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Determinants of Farmers' Willingness to Pay for Blue Nile River Protection: The Case of Gilgel Abay River Mouth, Ethiopia

Abdurhman Wariwo*
The Nature and Biodiversity Conservation Union (NABU), Bahir Dar, Ethiopia

Abrham Seyoum Tsehay (PhD)
Assistant Professor, Center for Rural Development, Addis Ababa University,
P. O. Box 62539, Addis Ababa, Ethiopia

Abstract
The paper examines the determinants of farmer's willingness to pay for protection of Abay River. This study employed Contingent Valuation Method with a double bounded elicitation format followed by open ended questions. A total of 158 randomly selected households were interviewed. Descriptive statistics and Econometrics Models particularly Probit and Seemingly Unrelated Bivariate Probit models were applied. Result of the study showed annual income, education, number of dependents in the household, family size, total cultivated land, extension contact, and community bylaw were determinant variables of farmers WTP in cash. Response to the hypothetical scenario revealed that the mean WTP in cash is 74.22 ETB per year per household with an aggregate value of 171,411.09 ETB per annum (1US$=28.3birr). In addition, extension contact and age of the respondents were important variables in determining labor contribution. While the mean labor WTP for household to be 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 (daily labor payment is 60 birr/per day). This indicates that aggregate WTP in labor is greater than cash payment. Therefore, the government should engage farmers in labor during River protection. Besides, socioeconomic and institutional variables should also be considers while deign river protection.
Keywords: Blue Nile River, improved river protection, Contingent valuation method, Willingness-to-Pay, Ethiopia
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1. 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 environment goods and services are generally categorized as public goods. Public goods are exhibit specific characteristics of non-rivalry and non-excludability character in consumption and individual's users often fail to take account of sustainable conservation.

More than 70% of Earth surface is covered by water however, rivers and lakes that provide freshwater represent only 0.7% of the resource (Shiklomanov's, 1993 cited in Zingraff-Hamed, 2018). Rivers play multi-dimensional functions for the wellbeing of the people. It provides supply of water for rural and urban inhabitant, support irrigation development, and provides 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 this sustainable land management and the protection of water resources are not only technical issues, but first and foremost is social and Economic ones (Anctil *et al.,* 2012).

Ethiopia highlands are the origin of international rivers that support arid and semi –arid area of the country and neighboring state (Haileslassie, *et al,* 2018). 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 river basins which account for 80%-90% of the country's water resource (MoWR, 2002). Blue Nile River (locally named as "*Abay*") in Ethiopia is the largest branches of the Nile draining the Ethiopia highlands. It covers an area of 311,437Km2 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 Rive[1]r 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

[1] WTP is Willingness- to-pay for Blue Nile river protection

surface erosions that detached and transport considerable quantities of soil particles which contribute to sedimentation dump in Rivers and the Lake Tana (Hurni, 1993; Yalew *et al*, 2016). According to Kidane (2015), Blue Nile river carrier's sediments load of 131 million ton/year to neighboring countries where, the Abay River in upper blue is major contributors of this sediment load to Lake Tana and Blue Nile River (Yirga and Hassen, 2015).

Soil erosion impeded the livelihoods of farmer in the area. During summery season Gilgel Abay river overflow damage the crop productivity by sedimentation of alluvial soil and sediment load on crop land. According to woreda report in 2017, 243 farmers were the victim of crop loss due to overflow of flood and the estimated yield loss during the same period was estimated to be 189 quintal in three kebeles boarder. On 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, 2007). However, the major tributary rivers of Lake Tana bringing 8.96 – 14.84 million tons of silt per year with high concentration of nitrate and phosphate chemical which affects the turbidity of water and fish reproduction (Yitaferu, 2007).

On other hand, the level of farmer's participation in sediment control is weak even if government policy promotes participatory resource management. Most of the conservation effort is orchestrated top down approaches where resource protection plan is prepared at government office and consult the community which lack active community participation. 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 place government use coercive force.

To control sedimentation, 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 assess farmer awareness about river, identify key determinants of willingness to pay, and compute mean WTP for river protection.

2. Methodology of the study

2.1 Description of the study area

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

The Rain Fall patterns of the woreda is characterized by biannual rainfall mode where the main rainfall season which accounts to 70-90% of the annual rainfall occurs from June to September, while small rains season also occurs during December to March. The mean annual RF ranges between 600mm to 900mm/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, Ficus sur, Millettia ferruginea, and many others (GMP ,2012).

2.2. Data type and source

The sources of the data for this study are primary and secondary data. The primary data was 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. The type of data for the study was Quantitative and Qualitative data.

2.3 Preliminary Survey and questionnaire design

Preceding the main survey, a pre-test questionnaire (with open-ended format) and focus group discussion was made with 15 randomly selected households to determine the starting prices (bid levels) as a reference 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. For labor WTP the bids ranges from 0- 48 person days per annum. In views of these, five starting bids: 50; 60; 70; 80; 100 ETB were randomly allocated to the respondents. Meanwhile, for labor WTP six bids; 11;12;16;18;24;36;48 person days per annum were allocated for the respondent

The questionnaire for the main survey is composed of three sections (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.

2.4 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 was collected from archival documents in government offices, review of annual reports, articles and paper in subject matter.

2.5 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 into 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 as invalid responses and the analysis of the study is based on the remaining 156 households who gave valid responses.

2.6. CVM Elicitation Format

For this research double-bounded dichotomous choice format with open-ended question were applied for eliciting the willingness to pay.. According to Haab and McConnell (2003) double-bounded dichotomous choice has gained statistically efficiency over single-bounded dichotomous choice in three different ways. First, the answer sequences yes-no or no-yes yield clear bounds on the WTP. For the no-no pairs and the yes-yes pairs, there are also efficiency gains. Finally, the number of responses is increased, so that a given function is fitted with more. Furthermore, in double-bounded dichotomous choice the respondents have chance to vote on the second bid value (Hanemann, et al., (1991) In addition, an open-ended follow-up question is used to increase the precision of the estimate with dichotomous choice question.

2.7 Method of Data Analysis

2.7.1 Descriptive analysis

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

2.7.2 Econometrics Model specification and analysis

Probit model are employed to assess key determinant variables of WTP. To compute mean households WTP, Seemingly Unrelated Bivariate Probit model employed. The detail specification of the models is presented below.

2.7.2. 1 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 is work well when dependant variables is binary choice and the independent variables revealed non linear relation with dependant variables and is categorizes as non linearly probability model.

The assumption of the Probit 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. According Haab and Mc Connell (2003) of valuation of environmental and natural resource, there are two choices or alternatives so that the indirect utility for respondent j can be written as;

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

Assume, 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 something has been changed from status quo to final state. It could be measureable 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

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

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

In other words, a farmer's household will agree to pay for protection of Gilgel Abay if the condition in equation 2 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 defines as (Hanemann, 1984; Cameron and Quiggin, 1994);

$$Y_i = \beta X_i + \varepsilon_i \quad (3)$$

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

$I = 0 \quad if\ Y_i < t_i$

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 dependants & initial bid)

2.7.2 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:-

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

$$Y_2^* = \beta_2 X_2 + \varepsilon_2$$

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

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

$$Var(\varepsilon_1) = Var(\varepsilon_2) = 1$$

$Cov(\varepsilon_1, \varepsilon_2) = \rho$, 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 $Y_1^* \geq ß_{i0}$ (initial bid), 0 otherwise.

$Y^*_{2=j}$ th respondent actual unobservable WTP at the second prices asked. Hence WTP =1 if $Y_1^* \geq ß_{i2}$ (Second bid), 0 otherwise.

2.8 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;

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

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 of river protection controlling the biases associated with data collection is very important. However, the data was collected by simple random sampling method and there is no bias in estimation. The most important things in calculating the aggregate value is accounting protest bid is essential.

For the open ended contingent valuation survey responses the maximum willingness to pay figures can be simply be averaged to produce an estimate of household mean willingness to pay:

$$MMWTP = \frac{\sum_{i=1}^{i=n} \boldsymbol{MWTP_i}}{\boldsymbol{n}}$$

Where, MMWTP is the mean maximum willingness-to-pay of households, MWTP denotes maximum willingness-to-pay of households and n is the sample size.

2.9 Description and measurement of variables

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

3. Result and Discussion

3.1 Descriptive analysis

3.1.1. 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% of the total households within the study area.

From the total surveyed household's majority of them were male and married. This implies that there is a low rate of divorce in the study site. The average household's size in study site is 5.9 persons which is higher than national average household size (5.1 persons). This indicates 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% of the households 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 mixed 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 support 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 show the mean annual income from agricultures was 30,495 ETB per household (see table 1).

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

Variables	Description	Variable type	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	Willingness to pay when price bid 1	Dummy	1=yes; 0=no	.72	0	1
Bid 2 cash payment	Follow-up bid amount	continuous	Birr	74.10	0	100
Answer 2	Willingness to pay when price bid 2	Dummy	1=yes; 0=no	.69	0	1
MWTP	Maximum Willingness to pay	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	Willingness to pay when labor price bid 1	Dummy	1=yes; 0=no	.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	.70	0	1
MWTP	Maximum Willingness to pay	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=Femal	0.04	0	1
Education	Education level of household head	Continuous	Grade	.36	0	10
By-law	Presence of local community institution for resource protection	Dummy	1=presence of law; 0= otherwise	.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: Author survey (2019)

3.2 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 command area. Consequently, among the sample household heads about 98.7 % are willing to pay in labor while the rest 1.3% were not WTP. On the other hand, among the total households of 156 respondents 96% of respondents were willing to pay in cash while 4% were not willing to pay (see Table 2).

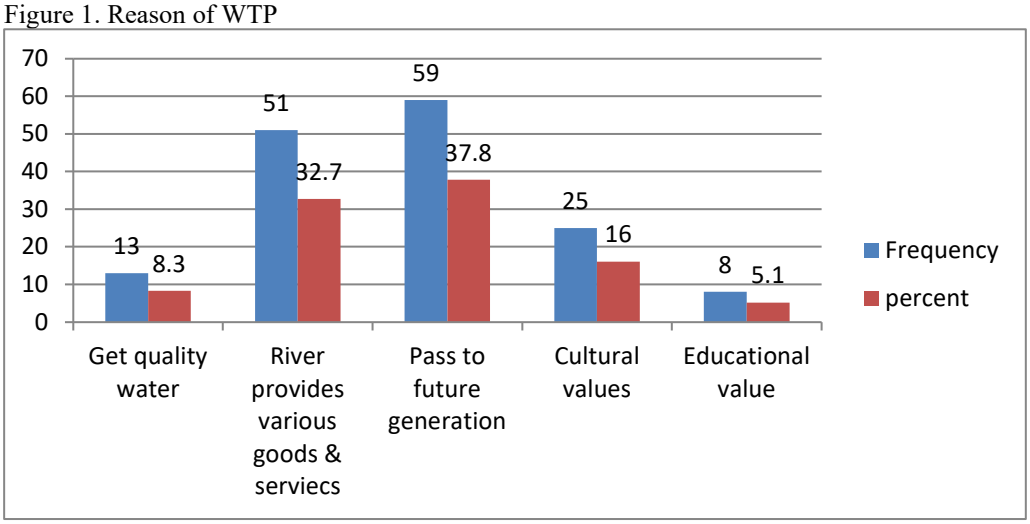
Table 2. Distribution of respondents WTP in labor and cash

Modality of payment	Willing to Pay	Non-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: Author survey (2019)

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% of the respondents value River for purpose of passing the resource for future generation .While 32.7% reported river provides different goods & services. In addition about 16% household value River for culture use despite only 5.1% value River for educational purpose (see figure 1).

Figure 1. Reason of WTP



Source: Author survey (2019)

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

3.3.1 The benefits of Blue Nile or Abay River for local community

Table 3 survey result revealed that majority of households (80%) reported that Abay River is important for irrigation while 75.6% reported the river useful for drinking. In addition, about 67.3% of the respondents reported the River is useful for cultural and spiritual values. Hence, the finding of study showed that irrigation value rank first and followed by drinking water and fishing and existence value ranked the least according to perception of the respondents. The pervious empirical study showed that community value resource more for direct use value than indirect use value and non-use value /passive use value (Solomon, 2004)

Table 3. Benefits derived from Blue Nile River

Values of Gilgel Abay River	Very important		Important		Moderately important		Of little importance		Unimportant		Ranking (%)
	Frequency	percent	Frequency	percent	Frequency	percent	Frequency	percent	Frequency	Percent	
Direct Use value											
Drinking water(2nd)	37	23.72	56	35.9	25	16	25	16	13	8.33	75.6
Irrigation (1st)	77	49.36	49	31.41	13	8.33	11	7.05	6	3.85	89
Cultural Value (3rd)	18	11.54	30	19.23	57	36.54	31	19.87	20	12.82	67.3
Grass & shrub for livestock (4th)	15	9.62	15	9.62	39	25	73	46.79	14	8.37	44.2
Fishing (7th)	9	5.77	7	4.49	29	18.59	60	38.46	51	32.69	28.8
Indirect use value											
Swimming or recreation (5th)	3	1.9	12	7.7	42	27	64	41	35	22	36.5
Passive Use value											
Existence for future generation (6th)	6	3.8	11	7	36	23	90	57.69	13	8	33.8

Source: Author survey (2019)

3.3.2 Anthropogenic threats of Blue Nile River

According to the respondent's views, sedimentation was the main problems in Abay river mouth and perceived by 90% of the respondents. On the other hand overgrazing in the river bank is the second largest problem in the area and reported by 88% of the households In addition, about 87%% respondents reported that there is a problem of deforestation. In addition, 80% 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. In this regard 75% the respondents are reported the occurrence of the problem. Another problem reported by households is waste disposal into the river which is reported by 66% households. House construction and sand mining are relatively low in the area as compared to others problems where only 61.5% and 57.1% of the respondents described the presence of the problems (see Table 4).

Table 4. Major threats of Blue Nile River in Ethiopia

Major threats	Strongly agree		Agree		Neither agree or disagree		Disagree		Strongly disagree		Problems ranking (%)
	Frequency	percent	Frequency	percent	Frequency	percent	Frequency	percent	Frequency	percent	
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**)

Source: Author survey (2019)

4. Econometric analysis

4.1 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. 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 and extension contact, number of dependants, and land size. The variables like age, TLU, and distance from the river were insignificant (see table 5).

Table 5. Marginal effect explanatory variables for Cash WTP

Determinants	**dy/dx**	**Std.Err**
Age (YRS)	-.0001213	.00154
Education dummy1 (illiterate, base)	.0725318	.10526 (*)
Edu_dummy2	-.1224169	12186
Total family size (No.)	-.0458303	-3.63 (*)
Total irrigation land (ha)	.0030051	.08593
Number of dependants (No)	.0477422	0.00955 (*)
Total cultivated land(ha)	-.0743402	0.3917 (*)
Total Livestock Unit (TLU)	0.01095	.01082
Total annual Income (ETB)	2.30e-06	0.000 (**)
By-law or local institution (presence of law=1))	.0301276	0.3184(*)
Level of extension given (got awareness=1)	0.026567	0.03069(**)
Distance from the Abay river (Near=1 & far=0))	.0151099	0.03069
BID 1	-.2101342	0.14560

Source: Author survey (2019)

Education level of the respondents (EDU) is negatively and significantly related to WTP at 0.1% probability. That is, respondents with more years of schooling are less willing to pay for river protection. A possible reason could be illiterate household has indigenous knowledge of resource conservation i.e illiterate individuals are more concerned about water resource. This is consistent with the findings of Assefa (2005) who reported illiterate people more concerned for water protection. The result also revealed that holding other things constant, a unit increases in years of schooling of the respondent decrease the probability of accepting the first bid by about 7.2%.

Income of the respondent (Inc) is positive association with WTP for river and significant at 0.05%. This implies that households with high annual income demand better river protection than low and medium economic status households. The finding is consistent with many empirical evidences that showed income is positive determinant of household WTP (Demeke, 200; Awad and hollaner, 2010; Mazgebo, 2013; Berhane and Geta, 2016). The marginal effect result shows that holding other things constant one birr increase in income of the respondent leads to increase the probability of accepting initial bid by less than 1% probability level.

The sign of family size (FSIZE) is negative and statistically significant at 10%. Looking marginal effect, keeping other factors constant, as the family size of household increase by one person the household WTP for river is decrease by 4.5%.

The extension contact or household awareness (Ext) is positive sign and significant at 5%. The result is consistent with Sylvie (2012). The marginal effect suggests a unit increase in extension in the probability of WTP for river protection by 2.6%.

The land ownership variable (LANDSIZ) has a negative and statistically significant effect on the households' probability of willing to pay the proposed bid level at 10 percent level. As the cultivated land ownership of the household increased by one ha, the amount of price that the household head is willing to pay will increase by about 7.4 percent, other factors remain constant. The possible reason might be the agriculture in the area is rain fall dependant which is little use of irrigation water.

Moreover, local law or bylaw (Blaw) is positive and significant at 10% probability. When the local farmers have empowered, prepared and implement local law the probability of WTP for river protection is increase by 3 percent assumes other variable kept constant.

The number of dependants in family (Ndenp) is positive and significant at 10 percent. In addition, keeping the influences of other factors constant, an increase in the number of dependants in the family would increase the probability WTP for river protection by 4.7%. Similar study reported direct relationship between number of dependant in family and WTP for river (Wright, 2011; Guan et al, 2016).

4.1 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 age of the respondent and extension contact were statistical significant variables at 5% and 10 % probability level respectively (see Table 6).

Table 6. Marginal effect of labor willingness to pay

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

Source: Author survey (2019)

Age of the respondents had also negative and significant effect on households' WTP in labor at 5% level of significance. This may be old people faced labor shortage to encroach the river protection. The negative relationship between WTP in labor and Age is consistent with the finding of Celeste (2009). Keeping other variables constant, an increase in a year of age of the household, the probability of accepting the first bid is decreased by about 1%.

The extension contact or awareness level (Ext) took positive sign and significant at 10%. The result is consistent with Sylvie (2012). The marginal effect suggests a unit increase in extension in the probability of WTP for river protection in labor by 0.4%. In similar manner, Awad and Holländer (2010) have also reported positive correlation between awareness level of the household and WTP for the water supply services in Palestine.

4.3. Results of the Seemingly Unrelated Bivariate Probit (SUBVP) Model

4.3.1 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 ; α is a coefficient for the constant term, and % is a coefficient for 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 is 74.22 ETB per year per household. In addition, Rho (ρ) value is positive and significantly different from zero at less than 1% probability level and the correlation coefficient of the error term is less than one i.e the random component of the first question is not perfectly correlated with the random component of follow-up question (see Table 7).

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

Variable	Coeff	Std.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: Author survey (2019)

4.3.2 Estimation of mean WTP in Labor modalities

The result of SUBVP model revealed the mean WTP of labor contribution of the households ranges from 15.7 person days to 19.22 person days per annum. With average labor value is 17.46 person days per annum (see Table 8).

Tables 8. Estimate of mean Labor WTP

Variable	Coeff	Std.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)

4.3.3 Aggregating WTP and welfare measures

In the previous section we have seen mean WTP by households' 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) 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 none response bias and sample selection bias. Random sampling method was used in this study using a list of household. In this paper protest zero responses were excluded from the data set and expected Protest zeros was accounted in the estimation of the total aggregate benefit of river protection. Hence, none of the above biases was expected in our analysis. Mean was uses as measure of aggregate value 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). The mean labor WTP for river protection to be 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 (see Table 9).

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 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)

5. Conclusion and Policy Recommendations

The major objective of this study was to investigate farmers 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 result of study revealed that Blue Nile River provides local community with direct and indirect use values. The major benefits of the river are provide irrigation water for small scale agriculture and drinking water; provide livestock forage, cultural value and recreation value. Despite, the River has local, national and regional importance, anthropogenic factors are damaging the status of the river The direct causes of river degradation are change in land use, population growth (human and livestock) and poor livelihoods of local community The major notified challenges of the river are soil erosion and sedimentation, livestock overgrazing, loss of forest and wetland areas and river catchment degradation by poor agriculture practice. Hence, this information is an essentially inputs for preparation of general management plan for river protection and rising the awareness of for long term resource management.

The empirical finding on the determinants of WTP indicated that annual income, formal education, extension contact, cultivated land, family size, and community bylaw are key factors influencing WTP in Cash. Besides, age and extension were key determinants of WTP in labor. Therefore understanding socioeconomic characteristics is necessary and the first step to achieve sustainable river protection through community participation.

Furthermore, the mean household WTP for river protection is computed at 74.22 birr per annum. The aggregate annual revenue for river protection is computed at 171,411.09 ETB per year (1US$=28.3 birr). The mean household labor WTP for river protection to be 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. Hence, the finding of the study substantiates

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.

Evidence from the study support the mean WTP in Labor higher than households WTP in Cash which implies the government policy should consider this factor to mobilize and protect the river and associated natural resource.

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