ECONOMIC PROPOSAL FOR THE COMPENSATION OF ENVIRONMENTAL GOODS AND SERVICES IN THE MOORS AND FORESTS OF THE PROVINCE OF CHIMBORAZO.

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Summary: *This article presents an economic proposal for the compensation of environmental goods and services in the páramos and forests of the province of Chimborazo. It is based on the recognition of the importance of these ecosystems in the provision of various environmental services, such as climate regulation and biodiversity conservation, among others; the proposal prioritizes water resources since they are threatened by various human activities, such as deforestation, extraction of natural resources and livestock and agricultural activity. Therefore, there is a need to establish a compensation mechanism for owners and communities that contribute to the conservation of these ecosystems and promote their sustainable use. The proposal presented in this article is based on the implementation of a system of payments for environmental services, through which owners and communities that commit to conserve and properly manage moorland and forest ecosystems would be compensated monetarily. The financing of this payment system would come from various mechanisms, such as public funds, international cooperation resources and contributions from the private sector.*

The implementation of this economic proposal that aims to conserve 756 hectares through a payment of 596,836 through the implementation of projects would encourage the conservation of natural ecosystems in the province of Chimborazo and promote their sustainable use, generating benefits for both the environment and the people who depend on them.

Palabras Clave *: economic proposal, environmental goods and services; environmental valuation; ecosystems, forests, páramo.*

1. INTRODUCTION

The conservation of natural ecosystems is essential to ensure the quality of life of people and the sustainability of the planet. In the province of Chimborazo, páramos and forests are an essential source of environmental goods and services, such as climate regulation, biodiversity conservation and the provision of water for human consumption and agriculture (1). However, these ecosystems are threatened by deforestation, natural resource extraction and irresponsible livestock and agricultural activity. Given this situation, the need arises to implement an economic proposal that allows compensating the owners and communities that contribute to the conservation of these ecosystems and promote their sustainable use. This article presents an economic proposal for the compensation of environmental goods and services in the páramos and forests of the province of Chimborazo, with the aim of promoting their conservation and sustainable use (2, 3).

Since the 90s, innovative initiatives have emerged to ensure the sustainability of ecosystem services known as Payments for Environmental Services (PES), focused on the protection of watersheds in Latin America and globally in terms of specific services markets such as carbon capture and storage (4-6). For the last decade this type of instruments has had a wide growth(7), hundreds can be found around the world and following Brazil as an example, by 2011 there were more than 50 mapped initiatives (8). Generally, Payments for Environmental or Ecosystem Services have been designed to guarantee four services: biodiversity conservation, hydrological services, carbon sequestration and

scenic beauty; However, the difficult implementation of the proposals shows deep criticisms of the instrument (9).

From the theory of Payments for Environmental Services, it has advanced from the generalized definition of PES, which required the definition and fulfillment of certain criteria: a voluntary transaction between a provider and demander, of an environmental service defined with conditionality, to a broader definition that allows an analysis of governance and institutionality necessary to successfully implement this type of initiatives (10). . The transfer of resources between social actors, with the aim of creating incentives that align individual and/or collective land use decisions with social interest in the management of natural resources (9).

Outcome-based PES, which pays for theeffective delivery of an environmental service, as opposed to action-based PES, which pays for the implementation of specific conservation practices, are funded by companies or individuals, rather than by the government, and community PES, which involve the local community in the management and distribution of payments (5). These types of PES can be designed and applied at different scales, from small local communities to large watersheds, and can address a wide range of ecosystem services, such as biodiversity conservation, climate regulation, water production and protection against natural disasters. In addition, they can be complemented with other conservation mechanisms, such as protected areas, conservation zones and sustainable agricultural practices, to increase their effectiveness and achieve long-term conservation objectives (11, 12).

The conceptual advances march in several directions, first it is accepted that a PES scheme should not necessarily define the Ecosystem Service, due to the complexity of the natural systems evidenced in practice, and instead, the proposal is framed in the type of activities that guarantee a certain service as explained by Wunder himself ten years after its first definition: "Payments for ecosystem services can be defined as a voluntary transaction between service users and service providers that are conditioned in agreed rules for the management of natural resources to generate external services, this definition takes into account the observation that in general agreements have been built around proxies on the use of resources and not on ecosystem services (which cannot always be well defined) as the first measurable behavior and as an indicator of compliance" (10)

The Compensation or Remuneration Mechanisms for Ecosystem Services (MCSE) can be defined as instruments that aim, through voluntary agreements between the parties, to channel economic resources to be invested in the conservation, recovery and sustainable use of the sources of ecosystem services. They emerged in the 90s with various names grouped as Payments for Environmental Services - PES, focused on the protection of watersheds in Latin America and worldwide in terms of specific services markets such as carbon capture and storage (4). For the last decade this type of instruments has had a wide growth, according to Singh et al, 2016, hundreds can be found around the world and following Brazil as an example, by 2011 there were more than 50 mapped initiatives (13). Generally, Payments for Environmental or Ecosystem Services have been designed to guarantee four services: biodiversity conservation, hydrological services, carbon sequestration and scenic beauty; However, the difficult implementation of the proposals shows deep criticisms of the instrument (9)

For the province of Chimborazo whose priority ecosystem service is water regulation and provision, it seeks to propose a compensation mechanism that takes into account the lessons learned worldwide by this type of instrument. To this end, this first part presents the different possibilities of compensation of water resources, to generate later with the analysis of the territory a coherent and applicable proposal.

The theory of PES has advanced from the generalized definition of PES proposed by Wunder in 2005, which required the definition and fulfillment of certain criteria as a voluntary transaction between a provider and demander, of an environmental service defined with conditionality, to a broader definition that allows an analysis of governance and institutionality necessary to successfully implement this type of initiatives (14). "the transfer of resources between social actors, with the aim of creating incentives that align individual and/or collective land use decisions with the social interest in the management of natural resources" (9)

Second, negative impacts were evidenced on certain communities with direct monetary payments, by displacing other sources of motivation such as altruism with the possibility of decimating the expectations of mutual social responsibility and changing the logic of behavior from civil duty to instrumentalism, which generates that the definition of PES is extended to compensations. remuneration or payments directly or indirectly; This possibility makes it possible to strengthen existing community schemes, taking advantage of the existence of conservation attitudes present in the territories (5). Examples of this change of approach are the Rewarding Upland Poor for Environmental Services (RUPES), compensation for ecosystem services (CES) or Rewards for ecosystem service stewardship (RESS) (15, 16) programs.

Third, the practical analysis of PES has led to the conclusion that 97% of the schemes implemented have been public schemes, insofar as it is the public sector that acts as a source of resources, that is, schemes in which the state (on behalf of the beneficiaries) compensates the actors that guarantee or promote conservation actions (17). . PES in practice are mostly government offsets such as subsidies or based on price signals, so their proposal is to speak in terms of economic instruments, and not market-based, although they warn that there are markets for ecosystem services such as carbon markets or emissions trading system. This result is expected if one takes into account that the ecosystem services included in PES schemes are mostly public goods or common resources, whose benefits cannot be excluded and therefore require state action (18). The illusion of creating (private) markets to guarantee services has been constrained by high transaction costs, inadequate demand, high interrelatedness and complexity of natural systems, and their characteristics of difficult exclusion and divisibility (public or common goods) (5, 8, 19).

Finally, the new definitions of PES seek to include the analysis of the existing institutionality, rules, values and actors that will jointly make possible the achievement of conservation objectives (9). PES can offer a fair and efficient way to deal with growing interconnections, but this solution needs to be based on the proper functioning of hierarchies and/or communities, i.e. under alternative governance structures (hierarchies, markets, community management) that can manage interconnections, a reconfiguration of state-market-community relations (20).

In practice, there are cases of small local communities that have generated direct agreements for the protection of the upper parts of watersheds (21-23), given the low transaction costs and the possibility of delimiting beneficiaries while having clear property rights in the upper parts, examples that will be analyzed for the proposal of the compensation mechanism in the province of Chimborazo. Likewise, the water PES that involve a greater number of beneficiaries and actors will be analyzed, which have required the formation of instances that act as intermediaries, such is the case of the water funds, mixed instances that seek to coordinate actions and contributions (voluntary and state) for the conservation of strategic areas for the provision of water service.

In the case of the province of Chimborazo, it is possessed as a strategic territory because it contains Paramo ecosystems, capable of supporting high biodiversity and being water regulators and carbon sinks, being able to ensure the importance of the forests and moors of the province to guarantee the environmental functions necessary to generate the water supply service; This study proposes to show possible actions that articulate the territory and the existing economic and social legal instruments. Distribution of burdens and benefits, would mean that the benefits offered valued were remunerated, compensated, to face the different pressures suffered by the province.

Although topics such as "conservation incentives" and "Payment for Environmental Services – PES" are not new in the economic literature, it is evident that there is still an unequal knowledge of these among the different social actors that by legal norms must, or voluntarily want to advance actions to conserve and sustainably use the existing natural resources in a certain geographical site in order to avoid, over time, the decrease or loss of the various ecosystem functions whose offer generates both direct and indirect benefits to human communities (14, 24).

Markets for ecosystem services can increase the efficiency and flexibility of resource allocation, but they can also exacerbate social inequalities and generate problems of exclusion, marginalization and privatization of the commons. In addition, markets for ecosystem services can undermine the legitimacy of decision-making and citizen participation in natural resource management by limiting

the ability of local communities and vulnerable groups to influence the definition of environmental services and conservation priorities (24). . Therefore, markets for ecosystem services must be subject to clear and participatory ethical, social and environmental criteria, and must be complemented by other forms of management and governance that promote equity, justice and sustainability.

From a general context, conservation incentives are signals (e.g. economic, tax) that some subject or social group sends to certain actors to induce them, specifically, to make voluntary changes in their usual decision-making patterns associated with the use or management of renewable natural resources and biodiversity (25).

These signals emitted from one actor to another, are monetary or non-monetary recognitions that in practical terms aim to avoid the deterioration or loss of natural ecosystems (forests, wetlands, moors); promote its restoration mainly in strategic areas for the generation of environmental services; and mitigate the negative social effects caused by the progressive decrease in the available environmental supply, in a given geographical space, when productive activities are carried out or unsustainable consumption habits are maintained (9).

These incentive mechanisms can have a positive impact on the conservation and sustainable use of natural resources, but it is important to note that their success depends to a large extent on equity and legitimacy in their design and implementation (26). As Corbera, Brown and Adger (2007) point out, markets for environmental services can be perceived as inequitable or illegitimate if the concerns and needs of local communities are not taken into account and they are involved in the decision-making process. It is therefore essential that these incentives are designed in a participatory and transparent manner, and that the social and cultural context in which they will be applied is considered.

2. Materials and Methods

For the construction of the proposal for economic compensation of environmental goods and services, it seeks to identify an adequate compensation mechanism for the prioritized areas, which is configured in the possibility of generating public policies around the water resource of the province of Chimborazo

In this context, in the province of Chimborazo the proposal of the compensation mechanism is based on the valuation and prioritization of water resources, the analysis of ecosystem services, environmental problems, and the quantification of beneficiaries and guarantors of water resources.

2.1.Analysis of existing incentives

Based on the collection of secondary information, the weaknesses and strengths of the existing incentives are analyzed: Socio Bosque Program (and internal line Socio Páramo), compensation mechanism proposed in the Rio Blanco micro-basin.

2.2.Identification of environmental services to be maintained or recovered

With the information collected, the environmental services to be maintained or recovered were mapped (in number of units/ha), as well as the socio-environmental problems, especially the relationships between the population, land uses and the positive and negative impacts on the generation of environmental goods and services that will be subject to the compensation mechanism.

2.3.Identification and characterization of the owners of the areas to be protected, conserved and/or recovered (the guarantors of ecosystem services - supply).

They are found in the prioritized areas applied to a representative sample for each of the areas. For which the instrument of information collection will be elaborated taking into consideration the measurement of the following characteristics: a) Analysis of Opportunity Costs: most representative productive systems in the region, structure of costs and income of the most representative productive systems, quantities produced, price of the final product, estimation of the net present value in order to calculate and project in the future the profitability of the most representative productive systems. representative, as an approximation to the opportunity costs of producers. b) Perception of compensation: to know the perception of the community for compensation. Compensation options for the maintenance of ecosystem services can range from direct recognition in monetary terms, to

support for specific projects, so it is important to know what the community expects regarding an SE compensation initiative. Among the alternatives can be: direct monetary recognition for conservation, development of activities and uses that enable the production of the service, facilities for the acquisition of inputs, technical assistance, investments in infrastructure for the development of sustainable activities, support for the marketing and marketing of environmentally certified products, training and environmental education

2.4.Analysis of beneficiaries (users) of ecosystem services

The analysis of the beneficiaries of ecosystem services will be carried out to identify possible sources of financing for the compensation of ecosystem services such as: identification of sources of financing, analysis of the cost structure of water service providers, analysis of the availability to pay of previous pilot studies, analysis of existing financial instruments (fees for use, royalties, transfers, taxes), identification of institutional arrangements, identification of companies, public institutions, NGOs, associations, interviews with identified actors

2.5. Analysis of the legal-technical-financial feasibility of developing an Environmental Service Payment (PES) scheme.

Based on the information, the feasibility of the compensation mechanism will be analyzed. The proposed compensation mechanism should analyze which is the most appropriate scheme, that is, the scale of work.

On the one hand, a local scheme with the prioritized micro-basins feasible to work at the local level strengthening their own rules and agreements, or on the contrary the possibility of articulating at the provincial level under a water fund different public and private contributions for the conservation and / or recovery of the upper parts of the basins. Therefore, we do not propose the commodification of water services, but a scheme that recognizes private efforts in conservation, under considerations of equity and recognition of existing cultural values: analysis of implementation scheme (scheme operator, fund), analysis of transaction costs (implementation, monitoring) and administrative costs, analysis of alternative costs (example: Biological corridors, Enrichment, Living fences, Agroforestry systems)

2.6.Proposed compensation mechanism

Based on the information collected, the structure of the compensation mechanism will be made: Determination of the amount of compensation: For the determination of the amount in money or in kind to be recognized, the opportunity cost assumed by the owner, possessor or holder of the property for his decision to conserve and / or recover natural resources will be taken as a reference. Faced with alternative land uses that contemplate economic benefits, determination of the operation scheme: The actors (public and/or private), the operator, and the respective functions will be defined, determination of the implementation costs and the operation of the system, determination of the sources of financing

To this end, water resource management strategies in the province (legislation, projects and programmes) are compiled. Subsequently, the implementations of Payments for Services type schemes are presented.

Environmental in Ecuador and specifically in the province, in a Latin American context. Subsequently, the location and delimitation of the prioritized areas is presented. The valuation of the amount to be compensated is made from the identification of the opportunity cost, while the financing is made through the analysis of the beneficiaries of the water resource.

3. Results and Discussion

The review of the legal basis and incentives is one of the first steps to analyze the management and compensation strategies that can be carried out within the framework of sustainable development and the main incentives at the national and provincial level are presented below as a basis for the proposal of the compensation mechanism:

Table 1 Environmental Incentives

Environmental incentives	Description
Agreement No. 169 (The "Socio Bosque" project of the Government of the Republic of Ecuador is established)	Official Journal 482, 5-XU-2008 Economic incentive Owners of native forests, moors and other native plant formations. Socio Bosque consists of the delivery of economic incentives to peasants and indigenous communities who voluntarily commit themselves to the conservation and protection of their native forests, páramos or other native vegetation.
Instructions for granting the economic incentive for afforestation and reforestation for commercial purposes	Official Register Supplement 863, 5-1-2013 - Economic incentive The incentive constitutes a direct non-refundable economic transfer, delivered by the Ecuadorian state through the Ministry of Agriculture, Livestock, Aquaculture and Fisheries MAGAP
Ecuador's Tax Equity Reform Law **Chapter IIICreación del Impuesto a las Tierras Rurales (Article 180)**	Exonerations.- Owners or possessors of real estate are exempt from this tax in the following cases: The properties located in moorland ecosystems, duly defined by the Ministry of Environment. Properties located in public or private protection areas or ecological reserves, registered with the corresponding public body. The properties of the communes, indigenous peoples, cooperatives, unions, federations and confederations of cooperatives and other associations of peasants and small farmers, legally recognized. Wetlands and natural forests duly qualified by the environmental authority.
Organic Law on Water Resources, Uses and Use of Water (Article 137)	Tariff component for water conservation. The Single Water Authority, as part of the authorization rates for the use and exploitation and service of water, will contemplate a component for conservation of the public water domain with priority in sources and areas of water recharge. The Decentralized Autonomous Governments, within the scope of their competences, will establish components in the tariffs of domestic public services linked to water to finance the conservation of the public water domain with priority in sources and areas of water recharge.
Ordinance that regulates the management and conservation of the paramo ecosystem, micro basins and hydrographic units in the chambo canton	Official Register 304, October 20, 2010 Tax incentive, moral 1. Protect and conserve the paramo ecosystem, native forests, watersheds and micro basins, fragile ecosystem and other adjacent priority areas for the conservation of water resources in the Chambo canton. Municipal environmental authority: Municipality of the canton Chambo 2. Tax Exemption.- Real estate declared as a reserve, and registered in the Regional Forest Registry of the Ministry of the Environment, must be exempt from payment of the tax on rural properties.
Ordinance for the protection of micro-watersheds, fragile ecosystems and other priority areas for the conservation of biodiversity of the Macará canton (Official Register 348, October 16, 2012)	The Municipal Decentralized Autonomous Government of the Macará Canton, in coordination with public and private institutions, will provide incentives to the owners and inhabitants of the areas declared as Reserves. It will focus on the protection of forests, micro-watersheds of water and natural importance, fragile ecosystems and other priority areas for the conservation of natural resources. The properties or buildings considered as a reserve must comply with conditions such as protection of natural resources, provision of natural services, refuges of wild flora and fauna, permanence of the vegetation cover in a natural state

	A tax incentive will be made exempting the payment of rural property tax and rural lands declared as a reserve. Support in the implementation and improvement of sustainable productive activities.

For the construction of the proposal of Compensation Mechanism for Ecosystem Services for the Province, the prioritization of areas has been taken into account, according to indicators such as population, areas of páramo and forest, unsatisfied basic needs (NBI), flow concessioned in irrigation and consumption, water catchments, number of users for water consumption, Land use change in forests and moors.

Areas were prioritized through the use of geographic information systems to validate existing information on the location of páramo and forest ecosystems in the province of Chimborazo. In addition, it influenced the selection of areas, the main sources of water since around these economic activities such as agriculture and livestock are carried out. Within these cantons, a prioritization was proposed in those parishes that are located in the agricultural frontier, upper part of the micro-basins. This would have four prioritized parishes, one in each Canton. In addition, for the prioritization the population was considered since it depends on the inhabitants the changes that can be made in moors and forests.

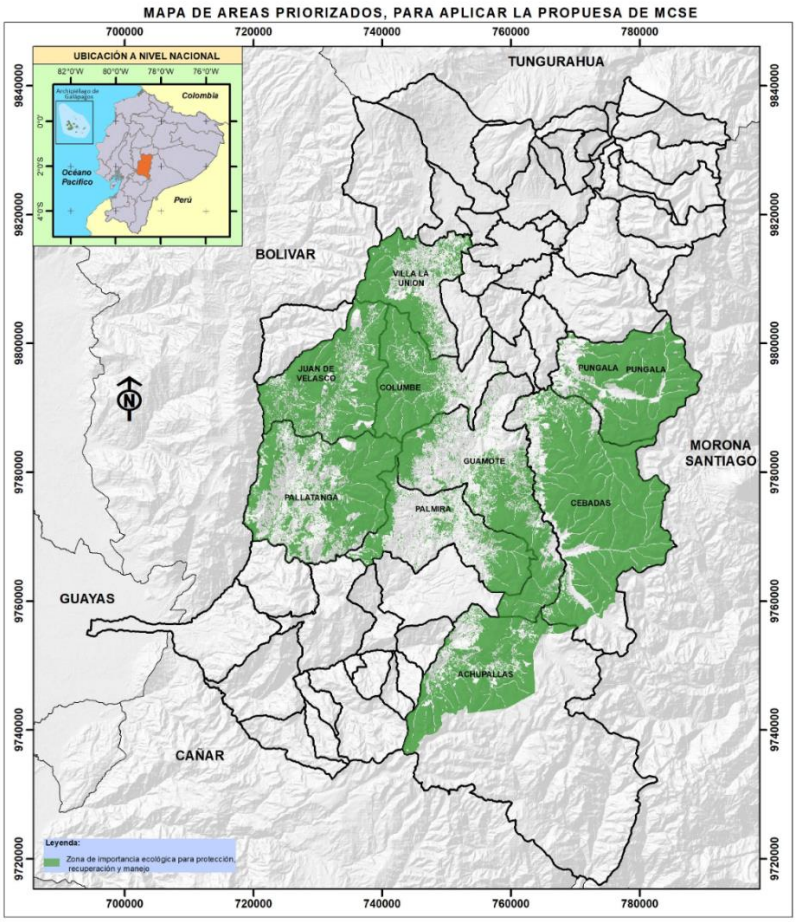
The area of highest priority is the Zone of ecological importance for protection, recovery and management, which corresponds to 47.37% (307,923.46 ha) of the provincial territory; in the same way they have determined the Agricultural Production Zone, which represents 12.76% (92,405.11 ha) of the territory; in the same way they consider the Sustainable Livestock Production Zone with 6.94% ; as well as with 5.32% the Agricultural Production Zone under irrigation. There are also other important areas with a lower percentage of the territory of Chimborazo, some of them oriented to the conservation of natural resources; while others focus on the development of productive subsistence activities.

In conclusion below, the areas in (ha) at the parish level, of the prioritization of the territories that can be considered within the proposal of Compensation Mechanism for Ecosystem Services (MCSE) for the province of Chimborazo are detailed, the same ones that collect information from the provincial Economic and Ecological Zoning, in which they determine that the Zone of ecological importance for protection, recovery and management; It is the area that occupies 47.37% (307,923.46 ha) of the province, so much importance should be given. Table Table **2.** Prioritized areas in the province of Chimborazo and Figure 42 below show the territories with the largest surface area that could be considered for applying the MCSE. **Figure**

Table 2. Prioritized areas in the province of Chimborazo

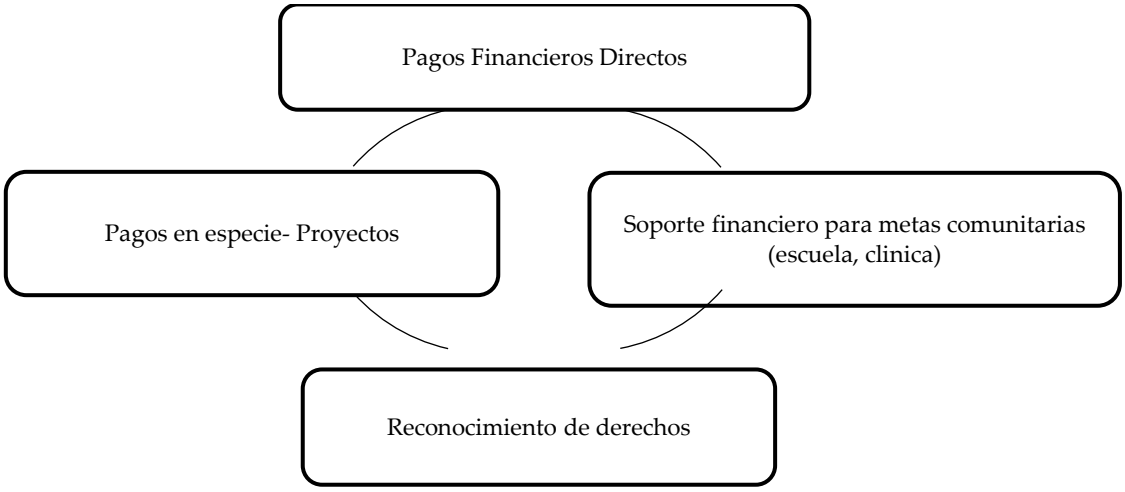
CANTON	PARISH	POPULATION	AREA HAS
GUAMOTE	Barley	9.964	41991,45
	Guamote (Cantonal Capital)	29.872	18787,26
	Palmira	14.910	10410,17
PALLATANGA	Pallatanga	12.251	21877,98
RIOBAMBA	Pungalá	6.746	21556,00
READ	Juan de Velasco (Pangor)	3.978	20616,10
	Columbe	16.104	14643,65
	Villa la Union (Cajabamba)	18.845	10508,79
ALAUSI	Achupallas	10.872	20255,67
TOTAL		123.542	180.647

Figure 1. Map Prioritized Areas for MC



The construction of the economic compensation proposal proposes as a financial mechanism the establishment of a fund with different possibilities to compensate the conservation effort of producers, compensate directly with a monetary contribution that covers the opportunity costs per hectare, or compensate through specific activities.

Figure 2 Types of compensation



According to the diagnosis, milk production and potato cultivation are the main agricultural activities. Of the overall area of crops in the province about 55% corresponds to pastures dedicated to livestock production especially livestock for milk production, generally the pasture areas are located in the area called foot of páramo between 3,500 and 3,700 meters above sea level and is defined as an area of high altitude crops. This area is characterized by being on the edge of the agricultural frontier,

where the grasslands have been devastated. The second important item corresponds to 25% dedicated to potato production. The agricultural frontier is increased by the increase in these activities, so their opportunity cost is analyzed, which allows identifying the cost that farmers would incur by ceasing to carry out their productive activities in favor of the conservation of vegetation cover. It seeks to obtain the value per hectare, which allows to be a reference within an availability to accept a change of activity.

- *Livestock Activity - Dairy Livestock*

Livestock for milk production is considered one of the most important within the livestock activity in the country, and constitutes the basis of the peasant family economy in a wide territory. Dairy producers can be classified, depending on the volume of milk delivery, into small, medium and large, the former have between 5 and 19 cows in milk, whose production does not exceed 50 liters per day, a medium production fluctuates between 100 and 700 liters per day, counting between 31 - 50 head of cattle, the stratum of large producers has a production of more than 700 liters per day with more than 50 head of cattle (27) . For the province, a production of 137,454.273 liters/year is estimated as shown in Table 3, mostly characterized as small producers.

Table 3 Provincial milk production

PRODUCT	PRODUCTION	SALE PRICE
MILK	137,454.273 liters/year	0,40 USD

Most dairy producers in the province of Chimborazo are small and of low technological level (infrastructure and equipment, pasture management, complementary feeding, sanitary control, artificial insemination), they also have little help dedicated to providing assistance to milk production, it does not allow them to obtain better yields in production. It means high unit costs of production; There are deficiencies in the technical indicators of the production of each of the producers are: interpartum periods, lactation periods, birth rate, effective weaning rate, mortality rate, and animal load, etc. (28).

The investments made by the farmers are then established in the cash flow which are assumed by the owner with his own resources. The necessary investments are calculated to be made in the first and fifth years, but the value of these investments may be deferred to the years of life of the project and according to the type of investment, as well as the depreciation of these. Investments in animals, fixed and variable costs were determined in order to perform the net present value analysis, as set out below.

Production costs are established according to categories or groups, so that they have certain common characteristics to be able to perform calculations, analysis and present information that can be used for decision making and are distributed among the various productive units through some distribution criterion, they are assimilable to fixed costs. Production costs are summarized in the following table which is broken down below:

Table 4 Cost of Production

Cost of production	1	2	3	4	5	6	7	8	9	10
Production cost	28.614	30.044	31.546	33.124	34.780	36.519	38.345	40.262	42.275	44.389
Contingencies 5%	1.431	1.502	1.577	1.656	1.739	1.826	1.917	2.013	2.114	2.219
TOTAL	30.044	31.546	33.124	34.780	36.519	38.345	40.262	42.275	44.389	46.608

The criterion used for the evaluation is the net present value of the projected flows to 10 years, and the internal rate of return - IRR, as indicators of profitability, for this it is necessary the sales budget, the flow of results and the cash flow described below. The income received by the activity corresponds to the projected sales of the product. The income line is a straight line (in this case) that is built with the amount of annual liters and the sale value according to medium producer, for the following years an increase in the price of 2% and costs of 5% per year is projected, the income for ten years of operation of the project is recorded. The data that are considered in the income correspond to a medium producer where he has about 22 cows in production in their best conditions, therefore there would be a monthly production of around 11,500 liters of milk.

If the project were liquidated at the end of year 10, the return on the monies invested in the project would be at the opportunity rate $ 66,457 of present value. This indicates that the project is financially viable.

In the context of a PES scheme, the net present value makes it possible to calculate what the future net benefits to be obtained from the development of the productive activity in question in question are worth at today's prices. In this case the discount rate (r) reflects the profitability of the best discarded alternative. The use of discount rates must be careful given that when it comes to evaluating environmental projects, it represents the pace at which we make use of natural resources. That is, the higher the rate at which the future is discounted, the greater the rate at which natural resources are likely to be degraded. The opportunity cost per hectare is then the flow value of results $25,436 divided by the 15 hectares we established as a standard farm: $1,696

- *Agricultural Activity- Potato Cultivation*

The potato is one of the main crops in the country for its participation in the diet of Ecuadorians and for its economic and social importance in generating income for producing families. It ranks tenth among the most consumed products by the population and is among the eight crops with the highest production in the country, with 397,521 tons (29)

The total cost to produce one hectare of potato in 2017 was USD 5,009.42. Regarding the cost structure, 31.10% is destined to the harvest due to the large amount of labor required to carry out this activity.

24.52% was destined for fertilization due to the amount of nutrients needed by the crop (calcium, magnesium, manganese, copper, cobalt, boron, zinc, among others). 14.38% corresponded to phytosanitary control because the crop needs pesticide applications due to vulnerability to disease attack. 13.86% was destined for sowing in which seed and labor are included. The remaining 30.00% was allocated to activities such as land rental, cultural work and land preparation. (30)

Table 5 Potato crop production

	HARVESTED AREA Ha	TONS PRODUCED	PERFORMANCE t/ha	SELLING PRICE QUINTAL/USD
POPE	7,450 ha	113.588 t	15.3 tons/ha	16,50

The main results obtained indicate that potato productivity at the national level exhibits an outstanding average yield of 16.49 tons per hectare. At the cantonal level, different rates of return are exhibited.

Table 6 Cost of Production

Activity	Production cost (USD/Ha)
Preparation of the ground	208.00
Sowing	1,580.56
Fertilization	1,228.50

Harvest	1,582.00
Indirect Costs (Land Lease)	410,36
TOTAL COST	5009,36

In summary, thevalues per hectare were obtained as an opportunity cost in which the bed has an opportunity cost of $ 1,696 and its lease cost per ha is $ 650; while the potato has an opportunity cost of $ $ 991and its lease cost per ha is $ 410.36

The Water Fund for the Province of Chimborazo proposes that it be established with a significant contribution from the constituent members, corresponding to 1% of the budget of the provincial, cantonal, and parish governments. It is proposed, as a second important item of financing, the contribution of direct users of water resources, attributable to the drinking water, sewerage and electricity plans, which would have to be established by ordinance of the Municipal Government and collected by the public companies providing the services, as constituent members of the Water Fund. This value is proposed to reach USD 0.5 per year for users of drinking water in the cantons of Guamote, Alausí, Colta, and Pallatanga, while a value of USD 1 is proposed for the canton of Riobamba given its socioeconomic conditions. It is clarified that these values correspond to an ideal, which must be adjusted according to the pilot areas chosen at the time of implementing a compensation mechanism. The economic proposal for the fund is made up of the contributions of water users (irrigation and consumption) explained above, through cash contributions. The contribution of the provincial, cantonal and parish governments corresponds to 1% of the general budget described above (**Error! Reference source not found.**). The other financial resources (national government, international cooperation, NGOs, private sector), will respond to the achievement made by the technical secretariat of the fund, which is why they are not included in this initial proposal. A 40% patrimonial fund is proposed, which by 2023 would reach a budget of 2,230,293, to serve as a counterpart for international cooperation resources, and 60% as extinguishable equity for investment. The first year does not include user contributions, as this will be part of the first year process. The Investment will be developed according to the prioritized areas and according to the approval of the constituent members. It is important to emphasize that this budget will depend on inter-institutional consultation, and therefore does not respond to actual funds, nor to commitments from the communities or the government.

The implementation and operation costs of the system to be taken into account include (i) landscape intervention costs, (ii) administrative costs and (iii) direct payments or projects as a compensation measure:

The scheme must contemplate the interventions that must be carried out in the landscape to generate the desired changes in terms of increasing forest cover, connectivity and conservation of water resources and biodiversity. The different types of landscape management tools (HMP) generate additional costs that must be taken into account as implementation costs of the scheme and it must be defined who assumes these costs, either the operator of the MCSE or the owner of the property.

As an initial proposal, they could be compensated through direct financial payments, for this the value of the opportunity cost analyzed is taken and multiplied according to the hectares to be compensated. Taking as a reference the initial budget of the second year (since the first year requires the design of the fund), and the opportunity cost obtained, 756 hectares could be covered. However, according to the analysis of different funds, investment in projects is more sustainable and effective as a compensation measure for the conservation of forests and moors of the Province with a total budget of 596,836.

In both cases (direct payments or by projects), the conservation commitments of the families receiving compensation must be clear, through the signing of agreements. The beneficiaries undertake to (according to the defined priority areas) maintain or increase the páramo ha, and the fund undertakes to carry out projects to conserve and improve the environmental conditions of the páramo and forest (or to a direct payment per ha).

CONCLUSIONS

Compensation for environmental goods and services in the páramos and forests of the province of Chimborazo is an important strategy to encourage the protection of these ecosystems and promote their long-term conservation. The payments for environmental services (PES) proposed in this study are an effective tool to incentivize landowners and local communities to protect the ecosystem services provided by páramos and forests, such as regulation of the hydrological cycle, carbon sequestration, biodiversity conservation and other services.

The implementation of a PES program in the province of Chimborazo seeks to generate environmental benefits for the protection of water resources and compensate for what communities would stop producing in agriculture and livestock and thus generate economic, social and environmental benefits, promoting sustainable development and improving the quality of life of local communities. It is important to consider a sustainable and long-term financing strategy for the implementation of the PES program, ensuring the financial viability and continuity of the program over time.

The implementation of the PES program must be accompanied by constant monitoring and evaluation to evaluate its effectiveness and make informed decisions to improve the program.

Finally, the implementation of the PES program must be part of a comprehensive strategy for the conservation and sustainable use of natural resources in the province of Chimborazo, involving all relevant actors and promoting dialogue and the active participation of local communities in the process.

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