Prospect of Payments for Environmental Services in the Blue Nile Basin: Examples from Koga and Gumera Watersheds, Ethiopia

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Abstract

In transboundary river basins, like the Blue Nile, conflicts over the use of water resources are growing and recent advances in sustainable resource management recognizes the need for approaches that coordinate activities of people dependent on a common resource-base to realize sustainability and equity. Payments for Environmental Services (PES) are a component of a new and more direct conservation paradigm and an emerging concept to finance conservation programs by fostering dialogue between upstream and downstream land users. Those kinds of approach are particularly useful if applied in basins where irrigation schemes are emerging and the service life of reservoir and irrigation canals, in downstream areas are threatened by the sediments moved from upstream region. Here we report the results of our study on the determinants of Willingness to Pay (WTP) and Willingness to Compensate (WTC) for improved land and water management practices in the Blue Nile Basin (Gumera and Koga watersheds). A total of 325 sample households were selected using a multi-stage sampling technique, and a structured and pre-tested questionnaire was used to collect data from the sample households. We applied Contingent Valuation Method (CVM) to elicit WTP using monetary and material payment vehicles. Our results showed that more households are willing to pay in labor than in cash. The mean WTP for improved land and water management was estimated at US\$1.06 and US\$1.3 months^{-1} household^{-1} for upstream and downstream farmers, respectively. Besides, 83.56% of the sample farm households showed WTC the upstream farmers in cash. However, the aggregate WTP falls far short of the estimated investment cost needed for ecosystem restoration. Among others, the number of livestock, size of arable land, access to education and credit by the sample farm households were identified to positively influence sample farmers' WTP for restoration of ecosystem services and downstream farmers' WTC for improved ecosystem regulation services. Therefore, institutions and policy measures that enhance environmental education, reduce poverty and foster stakeholders' cooperation must be promoted.

Key words: Upstream; downstream; improved land and water management; Blue Nile Basin; Transboundary Rivers

Introduction

The Nile Basin is one of the oldest river basins in the world where its ancient inhabitants managed the land and water resources to make the valley a cradle of civilization, and hitherto the national economy of the riparian countries remains heavily dependent on land and water resources (Arsano, 2004). Competition for water exists between nations and economic sectors. Present and potential conflict over water in the basin and watershed scales stems from the increased food and agricultural needs generated by a rapidly growing population. This potential conflict can also be viewed from the perspective of deteriorating regulating ecosystem services in upstream and its impacts on water quality and irrigation and hydropower infrastructures (e.g. sedimentation) in downstream parts of the basin (Arsano, 2004; Haileslassie et al., 2008). In view of postulated new development projects (e.g. irrigation and hydropower) along the Blue Nile, to meet countries growing food demand, it is important to explore mechanisms that can restore healthy ecosystem functioning and sustainable water uses in upstream and downstream regions of the basin.

Payment for Environmental Services (PES) is a new and more direct conservation paradigm to finance conservation programs. The principle of PES referred as those who provide environmental services should be compensated for doing so and those who receive the services should pay for the provisions (Stefano, 2006; Wunder, 2005). Thus, PES is a sound principle to share the costs and benefits of environmental conservation on an equitable basis among all stakeholders. This also applies to a watershed and means: upstream communities produce watershed protection services at an opportunity cost, while the downstream communities are consumers of these services with no payment. Such benefits are positive externalities to the downstream communities and PES aims at internalizing these benefits and to channel it to the upstream communities as an incentive to pursue their watershed conservation practices. In addition to its offsite impacts, erosion directly affects the livelihoods of the upstream community through land degradation and dwindling agricultural productivity.

Therefore, PES principles applied to watershed management must accommodate the downstream farm households willingness to compensate (WTC) the ecosystem service provider and willingness of the both upstream and downstream farmer to pay (WTP) for restoration of watershed's ecosystem services. To date little attention has been paid to the use of PES as a tool for improved land and water management. This study was undertaken in Gumara and Koga watersheds of the Blue Nile Basin (Ethiopia). Large scale irrigation schemes are under construction in the downstream parts of these watersheds. In both watersheds, high rates of erosion and sedimentation are anticipated and mechanisms to mitigate impacts on the livelihoods of the community in upstream and reservoirs in downstream are a major concern. The major objectives of this study were:

i) To investigate willingness of the sample farm households to pay (WTP) for restoration of ecosystem services and to examine the downstream farm households willingness to compensate (WTC) the ecosystem service provider (i.e. the upstream farmers);
ii) To explore socio-economic and institutional drivers of WTP and WTC.
iii) To estimate the mean value of WTP and WTC.

Material and Methods

Location and biophysical settings of the study areas

Gumera and Koga watersheds are located in Tana sub-basin (Eastern part of the Blue Nile, (Figure 2.1.)). The rivers draining Koga watershed originate from Mount Wezem and discharge into Gilgel Abay which eventually drain into Lake Tana (Figure 2.1.). While Gumera originates from Mount Guna and discharges into Lake Tana. The high run-off and associated sediment flow from the upper part of these watersheds have serious consequences on the downstream users and water bodies (e.g. Lake Tana and reservoirs developed for irrigation). Koga and Gumera watersheds exhibit an elevation range of 1890-3200 and 1782-3704 meter above sea level (masl (EMA, 1980)) respectively.

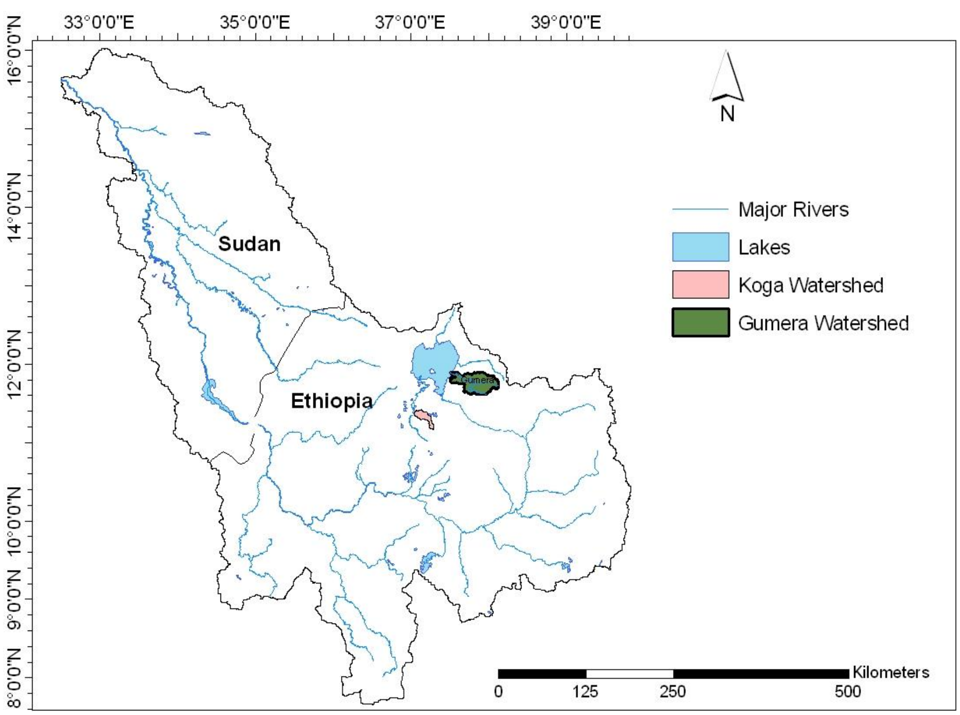

Figure:1 Location map of Koga and Gumera watersheds

As the result of this elevation difference, variables such as climate, vegetation and soils show discrepancy (WRDA, 1994; FAO, 1986; FAO, 1984). The study watersheds exhibit two major traditional climatic zones in Ethiopia: the **DEGA (2300-3200 MASL) AND WOYNADEGA (1500-2300 MASL).** Woynadega climatic zone has a cool to warm semi humid climate, with mean annual temperatures more than 200C. Dega climatic zone has a cool and humid climate with annual temperature ranging between 10^0C and 20^0C. The highest mean monthly rainfall, for both study watersheds, is recorded in July while the highest potential evapotranspiration is in May.

Agriculture is the main stay of livelihood in both study watersheds. Crop and livestock production are fully integrated and thus the production system can be referred as crop-livestock mixed system. Traditionally, rainfed production of cereals, dominated by barley (*Hordeum vulgare*) and wheat *(Triticum durum* and *Triticum aestivum)* in upstream areas and teff (*Eragrostis tef),* millet *(Eleusine coracana),* noug (*Guizotia abyssinica*) maize (*Zea mays*) in the downstream, is the main livelihood strategy in the two watersheds. Additionally rice (*Oryza sativa)* and pulses such as chickpea (*Cicer arietinum*) and rough pea (*Lathyrus hirsutus***)** are important crops in the downstream of the Gumera watershed. In the study watersheds, livestock play an increasingly important role in household budget and coping strategies during times of drought. Livestock provide meat, milk, energy. Manure fulfils important role through nutrient cycling between and within farms, which enables the continued use of smallholder farms. Farmers usually have cattle (e.g.*Bos indicus*), sheep (*Ovis aries*), goat (*Capra hircus*), horse (*Equus caballus*), and donkey (*Equus asinus*).

Frequent flooding and severe erosion (1,643 Mg $km^{-2}yr^{-1}$) are major problems in the downstream and upstream of Gumera watersheds respectively**.** In Koga watershed, erosion rate as high as 1.66 Mg $km^{-2}yr^{-1}$are reported (MOWR, 2005). In response to increasing demand for food and contrastingly dwindling agricultural production, the Ethiopian government is considering Tana sub basin as the development corridor and thus embarked on irrigation and hydropower development projects in the sub basin. Accordingly dams in Gumera and Koga are under construction to irrigate 23,000 and 7,000 ha respectively (MoWR, 2005).

Sampling and data collection technique

This study is part of the project called “Improved water and land management in the Ethiopian highlands and its impact on downstream stakeholders dependent on the Blue Nile Basin”. The primary goal of the project is to enhance food security and improve sustainability of livelihoods of poor rural people in the Ethiopian highlands of the Blue Nile through better management and use of water and land, with minimum negative impacts – and possibly positive impacts – downstream within Ethiopia and across international borders (e.g. Sudan). Therefore the sampling process focused on highlands of the Blue Nile basin and stratification of community into upstream and downstream.

In this study a multi-stage sampling technique was used to select the sampled farm households. In the first stage, Koga and Gumera watersheds were objectively selected as irrigation schemes are under development and upstream of the watersheds are degrading due to strong magnitude of erosion. More importantly, it is often indicated that the sedimentation of those dams and reservoirs will reduce the lifespan of the schemes and thus mechanisms of improving regulating ecosystem services are strongly sought. In the second stage, Peasant Associations (PAs), the lowest administrative units in Ethiopia, were selected using random sampling procedure. In the third stage, sample farm households were selected from each PAs using the lists of the farm households (in each PAs) obtained from the PAs offices. 175 respondents from the upstream and 150 farmers from the downstream communities were selected and a total of 325 farmers were interviewed. Finally structured and pretested questionnaire was administered to the sample farm households, in March 2008, to collect data on socioeconomic, policy and institutional characteristics that related to households' WTC and WTP for improved land and water management activities.

Theoretical and analytical models

Theoretical framework and hypotheses

Households decision whether to participate in a PES scheme or not could be modeled using random utility theory (RUT). Consider an individual who has to choose between two choice set of alternatives, for instance whether to participate or not participate. Assuming that the individual has perfect discriminatory power and unlimited information-processing capacity, allowing the individual to rank the alternatives in a well-defined and consistent manner, then the individual acts rationally and chooses the alternative with the highest level of utility. The researcher however does not observe the individual's utility function. The indirect utility function (U_i) can be decomposed into a utility function that depends solely on factors that are observed by the researcher (V_i) and other unobservable factors that influence the consumer's choice (ε_i). The utility faction could, hence, be written as:

$$U_i = V_i + \varepsilon_i$$

Equation 3 gives the true but unobservable (latent) utility for alternative i, V_i is the observable systematic component of utility, and ε_i is the factor unobservable to the researcher and treated as a random component (Hanemann, 1984). V_i thereby becomes the explainable proportion of the variance in the choice and ε_i the non-explainable. As the researcher cannot observe the individual's true utility function, a probabilistic utility function is used in the estimation. The most appropriate probabilistic choice model to apply depends on the assumptions made about the random parameter.

Assuming that the individual can choose between two alternatives, i and j, then the probability that alternative i is chosen is given by:

$$P_i = \Pr ob(U_i > U_j) = \Pr ob(V_i + \varepsilon_\varepsilon > V_j + \varepsilon_j) = \Pr ob(V_i - V_j > \varepsilon_j - \varepsilon_\varepsilon) \quad i \neq j$$

From this it can be seen that the higher the probability for choosing an alternative, the larger the difference in observed utility. Since probability is defined on a cardinal scale, so are the estimated utility scores (which is the reason why we obtain meaningful WTP estimates). The input of the model is the observed choices, while the output, i.e. what is to be estimated, is the difference in utility for the two alternatives, ($V_i - V_j$), characterized by the utility for each attribute. Every respondent makes a discrete choice and has chosen either alternative i or alternative j. As the choices are aggregated over individuals (taking personal characteristics into account, if possible), the total observed per cent of the sample that chooses alternative i is interpreted as the probability that an individual with specific personal characteristics chooses alternative i. This is the same as saying that the probability of choosing alternative i increase as the difference in estimated utility between the two alternatives increases. Treating V_i as a conditional indirect utility function and assuming that utility is linearly additive, the observable utility for alternative i can be written as:

$$V_i = \beta x_i + \mu_i$$

where $x_i = (x_{1i}, x_{2i}, ..., x_{pi})$ is the vector of the attributes (including a possible price attribute) and covariates that influence the choice for alternative i, and β is the weighting (parameters) of the attributes.

The model given in Eq. 5 can be used to model the determinants of WTP. Furthermore, following the theoretical model and empirical results of different studies on PES elsewhere as well as considering the information from the informal survey, the following x_i variables were hypothesized to influence farmers WTP and WTC

Educational level of the household head: This is a dummy variable, which takes a value 1 if the household head is literate and 0 otherwise. Farmers' ability to acquire, process and use information could be increased by education. Thus, education has been shown to be positively correlated with farmers WTP and WTC for improved land and water management practices (Tegegne, 1999; Ervin and Ervin, 1982; Noris and Batie, 1987, Pender and Kerr, 1996, Asrat et al., 2004). Education is expected to reflect acquired knowledge of environmental amenities. Therefore, it is hypothesized to have a positive role in the decision to participate in improved land and water management practice so as to be farmers WTP and WTC for improved land and water management activities.

Age of the household head: The effect of farmer's age in improved land and water conservation decision can be taken as a composite of the effect of farming experience and planning horizon. Whereas, longer experience has a positive effect, young farmers on the other hand may have longer planning horizon and hence, may be more likely willing to participate in improved land and water management. With more age farmer can become risk averse to engage in improved land and water conservation practices. The net effect could not be determined a priori. Featherstone and Goodwin (1993) suggested that age greatly matters in any occupation and it generates or erodes confidence. As a matter of fact, older farmers are more likely to reject in practicing improved land and water management practices. On the contrary, younger farmers are often expected to take risk due to their longer planning horizon (Tesfaye et al., 2000; Befikadu et al. 2008). Therefore, in this study it is hypothesized that age has a negative influence on the willingness to participate on improved land and water conservation activity.

Asset holdings: This variable represents the total amount of asset such as livestock and tree. Animal raring is one component of the farming system of the study area. The number of livestock owned (in tropical livestock unit (TLU)) by a farmer was hypothesized to positively relate to farmers' willingness to participate in improved land and water management practices (Haileslassie et al., 2008, under review). Farmers own more number of livestock, the probability of willing to pay for improved land and water management increases (Dasgupta (1989). On the other hand, number of trees (e.g. *Eucalyptus camaldulensis*) on homestead and distance farm plots was hypothesized to influence WTP and WTC positively. Farmers in the study areas are claiming that tree plating is becoming the best strategy to generate cash for the farm household (Pender and Kerr 1997).

Size of own cultivated land: This variable represents the total owned cultivated land by a household. It is an indication for the wealth status of a household. As land ownership is equated with asset ownership, a farmer with large cultivable land is considered to be wealthy. In addition, a farmer who owned a large size of cultivated land is expected to have enough land to practice improved land and water management activities. Farm size is often correlated with the wealth that may help ease the needed liquidity constraint (Bekele and Holden, 1998). Norris and Batie (1987) found that large farms are more likely to use conservation technology than small farms. Therefore, it is hypothesized that size of the cultivated land is positively related with WTP and WTC the cost of improved land and water conservation activity.

Distance to the nearest development center: This variable refers to the time a household may need to walk to get the extension agent. The further an extension office located from farmers' home, the less likely it is that farmers would have access to information. Therefore, distance to the nearest development center is expected to be negatively related to farmers' willingness in improved land and water management practices.

Dependency ratio: An increase in consumer – worker ratio (dependency ratio) reduces the capability to meet subsistence needs, and also increase the personal rate of time preference (Bekele and Holden, 1998). Thus, this variable is expected to have a negative effect on farmers' willingness to participate in improved land and water conservation activities.

Slope of the parcel: This variable is a dummy variable for slope category of a parcel, which takes a value 1 if the slope is steep and 0 otherwise. The slope category of the parcel has been found to positively affect the farmer's decision to invest in conservation technology (Ervin and Ervin, 1982; Norris and Batie, 1987; Gould et al, 1989). The slope variable is thus expected to have a positive effect on farmers' willingness to participate in soil conservation practices.

Information, training and visit: Information, training and visiting has big role in awareness creation about improved land and water management practice. It increases farmers' willingness to practice improved land and water management activities. In the context of this study, it refers to farmer participating in soil and water conservation training program, radio/video show, participation on farmers' field day, and participation in land and water conservation related meetings. If a nation desires a progressively increasing number of farmers to undertake improved watershed conservation activities, the implementation of substantial training program should get a high priority (Joyce, 2001). Therefore, information, training and visiting were expected to be correlated positively and significantly with farmers' willingness to participate in improved land and water management practices.

Assistance in land and water conservation practice: This variable is a dummy variable, which refers to any form of watershed conservation support provided to the farmers in the study area. It takes a value 1 if the respondent received any assistance from any source and 0 otherwise. It is obvious that improved land and water conservation activity is costly and it is difficult to see the benefit in the short term planning horizon. In other words, physical watershed conservation practices require more labor, cash and materials, which the farmer cannot afford. It is expected assistances in cash, material, technical and any other incentives encourages the farmers to engage in conservation practices and in this study we hypothesized that assistance will have positive and significant effects on farmers' willingness to participate in improved land and water management practices.

Contingent valuation methods and scenario settings

For this study, contingent valuation method (CVM), econometric estimation and descriptive statistics were applied. Contingent valuation method (CVM) can estimate the value that a person places on a good. Many applications of the CVM deals with public goods such as measuring WTP for environmental changes, for risk assessment, in litigation, in policy formulation and for evaluating investments (Alberini and Cropper, 2000). In this study, we used the so-called double-bounded dichotomous-choice format to illicit users' WTP. Initially land degradation impacts, possibilities and benefits of rehabilitation covering the following scenarios were elaborated to the sample farmers:

- Soil erosion has a serious on-site impacts agricultural productivity through removal of the most nutrient-rich top soil (e.g. 1,643 Mg $km^{-2}yr^{-1}$ in Gumera and 1.66 Mg $km^{-2}yr^{-1}$ for Koga watershed (**show photos**). On average this will result in a yield loss of equivalent to 200US$ ha^{-1} yr^{-1}.
- Off-site damage of erosion consists of deterioration in the quality of water and downstream sediment deposition on reservoirs (**show photos**). For instance, in Gumara, if the current situation will continue, the reservoirs capacity will decrease by 2% in five years and this has strong implication on irrigable areas and yield.
- But this trend can be mitigated through an integrated watershed management intervention that involves participation of upstream and downstream farmers. The estimated average investment for such land rehabilitation in Ethiopia is 1370 ha^{-1}. Farmers' participation will be through WTP and WTC either in labor or in cash.

Next, a dichotomous choice payment question asks the respondent if he/she would pay B_i (initial bid amount) to obtain the good. There are only two possible responses to a dichotomous choice payment question: 'yes' and 'no'. Then following the response, a follow up bid is presented as $B_i^d and B_i^n$, where $B_i^d \leq B_i \leq B_i^u$). The bid value (B_i) is varied across respondents. It is important to note that the dichotomous choice approach does not observe WTP directly: at best, we can infer that the respondent's WTP amount was greater than the bid value (B_i^d) or less than the bid amount (B_i^n), and form broad intervals around the respondent's WTP amount. Mean WTP is estimated statistically from the data of responses obtained from respondents using STATA software.

Econometric estimation

Double-bounded dichotomous choice payment questions typically require a different type of statistical analysis, based on the assumption that if the individual states his/her willing to pay for the given bid amount, his/her WTP might be greater than the bid. If the individual declines to pay the stated amount, than his/her WTP might be less than the bid. In both cases, the respondent's actual WTP amount is not observed directly by the researcher. Let WTP* be unobserved willingness to pay, which is assumed to follow a distribution F (θ), where θ is a vector of parameters, and form an indicator, I that takes on a value of one for 'yes' responses and zero for 'no' responses. The probability of observing a 'yes' (or I =1) when the respondent has been offered a bid equal to B_i is:

$$\Pr(I_i = 1) = \Pr\left(WTP_i^* > B_i\right) = 1 - F(B_i;\theta),$$

Whereas the probability of observing a 'no' (or I =0) is simply $F(B_i;\theta)$, i.e. the cumulative density function (CDF) of WTP evaluated at the bid value. The log likelihood function of the sample is:

$$\sum_{i=1}^{n}\left[I_i.\log(1 - F(B_i;\theta)) + (1 - I_i).\log F(B_i;\theta)\right]$$

If WTP is normally distributed, $F(\theta)$ is the standard normal cumulative distribution function and $F(B_i;\theta) = \Phi(B_i;\sigma - \mu/\sigma)$, where the symbol Φ denotes the standard normal CDF, μ is mean WTP and σ is the standard deviation of the distribution. The parameters θ can be estimated directly by maximizing (2) using Maximum likelihood estimation technique. The econometric results are reported in section 4 below.

Results and Discussion

Descriptive results

Sample household characteristics for selected continuous variables

Table 1 depicts eight continuous variables that characterize households' WTP and MWTP across the sample strata. The mean age of the sample farm household head was 42.8 and the mean age values for willing and non willing farmer, to pay for improved watershed management practices, were 41.1 and 46 respectively (Table1). A closer look at the age structure of the sample farmers indicates that the mean age of those willing farmers were younger than non willing farmers.

The mean size of land holding by the sample farm household is depicted on Table 1. The overall mean value of land holding in the study sites was 1.8ha. There were no apparent differences, in mean size of land holding, between upstream and downstream. Mean differences in size of land holdings by willing and non-willing farmers was not also strong (about 1.81 ha for willing and 1.84 ha for non-willing with T value of 0.292). Perhaps frequent land redistribution that took place in the region can better explain this weak disparity. Despite the increasing trends of land leasing practices in the study watersheds, the mean value of leased-in land by the sample household was only 0.0002 ha and thus could not influence the overall mean of land owned.

Unlike the size of land holding, mean values of assets on land (e.g. number of trees and livestock measured in Tropical Livestock Units (TLU[6])) showed apparent differences between upstream and downstream and between the willing and non-willing farmers. For example the mean values of trees per sample farm households for downstream farmers were three times higher than the upstream. There were also distinct differences between non-willing (149.6 trees per sample farm households) and willing (556.2) farmers. We found that number of trees owned were negatively correlated with distances of the farm to nursery sites (r= 0.56; p=0.03). Similar trends of TLU possession were observed. In general, the association between farmers' willingness to pay in cash for improved land and water management and the assets on land could be accounted for by the fact that trees and livestock are major sources of household cash income and thus enable the farmers to invest in improved land and water management.

Based on adult male equivalent (Table1), the mean available labor force per sample households was 3.04 and 2.64 for male and female respectively. In both upstream and downstream the mean values for adult labor forces tends to be stronger for male than the female and clustered around 3 and 2.5 respectively.

Sample household characteristics for selected dummy variables

Descriptive result of selected seven dummy variables is indicated on Table 2. Three of those are related to smallholders' institutional environment (i.e. access to credit, assistance and training in improved land and water management). Institutions are critical for farmers' decision in interventions. They create an environment and incentives that can either enable or undermine their efforts (e.g. Asrat et al., 2003). In upstream part of the study watersheds, 62% willing and 38% non-willing farmers got credit during the past twelve months. Respective figure for the downstream area was 80% and 20%. This result indicated that shortage of money (liquidity constraint) might discourage farmers to engage in improved land and water conservation activities. Farmers' willingness to spent

[6] The TLU values for different species of animals are: 0.7 for cattle; 0.8 for horse/mule; 0.5 for donkey; 0.1 for goat/sheep and one Tropical Livestock Unit (TLU) is equal to 250 kg

time for improved land and water management practices was higher than to spend some amount of money. This could be related to limited income source (see Appendix 1).

Education increases farmers' ability to get process and use information (Asrat et al., 2003). Our results show that 53 per cent of the sample farm households were illiterate. There was no significance difference between the upstream and the downstream community. Interestingly, the respective percentages for willing and non-willing farmers vary across upstream and downstream and, in both cases, indicated that the majority of farmers who were willing to pay for improved land and water managements were literate (Table 2). A very closely related dummy variable is farmers training in land and water conservation practice. This helps farmers to know available options for soil conservation and makes land users more receptive to conservation structures. In our result, a good proportion of those willing to pay, reported to have participated in different trainings related to improved land and water management practices. For example, out of the total upstream sample household heads, 65% of the willing and 35% of non willing farmers have participated in training respectively. Respective values for the downstream sample farm household were 72% for willing and 28% for non willing farmers (Table 2 and Appendix 2). There were also stronger relation between farmers' willingness to pay and institutional variables such as access to credit, distances to nursery sites and access to development center.

Table1 Descriptive results of continues variables for WTP in cash (Koga and Gumera watersheds, Blue Nile basin, Ethiopia)

Strata	WTP in cash		Age	Tree	DOA (in km)	DNR (in km)	TLU	CLI	Labor	
									Adult female	Adult male
Upstream	Non willing	Mean	46.50	78.57	14.80	6.24	4.20	0.26	2.79	3.22
		Std. D	13.61	158.72	4.96	5.91	2.64	0.51	1.16	1.39
	Willing	Mean	41.14	264.48	13.12	4.77	5.77	0.17	2.62	3.05
		Std. D	12.95	738.25	3.80	3.88	4.94	0.43	1.34	1.41
	Total	*Mean*	*43.47*	*183.74*	*13.85*	*5.41*	*5.09*	*0.21*	*2.69*	*3.13*
		Std. D	*13.47*	*571.28*	*4.41*	*4.90*	*4.17*	*0.47*	*1.26*	*1.40*
Downstream	Non willing	Mean	44.95	291.68	16.49	3.54	4.88	0.21	2.71	3.32
		Std. D	12.84	816.84	5.64	3.90	2.34	0.61	1.21	1.97
	Willing	Mean	41.13	814.08	13.04	3.54	5.83	0.21	2.54	2.82
		Std. D	12.09	1691.80	5.43	2.40	4.32	0.48	1.18	1.46
	Total	*Mean*	*42.09*	*681.74*	*13.91*	*3.54*	*5.59*	*0.21*	*2.58*	*2.95*
		Std. D	*12.35*	*1532.93*	*5.67*	*2.84*	*3.93*	*0.51*	*1.19*	*1.61*
All samples	Non willing	Mean	45.98	149.61	15.36	5.34	4.42	0.24	2.76	3.25
		Std. D	13.32	495.35	5.23	5.45	2.55	0.54	1.17	1.60
	Willing	Mean	41.13	556.21	13.08	4.12	5.80	0.19	2.57	2.93
		Std. D	12.47	1357.50	4.73	3.23	4.61	0.46	1.26	1.44
	Total	*Mean*	*42.83*	*413.59*	*13.88*	*4.55*	*5.32*	*0.21*	*2.64*	*3.04*
		Std. D	*12.97*	*1147.93*	*5.02*	*4.18*	*4.06*	*0.49*	*1.23*	*1.50*

Source: the survey result
DNR is for distances to nursery; DOA is for distance to Woreda office of agriculture; Std.D is for standard deviation, CLI is for crop land irrigated

Table 2 Descriptive results of dummy variables for WTP in cash (Koga and Gumera watersheds, Blue Nile basin, Ethiopia)

Attributes		Upstream						Downstream						Total	
		Willing		Non-willing		Total		Willing		Non -willing		Total			
		N	%	N	%	N	%	N	%	N	%	N	%	N	%
Education	Illiterates	50	54.35	42	45.65	92	52.57	60	74.07	21	25.93	81	54	173	53.23
	Otherwise	49	59.04	34	40.96	83	47.43	52	75.36	17	24.64	69	46	152	46.77
ALD	No	12	70.59	5	29.41	17	9.71	28	73.68	10	26.32	38	25.33	55	16.92
	Yes	87	55.06	71	44.94	158	90.29	84	75	28	25	112	74.67	270	83.08
Assistant ILWM	No	77	58.78	54	41.22	131	74.86	68	75.56	22	24.44	90	60	221	68
	Yes	22	50	22	50	44	25.14	44	73.33	16	26.67	60	40	104	32
Training	No	63	52.5	57	47.5	120	68.57	62	76.54	19	23.46	81	54	201	61.85
	Yes	36	65.45	19	34.55	55	31.43	50	72.46	19	27.54	69	46	124	38.15
Access to credit	No	48	51.61	45	48.39	93	53.14	53	69.74	23	30.26	76	50.67	169	52
	Yes	51	62.2	31	37.8	82	46.86	59	79.73	15	20.27	74	49.33	156	48
Slope of the parcel	Otherwise	16	43.24	21	56.76	37	21.14	2	66.67	1	33.33	3	2	40	12.31
	Flat	83	60.14	55	39.86	138	78.86	110	74.83	37	25.17	147	98	285	87.69
Responsibility	No	63	53.85	54	46.15	117	66.86	76	72.38	29	27.62	105	70	222	68.31
	Yes	36	62.07	22	37.93	58	33.14	36	80	9	20	45	30	103	31.69

Source: the survey result

ILWM is for improved land and water management; ALD is for awareness of land degradation

Households willingness to pay for environmental service restoration

In this section, we evaluated the sample households' WTP in cash or labor for improved land and water management practices. About 64.9% of the samples were willing to pay in cash (Table 3). All respondents were offered with follow-up questions to determine whether they were expressing a protest bid against the valuation or they placed no value on the resource, due to the course of CVM. Accordingly, 66.7% of the upstream farmers were not willing to contribute money. We observed a stronger willingness from the downstream sample households compared to their fellow farmers in the upstream. Accordingly, 53.1% were willing to contribute in cash for improved land and water management practices. These differences between upstream and downstream can be accounted for by the discrepancy of benefits that can be generated from such intervention (e.g. direct benefits from irrigation schemes, reduced flood damages, etc) and also from the differences in resources holding between the two groups (e.g. number of trees and TLU). In general our findings of farmers' willingness to pay in cash differ with Pawlos (2002), who reported insignificant farmers WTP in cash. We argue that Pawlos (2002) observation could be a bit generalization as farmers' willingness to pay in cash depends on the envisaged returns from investment and farmers' financial capacity to invest. Interestingly, farmers' willingness to pay in labor was twofold higher compared to their willingness to pay in cash. This implies that farmers are willing to invest in improved environmental services but obstructed by low level of income. Here, the major point of concern is also whether this farmers' contribution (either in cash or in labor) could cover the financial demand required for investment and maintenance of conservation structure and if this is not the case what can be the policy and institutional options to fill the gaps?

Table 3 Farmers WTP in cash and labor units (Koga and Gumera watersheds, Blue Nile basin, Ethiopia)

Attributes	Upstream		Downstream		Total	
	Willing	Non-willing	Willing	Non-willing	Willing	Non-willing
WTP (cash month^{-1})	99	76	112	38	211	114
WTP (labor MD month^{-1})	169	6	147	3	316	9

Source: the survey result
WTP is for willingness to pay; MD is for man day

As indicated in Table-4, the average labor contributions for upstream and downstream farmers were 3.3 and 3.9 man-days per month (MDmonth^{-1}) respectively. Whereas the average cash contribution of the upstream and downstream farmers were 10.4 and 13.1 Ethiopian Birr (ETB month^{-1}) respectively. Values of MWTP fails far short of covering the investment and maintenance cost for improved land and water management. The MoWR (2002) reported an estimated watershed management cost of 9216 ETB (760 US$ha^{-1}). Taking mean current land holding per household and inflation since the time of estimate in to account, a farm household may require about 13,104 ETB (1,365 US$) to implement improved land and water management on his plots. In general, the results suggest that the general public in the two watersheds are willing to pay for cost of activities to restore the regulating ecosystem services, although this amount is substantially less than the estimated costs of restoration. This trend could be argued from Stefanie et al. (2008), point of view. Stefanie et al. (2008), suggested that PES is based on the beneficiary-pays rather than the polluter-pays principle, and as such is attractive in settings where Environmental Services (ES) providers are poor, marginalized landholders or powerful groups of actors. The authors also make distinction within PES between user-financed PES in which the buyers are the users of the ES, and government-financed PES in which the buyers are others (typically the government) acting on behalf of ES users. In view of those points it can be concluded that improved ES will required the coordinated effort of all stakeholders: including the government, upstream and downstream community

Table-4 Estimated mean WTP in cash and labor units (Koga and Gumera watersheds, Blue Nile basin, Ethiopia)

Mean WTP	N	Mean value	C-I (95%)		P > t
MWTP ETB month^{-1} (upstream)	175	10.4	8.2	12.6	0.0029
MWTP in ETB month^{-1} (downstream)	150	13.1	11.8	14.5	
MWTP (in labor MD month^{-1} (upstream)	175	3.3	3.15	3.40	0.0000
MWTP in labor MD month^{-1} (downstream)	150	3.9	3.69	4.01	

Source: the survey result

MWTP is for mean willingness to pay; ETB is for Ethiopian currency which is 1US$ is equivalent to 9.6 ETB; MD is for man day

Determinants of upstream and downstream farmers' willingness to pay

In this section, selected explanatory variables were used in the interval regression model to analyze determinants of farmers' WTP for improved land and water management. A total of 23 explanatory variables (14 continuous and 9 dummy) were included in the model of which only significantly related variables are presented in this report (Table 5).

Table 5 Estimate of the interval regression model (Koga and Gumera watersheds)

Explanatory Variables	Downstream users			Upstream users			All samples		
	Coeff.	SD.E	P>z	Coeff.	SD.E	P>z	Coeff.	SD.E	P>z
Educational level	-1.87	4.67	0.69	-11.24	3.79	0.00***	-6.29	2.91	0.03**
Age of the household head	-0.45	0.19	0.02**	-0.19	0.15	0.22	-0.33	0.12	0.01**
Start Bid ~y	0.60	0.17	0.00***	0.46	0.14	0.00***	0.55	0.11	0.00***
Financial and technical assistant	5.37	3.95	0.17	4.31	3.48	0.22	5.76	2.64	0.03**
Training	-3.99	3.95	0.31	6.81	3.78	0.07*	1.78	2.72	0.51
Own cultivated land	-0.26	0.42	0.54	0.35	0.18	0.06*	0.17	0.17	0.33
Access to credit	1.98	4.11	0.63	5.31	3.69	0.15	4.73	2.65	0.08*
Number of trees owned	0.00	0.00	0.04**	0.00	0.00	0.86	0.00	0.00	0.03**
Distance to output market	-0.08	0.53	0.88	-0.42	0.49	0.38	-0.54	0.28	0.05**
Distance to nursery site	-0.18	0.78	0.82	-0.74	0.42	0.08*	-0.63	0.37	0.08*
Distance to agricultural office	-0.78	0.35	0.02**	-0.72	0.64	0.26	-0.77	0.29	0.01**
Livestock owned in TLU	0.67	0.58	0.24	1.22	0.45	0.01**	0.74	0.34	0.03**
Slope of the parcel	9.91	13.74	0.47	7.74	4.54	0.09*	10.44	4.29	0.02**
Adult male in the household	2.80	1.52	0.07*	-1.19	1.36	0.38	0.56	1.00	0.57
Adult females in the household	-1.20	1.82	0.51	-3.23	1.57	0.04**	-2.25	1.20	0.06*
Constant	7.88	18.13	0.66	12.25	12.64	0.33	12.01	9.65	0.21
Lnsigma	2.99	0.08	0.00***	2.90	0.09	0.00	2.99	0.06	0.00***
Sigma	19.79	1.64		18.18	1.59		19.89	1.19	
	N =150 LR chi2 (24) = 37.11 Prob > chi2=0.0317 Log likelihood = -212.27658 52 left-censored observations 0 uncensored observations 0 right-censored observations 98 interval observations			N =175 LR chi2 (23) =74.79 Prob > chi2=0 Log likelihood = -186.71088 83 left-censored observations 1uncensored observation 0 right-censored observations 91 interval observations			N =325 LR chi2 (25) =103.70 Prob > chi2=0.0000 Log likelihood = - 409.16806 135 left-censored observations 1 uncensored observation; 0 right-censored observations 189 interval observations		

Source: the survey result***, ** and * indicate significant level at 1%, 5% and 10% respectively.

The maximum likelihood estimate of the interval regression model shows 15 explanatory variables to significantly determine farmers' WTP. Of the 23 explanatory variables hypothesized to influence farmers' WTP for improved land and water management practices, fourteen variables were less powerful in explaining farmers' willingness to pay in cash. The Log-likelihood ratio test for the significance of the overall mode is -409.16806 for 135 left-censored observations and 1 uncensored observation; 0 right-censored observations and 189 interval observations. A host of household, asset holding, plot characteristics and institutional support related variables were found to be significant in explaining households' WTP. More specifically, the coefficients of educational level, age of the household head were found significant at 10% probability level or less. From the households' asset holdings, number of trees planted, number of livestock holdings in tropical livestock unit (TLU), and total adult female household member were found to be significant at 5% probability level. Institutional support related factors such as training (information and visit), and assistance in land and water conservation techniques and distance to the office of agriculture (proxy measure of access to extension service) were found to be significant at 1% probability level. Finally, plot level characteristics such as slope of the parcels and average land holding were found significant. The specific effects of these variables and their policy implications are discussed blow.

Educational level of the household head: the education level variable was significant at (P< 0.01) and had a positive association with farmers' willingness to pay in cash for improved land and water conservation practices. Farmers' ability to acquire, process and use information could be increased by education. Besides, education reflects acquired knowledge of environmental amenities. Thus, this variable positively correlated with farmers' willingness to pay in cash for improved land and water management practices. Number of studies suggested similar results (e.g. Tegegne, 1999; Ervin and Ervin, 1982; Noris and Batie, 1987; Pender and Kerr, 1996; Asrat et al., 2004). From our results it can be also realized that keeping the influences of other factors constant, every extra year of schooling increase the probability of farmers' willingness to pay cash by 3.62%. This implies that education could be an important policy instrument for improved environmental management.

Age of the household head: this variable was significant at (P<0.05) and had a negative influence on farmers willingness to pay in cash for land and water conservation activities. This contradicts with Bekele and Drake (2003) who suggested that farmers' age does not influence the conservation decision. This means also with more age farmer can become risk averse to engage in improved land and water conservation practices. The effect of farmer's age in improved land and water conservation decision can be taken as a composite of the effect of farming experience and planning horizon (e.g. Tesfaye et al., 2000). In general, older farmers are more likely to reject practicing improved land and water conservation practices. On the contrary, younger farmers are often expected to take risk due to their longer planning horizon (e.g. Befikadu, 2007). The result shows that a one year increase in age, keeping other factor constant, decrease the probability of farmers' WTP in cash for improved land and water conservation practice by 0.01%. In general, this suggests that research has to come up with conservation technologies that can reduce risks and yield returns in the short term.

Asset holdings: we report on the effects of livestock, tree holding and labor availability on the households' WTP. Livestock holding represents the total number of livestock, measured in Tropical Livestock Unit (TLU). Livestock is important household asset and is claimed as important means of cash income for households in both study areas (e.g. Haileslassie et al., 2008, under review). This is particularly important in farming system where farmers are producing non-cash crops and off-farm income is very limited (e.g. upstream areas of both watersheds). The model showed a significant and positive relation at 5% probability level for this variable. In other words as farmers own more number of livestock, the probability of WTP increases. This can be explained by two main reasons: firstly more livestock ownership means more assets possession, which in turn increases households' ability to make investment decisions. Secondly, as farmers own large livestock population, they need to have land and water available to them to provide their livestock population with sufficient and quality feeding and drinking water increasing investment in land and water conservation. Dasgupta (1989) and Rogers and Shomaker (1971) reported similar result. With the ceteris paribus condition holding, the probability of being willing to pay increases by a probability of 0.14% as livestock ownership increased by 1 TLU. Probably this may contrasts with recent thought about effects of increasing livestock population and resultant ecosystem degradation (e.g. overgrazing). In practical terms policy makers must focus on increasing the products and services per unit of livestock than the mere increase in number to attain the impacts of livestock ownership on farmers' willingness to invest in land and water management. Interestingly farmers in both study areas (mainly downstream) plant trees (e.g. *Eucalyptus camaldulensis*) on homestead and distance farm plots. Farmers in the study areas are claiming that tree planting is becoming the best strategy to generate cash for the farm household. Which is why the coefficient of number of tree on farm of the household was significant at 5% probability level and affects farmers' willingness to pay positively. Pender and Kerr (1997) also suggested that farms income have a significant effect on land and water management investment. A unit increase in this variable, with the assumption of ceteris paribus; the probability of farmer's willingness to pay in cash for improved land and water conservation activates increase by 2.6%. Moreover, on the effect of households' labor endowment on their WTP, we found that households with more number of female adults have significantly lower probability (1.08 %) of being willing to pay. This could be related to their female adults' income generating capacity as labor markets could be gender segregated.

Size of own cultivated land: this variable represents the total cultivated land owned by a household and it is significant for upstream farmers at 5% probability level. For an agrarian community, like our study areas, land size is an indication of wealth status of a household (e.g. Bekele and Drake, 2003). As land ownership is equated with asset ownership, a farmer with large cultivable land is considered wealthy (Haileslassie et al., 2007). The size of cultivated land is also often associated with a means that might help ease the needed liquidity constraint (e.g. Bekele and Drake, 2003) as land could be transferred temporarily through land transactions. Number of empirical study suggested that farmers who have large farms in the upstream are more likely to use conservation technology (e.g. Bekele and Holden 1998; Norris and Batie, 1987). It can be argued also that farmers with smaller plots were not willing to pay for soil conservation practices because of inconveniences created by some physical conservation measures during farm operation : e.g. turn oxen during ploughing and cultivation, further squeezing the small parcel owned by the farm household (Asrat et al., 2004).

The result of our model agrees with those suggestions and revealed that farmers' willingness to pay increase by the probability of 0.008% as the size of own cultivated land increase by one unit with the assumption of ceteris paribus. This could be argued from perspective of policy options that eradicate poverty and increase land and water productivity, as increasing land size could not be an issue in the face of high population pressure in the area. However, policy maker could still enhance conservation by promoting technologies that do not compete for more space.

Distance to the offices of agriculture: this variable is significant at 1% probability level and affects farmers' WTP negatively. It refers to the time a household may need to walk to get to the agricultural office. The negative sign of the coefficients indicates that as the distance of agricultural office from homestead increases, farmers would have less access to information and other services. Thus, they would not be willing to participate in watershed conservation activity (DBOA, 2007). This result showed that keeping the influences of other factors constant, farmers' WTP decrease by 0.16 % as distance of the district increases by 1 kilometer. Perhaps policy and institution measures that improve farmers' access to information and other services could help in increasing farmers' willingness to participate in such activities.

Information, training and visit: information and training increases farmers' willingness to practice improved land and water management activities (Pender and Kerr, 1998). In context of this study, this variable refers to farmer participation in improved watershed conservation training program. It also refers to radio or video shows related to watershed conservation and make use of improved land and water management practices, participating on farmers' field day, meetings, and visits of other farmers who practiced improved land and water management. If the nation desires a progressively increasing number of farmers to undertake improved watershed conservation activities, the implementation of substantial training program should get a high priority (e.g. Joyce 2001; Pawlos 2002). A unit increase in this variable, all other things being kept constant, leads to an increase in the probability of farmers' WTP in cash for improved land and water conservation activates by 0.18%. Finally, policy and institutional measures that improve farmers' access to information, skills and training must be a target to achieve the objectives of improved ecosystem services.

Assistance in land and water conservation practice: this variable was significant at 1% probability level and affects positively farmers' WTP in cash. Assistance refers to any form of watershed conservation support provided to the farm household in the study areas. Physical soil conservation measures are labor intensive and require technical, financial and material inputs, which farmers may not be able to afford by themselves (e.g. Asrat et al., 2004). This implies also that assistance from any source encourages farmers to adopt physical conservation measures. In Ethiopia, involvement of Non-Governmental Organizations (NGOs) and Governmental Organization (GO) in the soil and water conservation has a long history (Gebremedhin and Swinton, 2003). Thus, assistances in the form of safety net or food for work program were almost a norm for decades of soil and water conservation initiatives. Besides these farmers are also provided with technical support through the regular extension channel or specific NGO interventions that ranges from defining contours to establishing different types of SWC measures. This study indicated that the probability of farmers' willingness to pay increase by 6.6% as assistance in land and water conservation practice increase by one unit, keeping other factors constant.

Slope of the plot: specific plot level characteristics may predispose farm plots to erosion. For instance, sloppy lands are more susceptible to erosion. Including such variables in adoption regression is quite vital. Accordingly, we found that slope of household's plots have significant and positives effect on farmers' WTP in cash for improved land and water management practice at 10% probability level. This implies that households that have on average sloppy plots are more willing to pay for improved conservation as they have the understanding that such plots are susceptible to degradation. Our model outputs and empirical studies in Ethiopia and elsewhere showed similar trends (e.g. Shiferaw and Holden 1998; Ervin and Ervin, 1982; Norris and Batie, 1987; Gould et al, 1989). Finally it can be concluded that targeting farm households with steeper landscape unit can bring tangible changes in designing PES schemes.

Downstream households' willingness to compensate for the upstream farmers

The downstream users' of environmental services WTC the upstream environmental service providers in cash were also assessed in this study. Land degradation has serious on-site and off-site impacts for upstream and downstream users in the study area (e.g. Awulachew et al., 2008). The off-site damage through sedimentation and flooding instigated major concern mainly as related to safety and sustainable uses of ongoing construction of irrigation infrastructures. The result of this study showed that, of all downstream sample farm households, 83.6 % were willing to compensate the upstream farmers for the ecosystem regulation services they provided. The remaining 16.4 % were not willing to compensate the upstream farmers in cash. As indicated in previous section the mean values of WTP/WTC indicated by farmers will not be sufficient to undertake the commensurate measures to reduced land and water degradation. Therefore a policy measure that encourages community and intergovernmental cooperation and also considering watershed management as part of the investment in irrigation infrastructure is important. In the subsequent paragraph we shed light on selected explanatory variables for willingness to compensate.

A total of 13 explanatory variables (10 continuous and 3 dummy) were included in the model (Table 6). The maximum likelihood estimate of the interval regression model shows six explanatory variables to significantly determine downstream farmers' WTC. These are access to credit, total family size, ratio of irrigation to cultivated land, livestock holdings (in TLU), and distance to agricultural office. Interestingly, the model indicates stronger willingness from Koga watershed service users when the two watersheds are separated. Though 7 explanatory variables were not significant in explaining downstream farmers' WTC, clear trend of relation between the dependent and independent variables could be traced. Most of those explanatory variables correspond with those for willingness to pay presented in section 3.3 and therefore further explanation of variables can be referred to particular section.

Table 6 Estimate of the interval regression model for farmers WTC (Koga and Gumera watersheds, Blue Nile basin, Ethiopia)

Explanatory Variables	Coef.	dy/dx	Std. Err.	P>z
Start bid	0.013728	0.002388	0.012163	0.259
Age	-0.01751	-0.00305	0.011794	0.138
Educational level (dummy 1=illiterate and 0 otherwise)	-0.13372	-0.02349	0.325927	0.682
Access to credit	0.643803	0.114452	0.329956	0.051**
Sex	-1.02892	-0.28513	0.693857	0.138
Total family size	-0.23304	-0.04053	0.083337	0.005***
Adult male in the household	0.070711	0.012298	0.108249	0.514
Ratio of irrigated to cultivated land	-3.82163	-0.66466	1.936619	0.048**
Number of trees owned	6.58E-05	1.15E-05	0.000107	0.538
Off farm income	-9E-05	-1.6E-05	0.000163	0.579
Livestock owned (TLU)	0.110001	0.019131	0.056892	0.053**
Distance to agricultural office	-0.05925	-0.01031	0.033094	0.073*
Watershed (1=Gumera and 2=Koga)	1.035345	0.181854	0.381166	0.007***
_Cons	2.334752		1.051206	0.026
	Number of observation =146 LR chi2 (24) = 32.34 Prob > chi2= 0.0021 Log likelihood = -49.073538 Pseudo R2= 0.2478			

Source: the survey result
***, ** and * indicates significant level at 1%, 5% and 10% probability respectively.

<u>Access to credit</u>: this variable is significant at 5% probability level and affects farmers' WTC positively. It refers to whether the sample farm household had credit in the last couple of years or not. Access to credit for agricultural purposes can relax farmers' financial constraints. Our results show that downstream farm households with access to institutional credit are willing to compensate the upstream farmers for ecosystem services they provide. In this study, with the assumption of ceteris paribus, the probability of being willingness to compensate the upstream farmers increases by 0.11% for additional increment in access to credit service.

TLU owned is found significant at (P< 0.05) and affects, positively, the downstream users' decision to compensation. This means also as the downstream farmers own large livestock units, the chance of WTC increasing. With the assumption of ceteris paribus, the probability of being willingness to compensate the upstream farmers increases by 0.64% for additional increment in livestock ownership.

Total family size was also found significant at 1% probability level and affects farmers' WTC negatively. This refers to the total number of family members in a household. Accordingly, keeping the influences of other factors constant, downstream farmers' WTC decrease by 0.23% as the total family increases by 1 person. This may imply that farm households with larger family size are relatively cash constrained. Distance to the agricultural office was also found significant at 10% probability level and affects farmers' WTC negatively. The negative sign of the coefficients was as anticipated indicating that as the distance of agricultural office from homestead is long, farmers would have less access to information and services, thus, they would not be willing to participate in watershed conservation activity and will not be willing to compensate. Keeping the influences of other factors constant, downstream farmers' willingness WTC decrease by 0.06 % as distance of the district increases by 1 kilometer.

Unlike our expectation the ratio of irrigated land to total land holding of sample farmers shows a negative relationship to farmers WTC. This may contrast with the suggestion given with the land size and the underlying reason may need further study. The result also showed that there are differences between sample farmers in Goga and Gumera in terms of the proportion of WTP and WTC: sample farmers in Koga watershed showed more WTP and WTC than Gumera watershed. This can be explained for by the fact that farmers in Koga watershed have great expectation, since the constriction of Koga dam is almost completed.

Conclusion and Policy Implications

The major objectives of this study were to investigate farmers' WTP for restoration of ecosystem services and to examine willingness of the downstream environmental service users to compensate for the cost of improved land management in the upstream areas and to explore socio-economic and institutional drivers WTP and WTC. We also estimated the mean value of WTP and WTC. In view of the results the following conclusion and policy implications can be drawn:

i) More than half of the respondents were willing to pay in cash and 97.2% were willingness to pay in labor for restoration of environmental services. Furthermore, 83.6% of downstream sample farm households indicated their WTC the upstream farmers for the ecosystem regulation services they provided. Those finding substantiate our hypothesis of PES as an instrument for conflict resolution between upstream and downstream users and sustainable uses of land and water resources. However, the low magnitude of farmers' bid can be a challenge for its realization and thus a sole user-financed PES scheme may not be feasible in short term. Alternatively, we suggest a combination of environmental service paid by the users and government-financed PES schemes. The modality for government support can be part of investment in irrigation infrastructure. This can be also linked to global target of increasing soil carbon through land rehabilitation and tree plantation.

ii) As part of this study, number of livestock, size of arable land, and number of trees owned by the sample farm households were identified to positively influence sample farmers' WTP for restoration of ecosystem services and downstream farmers' WTC for improved ecosystem regulation services. In agrarian community access to those productive resources is strongly linked to level of poverty (e.g. Haileslassie et al., 2007). Also the positive relation between the probability of accepting the start bid, farmers' total income, and tree plantation substantiate this argument. Therefore policy options that target poverty reduction through intensification of agriculture must be promoted. These approaches may include increased adoption of technologies that improves product and productivity of the livestock and crop production.

iii) Explanatory variables such as education, awareness and access to information and credit were also influencing those farmers' decision positively. Institutions and policy measures that enhance environmental education must be promoted. This means also that policy makers must target both formal and informal education and include watershed management, upstream downstream relation and sustainable resources use into the formal education curricula to achieve the desired result.

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References

Alberini, A. and Cooper, J. 2000. "Application of Contingent Valuation Method in Developing Countries". Economic and Social Development Paper. FAO, No. 146, Rome.

Allen M. F., Barry K., Goodwin, B.K. (1993). Factors Influencing a Farmer's Decision to Invest in Long-Term Conservation Improvements. *Land Economics*, Vol. 69, No. 1 (Feb., 1993), pp. 67-81

Amahric version) Unpublished.

Arsano, Y., 2004. Ethiopia and the Nile dilemmas of national and regional hydro politics. PhD Dissertation submitted to the Philosophical Faculty of the University of Zurich, Switzerland

Asrat, P., Belay, K., and Hamito, D., (2004). Determinants of farmers' willingness to pay for soil conservation practices in the southeastern highlands of Ethiopia. Land Degrad. Develop. 15: 423–438

Awulachew, S. B. Ayalew, M., Steenhuis, T. S. , Easton , Z. M., Ahmed A. A. , and Bashar, K.E. ,Haileslassie. A. (2008). Characterizing erosion, modeling flow, sediment and impact of interventions in Blue Nile. Proceeding of the Second International conference of for The Challenge Program on Water and Food (CPWF), 10th - 14th November 2008. Addis Ababa, Ethiopia.

Befikadu Alemayehu, 2007. "Policy and Institutional Analysis of Smallholder Cattle Production in Dano District Of Western Showa, Ethiopia". M.Sc. Thesis Presented to the School of Graduate Studies, Alemaya University.116p.

Bekele, W. and Drake, L., (2003). Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. Ecological Economics 46: 437-451

CSA, 2005. Statistical Abstract. CSA, Addis Ababa.

Dasgupta, S., 1989. Diffusion of Agricultural Innovations in Village India. Department of Sociology and Anthropology, University of Prince Edward Island. Canada. 74-86p

DBOA, 2007. Socio economics and demographic characteristics of Gumera district

Ervin, C.A., and Ervin, E.D. 1982. “Factors Affecting the Use of Conservation Practices”: Hypothesis, Evidence and Policy Implications. Land Economics, 58(3), 97-307.

Ethiopian Mapping Agency (EMA), 1980. Contour map of Ethiopia (1:50,000). EMA, Addis Ababa.

FAO, 1984. Provisional soil map of Ethiopia. Ethiopian Mapping Agency (EMA), Addis Ababa.

FAO, 1986. Ethiopian highlands reclamation studies. Vol. 1 and 2. FAO, Rome

Featherstone, A.M., and Goodwin, B.K. 1993. “Factors Influencing a Farmer’s Decision to Invest in Long-Term Conservation Improvements”. Land Economics, 69(1), 67-81.

Gould, B.W., Saupe, W.E., Klemme, R.M. 1989. Conservation Tillage: “The Role of Operator Characteristics and Perception of Soil Erosion”. Land Economics 65, 167-182.

Haileslassie, A, Fitsum Hagos and Seleshi Bekele Awulachew, Don Peden Solomon Gebreselassie, Fekahmed Negash, 2008. Indicators of Environmental Degradation in the Blue Nile Basin: Exploring Prospects for Payment for Environmental Services**.** Proceeding of Nile basin development forum. 16-19 November, Sudan Khartoum

Haileslassie, A., Priess, J., Veldkamp, E., and Lesschen, J.P., 2007. Nutrient flows and balances at the field and farm scale: exploring effects of land-use strategies and access to resources. Agricultural System 94: 459-470.

Hanemann, W. M. 1984, "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses", American Journal of Agricultural Economics, 66, 3: 332-341.

Joyce, N.N, 2001. Community intervention in livestock improvement: The case of Kathekani, Kenya. pp. 77-84. Proceedings of Symposium on Community-based management of animal genetic resources. Mbabane, Swaziland, 7-11 May 2001,FOA.

Moses K. Tesi, 2000. The Environment and Development in Africa. Lexington Books, Murfreesboro, Tennessee, USA. 329 pages.

MOWR, 2005. Koga Irrigation and Watershed Management Project: Koga Small Scale Irrigation, Rural Water Supply and Sanitation. Volume-I main report, Addis Ababa, Ethiopia.

MoWR. 2002. Assessment and Monitoring of Erosion and Sedimentation Problems in Ethiopia. Final Report Volume V, MoWR/ Hydrology Department, Addis Ababa, Ethiopia.

Norris, P.E., Batie, S.S., 1987. "Verginia Farmers' Soil Conservation Decisions". An Application of Tobit Analysis. Southern Journal of Economics 19, 79-90.

Paulos Asrat, Desta Hamito and Belay Kassa , 2002. Determinants of Farmers' Willingness to Participate In Soil Conservation Practices in the Highlands of Bale: The Case of Dinsho Farming System Area. M.Sc. Thesis Presented to the School of Graduate Studies, Alemaya University.130p.

Pender JL, Kerr JM. 1998. Determinants of farmers' indigenous soil and water conservation investments in semi-arid India. Agricultural Economics 19: 113–125.

Pender, J., Kerr, J. 1996. Determinants of Farmers' Indigenous Soil and Water Conservation Investments in India's Semi-Arid Tropics. EPTD Discussion Paper No.7.International Food Policy Research Institute, Washington, D.C.

Shiferaw, B. and Holden, S.T. 1998. "Resource Degradation and Adoption of Land Conservation Technologies in the Ethiopian Highlands": A case Study in Andit Tid, North Shewa. The Journal of the International Association of Agricultural Economists, 18(18), 233-247.

Stefanie, E., Stefano, P., Sven, W. (2008). Designing payments for environmental services in theory and practice: An overview of the issues 6 5: 6 6 3 – 6 7 4

Stefano P., 2006. Payments for Environmental Services: An Introduction. Environment Department, World Bank. Washington DC, USA.

Storck, H., Bezabih Emana, Berhanu Adnew, A.Borowiecki and Shimeles W/Hawariate, 1991. Farming systems and farm management practices of small holders in the Hararghe highlands: Farming systems and resources economics in the tropics. Wissenshafts verlag vauk, Kiel, Germany. 11. 41-48p

Tegegne Gebere Egziabher, 1999. "Willingness to Pay for Environmental Protection": An Application of Contingent Valuation Method (CVM) in Sekota District, Northern Ethiopia. Ethiopian Journal of Agricultural Economics, 3(1), 123-130.

Tesfaye Zegeye, Bedassa Tadesse and Shiferaw Tesfaye, 2000. Determinants of high yielding maize technology adoption: empirical evidence from southwestern Oromia.EARO, Addis Ababa Ethiopia.

WRDA (Water Resources Development Authority (1994). feasibility study of the Birr and Koga irrigation project. Volume I main report. WRDA, Addis Ababa, Ethiopia. pp71

Wunder, S. 2005. Payments for Environmental Services: Some Nuts and Bolts. CIFOR, Occasional Paper No.42. Jakarta, Indonesia.

Appendixes

Appendix Table-1 Descriptive results of continues variables of WTP in labor by strata (Koga and Gumera watersheds, Blue Nile basin, Ethiopia)

Strata	WTP in labor	Age	Tree	Distance to agr. Off. in km	Distance to nursery site in km	TLU**	Crop land irrigated	Adult female	Adult male	
Upstream	Non willing	Mean	46.33	14.17	12.33	7.45	5.28	0.17	2.17	3.17
		Std. D	16.79	15.94	5.13	6.50	3.49	0.41	1.33	1.72
	Willing	Mean	43.37	189.76	13.91	5.34	5.08	0.21	2.71	3.12
		Std. D	13.39	580.47	4.39	4.85	4.20	0.47	1.26	1.39
	Total	Mean	43.47	183.74	13.85	5.41	5.09	0.21	2.69	3.13
		Std. D	13.47	571.28	4.41	4.90	4.17	0.47	1.26	1.40
Downstream	Non willing	Mean	52.00	2666.67	14.59	3.06	4.76	0.00	1.33	4.00
		Std. D	6.93	1258.31	1.23	1.22	3.25	0.00	1.53	2.00
	Willing	Mean	41.89	641.23	13.90	3.55	5.61	0.22	2.61	2.93
		Std. D	12.37	1514.55	5.72	2.86	3.95	0.52	1.17	1.61
	Total	Mean	42.09	681.74	13.91	3.54	5.59	0.21	2.58	2.95
		Std. D	12.35	1532.93	5.67	2.84	3.93	0.51	1.19	1.61
All samples	Non willing	Mean	48.22	898.33	13.08	5.98	5.11	0.11	1.89	3.44
		Std. D	14.01	1467.97	4.25	5.62	3.21	0.33	1.36	1.74
	Willing	Mean	42.68	399.78	13.90	4.51	5.33	0.21	2.66	3.03
		Std. D	12.93	1137.44	5.04	4.14	4.09	0.49	1.22	1.50
	Total	Mean	42.83	413.59	13.88	4.55	5.32	0.21	2.64	3.04
		Std. D	12.97	1147.93	5.02	4.18	4.06	0.49	1.23	1.50

Source: the survey result

Table 2 Descriptive results of dummy variables of WTP in labor by strata (Koga and Gumera watersheds, Blue Nile basin, Ethiopia)

Attributes		Upstream						Downstream						All samples	
		Willing		Non -willing		Total		Willing		Non -willing		Total			
		N	%	N	%	N	%	N	%	N	%	N	%	N	%
Educational states	Illiterates	87	94.57	5	5.43	92	52.57	78	96.30	3	3.70	81	54.00	173	53.23
	Otherwise	82	98.80	1	1.20	83	47.43	69	100.00	0	0.00	69	46.00	152	46.77
ALD	No	15	88.24	2	11.76	17	9.71	38	100.00	0	0.00	38	25.33	55	16.92
	Yes	154	97.47	4	2.53	158	90.29	109	97.32	3	2.68	112	74.67	270	83.08
Assistant ILWM	No	128	97.71	3	0.29	131	74.86	88	97.78	2	2.22	90	60.00	221	68.00
	Yes	41	93.18	3	6.82	44	25.14	59	98.33	1	1.67	60	40.00	104	32.00
Training	No	116	96.67	4	3.33	120	68.57	80	98.77	1	1.23	81	54.00	201	61.85
	Yes	53	96.36	2	3.64	55	31.43	67	97.10	2	2.90	69	46.00	124	38.15
Access to credit	No	88	94.62	5	5.38	93	53.14	75	98.68	1	1.32	76	50.67	169	52.00
	Yes	81	98.78	1	1.22	82	46.86	72	97.30	2	2.70	74	49.33	156	48.00
Slope of the parcel	Otherwise	36	97.30	1	2.70	37	21.14	3	100.00	0	0.00	3	2.00	40	12.31
	Flat	133	96.38	5	3.62	138	78.86	144	97.96	3	2.04	147	98.00	285	87.69
Responsibility	No	114	97.44	3	2.56	117	66.86	102	97.14	3	2.86	105	70.00	222	68.31
	Yes	55	94.83	3	5.17	58	33.14	45	100.00	0	0.00	45	30.00	103	31.69

ILWM is for improved land and water management; ALD is for awareness of land degradation

Source: the survey result