2.7 PAYMENTS FOR ENVIRONMENTAL SERVICES (PES) FOR WATERSHED MANAGEMENT IN NORTHERN LAOS

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Abstract

In this paper we discuss the main results of a feasibility study for the implementation of Payments for Environmental Services (PES) in a small watershed of northern Laos. The aim of the work was to assess the relevance of such a scheme as a way to control both the quality and flow of a small mountain stream. We found that the PES concept, with some adaptations, may offer interesting avenues as a means to maintain water quality through an improved control of soil erosion in the upper catchment: WillingnessToPay
(WTP) within the sampled population was approx. USD 0.3/month/household which would be sufficient to abate the negative impact of soil erosion. At the whole catchment scale, major impediments to the immediate implementation of a PES scheme were i) the lack an unequivocal relationship between environmental services, users and providers, ii) insufficient WTP to maintain water quality along the stream through waste management and iii) absence of a critical mass of buyers. A precondition of successful implementation of PES in the area is to increase the awareness of environmental issues in the concerned communities.

1 Introduction

Environmental Services (ES) are benefits that humans obtain from natural and cultivated environments (WertzKanounninoff, 2006). For example, hydrological services can be obtained through river flow regulation, flood control or protection against soil erosion (Wunder, 2002; WertzKanounninoff, 2006). ES are threatened worldwide, in a variety of ways, by human activities. In response to such threats, the concept of Payments for Environmental Services (PES) has been proposed as a simple mechanism to reward land users who adopt practices that generate ES, hence promoting sustainable land use. The concept of PES, can be described as follows: "Communities that are in a position to provide an ES should receive compensation, and it is those who benefit from these services that should pay [...] PES schemes are aimed at giving a specific value to ES and to setup effective systems of price setting, institutionalisation and distribution which favour changes in behaviour and the adoption of sustainable landuse practices that benefit the whole community" (Mayrand and Paquin, 2004; Fig. 1). In this paper we present the main results of a feasibility study aimed to assess whether this concept can be applied and help improve the management of a small upland catchment of northern Laos. The study was organised according to the guidelines of the FAO electronic forum on payment schemes for environmental services in watersheds (FAOREDLACH, 2004).

Data required to carry out the successive steps of this approach were collected through I) a survey of the local population's perception of water issues , II) a critical analysis and compilation of preexisting biophysical, socioeconomical and geographical information and III) field measurements of biophysical parameters.

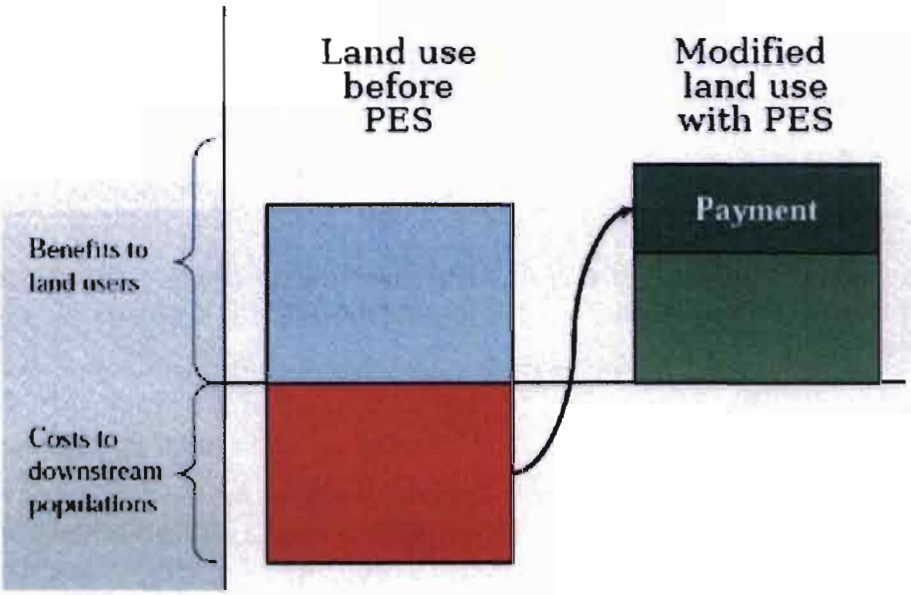

Figure 1: Schematic representation of the PES principle (After http://www.itto.or.jp/live/Live_Server/2869/18_Sander.pdf).

2 Location and characteristics of the study area

The Houay Xon watershed is located in the Luang Prabang province, in northern Laos, (Figure 2), south of the UNESCO World Heritage city of Luang Prabang. The studied watershed (Figure 3), covers 22 km² and includes 7 villages located along the Houay Xon stream. The stream runs for approximately 15 km and has three main tributaries. The average annual rainfall is 1403 mm (average of the last 30 years), and the mean annual temperature is 25°C. Two distinct seasons characterize the study site: a wet season from April to October, and a dry season from November to March. This catchment's maximum elevation is 584 m a.s.l., near the headwater area (Chaplot et al., 2005). The study area encompasses a population of 6251 inhabitants mostly of the Lao Lum, Khmu and Hmong ethnic groups. Farming activities are located upstream, in the Houay Pano headwater catchment. In downstream villages, the population is dominated by government employees and agricultural activities are limited to small scale vegetable gardening and fish breeding. Over recent years, the Houay Xon catchment has been subjected to increasing environmental pressure which resulted in degraded water quality and reduced flow. In addition, extreme climatic events, such as the flood of September 2006, have reportedly caused increasingly severe damage to infrastructure essential to the community.

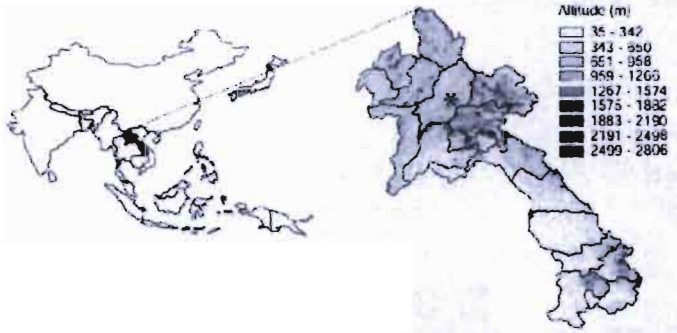

Figure 2: Laos and the Luang Prabang province (after Chaplot et al., 2005)

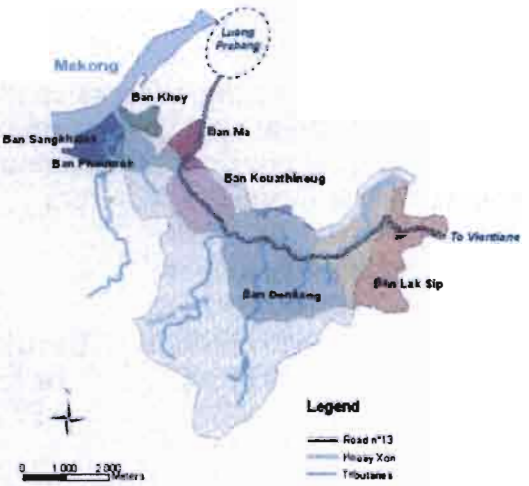

Figure 3: Map of the watershed and location of villages

3 Survey design and implementation

To estimate the supply and demand for hydrological services in the Houay Xon catchment, we selected a sample of 67 people who were interviewed over a period of one month. People included in this sample represented the five main categories of water users identified along the Houay Xon: farmers from upland and downstream areas, gardeners, tradespeople and villagers who only use the Houay Xon water for domestic purposes. Not all categories are represented equally in the sample because not all categories encompass equal numbers of people and some individuals were not willing to participate. All these users, who are scattered along the stream, potentially contribute to water pollution and/or flow decrease. Therefore they are potential buyers and suppliers of hydrological services since they participate in water extraction, transformation and discharge. The questionnaire was designed to document interviewees' socioeconomical background and that of their dependants, their awareness of water flow and quality changes, their perception of the causes behind these changes, their ability and willingness to participate in a payment scheme and their understanding of institutional and governmental support. This original data set was combined with information previously collected by public and private institutions and biophysical data monitored by IRD since 1991.

4 Calculations of ES provision

The cost of ES provision was assessed using the following equation:

$$\text{Cost of Change} = [C(1+2+3)] - B \quad \text{Eq. 1}$$

Where, C represents the total costs linked to the adoption of the new practice, including: 1) the cost linked with setting up the system including the initial investment to buy seeds and materials and provide training; 2) the economic losses related to the adoption of this use, calculated as [(yield of previous crop) x (area turned into new use) x unit selling price] – production costs; and 3) the production costs linked to management of the new practice, such as the workload, taxes on the crop etc... Finally, B corresponds to the benefits of the new practice i.e. the profits from the new crop are calculated by multiplying the yield of the crop by its unit price.

Results

The ES a guaranteed minimum water flow of set quality standard Surveys in 2007 revealed a clear downstream demand for improved water quality and more constant stream water flow in the Houay Xon catchment (Mousquès et al., 2007). Upstream from the agricultural areas under study, the Houay Pano and Houay Thong sub-catchments are suffering from variable degrees of erosion. In the past decade, annual cropping has intensified inversely to a drop in fallow time. The time under cultivation has doubled between 1995 and 2003 from 1 to 2 years, while the fallow times have been reduced from 8 to 2 years since 1970. These changes are mostly due to government pressure. The aim of the GoL's 'landuse planning and allocation programme' is to intensify agricultural production and eradicate slashandburn and shifting farming by 2010, in order to alleviate poverty and protect biodiversity and some of the last remaining pristine forest in SEA (Lestrelin et al. 2006).

In addition to topsoil loss, erosion is responsible for changes in water quality and increased instability of surrounding landscapes. In particular, a large amount of vegetative material/ waste can be observed saturating the stream. This material consists of large branches and stems resulting from land clearing and burning. Landslides are also common upstream. Most of these landslides were caused by diverse types of human pressure such as farming activities or construction related to urbanisation of the uplands. These landslides lead to a large loss of soil and increase the turbidity of the Houay Xon.

All of the farmers surveyed in the Houay Pano confirmed they were aware of erosion problems. Erosion from upland maize fields has now reached 5.9 t ha1 year1 of sediments, a marked increase from the 1990s where erosion was stable at 0.9 t ha1 year1 (with 1 year of upland rice cropping followed by 8 years of fallow) (Valentin et al. 2008). The gradual shift from upland rice to maize and other cash crops is primarily due to the workload associated with weeding, which is heavier with upland rice. The yearly sediment load exported from this catchment is increasingly affecting the quality of water downstream.

Survey results also showed that the downstream community is playing a major role in the deterioration of stream water quality. Indeed, when asked for the causes of reduced water quality, 68% of the interviewees mentioned increases in village population and household waste. Downstream villagers, market gardeners and fish farmers predominantly affect water quality by inputting chemical and organic waste into the stream. The results of a survey carried out by Lestrelin in 2003 in Ban Lak Sip showed that even 5 years earlier, 63% of interviewees thought that stream water quality was deteriorating due to increases in the population. The most visible cause of degraded water quality is insufficient waste management. Of all the villagers interviewed, only 7 use the existing garbage collection service. The need for an efficient garbage collection service was proposed by 47.8% of the villagers surveyed. Despite the lack of waste collection the primary form of household pollution along the stream is the input of grey water (i.e. water used for washing clothes, dishes, people) rather than solid waste. There are no systems in place for collecting grey water that is produced by activities carried out in the stream along the Houay Xon. Inputs of grey water varied quite a lot from 50 to more than 2,500 litres per week. 44% of the villagers interviewed throw between 1,000 and 1,500 litres of used water into the stream every week. Sewerage is also present from leaking toilets as well as direct defecation into the river.

5 the ESLand management practices and infrastructure measures that can be used to provide

In order to improve water quality in the catchment a dual target is required to combat upstream erosion and chemical use and downstream domestic waste and grey water. The MSEC (Management of Soil Erosion Consortium http:// msec.iwmi.org/),programme clearly established that alternative farming practices and careful management of sensitive areas (e.g. riparian areas; Vigiak et al., 2007) opens new avenues for the improvement of water quality by reducing sediment delivery (Van Breusegem, 2005; Valentin et al., 2006; van der Helm, 2007). As an example, a simple measure like the replacement of rainfed rice by Job's Tears on degraded land would reduce erosion; Table 1 summarises the factors explaining this reduction. Other measures to improve water quality include an improved garbage collection system which was suggested by 48% of the villagers surveyed, a grey water collection system and the installation of cheap toilets designed to limit seepage as much as possible.

Factors influencing soil erosion		Rain-fed rice	Job's tears
Soil cover	Length of time (months/year)	5-6	7-8
	Average % of area cropped during the season	70	90
	% after two months of cropping	10	20
Cropping practice	Days worked per season	228	168
	Activity spread throughout the season	Peaks and lulls	Spread out

Table 1: Factors associated with Job's Tears cropping that lead to a reduction in erosion

6 Managing erosion through change in crops

The cost of landuse changes results from a costbenefit analysis of the change determined by the equation (Eq. 1). Due to the lack of data for some parts of the Houay Xon catchment, the following economic evaluation is focused on the upstream Houay Pano catchment (67 ha). For some of the proposed ES, a lack of information makes it impossible to apply this calculation method. In that case, economic estimates were derived from the literature and were then adapted to the study zone. The team evaluated the effectiveness (either by field trials or modelling) and the cost induced by the adoption of each of these measures (see Table 2). For example, conservation or introduction of grass on river banks is both an effective and virtually free means to control sediment delivery to streams.

	Improved fallow	Contour planting	Conservation agriculture	Job's Tears	Vegetation on banks	Tree corridors/ Hedges
Total costs	328.4	357.6	240.6	305.9	204.6	8
Total benefit	44.8	80.1	20.6	182.1	176	0
Cost of change	283.6	277.5	220	123.8	28.6	8

Table 2: Cost (in USD/ha/year) induced by the adoption of a range of land use changes in the Houay Pano catchment.

Some of the possible land use changes could also lead to increased profits with a number of ES for abating erosion eventually leading to increased profit for the farmers, as can be seen in Table 3.

	Papaya plantations	Market gardens	Banana plantations	Animal husbandry
Total Costs	1191.4	476.4	297.4	568
Total Benefit	4019	2606	1045.2	688.5
Net Benefit of Change	2827.6	2129.6	747.8	120.5

Table 3: Land use changes which would reduce soil erosion in the Houay Pano catchment while bringing some net benefits (in USD/ha/year)

7 Managing domestic pollutants

The cost of using a garbage collection system is relatively low. The current price of the garbage collection system in Ban Kouathineug and Ban Khoy is 1USD/month/household. However, this system has many shortcomings; it is therefore probable that an improved system will be more expensive. The cost of managing grey water is higher. According to the statements made by inhabitants, the construction of appropriate toilets costs 100 USD per household for a standard model. This price is in agreement with a study by Duncan Mara (1985), who calculated the average costs to be 122 USD in four different Southeast Asian countries StakeholdersSuppliers,

8 Beneficiaries and mediators

The binary concept of user vs supplier is poorly suited to the situation studied because water extraction and contamination are diffuse along the stream. Figure 4 illustrates the lack of relationship between the location of users along the stream and the way they use water. Locating potential buyers downstream leads to an additional two obstacles. Firstly, downstream villagers are not the main water users. These villages are made up of a large majority of employees, factory workers, and shopkeepers, with only 3.7% identifying themselves as gardeners or farmers. The downstream population is rather unaware of the degradation of the hydrological service, and the villagers would be reticent to buy a service that they do not use. Secondly, the downstream users (farmers and gardeners) do not have sufficient income to support a PES market.

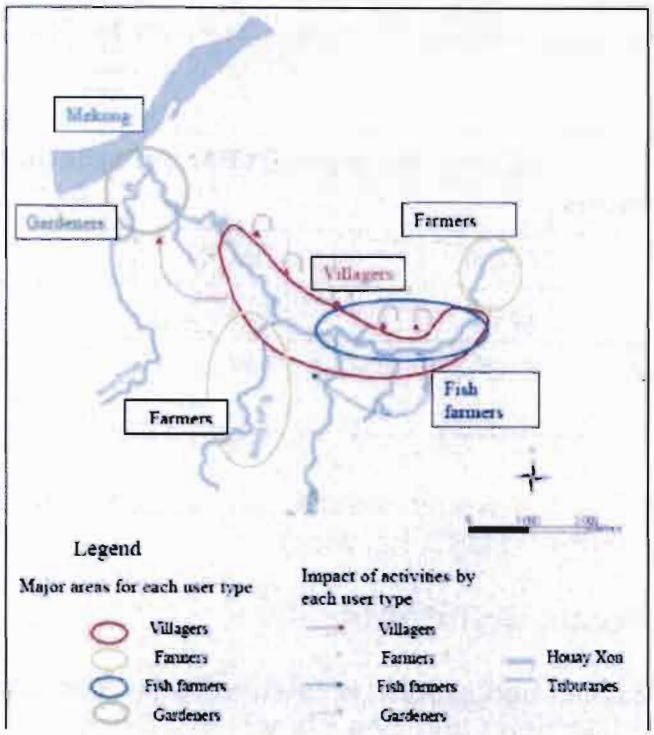

Figure 4: Complex userswater use relationships in the Houay Xon watershed

These groups derive little profit from their activities. In the villages of Ban Ma and Ban Sangkhalok the sale of vegetables represents only 46% of the income. Furthermore, data from the DAFEO from 2003 shows a clear decrease in the percentage of revenue derived from farming or market gardens between 1990 and 2003 in Ban Lak Sip and Ban Donkang (Lestrelin et al. 2005). This decrease is also observed in the villages downstream of Ban Donkang, which earned almost all income from agriculture 8 years ago (RDC , 1999). The main economic activity of these villages is now commerce and there has been a large decrease in crop production. Half of the producers interviewed declared that they want to decrease their area under cropping. Likewise, highincome earning stakeholders in the region do not seem to be the appropriate buyers of the ES. The majority of operating PES markets work with a single buyer of the service and several suppliers. The major companies in the study area, that is Nam Papa and DLPCP, both bottled water companies, are potential buyers. However, the quality of the stream water does not pose a major problem to them because they bottle spring water not river water. Nam Papa has license to act independently in an area of 3000 ha. It aims to completely reforest the Phu Phung Mountain by cropping in the area. The situation appears to be the same for the DLPCP Company that also owns large tracts of land around the spring source. It appears difficult to propose a PES to these companies that already have a huge influence on land usage in the surrounding areas. Thus in principle, there is a lack of buyer(s) for the ES, having determined that the few users downstream do not have the means to pay for such a service, and that the few potential buyers who do have enough money do not use the river or already have control over the usage of land upstream from their spring water source.

9 Additional obstacles to the immediate implementation of PES in the Houay Xon

In addition, the current land allocation system makes it difficult, if not impossible, for farmers to alter land use (National Growth and Poverty Eradication Strategy, cited in NAFRI, 2005), while it is a basic principle of the PES concept that land use can be altered with a certain flexibility so as to ensure delivery of ES. The population relocation policy initiated in the 1970's

by the GoL (Lestrelin et al., 2006), also contributed to the emergence of conditions rather adverse to the immediate success of a PES scheme: it resulted in the cohabitation of several ethnic groups within small communities, often inducing tensions, and fell short of establishing good communication between villages and between villages and local authorities. A side effect of the relocation policy was also that displaced populations did not fully bond with their new environment. This resulted in limited awareness of environmental issues and unsustainable use of the natural resource base by the community, naturally leading to a lack of WTP for ES among many.

10 Elements of hope for a successful ES market in the Houay Xon

Nevertheless WTP within the sampled population was approx. USD 0.3/month/household which, if put in practice through a PES, would suffice to abate significantly the negative impact of soil erosion on water quality (Table 4). However, at the whole catchment scale, this would not warrant good water quality as it would not be enough to maintain the waste collection system essential to abate the observed distributed contamination of the stream. Therefore, one of the preconditions of successful implementation of PES in the Houay Xon watershed is to increase the awareness of environmental issues in the concerned communities to increase their WTP for ES, as at the moment, they fail to recognize the cost of producing these ES.

Proposed Solution	Cost in USD/inhabitant/month (1 USD = 8750 LAK) except for # which is oneoff payment
Improved fallow	0.22
Contour planting	0.20
Conservation agriculture (i.e. zero tillage, crop rotations and permanent soil cover)	0.16
Grass on river banks	< 0.016
Tree corridors/plantations	0.15
Garbage collection system	0.23
Grey water collection system	0.46
Toilet construction	20#

Table 4: Selection of possible environmental management practices and estimated costs.

Discussion and conclusions

The need for improved water quality and more constant stream water flow in the Houay Xon catchment has been clearly identified. These results can be used to define an ES, such as a guaranteed minimum water flow of set quality standards. This study identified several obstacles likely to impede the straightforward implementation of a PES scheme along the Houay Xon. First, the binary concept of user vs. supplier is poorly suited to the situation studied because water extraction and contamination are diffuse along the stream. In addition, the current land allocation system makes it difficult, if not impossible, for farmers to alter land use (National Growth and Poverty Eradication Strategy, cited in NAFRI, 2005), while it is a basic principle of the PES concept that land use can be altered with a certain flexibility so as to ensure delivery of ES. The population relocation policy initiated in the 1970's by the GoL (Lestrelin et al., 2006), also contributed to the emergence of conditions rather adverse to the immediate success of a PES scheme: it resulted in the cohabitation of several ethnic groups within small communities, often inducing tensions, and fell short of establishing good communication between villages

and between villages and local authorities. A side effect of the relocation policy was also that displaced populations did not fully bond with their new environment. This resulted in limited awareness of environmental issues and unsustainable use of the natural resource base by the community, naturally leading to a lack of WTP for ES among many.
In spite of these obstacles, alternative farming practices and careful management of sensitive areas (e.g. riparian areas) opens new avenues for the improvement of water quality by reducing sediment delivery. WTP within the sampled population was approx. USD 0.3/month/household which, if put in practice through a PES, would suffice to abate the negative impact of soil erosion on water quality. However, at the whole catchment scale, this would not warrant good water quality as it would not be enough to maintain the waste collection system essential to abate the observed distributed contamination of the stream. Therefore, one of the preconditions of successful implementation of PES in the Houay Xon watershed is to increase the awareness of environmental issues in the concerned communities to increase their WTP for ES, as at the moment, they fail to recognize the cost of producing these ES.

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