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Abstract

All over the world the increasing disappearance of natural habitats and ecosystems is concerning policy makers, populations and nongovernmental organizations. Many ecosystems such as forests are multifunctional landscapes and they provide a range of environmental services (benefits that people obtain from the ecosystem) that are vital for humankind and therefore worth preserving. Payment for environmental services (PES) has been applied increasingly in countries with high conservation concerns. PES is a monetary compensation scheme to "reward" environmental service providers for their actions in protecting the ecosystem. Normally the compensation amount is a random value, based on budget restrictions rather than an accurate sum of social net benefits. This is the case for the biggest PES scheme in Brazil; the Bolsa Floresta program in the Brazilian Amazon forest where the local indigenous populations receive a fixed monthly amount for preserving the forest. The paid fixed monthly value of approximately 30USD may not reflect the true value an Amazonian ecosystem- therefore the purpose of this study.

In a tropical rainforest context, as the Brazilian Amazon, the local population plays an important role when conservation is the final objective of an environmental policy. The decision making process requires an assessment of costs and benefits incurred by the local population. A compensation scheme is often proposed as a solution and part of conservation policy. To assess a fair compensation amount, the economic values associated with those services need to be calculated. Such values are calculated for biodiversity preservation, carbon services and foregone benefits of alternative land use. The selected assessment methodology is benefit transfer, which makes uses of the previously estimated costs and benefits drawn from other studies. Benefit transfer uses economic information captured at a study site to make inferences about the economic value of environmental goods and services at a policy site. The biggest advantage of choosing benefit transfer is to reduce the need for costly and time-consuming original study for non market values. However the disadvantage of the method is the requirement for adjustment due to differences between the study and policy sites. The determinants of willingness to pay for an environmental good can greatly vary according to socio-economic and demographic characteristics.

The optimal payment level is obtained by maximizing the society's net welfare, when marginal values for producing both market and non market goods are equal. On the benefit side, the values were based in previous studies estimates for biodiversity protection and carbon services values were taken from market estimations and international default values. On the cost side, the values were transferred from opportunity cost studies for alternative land use made by Brazilian authors. The choice of using benefit transfer gives access to a broad database but also makes inevitable some degree of imprecision and inaccuracy. The analysis of the studied costs and benefits shows that this PES scheme does not compensate opportunity costs and the optimal payment exceeds current payment schemes.

Abbreviations

BF: Bolsa Floresta (Forest Allowance)

BFF: Bolsa Floresta Familia (Forest Allowance Family)

BFA: Bolsa Floresta Associação (Forest Allowance Association)

BFR: Bolsa Floresta Renda (Forest Allowance Income)

BFS: Bolsa Floresta Social (Forest Allowance Social)

CBA: Cost Benefit Analysis

CBD: Convention on Biological Diversity

CVM: Contingent Valuation Method

IPCC: Intergovernmental Panel on Climate Change

FAS: Sustainable Amazonia Foundation

PES: Payment for Environmental Services

REDD: Reduced Emissions from Deforestation and Forest Degradation

UC: Conservation Unit

WTA: Willingness to Accept

WTP: Willingness to Pay

SIPAM: Amazon Protection System

SIVAM: Amazon Surveillance System

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1 Introduction

Global discussions about climate change have opened an alternative path to the conservation debate. The climate change issue seemed more urgent and demanding for a quick solution than any other environment problem did before. Because the effect of warming goes beyond national borders, international commitment is required in order to find a common solution. There is a constant seek for mechanisms to finance solutions and compensation schemes and therefore economics provides an important source of solutions and theoretical background. In that context, financial mechanisms drive the light of the debate toward natural resources abundant countries such as Brazil, which makes use of this privileged position to gather international support and build national initiatives for forest conservation. These initiatives are structured to compensate forest dependent communities for providing environmental services such as biodiversity and carbon sequestration. Projects related to avoided deforestation are not officially included in the international agreements of the Kyoto Protocol however there is a voluntary carbon market which includes this kind of initiative. The expectation is that future negotiations for a post-Kyoto commitment will include avoided deforestation projects.

The Bolsa Floresta program, a scheme for payments for environmental services in the Brazilian state of Amazonas, has not yet been analyzed from an economic efficiency point of view. The purpose of this work is to evaluate the Payment for Environmental Service in the Bolsa Floresta Program. The analysis and discussion of the program's efficiency will tell if the benefit received by the providers of the environmental service is optimal and to which extent the results justify the policy implementation. This work will discuss the program from an environmental policy perspective and analyze some of the costs and benefits to both beneficiaries and payers within the program.

The limitation of this study is due to lack of reliable and up to date data. Selecting the Benefit Transfer approach which uses data from other studies instead of collecting own data represents the 'second best' option for a fairly reasonable comparison therefore increasing the risk of poor practice. The ideal scenario would contain assessment and proper data collection in the areas where the Bolsa Floresta program is active as well as an accurate investigation of the economic values of the Amazon forest. That was not the case for this work, data from similar studies were used to build the comparison and withdraw the conclusions. The studies selected to be part of this analysis had in some extent the same tropical forest context as the Brazilian Amazon. But the similarities are very limited.

The content of this work is unique mostly because it raises the discussion on the benefit side of this specific PES scheme in Brazil. Many studies have focused on the REDD initiatives and potential for PES in tropical forest areas, but since the Bolsa Floresta is relatively new there are no special analysis or debate on the benefits received by local population. The concept of the program is aligned with the country's policy of transferring income to the poor portion of the population. This type of policy highlights the social component and is doubtless, one powerful marketing tool to policy makers. On the other hand the benefit of preserving one of the world's richest ecosystems such as the Amazon forest cannot just fit a social policy perspective. There is much more value in the Amazon Forest and this value should be assessed, discussed and taken into consideration when setting the amount of benefit to be paid in such schemes.

This study is divided in five sections; first section provides a background on the Brazilian Amazon context and a brief overview of Bolsa Floresta. The theoretical background is presented in the second section, starting with PES theory and followed by the optimal design of payments. The third section introduces costs and benefits associated with the program and a description of data. An analysis on the actual payment scheme is introduced in the fourth section and the fifth section provides a comparison and discussion of actual and optimal payment schemes.

2. Bolsa Floresta and Environmental Services

This section is divided into three parts; first a background about the Brazilian Amazon context followed by introduction to the Bolsa Floresta program and environmental services definition.

2.1 Background: Brazil and Amazon context

Brazil is the owner of a large portion of world's natural resources and is an internationally recognized player in the climate change negotiations, mostly due to the fact that more than 3.3 millions km^2, almost 40% of its territory is the Amazon Tropical Forest. Nine Brazilian states are part of the so called Legal Amazon sharing the same biome characteristics and the Amazon basin. Part of the Legal Amazon region is the state of Amazonas which is the largest State in Brazil and holds the highest level of biodiversity, it has a surface area of 1,558,897.70 km^2 and a vast portion of this region is occupied by floristic reserves and the remainder by water. Around 25% of the planet's fresh water reserves can be found in the State of Amazonas. This part of Brazil is considered a hotspot for biodiversity, carbon storage and other environmental services.

The increasing global demand for feedstock and livestock is shifting the expansion of Brazilian agricultural frontier, towards the Amazon. As the demand for cultivation area increases, more pressure is directed to the region and small monoculture farms are created to cultivate different types of crops. Most of the time agricultural expansions occur in forest areas which are cleared to give space to crop production. Deforestation has been a national concern for more than three decades. According to the Brazilian Forest Code private land owners in the Legal Amazon area should preserve 80% of the forest, allowing cultivation only on the remaining area. To hinder the advancing of deforestation, protected areas have been created. Different types of protected areas can be found in the Amazon region: fully protected, sustainable use protected and indigenous land, the latter two corresponding to approximately 35% of the biome.

Recent climate change awareness has brought attention to the world's forest regions as they are responsible for a wide range of environmental services to populations. Perman et al. (1996) classify forests as multi-functional when they provide timber, fuelwood, food, water for drinking and irrigation, stocks of genetic resources and other forest products. As ecosystems, forests also provide a wide variety of services, including removal of air pollution, regulation of atmospheric quality, nutrient cycling, soil creation, habitats for humans and wildlife, watershed maintenance, recreational facilities and aesthetic and other amenities.

The conservation of the Amazon forests is essential if one wants to secure opportunities to improve life conditions of the region’s indigenous, traditional and riverside populations. Viana (2008) argues that these populations depend on the forests for their livelihood and possess a wealth of etno-ecological knowledge about the forest, which should be a strategic component of poverty reduction efforts and attempts to improve their quality of life.

2.2 Bolsa Floresta Program

As a result from the acknowledgement that the Amazonas state can have an important role in climate change mitigation, the Amazonas government elaborated, in 2007, the first state law in Brazil concerning climate change, environmental conservation and sustainable development. The law recognizes the importance of forest conservation as an instrument to combat climate change and bring sustainable development to local communities. The state law institutes on its fifth article the creation of the Bolsa Floresta (Forest Allowance) program with its multiple components: income, social, family and association. The Bolsa Floresta Program is the first Brazilian internationally certified initiative to reward traditional and indigenous populations for the protection of the environmental services provided by the tropical forests. The goal of the program is to institute the payment for environmental services and products provided by the traditional communities in favor of the sustainable use of natural resources, conservation, environmental protection and the incentive for voluntary policies for reducing deforestation.

To better understand the program context, a more in deep analysis must be conducted concerning the main features of the conservation units. These protected areas comprise a special administrative regime that aims to ensure full protection of natural resources and biodiversity. Since year 2000 a national system of conservation units has been implemented. It divides the protected areas in distinct categories, the two main groups being: fully protected and sustainable use. In the fully protected area the main objective is to preserve the nature and only the indirect use of its natural resources is allowed. In the sustainable use area the objective is to balance nature conservancy and the sustainable use of natural resources. The traditional populations living in this area have special concessions to reside in. Although they are not holders of any land tenure the special concession allows them to extract natural resources from the area as long as they apply sustainable management practices. They are also allowed to produce agricultural goods in small scale for subsistence needs.

By environmental services one can understand benefits provided by the standing forests, such as climate stability, rain maintenance, carbon storage in the trees and biodiversity conservation. The primary objective is to support traditional communities living inside state conservation units (UCs) and obtain their commitment to the zero deforestation target of the Amazonas state. The payments for environmental services are made directly to the communities who dwell at the UCs in Amazonas. It has as goal the reduction of carbon emissions originated from deforestation. The monitoring is made at two fronts: deforestation and field. The monitoring of deforestation is conducted annually inside the reserve through satellite images which are analyzed by partnering institutions. The field monitoring is performed in partnership among FAS (Sustainable Amazon Foundation), Environment and Sustainable Development Secretariat of Amazonas, State Center for Units Conservation, State Center for Climate Changes, SIPAM/SIVAM (FAS, 1, 2010). The following chapter will provide a deeper analysis of environmental services concepts and payments for this type of services.

2.3 Environmental Services

Environmental services are the benefits people obtain from the environment (Hanley and Barbier, 2009; Perman et al., 2003). In the literature this term brings together a variety of benefits, Hanley and Barbier (2009) categorize them into goods, services and cultural benefits. Table 1 shows different categories of environmental services, most of the times the PES schemes related to forest conservation can fit into more than one category. The services identified in Table 1 are, according to Wunder (2005), so far the only ones that exhibit significant commercial scale.

Table 1. Examples of Environmental Services in Tropical Forests

Environmental Services	Carbon	Biodiversity	Watershed protection	Scenic Beauty
Examples	Carbon capture in growing vegetation or carbon storage in soil and vegetation	Ecosystem structure regulation, genetical diversity and of species	Water purification, flow regulation and sedimentation	Natural landscape
Benefits paid for	Potential effect of climate change mitigation	Option value (future use) and existence value	Water quality and availability	Recreation and tourism

(Landell-Mills and Porras, 2002)

The targeted provision of water protection and carbon sequestration exists in a well-defined structure of coordination between the suppliers of these services and the demand for them. On the other hand, biodiversity conservation and scenic beauty remain public goods without a well-defined private demand, and without target payments (Biénabe and Hearne, 2006).

To Bond et al. (2009) natural ecosystems continue to be degraded or lost at an alarming rate because benefits of environmental services are public goods and the cost of ensuring their provision often falls on local land managers. As land is usually managed for private benefit, it is generally more attractive for land managers to convert their land to alternative uses such as agriculture rather than maintain it in its natural state (*Ibid*).

3. Optimal PES Theory

The theory section is divided into three parts; first a brief discussion on environmental services is provided, followed by payment for environmental services theory and optimal policy design of PES scheme.

3.1 Payment for Environmental services

The disappearance of natural habitats and species is directly associated to human action, imposing a threat to environmental services provision. Wunder (2005) argues that this emerging scarcity makes ES potentially subject to trade. The core idea of payments for environmental services (PES) is that external ES beneficiaries make direct, contractual and conditional payments to local landholders and users in return for adopting practices that secure ecosystem conservation and restoration (Wunder, 2005). A now commonly accepted definition of PES contains these elements (Wunder, 2007):

• A voluntary transaction
• A well-defined environmental service or a land use likely to secure its provision
• At least one buyer
• At least one provider effectively controlling service provision
• If and only if the environmental service provider secures service provision (conditionality)

PES is a tool used to address those specific problems in which ecosystems are mismanaged because many of their benefits are externalities from the perspective of ecosystem managers (Engel, 2008). PES is not based on the polluter-pays principle but on the beneficiary-pays principle, and as such is attractive in settings where ES providers are poor, marginalized landholders or powerful groups of actors. An important distinction within PES is between user-financed PES in which the buyers are the users of the ES, and government-financed PES in which the buyer is typically the government, acting on behalf of ES users. In practice, PES programs differ in the type and scale of demand, the payment source, the type of activity, the performance measure used, as well as the payment mode and amount (*Ibid*). The effectiveness and efficiency of PES depends significantly on program design. PES are used as an important mechanism to translate external, non-market values of the environment into real economic incentives for local actors to provide such services. The Brazilian initiative is designed for Amazon‘s traditional population in an important attempt to keep these population attached to the land they naturally belong to. It is a government-financed scheme but with private investment from other partners complementing the total budget.

Börner et al. (2009) argues that a major economic precondition for PES is that the beneficiaries' willingness to pay exceeds providers' willingness to accept. The value of the service(s) at hand (determining the environmental service user's willingness-to-pay [WTP] for PES) must at least exceed provider's opportunity costs determined by profits foregone from abandoning their first best land-use plan (determining the environmental service provider's willingness-to-accept [WTA] PES, plus transaction costs [TC]) (*Ibid*). Wunder (2008) stresses that in some situations, profits from alternative land uses may be too high for conservation to compete or transaction costs are prohibitive for PES. PES only makes environmental sense when it can increase service provision relative to a business-as-usual scenario. Börner (2009) remarks the need for establishing a set of economic and institutional preconditions for PES to become a feasible and cost-effective conservation mechanism in the Brazilian Amazon.

When comparing PES schemes with other environmental policy instruments many problems and several advantages arise. Subsidies schemes can suffer from lack of additionality, paying for activities that would have been conducted anyway. Another problem is leakage when environmental-damaging activities can be shifted to other places. Both problems are less likely to happen in a tax scheme, for example.

A main difference between command-and-control and PES schemes is that for example, forestry conservation would apply to all forests, not differing with respect to the level of benefits they provide, or to the cost of conserving them (Engel, 2008). On the other hand, a PES approach is more flexible benefiting forest areas of higher value and lower cost. For example, a PES approach with a fixed per hectare payment for forest conserved would induce landholders with relatively higher marginal costs of conservation to conserve less forest land than those with lower costs. If a hectare of forest conserved provides the same level of ES everywhere, such a solution would be more cost-efficient than regulating each landholder to conserve the same amount (*Ibid*).

Weak governance, imperfect information and high transaction costs are some of the problems associated with the design of command and control instruments in developing countries with respect to enforcement and monitoring according to Engel (2008). Equity issues and income distribution can be a result of command-and-control regulations. Many poor communities depend on forests for their livelihoods, and therefore a PES scheme that imposes restrictions on the use of forest resources can create economic drawback and may induce social conflicts. The main objective of PES programs is to make privately unprofitable but socially-desirable practices become profitable to individual land users, thus leading them to adoption of sustainable practises (*Ibid*). To Vatn (2009) PES may offer a fair and efficient way to deal with immensely growing interconnections. As they become more and more global, payments are a way to simplify necessary transfers as more groups can be directly involved in solving problems whose origin or solution may lie far away (*Ibid*).

3.2 Policy Design of PES

As multifunctional landscape forests produce both market and non-market goods. The non-market goods are public goods, which are non-rival and non-exclusive and therefore a lack of payment for those services results in underinvestment in the protection, management and establishment of forests (Landell-Mills and Porras, 2002). Moreover the existence of non-market ecosystem services incurs a need for governmental intervention to tackle the market failure.

Efficient policy design in a landscape context generally implies a combination of charges on polluting activities and compensation payments for land-uses providing public goods (Gren *et al.*, 2010). A policy design model, from Gren *et al.* (2010), will be used to first identify conditions for second best policy design for different ecosystem services. The same model will be adopted for this work. Assuming the landscape area is N^l ecosystems where $l=1 \ldots m$ different ecosystem. Each component provides market and non-market goods for final consumption Y^{il} where $i=1 \ldots h$ goods, market goods such as meat and soybeans and non-market goods such as biodiversity and carbon services. A unit value of p^i is determined by the market value of the good. To the case of non-market goods the unit value is determined by the society's appreciation.

An efficient calculation for total net values in this case implies reliable data concerning the production function, Y^{il} for both market and non-market outputs, and complete information on cost function C^{il} for producing each output. The production functions and costs functions associated with market goods can be defined clearly. Unit values for market good are also rather simple to obtain. However for non-market goods it is less straightforward. A demand function that reflects society's appreciation for environmental goods is needed. The unit price of non-market goods is complex and difficult to obtain.

Baumol and Oates (1975) stress that economists have been aware of the enormous amount of information necessary to achieve anything that can even pretend to be close to optimality by means of centralized calculations. There are different techniques for valuing environmental goods and for this reason estimations have to be observed and interpreted carefully.

The efficient policy design is society's maximum net welfare, W, considering efficient allocation of market and non-market goods. With restriction to total landscape area available, N

$$Max\ W = \sum_l \sum_i p_i . Y^{il} (N^{il}) - C^{il}(N^{il}) \quad s.t \ \sum_l \sum_i \quad N^{il} \leq N \qquad (1)$$

The first order conditions with respect to optimal choices of N^{il} are:

$$\sum_l \sum_j \quad p^i . Y^{il}_{Nil} - C^{il}_{Nil} - \beta = 0 \text{ for all } i=1,\ldots,h \qquad (2)$$

Land-uses are optimally allocated when their marginal net benefits are equal and correspond to β. This Lagrangian multiplier provides a measure of how changes in the restriction (total land) would affect the production function. A positive shadow price, β, for example, indicates that expansion in land use increases society net welfare. On the other hand a low value of the shadow price, β, indicates that there is not much to be gained by relaxing the constraint. To identify optimal policies it is necessary to distinguish market Y^m and non-market goods, Y^n. The condition is expressed as follow:

$$p^m Y^{ml}_{Nm\,l} + \sum_l \sum_n \quad p^n Y^{nl}_{Nml} - C^{ml}_{Nml} = \sum_l \quad (\sum_n \quad p^n Y^{nl}_{Nnl} + \sum_m \quad p^m Y^{ml}_{Nnl}) - C^{nl}_{Nnl} \quad (3)$$

Partial derivatives are denoted by the subscripts. The left hand side of (3) expresss the net value of marginal product from market goods. To calculate the net value from market goods, reliable information about production function and costs is needed, to accurately evaluate net profits from the activity alternative to conservation. It is composed of 3 parts: the value of a market good, $p^m Y^{ml}_{Nm\,l}$, the sum of values of non market goods from all types of ecosystems, $\sum_l \sum_n \quad p^n Y^{nl}_{Nml}$ and the marginal production cost of market good *m* in ecosystem *l* , C^{ml}_{Nml}. The second term at the left hand side of (3) can be positive or negative, for example if we consider that the market activity will cut down all forest, carbon storage will be lost therefore it will be negative. By producing soya crops the net difference between the carbon stored and the carbon sequestered in the growing crop might result in a negative value. An opposing example can be seen with scenic beauty as an environmental benefit, if society appreciate growing crops more than a tropical forest then a positive value will be given to the second term. Right hand side of (3) expresses the net value of marginal product obtained from non market goods. Again we need a production function and the costs associated with the provision of environmental benefit preserved. The net value on the right hand side is composed by the effects on the sum of the values of providing both non-market and market goods, $\sum_l \left(\sum_n p^n Y^{nl}_{Nnl} + \sum_m p^m Y^{ml}_{Nnl} \right)$, and the marginal production cost of non market good *n* in ecosystem type *l*, C^{nl}_{Nnl}.

This model assumes that, unless a subsidy/charge is imposed on ecosystem service *n* and p^n exists, the land owner makes decisions based on market prices of inputs and outputs. The efficient use of landscape is possible only after a charges or subsidies scheme is introduced, a charge for negative p^n and a subsidy for positive p^n. The land owner maximizes net benefits when marginal net benefits of different land uses are equal. If there is no compensation for producing non-market goods, nil p^n, there is no incentive to produce non-market goods, and all land is therefore devoted to produce solely market goods. When making decisions about efficient subsidy in non-market goods policy some criteria have to be considered such as low marginal provision cost and high unit value of market and non market goods. Condition (3) for optimal allocation and associated design of PES are illustrated in Figure 3.2

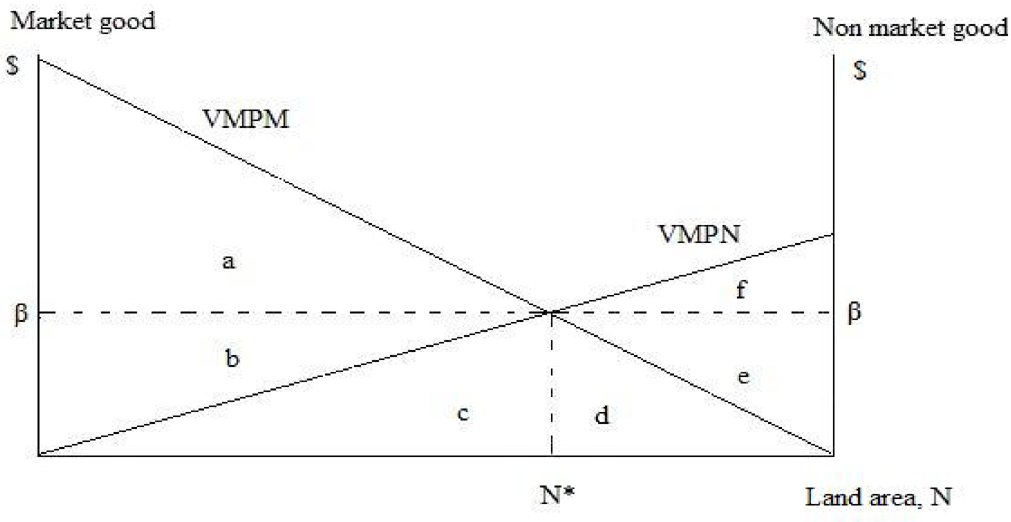

Figure 3.2 Allocation of market and non market goods

An optimal level of payment is observed when net values of marginal products are equal for both market and non-market goods. The Lagrange multiplier, β is the optimal net value of marginal product, and N* the optimal allocation of land between the two options. In the graphic above the big triangle area *abcd* represents the profits obtained by the landowner when total land is devoted only to production of market goods. The area *ef* represents the opportunity cost for the landowner for not entering the conservation program, the foregone net benefit from the program payment. On the other hand, the area *cdef* represents the gains when all land is devoted to preservation.

Ideally to calculate the optimal net value of landscape production, from scratch, two steps are essential: quantify production functions for both market and non market output and then associate monetary values with both types of outputs. Any accurate estimation demands an extensive set of data. For market output we would need data on the two most significant land uses in the Amazon, soya crops and cattle ranching, production function and market unit values of each output. Data concerning land use and projection of crop expansion would be also needed. For the non-market good we would need biodiversity and carbon storage production functions. The unit value used is obtained by the society's appreciation of biodiversity. The unit value of carbon storage is taken from the unregulated market of carbon credits and content of carbon per hectare is needed to calculate direct benefits from standing forest.

Instead of undergo sophisticated calculations and extensive data collecting this work will be using the above mentioned calculated values from other studies. Knowing costs and benefits will allow the assessment of the net benefit (by subtracting costs from benefits) of optimal payments which will later be compared with actual payments. Based on the cost benefit analysis (CBA) theory, the aim is to find out what is the net benefits and if the value is positive or negative. A negative net benefit means there are no incentives to carry on a project, whereas e positive means there is incentive to go ahead with the project. The explanation according to Boardman (2006) is that positive net benefits make it possible, in the sense of making it available the resources to compensate those who bear the costs so that some people are made better off without making anyone else worse off. Willingness to pay and opportunity costs are the guiding principles for measuring costs and benefits (*Ibid*).

CBA is one of the method used in decision making process, by assessing all cost and benefits incurred in a project scenario the resulting net benefit can indicate whether a project is feasible or not. It is specially used in public decision making when it concerns environmental regulations and development projects. It can be very useful in assessing the feasibility of projects that affects society's welfare in the present and can also prevent side effects and non-wanted costs to the future generations.

The limitations of CBA is discussed in the literature, for example Boardman (2006) alerts that two types of circumstances make the net benefit criterion an inappropriate decision rule for public policy. First, technical limitations make it impossible to quantify and then monetize all relevant impacts as costs and benefits. Second, goals other than efficiency are relevant to the policy. Okamura (2004) investigates the flaws in CBA such as problems due to evaluating non-economic values, limited considerations to distributional equity and political bias.

4. Description of Data

In the previous chapter the theoretical background concerning PES was presented, now the data will be introduced. This section presents a discussion concerning benefits and costs from forest conservation. Due to available data constrains concerning the Amazon, most of the numbers employed in the calculations are drawn from other studies using the benefit transfer method. Therefore we start this chapter with a brief overview on the benefit transfer method.

4.1 Benefit Transfers

The benefit transfer method is relatively new in the literature. The method is used to estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/or context (King and Mazzota, 2000). Thus, the basic goal of benefit transfer is to estimate benefits for one context by adapting an estimate of benefits from some other context. Benefit transfer is often used when there are little resources available to conduct an original valuation study, yet some measure of benefits is needed (*Ibid*).

Benefit transfer uses economic information captured at one place and time to make inferences about the economic value of environmental goods and services at another place and time. Using this approach, economic estimates are either transferred as monetary value units (e.g., means or medians) or as value functions conditioned on explanatory variables that define the attributes of an ecological and economic choice setting. King and Mazzota (2000) presents the method dividing in four basic steps: 1) To identify existing studies or values that can be used for the transfer. 2) To decide whether the existing values are transferable. 3) To evaluate the quality of studies to be transferred. 4) To adjust the existing values to better reflect the values for the site under consideration, using whatever information is available and relevant.

The advantage of the method is that any reality can be adapted, developing countries with less resources, for example, can still conduct own accurate policy analyses by using values previously calculated by a wealthier country with more resources for research. Most of the original valuation studies available in the literature are related to high income countries and often is the case they are adopted by studies in low income countries. Step number four from King and Mazzota (2000) is perhaps the most discussed aspect in benefit transfer theory as the values from an original study site are never a perfect match to the new study site, they need to be adjusted and this can be done in different ways.

In Figeroa (2011) three different types of benefit transfer were presented:

Unit Value type is the one used in this study for matter of simplicity. It consists in transferring the adjusted or not-adjusted unit value reported by the study site to the policy site. As the main advantage of this method is its simplicity, it has become one of the most used for policy analysis.

Benefit Transfer Function (BFT) is an alternative method to the simple unit transfer value which does not consider specific information from the policy site. That consists of transferring the whole benefit function estimated in the original study site to the policy site instead of transferring only point values estimates from.

Meta-analysis is the type of benefit transfer that summarizes information from several valuation studies averaging their values expecting that this procedure will provide more accuracy than simple unit value transfer.

Benefit transfer can also be used in different countries, Ready (2006) discuss benefit transfer usage across borders and argues that even when the good being valued is similar in two different countries there are still important issues to be taken into consideration in the analysis. International benefit transfer is mostly attractive both because of the potential cost savings as well as because of the ability to use consistent values in analyses of action that impact more than one country (*Ibid*). According to Ready and Navrud (2006) some of the issues that need to be addressed when using the BT method are related to currency conversion, difference in measurable attributes of the users and the measurement of wealth versus income.

The currency conversion problem is due to the fact that identical individuals using different currencies will not have the same real WTP, unless they have the same real income and face the same real prices. The recommendation is thus, to use the purchasing power parity (PPP) adjusted exchange rate to convert values from one country to another. This adjusted exchange rate measures the amount of local currency in one country that would purchase the same amount of market goods as one unit of local currency in the other country. Adjustment according to PPP is as well supported by Figeroa (2011) that in addition recommends adjustment for inflation if the value from study site and the value to policy site differ in moments of time (*Ibid*). In this present study the specific biodiversity values were adjusted for inflation considering the consumer price index however, were not adjusted for difference in income levels between study site and policy site.

To Ready and Navrud (2006) the difference in the measurable attributes of the users can arise because the value of an environmental good is determined by three different sets of factors: the characteristics of the good itself (quantity, quality), the context within which the good exists (scarcity, availability of substitutes, etc.), and the characteristics of the users who value the good (income, age, experience). In a contingent valuation method (CVM) survey sample, for example each individual give their responses based in a combination of factors such as experience, religion, education, utility, income, budget constraint, etc and these factors would probably vary between countries affecting the overall transferability of an economic value.

Regarding the issue about difference measurement of wealth versus income happens because valuation surveys takes into consideration answers regarding respondent's annual income and does not consider relevant budget constraint. Ready and Navrud (2006) concludes that annual income could serves as a reasonable proxy for wealth, only if this transfer is made within one country. Differences in income taxes for example between countries would affect the results in large extent and the solution proposed would be to subtract from the annual income reported in the survey the average tax burden per country.

4.2 Environmental Benefits

Estimating the net social benefits of a policy requires estimates of the change in social surplus. A change in social surplus requires knowledge of the appropriate market demand and supply curves (Boardman, 2006). Direct estimation of the demand curve is possible if we know at least one point on the demand curve, its functional form and either its slope or the price elasticity of demand. In many practical situations we do not know the slope or the price elasticity of demand (*Ibid*). Where markets function well, analysts know at least one point on the demand and supply curves, represented by the observed intersection of market price and quantity exchanged, but still have to estimate these curves to measure either existing social surplus or changes in social surplus (*Ibid*). Where markets do not function well, which is the case of most environmental services market, special valuation methods are needed.

When a market does not exist analysts try to obtain estimates of what the market price would be if the relevant goods were traded in a market where the demand curve measured marginal social benefits and the supply curve measured social marginal costs. This estimate is called shadow price (Boardman, 2006).

The economic field that attempts to connect environmental benefits with a monetary measure is relatively new and often contested in literature (i.e Perman, 1996; Pearce and Moran, 1994). The values, known as environmental benefits are divided in two categories: use and non-use values. Use value arises from actual use or direct use such as input in production, indirect use such as flood control and nutrient cycles. Non-use values are more difficult to assess and are related to future uncertainty such as option value which is the attributed value to safeguard the asset for the option of using it in a future time and existence value that arises from the knowledge that the service exists and will continue to exist.

The techniques to evaluate environmental goods are vast however only one method will be mentioned here. A very common method to assess environmental valuation is Contingent Valuation Method (CVM) which is a direct method that involves asking questions about WTP (i.e. for the deforestation not to occur) and WTA (i.e. compensation for biodiversity loss) to a sample of the relevant population. By using contingent valuation method we can get the theoretically correct monetary measures of utility change (Perman et al., 2003). One advantage of CVM is that it can deal with both use and non-use values, but there are also disadvantages associated with this method, such as overestimation of WTP and difficulty from respondents to answer the questions related to WTA.

The range of benefits resulting from forest conservation is broad, for this work only biodiversity and carbon storage will be discussed. The existence of watershed protection and scenic beauty provision in the Amazon forest context is acknowledged, however. Although carbon cycle is complex the emphasis has been mostly on two points, here the analysis is narrowed to carbon storage and carbon sink. Similarly, biodiversity analysis will be quite simple.

4.2.1 Biodiversity

Biological diversity, or biodiversity, is defined by Pearce and Moran (1994) as the umbrella term used to describe number, variety and variability of living organisms in a given assemblage. In order to protect this valuable world resource the global community has agreed upon a Convention on Biological Diversity (CBD) which is an international treaty for the conservation and sustainable use of biodiversity. The treaty was part of the 1992 Earth Summit in Rio.

> *The objectives of the Convention, are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding (CBD, 1992).*

Aligned with this commitment, countries should promote local biodiversity protection and improve policies, laws and livelihoods of populations. The Brazilian government created a national commission to monitor and follow the objectives of CBD as well as develop cooperation in biotechnology and protection of national resources against bio-piracy. The creation and expansion of conservation units is also in accord with the commitment objectives. CBD classifies Brazil as one of the world's 17 megadiverse countries, which incorporates 70% of the world's catalogued animal and plant species. It is estimated that Brazil hosts between 15-20% of all the world's biological diversity, and the greatest number of endemic species on a global scale (CBD,1, 2010). An important attempt is made here for the role of local communities and indigenous populations in preserving biodiversity which explains in part why should be monetarily compensated. The local communities and villages store significant knowledge of flora and fauna species, as well as the traditional management systems of these natural resources. The contribution of these communities is fundamental for the conservation and sustainable use of the genetic and biological resources of Brazil. The main threats to biodiversity are: fragmentation and loss of habitats, introduction of alien species and exotic illnesses, overexploitation of plants and animals, use of hybrids and monoculture in agro-industry and reforestation programs, pollution and climate change (CBD, 2010).

There are some obstacles in associating biodiversity with a monetary value: firstly biodiversity hotspots like the tropical forest are extremely diverse in number of species and genetic content and secondly those areas are often of remote access. A remarkable fact is that within one single hectare of Amazon forest 200-300 species of trees can be found (Verweij et al., 2009). For Mendonça et al (2003) the utility of biological diversity lies in several factors such as the maintenance of the integrity of an ecological system, esthetic distinctions, the option of the future discovery of a product among others. Therefore, when biodiversity is regarded from an economic standpoint, it must be defined with regard to these benefits (*Ibid*). Thus, the preservation price must represent the value of the contribution of the benefits coming from biodiversity which were produced by a change in the habitat for a single land unit (*Ibid*).

Preservation of biological diversity constitutes an environmental service for which beneficiaries around the world might be willing to pay. Benefits from the conservation are observed both locally and globally. Although the benefits are rather challenging to measure, Nijkamp (2008) concludes that it is generally accepted that biodiversity benefits cannot exclusively be expressed in numbers. Additionally the fact that it also depends on the ecological structure of a whole area makes it even more difficult to valuate accurately in monetary terms. Moreover, there is not a precise estimation of the biodiversity for the Amazon area; approximately half of the world's biodiversity can be found within this tropical forest.

The most common measure of biodiversity is the number of species in an area, and the primary concern about human effects on biodiversity is expressed in the loss of species (Huston and Marland, 2002). Nevertheless, for the purpose of simplicity in this study the biodiversity measure will consider not the number of species but people's appreciation of biodiversity value. Two different studies were taken into account. Constanza *et al.* (1997) attributed the value of US$18 (biological control and genetical resources) to forest biodiversity service, per hectare per year. Biological control as trophic-dynamic regulations of populations and genetic resources as sources of unique biological materials and products. In this study Constanza *et al.* (1997) attempts to estimate a global economic value for ecosystem services considering 17 ecosystem services for 16 biomes, the value per unit area of each ecosystem service for each ecosystem type. To estimate this 'unit value' for forest they used either: (1) the sum of consumer and producer surplus; or (2) the net rent (or producer surplus); or (3) price times quantity as a proxy for the economic value of the service (see appendix 3). Converting to 2010 prices (using consumer price index), US$ 26.43 is the benefit generated by biodiversity in forests.

The second one, making use of willingness to pay, Cartwright (1985) estimated the benefit of biodiversity US$ 20 which corresponds to international appreciation for tropical forest preservation. The value suggested by Cartwright (1985) of US$ 20/ha/year represents what would be needed in order to convince tropical countries to enter into agreements for biodiversity conservation. Cartwright believes such a value is reasonable and Fearnside (1996) agrees this is a good starting point to discuss biodiversity conservation in Brazil. In 2010 prices, we have US$40.45 value of biodiversity per hectare per year. For the biodiversity benefits case the two estimations above were considered.

Table 2. Biodiversity Benefits

Biodiversity Benefits	Min*	Max**
US$/ha/year	26.43	40.45

*2010 Values corrected from Constanza et al. (1997)
**2010 Values corrected from Cartwright (1985)

4.2.2. Carbon Storage

Climate change is driven by greenhouse gas (GHG) concentration in the atmosphere and by the rate of change of those concentrations through time (Perman et al., 2003). The extent of climate change depends on previous net emissions, in future GHG emissions and actions that affect carbon sinks. The main GHG, carbon dioxide, derives mainly from fossil fuels; however a big contribution of the emissions comes from deforestation. There are two main forms of carbon: organic (such as biomass of plants) and inorganic (CO_2 in the atmosphere). Photosynthesis in plants turns organic carbon into inorganic carbon, which is either stored in biomass or turned back to its inorganic form (CO_2) by decomposition or soil respiration. This CO_2 can either return to the atmosphere or enter the rivers. Alternatively, it can react with soil minerals to form inorganic dissolved carbonates, which remain stored in the soils or wash out into the rivers (Verweij et al., 2009).

Forests are an important storage of carbon, if cleared for agricultural production carbon will be released to the atmosphere. The carbon released contributes to greenhouse gas concentration. Pearce and Moran (1994) analyze two aspects in order to derive a value for carbon credits in a tropical forest context: 1) net carbon released when forest are converted to other uses, and 2) the economic value of one ton of carbon released to the atmosphere. Carbon will be released at different rates and depending on the method of clearance and posterior land use. It also takes into consideration the carbon content of biomass if land is converted to pasture or agriculture use.

According to Verweij et al. (2009) the potential value of sequestering or emitting carbon in the Amazon can be determined in two different ways: 1) the value can be derived from currently emerging international markets for trade in avoided carbon emissions 2) investing in the conservation of carbon sinks in developing countries, which is economically more efficient than avoidance of greenhouse gas emissions in developed countries and the international community is willing to pay to prevent such releases resulting from the conversion of rainforest.

Several researches suggest different estimations of carbon storage values. They mostly depend on the local characteristics of each forest type, which can widely differ across the Amazon region. In an attempt to reflect the local characteristics of this specific area of the Amazon, values from the conception document of Juma Reduced Emissions from Deforestation and Forest Degradation (REDD) were observed. This REDD project takes place in one of the 14 conservation units participating in the PES program. The document argues against Intergovernmental Panel on Climate Change (IPCC) default value for tropical forest of 131 tCO_2/ha as it believes IPCC does not reflect all features of the area where the project is inserted. Hence values from Nogueira et al. (2008) with the estimation of 172.9 tCO_2/ha to 184.5 tCO_2/ha were used to define the final values negotiated within the project. Final values vary from 156 tCO_2 per hectare of alluvial forest and 161 tCO_2 per hectare of dense forest. Until 2050 the REDD project will result in avoided emission of 189 million tCO_2 and an equivalent protection of 329,483 hectares of tropical forest compared to the baseline scenario. REDD projects are already becoming part of conservation strategies and the development of this kind of projects is a financing source for the Amazonian PES. Pearce and Moran (1994) estimate the carbon released from deforestation of secondary and primary tropical forest to range from 100 to 200 tCO_2/ha. However this study will adopt two values for carbon content: a conservative estimate of 110 tCO_2/ha from Houghton et al. (2001) and the IPCC default value for tropical forest of 131 tCO_2/ha as the maximum reference. The lower estimate was also adopted by Börner and Wunder (2008) to calculate opportunity cost estimations that will be presented in the next section. The calculated benefits range from carbon storage US$ 255.2 to US$ 720.5 per hectare per year, as shown below in table 3.

Table 3. Carbon Benefits

		Börner and Wunder		Börner and Wunder		Börner and Wunder		Nepstad	
Carbon content	ton/ha	110	131	110	131	110	131	110	131
Carbon price	US$/tCO2	3.24		3.88		2.32		5.5	
Benefits	US$/ha/yr	356.4	424.44	426.8	508.28	255.2	303.92	605	720.5

4.2.3 Carbon sequestration

Besides carbon storage the other relevant part is related to how much carbon can be absorbed from the atmosphere. IPCC defines carbon sequestration as an augment in carbon stocks other than in the atmosphere (IPCC, 2000). The Kyoto Protocol stated on article 3.3 that 'emissions by sources and removals by sinks resulting from direct human-induced land-use change and forestry activities' are to be 'measured as verifiable changes in carbon stocks' and then generate negotiable credits of carbon. Old growth forests may have large stocks of carbon sequestered compared to young growth forest. Estimates range from 1 to 9 tons of carbon sequestered per hectare of forest. Depending on the land use change from deforestation a carbon net release can be also significant for calculations. Bearing in mind that this conservation initiative is more related to standing forest, carbon sequestration will not be a part of this study's benefit calculations. It is noteworthy to mention that in the relation between carbon sequestration and biodiversity, there is both a direct and indirect effect from the first in the later, Díaz et al., (2009) indicates that different components of biodiversity have the potential to modify the earnings, magnitude, and long-term permanence of the terrestrial biosphere's carbon stocks and fluxes.

In order to assess a monetary value for carbon the Kyoto Protocol made it possible, through its flexible mechanisms, to create a carbon market. A voluntary carbon market was also created as an alternative to Kyoto regulated carbon market. The two initiatives differ in the costs associated with project implementation and carbon offset prices. Less regulation in carbon market makes the process simpler and thus reduces transactions costs. The price level can be an advantage in the regulated market, as it is much higher. The main impediment is related to which kind of project is suitable for each market. The Kyoto Protocol does not yet include the avoided deforestation scheme which is the reason why voluntary market prices were taken into account. The Chicago Climate Exchange (CCX) is part of the voluntary market. It operates in the North America cap and trade system. All CCX emitting members make a voluntarily but legally binding commitment to meet GHG reductions trough projects that must undergo a third party verification (CCX, 2010). The price range adopted in this study is based on CCX prices and it varies from US$ 2.32 to US$ 5.5 ton of CO_2

4.3 Cost of Environmental Service Provision

PES efficiency is not only determined by the extent to which incremental ES are provided but also by the cost at which this was achieved. These costs include: (1) opportunity costs of the benefits foregone from alternative activities; (2) when land use changes are required, the implementation costs of making and maintaining those changes; and (3) the transaction costs of the program (Wunder et al., 2008). Here we assume that costs (2) and (3) are zero. According to Pearce and Moran (1994) the opportunity cost approach is not a valuation technique but it can be a powerful approach to a form of judgmental valuation. The approach consists in estimating the benefits of the activity causing environmental deterioration in order to set a benchmark for what the environmental benefits would have to be for the development not to be worthwhile. One essential aspect of opportunity costs related to conservation is stressed by Fearnside (1995), according to whom the usual tendency of including opportunity cost only for one side of the comparison should be avoided. Not only the foregone profits but also the value of the ES that would be sacrificed should be considered.

In PES schemes for forest conservation, the opportunity cost can be calculated by estimating the foregone profits of alternative uses of land. Two different studies present the opportunity cost of preserving forests in the Amazon region. Nepstad et al. (2007) use net return simulation of economic activities such as soya production, cattle ranching and timber extraction. In a complementary method Börner and Wunder (2008) calculate the opportunity cost using broader data including crops such as coffee beans and corn. However it is worth to observe that Börner and Wunder's derivations of opportunities costs are based on the assumption of nil current returns from standing forests, as a result of that simplification profits from converted uses are identical to the conservation opportunity costs. All opportunities costs are expressed in table 4.

Table 4. Opportunities Cost Results

		Börner and Wunder 1	Börner and Wunder 2	Börner and Wunder 3	Nepstad
Total OC	mill US$	143	143	123	257000
Annual OC	mill US$	14.3	14.3	12.3	8566.67
reduced forest loss	ha	564849	564849	525094	330000000
OC/ha of reduced forest loss	US$/ha/year	25.31	25.31	23.42	25.95

1) Max price (hypothetical price needed to buy out all deforestation)
2) Permanent CCX price (value in 2006)
3) Temporary CCX price (same as above but with a 39% discount rate)

Both studies mentioned above are designed for a REDD scheme context. However most PES schemes are designed to compensate private land owners for conserving the forests, and there are no legal barring for traditional populations residing on public land to receive monetary compensation for ES.

4.4 Comparison of Estimated Costs and Benefits from forest conservation

In this section comparisons for costs and benefits from forest conservation are presented, by analyzing the net value of the marginal product obtained from market goods and non-market goods. As a result of Amazon particularities it is observed that opportunity costs of agriculture and other land use are not high enough to represent a significant incentive for not preserving. In Börner and Wunder (2008) a comparison of opportunity costs was made between the Amazonas state and Mato Grosso state, one of Brazilian's top agricultural frontier and the result was a total opportunity cost almost five times bigger than for the Amazonian state. Reasons for considerably low opportunity costs in the tropical forest can be explained by the remote location, far from consumer centers. In addition climate and soil conditions are not appropriate for soya beans and other crops. The main implication of such a low opportunity cost is the motivation for conservation actions. Benefits from the environmental service provision exceed the foregone profits (opportunity costs) of alternative land use, as we can see in Table 5. Total benefits are the sum obtained by biodiversity estimation and carbon content for both minimum and maximum values previously presented. The minimum estimated net value of the marginal product obtained from non-market goods is US$ 281.63 and the maximum is US$760.95.

Table 5. Costs and Benefits

		Börner and Wunder 1		Börner and Wunder 2		Börner and Wunder 3		Nepstad	
Costs	US$/ha/yr	25.31		25.31		23.42		25.95	
		min	máx	Min	Máx	min	máx	min	máx
Total Benefits	US$/ha/yr	382.83	464.89	453.23	548.73	281.63	344.37	631.43	760.95

It is evident that benefits exceed by far the opportunity costs for the families attended by the program. Due to the low level of their opportunity cost one can say there is no relevant argument against families' compliance with the program, a situation which would certainly happen in a scenario where benefits are fully compensated. One reason for not fully compensated benefits relies on the fact that families have imperfect information about benefits of environmental services provided by them.

5. Bolsa Floresta

This section presents a brief analysis on the economic context of Bolsa Floresta PES. The first part describes the payment system and financing sources and the second part the cost frame of the whole program, including direct and indirect benefits. The third part discusses the additionality of the program.

5.1 Actual payment system

The program was constructed with participative approach giving a significant role to the communities and governmental institutions in Amazonas after broad discussions between the actors (FAS, 1, 2010). After an informative workshop on a zero deforestation target with local residents at each CUs, a specific contract was made individually with each family. This contract is applicable for those who had been living in the area for at least two years. In the contract, the CU community dweller commits to not to deforest areas of primary forest. This does not have any impact on the remainder of land used for subsistence plantation. An intern committee was created in order to ensure that the program functions well. The committee is responsible for studies and diagnoses of potential beneficiary families from CUs; the establishment of targets and operational procedures for implementing the program; promotion of institutional interaction with different organizations participating in the program; follow-ups, subsidies and valuation of program implementation (*Ibid*). The program has four components:

- Forest Allowance Family (BFF): monthly payment of R$ 50[1] (approx. US$ 28.6) to the mothers of families living inside the CUs who are willing to make a commitment to environmental preservation and sustainable development;
- Forest Allowance Association (BFA): direct payment to CUs dwellers' association. It is equivalent to 10% of the sum of BF family paid in each CUs. The aim is to strength the organization and social control of the program.
- "BF" Income: annual average payment of R$ 4.000 (approx. US$ 2285.7) to each CUs, R$350 (approx. US$ 200) per year per family. This component is to support and foment sustainable production of forest products such as fish, oils, nuts, fruits, honey, etc.

[1] Currency exchange rate R$1/US$1.75

- “BF” Social: annual average payment of R$ 4.000 (approx. US$ 2285.7) to each CUs, R$350 (approx.US$ 200) per year per family. To support local improvements in education, health, communication, transport and other basic features to build citizenship and social power.

According to Sustainable Amazonas Foundation, until October 2009, there were 6325 families representing a total of 28623 people benefitting from the Bolsa Floresta program in 14 conservation units covering more than 10 millions hectares in total (FAS, 1, 2010). The program is financed partly by the Amazon Fund (held by the Brazilian Development Bank-BNDES), and partly by FAS and other revenues. The idea is to invest more than half of the resources (58%) in activities that will generate income through sustainable activities, the BF Income, 10% will be devoted for the strengthening of associations, BF Association, and 32% of the resources will be applied in aiding programs of monitoring, education, health, productive chains, management and scientific development (FAS, 2, 2010). Revenue from REDD will also contribute to program funding. So far there is only one REDD project approved and implemented, Juma REDD, the next one is in conception phase. It is expected that in the post-Kyoto commitment REDD projects will be officially regulated. Consequently more revenue from high-priced carbon credits can be obtained by the programme and increase directly the benefits for traditional populations.

5.2 Bolsa Floresta Costs Frame

In the annual report for 2009 the program shows costs and investments made for a one year period from June of 2009 (FAS,3,2010). Program annual costs considering all four components are:

Table 6. Bolsa Floresta Costs

	Family	Income	Social	Association	Total BF
Total US$	1,974,828.57	969,142.86	1,103,656.00	368,156.00	4,415,783.43
Total US$ /family	312.23	153.22	174.49	58.21	698.15
Total US$ per ha	0.20	0.10	0.11	0.04	0.44

Annual payment for the BF Family component is US$ 312.22 for each family; here the direct monetary benefit of the program were considered. Indirect gains are represented by the remaining three components Income, Social and Association. Annual cost per family including all four components would thus be US$ 698.15. Annual cost per hectare, considering total conservation area of 10 million hectares is US$ 0.44 based on the annual cost estimations above.

5.3 Meeting the environmental target

Projection models based on satellite images and spatial data for the expansion of Brazilian deforestation indicate an increase of deforestation area in a business as usual scenario (see Appendix 1). In the absence of any environmental policy such as a subsidy scheme, deforestation activities would represent a great part of the conservation units attended by the PES program in the year of 2050. These projection models are a good instrument to prove the additionality of the program,. Wunder (2009) argues that in order to be useful in building the baseline scenario, deforestation projection models need to indicate where and when deforestation will possibly occur. To demonstrate effectiveness the methodologies have to be very precise regarding to spatial and temporal conditions. In the case of overestimation of deforestation rate there is a risk to the buyer that additionality is only partially observed and therefore the buyer would pay for an environmental service provision that cannot be effectively proved. The debate about additionality also includes two important counter arguments in the Amazon case: 1) the traditional population would have carried on with their ancestral practices anyway; 2) the Amazon region has shown a trend of decreasing rates of deforestation before the introduction of PES.

The Amazon region and conservation units have experienced small increases in deforestation rates since 1997. Satellite monitoring by the National Institute of Spatial Research (INPE) shows the slow advance of deforestation rates (see Appendix 2) with a maximum percentage of 3% increase. This can be explained through the increase of conservation units areas, technological improvements in monitoring systems and implementation of compensation schemes.

6. Optimal design and actual payment - A comparison

The main objective of this work is to discuss an optimal payment that compensates foregone profits and benefits of preserving the forest. Table 7 describes the range of estimated optimal payment based on the minimum and maximum amounts and benefits from biodiversity and carbon storage discussed in session 3.

Table 7. Optimal Payment

	Börner and Wunder 1		Börner and Wunder 2		Börner and Wunder 3		Nepstad	
	min	máx	min	Máx	Min	máx	min	máx
US$/ha/year	357.52	439.58	427.92	523.42	258.21	320.95	605.48	735

In PES schemes the payments are normally based in hectares, not number of people or per family. For example in Costa Rica one of the pioneer countries in PES schemes, forest conservation contracts now pay to private land owners $64 dollars per ha/yr for each year over a five year period (Steed, 2007). Costa Rica's system of PES consists of voluntary incentive contracts targeted to small and medium parcels of privately owned forest land, up to a maximum of 300 ha. Through these contracts, the landowners commit to adopt specified forest management plans for five years. In exchange, they are compensated for the actual costs of protection and the foregone revenues from alternative land uses. The ES considered in this PES scheme have been enumerated in the Costa Rican 1996 Forestry Law 7575. These include: 1) carbon sequestration; 2) water protection; 3) biodiversity conservation; and 4) scenic beauty. (Bienábe and Hearne, 2006).

Some issues have to be raised in order to make a fair comparison between optimal and current payments. The environmental target for conservation comprises 10 million hectares, however not all of it is available for agricultural purposes and consequently families have a constraint on the availability of land. Limited data about total area of land that can be used for agriculture imposes an obstacle to this comparison. For example, in the Rio Gregorio Conservation Unit, the average area available for agriculture, is 3671 hectares; each family would thus have access to produce on 31.38 hectares. To have a more realistic hectare based comparison this value of area per family is included in table 7, as part of the analysis. A more fair distribution of the benefits would be hectare-based but in the case of the Conservation Units the possession of land per family is not well defined. Families have the right to inhabit and produce in the land but not the official possession. Assuming the average of 31.38 hectare mentioned above we would get to an average current benefit of US$ 9.95 ha/yr, still too far from a ideal scenario where the minimum optimum calculated is US$ 258.21ha/yr and the maximum optimum is US$735 ha/yr. Following the optimal estimations payment, each family, holder of 31.38 ha, would then receive an annual total payment range of US$ 8102.6 to US$ 23,064.3. Additional comparison can be made regarding total benefits from the program, which considers not only the direct payment from the BFF (but indirect benefits from the other components of the program. In this case, each family's total annual benefits sum up to US$ 698.15 (see table 8), a total benefit of 22.25 ha/year, considering same area from above.

Table 8. Annual Benefits

	Direct Benefit	Indirect Benefit	Total
US$ per family	312.23	385.92	698.15
US$ per ha*	0.20	0.24	0.44
US$ per ha **	9.95	12.30	22.25

*Total Cost divided by the total conservation area
**Cost per family divided by 31.38 ha average agricultural area available per family

Although it may seem very unrealistic to the vast Amazon context the comparisons on a hectare basis are useful in order to illustrate the gap between the two forms of payments. It does not matter in which direction our discussion goes, the optimum payment will always exceed the actual payment. Although the optimum payment greatly exceeds the actual payment it is worth noticing the social impact of the direct payment to the traditional populations. The average income of those traditional populations barely exceeds the national minimum wage (approx. US$ 292) per month. Furthermore the benefit from the ES provision would represent to each family an extra income per year that exceeds their monthly income.

So far the discussions has focused on the optimal level of payment that maximizes the society's net welfare. Bond et al (2009) agrees that at the very minimum, payments need to meet the opportunity costs (plus transaction costs) that resource managers incur from changing their behaviour. Equally important to the size and duration of the payments are how the price is determined, the frequency of payments, and to whom and in what form the payments are made (*Ibid*). As discussed in the theoretical section, a PES scheme makes economical sense if the compensation payment exceeds the opportunity costs. The minimum opportunity cost is US$23.42 and maximum is US$ 25.95 (table 4). The direct benefit received by families represents 42% of the minimum opportunity cost. However, if compared with the actual total payment level in the last row (table 8) a number which is very close to the opportunity cost range, 95% of the minimum value is achieved. Considering all assumptions made before total benefit (direct and indirect) received by families in the Amazon it can be concluded that the total benefits do not totally compensate the families' foregone profits of alternative land use such as soya and cattle production.

7. Conclusion

Assessing values for ES and comparing the benefits associated with conservation of natural areas with the benefits from conversion of land can provide useful information for setting priorities in a variety of contexts. Values of ES should be reflected in national decision making and policy planning. PES schemes should be built in ways that properly address social and environmental concerns. It is also important to ensure that the right people pay and that they pay the full cost of providing the ES. Cost-benefit analysis can be a powerful tool for policy changes, especially in developing countries and it can provide useful results to discuss feasibility of environmental policy.

When dealing with market failure situations one will always faces a number of limitations such as data constrain and imperfect information. The main weakness of this study is related to data constrain, especially concerning non-market goods. As most of the data was collected from other studies the study ended up being more limited than initially expected. CVM methods, for the biodiversity case, are also often controversial and no good substitute method was found to built upon. An important issue, however, was to express the overall difference between an optimal scenario that maximizes the society‘s net welfare and the current situation of payments. The current payment scheme is better than a business as usual scenario but it is far from optimal. Opportunity costs of other land use are not completely compensated in the payment scheme. Nevertheless, more effort should be made from the buyers of ES towards introducing payments that reflect all value incorporated in what they are paying for. Adjustments from family-based to hectare-based could help to improve efficiency within the program. But it is understandable that this shift depends more on other issues such as a proper definition of land possession and land tenure agreements, than simple regulation.

Admittedly the calculations were only possible after some simplifying assumptions concerning costs and production functions, which have a real impact in the numerical results. Regardless of the generalizations a clear trend can be observed – optimal payment exceed current payment.

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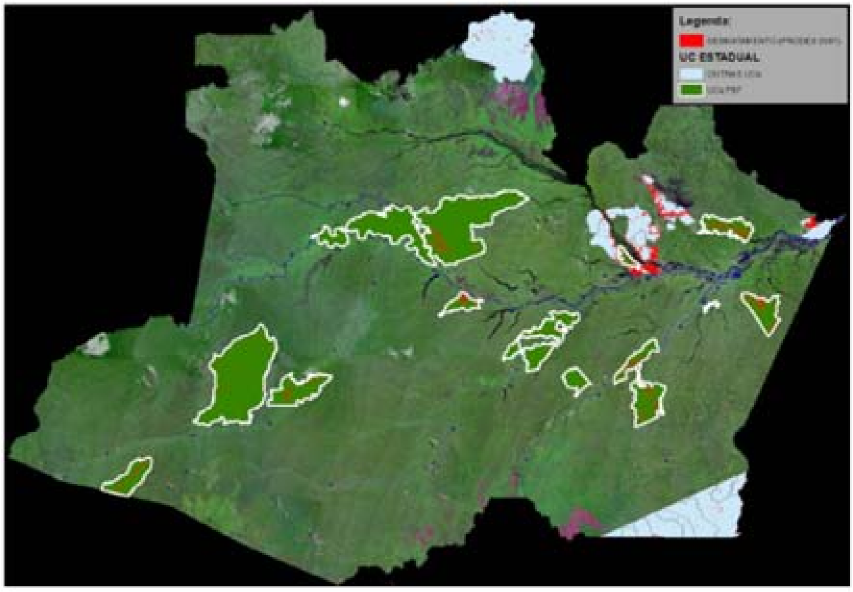
APPENDIX 1. DEFORESTATION PROJECTION: BOLSA FLORESTA SCENARIO

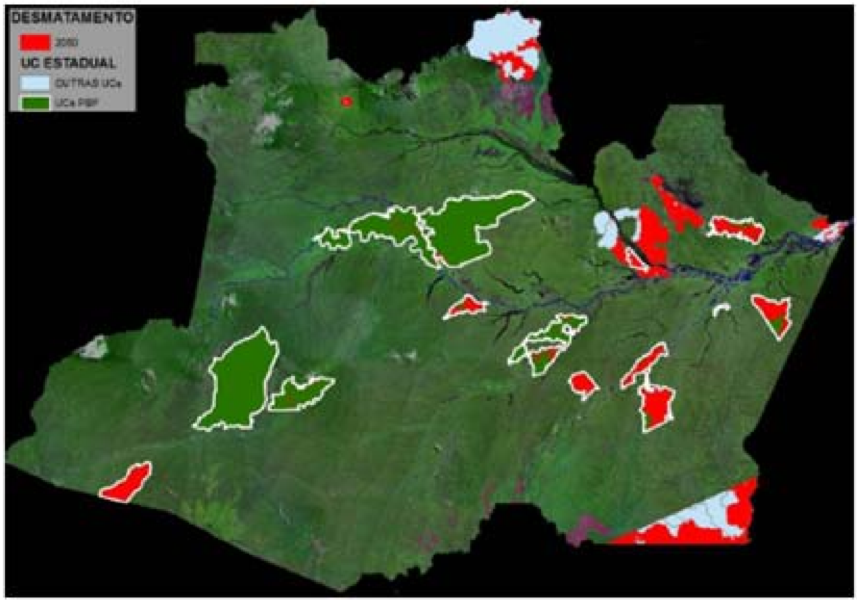
1) Projection for 2050: Areas previously deforested in the Coservation Units attended by the Bolsa Floresta Program



Source:INPE_PRODES(2007)

APPENDIX 2 : DEFORESTATION PROJECTION: BUSINESS AS USUAL SCENARIO

Projection 2050: Deforestation foreseen in the Conservation Units attended by the Bolsa Floresta Program as per the scenario "'Business as Usual'" of SIMAMAZONIA MODEL.



Source: Soares-Filho et al.(2006); FAS(2008)

APPENDIX 3 : From Constanza et al 1997, assuming that the demand curve for ecosystem services looks more like Fig. 1b than Fig. 1a, and that therefore the area pbqc is a conservative underestimate of the area abc .