

Economic Valuation of Natural Forest: The Case of Hunase Forest, Gibe District, Hadiya Zone, Southern Ethiopia

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Abstract
This study was evaluating the economic value of the Hunase forest using a double-bounded contingent valuation method followed by open-ended questions. The sample respondents were chosen using a two-stage stratified random sampling approach. A total of 152 households were surveyed. Both primary and secondary sources were used gather data. The collected data were estimated using descriptive statistics and a bivariate probit econometric model. According to the findings, 71.7% of the respondents were willing to pay for the proposed bid in order to improve forest service. For the first and follow-up bids, the mean willingness to pay for the double-bounded bivariate probit estimate ranged from Ethiopian Birr 58.8 to 51.7 per household per year, respectively. The mean maximum willingness to pay was 47.86 Ethiopian birr. The findings of the bivariate probit model revealed that education level, family size, annual income, and forest benefit have positive and significant effects on willingness to pay for forest conservation, while distance from the forest and bid amounts have negative and significant effects. The aggregate mean willingness to pay is calculated to be Birr 68,614.5 per year using the second bid. The results suggest that the majority of people place a high value on forest protection, implying that natural forest ecosystems are critical to human well-being. To create forest conservation strategies, policymakers should take into account education level, family size, annual income, forest benefit, and distance of the homestead from the forest variables, according to the findings.
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INTRODUCTION

Forests provide a wide range of ecosystem benefits to humans. These ecosystem services not only provide for essential survival needs, but also for other aspects of happiness like health, security, good social relations, and freedom of choice. The entire scopes of forests' direct and non-cash support to livelihoods has recently attracted more attention (IUCN, 2011; EMG, 2011; UNEP, 2012). Furthermore, forest ecosystem resources are important for the provision of services that people rely on to make a living (like timber and non-timber forest products), supporting services (like soil and water conservation, watershed protection, nutrient recycling, and biodiversity conservation), regulating services (like climate regulation, hydrological service, nutrient retention, carbon sequestration, fire protection, pollination, and disease regulation), and cultural services (like amenity and recreation) (Millennium Ecosystem Assessment, 2005). Natural forests, in particular, are the most ecologically diverse as well as provide a considerably larger range of ecological, amenity, recreational, and other economic functions than plantation forests (Perman *et al*., 2003).

However, Ethiopia's forest resources have been shrinking in both quantity and quality through time. The forestry sub-sectors are being challenged by these issues. The biggest problems to forest development and conservation in Ethiopia appear to be deforestation and forest degradation, livestock and free grazing systems, forest fires, and an increasing demand for wood and wood products, among others (Abate M., 2020). For the benefit of all living things, sustainable forest management protects and improves the long-term health of forest ecosystems while providing environmental, economic, social, and cultural opportunities for current and future generations (NRCan., 2011).

At the national, continental, and global levels, economic valuation of forest ecosystem services is critical for the design and implementation of effective sustainable forest management options and forest policies. The forest, as a source of numerous goods, should be valued both for its own sake as natural capital and for its contribution to socioeconomic life. Forest goods and services have recently become more important non-market values, whose products in the form of goods can be used by society. Non-market forestry goods and services serve to meet social requirements, but they are not regulated or valued by market mechanisms (De Groot *et al.,* 2010).

Hunase forest, one of Ethiopia's natural forests, encompasses 239 hectares in the southern nations, nationalities, and peoples (SNNP) regional state. Plant and animal species, honey, and other non-timber forest products exist in the forest. However, increased deforestation and intense resource competition, particularly for agricultural land, as well as illegal tree felling for fuel wood, construction materials, and charcoal manufacturing, have a negative impact on these resources. The majority of environmental services, including forest management, are considered public goods and services because they have no commercial value. Non-market valuation determines user preferences to determine the value of ecosystem services to human well-being. The lack of understanding about the total economic value of these resources is one of the difficulties to successful natural forest management. No study has yet been undertaken to determine the worth of the Hunase natural forest on which this study was conducted to address this problem.

Objectives of the study

The overall objective of this study is to investigate the economic value of the Hunase natural forest.

Specific objectives

- To elicit and determine households' willingness to pay (WTP) for forest ecosystem conservation,
- To determine the factors that influence respondents' willingness to pay for Hunase natural forest.

MATERIALS AND METHODS

Description of Study Area

This research was carried out in the Hunase forest, which is located in the Hadiya zone's Gibe district. The Gibe district is 262 kilometers from Addis Ababa, Ethiopia's capital. It is situated between 70 37' 53" and 70 42' 43" north latitudes and 370 37' 07" and 370 44' 25" east longitudes. With an average altitude of 1650 meters, the topography spans from 1250 meters to 2850 meters above sea level (GWFEDO, 2020). The district has kolla, woina-dega, and dega climates, with annual rainfall ranging from 600 to 1200 mm on average. The area's typical annual temperature ranges from 12.60°C to 250°C, with an average of 18.80°C. The district has a total area of 44,783 hectares. According to the land use system, 69.8% of the land is agricultural, 14.5 % is forest, 8.4 % is grazing land, and 7.3 % is other. Agriculture is the primary source of income for the majority of the population (GWARDO, 2020). The district's total predicted human population is 134,777, with 66,892 (49.6%) males and 67,885 (50.4%) females (CSA, 2013). The district has a total area of 44,783 hectares.

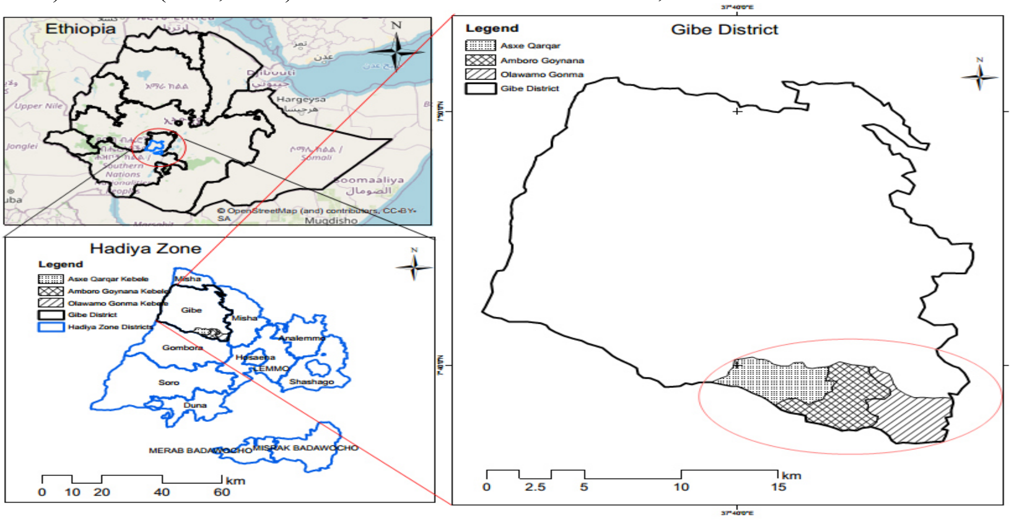

Figure 1 study area map

Sampling Techniques and Sample Size

A two-stage stratified random sampling technique was used for selecting the sample respondents for the study. In the first phase, out of the twenty-one rural kebeles (*Kebele is the smallest administrative unit in an Ethiopian Administrative Structure*); three potential kebeles were purposively selected based on their nearness and the level of dependence on the benefit of a forest. In the second phase, proportional sample households were selected from the selected kebeles using simple random sampling techniques. The selection is usually made with the help of random numbers. Rules-of-thumb have been suggested for determining the minimum number of sample households required to conduct multiple regression analysis. The study used a method developed by Green (1991) to select the total sample size from the total households. He suggested a rule-of-thumb that $N \geq 50 + 8m$, where "N" is the minimum number of sample households required to conduct multiple regression analysis and 'm' is the number of explanatory variables used in the regression analysis. According to the formula, 138 respondents were selected, and with 10% contingency, a total of 152 respondents were selected. The number of households included in the sample was based on the proportion of households in each kebele.

Data Sources and data collection methods

The data for this study was obtained from both primary and secondary sources. A structured questionnaire, key informant interview, focus group discussion, and field observation were used to obtain primary data. Furthermore, secondary data was gathered from both published and unpublished sources.

Field Work Procedure

A pre-test and focus group discussions (GDs) were conducted prior to the final survey implementation. The pre-test survey was done with 16 randomly selected households from various kebeles, and four enumerators were trained on how to approach the problem and describe the scenario to the respondents, as well as other potential problems. The results of the pre-test were used to make changes to the design of the final survey questionnaire based on the responses, making it more obvious for respondents.

In a double-bounded referendum approach, Cameron and Quiggin (1994) explained that open-ended questions from a pre-test survey were used to set initial bid prices, and follow-up bids were formed by doubling and halving the initial bids if the response is "yes" for the first bid value and "no" for the first bid value, respectively. To establish the starting point bid prices and gain a better understanding of how the real survey was done, a pre-test survey and focus groups were held. Accordingly, 40, 60, 80, and 100 ETB per year were determined. Using these initial bids, sets of follow-up bids were constructed based on whether the response was "no" or "yes" to the initial bid. If the respondent was willing to take the offered initial bid, the follow-up bid is doubled to 80, 120, 160, and 200 birr per year; in the case of a "no" response, the follow up bid is halved to 20, 30, 40, and 50 birr per year, respectively, and then the respondent is requested to state his/her maximum amount of WTP for the proposed project. Next, each bid was randomly assigned with equal probability to each respondent. Thus, the total sampled households were divided into four equal groups with four initial bids in the final survey. To support forest conservation and protection, the method of payment was proposed to be paid as a surcharge with the rural land use tax.

Methods of data analysis

Descriptive analysis

The socio-economic and demographic variables, as well as WTP values, were analysed using descriptive statistical tools such as frequencies, means, standard deviation, and percentages. SPSS version 20.0, STATA version 12 and Excel statistical tools were used for descriptive and econometric data analysis.

Econometric Model Specification

A bivariate probit econometric model was used to identify factors influencing a household's willingness to pay for Hunase forest conservation and to estimate the mean willingness to pay for this study. The variance inflation factor (VIF) was used to test the multicollinearity between continuous explanatory variables before applying the bivariate probit model to analyse the effect of explanatory variables on WTP. It was computed as:

$$\mathbf{VIF} = \frac{1}{1-R_i^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{(1)}$$

Where, Ri2 is the coefficient of determination in the regression of one explanatory variable (X) on the other explanatory variables (Xj). If there is no collinearity between repressors, the value VIF is 1. A VIF value of a variable exceeds 10, which happened when R2i exceeds 0.90, and that variable is said to be highly collinear (Gujarati, 2004).

A contingency coefficient also estimated to see the degree of association between the dummy explanatory variables. A value of 0.75 or more indicates a stronger relationship between the two variables (Healy, 1984). The contingency coefficient (C) was compute as:

$$\mathbf{C} = \sqrt{\frac{\chi^2}{N+\chi^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{(2)}$$

Where: - C= coefficient of contingency, $\chi 2$= Chi-square test and N= total sample size

Bivariate Probit Model

Bivariate normal probability density functions are one of the most often used bivariate distributions by statisticians; they allow for non-zero correlation, whereas the typical logistic distribution does not (Cameron and Quiggin, 1994). As a result, in this study, the bivariate probit model is utilized to calculate the mean WTP from the double bounded dichotomous choice.

The bivarate probit model, also known as the double bound dichotomous choice model, is used to estimate WTP (Haab and McConnell, 2002).

The j^{th} contribution to the Likelihood function is given as

$$\mathbf{Lj\ (\mu / t) = Pr(\mu 1 + \varepsilon 1j > t1,\ \mu 2 + \varepsilon 2j < t2)^{YN} * Pr(\mu 1 + \varepsilon 1j > t1,\ \mu 2 + \varepsilon 2j > t2)^{YY} * Pr(\mu 1 + \varepsilon 1j < t1,\ \mu 2 + \varepsilon 2j < t2)^{NN} * Pr(\mu 1 + \varepsilon 1j < t1,\ \mu 2 + \varepsilon 2j > t2)^{NY}} \quad \ldots\ldots \mathbf{(3)}$$

This formulation is referred to as the bivariate discrete choice model

Where: - μ = mean value for willingness to pay
YY = 1 for a yes-yes answer, 0 otherwise, NY =1 for a no-yes answer, 0 otherwise, etc.
And the jth contribution to the bivariate probit likelihood function becomes.

Lj (μ / t) = Φε1 ε2 (d1j ((t1-μ1)/σ1), d2j ((t2-μ2)/σ2), d1jd2jρ).

Where Φε1 ε2= Standardized bivariate normal distribution function with zero means
Y1j=1 if the response to the first question is yes, and 0 otherwise, Y2j=1 if the response to the second question is yes, 0 otherwise, d1j = 2y 1j-1, and d 2j= 2y2j-1, ρ = correlation coefficient and σ = standard deviation of the errors
This general model is estimated using the standard bivarate probit algorithms. Finally, the mean willingness to pay (MWTP) from bivariate probit model were calculated using the formula specified by Haab and Mconnell, (2002).

MWTP **(μ) = -α/β ……………………………………………………. (4)**

Where: - α = coefficient for the constant term and ß = coefficient offered bids to the respondent
The household willingness to pay (WTP) for the first (BID1) and second (BID2) bids to improve forest preservation and hence boost services is the dependent variable in this study. The first and second bids are both dummy variables, with a value of "1" for households willing to pay for the proposed bid and a value of "0" otherwise. Eleven potential explanatory variables were chosen based on the outcomes of previous investigations (Youe, & Pabuayon, 2011; Edstrom *et al*, 2012; Bamlaku *et al*., 2015; Elmi et al., (2016) Tadesse Getachew, 2018), existing theoretical explanations, and researcher knowledge

RESULT AND DISCUSSION

Using descriptive statistics and econometric models, the data collected through the CVM questionnaire was analysed and interpreted. An econometric model was used to calculate the mean willingness to pay and identify the factors affecting households' willingness to pay for Hunase forest protection. Descriptive statistics were used to analyse the socio-economic and demographic characteristics of sample households.

Socioeconomics and Demographics Characteristics

Tables 1 and 2 demonstrate that 109 (71.7%) of the total sample households were willing to pay for forest protection, whereas the remaining 43 (28.3%) were not. Male household heads made up 79.6% of the total, while female household heads made up 20.4 %. Male-headed households contribute 83.5 % of willing households, while female-headed households give 16.5 % (Table 1). From the studied respondents, 70 (46.1%) were satisfied with the current conservation of Hunase natural forest, while 82 (53.9%) were not. Furthermore, of the 70 respondents who were satisfied with the current Hunase forest conservation, 48 (44%) were willing to pay for the forest conservation, whereas 22 (51.2%) were not. Apart from the 82 respondents who were dissatisfied with current conservation, 61 (56%) were willing to pay and 21 (48.8%) were not (table 1). Unsatisfied respondents comprise the majority of the households prepared to pay for forest conservation. The reason for this could be that respondents who were dissatisfied with current forest conservation and protection wanted to reverse forest degradation and reclaim the forest's original benefits.

Table 1 Descriptive statistics of dummy variables

Variables	Description	WTP 109(71.7%)	NWTP 43(28.3%)	Total 152
Sex	Male	91(83.5)	30(69.8)	121(79.6)
	Female	18(16.5)	13(30.2)	31(20.4)
Marital status	Married	97(89)	36(83.7)	133(87.5)
	Single	4(3.7)	2(4.7)	6(3.9)
	Divorced	5(4.6)	5(11.6)	10(6.6)
	Separate	3(2.8)	0	3(2)
Level of satisfaction	Satisfied	48(44)	22(51.2)	70(46.1)
	Unsatisfied	61(56)	21(48.8)	82(53.9)
Awareness	Aware	64(58.7)	14(32.5)	78(51.3)
	Not aware	45(41.3)	29(67.5)	74(48.7)

The average age of willing and non-willing respondents was 41.6% and 40.51%, respectively. The educational level ranges from zero to fifteen (12+3) years. The average level of education for willing and non-willing responders was 6.4% and 5.31%, respectively. The findings imply that willing respondents had a higher educational level than non-willing respondents on average. This could be due to households accepting offered bids for forest conservation when their level of education increases. The willing and non-willing respondents have average annual incomes of Ethiopian Birr 16732.7 and 13559.5, respectively. According to the findings, higher-income households are more likely to contribute for forest protection than lower-income families. This is consistent with the theoretical assumption that income has a positive impact on demand for normal goods. In terms of distance from the homestead to the forest, it takes an average of 22.86 minutes to walk into the forest area. The willing and non-willing respondents took an average of 20.36 and 29.4 minutes to walk to the forest, respectively. That is, residents who lived close to the forest were more likely to pay for forest protection since they benefited more than those who lived far away from the forest. (See Table 2)

Table 2 Descriptive statistics of continuous variables

Variables	WTP	Min	Max	Average	St. Dev.
Age	Willing	25	73	41.6	9.715
	Not willing	25	72	40.51	11.941
Education	Willing	1	15(12+3)	6.4	2.806
	Not willing	0	9	5.31	2.261
Annual income	Willing	4300	32000	16732.727	6006.462
	Not willing	3900	30000	13559.524	5852.706
Distance from forest area	Willing	5	35	20.3636	6.48601
	Not willing	15	50	29.4048	7.2585

Awareness about Forest benefit

This section looks at how well-informed sampled households are about the benefits of Hunase natural forests. Out of the 152 people polled, 51.3 % knew about Hunase natural forest and were well knowledgeable on what a forest is and what it does, whereas 47.7% had no idea what a forest is or what it does (Table 1). Those that were aware of the forest were also asked for their opinion on the value of forest benefit and service. Other than providing fire wood and other wood products to the surrounding community at large, Table 3 highlighted the relevance of forest benefit (in order of increasing importance).

According to the findings, forests improve the amount of rainfall and prevent the occurrence of droughts, soil protection, shelter for wild animals, and forest provide shade, cool and clean air are the four top environmental services valued by respondents, while forests increase water percolation and water availability, absorb atmospheric carbon, check global warming, recreational value, and spiritual value are the four least valued environmental services. (See table 3)

Table 3 Respondents' rank order of benefit and services of forest

Forest benefits	Ranks(% of respondents)							
	1st	2nd	3rd	4th	5th	6th	7th	8th
Forests improve amount of rainfall/ prevent occurrence of drought	28.2	8.6	14.5	10.5	11.2	17.8	8.5	9.8
protect the soil erosion	16.5	23.7	22.4	17.1	7.9	13.2	12.5	13.2
Increase water percolation and water availability	17.1	13.1	21	6.6	13.2	15.1	11.8	8.6
provide shelter for wild animals	15.8	15	25	13.2	20.4	12.5	12.5	7.9
provide shade, cool and clean air	8.6	13.2	9.2	26.3	19	14.5	15.8	11.2
Absorb atmospheric carbon, check global warming	5.3	13.2	3.3	17.8	22.4	21	17.1	11.8
Recreational value	4.6	7.9	2.6	4.6	3.3	3.9	15.1	18.4
Spiritual value	3.9	5.3	2	3.9	2.6	2	6.6	19.1
Total	100	100	100	100	100	100	100	100

Perceptions on forest cover change

FAO's 2010 study explained that an average of almost 13 million hectares of forest is lost every year in Ethiopia. The loss of forests has been accompanied by the loss of the many valuable services that forests provide, such as regulation of hydrological flows, carbon sequestration, and biodiversity conservation. The sampled respondents in the study area recognized that lack of ample attention concerning bodies, illegal extraction of wood and economic factors like poverty were the main reasons for deforestation. This is because of the cutting of trees for fuel, construction, charcoal making, and pit-sawing, which are manifestations of population pressure as well as failure in property rights institutions. On the other hand, population growth and the expansion of agriculture were less dominant driving causes of deforestation (figure 2).

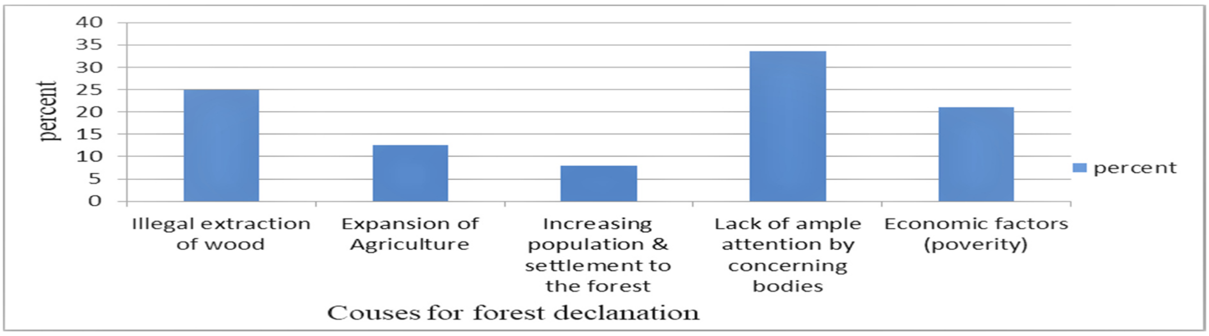

Figure 2 Percentage distribution of perception of households for forest resource degradation in Hunase natural forest

With regard to the solutions to the problem of deforestation, the sampled households were also asked; about 28.28% of the respondents suggested increasing awareness of local communities as a means or solution to control forest depletion. About 23.03% chose tree planting and other conservation activities, while 19.74% of the respondents supported looking for another source of income as a solution. Furthermore, approximately 15.79% suggested strong natural forest protection and management rules and regulations, and 8.55% suggested collaboration between local government and community as a solution to reduce deforestation and conserve the forest (figure 3).

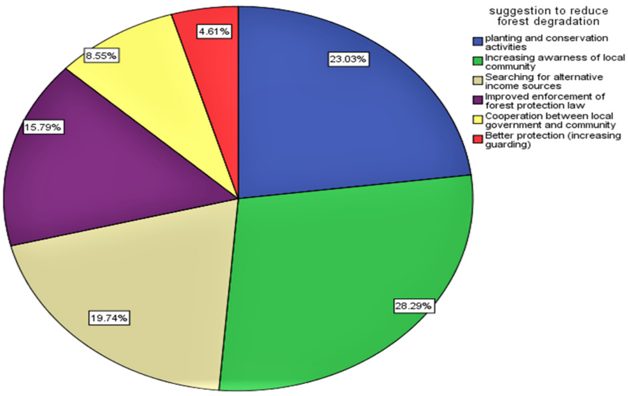

Figure 3 Percentage distribution of household suggestion to reduce forest resource degradation in Hunase Natural forest

Based on the hypothetical market, respondents were asked whether they were willing to pay for the Hunase forest's protection and conservation. This study used four initial bid values (40, 60, 80, and 100 ETB per year); respondents were asked to express their willingness to pay by proportionally dividing the randomly offered initial bids. The follow-up bid was doubled if the respondents accepted the randomly offered initial bid; if they did not accept the initial bid, the follow-up bid was halved. As a result, 109 (71.7%) of the respondents accepted the randomly offered initial bid, whereas 43 (28.3%) of the respondents refused to pay the initial bid. Furthermore, 102 (67.1%) of respondents were willing to pay the follow-up bid value, whereas the remaining 50 (32.9%) were not willing to pay the follow-up bid value for forest protection. Also, based on the combined frequencies of discrete replies, approximately 54.6 % said "Yes" for both the first and second bids, 17.1 % said "Yes-No," 12.5 % said "No-Yes," and 15.8 % said "No-No."

Figure 4 Households Willingness to Pay for the initial and follow up bid

WTP category	Frequency	Percentage
Yes-Yes	83	54.6
Yes- No	26	17.1
No-Yes	19	12.5
No-No	24	15.8
Total	152	100

In open-ended questions, households were also asked to state their maximum willingness to pay for forest protection.

The mean maximum willingness to pay for forest conservation:

$$Mean\ MWTP = \frac{\Sigma \text{MWTP}}{n}$$

Mean MWTP = 7275/152 = 47.86 ETB

Where, Mean MWTP is mean maximum willingness to pay, ''∑MWTP'' is summation of maximum willingness to pay of the sampled respondent and ''n'' is number of sampled respondents. The mean willingness to pay for the sampled respondents is 47.86ETB per household per year, which ranges from a minimum of 20 to a maximum of 300 ETB from open-ended question.

Econometric analysis

Determinant Variables of Households' Willingness to pay

The explanatory variables were evaluated for multicollinearity before running the bivariate probit regression model. The results revealed that there were no issues with multicollinearity between the variables. The value of the Contingency Coefficient (CC) for dummy variables was less than 0.75, and the value of the Variance Inflation Factor (VIF) for continuous variables was less than 5, indicating that multicollinearity was not present.

When we use cross-sectional data, we may encounter a problem of heteroscedasticity (Greene, 2008). To correct the heteroscedasticity problem, we can estimate the robust standard errors instead of the usual standard errors (Wooldridge, 2002). Thus, the econometric models which are used in this study were corrected for heteroscedasticity problem using the robust command in Stata.

Figure 5 Contingency coefficient and Variance inflating factor of variables used in regression

	Sex	Marital status	Forest benefit	Awareness	Satisfaction
Sex	1.0000				
Marital status	0.2463	1.0000			
Forest benefit	-0.0279	0.1377	1.0000		
Awareness	0.1490	0.0715	0.0057	1.0000	
Satisfaction	-0.0501	0.0127	-0.0502	0.0603	1.0000

Variance Inflation Factor for the continuous variable

Variables	Age	family size	Income	Education	Distance
VIF	1.79	1.73	1.10	1.09	1.05

In bivarate probit model estimation, the chi-square ($\chi 2$) distribution was employed to determine the overall significance of a model. The model fits the data well ($\chi 2$= 98.72, p<.0000), according to the results of our study. As a result, the bivariate probit model fits all of the variables in the model that are expected to explain WTP. In general, it appears that the data closely matches the model. The table below contains variables that are both significant and insignificant. However, just the most significant variables were discussed.

Figure 6 Bivariate probit model regression result

Model output with initial BID				Model output with second BID		
Variables	Coeff.	Robust Std. Err.	P> /Z /	Coeff.	Robust Std. Err	P> /Z /
Sex	-0.32544	0.35254	0.356	0.20661	0.27709	0.456
Age	-0.01195	0.01540	0.438	-0.01158	0.01249	0.354
Marital status	0.01522	0.20754	0.942	0.17125	0.15430	0.267
Education	0.11218	0.04822	0.020**	0.048087	0.03966	0.025**
Family size	0.15118	0.09085	0.096*	-0.00286	0.07218	0.968
Annual income	0.00006	0.00002	0.001***	-5.07006	0.00002	0.742
Forest benefit	0.00684	0.29597	0.982	0.026401	0.23090	0.009***
Distance	-0.11275	0.02235	0.000***	-0.032122	0.01414	0.023**
Awareness	-0.57655	0.29359	0.150	-0.419790	0.26379	0.112
Level of satisfaction	-0.02762	0.28087	0.922	-0.206541	0.25654	0.421
Bid1/Bid2	-0.041982	0.02879	0.000***	-0.030424	0.01208	0.000***
_cons	2.47155	1.03748	0.017	1.574275	0.80356	0.050

Number of obs. = 152 Prob.> Chi2 = 0.000
Log pseudo likelihood = -139.89 Wald Chi2 (22) = 98.72
Likelihood ratio test of rho=0 Chi2 (1) = 16.651

Note: ***, ** and * significant at 1%, 5% and 10% probability levels, respectively

Education level of household head (EDUCATION):- As expected, education level had a positive and statistically significant impact on saying "yes" to both the first and second bids at a 5% significance level. This suggests that as the household head's education level rises, so does his or her willingness to pay for forest ecosystem conservation techniques to improve the forest's benefits. The explanation for this could be that education raises people's knowledge of forest conservation and protection. Similar study was reported by Yoeu and Pabuayon (2011), Gebremariam and Edriss (2012), Girma, *et al.,* (2012), Negewo *et al*. (2016), Seifu, (2017) and Getachew, (2018).

Family size: - Accepting the initial bid and WTP for forest conservation activities has a positive sign and is statistically significant at the 10% significance level. This could be due to the fact that households with a high family size of active labour force are more willing to pay or donate work for environmental protection than households with a smaller family size.

Annual Income: income had a positive relation to households' willingness to pay in initial bid and statistically significant at 1% level of significance. This effect indicated that respondents with higher annual income were more likely to say yes to the initial bid than households with lower income. The results indicate that households with high income tend to reveal a high WTP for the protection of forest than their counterparts with low incomes. The result is consistent with Seifu, (2017), Mezgebo, (2011), Ansong, and Roskaft, (2014).

Forest Benefit: The model's findings revealed that this variable has an impact on a household's willingness to pay. In the second bid, this variable had a positive relationship with households' willingness to pay, as expected, and was statistically significant at the 1% level of significance. This could be because forest-dependent household heads are willing to pay for forest conservation in order to increase their benefits.

Distance of the homestead from the forest (Distance): As expected, this variable showed a negative relationship with the household's WTP for forest conservation and is statistically significant at 1% and 5% in the initial and second bids, respectively. The reason is that the farther the family residence is from the forest, the more inaccessible the benefits from the forest are, the lower the probability of WTP for conservation of this forest. The result agrees with the works of Yoeu and Pabuayon (2011), Tao *et al*., (2012), Amirnejad *et al*., (2013), Negewo *et al*., (2016), and Getachew, (2018).

Bids amount (Bid1/Bid2):- As expected, both bid values one and two have a negative coefficient and are statistically significant at the 1% significance level. The proportion of respondents who answer "yes" in the choice question decreases as the bid amount increases, which is consistent with the law of demand. This is consistent with the findings of Bamlaku *et al.* (2015), Negewo *et al*. (2016), and Getachew (2018).

Mean willingness to pay for forestry conservation

According to Cameron and Quiggin (1994), the model that uses determinant factors to estimate mean WTP is preferable since it has a higher marginal value accuracy estimation for environmental changes. As a result, for the initial bid and the follow-up second bid, the mean WTP value of conserving forest was estimated using equation (4) described in the preceding section and varied from 58.8ETB to 51.7ETB per family per year, respectively. The mean willingness to pay amount from the open ended question maximum WTP was 47.86 ETB, which is greater than this value. Free riding and a lack of foundation for answering WTP questions in an open ended approach could be the reasons. Bamlaku *et al.* (2015) came to a similar conclusion after studying the economic assessment of forest resources.

If the bivariate probit model is estimated on a dichotomous choice CV question with a follow up and the parameter shows that either the mean, or variance or both differ between the initial bid-price and the follow up, the researcher must decide which estimates to use to calculate the WTP measure (Haab and McConnell, 2002). Hence, in order to choose the appropriate WTP among the two bivariate estimates, it was looked into the data and the total amount for the YY and NN responses accounted for about 70.4 % of the total responses. For these reasons, the mean WTP from the follow up question is used to calculate the aggregate WTP. Hence, using the follow up mean WTP (Birr 51.7 per year) the aggregate benefits (WTP) of the society can be estimated. As explained above (Table 3), from 152 sampled households 109(71.7%) of them were accepted the proposed project and willing to pay for the conservation of the forest hence the total revenue (aggregate WTP) generated could be calculated using Turner, *et al*. (2004) method,

Aggregate WTP = NHH x M (WTP) x %HHPV

Where; NHH = total number of households in the study site

M (WTP) = expected mean willingness to pay

%HHPV = percentage of households with positive valuation or those answer yes

Aggregate WTP = 1851* Birr 51.7 $*\frac{109}{152}*$100 = Birr 68,614.5 per year

Thus in aggregate for this forest protection and conservation project, Birr 68,614.5 per year can be collected from three kebele dwellers.

CONCLUSION AND RECOMMENDATION

Hunase Forest supplies a variety of forest goods and services for the local community. However, due to a variety of circumstances, this forest is diminishing. The findings suggest that 109 (71.7%) of the total sample households were willing to pay for forest protection, whereas 43 (28.3%) were not. The main top three reasons for deforestation indicated by respondents were a lack of enough attention by concerned bodies, illegal wood extraction, and economic factors such as poverty. The sample families were also asked about remedies to the problem of deforestation, and the majority of the respondents supported raising local community awareness, tree planting, and other conservation efforts as a means or solution to control forest depletion.

According to the results of a bivariate probit model, education level, family size, annual income, and forest benefit all exhibited a positive and statistically significant relationship with households' willingness to pay in both the first and second bids. The distance between the homestead and the forest, as well as the amount of the initial and follow-up bids, exhibited a statistically significant negative relationship with households' willingness to pay. From a bivariate probit model, the mean WTP for Hunase forest conservation is 58.8 ETB per household per year for the initial bid and 51.7 ETB per household per year for the follow-up second bid, respectively. This indicates that the majority of people place more value on forest conservation, implying that natural forest ecosystems are critical to human well-being. As a result of the findings, a better understanding of the function of forests as providers of various goods and services, as well as the economic valuation of these services, should be developed. To assure the supply of watershed services, a motivation mechanism is required to maintain continual support for communities living near to the forest region, as well as to establish a regular flow of funding for forest management to ensure conservation effectiveness.

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