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Potential and limitations of Payments for Environmental Services (PES) as a means to manage watershed services in mainland Southeast Asia

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Abstract: Based on two case studies conducted at local sites in Northern Thailand and Lao PDR, the objectives of this paper are (i) to assess whether conditions for the establishment of PES at the watershed level exist in the uplands of mainland SE Asia and (ii) to examine and discuss limitations that are likely to impinge

on direct transfer of the PES concept as well as the institutional adaptations and support that are required for the successful implementation of PES markets in this regional context. The study's main findings are that: (i) acceptance of PES principles and constraints are directly related to stakeholders' perception of their land rights irrespective of their actual rights; (ii) willingness to pay (WTP) is very low among local stakeholders, making any PES market unlikely to emerge without external support; (iii) the classical scheme for watershed services hardly applies in its original form because environmental service (ES) providers and buyers are generally the same people; (iv) where potential ES buyers feel that ES providers are better-off or wealthier than them, they do not have any WTP for ES; (v) good governance, including a strong liaising at various levels between people and the authorities is a strong prerequisite for the successful establishment of PES markets, even without direct government funding.

Keywords: Lao PDR, PES, soil erosion, Thailand, watershed, water quality

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1. Introduction

Van Lynden and Oldeman (1997) categorise virtually all land within Southeast Asia as moderately to severely degraded. Erosion by water represents the most common mode of land degradation, with agriculture and deforestation as the two major causal factors. Northern Thailand is highly susceptible to soil erosion due to its undulating topography, steep slopes and high rainfall, but natural degradation and decline in soil fertility has been accelerated over the past few decades by the encroachment of agricultural activities on forests and poor land management practices (Lu et al. 2008). In Thailand the heightened risk of landslides and flash floods from acute erosion was instrumental in the Royal Forest Department's (RFD) decision to cancel timber concessions in natural forests, particularly in upland areas (Lakanavichian 2001). Land degradation

is also a major concern in northern Lao PDR, where the combined effects of climate, topography and soils make much of the sloping uplands susceptible to erosion (ICEM 2003). Moreover, the soaring expansion of maize cultivation throughout Lao PDR and northern Thailand since the early 2000s has caused so much erosion that, in some places, the entire topsoil has already disappeared, which led Lienhard et al. (2006) to label this land use change an example of 'resource mining' agriculture. In this context, there clearly is a pressing need for the adoption of improved land-use and agricultural techniques in the region.

Environmental governance in developing countries has not yet effectively addressed such urgent needs. It has characteristically been oscillating between command and control limitations imposed upon local people and integrated conservation and development projects (ICDPs) (Wunder 2006). Proponents of ICDPs postulate that poverty alleviation programmes will catalyse trickle down improvements in sustainable land-use, based on the theory that raising incomes is a critical precursor to adoption of sustainable production techniques and movement away from poverty related deforestation (Gillis and Vincent 2000; Wunder 2006). Thus far, however, none of these strategies have proven successful in SE Asia. For example Chape (2001) argues that the effectiveness of ICDP projects in the Lao PDR is unclear because of their inability to address "urgent, priority (environmental) issues." Recent studies conducted in five SE Asia countries also showed that the rate of adoption of conservation technologies is not always directly related to farmers' income (Clement et al. 2007; Clement and Amezaga 2008; Valentin et al. 2008). In addition, it often proves difficult to arrange timely governmental intervention in environmental issues in a context of rapid change such as the one that has prevailed in SE Asia over the past two decades (MIDAS 1998). When available, governmental policy is often unrealistic at the local scale and may even lead to conflicts among villagers (Phengsopha and Morimoto 2003). Thus, one of the greatest challenges for watershed management remains to design and establish integrative frameworks for coordination and harmonization of government and local community actions (Thomas 2008).

In this context PES markets represent an alternative to conventional regulations and market-based tools and are popular where physical and financial demand for environmental services cannot be financed by traditional fiscal tools (Scherr et al. 2006). The already insufficient level of government finance, Overseas Development Assistance and private philanthropy allocated to natural resource management is also consistently declining (FAO 2007). In these cases, proponents see PES markets as an institutional solution to formally counter the so called "tragedy of the commons" (Hardin 1968), defined as "a dilemma in which multiple individuals acting independently in their own self-interest can ultimately destroy a shared resource even where it is clear that it is not in anyone's long-

term interest for this to happen". There is also a trend toward growing corporate interest in environmental investments, partly due to the realization that payments for ES can deliver a return on investment, such as increased life expectancy of expensive hydropower generators (Mulder et al. 2005). In Lao PDR, for example, under the former Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme (MWPB), launched in 2006 for the Nam Theun 2 project, the hydropower company committed itself to pay for protection of upstream forests in order to prevent reservoir siltation over a period of 30 years. In practice PES markets are at various stages of development worldwide and few programmes have actually proceeded beyond the planning stage.

Mountainous areas of mainland SE Asia form a physically, culturally and linguistically diverse region that stretches across the northern part of Myanmar, Lao PDR, Thailand, Vietnam and into Yunnan, China. Common across the region is a high dependence on agriculture for subsistence and income. Likewise many people's livelihoods are vulnerable to any loss in productivity associated with resource degradation (Yasuyuki and Rambo 2004). Finding ways that can guarantee the maintenance of ES through sustainable resource management is therefore a major regional challenge for the uplands of SE Asia.

The objective of this paper is to discuss, based on two case studies conducted at sites in northern Thailand and Lao PDR, whether or not such upland areas of mainland SE Asia offer conditions suitable for establishment of payments for watershed services, i.e. locally-based programmes (villages, land-user groups) designed to control soil erosion, sediment transport and water quality. The paper will also (i) discuss limitations that are likely to impinge on direct transfer of the PES concept; (ii) examine institutional adaptations and support that will be required for successful implementation of PES markets and; (iii) highlight those areas where PES appear especially promising, where they are likely to be ineffective, and where they could complement other policy instruments.

2. Background and methods

2.1. Basic principles of PES

The literature identifies five general criteria central to a successful and self supporting PES market (Landell-Mills and Porras 2002; Wunder 2005; van Noordwijk et al. 2007; Pagiola 2008); (i) transactions must be voluntary; (ii) the ES (or the lands used to provide the service) must be well defined; (iii) the ES must be bought by at least one buyer; (iv) the ES must be sold by at least one supplier; and (v) payment is conditional upon receiving the ES. Several additional conditions are also critical for PES implementation. Sufficient awareness of stakeholders at every level is critical to ensuring that PES operates as a true market rather than a non-conditional form of taxation or subsidy (Tomich et al. 2004). The institutional context of PES is also unanimously recognised by authors as critical to the success of PES. Intermediary institutions must play a fundamental role

in supporting all aspects of operation of PES markets, particularly in countries with relatively weak governance structures (FAO and REDLACH 2004; Mayrand and Paquin 2004; Wunder 2005; Huang and Upadhyaya 2007; Pagiola 2007). Lastly, successful PES projects tend to appear in regions with an existing level of stakeholder organisation (Gutman 2003; Rosales 2003) and clear property rights are usually considered as central to PES markets (Wunder 2007).

2.2. Payments for watershed services: previous and current experiences in SE Asia

Whether or not watershed services make good PES markets is a subject often debated. In a 2006 report prepared for the Canadian International Development Agency (CIDA), Robinson and Venema (2006) claimed that hydrological watershed services are 'ideally' suited to PES markets because there are direct and obvious users of water in a watershed, meaning that prospective buyers can be easily identified and targeted. This is the case when there is a clear delineation between the beneficiaries (often downstream domestic water users) and the providers (upstream farmers who have a direct impact on land-use) of the ES. Other authors argue that where the water resource is owned by many poor smallholders, or where there are many non-point sources of degradation/contamination, difficulties in setting up the market and monitoring individuals' behaviour result in high transaction costs and reduced cost-effectiveness (Jack et al. 2008). Accordingly, in their evaluation of Vietnam's potential for PES, Wunder et al. (2005) concluded that PES is unsuitable to watersheds where potential buyers are predominantly poor or lack basic knowledge of the linkages between land-use and watershed services. Thus, in the uplands of mainland SE Asia, where many potential ES providers are poor smallholder farmers, it is necessary to determine whether payment for watershed services can be effectively implemented.

Countries of mainland SE Asia have engaged in PES at a much slower pace than in Central American countries at a similar level of economic development, with many proposed schemes, but few mature projects (Landell Mills and Porras 2002; Huang and Upadhyaya 2007). In SE Asia, the majority of PES markets are located in the Philippines and in Indonesia – where the Rewarding the Upland Poor for Environmental Services (RUPES) programme currently oversees a number of PES markets which vary in operation and focus. In their review of PES in Asia, Huang and Upadhyaya (2007) argue that successful take-off of PES in Asia will depend upon five context-specific factors: (i) diverse governance structures and regulatory frameworks; (ii) risk of high transaction costs from high population density and low land holdings per capita; (iii) weak property rights for forest and agricultural land; (iv) insufficient hydrological data and understanding of watershed services; and (v) low awareness of PES. There is a significant need for further research that explains the effects of these factors on PES uptake for watershed services in upland communities where both upland and lowland communities are relatively poor and in some cases overlap.

2.3. Choice of the study sites

Two sites with contrasting socioeconomic contexts have been selected, in Thailand and Lao PDR, respectively, to allow for general insights about PES schemes in mainland SE Asia, and to discuss the variability of PES feasibility in upper watersheds of mainland SE Asia. At the Thai site, relatively wealthy and well-coordinated lowland paddy farmers are progressively deforesting the midlands to grow maize for the local animal feed industry. By comparison, the swidden-fallow landuse in the sparsely populated highlands has a relatively limited impact on the environment. Although this pattern is not general to northern Thailand, the selected site remains representative of land degradation processes that prevail in this region, such as widespread forest encroachment for cash crop production (Lu et al. 2008). At the Lao site, the community is composed of poor farmers who grow mainly subsistence food crops and timber on steep slopes, gardeners who sell part of their production at the nearby Luang Prabang market, fish breeders, small traders and government employees. Some particularities, such as ethnicity dominated by Lao Lum, Khmu and Hmong, proximity to a major road and an average-sized urban centre, combine to make some characteristics of the Lao site relatively atypical compared to Lao PDR as a whole. Yet, the livelihoods of its residents as well as their ethnic diversity (a result of the government's relocation policy) are clearly characteristic of most of Lao PDR's upland populations (Lestrelin and Giordano 2007).

2.3.1. The Mae Thang watershed, Thailand

The Mae Thang watershed covers a 130 km^2 area located in Phrae province of northern Thailand, about 550 km north from Bangkok. Phrae province includes eight districts and numerous sub-district administrative bodies known as Tambon Administrative Organisations (TAOs). The non-municipal area of the surveyed district incorporates 74 villages, which are divided among nine TAOs. The population of these villages totals 40,851 or 10.5% of the total non-municipal population of the greater Phrae province. The district has the lowest provincial population density at 32 inhabitants km^{-2} compared to an average 72 inhabitants km^{-2}, due to the lack of inhabitants in the midlands (Phrae Province Statistical Office 2005).

The catchment includes a 36 million m^3 reservoir, operated since 1995 under the authority of the Royal Irrigation Department (RID) to irrigate 620 ha of paddy fields located in the plain immediately downstream from the dam. The reservoir hosts nine floating restaurants and 45 fish farms. The upper watershed is composed of mountainous highlands (>600 m) inhabited by Hmong and Mlabri populations who rely on subsistence agriculture for their livelihoods. In the few villages with road access, cabbage is grown to supply the local market. Between the highlands and lowlands lie uninhabited hills, which we will subsequently refer to as midlands. Lowland farmers began cultivating the midlands approximately 35 years ago when the opening of logging roads provided easy access to this area. Today, maize fields (Figure 1) permanently cover a large part of the midlands. The area converted to

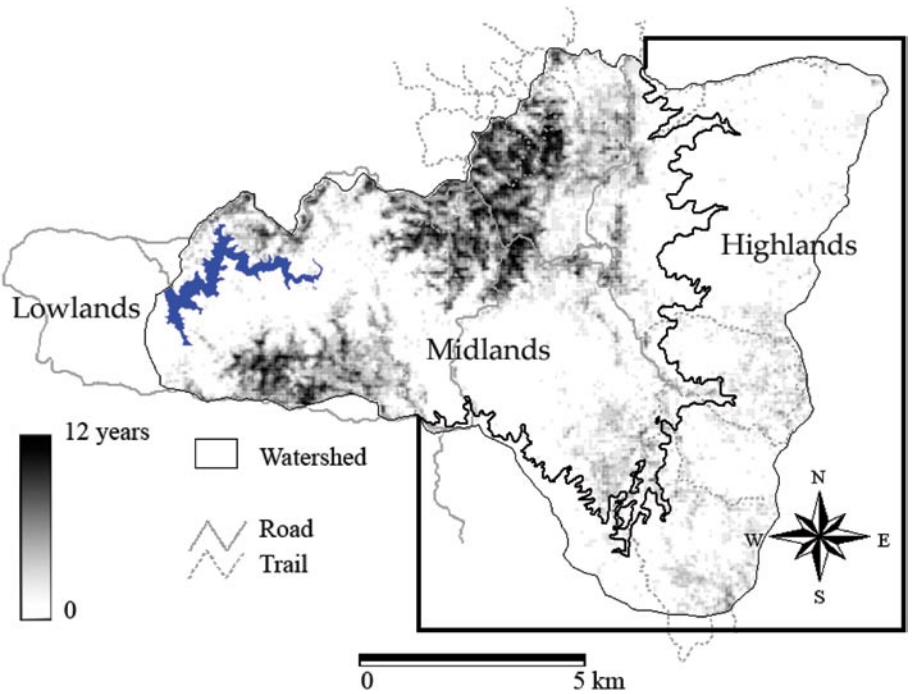

Figure 1: Number of years of cultivation since 1995 in the Mae Thang watershed, Thailand.

annual cropping currently expands at a yearly rate of 3.35%, a twofold increase compared to 2000, when maize was first introduced in the watershed.

2.3.2. The Houay Xon watershed, Lao PDR

The Houay Xon watershed is located in the Luang Prabang province in northern Laos, south of the UNESCO World Heritage listed city of Luang Prabang. The studied watershed (Figure 2) covers 22 km^2 and includes seven villages located along the Houay Xon stream. The stream runs for approximately 15 km and has three main tributaries. Average annual rainfall is 1403 mm (average over the last 30 years). Elevations in this catchment range from 280 to 1336 m.a.s.l. (Phu Phung moutain range) with an average slope gradient of about 31%. The study area encompasses a population of 6251 inhabitants mostly of the Lao Lum, Khmu and Hmong ethnic groups. Most farming activities are located upstream, in the Houay Pano and Houay Thong headwater catchment, which were both surveyed for this study. Downstream village populations are dominated by government employees, and agricultural activities are limited to small scale vegetable gardening and fish breeding. Income levels in Houay Xon, although diverse, are typically very low (Figure 3). The majority of the population earns just enough money to satisfy their basic needs with an average 95% of income spent on food. 15% of the 67 studied households do not have access to electricity.

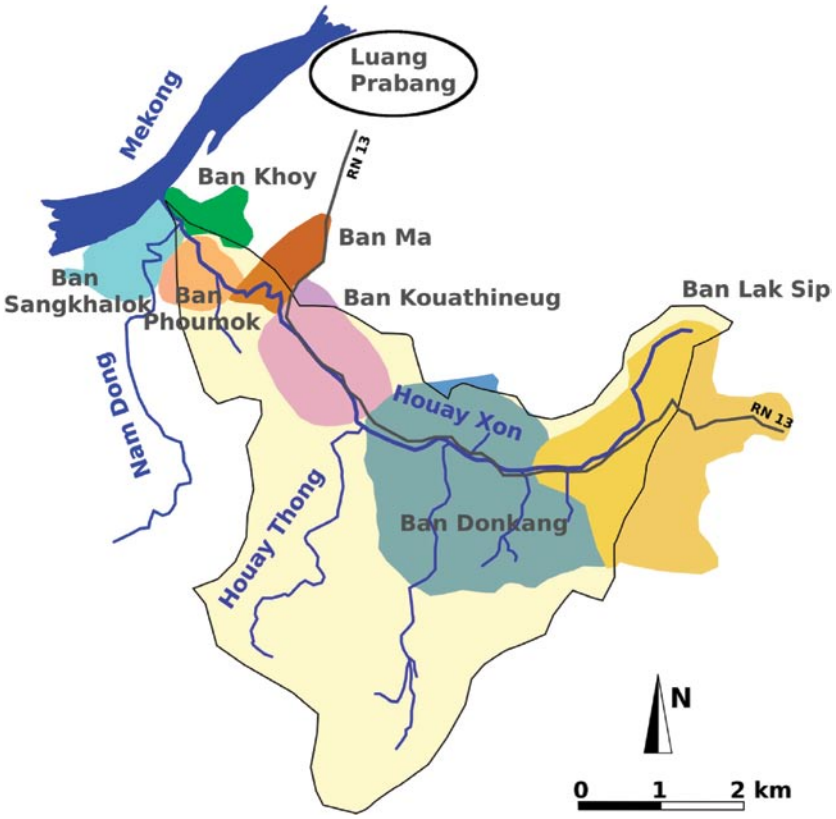

Figure 2: The Huay Xong watershed, Lao PDR.

2.4. Data collection procedure

Our data collection procedure was designed following the guidelines of the FAO electronic forum on payment schemes for environmental services in watersheds (FAO and REDLACH 2004). It included: i) surveys of local populations' perception of environmental issues such as land degradation and/or changes in water quality, ii) critical analysis and compilation of pre-existing biophysical, socio-economic and geographical information and iii) field measurements acquired by the MSEC programme, an interdisciplinary research programme focused on on- and off-site impacts of soil erosion and active in six SE Asia partner countries (http://msec.iwmi.org/).

To estimate the supply and demand for watershed services at both study sites we surveyed various target groups that included key stakeholders, such as farmers, villagers and traders, as well as provincial and government departments. For this

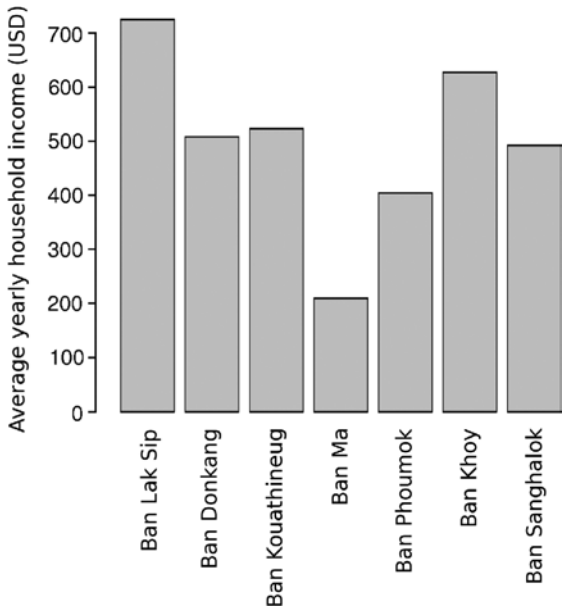

Figure 3: Average annual income per household in the sampled villages in Laos.

purpose, we conducted semi-structured interviews with questions formulated to elicit both general and specific information, with both closed- and open-ended questions for basic livelihood data and enquiries regarding environmental services, respectively. While questionnaires differed according to the target group, all integrated three main sections: i) background information on livelihoods, ii) economic aspects, iii) perceptions and knowledge of environmental issues in the study area, and perceptions of the concept and feasibility of PES scheme.

In Thailand, our survey focused on activities and environmental concerns of lowlanders only. Highlands represent a small proportion of the watershed only (Figure 1) and deforested patches are relatively small as well, typically <5 hectares. Overall, highlanders have limited negative offsite impact on the environment at the watershed level. By comparison, the largest deforested area in the midlands extends over more than 20 km^2, and lowlanders have started clearing the midlands for more than three decades for cash crop production. A sample of 50 interviewees were surveyed, including downstream villagers, most of whom were involved in cash crop production in the midlands, head of villages, traders, and representatives from NGOs and municipal, regional and national departments. In Laos, our survey relied on a sample of 67 households encompassing five categories of water users: farmers from upland and downstream areas, gardeners, traders and downstream villagers who only use water for domestic purposes.

2.5. ES valuation

The cost of ES provision through various land management practices was assessed using simple calculations. The total costs linked to the adoption of the new practice were subtracted from the benefits derived from the new practice. Three types of costs were identified: (i) set-up costs including any initial investments e.g. to buy seeds, equipment and access training; (ii) initial opportunity costs associated with change in land use (e.g. loss of profits as new crops mature); and (iii) production costs associated with managing the new practice (more labour intensive, new taxes etc).

3. Results

3.1. Thailand

3.1.1. The ES: controlled soil erosion and sediment transport

Although most interviewees reported that water quality is steadily declining in the Mae Thang due to upstream agriculture-related chemical pollution, as well as contamination from fish farms, river water is not used for downstream domestic purposes. Therefore, there is little motivation amongst lowlanders to pay for cleaner water. Based on interviews of 50 households, the average household expenditure for bottled water is 30 Thai baht (~1 USD) per week. As almost all surveyed households included a farmer involved in the chemical pollution of the river, it is even more unlikely that this figure can be translated into willingness to pay (WTP) for foregoing the opportunity costs of discontinuing upstream use of fertilisers and other chemical inputs.

Over 90% of surveyed midland farmers believe that soil erosion affects their land production negatively (Figure 4). Furthermore, 67% claim that runoff and

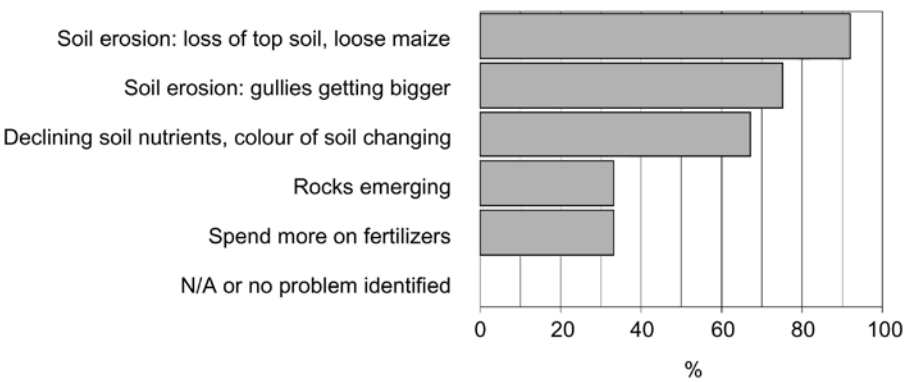

Figure 4: Responses in Ban Pong village to the question "Are these environmental issues of concern for you?".

erosion are leaching the soil of valuable nutrients, with a negative impact on productivity, while 33% stated an increase in expenditure on fertilisers in recent years. Most interestingly, 75% of farmers have noticed visible changes in gully size on their land, reporting a widening of "several centimetres" following each major rainfall. However, these farmers continue to dismiss most of the mitigation methods offered to them. At the time of the survey, 75% declared that a cultivation ban on the steepest slopes was unacceptable to them, even with compensation, while 50% said they would not consider reforestation (e.g. with tamarind) as an option. In contrast, 82% of the interviewees regarded gully correction favourably, provided cost of building materials and labour is not charged to them. Discussions with TAO officers confirmed this interest in and demand for erosion control through gully correction. However, discussions also revealed that farmers already have the opportunity to build small check dams, through aid from the nationwide "check-dam Royal project", but prefer using this aid to build temporary ponds in their villages in order to secure water supply during the dry season.

Based on survey findings, control of erosion and sediment transport within the catchment via the building of a network of check dams for gully correction, appears to be a possible watershed service (WS) that Mae Thang farmers might sell within the framework of a PES scheme. We also found, however, that 1) the potential WS sellers are also those primarily interested in benefiting from the service provision and, 2) it is not possible to distinguish between upstream WS providers and downstream buyers in the Mae Thang watershed. These specificities foreclose the possibility of setting up a simple PES scheme as defined under section 2.

3.1.2. Factors favourable to PES implementation

The site displayed two key features common to successful PES schemes in SE Asia. Firstly there is a significant level of pre-existing organisation and effective coordination among farmers. In 2007 water user groups were established in the lowlands in response to chronic water shortages blamed on low rainfall and poor water management. Water-use management groups now regulate dry season irrigation and coordinate water allocation to farmers in anticipation of future water shortages due to increasing demand and climate change. Many mid and lowland farmers are also grouped in agricultural co-operatives or *sahagon* that coordinate their access to capital and sale of produce. At the request of village heads these farmers have previously altered their practices from mechanical to manual sowing with no compensation for additional labour incurred, in order to minimise erosion in valley heads which drain directly into the Mae Thang reservoir. This precedent suggests the community is responsive to ES conservation. Secondly, regardless of the actual nature of their land rights, all land managers behave as legal owners and land transactions are commonplace within the community. This strong sense of ownership should act as a positive condition for management of land-use within a legal framework.

3.1.3. Obstacles to PES implementation

A majority of interviewees expressed scepticism towards PES because they believe that services 'from nature' should be free. They also had bad experiences with contracts in the past (in particular with multinational agribusiness firms like Monsanto®), and they regarded the possibility of altering farming practices with disbelief (although some had already implemented such changes, as seen in the previous paragraph). Another important fact to take into account when considering putative PES schemes in the Mae Thang watershed is that midland maize fields are cultivated for cash, whereas lowland paddy fields are cultivated for subsistence. Consequently, there is very little motivation from other stakeholders to provide any sort of support, especially financial support, to midland farmers.

Stakeholders have a limited understanding of soil erosion and means to combat it, a key obstacle to PES identified by Wunder (2005). One third of the interviewed farmers described an increased occurrence of rocks at the surface of their land but did not associate it with topsoil loss. Instead, they referred to this process as "rocks coming out of the soil". Farmers also tend to disregard authorities and their efforts to control erosion and conserve land. In the site, the foothills are owned by the government of Thailand and placed under the authority of the National Park, Wildlife and Plant Conservation Department (DNP). Even where usufruct rights have been issued to some individuals they are accompanied by strict land-use restrictions such as prohibitions on clearing, and on cultivating steep slopes. Nevertheless, due to insufficient law enforcement, farmers now cultivate the entire foothills, including steep slopes and some valley heads directly connected to the reservoir. The authorities, especially DNP officers, are reluctant to consider payments to upland farmers in exchange for ES provision, as they pointedly observe that farmers cultivate the foothills illegally and have previously cleared tamarind trees planted by a conservation project.

3.1.4. Institutional capacity

The institutions and planning process that influence PES arrangements were studied by combining responses from upstream and downstream water users with those of local authorities. TAO officers were interviewed to assess the potential involvement of local administration in a PES scheme. TAO budgetary rules prevent the transfer of money outside of the *tambon*, thereby preventing joint projects involving more than one *tambon* across a given watershed. This is particularly problematic for PES where payments from downstream service beneficiaries must be made to upstream service providers located across such administrative boundaries.

The Royal Irrigation Department (RID) was identified as another potential buyer of the controlled erosion and sediment transport service. An echo-sonar sounding carried out in 2005 showed that the reservoir had been filled with $3.5\ 10^6\ m^3$ (almost 10% of its capacity) of sediments during a period of ten years. As with soil erosion, sedimentation varies significantly depending on rainfall intensity. In 2004, for example, the same amount of sediment as that deposited over the eight

preceding years reached the reservoir after one single extreme storm (rainfall of 218 mm over 6 hours). RID estimates the dredging cost at THB 15 m^{-3} (USD 0.5 m^{-3}). On this basis, the cost of sedimentation would represent THB 5.4 million per year (USD 160,000). However, this amount does not represent a WTP from RID because the objective of dredging is to prevent siltation of the intake pipe, which is usually achieved by dredging a tiny fraction of the accumulated sediments. Especially, the coarser fraction of the sediments (≈60% of total sedimentation) settle at the mouths of rivers and gullies often located kilometres upstream from the dam. Moreover, dredging is requested only after the level of sediment has reached the intake pipe. In the Mae Thang reservoir, dredging of the reservoir is not anticipated before a few decades despite the high siltation rate. Interviews of RID officers highlighted that agriculture is not the only cause of dam siltation. A nearby dam, for example, was severely damaged by massive landslides during an extreme storm in 2004, despite the fact that the surrounding watershed was entirely forested. This is further confirmed by measurements made in the Mae Thang watershed during the same event, indicating that channel erosion prevails during extreme storms (Valentin et al. 2008), thus limiting the efficiency of any soil conservation practice with regard to control of reservoir siltation. Finally, RID authority is limited to the dam and the irrigated area, whereas the watershed is under the authority of DNP.

3.2. Lao PDR

3.2.1. The ES: a guaranteed water flow of defined quality

Our surveys revealed a clear downstream demand for improved water quality and more constant stream water flow in the Houay Xon catchment (Mousquès et al. 2007). In addition to topsoil loss, soil erosion is responsible for changes in water quality and increased instability of surrounding landscapes. In particular, frequent land clearing and burning yields large amounts of vegetable material that can often be seen obstructing the stream. Human pressure such as farming activities and construction works cause landslides (Lebreton 2007), which lead to dramatic soil loss and increased the turbidity of the Houay Xon (Ribolzi et al. 2008). Erosion from upland maize fields has now reached 5.9 t ha^{-1} $year^{-1}$ of sediments, a marked increase from the 1990s where erosion was stable at 0.9 t ha^{-1} $year^{-1}$ (Valentin et al. 2008). Furthermore, the yearly sediment load exported from this catchment is increasingly affecting downstream water quality. The MSEC programme 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 downstream water quality by reducing sediment delivery (van Breusegem 2005; Valentin et al. 2006; van der Helm 2007). The effectiveness and cost of each of these measures have been evaluated (Table 1), either via field trials or modelling. Based on these assessments, conservation or introduction of grass along river banks is an effective means ES that can control sediment delivery to streams and meet downstream demand for improved water quality with virtually zero associated costs apart from labour. All the Houay Pano farmers interviewed

Table 1: Selection of possible environmental management practices and estimated costs in the Laos site.

Proposed solution	Cost in USD/inhabitant/month
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#

Note: 1 USD=8750 LAK; # was a one-off payment.

confirmed they were aware of soil erosion problems and, in principle, are willing to implement soil conservation practices in exchange for some compensation.

3.2.2. Factors favourable to PES implementation

Survey findings indicate 3.7% of villagers identify themselves as gardeners or small-scale producers of fruits and vegetables sold directly to consumers and restaurants in Luang Prabang. They comprise the only users of stream water in downstream villages (Figure 5). The use of polluted water for garden irrigation is undoubtedly a cause of concern for consumers, but its actual impact compared to those associated with excessive use of fertilisers and herbicides was not assessed by this study. Land use in downstream villages is undergoing change; 2003 data from the DAFEO (Lestrelin et al. 2005) 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 (Figure 6) and although market gardeners derive 46% of their income from the sale of vegetables, this still remains a marginally profitable activity. This change was also observed in villages further downstream from Ban Donkang (Rural Development Committee 1999). The main economic activity of these villages is now commerce, and half of the producers interviewed declared that they wanted to decrease their area under cropping. Downstream villagers who are fish farmers are also potential ES buyers as they complain about water quality. But they themselves cause serious water pollution because of the lack of infrastructure to collect wastes or wastewater from their fish ponds. The survey identified that, overall, WTP within the sampled population was approximately USD 0.3 $month^{-1}$ $household^{-1}$, which if used to compensate upland farmers for implementing new land management practices (Table 1), would be sufficient to abate some of the negative impacts of soil erosion on water quality. However, in addition to soil erosion control upstream, improving water quality in the stream will require collection of domestic waste and grey water, as well as reduction of water seepage from latrines, but the current WTP is too low to support these interventions.

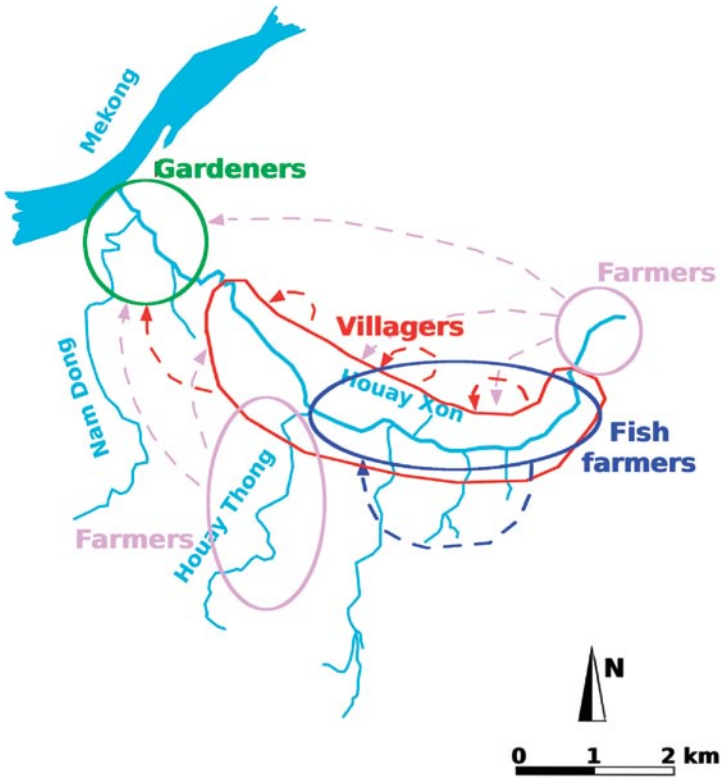

Figure 5: Spatial relationship between the different water users along the Houay Xon.

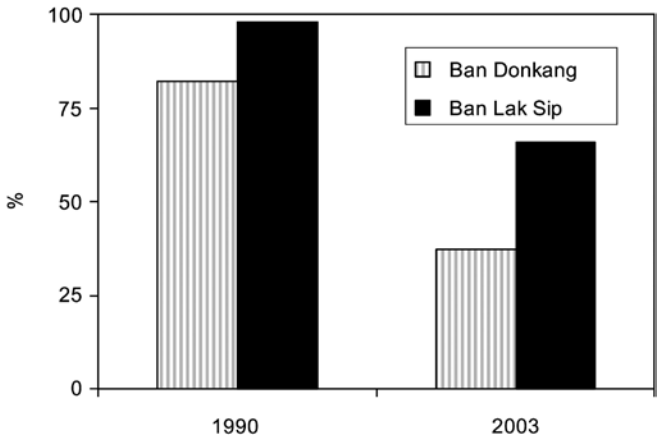

Figure 6: Evolution of the share of households' income generated by agriculture in two study villages from 1993 to 2003.

3.2.3. Obstacles to the implementation of PES

The alternative land-use practices priced in Table 1 may be hard to implement due to a range of reasons, among which the most conspicuous are inflexible land use and land allocation policies, and the strong overlap between ES users and providers.

In all the villages downstream of Ban Kouathineug the official land-use plan is to increase the area under intensive annual cropping. This intensification risks increasing soil erosion and is at odds with land-use changes suggested by the MSEC programme. In addition, the current land allocation system makes it difficult, if not impossible, for farmers to alter land-use (NGPES, cited in NAFRI et al. 2005). Whereas it is a basic principle of PES that there is enough flexibility to alter land-use so as to ensure delivery of ES, district land was strictly allocated on a village basis under the National Growth and Poverty Eradication Strategy (NGPES). There also appears to be confusion amongst villagers about the land allocation process, which further complicates the process of negotiating changes to land-use allotments. According to village chiefs, different authorities or institutions conduct land allocation in different villages. In Ban Phoumok, the provincial government is responsible, whereas it is the UNESCO Heritage House at Ban Khoy. Such variability in authority can further increase transaction costs when setting up a PES market. This complexity obviously calls for reassessment, as recently acknowledged by the Lao government (Lestrelin and Giordano 2007).

As in northern Thailand, environmental degradation is not only caused by agricultural activities in the Houay Xon catchment. Fish farmers also affect water quality by releasing chemical and organic waste into the stream. Even more importantly, our survey showed that the downstream community is playing a major role in the deterioration of the quality of water in the stream. 68% of the interviewees said increasing population density along the stream and household waste were the major causes of reduced water quality. Only seven of the 67 surveyed households are currently using the existing garbage collection service, and 48% mentioned the need for an efficient garbage collection service. Estimated input of grey water (i.e. water used for washing clothes, dishes, personal care, etc.) varied from 50 to more than 2500 litres household^{-1} week^{-1}, and 44% of surveyed households declared releasing from 1000 to 1500 litres of wastewater into the stream every week, which is in the range of observed values for developing countries in the wet tropics (Gleick 1996). Seepage from poorly built latrines as well as direct defecation into the river are also commonplace. Nevertheless, villagers are not aware of the existence of a groundwater table and its connection with the river system, so that the concept of contamination of groundwater through the infiltration of polluted water is not understood. Efforts will be needed to help communities recognize their responsibility for this pollution, change their behaviour and increase their WTP. Their currently low WTP results from a poor understanding of environmental processes and scepticism of the potential benefits they will derive from improved WS, especially since downstream villages are populated by a majority of employees, factory workers and shopkeepers, whose needs for stream water are rather limited.

Potential private sector ES buyers include two downstream bottled water companies, namely the Nam Papa and the Luang Prabang Pre-Stress Concrete Plant (DLPCP) companies. However, as both these water companies have direct access to and control of headwaters that they exploit, there is, within the catchment, no other stakeholder they could possibly buy a watershed service from. Moreover, the Nam Papa company has a license to operate as the exclusive user of a 3000 ha area located on the Phu Phung Mountain and aims to completely reforest it by banning annual cropping. The DLPCP also owns large tracts of land around the spring that is the source of its water. Proposing a PES scheme to companies that already have such a substantial influence on land use in the surrounding areas will more than likely fail.

The population relocation policy initiated in the 1970s (Lestrelin et al. 2006) resulted in the cohabitation of several ethnic groups within small communities, often inducing tensions, and fell short of establishing good communication among villages and between villages and local authorities. Such a low level of communication within groups in the watershed will bring substantial difficulties in the negotiation process of any PES scheme between them.

3.2.4. Institutional capacity

In response to the question "If there is not enough water in the stream or it becomes suddenly unusable, towards whom will you turn for help?" more than half of interviewees answered that there was no one to help them. Less than 20% said they would turn to district authorities, and about 16% would go to their village chief. Overall, interviews highlighted that the community does not consider local authorities responsible for their well-being, or for the state of the environment. This may relate to the historical lack of direct government support for development programmes, matters for which the government still largely relies on support from international development agencies. Given such a low level of the people's expectation towards the government, it appears highly unlikely that district authorities would be in a position to manage a PES market which would be put in place in this type of area. Perhaps more realistically, the UNESCO Heritage House, which is a national Lao authority reporting directly to the Minister of Information and Culture from its base in Luang Prabang, could act as an administrative mediator for the PES scheme. Currently, the main missions of the Heritage House are to manage, conserve and enhance the natural, cultural and architectural heritage within the protected area encompassing the old historic city and adjacent banks of both the Mekong and Nam Khan rivers. The Heritage House has actively promoted gardening with organic fertilisers in several villages, including Ban Ma and Ban Khoy within our study area. The Heritage House is also involved in planning land-use and implementing building regulations. Other scientific organisations could also assist with implementing new land management practices. One of the missions of the Northern Agriculture and Forestry Research Centre (NAFReC) based in Luang Prabang, is to establish alternative cropping systems which protect soils. Public institutions concerned with water issues are

numerous in Laos and could also be of valuable assistance with implementation of a PES. Similarly, the National Centre for Environmental Health and Water supply, or *Nam Saat*, is a unit under the Ministry of Health that is in charge of the Water Supply System (WSS) and receives support from several national and international organisations. One WSS coordination unit in Luang Prabang, the Administrative Authority of urban planning, works with the Heritage House and already coordinates garbage collection in 36 villages. Thus, this unit might prove a key partner for efforts to implement a PES in the study area.

4. Discussion

4.1. PES and poverty

Pagiola et al. (2007) showed that in Colombia poor households could engage in PES markets almost as easily as more wealthy stakeholders. The most noticeable difference was higher transaction costs when the ES was supplied by poor households because a larger number of suppliers had to be contracted to cover a given area. Similarly, our study suggests that poverty does not limit engagement in PES programmes. At the Thai site, the spontaneous emergence of water users group following the 2007 water shortages, as well as the discontinuation of mechanical sowing to reduce soil erosion, reflect attitudes which show potential for ES conservation and trade by local stakeholders. At the Lao site, although farmers and villagers are poor, they showed some awareness of environmental problems which translated into modest levels of WTP for improved water quality.

4.2. Downstream ES buyers vs upstream ES suppliers

The prevailing conceptual framework for PES is restricted to a dichotomous view that strictly separates ES suppliers from ES buyers. Classically, ES provision by a well identified and delimited community (usually based upstream in the case of WS) is enhanced as a result of some form of incentive provided by a separate community (based downstream in the case of WS). It is usually more advantageous for the ES 'buyer' to compensate the costs of ES provision rather than reactively manage the consequences of ES degradation. A fundamental finding of this study is that this simple concept can be difficult to apply in specific local contexts. At the Thai site, upstream and downstream stakeholders were found to be part of the same community. In addition, income distribution was atypical with poorer people taking on the role of ES buyers. At the Lao site, various communities distributed along the stream all contribute to water pollution. Moreover, the administrative structures that should act as intermediaries between upstream and downstream communities were found to be either lacking or not readily suitable.

4.3. Socio-economic barriers

At the Thai site, lowland paddy fields are cultivated for subsistence, while maize is grown for cash in the midlands. Farmers who cultivate land in the hills are to some

extent wealthier than those who do not, or at least this is how they are regarded by those not involved in midland farming. As a consequence, rice growers from the plain have no WTP to pay for combating erosion in the fields of midland maize growers. At the Lao site, reduced or inexistent communication among villages jeopardizes any possible transaction between them. Moreover, both upstream and downstream users negatively affect water quality. As a consequence, a PES programme which would only target upstream farmers as ES suppliers would only address part of the problem and would likely exacerbate tensions among communities across the catchment.

4.4. Private property and institutional frameworks

In the literature, several authors suggest that clear land ownership is a prerequisite to commitment to conservation practices. Bracer et al. (2007) describe property rights as the 'foundation for legal (market) transactions'. Kerr and Jindal (2007) also set land rights at the highest rank of requirements for PES scheme viability. This assertion, however, is also debated. In Kulekhani, Nepal, research showed that in the absence of land tenure, user rights were sufficient to establish a working PES scheme (Huang and Upadhyaya 2007). Extending property rights to environmental commodities such as water is viewed as another way of encouraging stakeholders to increase their WTP (Vincent et al. 1995) and show interest in a PES market. However, establishing environmental markets of this sort in SE Asia would 'require an institutional revolution' (Vincent et al. 1995). Our results support an intermediary position. At the Thai site, perceived land rights appear to prevail over legal entitlements. As long as owners' rights are respected, and there are efficient and trusted local procedures to solve conflicts related to land rights, the need for titles issued by the government did not appear to be an issue. In Lao PDR, however, the rather strict control of land use and allocation by the government remains a constraint for implementation of a PES scheme based on land use change.

4.5. Who should really be paying for the ES?

Advocates of PES usually describe it as a system of economic incentives for ES provision, wherein "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 …" (Mayrand and Paquin 2004, p. 5). Accordingly, large private or public agencies located downstream are often targeted as potential buyers of watershed services. Because Lao PDR is the country where most of the region's hydropower development will occur in the future, hydropower operators will likely play an important role in PES schemes that may be established in this country.

A frequently cited inventory of PES markets around the world by the same authors, often applies the term 'compensation' to describe the process of internalising positive externalities. In reality, however, discussions limited to economic incentive concepts can distort the nature of ES provision by upland farmers. Examples

from Thailand and Lao PDR reveal an existing willingness of communities to provide ES without compensation when they recognise that long-term benefits will accrue to upstream as well as downstream stakeholders. In these cases, payment may be understood as a means for facilitating technology transfer, education and institutional organization to support ES provision, rather than as compensation in a narrow sense. Indeed, the term 'compensation' tends to suggest that sellers are providing a service from which they themselves do not benefit, and reinforces the often unrealistic binary distinction of flows between uplands and lowlands. Finally, as shown by the Lao case, not all environmental issues are eligible for a PES market and would be better served by other programmes and fiscal tools.

5. Conclusions

Our study aimed to assess the potential and limitations of PES as a means to manage watershed services under conditions in mainland Southeast Asia. Based on two case studies, in Lao PDR and Thailand, we can conclude that neither situation offered an immediate opportunity for launching a PES market for watershed services. Major issues and obstacles found at case study sites included the following:

- The classic watershed-oriented downstream vs upstream scheme did not apply. In Lao PDR, the main concern was water pollution, but downstream villagers were causing as much pollution as upstream stakeholders. In Thailand, downstream and upstream stakeholders turned out to belong to the same community.
- WTP was consistently low, and largely insufficient to address environment service issues raised in the study. External sources of funding will likely be needed to establish PES schemes at the local scale. Alternatively, PES might address the issues at larger scales than explored in this study (22–130 km^2).
- When upstream stakeholders are (or are perceived as) wealthier than downstream stakeholders, WTP for ES provided by upstream stakeholders was very low. In this case, law enforcement, new regulations, education and/or a PES market at a larger scale might be better alternatives.
- Restricted and inflexible land rights inherently contradict the PES concept which requires that land use can be altered at the will of service providers. However, in areas where the enforcement of land use regulations is weak, perceived land rights prevail, regardless of the formal rights that support the perception. Rather unexpectedly, this may prove an important factor to the success of PES.
- Effective social organisation, including trust in local authorities, farmers' organisations (e.g. co-operatives), etc., is a strong prerequisite for launching a PES market. Conversely, rigid administrative bodies with inadequate mandates, will or funding to address watershed issues may make it difficult to implement a PES market at the local level.

Literature cited

Bracer, C., S. Scherr, A. Molnar, M. Sekher, B. O. Ochieng, and G. Sriskanthan. 2007. *Organization and governance for fostering pro-poor compensation for environmental services: CES Scoping Study Issue Paper no. 4*. ICRAF Working Paper no. 39. Nairobi, Kenya: World Agroforestry Centre (ICRAF) [online] URL: http://www.worldagroforestry.org/downloads/publications/PDFs/WP14961.PDF.

Chape, S. 2001. An overview of integrated approaches to conservation and community development in the Lao People's Democratic Republic. *Parks* 11(2):24–32.

Clement, F. and J. M. Amezaga. 2008. Linking reforestation policies with land use change in Northern Vietnam: Why local factors matter. *Geoforum* 39(1):265–277.

Clement, F., J. M. Amezaga, D. Orange, and Tran Duc Toan. 2007. *The impact of government policies on land use in Northern Vietnam: an institutional approach for understanding farmer decisions*. IWMI Research Report 112. Colombo, Sri Lanka: International Water Management Institute (IWMI). [online] URL: http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/PUB112/RR112.pdf.

Food and Agricultural Organization of the United Nations (FAO). 2007. *The state of food and agriculture: Paying farmers for environmental services*. FAO Agriculture series N° 38. Rome, FAO. [online] URL: ftp://ftp.fao.org/docrep/fao/010/a1200e/a1200e00.pdf.

Food and Agricultural Organization of the United Nations (FAO) and Latin American Network for Technical Cooperation in Watershed Management (REDLACH). 2004. *Electronic forum on payment schemes for environmental services in watersheds*, Santiago, Chile: FAO. [online] URL: http://www.rlc.fao.org/foro/psa/pdf/report.pdf.

Gillis, M. and J. D. Vincent. 2000. National self-interest in the pursuit of sustainable development. In *Sustainable Development: The challenge of transition*. eds. J. Schmandt and C. H. Ward, 11–62. Cambridge: Cambridge University Press.

Gleick, P. H. 1996. Basic water requirements for human activities: meeting basic needs. *Water International* 21:83–92.

Gutman, P. ed. 2003. *From goodwill to payment for environmental service: a survey of financing options for sustainable natural resource management in developing countries*. Washington, DC: World Wildlife Fund (WWF). [online] *URL: http://assets.panda.org/downloads/fin_alt.pdf*.

Hardin, G. 1968. The tragedy of the commons. *Science* 162:1243–1248.

Huang, M. and S. K. Upadhyaya. 2007. *Watershed-based payment for environmental services in Asia*. Winrock International Working Paper No. 06-07. OIRED. [online] URL: http://www.oired.vt.edu/sanremcrsp/documents/PES.Sourcebook.Oct.2007/Sept.2007.PESAsia.pdf.

ICEM. 2003. *Lao PDR National report on protected areas and development. review of protected areas and development in the lower Mekong river region*. Indooroopilly, Queensland, Australia: ICEM. [online] URL: http://www.mekong-protected-areas.org/lao_pdr/docs/lao_pdr_nr.pdf.

Jack, B. K., C. Kousky, and K. R. E. Sims. 2008. Designing payments for ecosystem services: lessons from previous experience with incentive-based mechanisms. *Proceedings of the National Academy of Science of the United States of America* 105(28):9465–9470.

Kerr, J. and R. Jindal. 2007. Policies and institutions: enabling factors for PES. USAID PES. Brief 5. Virginia Tech, Blacksburg: SANREM CRSP.

Lakanavichian, S. 2001. *Forest policy and history in Thailand*. Bangkok: Research Centre on Forest and People in Thailand. [online] URL: http://www.rockmekong.org/events/html_file/MMSEA (D)/References/Forest policy and history in Thailand_Suree.pdf.

Landell-Mills, N. and I. T. Porras. 2002. *Silver bullet or fools' gold? A global review of markets for forest environmental services and their impact on the poor*. London: International Institute for Environment and Development (IIED). [online] URL: http://www.cbd.int/doc/external/iied/iied-silver-report-2002-en.pdf.

Lebreton, M. 2007. Rôles de l'occupation des sols sur la stabilité des berges dans un bassin versant des régions montagneuses du nord du Laos. Rennes, France: Report for obtaining the Diploma of Engineer of the National Institute of Applied Sciences.

Lestrelin, G. and M. Giordano, 2007. Upland development policy, livelihood change and land degradation: interactions from a Laotian village. *Land Degradation and Development* 18: 55–76.

Lestrelin, G., M. Giordano, and B. Keohavong. 2005. *When "conservation" leads to land degradation: Lessons from Ban Lak Sip, Laos*. IWMI research report 91. Colombo, Sri Lanka: IWMI. [online] URL: http://dlc.dlib.indiana.edu/archive/00003890/01/RR91.pdf.

Lienhard, P., H. Tran Quoc, C. Khamxaykhay, T. Sosomphou, F. Tivet, G. Lestrelin, K. Panyasiri, and L. Séguy. 2006. Improving smallholder livelihood, watershed and soil management through conservation agriculture in Laos. Paper presented at the International Symposium on Towards Sustainable Livelihoods and Ecosystems in Mountainous Regions, 7–9 March 2006, Chiang Mai, Thailand.

Lu T., X. Sun, D. Zhang, Z. Xue, and J. Gong. 2008. Assessment of soil erosion risk in northern Thailand. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* 37(B8):703–708.

Mayrand, K. and M. Paquin. 2004. *Payments for Environmental Services: A Survey and Assessment of Current Schemes*. Montreal: Unisfera. [online] URL: http://www.cec.org/files/PDF/ECONOMY/PES-Unisfera_en.pdf.

MIDAS Agronomics Co. Ltd. 1998. *Land-Forest Allocation in Protected Areas in the Lao PDR: Issues and Options*. Vientiane, Laos: Global Environmental Trust Fund.

Mousquès, C., P. Sengsoulychanh, O. Sengtaheuanghoung, K. Latchackack, O. Ribolzi, and A. Pierret. 2007. Relevance of payments for environmental services (PES) for watershed management in northern Laos. Paper presented at the International Forum on Water Environmental Governance in Asia. 3–4 December 2007, Beppu, Japan.

Mulder, I., K. ten Kate, and S. Scherr. 2005. *Private sector demand in markets for ecosystem services.* Washington, DC: Forest Trends. [online] URL: http://www.fsd.nl/downloadattachment/72341/60533/private_sector_demand.pdf.

NAFRI, NAFES and NUOL. 2005. *Improving livelihoods in the uplands of the Lao PDR Volume 1: Initiatives and approaches*. Vientiane: The National University of Lao PDR (NAFRI).

Pagiola, S. 2007. Payments for environmental services: from theory to practice. Paper presented at the Global Workshop on Payment for Environmental Services, Mataram, Indonesia, January 24, 2007.

Pagiola, S. 2008. Payments for environmental services in Costa Rica. *Ecological Economics* 65:712–724.

Pagiola, S., A. R. Rios, and A. Arcenas. 2007. Poor household participation in payments for environmental services: lessons from the silvopastoral project in Quindío, Colombia. MPRA Paper 4794. Munich, Germany: University Library of Munich. [online] URL: http://siteresources.worldbank.org/INTEEI/Resources/Silvopastoral-Poverty-Colombia.pdf.

Phengsopha, K. and T. Morimoto. 2003. Local forest management and strategies in northern Laos following government intervention. Towards participatory forest management. In: *Laos Country Report 2003: Towards Participatory Forest Management in Laos*, eds. K. Hyakumura, M. Inoue, M. Nanang, K. Harada, and K. Komatsu. Kanawaga, Japan: IGES. 1–11. [online] URL: enviroscope.iges.or.jp/modules/envirolib/upload/380/attach/02_chap01.pdf.

Phrae Provincial Statistical Office. 2005. *Provincial Statistical Report 2005*. Changwat Phrae. Phrae, Thailand: Ministry of Information and Communication Technology.

Ribolzi, O., J. Cuny, P. Sengsoulichanh, A. Pierret, J. -P. Thiebaux, S. Huon, E. Bourdon, H. Robain, and O. Sengthaheuangoung. 2008. Assessment of water quality along a tributary of the Mekong river in a mountainous, mixed land-use environment of the Lao P.D.R. *The Lao Journal of Agriculture and Forestry*, special issue, volume 17, chapter 5.

Robinson, L. W. and H. D. Venema. 2006. Perspectives on watershed-based payments for ecosystem services. Livelihoods and Ecosystems project technical Report #2. CIDA. [online] URL: http://www.nesh.ca/sl-esh/reports/SLESH-TechnicalReport2.pdf.

Rosales, R. M. P. 2003. *Developing pro-poor markets for environmental services in the Philippines*. London: International Institute for Environment and Development (IIED).

Rural Development Committee. 1999. *Integrated rural accessibility planning, accessibility database Luang Prabang District*. Luang Prabang, Laos: IRAP et Rural Development Committee.

Scherr, S. J., M. T. Bennett, M. Loughney, and K. Canby. 2006. *Developing future ecosystem service payments in China: lessons learned from international experience*. Beijing: CC*IED*. [online] URL: http://www.forest-trends.org/documents/publications/ChinaPES from Caro.pdf.

Thomas, D. E. 2008. Where Central Policies Meet Local Objectives: Exploring Sub-Basin-Level Participatory Watershed Management in Northern Thailand. In *Proceedings of the Sustainable Sloping Lands and Watershed Management Conference,* 12–15 December 2006, eds. L. Gebbie, A. Glendinning, R. Lefroy-Braun, and M. Victor 21–34. Vientiane, Laos: National Agriculture and Forestry Research Institute (NAFRI).

Tomich, T. P., D. E. Thomas, and M. van Noordwijk. 2004. Environmental services and land-use change in SEA: from recognition to regulation or reward? *Agriculture, Ecosystems & Environment* 104:229–244.

Valentin, C., A. Boosaner, T. de Guzman, K. Phachomphonh, K. Subaygyonos, and T. Toan. 2006. Impact of innovative land management practices on annual runoff and soil losses from 27 catchments of South-East Asia. Paper presented at the 2nd International Conference on Sustainable Sloping Lands and Watershed Management, 12–15 December 2006, Luang Phrabang, Laos. [online] URL: http://www.mekonginfo.org/mrc_en/doclib.nsf/0/E1DFBBEFB9263E6B4725724A00123F75/$FILE/Presentation_01.html.

Valentin, C., F. Agus, R. Alamban, A. Boosaner, J. -P. Bricquet, V. Chaplot, T. de Guzman, A. de Rouw, J. -L. Janeau, D. Orange, K. Phachomphonh, D. Phai, P. Podwojewski, O. Ribolzi, N. Silvera, K. Subagyono, J. -P. Thiébaux, T. Toan, and T. Vadari. 2008. Impact of rapid land-use changes and conservation practices on annual runoff and sediment losses from 27 upland catchments in South-East Asia. *Agriculture, Ecosystems & Environment* 128(4):225–238.

van Breusegem, N. 2005. Sediment trapping capasity of riparian vegetation in a small watershed catchment of Northern Lao PDR. MSc Thesis. Wageningen: Wageningen University.

van der Helm, R. B. 2007. Evaluating alternative land-use scenarios using the AnnAGNPS model in the Houay Pano catchment of northern Lao PDR. Msc Thesis. Wageningen: Wageningen Univerity.

van Lynden, G. W. J. and L. R. Oldeman. 1997. *The assessment of the status of human-induced soil degradation in South and Southeast Asia*. Wageningen: ISRIC.

van Noordwijk, M., B. Leimona, L. Emerton, T. P. Tomich, S. J. Velarde, M. Kallesoe, M. Sekher, and B. M. Swallow. 2007. *Criteria and indication*

for environmental service compensation and reward mechanisms: realistic, voluntary, conditional and pro-poor: *CES Scoping Study Issue Paper n° 2*. ICRAF Working Paper n° 37. Nairobi: World Agroforestry Centre (ICRAF).

Vigiak, O., O. Ribolzi, A. Pierret, O. Sengtaheuanghoung, and C. Valentin 2007. Trapping efficiencies of cultivated and natural riparian vegetation of northern Laos. *Journal of Environmental Quality* 37:889–897.

Vincent, J. R., M. Kaosa-Ard, L. Worachai, E. Y. Azumi, N. Tangtham, and A. B. Rala. 1995. *The economics of watershed management: a case study of the Mae Taeng*. Bangkok: Development Research Institute.

Wunder, S. 2005. *Payments for environmental services: some nuts and bolts. Occasional Paper No. 42*. CIFOR. [online] URL: http://www.cifor.cgiar.org/publications/pdf_files/OccPapers/OP-42.pdf.

Wunder, S. 2006. Are direct payments for environmental services spelling doom for sustainable forest management in the tropics? *Ecology and Society* 11(2):23.

Wunder, S. 2007. The efficiency of payments for environmental services in tropical conservation. *Conservation Biology* 21:48–58.

Wunder, S., B. D. The, and E. Ibarra. 2005. *Payment is good, control is better: why payments for forest environmental services in Vietnam have so far remained incipient*. Bogor, Indonesia: CIFOR [online] URL: http://www.cifor.cgiar.org/Publications/Detail?pid=1912.

Yasuyuki, K. and T. A. Rambo. 2004. Some key issues relating to sustainable agro-resources management in the mountainous region of mainland Southeast Asia. *Southeast Asian Studies* 41(4):550–565.