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Full Length Research Paper

Determinants of farmers' willingness to pay for blue Nile River Protection: The Case of Gilgel Abay River Mouth, Ethiopia

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The paper examines the determinants of farmer's willingness to pay for the protection of Abay River. A total of 158 randomly selected households were interviewed. Descriptive statistics and Econometrics Models particularly Contingent Valuation Method, Probit and Seemingly Unrelated Bivariate Probit models were applied. Result of the study showed that annual income, education, number of dependents in the household, family size, total cultivated land, awareness trainings, and community bylaw are significant determinants of farmers WTP in cash. Response to the hypothetical scenario revealed that the mean WTP in cash is 74.22 ETB per year for each household with an aggregate value of 171,411.09 ETB per annum. In addition, awareness trainings and age of the respondents were important variables in determining labor contribution. The mean labor WTP of households is 17.46 labor days per year with an aggregate benefit of 41, 291 labor days per year, which is equivalent to 2, 477, 460 ETB Birr. This indicates that aggregate WTP in labor is greater than cash payment. Therefore, river protection efforts should be focused more on labor contribution of rural households than in cash and key socioeconomic and institutional derivers of community participation should also be considered while deigning river protection.

Keywords*:* Blue Nile River, Improved River Protection, Contingent Valuation Method, Willingness-to-Pay, Ethiopia.

INTRODUCTION

Natural resources such as river, wetlands, forest, and lakes produce flows of goods & services that include clean water, clean air, fish, and recreation sites or aesthetic value. In addition, natural resource protects excessive flood and enhance microclimate that boost production (Strange *et al*., 1999). Most of environmental goods and services are generally categorized as public goods. Public goods exhibit specific characteristics of non-rivalry and non-excludability character in consumption and individual users often fail to take account of sustainable conservation.

More than 70 percent of Earth surface is covered by water however, rivers and lakes that provide freshwater represent only 0.7 percent of the resource (Shiklomanov's, 1993 cited in Zingraff-Hamed, 2018). Rivers play multi-dimensional functions for the wellbeing of the people. They provide supply of water for rural and urban inhabitants, support irrigation development, and provide livestock forage and material for handcraft making. Besides, rivers are hotspots for biological diversity and societal development (Zingraff-Hamed, 2018). Moreover, water is one of the most important natural resources to maintain the balance of global ecosystems. It directly affects food security, socioeconomic development, and health. In light of these, sustainable land management and the protection of water resources are not only technical issues, but first and foremost social and economic ones (Anctil *et al.,* 2012).

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Ethiopia highlands are the origin of international rivers that support arid and semi –arid areas of the country and neighboring countries (Haileslassie et al. 2003). Ethiopia is "the water tower of Africa", located in North Eastern Africa. The country has more than 10 river basins with an annual runoff volume of 122 billion m^3 of surface water and an estimated 2.6 billion m^3 of ground water potential. *Abbay, Baro-Akobo, Tekeze and Omo-Ghibe* are the four major rivers basins which account for 80-90 percent of the country's water resource (MoWR, 2002). Blue Nile River (locally named as "*Abay*" in Ethiopia) is the largest branch of the Nile draining the Ethiopia highlands. It covers an area of 311,437 km^2 and joins White Nile in Khartoum (ENTRO, 2006).

Though Blue Nile River has local and international importance, in recent years, sedimentation is one of the most serious challenges of conservation. The prevalence of traditional agricultural land use and the lack of suitable resource management often result in the degradation of soil and river bank. Moreover, high population growth with tremendous human induced problems in Abay River has changed the magnitude of surface runoff and ground water potential in the last 16 years (Geremew, 2013; Guo *et al.*, 2008).

Besides, the status of river bank and watershed are under serious degradation due to gully formation and surface erosions that detached and transport considerable quantities of soil particles which contribute to sedimentation dump in Rivers and Lake Tana (Hurni, 1993; Yalew *et al.*, 2016). According to Kidane (2015), Blue Nile river carries sediments load of 131 million ton/year to neighboring countries while Ethiopian upper Blue Nile catchment is the major contributors of the sediment load to the river (Yirga and Hassen, 2015).

Soil erosion impeded the livelihoods of farmer in the area. During summer season Gilgel Abay river overflow damages the crop productivity by sedimentation of alluvial soil and sediment load on crop land. According to Woreda report in 2017, 243 farmers were the victims of crop loss due to overflow of the river and the estimated yield loss during the same period was about 189 quintals in three Kebeles adjacent to the river. On the other hand, soil erosion and sedimentation have negative impact on fish reproduction (Dereje, 2017). Abay river mouth is the core habitat of *Barbus* and *Labeobarbus* fish species reproduction (Gordon et al. 2007). However, the major tributary rivers of Lake Tanabring 8.96 – 14.84 million tons of silt per year with high concentration of nitrate and hosphate chemicals, which affect the turbidity of water and fish reproduction (Yitaferu, 2007).

On the other hand, the level of farmer's participation in sediment control is weak even if government policy promotes participatory resource management. In Ethiopia, most of the conservation activities and resource protection plan are prepared at central government level (top-down) approaches, while local community only consulted to implement the plan. As a result community shows weak sense of ownership to protect natural resource and degradation of natural resource continuing from time to time. According to Bawket (2003), the involvement of local community in catchment conservation activities including erosion control is limited to food-for work, cash for work program, and in some places government use coercive force.

To control sedimentation in the area, however, there is lack of more reliable information of farmer interest and level of participation in labor and cash payment to design bottom-up river management. Thus, the objective of this study is to examine farmers' willingness to pay and their determinants for river protection in Gilgel Abay River mouth.

METHODOLOGY OF THE STUDY

Description of the Study Area

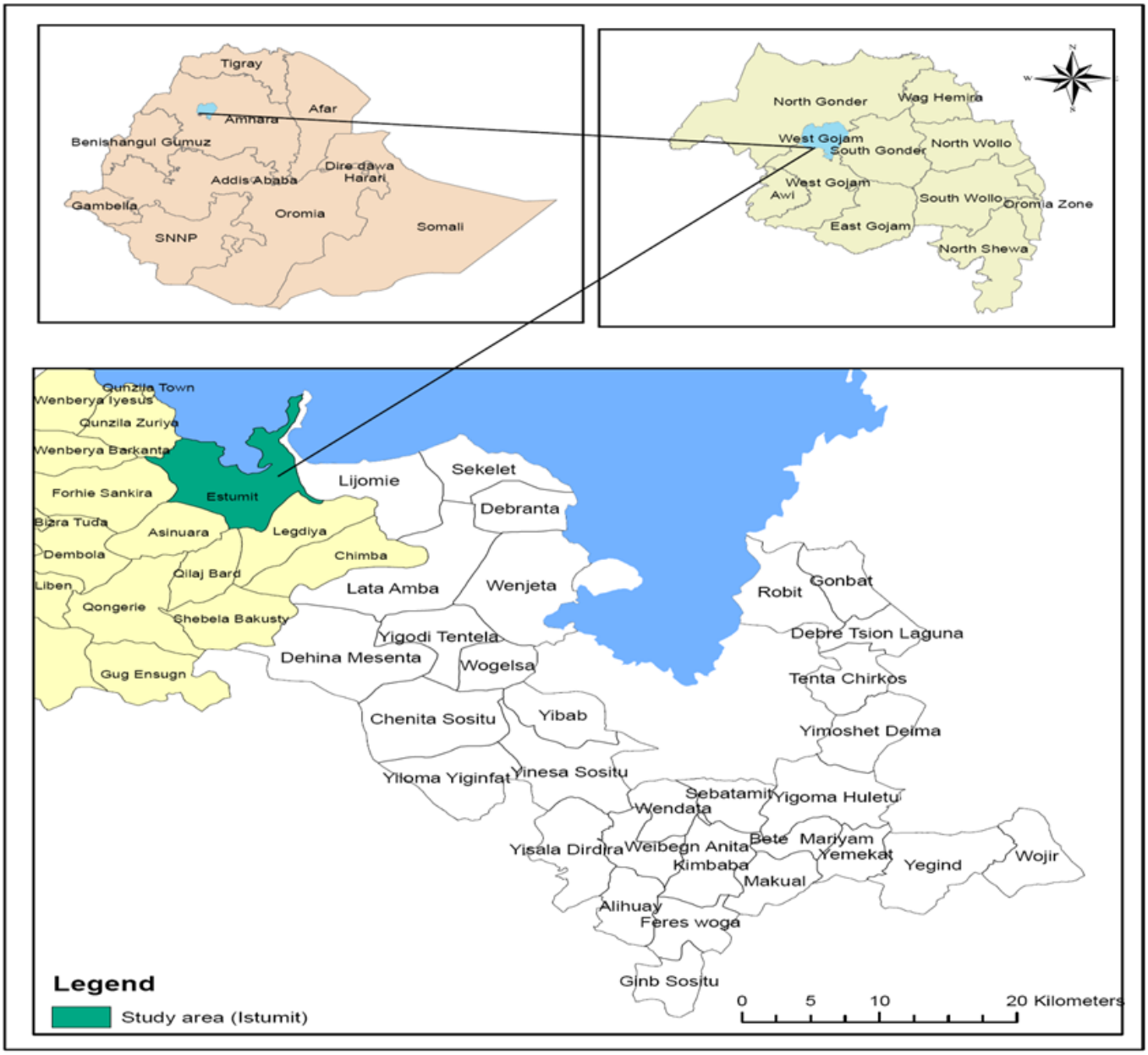
The study was conducted in North Achefer *Woreda* in Blue Nile river mouth in *Estumit kebele*. North Achefer Woreda is located at about 585 km in Addis Ababa (capital city of Ethiopia) and 60 km form Bahir Dar city (regional capital of Amhara). The *Woreda* comprises of 18 *Kebele* administrations (KAs). The geographic coordinate system for the Woreda lies in between 11^o 00' 40" to 11^o 38' 00" North and 36^o 48' 00" to 37^o 01' 35" East. The *Woreda* is bordered by north Gonder in the West, Lake Tana in the North, Awi zone in the South and Bahir Dar Zuria Woreda in the East. According to the Central Statistical agency (2005), the total population of the *Woreda* is estimated to be 189,716, of whom 96,856 are men and 92,860 women; and 15,583 or 8.21 percent are urban inhabitants. The major livelihoods activity in the *Woreda* is agriculture giving job opportunities for more than 85 percent of the population. Maize, Teff, Millet, and potato are the major crops produced in the *Woreda.*

The rainfall pattern of the Woreda is characterized by biannual rainfall mode. The main rainfall season which accounts for 70-90 percent of the annual rainfall occurs from June to September, while small rainy season occurs during December to March. The mean annual rainfall ranges between 600 to 900 mm/year. The annual average temperature is 20^0C due to variation in topography. The *Woreda* is rich in physical and biological diversity. It is part of Lake Tana Basin and known for endemic flora and fauna. The most dominant plant species found in the area include: *Celtis africana, Coffee Arabica, Cordia africana, Bersama abyssinica, Croton Macrostachyus, Ekbergia capensis, Ficussur, Millettia ferruginea,* and many others (GMP, 2012).

Data Type and Source

The study employed both quantitative and qualitative types of data. The sources of the data for this study are

Figure: Map of the Study Area



Source: EFWPDA (2019).

primary and secondary data. The primary data were collected from sample households in *Estumet Kebele*. The nature of data for the study was cross-sectional data collected at one time from sample respondents. In addition, secondary data was collected from government reports, archival document in *Woreda* office, journals, magazines and articles published in the area.

Preliminary Survey and Questionnaire Design

Preceding the main survey, a pre-test questionnaire (with open-ended format) and focus group discussion were made with 15 randomly selected households to determine the starting prices (bid levels) as a reference point for eliciting the mean WTP. From this pilot survey, the starting prices were found to be ranging from 0 to 100 ETB for cash payment. Based on this pilot survey five starting bids prices of 50, 60, 70, 80, and 100 ETB were randomly allocated to the respondents for dichotomous choice questions. Besides, for farmers WTP in daily labor form the labor bids range from 0-48 person days per annum were identified during the pilot survey. Consequently, six bid labor values i.e11, 12, 16, 18, 24, 36, and 48 person days per annum were allocated for response during dichotomous choice questions.

The questionnaire for the main survey is composed of three sections following Haab and McConnell (2002). The first section contains the socioeconomic characteristics of household respondents. The second section contains awareness about importance and challenges of conservation in Abay River. The third section consists of detailed description of hypothetical market scenario and mean WTP question.

Data Collection Techniques

The study applied different techniques of data collection for the primary and secondary data sources. The primary data collection instruments are contingent valuation questionnaire survey. In Contingent Valuation Method (CVM), double-bounded dichotomous choice elicitation formats are employed where a respondent was asked about his/her WTP of a pre-specified amount of initial bid and follow-up bid for the proposed river conservation practices. The secondary data were collected from archival documents in government offices, review of annual reports, articles and paper in subject matter.

Sampling Techniques

A multi-stage sampling technique is used to select the respondents. The study area of *Estumit* Kebele was selected purposively for the study. This is due to the fact that the selected Kebele (*Estumit*) is erosion prone area where high sediments load enter Lake Tana. Soil erosion over flow also affects farmer's productivity. Furthermore, sample respondents/farmers were selected using simple random sampling techniques among the whole list of farmers in the selected Kebele. A total sample size of 158 was determined following Kothari (2004) sample size determination formula. Although 158 households were interviewed in sample Kebele, 2 observations were eliminated due to invalid responses and the analysis of the study is therefore based on the remaining 156 households, who gave valid responses.

CVM Elicitation Format

For this research, double-bounded dichotomous choice format with open-ended questions was applied for eliciting the willingness to pay for respondents. According to Haab and McConnell (2003), CVM method in form of double-bounded dichotomous choice elicitation format have four possible answers for giving dichotomous questions. The double-bounded dichotomous choice format (yes-no response, no-yes response) makes clear bounds on unobservable true WTP. Besides, the yes-yes, no-no responses sharpens the true WTP. Finally, the double-bonded dichotomous choice format help to elicit more information about respondent's WTP than singe bounded format. Finally, the number of responses is increased so that a given function is fitted with more responses. Furthermore, double-bounded dichotomous choice has advantage over single bound choice as the respondents have chance to vote on the second bid value (Hanemann, *et al*., (1991.)

Method of Data Analysis

Descriptive analysis

Descriptive statistics were applied to measure the central tendency and variability of the data. The results of the survey were summarized and interpreted in percentage distribution, frequency level, mean and standard deviation. Besides, table and charts were applied for analysis.

Econometric Model Specification and Analysis

Probit model is employed to assess the determinant variables of WTP while seemingly Unrelated Bivariate Probit model is employed to compute mean WTP of households. The detail specifications of the models are presented below.

Probit Model

The Probit model was developed by McFadden with the concept of utility theory or rational choice perspectives on observed behavior of an individual. The model works well for dependent variables of binary choice and the independent variables reveal nonlinear relation with dependent variables and are categorized as non-linear probability model.

In probit model the respondent households was offered a double bound dichotomous choice question to indicate their willingness to pay for improved river protection by answering "yes" or "no" to specified prices. Hanemann (1984) has developed the basic random utility model for analyzing dichotomous CV responses aim at modeling the choices of individuals among discrete sets of alternatives. The assumption of the model is that the preferences of an individual among the available alternatives can be described by a utility function i.e, the individual chooses the alternative with the highest utility. Haab and Mc Connell (2003) describe the indirect utility for respondent j as;

$$U_0 = U_i(Y_j X_j, \varepsilon_{ij}) \quad ----------(1)$$

Where, i=1 is the final state (state or condition that prevail when CV programme implemented), and i=0 for the status quo.

Y_j is the j $_{th}$ respondent's income,

X_j is households socio-economic characteristic and attribute of choice, and

E_{ij} is a component of preferences known to the individual respondent but not observed by the researcher.

It is clear from the equation that something has been changed from status quo to final state. It could be meas-

2.9. Description and measurement of variables.

NNo	Variable	Description and unit of measurement	Type of variable	Expected sign
1.	Edu	Education level of household head in years	Discrete	+
2.	Age	Age of household Head in years	Discrete	-
3.	TFsize	Family Size in number	Discrete	+
4.	Inc	Total annual income of households in Ethiopian Birr (ETB)	Continuous	+
5.	TLU	Total Livestock owned in Numbers	Continuous	+
6.	Irrl	Irrigation land size in hectare	Continuous	+
7.	Cultland	Cultivate land size in hectare	Continuous	-
8.	No Depnt	Total number of dependents in the family	Continuous	+
9.	Blaw	Presence of Local community in the village	Dummy; 1= yes; 0 = otherwise	+
10.0	Ext	Access to extension services	Dummy; 1= yes; 0 = otherwise	+
11.1	Dist	Proximity to the Blue Nile River	Dummy; 1= near to the river; 0= far	+/-
12.2	BID1	Initial bid price in Ethiopia birr	Continuous	-

ureable attribute, e.g., an improvement indicators q could be change from q_0 to q_1 so that utility from status quo would be $U_{0j} = U_0 (Y_j, X_j, \varepsilon_{0j})$ and Utility in the final state would be $U_{1j} = U_1 (Y_j, X_j, q_1, \varepsilon_{1j})$. Based on this model, respondent j answers yes to a required payment of B_j if the utility with the CV program exceeds utility of the status quo:

$$U_1 = (Y_j - B_j, X_j, \varepsilon_{1j}) > U_0(Y_j, X_j, \varepsilon_{oj}) \quad ----------(2$$

Where, B_j is the bid amount in birr and ε_{0j} and ε_{1j} are the error terms.

In other words, a household will agree to pay for protection of Gilgel Abay if the condition in equation 2 is satisfied, i.e., the utility derived after paying Bj for improvement of river is greater than utility derived without the change.

In view of that, the Probit model can be defined following Hanemann (1984) and Cameron and Quiggin (1994) as:

$$Y_i = \beta X_i + \varepsilon_i \quad ----------$$

$I = 1$ if $Y_i \geq t_i$

$I = 0$ if $Y_i < t_i$

Where,

Y_i = i^{th} respondent's true unobserved point valuation for the Environmental resource in question.

ß = a vector of coefficients for the vector of explanatory variables, X

t_i= the offered threshold, assigned arbitrarily to the i^{th} respondent

I = discrete response of a respondent for the WTP question (1=Yes or 0= No)

ε_i = unobservable random component distributed N(0, σ)

X_i= vector of observable attributes of the respondent (Education, Age, Sex, family size, TLU, Irrigation land, cultivated land, by-law, extension contact, distance from River, number of dependents & initial bid)

Seemingly Unrelated Bivariate Probit Regression (SUBVP) Model Specification

The Bivariate Probit model is a natural extension of probit which involves more than two equations with correlated error term seemingly unrelated regression model. The model is used to estimate the mean WTP from the double bounded dichotomous choice format. The mathematical estimation of the SUBVP model is presented below.

According to Greene (2000), the SUBVP Model is defined as:

$$Y_1^* = \beta_1 X_1 + \varepsilon_1 \quad ----------(4)$$

$$Y_2^* = \beta_2 X_2 + \varepsilon_2 \epsilon(\varepsilon_1) = \epsilon(\varepsilon_1),$$

$$\epsilon(\varepsilon_1) = \epsilon(\varepsilon_2) = 0; Var(\varepsilon_1) = Var(\varepsilon_2)$$

$Cov(\varepsilon_1$, this implies that disturbance terms of these two equations correlated in the same sprit as the seemingly unrelated regression models.

Where; $Y^*_{1=j}$ th respondent actual unobservable WTP at initial bid prices asked. Hence

WTP = 1 if $\geq ß_{i0}$ (initial bid), 0 otherwise.

$Y^*_{2=j}$ th respondent actual unobservable WTP at the second prices asked. Hence

WTP =1 if $\geq ß_{i2}$ (Second bid), 0 otherwise.

Welfare Measure

The ultimate goal pursued in most contingent valuation studies is to estimate willingness to pay (WTP) measures.

Besides, a plausible goal of welfare analysis is to expand the sample mean willingness to pay to the population. In such a case, it would be reasonable to calculate the welfare for each individual in the sample by using the sample mean.
According to Haab and McConnel (2002), the mean WTP in SUBVP model is calculated by the following formula;

$$\mu = -\frac{\alpha}{\beta}$$

Where:
α = is the coefficient for constant term intercept
β = is the coefficient of the amount of bid asked by the household

Aggregating the mean WTP is an important measure of welfare change in the society. In calculating the aggregate value from sample respondent's two problems were controlled. The first one is sampling bias associated with data collection and the second one is not taking into account protest bid. Since, the study was employed simple random sampling method there was no error associated with sampling method to aggregate the value to whole community. Besides, protest bids were accounted during calculating aggregate value
For the open ended contingent valuation survey responses, the maximum willingness to pay figures can simply be averaged to produce an estimate of household mean willingness to pay:

$$MM \qquad \Sigma$$

Where, MMWTP is the aggregate mean of the total respondent households.
MWTP denotes maximum average WTP by the respondents and
n is the sample size.

RESULTS AND DISCUSSIONS

Descriptive analysis

Socio-economic Characteristics of the Respondents

A total of 158 households within the study area were surveyed randomly. The data of 156 households were utilized for data analysis. This represents about 7 percent of the total households within the study area (Table 1).
Out of the total households participated in study, 95% of them were male headed households and married while 5% them were female headed households. This implies that there is a low rate of divorce in the study site. The average household's size in study community is 5.9 persons, which is higher than the national average of 5.1 persons. This indicates higher population growth in the study area. The mean age of the respondents was 40 years, which implies majority of the respondents are in working age group. The education levels are low across the households. There is high illiteracy rate in the study site where about 94 percent of the household heads were not enrolled in formal education. Lack of education hinders the development of rural households and natural resource protection.
The dominant farming system in the study area is mix of crop-livestock production system. Livestock production is subsistence-oriented and is an important component of the mixed farming system and is well integrated with crop production. The dominants crops produced in the area were maize, Finger millet, Niger seeds, & Teff (*Eragrostis teff*). It implies agriculture sector supports high employment in the area. In addition, the survey result revealed that there is shortage of cultivated land where average landholding per household was 0.88 hectare (ha). Similarly, the average livestock holding per household was 4.5. The survey result showed the mean annual income from agricultures was 30,495 ETB per household.

Households' Willingness to Pay for river protection

In the questionnaire, households were asked whether they are willing to pay for the improved river protection in the study area. Consequently, among the sample household heads about 98.7 percent are willing to pay in labor while the rest 1.3 percent were not willing to pay in labor. On the other hand, among the total households of 156 respondents, 96 percent of respondents were willing to pay in cash while 4 percent of them were not willing to pay in cash (table 2).

Reason of WTP for river protection

The willing respondents were also asked to point out their reasons for maximum WTP. The respondents provided different reason for their maximum WTP. About 37.8 percent of the respondents value the river for the mere purpose of passing the resource for future generation. While 32.7 percent reported river provides different goods & services. In addition, the response from 16 percent of respondents revealed that the framers use Blue Nile River for cultural practice while about 5 percent of them use or value the river for education (Fig.1 below).

Perception of benefit and anthropogenic factors affect long term value of river

The benefits of Blue Nile or Abay River for local community

The survey result revealed that majority of households (89 percent) reported that Blue Nile River is important for irrigation while 75.6 percent reported that the river was useful for drinking (Table 3). In addition, about 67.3 percent of the respondents reported the river is useful for cultural and spiritual values. Hence, the findings of study

Table 1. Descriptive statistics of the socioeconomic characteristics of the respondents.

Variables	Description	Form	Measurement	Mean	Min	Max
WTP in cash						
Bid 1 cash payment	Initial bid amount cash	continuous	Birr(1$=28.23 in May 2019)	64.35	0	90
Answer 1	WTP when price bid 1	Dummy	1=yes; 0=no	0.72	0	1
Bid 2 cash payment	Follow-up bid amount	continuous	Birr	74.10	0	100
Answer 2	WTP when price bid 2	Dummy	1=yes; 0=no	0.69	0	1
MWTP	Maximum WTP	continuous	Birr	88.67	0	350
Labor WTP						
Labor Bid 1	Initial bid amount labor	continuous	Person days	13.69	0	24
Answer labor bid 1	WTP when labor price bid 1	Dummy	1=yes; 0=no	0.80	0	1
Labor Bid 2	Follow-up bid amount labor	continuous	Person days	23.49	0	48
Answer labor bid 2	Answer 2	Dummy	1=yes; 0=no	0.70	0	1
MWTP	Maximum WTP	continuous	Person days	19.41	0	41
Age	Age of the household head	Continuous	Year	40.65	20	96
Family size	Family size of the household	Continuous	Number	5.92	1	9
No. of dependent	Number of dependants of the household head	Continuous	Number	4.19	0	8
Cultivated land Size	Cultivated land size	Continuous	ha	0.88	0	3
Irrigation Land	Potential irrigable land	Continuous	ha	0.21	0	0.9
TLU	Total livestock unit	Continuous	Number	4.46	0	9
Income	Annual farming Income of the household Continuous Birr	Continuous	Birr	30,495.3	2950	77000
Sex HH	Sex of Household head	Dummy	1=Male; 0=Female	0.04	0	1
Education	Education level of household head	Discrete	Grade	0.36	0	10
By-law	Presence of local community institution for resource protection	Dummy	1=presence of law; 0= otherwise	0.58	0	1
Extension	Informal education given for households	Dummy	1=aware 0=not aware	0.62	0	1
Distance	Perception of the household head whether she/he live near to river	Dummy	1= near to river 0=far	0.64	0	1

Source: Authors survey (2019).

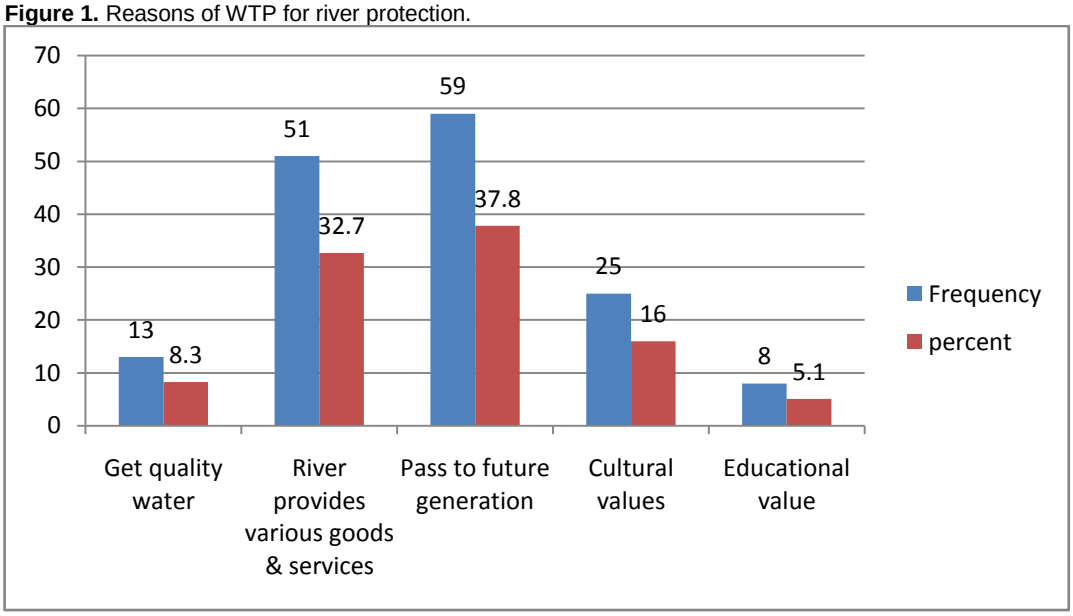
Table 2. Distribution of respondents WTP in labor and cash.

Modality of payment	Willing to Pay	Not-Willing to pay	Total	%
WTP Labor				
Male	147	2	149	95.5
Female	7	0	7	4.48
Total	**154**	**2**	**156**	
%	**98.7**	**1.3**		**100**
WTP by cash				
Male	143	6	149	95.5
Female	7	0	7	4.48
Total	**150**	**6**	**156**	
%	**96**	**3.8**		**100**

Source: Authors survey (2019).

showed that irrigation value ranked first followed by drinking water and fishing while existence value ranked the least according to perception of the respondents. This result is line with past studies showing that community values resource more for direct use value than indirect use value and nonuse value /passive use value (Solomon, 2004).

Figure 1. Reasons of WTP for river protection.



Source: Authors survey (2019).

Table 3. Benefits derived from Blue Nile River.

Values of Gilgel Abay River	Very important		Important		Moderately important		Of little importance		Unimportant		Ranking
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	%
Direct Use value											
Drinking water	37	23.7	56	35.9	25	16	25	16	13	8.3	75.6 (2nd)
Irrigation	77	49.4	49	31.4	13	8.3	11	7.05	6	3.9	89 (1st)
Cultural Value	18	11.5	30	19.2	57	36.5	31	19.9	20	12.8	67.3 (3rd)
Grass & shrub for livestock	15	9.6	15	9.62	39	25	73	46.79	14	8.37	44.2 (4th)
Fishing	9	5.77	7	4.49	29	18.6	60	38.5	51	32.7	28.8 (7th)
Indirect use value											
Swimming or recreation	3	1.9	12	7.7	42	27	64	41	35	22	36.5(5th)
Passive Use value											
Existence for future generation	6	3.8	11	7	36	23	90	57.7	13	8	33.8 (6th)

Source: Authors survey (2019). Note: 'Freq' refers to frequency.

Anthropogenic threats of Blue Nile River

According to the respondents' view, sedimentation is one of the main problems in Abay river mouth and perceived by 90 percent of the respondents followed by overgrazing in the river bank, which is reported by 88 percent of the households. And about 87 percent respondents reported that there is a problem of deforestation. Likewise, 80 percent of the respondents agreed that there are cultivation problem around river bank that causes soil erosion and sedimentation. Another big problem of the area is loss of wetlands and 75 percent the respondents reported the occurrence of the problem. Another problem reported by households is waste disposal into the river, which is reported by 66 percent of the households. House construction and sand mining are relatively low in the area as compared to others problems where only 61.5 percent and 57.1 percent of the respondents described the presence of the problems (Table 4).

Table 4. Major threats of Blue Nile River in Ethiopia.

Major threats of Blue Nile River	Strongly agree		Agree		Neither agree or disagree		Disagree		Strongly disagree		Problems ranking (%)
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	
Overgrazing near river	60	38.4	78	50	8	5.1	10	6.4	-	-	88.4% (2nd)
Deforestation	85	54.5	52	33.3	8	5.1	11	7.05	-	-	87.8% (3rd)
Cultivation in river bank	60	38.4	66	42.3	13	8.3	17	10.9	-	-	80.7% (4th)
House construction(settlement)	50	32.0	46	29.5	18	11.5	42	27	-	-	61.2% (8th)
Sedimentation	61	39	80	51.3	8	5.1	7	4.5	-	-	90.3% (1st)
Sand mining	46	29.5	43	27.6	34	21.8	33	21.2	-	-	57%(9th)
Waste disposal in river	59	37.8	44	28.2	19	12.2	33	21.5	1	0.6	66%(6th)
Overfishing	44	28.2	58	37.2	27	17.3	26	16.7	1	0.6	65.4% (7th)
Loss of wetlands	70	45	47	30	26	16.7	13	8.3	-	-	75%(5th)

Table 4. Major threats of Blue Nile River in Ethiopia.

ECONOMETRIC ANALYSIS

Result of the Probit Model for Cash Willingness to Pay

In Probit model, the dependent variable assumes the value of 1 if a household is willing to pay the proposed bid amount and 0 otherwise. The regression result is summarized in Table 5 below. In this model, out of the 12 explanatory variables fitted into model for cash payment, 7 of them were significant variables in determining farmers' WTP for River Protection. The variables are household income, education, family size, community by-law, awareness training, number of dependents, and land size. The variables such as age, TLU, and distance from the river were insignificant.

Literacy of the household is positively and significantly related to WTP at 10 percent level of significance. This is in line with our expectations and theoretical expositions that households headed by literate individuals would have better concerns and willingness to pay for river protection. The resulted showed that literate household heads have 7.2 percent higher probability of WTP for river protection compared to illiterate household heads, holding other factors constant. However, the result contradicts with the findings of Assefa (2005), who reported illiterate people are more concerned for water protection.

Income of the respondent is found to have positive association with WTP for river and significant at 5 percent. This implies that households with higher annual income demand better river protection than those with lower income. The finding is consistent with many empirical evidences that showed income is positive determinant of household WTP (Demeke, 2009; Awad and hollaner, 2010; Mazgebo, 2013; Berhane and Geta,

2016). On the contrary, family size (FSIZE) is negatively related and statistically significant at 10 percent. The result indicated that, keeping other factors constant, an increase in household size by one unit reduced the probability of willingness to pay for river protection below 4.5 percent.

Awareness training given for households is found to be positive and significant at 5 percent. The result is consistent with Sylvie (2012). The marginal effect suggests those households who got awareness training would have 2.6 percent higher WTP for river protection than those who do not get the training.

Contrary to our expectation, size of cultivated land has a negative and statistically significant effect on the households' willing to pay the proposed bid level at 10 percent level. As the size of cultivated land by the household increase by one ha, the probability of accepting the proposed bid in cash will decrease by 7.4%, holding other factors constant. Apparently, the result could be due to the fact that crop cultivation in the area is dependent on rain-fed framing and less dependent on irrigation water from the river.

Moreover, local law or bylaw is positive and significant at 10 percent level of significance. The result implies that households who perceive and comply to local laws/institutions have a 3 percent higher WTP in cash for river protection compared to those who do not, holding other factors constant. Finally, the number of dependents in family has positive and significant effect on WTP in cash for river protection at 10 percent level of significance. Holding other factors constant, an increase

Table 5. Marginal effects of explanatory variables for cash WTP.

Determinants	dy/dx	Std. Err
Age (YRS)	-.0001213	.00154
Literacy of the household head (Literate 1, 0 otherwise)	.0725318	(.10526)*
Total family size (Number)		
Total irrigation land (ha)		
Number of dependants (No)	-.0458303	(-3.63)*
Total cultivated land(ha)	.0030051	.08593
Total Livestock Unit (TLU)	.0477422	(0.00955)*
Total annual Income (ETB)	-.0743402	(0.3917)*
By-law or local institution (presence of law=1, 0 otherwise))	0.01095	.01082
Awareness training given (got awareness training=1, 0 otherwise)	2.30e-06	(0.000)**
Distance from the Abay river (Near=1 & far=0))	.0301276	(0.3184)*
BID 1	0.026567	(0.03069)**
	.0151099	0.03069
	-.2101342	0.14560

Source: Author survey (2019). Note:** Significant at 5%, * significant at 10%.

Table 6. Marginal effect of labor willingness to pay.

Variables	dy/dx	Std. Err.
Age (YRS)	-.0051997	(.00086)**
Number of dependents(No)	-.0015516	.00537
Total Family Size (No.)	.0073823	.00682
Total irrigation Land (ha)	.0281329	.04724
Total annual income (ETB)	1.46e-06	.00000
Awareness training given to farmers (got awareness= 1)	.0043568	(.01724)*

Source: Authors survey (2019).

in the number of dependents in the family by one would increase WTP of households for river protection by 4.7 percent. Previous studies such as Wright (2011) and Guan et al. (2016) reported a direct relationship between number of dependents in family and WTP for river protection.

Result of the Probit Model of Labor Contribution

For identifying the determinants variables for labor willingness to pay 6 explanatory variables were fit into the regression model and only age of the respondent and awareness training given were found to significantly associated with WTP in labor (see Table 6 below).

The Probit estimation results showed that age of the respondent has negative and significant effect on households' WTP in labor at 5 percent level of significance. Holding other factors constant, an increase in the age of respondents by a year reduces the probability of accepting the bid 0.52 percent. The result implies that older respondent/household heads have problems of supplying labor for river protection compared to households headed by relatively younger persons. The negative relationship between age of the households and labor contribution is consistent with finding of Celeste (2009).

Awareness training is found to be positive and significant at 10 percent. Assuming other factors constant, households who received awareness training have 0.44 percent higher probability of accepting the bid offered in labor for river protection compared to those who are not given awareness trainings and is consistent with Sylvie (2012). The result also collaborates with the study of Awad and Holländer (2010), who reported positive correlation between awareness level of the household and WTP for the water supply services in Palestine.

Results of the Seemingly Unrelated Bivariate Probit (SUBVP) Model

Estimation of mean WTP in cash

The mean WTP from Bivariate Probit model was computed using the formula specified by Haab and Mconnell (2002). That is, mean WTP=- α/ β where α is a coefficient for the constant term, and β is the coefficient

Table 7. Estimates of the Double Bounded Dichotomous Choice format in cash payment.

Variable	CoeffStd.Err	Z	P >|Z|	
Initial Bid	-.0315112	.0073954	-4.26	0.000***
Constant	-3.298625	.9750046	-3.38	0.001
Second Bid	.0815604	.0131348	6.21	0.000***
Constant	.5277946	.1046295	5.04	0.000
Athrho	4.36724	1495.099	0.00	
ρ	.9996762	.9621743		
Log-likelihood= -114.78925 Number of Observation= 156 Wald chi2(2)= 43.35 Prob>chi2=0.0000				
Likelihood-ratio test rho= 0	chi2(1)= 28.8897	Prob>chi2=0.0000		

Source: Authors survey (2019).

Tables 8. Estimate of mean Labor WTP.

Variable	CoeffStd.Err	Z	p>/Z/	
Initial Bid	.0553396	.0165743	3.34	0.001***
Constant	.8693456	.1174617	0.00	.000***
Second Bid	-.0635454	.0084648	-7.51	.000***
Constant	.1.226104	.26067	7.40	.000***
Athrho	4.079944	1008.779	0.00	.997
ρ	.999484	1.152959		
Log-likelihood= -155.18381 Number of Observation= 156 Wald chi2(2)= 57.20 Prob>chi2=0.0000				
Likelihood-ratio test rho= 0	chi2(1)= 30.5623	Prob>chi2=0.0000		

Source: Author survey (2019).

for the bid offered. The result of the model shows the mean WTP in cash ranges from 44.44 ETB to 104 ETB per person per annum with the average value of 74.22 ETB per year per household. In addition, Rho (ρ) value is positive and significantly different from zero at 1 percent probability level and the correlation coefficient of the error term is less than one indicating thathe random component of the first question is not perfectly correlated with the random component of follow-up question (Table 7).

Estimation of mean WTP in labor

As depicted in Table 8, the result of SUBVP model revealed that the mean WTP of labor contribution of the households ranges from 15.7 person days to 19.22 person days per annum while mean labor value for total respondents was 17.46 person days per annum.

Aggregating WTP and welfare measures

In the previous section we have seen mean WTP of individual household's contribution for river protection. Theoretically, the next step in CV survey becomes aggregation. An important issue related to the measurement of welfare using WTP is aggregation of benefit obtained from the sample respondents to the total population. According to Mitchell and Carson (1989),

Table 9. Aggregate value of Blue Nile river protection.

Kind of WTP	Name of the Kebele	Total HHs in the kebele	No of sample HHs	No. of HHs protest zero	Proportion of protest zero (%)	Expected HHs with protest	HHs with valid responses	Mean WTP (ETB/ days	Total Revenue/year	Aggregate revenue in 5 years
WTP in Cash	Estumit	2418	156	7	4.5	108.5	149	74.22	171,411.09	857,056.09
WTP in Labor (person days)	Estumit	2418	156	2	1.23	53.1	154	17.46	41,291 x 60ETB=2,477,469.24 ETB	12,387346.20
Total		**2418**	**156**	**9**	**-**	**233.6**				

Source: Author survey (2019).

there are four important issues to be considered regarding sample design and execution in order to have a valid aggregation of benefits: population choice bias, sampling frame bias, sample non-response bias and sample selection bias. Random sampling method was used in this study using a list of households in the study kebele. In this study, protest zero responses were excluded from the data set and expected protest zeros were accounted in the estimation of the total aggregate benefit of river protection. Hence, none of the above biases are expected in our analysis. Mean is used as measure of aggregate value of river protection. As indicated in Table 9, the aggregate WTP for river protection in cash was computed at 171,411.09 ETB per year (1US$=28.3 birr). Moreover, the finding of study revealed that the average labor contribution of the households for river protection was computed at 17.46 labors (person) days per year with annual aggregate labor contribution was 41,291 person days. At current labor price in study area of 60 ETB per day the total labor contribution by farmers was equivalent to 2,477,460 ETB Birr which bit higher than WTP in cash (Table 9).

CONCLUSIONS AND POLICY RECOMMENDATIONS

The major objective of this study is to investigate rural households 'Willingness to pay for Blue Nile river protection. This study used double bounded elicitation format followed by an additional open ended question. The survey was administered via in-person interview through trained enumerators.

The results of study revealed that Blue Nile River provides local community with direct and indirect use values. The major benefits of the Blue Nile river includes small scale irrigation for agriculture, water supply for drinking purpose, livestock forage, cultural and recreation values.

Blue Nile River has local, national and regional importance. However, human-induced anthropogenic factors are damaging the current status of the river and the whole watershed. The immediate and direct causes of degradation were land use change from forest/vegetation to agriculture land, increase in population or high growth rate (both human and livestock), unwise natural resource utilization and poor livelihoods of the local community. The major notified challenges of the river are odd soil erosion and sedimentation, loss of biodiversity, loss of native ecosystem and shortage of natural resource for fuel and consumption. Hence, the evidences found in this study are vital inputs for the preparation of general management plan for river basin protection and create awareness of the community for long term resource management and utilization.

The empirical findings of the determinants of WTP indicated that annual income, formal education, awareness trainings, cultivated land, family size, and comm-

unity bylaws are key factors influencing WTP in Cash. Besides, age and awareness trainings were key determinants of WTP in labor. Therefore, understanding the key drivers of households' WTP is necessary and the first step to achieve sustainable river protection through community participation. Government and Non-Government actors in the area should be focused on creating awareness on the importance of protection the ecosystem services rendered by the River by providing trainings and institutionalizing and strengthening community bylaws that positively contribute to the preservation of natural resources in the area.

Furthermore, the mean household WTP in cash for river protection is computed at 74.22 birr per annum with aggregate annual revenue for river protection computed at 171,411.09 ETB per year for the entire community. Moreover, the finding of study revealed that the average labor contribution of the households for river protection was computed at 17.46 labor (person) days per year with annual aggregate labor contribution was 41,291 person days. At current labor price in study area of 60 ETB per day the total labor contribution by farmers was equivalent to 2,477,460 ETB Birr.

Overall, the findings of the study, therefore, substantiate payment of ecosystem services which gained global attention where beneficiaries of Ecosystem services share the cost and benefit of resource. Besides, the study serves as baseline for feasibility study of government to assess community contribution for resource management. The evidences from the estimates of households' WTP suggest that rural households are more willing to support river protection efforts better in terms of labor than cash. As a result, Government's effort for protection the Blue Nile river mouth requires understanding the characteristics of the community not only in terms of their demographic and socio-economic features but also their perception, knowledge and practices in relation to the services rendered by the Blue Nile River in the locality.

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