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Willingness of upstream and downstream resource managers to engage in compensation schemes for environmental services

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Abstract: Providing compensation for land conservation practices adopted by upstream farmers is still an alien concept in the Thai political context. The governance of common-pool natural resources, such as forest and water, has traditionally been under the control of powerful government line agencies, while the contribution of local communities to natural resource conservation have been hardly recognized by policy-makers. Drawing on a case study in Mae Sa watershed, Chiang Mai province, northern Thailand, this paper discusses the potential of developing compensation schemes in a socio-political context where upland farmers – mostly belonging to ethnic minority groups – tend to be considered a threat to the natural resource base rather than providers of environmental services. Based on data obtained from 371 farm households in the upstream communities and 151 farm households in the downstream communities of the watershed, upstream resource managers' willingness to accept compensation for the conservation measures and downstream resource managers' willingness to pay for water resource improvements were estimated through the use of choice experiments. Results from the study suggest that downstream resource managers would be willing to provide on average nearly 1% of their annual income for a substantial improvement of the quantity and quality of water resources, which could be achieved by compensating upstream farmers' change of their agricultural systems towards more environment-friendly practices. Both willingness to pay of downstream respondents and willingness of upstream resource managers to accept compensation were positively correlated with age, education, participation in environmental conservation activities and previous experiences with droughts and/or erosion. The paper concludes that there is a potential for establishing compensation schemes for provision of environmental services in northern Thai watersheds if other actors, such as private businesses and local administration, contribute a substantial share of the budget and if all relevant stakeholders get involved in the institutional design of compensation schemes.

Keywords: Choice experiments, compensation schemes for ecological services, northern Thailand, water resource improvement

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1. Introduction

There have been rising concerns that upland watersheds in Mainland Southeast Asia deteriorate at a rapid pace due to a variety of reasons, with inappropriate agricultural practices among the most often cited (El-Swaify and Evans 1999; FAO 1999; Kunstadter 2007). Excessive use of agrochemicals, high demand for irrigation during the dry season, and cultivation of annual crops without erosion control measures on sloping lands bring about problems of reliability of water supply, loss of topsoil and contamination of water quality affecting downstream users. To address these problems, the adoption of soil and water conservation practices by upstream communities have been discussed as a potential solution. The voluntary uptake of such measures has been slow, however, since their adoption often reduces available land and requires more labour (El-Swaify and Evans 1999; Neef et al. 2007). In many cases, the effects of such measures can only be reaped in the long-term, while poor smallholders' discount rates tend to be rather high. As downstream residents are the immediate beneficiaries of sustainable agricultural practices, the principle that upstream farmers need to be compensated for their losses when managing water and land in more sustainable and 'downstream-friendly' ways has been increasingly accepted by academics, NGOs, donors and – more reluctantly – by national policy makers (e.g. Tomich et al. 2004; Swallow et al. 2005).

Providing compensation for agricultural conservation practices adopted by upstream farmers is a rather new concept in the Thai political context. The governance of natural resources, such as forest and water, has traditionally been under the control of powerful government agencies (e.g. Royal Forest Department, Royal Irrigation Department), while the contribution of local communities to natural resource conservation have been largely ignored by policy-makers (Vandergeest 1996; Ganjanapan 1997; Neef et al. 2006). A focal point of command-and-control environmental policies has been the northern part of the country where more than 50 percent of the country's total forest area and the major head watersheds feeding the Chao Praya River, the lifeline of Thailand's rice bowl, are located (Ganjanapan 1998; Laungaramsri 2000; Forsyth and Walker 2008). Drawing on a case study in Mae Sa watershed, Chiang Mai province, northern Thailand, this paper discusses the potential of establishing compensation schemes for watershed improvements in a socio-political context where upland farmers – mostly belonging to ethnic minority groups – tend to be considered as destroyers of forests and other natural resources rather than providers of environmental services.

In this study we attempt to simultaneously determine upstream and downstream resource managers' willingness to engage in a compensation scheme that would reward upstream resource managers for shifting from their conventional agricultural practices towards environment-friendly practices, thus improving water resources for irrigation and household use of downstream resource managers. Hence, while recent studies in northern Thailand have focused on urban residents' willingness to pay for resource improvements in northern Thai hillsides (Ahlheim et al. 2006; Frör 2007), this study provides a complementary perspective with its focus on internal compensation mechanisms among rural residents within a small mountainous river basin. Choice Experiments (CE) were used to elicit upstream resource managers' willingness to accept compensation for adopting environment-friendly agricultural practices and to determine downstream resource managers' willingness to pay for water resource improvements through a change in upstream resource management. A logit model was applied to investigate socio-economic factors determining the willingness of both groups to engage in a compensation scheme.

The structure of the remainder of this paper is as follows: in section 2, we discuss the methodology and conceptual framework, including theoretical background, characterization of the study area, sample selection and model development. Empirical results of the choice experiments for both upstream and downstream farm households are presented and discussed in section 3. The paper concludes with a discussion of policy implications.

2. Methodology and conceptual framework

2.1. Theoretical background: choice experiment model

Choice experiments (CE) have their origins in conjoint analysis, a method that has been widely used to measure individual's preferences in the areas of economics, transport, and geography (e.g. Green 1978; Ben-Akiva and Lerman 1985; Louviere 1988; Swait and Adamowicz 2001). Since the mid-1990s, CE have also been applied and discussed in environmental economics (e.g. Morrison et al. 1996; Hanley et al. 1998a). Valuation studies of non-market goods – for instance, the ecological value of a watershed – that employed CE are increasingly found in the economic literature (Hensher et al. 2006; Hanley et al. 2007; Peterson et al. 2007) and there has been a lively scholarly debate regarding the advantages and limitations of CEs in comparison to other environmental valuation methods, such as Contingent Valuation Methods (CVM) (Boxall et al. 1996; Adamowicz et al. 1997; Adamowicz et al. 1998; Hanley et al. 1998b; Swait and Adamowicz 2001; Bateman et al. 2002; DeShazo and Fermo 2002; Rolfe et al. 2002; Rosenberger et al. 2003). Proponents of CE claim that elicitation of the willingness-to-pay and/or willingness-to-accept is more subtle in choice experiments than in a CVM interview and, as a consequence, the danger of strategic answers and protest bids by respondents is reduced (Ahlheim and Neef 2006; Yabe and Yoshida 2006). The use of CE helps in eliciting trade-offs that individuals make when choosing among alternative options or attributes. Through determining the amount of money that respondents would be willing to pay to effectuate a proposed change, it is possible to compute the marginal value of changes in each attribute. In many situations, such an approach may provide more realistic outcomes than focusing on a single change in the provision of the whole good which is a characteristic of most CVM studies (Mogas et al. 2006). With its emphasis on the combination of various attributes and levels, CE can be used for designing multidimensional policies, for conducting a cost–benefit analysis of such policy measures and for supporting conflict resolution and negotiations over the protection and use of non-market goods (Bateman et al. 2002; Mogas et al. 2006; Hanley et al. 2007).

CE can be applied to generate estimates of compensating surpluses for different attribute levels. Choice experimentation is based on random utility theory in which an indirect utility function is comprised of a deterministic element (V_i) containing the attributes of the situation, and an error term (ε_i). The model can be represented by the equation (1):

$$U_i = V_i + \varepsilon_i = \beta X_i + \varepsilon_i \tag{1}$$

where X_i is a vector of attributes of the option and β is a vector of coefficients that reflect the relative importance of the attributes. Selecting one situation over another implies that the utility gained from the first situation (U_i) is greater than the utility gained from an alternative (U_j). The probability of choosing alternative i over j is represented by the form:

$$prob(i\ chosen) = prob(V_i + \varepsilon_i > V_j + \varepsilon_j ; \forall j \in C) \tag{2}$$

The error term is assumed to be independently and identically distributed (IID) with a type I extreme value distribution, a so-called Gumbel distribution, then equation (3) applies. The scale parameter λ is typically assumed to equal one and is inversely proportional to the variance of the error term.

$$prob(i) = \frac{e^{\lambda V_i}}{\sum_{j \in C} e^{\lambda V_j}} \tag{3}$$

An estimated linear-in-parameters utility function for alternative i then comes in the form of equation (4):

$$V_i = \alpha_i + \sum_{j=1}^{n} \beta_j X_j \tag{4}$$

To obtain welfare estimates or compensation variation (CV) in choice experiment studies, the following general formula described by Hanemann (1984) is employed:

$$CV = \frac{1}{\mu}\left[\ln \sum_{i \in C} e^{V_{i1}} - \ln \sum_{i \in C} e^{V_{i0}} \right] \tag{5}$$

where μ is the marginal utility of income, C is the choice set and V_{i0} and V_{i1} represent the indirectly observable utility before and after the optional changes. When the choice set includes only one ‘before’ and ‘after’ alternative, equation (6) applies:

$$CV = \frac{1}{\mu}[\ln e^{V_{i1}} - \ln e^{V_{i0}} l] = \frac{1}{\mu}[V_{i1} - V_{i0}] \tag{6}$$

From equation (6) it can be concluded that the marginal rate of substitution between two attributes is the ratio of their coefficients (Hensher and Johnson 1981). The marginal willingness to pay (MWTP) for a change in attribute is then provided by equation (7).

$$MWTP_{tn} = \frac{dP_i}{dX_{tn}} = \frac{\partial V_{ij}}{\partial X_{tn}} \bigg/ -\frac{\partial V_{ij}}{\partial P_i} = -\frac{\beta_{tn}}{\delta} \quad (7)$$

2.2. Study area

The Mae Sa watershed, Mae Rim district, Chiang Mai province covers an area of 142.2 km^2 and extends from 20 to 45 km northwest of the northern city Chiang Mai (Figure 1). The watershed is intensively used for market-oriented agriculture, mainly fruit, flower and vegetable production. 80 percent of the total agricultural area of 1086 ha is under irrigation (Schreinemachers et al. 2008). The population is composed of northern Thai (*khon muang*) and the Hmong ethnic minority group. Of the total 3046 households in the watershed, 1309 (43%) are engaged in agriculture on an average landholding of around 1 ha (Schreinemachers et al. 2008).

Major parts of the watershed are included in the Doi Suthep-Pui National Park, where agricultural activities are considered illegal under Thai environmental legislation. The watershed has been part of a pilot project of the Thai government to introduce river basin committees and sub-basin working groups to enhance

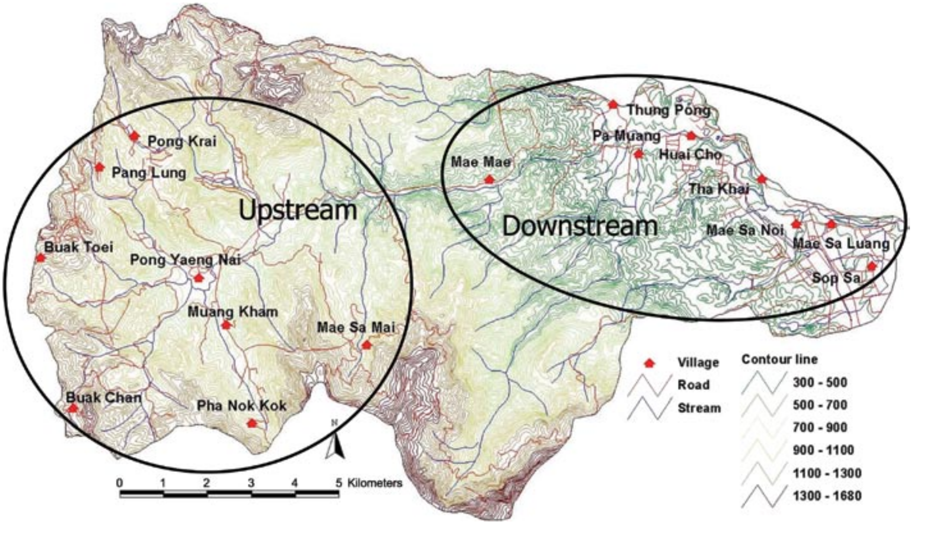

Figure 1: Map of the study area Mae Sa watershed.

public participation in water governance (Heyd and Neef 2006; Neef 2008). The Mae Sa Watershed Management Working Group is the first of its kind in Thailand. Recently, a sub-committee of the working group decided to establish the so-called "Mae Sa Watershed Conservation and Development Fund" with the objective of funding selected resource management projects that would improve watershed functions and services. The pilot project can thus serve as an example how such funds are established and how they can be further developed into viable compensation schemes for environmental services and – more specifically – for enhancing adoption of soil and water conservation practices by upland farmers.

2.3. CE design, sample selection, and model descriptions

This study applied the CM technique to examine upstream farmers' preferences for different agricultural conservation measures, and downstream farmers' preferences for various schemes of water resource improvement (Figure 2). The choice task required respondents to choose one outcome from a set of several possible alternatives (known as a 'choice set'). Upstream respondents were presented with a series of 12 choice sets, while downstream farmers faced ten choice sets. Each choice set had three options, including a 'no change' option that characterized the status quo and two change options. The change options were

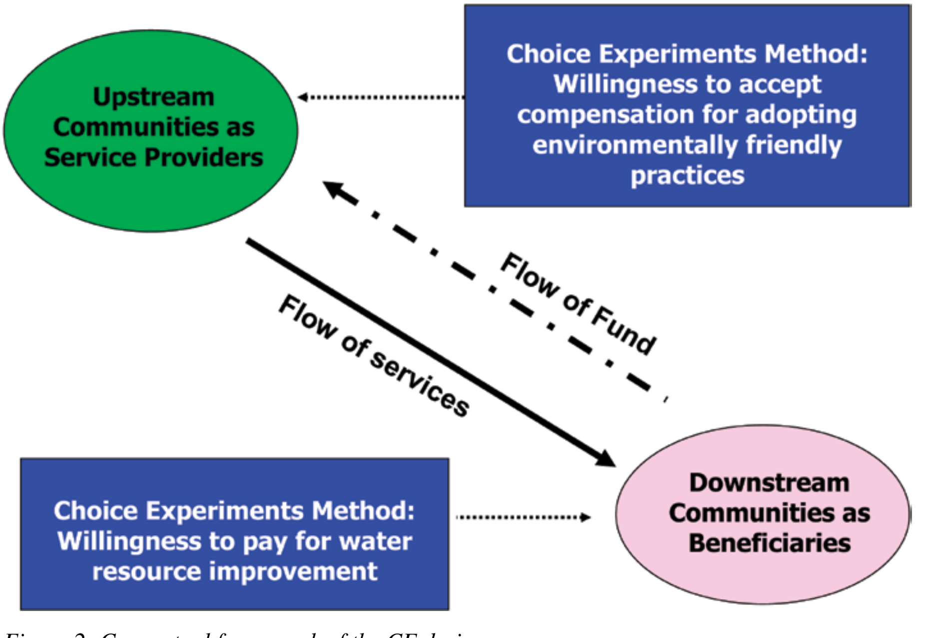

Figure 2: Conceptual framework of the CE design.

generated by varying the levels of each attribute according to an experimental design.

Due to their long-term research collaboration with local stakeholders in the watershed, the research team had gained the trust of the local population which helped to minimize strategic responses and political correctness in stating their willingness to pay/to accept. Respondent fatigue was controlled through small compensation in kind for the participants' opportunity costs of time.

The CE study involved a number of methodological steps. The first step was to select attributes and set their levels. Attributes in this CE study were based on both supply- and demand-driven approaches. Under the supply-driven approach, attributes were derived from what policy-makers and/or researchers perceive to be factors that can be influenced by policy measures. The demand-driven approach involved selecting the attributes that individual or groups of upstream farmers consider important when making choices. In this study, four attributes were selected including installing water saving technology, planting vetiver (*Vetiveria zizanoides*) grass strips for erosion control, applying bio-insecticides and compensation or subsidy. The levels of each attribute were designed based on the costs involved. In each upstream sample village focus group interviews with village leaders and key informants in the field of water resource management were conducted in two rounds. First, the selected attributes and levels were discussed as regards their likelihood to be put into practice. Among various types of compensation, cash compensation was the most preferred option. The second round of discussions provided the final sets of attributes and levels that were used for designing choice sets for upstream farm households' decision making. Each attribute consists of four levels as shown in Table 1 below. Orthogonal design using SPSS provided choices which were then used for designing 12 choice sets. Each choice set contains three alternatives, two alternatives were obtained from the designed choices and the other – the so-called *status quo* – refers to the 'no change' alternative, i.e. maintaining the existing utility of the current practice and receiving no compensation (see example in Figure 3). The randomly selected 371 farm households from seven villages with a total population of 776 households located in the upstream part of the Mae Sa Watershed were asked to state their preferences on willingness to accept compensation according to the 12 choice sets.

Table 1: Attributes and attribute levels in the choice experiments for upstream farmers.

Attribute	Level
Application of bio-insecticides	(% increase of area) 30, 50, 70, 100
Planting of vetiver grass strips	(% increase of area) 10, 20, 30, 40
Installation of water saving irrigation system	50% micro sprinkler, 100% micro sprinkler, 50% drip irrigation, 100% drip irrigation
Compensation	(Baht/rai/year) 300, 546, 1010, 1717

Note: 1 rai=0.16 ha.

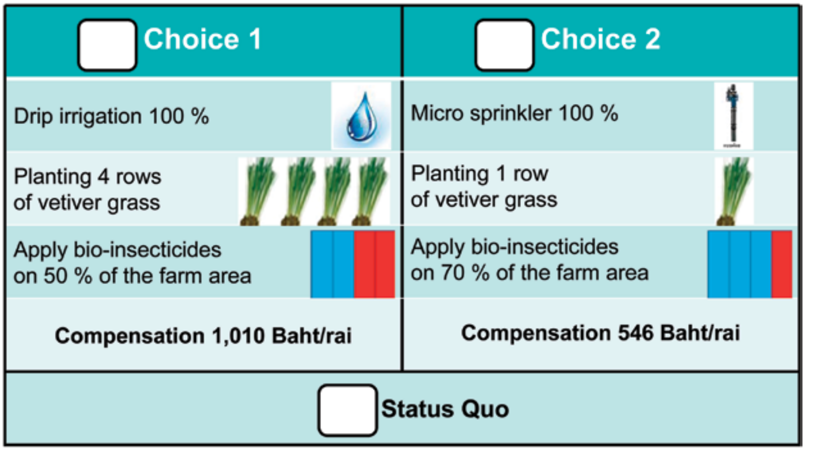

Figure 3: Example of a choice set for upstream farmers.

In the case of the downstream area of the watershed, the same procedures as described for the upstream villages were applied to obtain attributes and levels of water resource improvement as shown in Table 2. Choice sets were constructed with three alternatives, namely two alternatives obtained from the designed choices and the *status quo* (see example in Figure 4). 151 farm households were randomly selected from the total 198 farm households that relied on water from the Mae Sa River for both irrigation purposes and for household consumption. Each respondent faced 10 choice sets.

This study used a simplified version of CE, which is constructed solely on the basis of non-price and price attributes of designed choices. Conditional logit models were employed to estimate implicit prices and willingness-to-pay/ willingness-to-accept compensation as depicted in the appendix. In order to investigate the influence of socio-economic factors on the respondents' preferences a logit model was developed. The marginal effect of each socio-economic factor

Table 2: Attributes and attribute levels in the choice experiments for downstream farmers.

Attribute	Level
Water for agriculture	Level 1: No water shortage Level 2: 1 month shortage Level 3: 2 months shortage (status quo)
Water for household consumption	Level 1: No water shortage Level 2: 1 month shortage Level 3: 2 months shortage (status quo)
Water quality	Level 1: Drinking and cooking Level 2: Household use Level 3: Cultivation (status quo)
Water fee (Baht/household/year)	525, 440, 300, 150 (status quo)

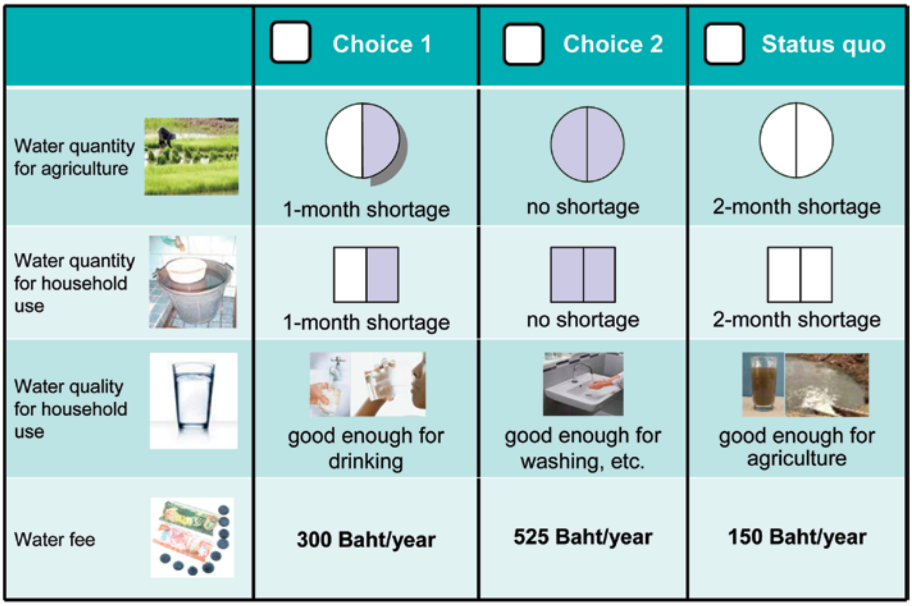

Figure 4: Example of a choice set for downstream farmers.

could be estimated, providing the magnitude of the probability to choose improved alternatives over the status quo.

3. Results and discussion

3.1. Upstream resource managers' willingness to accept compensation for downstream-friendly practices

The major socio-economic characteristics of the upstream farm households in our sample are depicted in Table 3. The most important crops are vegetables, cut-flowers and fruit trees, mainly lychee. Farm sizes of northern Thai farmers are much smaller than those of their Hmong peers, but they also have less family members to feed. Average per capita income in Hmong communities is generally lower than that of the northern Thai communities, the latter being engaged in more intensive farming systems, often in greenhouses.

Table 4 shows the conditional logit model results with respect to upstream farmers' stated willingness to accept compensation for switching to more environmentally friendly practices. The signs of the parameters are consistent with theory and a priori expectations. The negative coefficients for applying bio-insecticides and planting *vetiver* grass suggest that these attributes contribute negatively to utility and therefore need to be compensated for. Marginal willingness to accept was estimated by dividing the attribute coefficient with the price coefficient. The figures show that the upstream farmers would need to

Table 3: Socio-economic characteristics of the upstream communities.

Village	No. of sample house-holds	Major crops (in % of agricultural area)	Total household income (and average per capita income) (Baht/year)	No. of family members	Farm size (ha)	Ethnicity
Buak Chan	53	Vegetables 62% Flowers 13% Fruit trees 9%	119,352.92 (13,261.44)	9	1.91	Hmong
Buak Toei and Pang Lung	30	Flowers 50% Vegetables 20% Fruit trees 10%	101,988.83 (14,569.83)	7	1.33	Hmong / Northern Thai
Pha Nok Kok	52	Vegetables 84% Flowers 6% Fruit trees 8%	122,347.18 (20,391.20)	6	1.50	Hmong
Mae Sa Mai/Mae Sa Noi	118	Vegetables 52% Fruit trees 38%	86,627.75 (10,828.47)	8	1.49	Hmong
Pong Krai	23	Vegetables 65% Flowers 34%	80,523.91 (16,104.78)	5	0.64	Northern Thai
Pong Yang Nai	44	Vegetables 79% Flowers 16%	113,569.32 (28,392.23)	4	0.31	Northern Thai
Muang Kam	51	Vegetable 75% Flowers 22%	169,405.29 (42,351.32)	4	0.39	Northern Thai

Source: Own survey 2007/2008.

be compensated at the rate of about 100 Baht per ha and year for applying bio-insecticides on 1% of their agricultural area. For a 1% increase of area planted with *vetiver* grass strips upstream farmers would need a compensation of more than 400 Baht per ha and year. These results suggest that the willingness to adopt *vetiver* grass under a compensation scheme is lower than the willingness to adopt bio-insecticides, reflecting farmers' scepticism vis-à-vis soil conservation measures that reduce land available for profitable crops.

The coefficients for installing micro-sprinkler systems on 50% of the area and for installing drip irrigation on 50% and 100% of the area respectively have a positive sign which means that farmers do not need any compensation for adopting these practices. These results indicate that upstream farmers are increasingly aware of the need to switch to water-saving irrigation technologies as competition among water users within the same community and upstream-downstream conflicts between neighbouring communities have dramatically increased in recent years (Neef et al. 2006; Becu et al. 2008). In focus group discussions, upstream farmers stated their willingness to invest in such water-saving technologies, if they were assured that they would have sufficient access to water around the year.

Table 4: Model results of upstream farmers' willingness to accept compensation for adopting environmental friendly practices.

Attribute	Model output		Willingness to accept (Baht/ha/year) for 1% increase of area
	Coefficient	Z-statistics	
Application of bio-insecticides	–0.0017	–1.8918**	101.63
Planting *vetiver* grass strips	–0.0070	–2.8761***	423.63
Installation of water saving irrigation system (50% of area under micro-sprinkler)	0.1233	2.4925***	–
Installation of water saving irrigation system (100% of area under micro-sprinkler)	–0.0450	–0.7555	–
Installation of water saving irrigation system (50% of area under drip irrigation)	0.1041	2.2628**	–
Installation of water saving irrigation system (100% of area under drip irrigation)	0.2863	5.8049***	–
Compensation	0.0001	1.7434*	

Note: Significance levels: ***1%, **5%, *10%.
Source: Own analysis.

Table 5 depicts the regression results of the logit model employed to understand the socio-economic factors that influence upstream farmers' willingness to engage in a compensation scheme supporting the adoption of environment-friendly agricultural practices.

Age and education played a significant and positive role in the willingness to adopt environmentally friendly practices under a compensation scheme. Households with a high number of family members (mainly belonging to the Hmong ethnic group, cf. Table 3 above) engaged in farming and with vegetable production as the main activity were also more likely to adopt such practices. Another positive influence on willingness to adopt stemmed from previous experiences with on-site soil erosion, water shortages in the household and drought. If farmers were member of an environmental conservation group they also had a higher probability to engage in such compensation schemes. On the other hand, household heads who perceived themselves as rich or medium wealthy were less willing to adopt environmentally friendly practices than their poorer peers.

The fact that poorer resource managers had a higher willingness to engage in a compensation scheme for providing better ecological services can be attributed to two reasons: first, poorer farmers usually suffer from low tenure security and adopting soil and water conservation measures improves their reputation among government officials, thus reducing the risk of losing their land rights (cf. Neef

Table 5: Regression results of socio-economic factors determining upstream farmers' willingness to participate in a compensation scheme for environmental friendly agricultural practices.

Socio-economic factors	Coefficient	Z-statistics	Marginal effect
Constant	0.2590	1.0651	0.04560
Age of household head (years)	0.0099	2.8251***	0.00175
Education (years)	0.0377	3.7109***	0.00664
Vegetables as main crop (yes=1, no=0)	0.2082	2.6567***	0.03719
Family labour in agriculture (persons)	0.0586	2.9943***	0.01032
Household perceived as rich (yes=1, others=0)	–1.1442	–4.2812***	–0.25184
Total household income (Baht/year)	–2.76E–07	–1.1409	–4.86E–08
Ratio of agricultural income to household income	–0.0587	–0.4149	–0.0103
Household perceived as medium wealthy (yes=1, others=0)	–0.4638	–3.9463***	–0.07554
Past erosion experiences (yes=1, others=0)	0.3076	2.9715***	0.05165
Past household water shortage experiences (yes=1, no=0)	0.4072	4.5109***	0.06932
Past drought experiences (yes=1, no=0)	0.4164	4.9670***	0.07363
Be a member of environmental conservation group (yes=1, no=0)	0.2704	2.9558***	0.04609
Total income (Baht/year)	–2.76E–07	–1.1409	0.00000
Ratio of agricultural income to total income	–0.0587	–0.4149	–0.01033
Log likelihood function	–2355.326		
Number of observations	4,452		
Number of respondents	371		

Note: Significance levels: ***1%, **5%, *10%.
Source: Own analysis.

et al. 2006). Second, poorer households regard a viable compensation scheme as a way to generate a secure stream of cash income and to reduce their general livelihood risks, while more affluent farm households have accumulated their wealth through intensification of agriculture and are less willing to give up practices that have proved economically viable for them in recent years.

3.2. Downstream resource managers' willingness to pay for upstream water resource improvement

Downstream resource managers' agricultural systems are more homogeneous than the farming systems of their upstream counterparts. 31.2% of the agricultural area is under paddy rice, longan orchards constitute 28.7% and the area planted with soybean accounts for 13.6% of the total agricultural area during the rainy season (Schreinemachers et al. 2008). The major socio-economic characteristics of downstream resource managers are depicted in Table 6. The average farm size is just below one hectare. Many young people have moved to the nearby city of Chiang Mai to find non-farm income opportunities, reflected in a high age of the remaining farm population and a high share of non-agricultural income (78.1% of the total household income).

Table 6: Socio-economic characteristics of downstream resource managers.

Socio-Economic Characteristics	Mean
Age (years)	57.43
Education (years)	5.05
Farm size (ha/household)	0.99
Agricultural income from rice and soybean (Baht/household/year)	38,754
Non-agricultural income (Baht/household/year)	138,452

Source: Own survey 2007/2008.

Downstream residents take water for non-food household use, e.g. for bathing and laundry, mainly from a communal water system fed by the Mae Sa river and its tributary creeks (Table 7). Only a minority of the households use water from ponds or groundwater (cf. Sangkapitux et al. 2007). Due to health concerns, most households buy their drinking water in bottles from nearby water companies. Only a quarter of the households use water from the community-based water system for their food and usually they would boil the water first before they drink it. For irrigation, most farmers can use water from the Mae Sa River only, while a small privileged group of farmers in the lowest part of the watershed have access to another water source, coming from the Mae Taeng irrigation dam.

Results of the CE's conditional logit model for the downstream resource managers are presented in Table 8. Apart from the attributes of one-month water shortage for both cultivation and household use, all attributes are statistically significant at the 99 and 95% level. The positive coefficients of sufficient water for cultivation and drinking for the whole year and good water quality for drinking and household use (laundry, bathing, etc.) suggest that these attributes contribute positively to the respondents' utility, while the attribute 'water fee' showed a negative coefficient. Hence, the signs of the parameters are consistent with theory and a priori expectations.

The implicit price or marginal willingness to pay could be estimated by dividing the attribute coefficient with the price coefficient. The willingness to pay of the

Table 7: Water sources of downstream resource managers.

Water source	Non-food household use consumption	Drinking and cooking	Agriculture
Community-based water system (pipes)	118 (78%)	38 (25%)	–
Pond	24 (16%)	21 (14%)	–
Groundwater	9 (6%)	5 (3%)	–
Bottled water	–	87 (58%)	–
Mae Sa River only	–	–	71 (86%)
Mae Sa River and Mae Tang Irrigation Dam	–	–	12 (14%)

Source: Own survey 2007/2008.

Table 8: Model results of downstream farmers' willingness to pay for improved water resources.

Attribute	Model output		Implicit Price (Baht/household and year)	Willingness to pay (Baht/household and year)
	Coefficient	Z-statistics		
Sufficient water quantity for cultivation (no water shortage)	0.7090	9.45***	377.59	737.42
One-month water shortage for cultivation	0.0007	0.0095	–	–
Sufficient water quantity for household use (no water shortage)	0.4590	5.12***	368.71	477.43
One-month water shortage for household use	0.0537	0.5327	–	–
Good water quality for drinking	0.7261	5.98***	238.71	755.19
Good water quality for household use (e.g. laundry, bathing)	0.1718	3.41***	89.34	178.68
Water fee	–0.0019	–2.01**		

Note: Significance levels: ***1%, **5%, *10%.
Source: Own analysis.

downstream farmers to move from the *status quo* to improved water resources along the different attribute levels is calculated as indicated in equation (5) above. The results show that the downstream farmers' willingness to pay was highest with 755.19 Baht per household per year for having the water quality improved from its current status (sufficient quality for irrigation) to drinking water quality. This is followed by the willingness to pay 737.42 Baht per household per year to avoid drought problem for agriculture, and 477.43 Baht per household per year to mitigate water shortage for household use. The lowest amount of money that the downstream resource managers are willing to pay is 178.68 Baht per household per year to obtain good water quality for household use (laundry, etc.). The results imply that downstream resource managers give the first priority to the aspect of water quality improvement as the welfare estimate is found highest, followed by the welfare improvement obtained from an elimination of water shortages for irrigation.

The welfare estimate indicates that the average downstream farm household is willing to pay 1492.61 (737.42+755.19) Baht per year for an improvement of water resources from the *status quo* (2-month shortage and insufficient water quality for drinking and other household use, such as washing) to sufficient water around the year and good water quality for drinking. This amounts to about 0.8% of the average household income of downstream communities.

Table 9 shows the regression results of the logit model determining the socio-economic factors that influence downstream farmers' willingness to participate in a payment scheme for water resource improvement. Age and education of the household heads in the downstream communities were positively correlated with willingness to pay for an improvement of water resources. Farm households with high acreage and rice as the main crop were also more likely to participate in a compensation scheme. Those households that were characterized by a low water

Table 9: Regression results of socio-economic factors determining downstream farmers' willingness to participate in a payment scheme for water resource improvement.

Socio-economic factors	Coefficient	Z-statistics	Marginal effect
Constant	–3.7701	–3.3298***	–0.14335
Age of household head (year)	0.0449	3.5542***	0.00171
Education (year)	0.0813	2.0147**	0.00309
Household member (person)	0.0321	0.4244	0.00122
Agricultural labor (person)	0.0800	0.4763	0.00304
Rice is the main crop (yes=1, no=0)	1.0915	3.8863***	0.05497
Size of land (rai)	0.0897	3.0107***	0.00341
Ownership right (owner=1, non-owner=0)	0.2673	1.1038	0.01002
Non-farm income (Baht/year)	–2.83E–06	–3.3264***	0.00000
Frequency of past drought experiences	0.1505	2.5304***	0.00572
Participation in environmental activities (yes=1, no=0)	1.7206	4.1121***	0.04362
Support of Mae Sa watershed improvement (yes=1, no=0)	1.7293	5.8578***	0.12892
Use water from Mae Sa river and Mae Taeng irrigation system (yes=1, no=0)	–0.4603	–1.7899*	–0.01654
Buy bottled water for drinking (yes=1, no=0)	0.9873	3.9629***	0.04270
Log likelihood function	–318.1640		
Number of observations	1510		
Number of responders	151		

Note: Significance levels: ***1%, **5%, *10%; 1 rai=0.16 ha.
Source: Own analysis.

resource security – reflected in a low diversity of water sources for irrigation, past drought experiences and the need to buy bottled water for consumption – had a higher probability to get involved in such payment schemes (cf. Sangkapitux and Neef 2006). In accordance with the results from the upstream part, resource managers who had previously been engaged in environmental activities and supported an improvement of the ecological status of the watershed were more willing to contribute financially to an improvement of water resources.

On the other hand, a high share of non-farm income had a negative effect on willingness to pay. This result is particularly relevant for policy-makers and for the appropriate design of compensation schemes since rapid development in northern Thai cities and rural-urban migration may further reduce the share of farm revenues in rural people's income portfolio.

3.3. Bringing upstream and downstream resource managers together in a payment scheme for environmental services

Based on the conditional logit model results depicted in Table 8 (Section 3.2) an estimate of the total willingness to pay of the 198 farm households in the downstream area for improved water resources could be calculated at 295,537 Baht (6157 Euro) per year. By contrast, the estimated total compensation needed for upstream farmers to adopt bio-insecticides on 30% and grass strips on 5%

of their combined agricultural area[1] is 6,288,300 Baht (131,006 EUR) per year, according to the figures in Table 4. This means that around 4.7% of the amount needed to compensate upstream resource managers could be collected from downstream resource managers in the watershed, while the remainder would need to be contributed by other stakeholders (e.g. tourist resorts, drinking water companies, waterworks authority). For the implementation of a viable, long-term compensation scheme, an appropriate institutional framework would need to be set in place. It is also crucial that potential beneficiaries of improved water resources are certain that free-riders are excluded from the scheme and that the services they are asked to pay for are delivered in a reliable way. This principle of conditionality, however, poses considerable problems because it is unclear to what extent upstream resource managers would need to change their practices in order to achieve the standards requested by downstream water users.

Lack of trust between beneficiaries and providers of environmental services is probably one of the most constraining factors in setting up viable compensation schemes. Particularly in the Thai socio-political context, trust levels between potential beneficiaries/buyers of environmental services (e.g. downstream resource managers, water work authorities, drinking water companies, urban residents) and upstream providers/sellers of environmental services cannot be taken for granted and would need to be gradually built up in the course of designing appropriate compensation schemes. Experienced and trustworthy intermediary organizations can play a crucial role in (1) facilitating the institutional design of such schemes, (2) mediating in the negotiations that need to take place in their implementation, and (3) setting up appropriate monitoring and enforcement mechanisms.

In the Mae Sa watershed, such a role could be played by the "Mae Sa Watershed Conservation and Development Fund" (MSWCDF) established in 2007 under the Mae Sa Watershed Working Group, a pilot project of the Thai government towards greater stakeholder involvement in managing the kingdom's water resources (Neef 2008). The primary objective of the MSWCDF is to fund various activities devoted to sustainable management of water resources and to minimize potential conflicts resulting from water use both in quantity and quality aspects. In principle, it has been agreed that the fund's management committee would involve representatives from all stakeholder groups. Two elected chief executives from the four sub-district (*tambon*) administrative organizations (TAOs) in the watershed are entrusted as chairman and vice-chairman of the fund respectively. Yet, appointed representatives from government line agencies, such as the Watershed Management Unit (WMU) and the Water Resources Department's regional office, are also involved in managing the fund's budget, although they cannot contribute financially to the fund due to inhibiting ministerial regulations

[1] The total agricultural area in the upper part of the watershed is 1217 ha. It would be unrealistic to assume that all upstream farmers would adopt environment-friendly practices on their entire agricultural area.

on budget expenditure. Given their history of not being very conducive to stakeholder participation in natural resource management, these organizations would need to build up a great deal of trust in order to gain the support of other local stakeholders.

Until October 2008, no concrete measures have been taken apart from designing a logo and setting up donation boxes at major tourist and business locations in the watershed. Voluntary monetary contributions are expected from all major stakeholder groups involved in water resource use. The agreement upon the regular contribution on an annual basis in order to sustain the funding scheme is still under negotiation. In its latest meeting in September 2008, the MSWCDF's committee agreed that each of the four TAOs should contribute at least 50,000 Baht (1042 Euro) in the 2009 fiscal year for supporting various activities that would improve watershed services, such as removing sediments from the rivers, constructing check dams and reforestation.

Being one of the first of its kind in Thailand, the MSWCDF set up as a pilot project does not fully reflect the idea of a payment scheme for ecological services since all stakeholders in principle could benefit from the fund, not just the potential service providers, which are primarily the upstream communities. However, a compensation scheme could be easily incorporated in this type of fund. Hence, the creation of this fund can be seen as a positive sign and a first step towards supporting the principles of Payment for Environmental Services (PES). A proposed institutional framework for such a PES scheme is depicted in Figure 5. Such a framework could then serve as a model for other

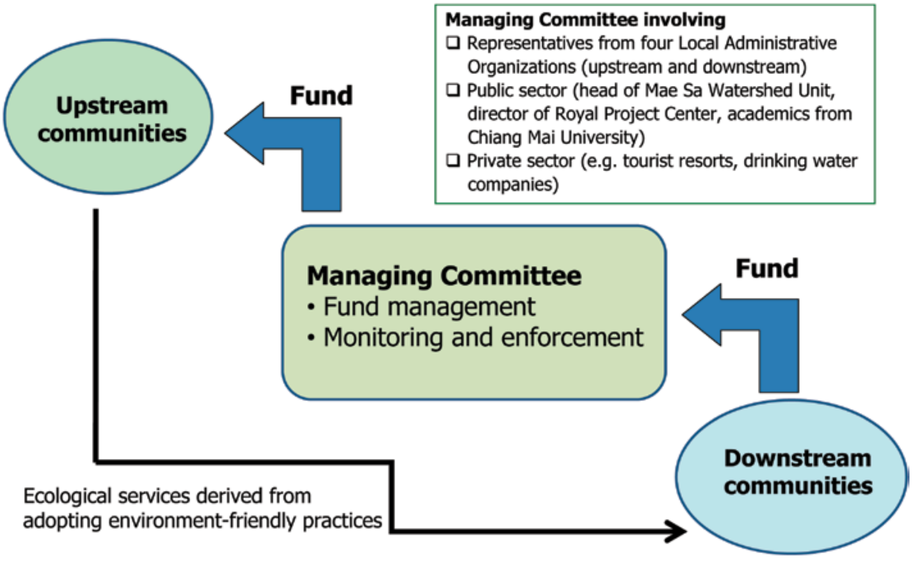

Figure 5: Proposed institutional framework for a PES scheme in Mae Sa watershed.

watershed areas where upstream and downstream stakeholders are willing to engage in negotiations and compensation schemes for improved agricultural and ecological practices in a watershed context.

4. Conclusion and policy implications

Most resource managers in northern Thai watersheds are smallholder farmers and tend to be among the poorest and most marginalized groups of society. It has often been argued that these people are driven by short-term economic interests only and are not willing to engage in efforts to sustain the ecological functions of mountain watersheds in the long run. Yet, as this study shows, both upstream and downstream resource managers in the Mae Sa watershed are aware of a deteriorating environment and are likely to get involved in compensation schemes for environmentally friendly agricultural practices. The finding that the poorer groups among the upstream farmers are more willing to engage in such compensation schemes underscores the potential of PES to become an effective tool for poverty alleviation by its ability to provide a continuous, albeit modest stream of income. Results also suggest that such schemes may not be viable when designed only as an agreement between upstream and downstream resource managers within the boundaries of a watershed. Other local stakeholders in the area (e.g. private businesses, local administration) and urban residents will need to provide the bulk of the compensation needed to effectuate changes in land use practices. Binding agreements and strategic alliances among service providers, beneficiaries and credible and experienced intermediaries will be crucial components of such schemes.

At the national level a specific regulatory framework in support of compensation schemes for ecological services needs to be established to facilitate the implementation of compensation measures on a broader scale. Yet, this requires a dramatic shift in policy-makers' mindset: they need to move from ineffective command-and-control regimes with an exclusive focus on 'fixing uplanders' destructive resource management practices' towards incentive-based approaches that embody both upstream and downstream resource managers. While this study's focus was on monetary compensation, the allocation of secure, but conditional resource entitlements to farmers and/or communities in upland areas – as successfully tested in other Southeast Asian countries like Indonesia – could be an additional incentive to adopt agricultural conservation practices under such compensation schemes.

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Appendix

Attribute-based model for upstream farmers

$Y_{ij} = f$ (VET, BIO, IRRDA, IRRMH, IRRMA, IRRDH, COMP) (8)

Y_{ij} = 1 if respondent j says 'yes', and 0 if 'no' to choice i
VET: percentage of planting *vetiver* grass which are 10%, 20%, 30%, and 40%
BIO: percentage of area applying bio-insecticides which are 30%, 50%, 70%, and 100%
IRRMH = 1 for 50% of area under micro-sprinkler, = –1 for status quo, = 0 for others
IRRMA = 1 for 100% of area under micro-sprinkler, = –1 for status quo, = 0 for others
IRRDH = 1 for 50% of area under drip irrigation, = –1 for status quo, = 0 for others
IRRDA = 1 for 100% of area under drip irrigation, = –1 for status quo, = 0 for others
COMP: compensation which are 300, 546, 1010, and 1717 Baht/rai

Attribute-based model for downstream farmers

$Y_{ij} = f$ (AGRY, AGRI, CONSY, CONSI, QUALA, QUALL, WATFEE) (9)

Y_{ij} = 1 if respondent j says 'yes', and 0 if 'no' to choice i
AGRY = 1 for no water shortage for cultivation, = –1 for status quo (2-month shortage), = 0 for others
AGRI = 1 for one month shortage for cultivation, = –1 for status quo (2-month shortage), = 0 for others
CONSY = 1 for no water shortage for consumption, = –1 for status quo (2-month shortage), = 0 for others
CONSI = 1 for one month shortage for consumption, = –1 for status quo (2-month shortage), = 0 for others
QUALA = 1 for water quality for consumption, household uses and agriculture, = –1 for status quo (water quality for agriculture use), = 0 for others
QUALL = 1 for water quality for household uses and agriculture, = –1 for status quo (water quality for agriculture use), = 0 for others
WATERFEE: water fee at the levels of 525, 440, 300, and 150 Baht/rai

Note: 1 rai = 0.16 ha.