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Environmental services application

The CPWF projects evidence in the Andean Catchments

Contribution for the Sustainable Development of the Andes
Issue. 8, December 2007

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Ma. Catalina Ramírez

Synthesis Report 2006: Andean System of Basins Coordination
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International Potato Center
Apartado 1558, Lima 12, Perú
cip@cgiar.org • www.cipotato.org

Author: Ma. Catalina Ramírez
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Content

Introduction

The Coordination of the Andean System of Basins (ANDES) for the Challenge Program on Water and Food (CPWF) has the responsibility of compile information, raise awareness and gather fogether all the knowledge obtained under the umbrella of the CPWF and convert it into something called synthesis. One of the results of these processes is this Synthesis Report. This document is focused on one special topic that is expected to have a great impact in the Andes. The topic selected is Environmental Services.

The CPWF in its first competitive call financed five projects that have activities in the Andes and Central America. This document is based on how the projects relate to the topic Environmental services, the experience of CONDESAN and its partners, and the different experiences of the use of Environmental services as means to promote conservation and development in the Andean Region.

This document collects around one subject the findings of the research being done by the CPWF in the Andean Region. It will allow researchers and development institutions to have a grasp over the different initiatives in the Andes.

The document is divided in three parts; the first one presents an overview of the concept of environmental services and its logic. The second part relates the CPWF projects findings and research with the environmental services topic, for this purpose the projects where grouped in 2, the first kind that are more related to the biophysical aspects of the environmental service topics and the second kind that are more related to the social aspects of the environmental services topic. The last part presents an overview of the perspectives of conservation and development promotion through environmental services concept in the Andean Ecoregion.

Environmental services

The concept

A healthy environment provides many services and goods necessary to humans. The environmental services can be grouped in four: Water-related services, greenhouse gases capture, biodiversity conservation, and landscape beauty (Mayrand and Paquin, 2004). These four groups can be re-grouped in two (De Heck et al, 2004), the first one is related to global or large scale services, in this group services providers and users are not restricted to a local scale as in greenhouse gases capture, biodiversity conservation and landscape beauty. In the second group users and providers are within a concrete scale, e.g. water related services in a watershed.

The water related services usually flow from one place to another meaning that the benefits may be perceived in a different place from where they are originated. Water related services are usually originated upstream and benefit users downstream. The production function of every service may be different, so increasing the flow of one service may decrease the production of the other, for example a fast growing tree plantation may increase the carbon sequestration but may not be good for biodiversity or for water provision (Wunder, 2006).

Humans usually modify the environment in which they live, changing the natural flow of services, altering them in a positive or negative way. Individuals, communities, and country governments have noticed that a damaged environment stops providing the necessary services for human, industry and environment needs. All over the world studies about environmental services are being undertaken. Services have shown humanity how important environment is to us and to our way of living. Environmental Services concept may provide an answer to the sustainability paradigm: How to increase our development and production indexes while keeping a healthy environment?.

Logic behind the markets for environmental services

The logic behind the Environmental Services Payment schemes relies in the fact that the environmental externalities (positive or negative) are not incorporated to the price or services available in the market. As a consequence some markets may be bad for conservation or pollution controls by the signs the send through its prices. The situation may ends up in a destruction of the natural capital or pollution at unacceptable levels. Traditionally the situation has been tackled by command and control mechanisms. Nevertheless PES schemes can be more effective and less expensive. Furthermore, it can be impossible to implement command and control measures to poor rural communities that depend on the resource exploitation for survival. The regulatory perspectives may end affecting these groups pushing them to illegal situations (Mayrand 2004).

How the Environmental services, water, and food are related?

For humans, especially those poor, changing the environment is vital. Cultivate crops may be their only

source of food or income. This new “agro-ecosystems” may improve or deteriorate the environmental services flows. The research being done by CPWF tries to find solutions to this dilemma. Improve water productivity in the following way: while more food is produced with less water, better living conditions are provided and a healthy environment is maintained.

Most of the CPWF projects working in the Andean System of Basins deal with the concept of Environmental Services. The approach is different in every case, some of the projects study the services and try to quantify them, other may want to identify the types of services provide by one special ecosystem or agro-ecosystem, other study the valuation of the services and study the possibility of a market to preserve or motivate the provision of services, other deals with the social and/or institutional organization necessary to continue or start the provision of the services, etc. A more detail explanation is given in the following paragraphs.

The projects and environmental services

Causes and effects: The biophysical aspects of the environmental services

There are three projects working under the ANDES coordination that study the biophysical relationships between land uses or policy decisions and environmental services, they are presented in the following paragraphs: PN 15, PN 22 and PN 40.

PN15: "Unraveling the Mysteries of the Quesungual"

The Project 15 develops its activities in Honduras. The project wanted to study why de Agroforestry system implemented there called, Quesungual Slach and Mulch Agroforestry System (QSMAS) by FAO, was so successful and resilient showing an excellent behavior in front to natural disasters such as the Mitch hurricane. The system changed the typical Slash and Burn technology (S&B) to a more "environmentally friendly" system QAS, improving environmental conditions while maintaining or in some cases improving agricultural production. The project is now focused on discover the critical success factors as well as understanding the QSMAS behavior.

Different scientific research projects started looking in to plant, water, soil, and atmosphere relationships and dynamics. The results of the research have showed that the QSMAS compared against to the S&B produces positive environmental externalities[1] . There is scientific evidence that shows that water related services are improving generating positive environmental externalities or at least diminishing negative externalities caused by S&B. Soil erosion is diminishing improving water quality indexes. As well green house gases are captured in a better way comparing QSMAS against S&B.

The system may be a solution for some social and environmental problems in poor rural areas of LAC. The system improves agricultural yields, bringing food security to poor farmers, and slowing down the cutting of forests. The PN 15 is looking at results of the extrapolation of the system to Nicaragua, and there is a possibility to extrapolate it to other watersheds where CPWF is working in the Andean region, scientists have evaluated similar areas both in social and environmental aspects.

Following are QSMAS project Highlights:

About water related services:

- Losses of soil by runoff are reduced compared with typical S&B practices. Soil losses by runoff were greater at the beginning of the rainy season than during the rainy season differing from slash-and-burn system where soil losses occur all the time and even rise at the end of the rainy season. This fact reduces the sediments in watercourses improving the water quality available to users downstream; As well it increases soils water retention capacity, improving the soils' buffer capacity against

1 An Externality is an effect that a person or a EMPRESA cause over the other's well being. This effect may be positive or negative. Who causes the effect does not receive the compensation from the benefit or costs from the damage

fluctuations in rain patterns, helping with the prevention against floods and droughts. *Figure* 1.

- The presence of stones in the soil is one of the factors improving the performance of Quesungual system during the dry season. Found that soil with stone proportion of up to 60% do not restrict total biomass (shoot + root) production of maize with high and intermediate frequency of water application but the presence of stones between 40 to 60 % volume of soil can markedly improve soil moisture retention and therefore improve maize plant growth under low frequency of water application that simulates drought conditions. *Figure* 2
- Studies on soil physical characterization and water dynamics in the fallows of Quesungual system indicated a significant positive correlation between root biomass and available water holding capacity in soil.
- Quesungual system older than 10 years minimized soil losses by reducing runoff and improving water infiltration. *Figure* 1
- The researchers are also following the nutrients dynamics in the soils. Nutrient dynamics is a determining factor regarding soil productivity. Preliminary studies on nitrogen and phosphorus dynamics in Quesungual systems showed that the total pools of N and P were maintained or even increased in the plots of over ten years of the use of the system. *Figure* 3.

Figure 1. Soil losses rates at different QSMAS ages. The difference between S&B and the establishment of Quesungual. Source: TSBF, 2006

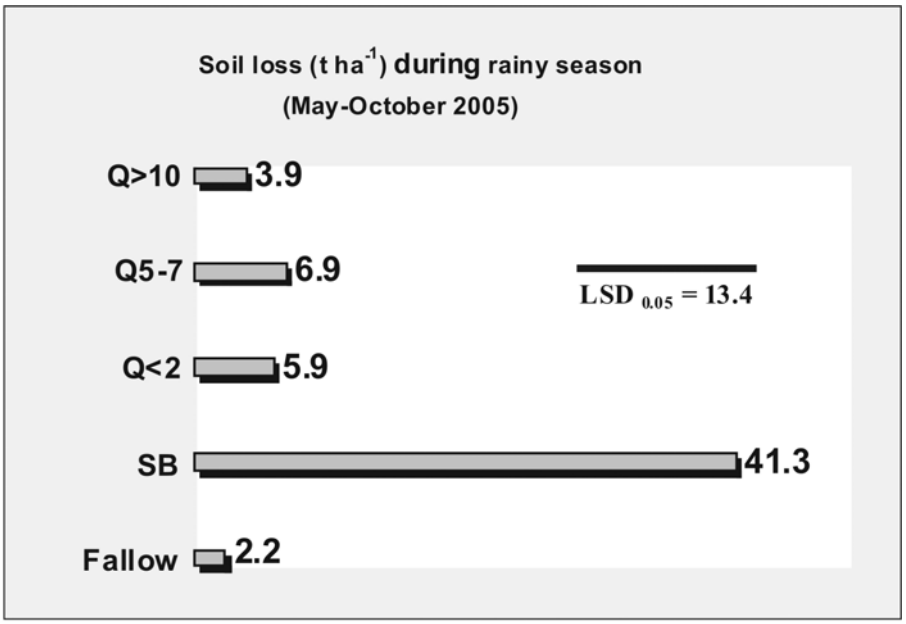


Figure 2. Differences in soil strength (kPa) across the soil profile in the high, medium and low parts of the slope of the Fallow 1 and Fallow 2 farms before establishing the QSMAS. Source TSBF, 2006

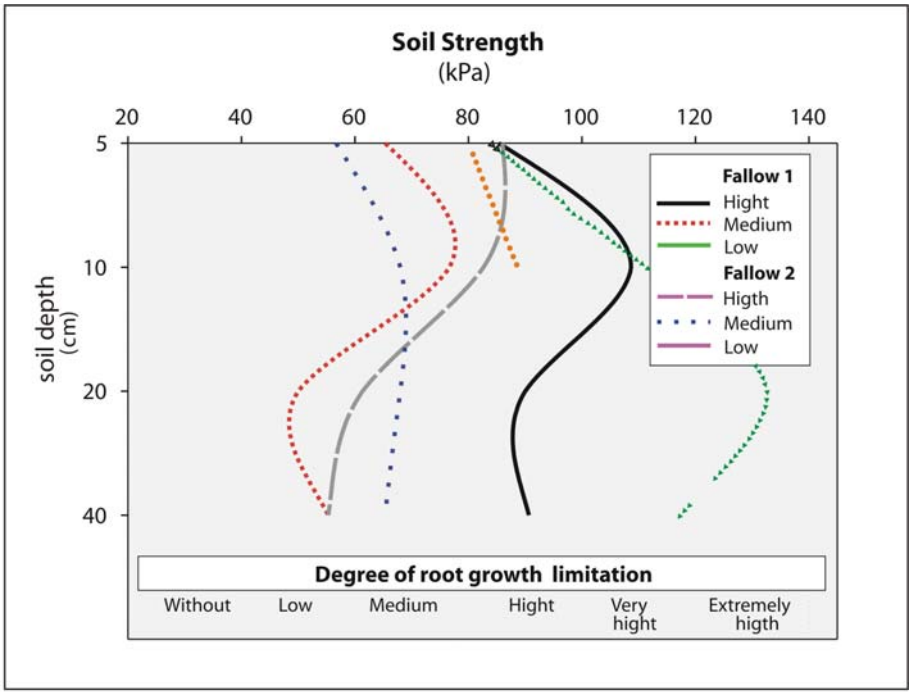
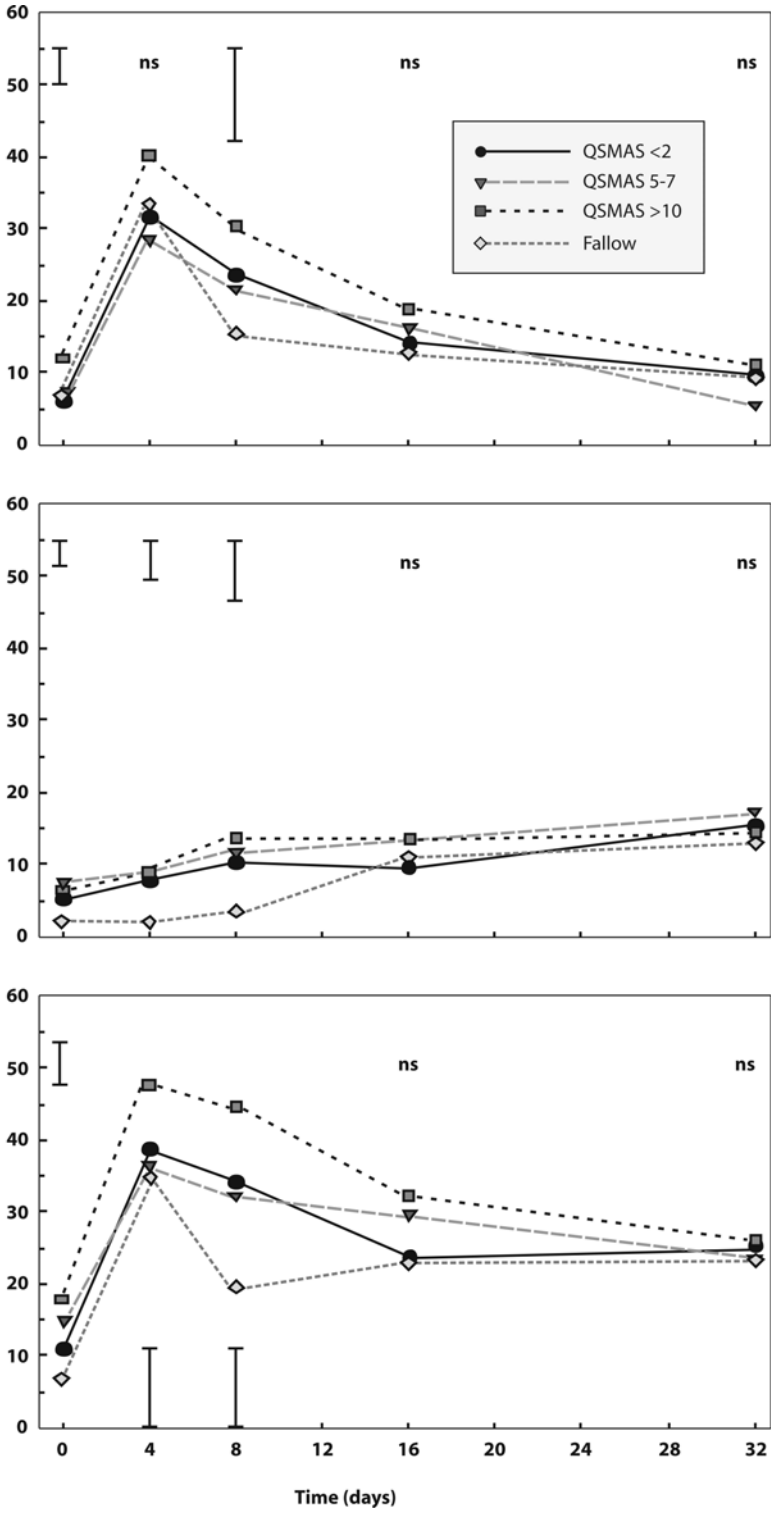


Figure 3. Soil NH4+, NO3- and total inorganic N during 32 days of incubation of soils from different land-use systems in a hillside agroecosystem of southern Lempira, Honduras. Data are the mean of three replications. Vertical bars indicate LSD0.05 (Tukey's Studentized Range Tests). Source TSBF, 2006



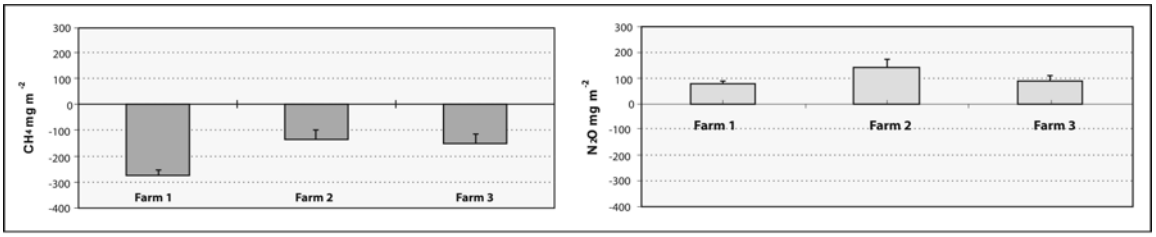
About greenhouse gases capture:

Fluxes of greenhouse gases (GHG) such as nitrous oxide (N_2O) and methane (CH_4), were determined in three farms during two years since the land use conversion, from secondary forest to Quesungual Slash and Mulch Agroforestry System (QSMAS), at Candelaria, Lempira, Honduras.

QSMAS is defined as a highly conservationist agroforestal system that implies not burn, slash, and mulch use, sowing by site, and cover from tree and crop, that has helped to improve life quality and food security from southern Lempira slope producers.

The GHG samplings were taken every three weeks during 24 months, from July 2003 to June 2005, using in each farm five closed chambers at ground level distributed considering the topographical sequence. Air samples were obtained from the closed chambers at four different times (0, 12.5, 25 y 32.5 minutes).. The results showed the following CH_4 fluxes: Farm 1 (-274,77 mg m-2), Farm 2 (-134,24 mg m-2) and Farm 3 (-149,68 mg m-2) and N2O fluxes were: Farm 1 (78,11 mg m-2), Farm 2 (142,73 mg m-2) and Farm 3 (86,70 mg m-2). It can be concluded that these three farms are CH_4 sink, related to low soil compaction, Farm 1 presents the smaller CH_4 emission and Farm 2 the greater emission. In N_2O case, all the farms are emissaries; Farm 1 presents the smaller levels and Farm 2 the higher levels, which can be due to high fertilizer use in study area. This work is preliminary and at present time GHG fluxes are measured in different ages and covers to quantify QSMAS environmental benefits related to climatic change mitigation (Ferreira-Catrileo, 2006).

Figure 4. Cumulative CH_4 and N_2O net fluxes (July 2003-June 2005) in 3 farms (fallows) converted to QSMAS. Source: Ferreira-Catrileo, 2006



About biodiversity conservation:

Although no direct research is being done in this area, there is evidence that agroforestry systems provide recovery of biodiversity (Montagnini et al, 2005). Local biodiversity is favored through the conservation of about 14 species (from 12 families) of trees and shrubs (TSBF, 2006).

PN22: "Environmental services promoting rural development"

The Project "Environmental services promoting rural development" is being working in five Andean watersheds. The project aims to promote the sustainable rural development by increasing flow of resources from government and civil society to poor rural producers, reducing the impact of negative

externalities and strengthening the competitive capacity of the poor through higher incomes, and better administrative and organizational skills.

As part of the project the team has develop a methodology for the water related environmental services quantification. The goal of this methodology is being a solid base for the development of a Payment for Environmental Services scheme. The methodology has 4 steps that are described by Rubiano et al, 2006. The methodology is the result of many years of research for development by CONDESAN and its partner's work.

Step 1. Localization and quantification of the environmental externalities and identification of the main stakeholders involved. In this step the Hydrological Response Units (HRU) are identified. These are geographical units with similarities in biophysical conditions (land use, topography, soil type, and climate). The HRU produce a similar effect regarding the environmental externalities (e.g. sedimentation, erosion, flow regulation). The definition of these geographical units is based on maps, aerial photos or satellital images. The HRU are determined with a software tool called SWAT (Soil and Water Assessment Tool). According to the results produced by the hydrological model the HRU are prioritized according to the response in runoff and erosion. At the same time the model helps to assess the effects in land use changes scenarios.

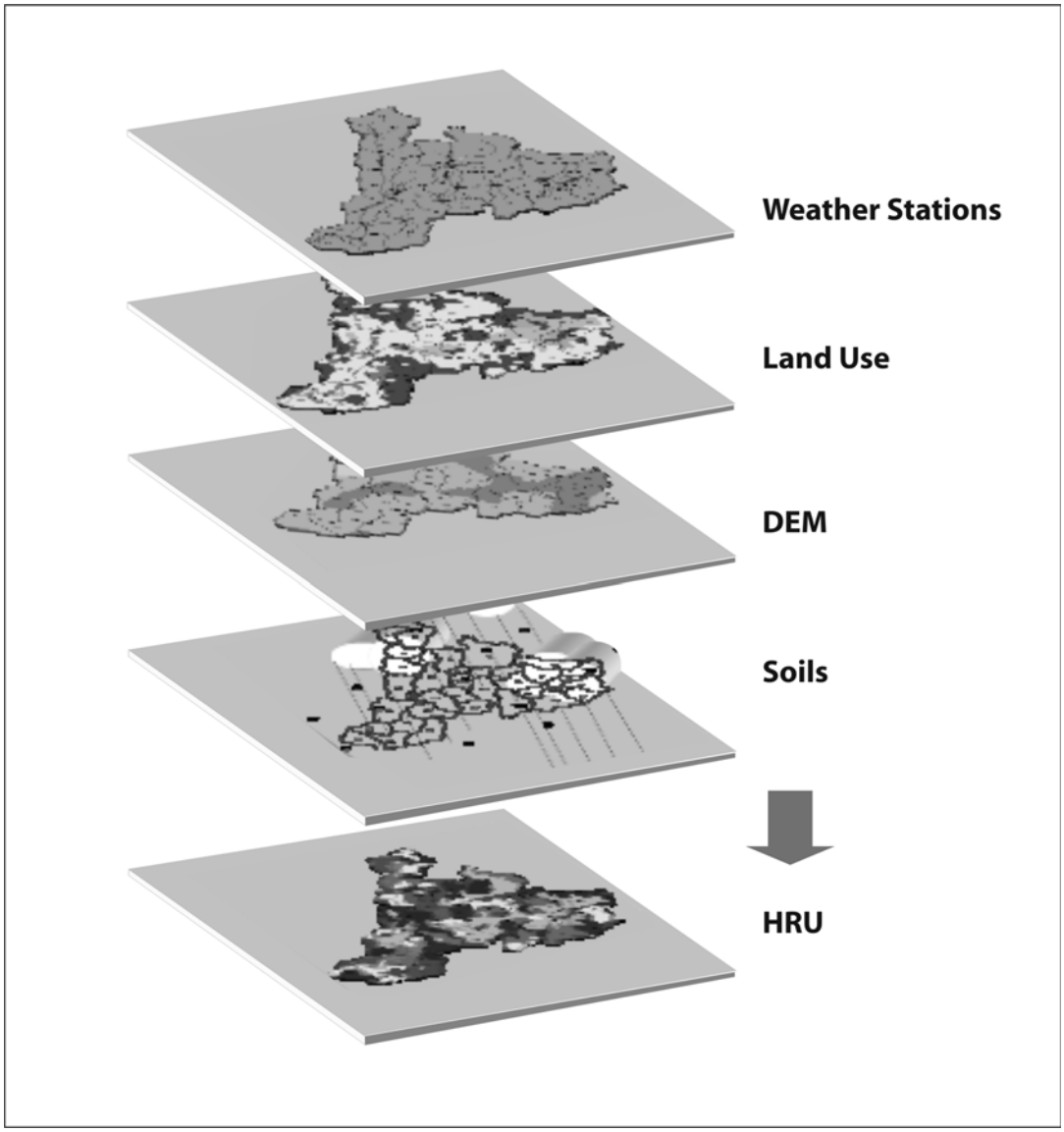
Step 2. Externality Valuation. The valuation of the externality is carried out by the optimization models where the income of the different land use scenarios is maximized taking into account the budgetary, technological, resources and environmentally restrictions. The value of the externality is defined as the shadow price of the environmental restriction from the optimization problem.

The research group created a software model called ECOSAUT (Quintero et al, 2006). This model is a optimization multi-criteria model based on lineal programming. It is used to find the land use for each HUR that is optimum for its owners or inhabitants. The model take into account the different environmental (e.g. water availability) and socio-economical (e.g. labor availability, income, etc.) restrictions. With the results it is possible to determine the cost of reducing a negative externality. This information is latter used to establish a PES mechanism.

Step 3. Identification of strategic alliances. Using economic games the stakeholder willingness to pay can be observed. The games are a simulated exercise where different actors (environmental services' users and providers) get together to assess different options facing an environmental problem.

Step 4. Negotiation of alternative scenarios to modify the externalities. With all the information collected above, institutional arrangements are designed in order to improve the natural resource management in the watershed. It is hoped that probable arrangements may help to solve watershed conflicts, promote different land use alternatives and the use of better technologies.

Figure 5. Information needed to establish the HRU (Hydrological Response Units) Source: Quintero and Estrada 2006b



Alto Mayo, Peru

One of the project sites is the Alto Mayo watershed in northeastern Peru (Paz, 2007). This watershed is located in the eastern slopes of the Andes Cordillera draining in to the Amazon Basin. The main activity in the watershed is agriculture. The wrong agricultural practices are generating deforestation, erosion and lost of biodiversity.

The population settled in the upper part of the watershed cut down the forest for coffee plantation, altering the soil properties and generation soil erosion problems. Furthermore, the wrong processing practices also affect the water quality properties.

In order to improve the water quality and to control the water volumes a scheme of payment for environmental services was designed. This mechanism intends to promote the generation of positive environmental externalities, contrary to the "pollutes pay principle" since in this case the "polluters" cannot pay.

The scheme tries that those benefiting from the positive externality derived from the change of activities will have to pay to those that are changing the agricultural activities.

The PES mechanism established first, who offered the service and who demanded the services. In the Alto Mayo watershed the service providers are the population living in the upper part of the watershed (sub-watersheds Mishkiyacu and Rumiyacu).

The users of the services are the population living in the lower part of the watershed, (urban population of the Moyobamaba, Nueva Cajamarca and San Fernando districts, Valle de la Conquista inhabitants, and irrigation groups) they are affected by the inappropriate agricultural practices in the upper part of the watershed. The service is the protection of the quality and quantity of the water resource.

In order to establish the areas of the upper watershed that are critical regarding sediments and water flows, as well as the potential to produce the environmental service, and hydrological analysis was carried out. The analysis was made using the software SWAT (Soil and Water Assessment Tool), based on the results from the hydrological modeling the prioritized areas were defined to implement the land use changes.

Using the prioritized areas a scenario analysis was carried out in order to assess the impact of different land uses (shadow coffee, reforestation, and live barriers) comparing them with the traditional slash and burn (burn-corn-grass cycles) practices. The variables analyzed are the income of farmers, the initial investment, the sediments generated, and the flow changes. The result of the evaluation showed that the best alternative is shadow coffee; nevertheless it is the most expensive option regarding initial investment.

The next step is to calculate the cost of each reduced tons of sediment, at the same time the cost of reducing erosion by hectare.

The following step is to know the willingness to pay by the service users. For knowing this, the project used the contingent valuation. This method uses surveys that assess the willingness to pay after the explanation of the relevance of the project.

It is necessary to find or create an entity in charge of the administration of the PES financial mechanism. In that order of ideas one of the project's objective is to design or identify an institution for this purpose. This institution is called fund.

The fund will be in charge of signing the contracts between the service providers (organized in groups of 5 to 12 families or other community suggested forms represented by one person). Each group member and the fund, with the purpose of the generation of the service or the reduction of the negative externality, sign the contract. In the contract there will be explicit the technological aspects needed,

the amount, and the payment conditions. It will also include the penalties due to breach of contract of any of the parties. The fund will certify the fulfillment of the conditions every six months.

In order to create the fund it was necessary to form a Fund Committee. This Committee was formed on July 21 2006 and is leaded by local organizations conforming the group "Frente de Defensa de los Intereses de Moyobamba y el Alto Mayo (FEDEIMAM)". Other task of the committee is to find the seed capital for financing the land use changes.

The agricultural technology that is going to be used is the agroforestry. The system has as an objective reinforce and guaranty the sustainability of the plots by the diversification of crops and the capacity building in the crop management.

Other benefits of the agroforestry systems, for the farmer and the environment, are:

- Optimization of the production by surface unit
- Soil increased organic matter content
- Diminishing the water erosion problems
- Soils water storage capacity enhanced
- Value-added forestry plantations in the plots
- Live barriers as animal fed and soils natural fertilizer

The technological package includes: coffee, wood trees or fruit, cover crops, live barriers and stop the traditional slash and burn practices.

Fuquene, Colombia

Another project site is the Fuquene Lake watershed in central Colombia. The watershed is located 80 km northeast of Bogota in the eastern cordillera of Colombia. The watershed drains into the Magdalena River, the main river of the country emptying at the Caribbean sea.

There are two main activities in the watershed, agriculture and cattle raising. Agriculture occupies the biggest portion of land and uses most of the water in the watershed, cattle raising is a very important economic activity supplying most of the country's needs for dairy products and it is a source of income for most of the inhabitants. These activities have degraded the ecosystem specially the *paramo* because of the expansion of the agricultural frontier, and the lake due to land reclamation for cattle raising. At the same time agricultural nutrients and cattle manure, end up in the Lake causing an explosion in water plants generating eutrophication problems, as well as endangering the human settlements that take their domestic water from the lake.

To improve the environmental situation and to act as a seed for rural development a compensation scheme was designed.

First a hydrological analysis was done in order to prioritize the areas causing more damage to the lake (sediments, nutrients) using SWAT and site experiments, secondly different possible scenarios were analyzed in order to select the best land use alternative that at the same time improved the environmental conditions without worsening the social conditions of the dwellers.

A change from agricultural practices, changing from traditional agriculture methods to conservation agriculture was selected as a mechanism to decrease the sediment and nutrient flows to the lake (main environmental problem in the watershed). The conservation agriculture is based in three principles as follows (Quintero and Otero, 2006):

- Permanent soil cover
- Minimum tillage
- Crop rotation with green fertilizers

The conservation agriculture in comparison with traditional agriculture has several advantages such as: controls erosion, Increases water percolation, increases soils water storage capacity, increases soils organic matter content, better quality of crops, and better crop yields, among others.

Nevertheless, conservation agriculture was not wide adopted by farmers although some regional initiatives were made in the past. Some of the major restrictions found were (Quintero and Otero, 2006): Lack of financial resources for initial investment; traditionalism of producers, technicians, and politicians; production in rented land; lack of knowledge about conservation agriculture, and low availability of new agricultural inputs, since new seeds and tools are needed.

In order to tackle this situation an innovative financial arrangement was design. The financial mechanism is a fund managed by the producers; the fund will allow small farmers to have capital for the initial investment for the conversion to conservation agriculture. The credit rates are smaller that the normal credit rates, since no profit is needed and the management is in hands of locals to keep the transaction costs as low as possible.

The fund has received two capital inputs. One from the GTZ through the Cuencas Andinas projects and other from the Ford Foundation through CONDESAN. In November 2006 (Quintero and Otero, 2006) almost the 100% of the capital was recovered and more than 200 ha were used to grow green fertilizers.

At the moment new financial mechanisms are required by producers that are changing from traditional to conservation agriculture. The improvement in environmental conditions is monitored in order to show downstream producers of the benefits of the change and to start a true compensation mechanism that will improving not only environmental conditions but also economic conditions.

PN40: "Integrated governance and Modeling"

Project 40, Integrated governance and Modeling, research about the use of integrated simulation models as decision-tools in multi-stakeholder negotiation processes at the sub-basin level.

The project sites are the Volta-Basin (Ghana) and the Andean System of Basins (Melado basin, Chile), where construction of agent-based simulation models that combine economic and hydrological sub-models is already underway.

The project focuses on (1) the analysis and strengthening of multi-stakeholder governance structures in the two project sites, (2) the identification of problems, policy options to address the problems, and

criteria for evaluation policy options by the stakeholders, (3) the extension of simulation models to incorporate the impact of climate change on land and water use decisions of risk-averse producers, (4) the evaluation of alternative policy options, as identified by stakeholders, (5) the development of decision-support tools that present and visualize the outputs of the simulation models in a form that is useful for the stakeholders, and (6) the actual use of the decision-support tools in negotiation and planning processes in the multi-stakeholder governance structures.

The project provides stakeholders with information on the implications of different policy options selected by them on the environmental parameters included in the model. The model may quantify the externality produced by a policy option. These will include hydrological parameters (derived from the hydrological model component) and other environmental information, which the model can produce as output together with the socio-economic output of model simulation runs. Examples are the amount of fertilizer and pesticides used, if such activities are taken up, the conversion of forest land to agricultural area, and the salinization of soils. By quantifying the environmental impact of different policy options and presenting this information in appropriate visualized form to the different stakeholders, the project will improve the possibilities to include such environmental information in collaborative planning processes. Due to the spatial agent-based modeling approach, it is possible to specify environmental implications for different target groups (the agents), depending on their location in the watershed.

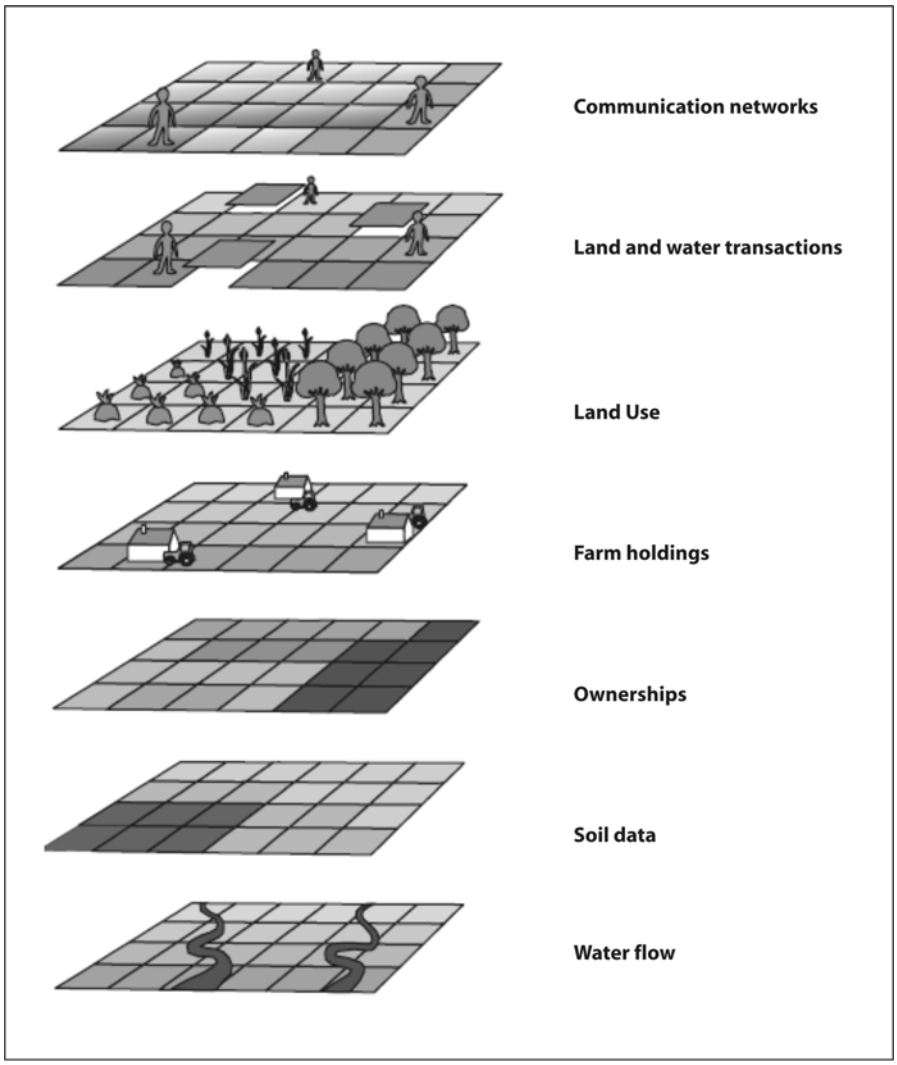
By simulating different regulation scenarios, the model approach allows to assess the costs of different instruments on environmental regulation for different stakeholders, thus making it possible to assess no only the environmental, but also the economic and equity implications of different regulation strategies. While – in view of trade-offs - the final responsibility for the policy decisions and the environmental implications they have rests with the stakeholders who have the authority to make these decisions in the multi-stakeholder governance structures, the adoption of the technologies developed by the research project.

In an exercise of scenario modeling the environmental externalities can be taken into account in order to select a policy. So environmental services are include in the policy making exercise. It is important to mention that within the activities carried out in the ANDES, the project had a workshop where the software tool was socialized with key actors, such as public institutions, universities and local irrigation groups.

Social and/or institutional arrangements

The other two projects working under the ANDES coordination study better social or institutional organizations for natural resource management bearing the sustainability issue. Policy should benefit population without exclude any group and also it should benefit the environment to guarantee the sustainable provision of environmental services for human development activities.

Figure 6. Components of the Multi agent simulation model. First published in Berger and Ringler 2002. Source: Berger et al. 2005



PN20: "Sustaining inclusive Collective Action that Links across Economic and Ecological Scales in watersheds"

The project SCALES. The project aims to contribute to poverty alleviation by improving collective action across scales. Although the project proposal states that the goal is to improve the livelihoods of the poor and not to protect the environment, the project identifies three potential ways in which environment and welfare can be improved:

1) Reduction of negative externalities
2) Reduction in inefficient use of water and other resources
3) Increase collective conservation activities.

So far the project has carried out 2 activities that are focused on environmental protection and

environmental services. The first one is the use of experimental economics through economic games, in the ANDES these games have been used in Fuquene (together with PN22) and Coello watersheds in Colombia. The games (Cardenas, 2006) help to assess the existence or not of the cooperation between the duelers of a watershed, the willingness to cooperate if a compensation scheme in proposed or to undertake a collective conservation activities. The economic games can generate conscience and can explain some of the effects of the collective vs. particular actions have under common goods.

The second activity refers to the *conversatorio* process. The *conversatorio* is a community participation tool, recognized by law in the Colombian constitution, it is a meeting where local stakeholders speak out their concerns about environmental quality to local, regional and national environmental authorities. The project has helped the community to understand the causes of what they think are the main issues in the watershed, the local authorities are committed to solve some of the issues within a restricted time line.

Figure 7. Conversatorio process in Fuquene. February 2007. Source: Alexandra Peralta, CPWF Theme 2

PN28: "Multiple Uses of Water"

Project Multiple Use of Water (MUS) aims to change some water supply policies. The project works in two countries in the Andes. In Colombia at a couple of watersheds in the Cauca Valley region at the southwest of Colombia, and in Bolivia in the Cochabamba Valley in the center of the country.

Domestic water supply systems in the Colombian and Bolivian cases have separated management regulation from "productive" water supply systems (irrigation, industrial, commercial). By making some case studies the projects aims to collect all the evidence necessary to show that the systems are being used for multiple purposes although there were not planned as such and that the legislation may punish this multiple use. Nevertheless the restriction in use is affecting severely the more vulnerable population.

In the rural and peri-urban areas, households depend on small productive activities that need water such as gardening, small cattle rising, and so on. At the same time the project is working with strategic local stakeholders who meet in a regular basis. These are called learning alliances. The learning alliances in Colombia are groups of interested people in water, most of them working in water- related organization at local scale, the groups have discuss different water policies and water management strategies.

Different uses of water compete with each other making it difficult to synchronize policy agendas through economic sectors. Multiple uses systems will not allow prioritizing between uses and this may be contradictory with economic agendas. Assuring the provision of water related services would assure a minimum provision of water to supply for some uses. The allocation of the water is controlled by men and its institutional arrangements and is through the learning alliances that the optimal arrangement is designed.

Environmental services in the Andes

According to Blanco, 2006, there have been many cases of PES schemes in Colombia. Most of them lack of quantitave grounds that allow to establish a proper link between the providers and the users of the service, another failure is the lack of monitoring process that show the accomplishment of the agreements, the provision of the service. In this case is CPWF PN 22 and CONDESAN-GTZ-REDCAPA project "Andean Watershed Project" giving further steps toward a clear methodology to establish the service flow.

Blanco listed and analyzed diverse PES schemes initiatives in Colombia. He compared them to the theoretical characteristics of a PES, all of the schemes fail in to being a 100% PES scheme, according to theory. Nevertheless from the 12 cases studied, 6 are working having an important social and/or environmental impact, 5 are under design, and only 1 failed and is not implemented.

It was also shown that there is a complete absence of monitoring systems in the effectiveness of the PES schemes. Some observations were:

• The initiatives have been successful in mobilizing resources for the payment schemes.

• Most of the cases cannot document its impacts in terms of the change or improvement of the environmental service that is trade (not including the Clean Development Mechanism of the Kyoto Protocol projects).

• In general terms the schemes have improved the well being of the services providers.

According to Quintero and Estrada (2006a) after a revision of several PES cases in Latin America the have evaluated the potential of implementing a PES schemes in the Andes, using hydrological services as the transaction object. They have seen that the firsts evidences show how difficult will be to create PES schemes related with water and sedimentation reduction, the following elements are the base to this:

• The magnitude of the externality represents an important amount of money given the size of the affected area but the contribution per hectare to the externality is very low. This increases the transaction costs specially the ones needed to establish the baseline, the causality relationship and the economic feasibility of the change in the potential sites to grant the service provision.

• The type of watersheds (small, steep slopes, high rain intensity, and short lag time) in the Andes makes that the magnitude of the externalities smaller than in bigger watersheds.

• The upper Andean soils quality properties make the income from agricultural and cattle ranching activities more profitable than the income from service selling.

• Given the water importance in the upper Andes, there is a legislatory framework to regulate the land use in the upper Andes, specially the Paramos. This make that the land management can be done through regulatory agents and in second place through the market.

It is important also to bear in mind that we have to avoid myths and learn from the mistakes. Some of the more common myths are listed by de Heck (2004) and are cited as follows:

Table 1: Myths and possible realities about land uses and environmental services

Myth	Possible reality
Reforestation increases water availability	Reforestation may diminish water availability
Vegetal cover decreases large floods probability	Vegetal cover may have little or no impact on large flooding
Reforestation decreases erosion	Reforestation may increase erosion (depending on the specie used)
Itinerary cattle ranching and agriculture activities are the most important causes of sedimentation increase	Climate variations can be the most important cause in the sedimentation increase
Forests increase precipitation	Forest can have little effect on precipitation especially on local scale

In conclusion, research being done in land use – soil – water – vegetation – atmosphere and social dynamics is very important in order to establish, with solid empirical grounds, about the nature of the services, the quantity and the quality. This being basic characteristics for being able to buy or sell any service. It is also very important to study the social possibilities to carry out PES schemes according to every site situation.

PES schemes should be easy to implement in order to keep transaction cost down but they have to have monitoring mechanism that will permit a transparent service provision and payment. Maybe a PES mechanism is not the way to improve environmental and socioeconomic situation, but in the process of design innovative institutional and social arrangements and after studied the biophysical causes and effects of the environmental problems, efficient solutions can appear as is seen in many cases of the studied by the authors listed before.

From the experiences of the CPWF projects working in the ANDES it can be shown that many research projects are working around the environmental services idea. Many of those projects may not have the intention to set up PES schemes but its results may help to establish the characteristics of a successful PES schemes, find relationships, the tradeoffs, quantify services and valuate them. So far most of the CPWF projects focus only in one of these many characteristics that a PES scheme should have . Nevertheless its results are proving that there is possible to use environmental services as a development tool that improves not only the quality of life of rural dwellers but keeping the environment in good shape.

Biophysical research is showing results, proving land use alternatives that can bring social development and environmental conservation. As well social research are showing how different social and or institutional arrangements may help environmental services, and how information can be shared and used in a more effective way. Another important side of PES is valuation, in a rapidly changing economic

world valuation is a social tool with powerful impact that moves society to a specific direction, and a PES scheme must direct environment users to conserve the services. The paradigm seems to apply all the concepts and put them together in a single scheme.

In order to finish this document I would like to quote Mr. Albert F. Appleton (Appleton, 2007) on his presentation in Colombia: “Payment for Environmental Services may not be the golden bullet but is the only bullet we’ve got now”.

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