Tab. 2. Per capita ecological footprint by country

| | Population | Total Ecological Footprint | Total Biocapacity | Ecological deficit (-) or reserve (+) |
|---|---|---|---|---|
| | (millions) | (global ha/person) | (global ha/person) | (global ha/person) |
| World | 6.301,5 | 2,2 | 1,8 | -0,5 |
| High income countries | 955,6 | 6,4 | 3,3 | -3,1 |
| Middle income countries | 3.011,7 | 1,9 | 2,1 | 0,2 |
| Low income countries | 2.303,1 | 0,8 | 0,7 | -0,1 |
| Africa | 846,8 | 1,1 | 1,3 | 0,2 |
| Asia-Pacific | 3.489,4 | 1,3 | 0,7 | -0,6 |
| Latin America | 535,2 | 2,0 | 5,4 | 3,4 |
| Middle East and Central Asia | 346,8 | 2,2 | 1,0 | -1,2 |
| North America | 325,6 | 9,4 | 5,7 | -3,7 |
| European Union (EU25) | 454,4 | 4,8 | 2,2 | -2,6 |
| Rest of Europe | 272,2 | 3,8 | 4,6 | 0,8 |

(Global Footprint Network 2007)

consumption of biocapacity, are suppliers of biocapacity as they consume nationally less than they have in biocapacity. This is due to the fact that these countries are very large, have many reservoirs of natural resources and are not dense. China and India are the opposite examples. They have a very low per capita use of biocapacity in comparison with the world mean; however, due to their huge populations they are overusing their national available biocapacity.

Based on the table 2 and on the figure 6 one can conclude that, with the expressive exceptions cited above, middle and low income countries are providing high income countries with biocapacity. As a consequence, would an ideal PES instrument exist, a flow of financial resources would go from richer to poorer countries, especially from Europe and the USA to Latin America and Africa.

In this context, PES could be a good tool to promote international fairness in case the countries would consider the availability and the use of biocapacity, of which a great part are ecosystem services from forests (see section 2), into their accounts. In this case, the nations could trade their exceeding biocapacity with countries which extrapolate their biocapacity. Countries in Africa, and Latin America with tropical forest areas would arise as ecosystem services suppliers together mainly with Russia, Canada and Australia, and some Asian countries and could raise funds for ensuring the provision of the ecosystem services from forests providing a financial flow from mainly richer to poorer countries.

Accordingly, the USA, Europe, Middle East and the greater part of Asia would emerge as ecosystem services consumers. The countries would than need to promote either a population policy, especially in the case of the far eastern countries, or a consumption restriction policy, especially in Europe and USA or would need to buy biocapacity from other countries. It is important to see that these assumptions require the existence of a set cap for ecosystem services use, an agreed scale of the economic system, as will be discussed in the following section.

The above mentioned perspective suggests the idea that there is a high potential for tropical countries with large forest areas in Latin America and in Africa, to be suppliers for ecosystem services, and thus to benefit from the selling of these.

Despite of this potential, studies show that in fact, the high income countries will be the ones to beneficiate at most from the ecosystem services markets. Bosello and Roson (1999, cited in Landell-Mills and Porras 2002) estimated through a model the per capita economic welfare benefits carbon markets will provide to the USA, the EU countries, China, and the rest of the world. Their estimation suggests that in a context where global trading and banking is permitted, the per capita welfare gains due to the carbon markets would achieve US$ 278 in the USA, US$ 305 in the European Union countries, US$ 6 in China and USD 12 in the rest of the world. In this model, the gains of the USA and EU with the trading, although they are the main emitters from $CO_2$, are at least 23 times higher than that of the rest of the world. Although there are diverse assumptions behind the calculations, it exemplifies that it is very likely that richer countries beneficiate more from the markets than the poorer ones, contradictory to the idea that the markets would beneficiate more developing countries as ecosystem services providers.

### Scale

The question now is whether PES and the consequent creation of markets for the ecosystem services can contribute to ensure that the economic systems guarantee a minimum level of ecosystem services maintaining the carrying capacity of the earth for this as well as for the next generations. In other words, if with PES the level of ecosystem services provided in the aggregate is the desirable one.

The ecological pillar of the sustainable development paradigm has not been analyzed as such in the literature reviewed. The ecological sustainability has been mainly analyzed as whether the implementation of PES promotes an efficient allocation by reducing deforestation at lower costs. It has not been assessed whether PES contributes so that a minimum level of ecosystem services is provided.

Some risks to the ecological effects though have been raised by Wunder (2005), Chomitz (2007), ITTO (2004). These authors posed the risks of the leakage effects in which the conservation could raise the prices of the products which are not being produced anymore (such as cattle) leading other actors to invest in the activity. These effects can occur because of two problems of the markets, which are explained below.

Landell-Mills and Porras (2002) raises the problem that the markets for ecosystem services from forests today are still driven by demand, due to the non-excludability of consumption of the majority of services provided. The prices depend on the buyers' voluntary willingness to pay leading to prices which still do not express the marginal benefit of the actors in consuming the ecosystem services. Ecosystem services from forests are thus not considered in the economic decision of the majority of the actors and it is unlikely that these markets will lead to the sustainable scale of the economic system.

Daly (1999) argues that the markets per definition do not solve the mentioned problem of achieving the sustainable scale of the economic system as the instrument, as it is its aim. Here it is argued that the markets as such cannot lead to a sustainable scale of production of ecosystem services.

Therefore, as advocated by Daly (1999), before assigning property rights it is necessary at first to know the scale. This presupposes the questions: how many property rights should be assigned? What is the environmental goal? Which ecosystem services from forests should be produced, at what quantity? Which leads to the question: which kinds of forests or forest management areas are capable of providing these? Leading finally to the question: how much of the tropical forests should be conserved?

Daly (1999) defends the one advantage of the tradable permits instrument in that it enables the decision about the scale before the property rights are distributed. One example of such a market is the carbon market created by the Kyoto Protocol. This agreement between nations determined green house gases reduction targets for the Annex B countries and promoted instruments for emissions to be traded. The protocol thus determined the scale, distributed the responsibilities between the countries, and then let the markets allocate efficiently.

This approach could also be implemented for the other ecosystem from the forests, determining the minimum forest areas that should remain to supply the ecosystem services expected.

The findings from the study demonstrate that the payment for ecosystem services as a market approach can contribute to sustainable development, however only if the markets are constrained by distributional and scale issues. Pure markets for ecosystem services are unlikely to solve the distribution and scale issues.

As a market approach, PES is by definition the best instrument to allocate efficiently. However, it does not necessarily lead to a fair distribution. Therefore it is necessary that in the distribution of property rights, the poorer and weaker actors are considered and that extra policies ensure that they benefit from the markets.

These results show similarities to Wunder (2005), Chomitz (2007), Landell-Mills and Porras (2002), Alix-Garcia *et al.* (2004). These authors showed how stronger actors may have a higher share of gain in these markets, in the absence of specific policies aiming a fairer distribution. Alix-Garcia *et al* (2004) show that most efficient PES schemes are also the less egalitarian ones, thus leading to a trade-off between the goals of efficient allocation and fair distribution.

The authors above illustrate that in the case of tropical forests, to ensure that the poorer and weaker actors benefit from ecosystem services markets it is necessary to ensure their right to land, their right to the ecosystem services, enable the access to the markets, provide the training and education necessary so that they can produce the ecosystem services and also that they can deal with the emerging markets. Moreover it is important that the ecosystem services markets do not pose a threat to poor people's livelihood. The access to the forests and its goods and services must be ensured and food security cannot be endangered.

From the perspective of an international fair distribution the results demonstrate that many tropical countries especially in Latin America and in Africa could benefit from ecosystem services markets by being sellers of ecosystem services. The forests play a key role in providing these services.

Despite these advantages suggested by this study, some studies illustrate that the gains from ecosystem services markets should benefit mainly the richer countries Cosello and Roson (1999, cited after Landell-Mills and Porras 2002).

Here it is suggested that in defining the rights to the ecosystem services and in establishing the markets, international fair distribution should be considered, as called by the Rio Declaration on Environment and Development.

This study also shows that it should not be expected that pure markets for ecosystem services will lead to the sustainable scale of the economic system. The reality of the PES schemes is that, in fact, there is still no agreement regarding the levels of forest ecosystems services to be provided. There is still no created demand for the forest ecosystem services and it is therefore not clear who should pay for their use. The drivers of these markets are still the buyers. Differently from the carbon markets, where property rights are somehow more precisely defined through an overarching international agreement, the markets for the other forest ecosystem services are mainly determined by the willingness to pay of the interested buyers of ecosystem services, such as governments, non-governmental organizations, or private companies (Landell-Mills and Porras 2002).

However, it is important to remember that the studies did not handle the question of the scale as such. Studies of PES focused mainly on the efficient allocation question, proving that the PES is an instrument to protect ecosystem services at lower costs, than whether PES can contribute to the sustainable scale of the economic system guaranteeing a level of supply of ecosystem services.

These results suggest that the scale cannot be set by the markets and thus it is necessary to define the sustainable scale from the international perspective. It is necessary to know how much of which ecosystem services from the forests men need.

Once the scale and the commodities are defined, PES can be a good tool for sustainable development. After a level of production of ecosystem services is established, one can define how much of the forests, and which forests should be preserved. This is an important direction for suppliers to know what to produce. On the demand side, the assignment of property rights to the consumption of ecosystem services would oblige consumers to pay for it. After the scale (and a limit of consumption by country or by person for example) is set, the countries who want to consume extra amounts of ecosystem services should buy it from countries (persons) which have extra ecosystem services to provide. In the aggregate, the level of ecosystem services provided will be the one set by the international community, corresponding to the sustainable scale. This would be similar to the Pollution Trade markets set by the Kyoto Protocol.

These results suggest that the markets for ecosystem services can support sustainable development, acting similarly to the markets for pollution trading schemes which lead to the reduction of pollution levels in the USA. However, these markets need to be constrained by the scale question first, by the distribution question second, and only then can they be freely and efficiently allocated.

## Conclusion

The payment for ecosystem services is being implemented in several tropical forests in the globe with the objective to provide economic benefits for the people who ensure the maintenance, protection or the establishment or reestablishment of tropical forests. It aims to provide an incentive for people to conduct sustainable activities instead of degrading or converting these forests at the same time that it aims to provide some economic benefit to the mostly poor people living in these forest areas.

Through the PES instrument, markets with buyers and sellers of ecosystem services are evolving in the actuality. The idea is that in an ideal stage, consumers of ecosystem services will pay for the ecosystem services they consume from forests, and sellers will have a financial benefit to invest in protection, establishment of forests or other sustainable land use patterns such as agroforestry systems. At the end, all actors would consider the environmental impacts of their activities in their decisions, thus internalizing the externalities of their actions (being these either positive or negative).

The markets for ecosystem services are however very incipient in the world and the impacts of the PES towards sustainable development are still unclear. There are several concerns related to the distributional and ecological effects of this instrument.

This article analyzed the potentials of PES to contribute to sustainable development in the Brazilian Amazon from ecological economics perspective. It shows that defining property rights to the ecosystem services, creating markets for them and allowing them to be traded is the most efficient alternative to solve the market failure related to the ecosystem services, being able to provide the greatest level of ecosystem services at the lowest costs.

However, this approach is not likely to address distributional issues properly (neither in the national nor in the international or intergenerational levels) and in addition, the markets will most probably not solve the scale problem. This problem is almost not handled in the economic mainstream literature.

The results suggest that the actual model of payments for forest ecosystem services are still driven by the willingness to pay of governments, NGOs, and some private actors. These markets are created by the definition of a price by the buyers. Although the markets may lead to the correct direction of sustainable development by stimulating the production of ecosystem services in some forest areas, it is still an incipient initiative to create complete markets for ecosystem services. The prices still do not reflect marginal costs of producers and marginal benefits of consumers.

As there is still no obligatory demand for the ecosystem services determined by the scale limit and by the distribution of the rights for the ecosystem services, there is still no solution to the free riders problem and the ecosystem services are still not considered in the economic decisions of the majority of economic agents in the world. Thus, it is unlikely that these markets will lead to an efficient allocation, although they are already more efficient than in the complete absence of PES. These markets will not lead however to a sustainable scale, since the scarcity is not reflected in the prices of ecosystem services and the majority of the consumers can still consume them for free – leading to an over consumption of these. Producers also do not benefit from ensuring ecosystem services supply and there is a tendency for the undersupply of the services. Policy and governance instances, especially the international policy processes related to forests should raise these points for the ecosystem services from forests issues to come to the agenda. It is necessary to set international and national regulations to achieve the sustainable scale.

Economic theory already showed that a market approach will not be capable to solve the distribution problems. Therefore, it is necessary that complementary instruments are created to promote fairness from a local as well as from the international point of view. In dealing with forest and poor rural people, it is necessary to know their limitations regarding their capacities to implement the land use systems demanded for ecosystem services supply, their lack of secure land tenure, difficult access to markets, among other. Moreover, their livelihood should not be endangered by the instrument, which could happen in case it poses high restrictions to the use of the forests, forest resources or forest land. The distribution of the rights is decisive for the distribution issue. Therefore, in distributing the rights, governments, governance instances should take the issue into consideration and promote regulations and rules to stimulate a decrease in the levels of inequality in the society.

The fair distribution needs also to be thought in an international level. The international community must evaluate who are the consumers and the providers of ecosystem services and the property rights to the positive and negative externalities need to be assigned to the actors and nations. In this sense, it is necessary the international negotiations develop and enhance the knowledge about what role forests play for human well being. It is necessary to work further towards a forest convention.

Science should work towards answering questions such as how much it would costs if technologies available would need to substitute the ecosystem functions from forests? Are they really capable to substitute forest functions? What are the limits? Which is the carrying capacity, how much are we using from it? What can be the consequences of the overuse of the forests carrying capacity? Here there is much need for further research.

However, even with advancements in science, it cannot answer everything. And whether there is risk of irreversible harm, it is important to remember and reinforce the precautionary principle. Since several politicians, scientists and people insist in not to accept the limits of the earth, it will be difficult to come to an agreement regarding the sustainable scale, but it is extremely necessary.

Considering these limitations of a market approach, PES would however have high potentials to contribute to sustainable development in case the markets are constrained by the scale and distributional questions. As tested with the trading pollution permits, to determine a maximum scale for the pollution, distribute the rights to pollute, and let them to be traded showed to be an efficient way to combat air pollution in the United States. Once a level of pollution is determined, the rights to pollute can be distributed considering fairness issues. After that, market allocate efficiently. For instance industries that can reduce its levels of pollution can sell pollution rights to other companies which would have higher costs to change their technologies. In the aggregate, the pollution levels do not exceed the environmental goal and the environmental goal is achieved at lower costs. This is similar to the implementation scheme of the Kyoto Protocol. The problem there is that, although science demonstrates that the levels of green house gases emissions should diminish, politicians insist not to accept more restrictions because of the consequences it would cause to the economy.

The Brazilian Amazon, having the biggest tropical forests in the world which provide many ecosystem services for the whole global community. Brazil has exceeding biocapacity and could therefore consolidate itself as a supplier of ecosystem services worldwide and benefit from selling ecosystem services. This would potentially provide an important revenue source for this economically poor area. However, for the Amazon to beneficiate from the markets it is necessary to further negotiate in international arenas so that the scale is set and consequently the demand for ecosystems from forests is created.

Brazil could however be a pioneer and create such markets internally so as it happens in Costa Rica promoting a fair distribution of the benefits and costs within the nation, the richer and high consuming areas paying for the Amazon to be protected. By having a good and working instrument it is likely that international communities will be more interested in participating of these markets.

But most importantly, Brazil needs to further negotiate in the international arena. The international discrepancies regarding the consumption of ecosystem services needs to be reduced as a manner to ensure a fairer world.

PES can be a good tool to promote sustainable development for the Brazilian Amazon; however it depends on the implementation of such instrument. This article suggest that for PES or ecosystem services markets to contribute to sustainable development it is necessary to consider the three goals of efficient allocation, fair distribution, and sustainable scale – and complementary policies and regulations are necessary for it. PES can be a good tool if the markets for ecosystem services are constrained by the scale question first, by the distribution question second, and only then let the markets to allocate efficiently.

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