Estimating the non-market value of protected areas: the case of Senkele Swayne Hartebeest Sanctuary, South Ethiopia

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Abstract

Protected Areas provide secured habitat for plants and animals. The principal objective of the study was to estimate the determinants that influence households' decision, maximum and the mean willingness to pay local rural farm for conservation and restoration of Senkele Swayne's hartebeest sanctuary. To achieve the objective of the study, the contingent valuation method (CVM) was using double bound dichotomous questions followed by open-ended questions. Sample data from 175 rural households were collected by applying two stage sampling procedures. The primary data was collected using structured and semi-structured questionnaire interviews, conducting, a focus group discussion and a key informant interview. Relevant secondary data was also reviewed. Both descriptive statistics and econometric methods of analysis were used. Econometric models such as bivariate probit, binary probit and Tobit models were used to estimate mean WTP, determinants of decision WTP and the intensity of WTP respectively. The WTP result shows that the average amount of money from the open-ended format was 31.71 ETB per month and the mean WTP values from double bounded dichotomous households in the senkele sanctuary can pay up to 34.59 ETB per month. Determinants such as educational level, livestock holding and total land size had a positive and significant effect on the decision of households' WTP. While distance from sanctuary and initial bid amount had a negative influence on households' WTP decisions. Therefore, the aggregated welfare gain expected from the conservation intervention of sanctuary from the open-ended format and double bounded dichotomous format were 12,024,812.52 ETB and 13,116,943.08 ETB per year respectively. Based on welfare gains from the sanctuary intervention, results show that the aggregate value of Sanctuary from an open-ended question format (12 million ETB) was underestimated as compared to a double bounded dichotomous choice format (13.12 million ETB). This indicates that there may be the existence of free riding problems in the study area. EWCA, researchers, local people and non-governmental organizations are working together to minimize deforestation and develop a sustainable management system for Senkele sanctuary.

1. Introduction

1.1 Background of the Study

As defined by [1] "A protected area is an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed by other effective means". Protected areas are seen as one key to conserving natural resources, on land and at sea globally. Currently, about 30,000 protected areas meet the definition of conservation [2]. Among a few countries in the world that possess unique features of fauna and flora with a high level of endemism,[3] challenges facing the conservation of Ethiopian wildlife today are becoming increasing at an alarming rate. Agricultural productivity is very low, and an increase in food production depended on increasing the area under cultivation and grazing. Usually, s is at the cost of wildlife resources, leading to the loss of flora, fauna and their habitats [2].To conserve natural resources, Ethiopia has established many protected areas such as National Parks and Sanctuaries, which are referred to as principal conservation areas, cover only approximately 2.9% of the country's surface area[4].

The Senkele Swayne's Hartebeest Sanctuary (SSHS) is among the protected areas in Ethiopia. Senkele Sanctuary was established in 1976 to protect the Swayne's (*Alcelaphus buselaphus swaynei*) [5]. Swayne's hartebeest is one of the fifteen races of African hartebeest, of which two are already extinct and Swayne's hartebeest is critically endangered. It was first discovered by Brigadier General Swayne in 1891-92 at Jijiga, as a herd of 300–400 and even herds of thousands were observed. As a result of the render pest outbreak, at the end of the 19th century, the number of Swayne's hartebeest (*Alcelaphus buselaphus swaynei)* decreased to 880. This subspecies, which was formerly found in both Somalia and Ethiopia, is now limited only to a few localities in Ethiopia. The Senkele area had the largest population of Swayne's hartebeest in 1973. The 200 km2 area occupied by the hartebeest before 1972 was reduced to about 58 km2 in 1973, and then to 36km2 [5].

At present, 54 km2 of sanctuary remains for the Hartebeest[6]. In the Senkele Plains, in the late 1960s, areas of pasture were increasingly brought under cultivation and the pressure on remaining pasture was intensified [5]. At present, rapid degradation and depletion of the forest resource base is already finding its expression in the different sectors of the economy, such as agriculture, water resources, energy and biodiversity.

Valuation can be defined "as an attempt to put monetary values on environmental goods and services or natural resources" [7]. The goods and services include recreation and tourism, plant and wildlife habitat, genetic resources, water supply, protection against natural disasters, and so on. Many of these goods and services are not traded on commercial markets and therefore have no obvious market value. Economic valuation methods or non-market goods and services comprise a range of empirical approaches to estimate the monetary value the trade-off a person would be willing to make to increase the amount or the quality of a good or service for which there exists no market.

Economic valuation deals with estimating the monetary price of those resources. It helps decision makers to settle between alternatives and competitive use of the resource to convey a sound decision for long term management. Moreover, most natural resources in Ethiopia are public goods, hence the ownership of particular resources is not well defined and the exclusion of resource use by non-owners is difficult. CVM is an environmental valuation method, which uses a hypothetical market to appraise consumer preferences directly, asking their willingness to pay or willingness to accept changes in the level of environmental goods or services. The study of local household`s WTP for conservation of natural resources to extend the advantages derived from the resources helps to overcome the problem of attaching price to public and common pool resources an appropriate pricing and valuation is an inevitable exercise [8, 9] .

Valuation of non-market resource goods and services is, in relative terms, a newly emerging research area, particularly in Ethiopia and other developing countries. The importance of sustainable management of non-market resource goods and services has increased during the last few years [8, 10]. In addition, these valuation studies have many methodological limitations in capturing biases, which usually emanate from contingent valuation methods (CVM), the constructed market scenario and the payment

vehicle they used. Therefore, this study aimed to contribute to the scanty literature by estimating mean WTP and identifying determinants that affect the probability and intensity of WTP for the conservation, restoration, and enhancement of Senkele Swayne's Hartebeest Sanctuary.

2.Research methodology

2.1 Description of the Study Area

The study was conducted in Senkele Swayne's Hartebeest Sanctuary, located between Oromia regional state and Sidama regional state. It is located at 53 km south of the Shashemene-Arba Minch road near the town of Aje and lie between 7°07'–7°12'N and 38°15'–38°19' E, (Fig. 1) and on the western side of the Great Rift Valley, west of Hawassa and 320 km away from Addis Ababa (the capital of the country). The altitude of the Sanctuary is estimated to be ranging from 2000 to 2100 above sea level. The Sanctuary was established in 1976 to protect the Swayne's hartebeest (*Alcelaphus buselaphus swaynei*), a mammal endemic to the country. The 200 km^2 area occupied by the hartebeest in 1972 was reduced to about 54 km^2 in 1973[6].

2.2 Sampling Techniques and Sample Size

In this study, two stage sampling techniques were used to select areas and households for this study.

In the first stage, Senkele sanctuary was selected purposely because of the next reason: lack of back-ground information about willingness to pay for conservation of background Senkele Swayne hartebeest sanctuary and its determinations.

In the second stage, sample households were selected applying simple random sampling techniques from three kebeles which are borders of sanctuary. The required sample sizes were determined based on the rule-of-thumb proposed by Green i.e

$N \geq 50 + 8m$ Eq. 1

Where N = sample size, m = number of explanatory variables [11].

Then, sample households from each kebele were distributed randomly using a proportionate probability based on the size of the sampling technique. Finally, a total of 180 physically identified households have been contacted for the detailed socio-economic survey (Table 1).

Table 1
Number of households and sample size n = 180

Population Category	Target households (Nh)	Sample Size, nh=((Nh/N)n
Kite Tesisa	930	45
Senbete Lencho	1200	58
Loke Sifo	1598	77
Total households(N)	3728	180

2.3 Data Source and Method of Data Collection

Both primary and secondary data were used for this study. The primary data were collected including household survey, focus group discussion (FGD), and key informant interview. Secondary data collection was done through published documents such as journals, articles, and books, and unpublished documents such as population data, additional socioeconomic information were gathered from the respective kebeles administration offices, Senkele Swayne's Hartebeest Sanctuary administration office and siraro woreda administration office.

2.3.1 Household Survey

The household survey was carried out on sample households drawn from the population in each kebele Structured and semi- structured questionnaire were used as data collection instrument. The questionnaire was prepared in English and translated in to local language (AfanOromo) for it to be easily understood by the respondents. The survey was accomplished with face to face personal interview using double bounded dichotomous choice and open ended follow up contingent questionnaire designed by researcher. The questionnaire was administered by enumerators under the supervision of the researcher. Six enumerators hired for this purpose were selected based on their educational qualification and experience in conducting survey. Short training on how to conduct the survey was given to all the recruited enumerators.

Dichotomous choice format CVM studies were preceded by a pre-test survey of the small sample households. The discussion [12] indicated that pre-test survey with open ended questions can help to provide some information on the bounds of respondents' WTP. So before the formal survey was conducted, the questionnaire was pre-tested with randomly selected 30 households from adjacent kebeles.

As [13] rightly stated the purposes of pre-testing are: (1) to check the soundness of the questionnaire; (2) to incorporate or exclude variables, which are important or irrelevant for the area; and (3) to set the appropriate initial bid values for the double bounded-dichotomous choice method. After pre-testing the questionnaire, some imminent modifications were done. Most importantly, the initial bid sets were

determined by using the mean, median and mode of the WTP amount from the open ended question during the pre-test.

In addition to the pre-test survey were held to determine initial bids in terms of cash using open-ended contingent valuation format. As a result, 15, 20, 25, 30 and 40 Ethiopian Birr per month followed by closed ended questions (upper and lower bids) were used as a starting bid for the actual survey. After the bids were designed, the respondents were asked a yes/no question to elicit their willingness to pay. If his/her answer was yes, the next higher amount was asked to state their answers.

Finally, the respondents were asked their maximum willingness to pay. If his/her answer was no, the next minimum amount followed by open-ended question was also employed to solicit his/her maximum amount. The main survey was conduct for the first four consecutive weeks in the month of February, 2022.

2.3.2 Key Informant Interview

The key informants (KIs) in this study were individuals who had good knowledge and information about the biophysical and socioeconomic conditions of the area and who were native to the area. Hence, the elderly, local leaders, sanctuary police, religious leaders, experts and the coordinator of sanctuary. It was important to get an overview of the sanctuary's benefits. To guide this interview, a checklist of the relevant questions was used to get deep information and cross check the collected data.

2.3.3 Focus Group Discussion

To gain qualitative information, the researcher undertook focus group discussion for data collection tools to generate qualitative information on the issue. The FGD involved 36 households. The method aims to obtain data from a purposely selected group of individuals rather than from a statistically representative sample of a broader population. There were five FGD and discussants included six-eight persons in one group, such as community sanctuary police' in one group, religious leaders in one group', women in one group, local elders in one group and landless young people in one group that were not included in the household survey and key informant interview when resident in the kebeles.

2.4 Questionnaire Design

The survey questionnaire comprises of three parts. The first part is about demographic and Socio-economic information like sex, age, marital status, family size, and level of education. In the second part of the questionnaire attention is given to obtain information on respondents' awareness and opinions about Senkele Swayne's Hartebeest Sanctuary area. Finally, the third part deals with the valuation scenario to elicit respondents willingness to pay for restoration and conservation program.

2.5 Contingent Valuation Scenario

Contingent valuation method (CVM) in the form of double bounded dichotomous choice elicitation method [14] with open-ended follow-up question were also employed to explore households' WTP for restoration and conservation of Senkele Swayne's Hartebeest Sanctuary area. The double-bounded

dichotomous choice format (yes-no, no-yes responses) [15] makes clear bounds on unobservable true WTP and the yes-yes; no-no response closely the true WTP ([14]. The double-bounded dichotomous choice format also helps to elicit more information about respondents WTP than single bounded format [15].

Bid design scenario

The payment vehicle were a monthly conservation fee to be paid to the area[16], based on the scoping pre-test survey birr 15, 20, 25, 30, and 40. Using these initial bids, sets of bids were determined for follow-up questions based on whether the response is “no” or “yes” for the initial bid. If the respondents were willing to take the offered initial bid, the follow-up bids were 20,25, 30, 40, and 45 birrs; in case of a “no” response to the initial bid; the follow-up bids were 10,15, 20, 25, and 30 birrs respectively(table 2).

Table :- 2 Bid design scenario

Lower second bid (LSB)	Initial bid (IB)	Upper second bid (USB)
10	15	20
15	20	25
20	25	30
25	30	40
30	40	45

2.6 Method of Data Analysis

The data analysis and interpretation ware conducted through a predominant qualitative and quantitative (descriptive statistics and econometric) method. Qualitative data from key informant interview and focus group discussion were analyzed through careful translation and narrating in to text form. The descriptive statistics and econometric model tools are outline and discussed as below.

2.6.1 Descriptive Analysis

The quantitative data of this study was analyzed using descriptive statistics because important to have a clear picture of the characteristics of the sample size. Descriptive statistics tools such as frequency, mean, percentages. Chi-square test and independent t-test were used to test and compare the significance of the discrete and continuous variables with the support of statistical package for social studies version 20 ($SPSS_{20}$), Excel and Stata version 14.2.

2.6.2 Econometric Model Specification

2.6.2.1 Econometric Estimation of Mean Willingness

With two binary responses (WTP1 and WTP2), it is impossible to use the conventional probit or logit model to estimate these two equations simultaneously. Thus, a seemingly unrelated bivariate probit, which simultaneously estimates the initial and follow-up bid equations, becomes an appropriate econometric model. Estimation of mean WTP using such a model could lead to a more statistically efficient WTP estimation. A study by[17] also used that, when there is inter dependence between the two responses, which is manifested by the significant correlation coefficient (Rho) ($\rho < 0.88$), seemingly unrelated bivariate probit could be the appropriate econometric model to estimate the mean WTP. Therefore, seemingly unrelated bivariate probit was employed to estimate households' mean WTP for the protection of SSHS. According to[18], there are four possible outcomes in the double bounded dichotomous choice elicitation method with their probability:

$B_1 < WTP < B_2$: Pr (Yes, No) = Pr ($\mu_1 + \varepsilon_{1j} \geq B_1, \mu_2 + \varepsilon_{2j} < B_2$)-Eq. 2

$B_1 > WTP > B_2$:Pr (No, Yes) = Pr($\mu_1 + \varepsilon_{1j} < B_1, \mu_2 + \varepsilon_{2j} > B_2$) -Eq. 3

$WTP > B_2$: pr(Yes, Yes) = pr($\mu_1 + \varepsilon_{1j} > B_1, \mu_2 + \varepsilon_{2j} \geq B_2$) –Equation 4

$WTP < B_2$:pr(No,No) = pr ($\mu_1 + \varepsilon_{1j} < B_1, \mu_2 + \varepsilon_{2j} < B_2$)-Eq. 5

Where, B_1, B_2 and WTP are initial bid, second bid amount and WTP amount for the follow-up question, respectively. According to[19] seemingly unrelated bivariate probit model can be specified as follows:

$Y_1 = \alpha_1 + \beta_1 B_1 + \varepsilon_1$ ..... Eq. 6

$Y_2 = \alpha_2 + \beta_2 B_2 + \varepsilon_2$ ..... Eq. 7

$$Y_1 = \begin{cases} 1 if Y1* \geq B1 \\ 0 if Y1 * B1 \end{cases}$$

$$Y_2 = \begin{cases} 1 if Y2* \geq B2 \\ 0 if Y2 * B2 \end{cases}$$

Corr ($\varepsilon_1, \varepsilon_{2/} B_1, B_2$) = ρ

where, Y_1 and Y_2 are WTP responses for the first and second equations, respectively, B_1 and B_2 are the bid in the first and second bid questions, α_0 s and β_0 s are parameters to be estimated and ε_1 and ε_2 are unobservable random components and correlation coefficient ρ, is the covariance between the errors for the two WTP function.

Therefore, the mean WTP was calculated by using the coefficients from the constant term and the bids offered.

These coefficients were obtained by regressing the dependent variables (WTP1 and WTP2) on the initial and follow-up bid amount holding other explanatory variables constant [14].

Thus, mean WTP was calculated by using the formula:

MWTP= - α/ β …... Eq. 8

Where, α is a coefficient for the constant term, β is a coefficient offered bids to the respondents.

2.6.2.2 Determinants for the Probability Decision and Intensity of WTP

One of the main objectives of this study was to investigate determinants of households' WTP decision and its intensity. Therefore, sampled households are expected to make two sequential decisions on WTP (willing or not willing to pay) (binary outcome) and then the amount of maximum WTP (continuous outcome). In this case, the first decision (WTP) indicates the households' willingness to pay for the proposed conservation. Whereas, the maximum WTP amount is the final amount that households are willing and able to pay for the conservation. When the dependent variable has a continuous nature, multiple regression such as Ordinary Least Squares (OLS) can be used for the analysis[20]. On the other hand, for dummy dependent variable (WTP) binary probit and logit models allow for estimating the probability of WTP for sanctuary conservation given some relevant demographic, economic and institutional factors[21, 22].

Under the two sequential decisions, the dependent variable has continuous value for those who are willing to pay and zero for those who are not. Here, the nature of the data is a censored form i.e., some observations on the outcome variable are not observed as long as they do not pass a certain threshold. In this case, all values below or equal to zero were limited to zero and the only observable are the corresponding values of the independent variables. Thus, using OLS models in the case of censored data sets makes OLS estimates biased and inefficient, and Best Linear Unbiased Estimator (BLUE) does not hold[21, 23].

In this case, Heckman two-stage, Tobit and Double hurdle models can be used for limited dependent variables but for different reasons. Thus, to identify the model that best fits, different econometric models were fitted. First, Heckman two-stage model was fitted if there is selectivity bias but the Mill's ratio or lambda was not significant and analyzed different independents variables from first stage. Therefore, using the Heckman selection model become irrelevant for the thus study. Hence, selection of appropriate model was made between Tobit and double hurdle models using a method called likelihood ratio (LR) test statistics. Using the procedure followed by[23] the likelihood ratio (LR) test statistics Γ was computed as:

$\Gamma = -2[\ln L_{tobit} - (\ln L_{probit} + \ln L_{truncated})] \sim \chi^2_k$ …… Eq. 9

Where, Γ = likelihood ratio statistic; ln = natural logarithm; LTobit, LProbit and LTruncated are likelihood values for Tobit, probit and truncated regression models, respectively, χ2 = Chi-square statistic and k is the number of independent variables in the equations.

Based on Eq. (9), the value of likelihood ratio statistic (Γ) (293.42) was greater than the value of the chi-square statistic (291.82) at 11 degrees of freedom. This indicates the superiority of the Tobit model over the double hurdle model. Hence, factors that influence the probability of households' WTP determine in probit and its intensity can be determined separately in the Tobit model. This model allows in modeling the decision process in two steps. First, households decide on willing to pay for the conservation (WTP decision) and then they decide the maximum amount they can contribute (intensity decision). Therefore, the first decision was specified using probit model as follows:

$WTPi^* = \alpha + \beta' X_i + u_i$ .....Equation 10

$$WTPi^* = \begin{cases} 1 if WTP^* > 0 \\ 0 otherwise \end{cases}$$

Where WTPi is a dummy variable that takes the value 1 if the household head is willing to pay for the conservation intervention and zero otherwise; Xi is a vector of household characteristics and α is a vector of parameters.

$WTPi = \alpha + \beta_1 SEX + \beta_2 AGE + \beta_3 EDUC + \beta_4 MSTA + \beta_5 TLU + \beta_6 DIST + \beta_7 LARE + \beta_8 BECS + \beta_9 SP + \beta_{10} Initial\ bid + \varepsilon_i$ ……Eq. 11

In the second Tobit model, [24] "what are the factors that influence households maximum willingness to pay for the conservation and restoration Senkele sanctuary." was specified as follows:

$MaxWTP_i^* = \beta_0 + \gamma' X_i + \varepsilon_i$ .....Eq. 12

$$MaxWTPi^* = \begin{cases} 1 if MaxWTP^* > 0 \\ 0 otherwise \end{cases}$$

Where, $MaxWTP_i^*$ is household unobserved maximum willingness to pay for restoration and conservation of Senkele sanctuary, $MaxWTP_i$ represents the maximum amount that households are willing to contribute; Xi is a vector of the individual's characteristics and βo; γ is a vector of parameters.

$MaxWTPi = \beta_0 + \beta 1\ SEX + \beta 2 AGE + \beta 3 EDUC + \beta 4 FSIZE + \beta 5\ TLU + \beta 6 DIST + \beta 7 LARE + \beta 8 PIEC + \beta 9 MNFOODE + \beta\ 10\ NONFINCOME + \beta\ 11 FINCOME + \varepsilon i$ ……Eq. 13

Then coming to our specific situations with a list of explanatory variables,

These variables are selected because of most of the time the household's decision regarding willingness to pay for conservation and restoration is affected by these variables.

The probability and intensity of WTP for the conservation are contingent on the household-specific variables. For instance, variables like age, education level, distance from the sanctuary, contribution of the sanctuary to a given household, income source, family size, etc., can influence the households' WTP decision and its payment intensity. Thus, the independent variables for this study were those determinants, which were hypothesized to have an association with the WTP and its intensity. In this study, demographic, socioeconomic and institutional factors are selected based on empirical reviews, prevailing theoretical explanations and prior knowledge about the households in the study area.

Before including the hypothesized variable and running the model analysis the existence of a serious of multi-collinearity or highly degree of association problem among independent variables for all continuous and discrete variable were tested. The check for multi-collinearity checks whether or not any perfect linear relationships between the explanatory variables. However, multi-collinearity tough is the presence of a "perfect" or exact, linear association amongst some or all explanatory variables of a regression model [21].

In order to test the existence of multi-collinearity problem, VIF (Variance Inflation Factor) is utilized for continuous variables while contingency coefficient (CC) for dummy variables. As a rule of thumb for multi-collinearity, check the model states a variable whose values are more than 10 or whose 1/VIF value is less than 0.1 shows feasible problem of multi-collinearity. Collinearity coefficient is chi-square based totally degree of association. A cost of 0.75 or extra shows the more potent relationship[25].

Correlation matrix examines the extent or direction of relationship among two variables and the way one variable is associated with another. Correlation matrix also indicates multi-collinearity [21]. Multi-collinearity problem when the correlation result is above 0.80 and below − 0.80. Cheek goodness-of-fit test for probit model by link test, then done Hosmer-Lemeshow chi2 test when prob > chi2 > result is more than 0.05 (5%) it is the model is good fitted model.

2.7 Description of Variables and Working Hypothesis

WTP

WTP is defined as the maximum amount of money the individuals are willing to pay for restoration and conservation of Senkele Swayne's Hartebeest Sanctuary. It is dependent and a dummy variable takes the value of "1" for the households willing to pay for the proposed bid, otherwise, "0" non- willingness to pay (table 3).

Maximum Willingness to pay

- it is the dependent variable for the Tobit regression model analysis in identifying determinants of the stated maximum WTP amount. In this study, respondents who refused to pay the given initial bid were also asked to specify their maximum amount. If the answer for the double bounded dichotomous choice was yes, the maximum WTP would not be lower than the proposed bid value. If the answers were no, the

maximum WTP must be lower than the assigned initial bid value and also may be the second lower bid value.

Independent variables

Based on the findings of past studies, the following variables are hypothesized to determine the household's WTP in Senkele Swayne's Hartebeest Sanctuary (table 3).

Table :-3 Definition and expected effect of variables.

Variables	Explanation	Measurement	Expected sign.
Dependent Variables			
WTP	Respondent's willingness to pay for the proposed Change, Dummy variable.	1 = Yes 0 = No	
Max WTP	Amount of payment (**intensity)**	Continuous	
Independent Variables			
SEX	Sex of respondent is a dummy variable	1 = male 0 = female	+/-
AGE	Age of head of the family, continuous variable	Year	+/-
EDUC	Education level of the respondent is continuous Variable.	Year	+
FSIZE	Size of the family, continuous variable	Number	+/-
MSTA	Marital status of respondent, categorical variable.	1 = single, 2 = married, 3 = divorces, 4 = windowed	-
DIST	Distance of the conservation area from the residence, continuous variable	Minute	+/ -
LARE	Total area of land owned by household's head, continuous variable	Hectare	+
PIEC	Participation in environmental conservation, dummy variable	1 = participate 0 = if not	+
TLU	livestock holdings converted to tropical units, continuous variable	Convert in to tropical livestock unit	+
MNonFincome	Monthly non-farm income of households ,continuous variable	ETB	+
BECS	Benefit from existing conservation service, dummy variable.	1 = beneficiary0 = not direct beneficiary	+
MNFoodE	Monthly non-food expenditure of households ,continuous variable	ETB	-
SP	Social position, a dummy variable	1 = yes 0 = no	+
FIncome	Annual income of the household this, a continuous variable	ETB	+
Initialbid	Offered bid price to the respondent, continuous variable.	Bid value in ETB	-

3. RESULTS AND DISCUSSION

From the surveyed households, 54 of them were not willing to pay the offered bid for sets. From these, the 49 responses were collected as a valid zero in the data set for further analysis. Whereas, the 5 responses were protest zero were excluded from the data set. Hence, 175 valid responses were used for further analysis.

3.1 Socio-economic Characteristics of Respondents

Socioeconomic characteristics of sampled households from the surveyed (valid responses) households, 126(72%) of them were willing to contribute in favour of the conservation intervention, whereas 49 (28%) of them were not willing for the proposed intervention for various reasons (table 4). In this regard, the household's decision to accept or reject the offered bid amount is found to be a function of many socio-economic and demographic characteristics. Hence, the relationship between these factors and households' WTP is presented below.

3.1.1 The Relationship between Discrete Variables and WTP Decision

Sex of the household head

From the total surveyed household heads, 71(40.6%) were female respondents, while 104(59.4%) were males. As indicated in table 4, of the 175 total sampled households, about 49(28%) were not willing to pay the randomly pre-specified bid value and 126 (72%) households were willing to pay the pre-specified bid value. Of the 49 total households non-willing to pay the specified bid value, 28(57.14%) were female-headed and 21(42.86%) were male-headed. On the other hand, from the 126 total households willing to pay the initial specified bid, about 43(34.13%) were female-headed households and 83(65.87%) were male-headed households. In table 4 below, the value chi square ($\chi 2$) indicates that there was a significant difference in willingness to pay status for sanctuary conservation between female-headed and male-headed households at less than 5% probability level. This underlines that sex difference is an important component in willingness to contribute to decisions.

Marital status of the respondent

As indicated in table 4, out of 175 total sample households interviewed, 101(57.7%) were married, 40(22.9%) unmarried, 25(14.3%) divorced and 9(5.1%) were widowed household heads. Out of the 101 total married household heads, 79(78.2%) were willing to pay the pre-specified bid while the remaining 22 (21.8%) were not willing to pay. In the chi-square test indicated, there is a 5% significant difference between martial statues of willing and non-willing participants in a sanctuary conservation program.

Table :-4 The relationship between discrete variables (dummy) and WTP decision

Variables		WTP		Non-WTP		Total (N = 175)		χ2 value	p-value
		(N = 126) 72%		(N = 49)28%					
		N	%	N	%	N	%		
Sex	Male	83	65.87	21	42.86	104	59.43	8.654	0.003*
	Female	43	34.13	28	57.14	71	40.57		
Marital status	Married	79	62.7	22	44.9	101	57.7		
	Single	23	18.25	17	34.69	40	22.86		
	Divorced	19	15.08	6	12.24	25	14.29	15.497	0.004*
	Windowed	5	3.96	4	8.16	9	5.14		
Participation on voluntary environmental soil and water conservation	Participant	89	70.63	16	32.65	105	60		
	non-participant	37	29.37	33	67.35	70	40	19.598	0.000*
Direct Benefit from SSHS	direct benefit	99	78.57	31	63.27	130	74.29		
	non-direct benefit	27	21.43	18	36.73	45	25.71	3.26	0.07
Social position	Yes	36	28.57	11	22.5	47	26.86	11.042	0.001*
	No	90	71.43	38	77.5	128	73.14		

* show 5% significant probability levels N = frequency, %= percent Source: Own survey result, 2022

Participation in voluntary environmental soil and water conservation

The respondents' answers on participation in any voluntary environmental conservation total 105 (60%) of respondents made their own contribution. The remaining 70 (40%) of respondents were not participant in voluntary environmental soil and water conservation around SSHS. In the chi-square test indicated that there is 5% level of probability significant difference between participation on environmental conservation of willing and non-willing participant (table 4).

Benefit from existing conservation service

Based on respondents' answers on direct benefit from existing sanctuary (BES), 130 (74.29%) of total respondents were direct benefit from existing sanctuary. The remaining 45 (25.71%) did not assume direct benefit from the existing sanctuary SSHS. Depending on respondents' assumption, direct benefit is direct grazing their livestock. The other remaining benefits were indirect benefits like thatcher for housing lids and job opportunities for family members and as a material and source of income for wicker work

and selling them to female students. The value of chi-square ($\chi 2$) in table 4 indicates that there was no significant difference between household heads who had benefits and those who did not have regard to willingness to pay for programs.

Social position of household head

In total, 47 (26.86%) respondents a share of different social positions to 36 (28.57%) and 11(22.5). Remaining 128 (73.4%) was not any big social position. In the chi-square test indicated, there is a 5% probability of significant difference between participants' positions of willing and non-willing participants (table 4).

3.1.2 The Relationship between Continuous Independent variables and WTP Decision

Age of the household head

Where the average respondent age wiling household heads is found 42.65 and non-willing is found 44.75. But as the summary statistics in the table 5 below reveals, the mean age difference between willing and non-willing households was not statistically significant.

Education

From 175 respondents, 36 (20%) do not attend any regular education. The average year of households stay in school the willing and non-willing 6.56 and 1.96 years respectively. The respective independent t-test results show that the difference in mean years of education between the willing respondents and the non-willing ones is statistically significant at a 5% level (table 5).

Family size

The average household family size was 6.72 with a minimum of 2 and a maximum of 16 household members per household. The sampled willing households had a mean family size of 6.57 people and that of the non-willing households had a mean family size of 6.87 people. However, the statistical result of t-value shows that the mean difference in family size between willing and non-willing respondents was not a significant influence on their willingness status for the senkele sanctuary conservation program (table 5).

Livestock holding

The number of livestock owned was converted into tropical livestock. The data shows that on average a household owned about 4.83 and 2.93 tropical livestock units for non-willing. The independent sample t-test shows that there was significant difference between the average tropical livestock units of willing and non-willing at 5% of probability. This result shows that the mean livestock availability difference

brings a willingness status difference among respondents and hence, is an important variable for willingness to pay decision for the proposed sanctuary conservation program (table 5).

Land area

The total land holding size of the sampled households was estimated at 2.6 hectare with average for willing respondents and 1.53 ha for non-willing respondents. The independent sample t-test shows that, there was significant difference between the average total land size of willing and non-willing at 5% of probability (table 5). This implies that, when sufficient size of land holding is the basic requirement for good income. It could be thus expected that the farmers who have larger farm size would have got higher income from the practice than those of small farm size. Respondent's land area directly related to the WTP for Senkele sanctuary restoration and conservation.

Table :- 5 The relationship between continuous independent variables and WTP decision

Variable	WTP (72%;N = 126)		Non-WTP(28%;N = 49)		Total mean	t-valve	P-value
	Mean	Std. Dev.	Mean	Std. Dev.			
Age	41.65079	11.51578	44.7551	11.25561	42.5	1.42	0.158
Education	6.563492	3.827262	1.959184	2.318038	4.6	-9.414	0.000*
Family size	6.571429	3.25067	6.877551	2.697473	6.7	0.734	0.464
Livestock holding	4.839762	1.367023	2.927245	1.4909	4.3	-7.728	0.000*
Distance	7.075397	7.468619	20.91837	9.499094	10.9	8.787	0.000*
Total land size	2.55459	1.28715	1.532302	0.87936	1.8	5.077	0.000*
Monthly NFE	1041.984	746.185	978.1429	737.0339	1024.1	-0.382	0.703
Monthly Non-farm income	991.9048	361.2328	410.2041	212.3724	829.02	-12.89	0.000*
Annual On-farm income	11559.81	6572.54	6205.408	3555.611	10060.	-6.937	0.000*

N = frequency, %= percent, NFE = non-food expenditure * show 5% significant probability levels, Source: Own survey result, 2022

Distance of the homestead from the protected area

Distance of the homestead from the sanctuary which expressed in minutes of time taken from survey data the average time (minutes) to reach the sanctuary is close to 7.1 minutes for willing respondents and 20.9 minutes for non-willing respondents with 1 minute minimum and 40 minute maximum. The independent sample t-test shows that, there was significant difference between the average distance of

willing and non-willing at 5% of probability (table 5). This implies that, when households far from sanctuary less participate on conservation of sanctuary.

Annual Farm income of the household

The majority of the households were agricultural dependent, such as crop production and animal rearing, with average annual net income of willing 11559.81 ETB and non-willing 3555.611 ETB. The independent sample t-test shows that, there was significant difference between the average annual agricultural income of willing and non-willing at 5% of probability (table 5). This implies that income plays a great role in the willingness to pay of households for the hypothetically designed sanctuary conservation program.

Monthly Non-Farm income

The respondents wore monthly non-agricultural income such as from motor transport, petty trade and seasonal labor and others, with an average of 991.9 ETB for willing and 212.4 ETB for non-willing respondents. The independent sample t-test shows that there was significant difference between the average monthly non- agricultural income of willing and non-willing at 5% of probability (table 5). This implies that non-farm income plays a great role in the willingness to pay of households for the hypothetically designed Senkele sanctuary conservation program.

Monthly non-food expenditure

With regard to the average monthly household's expenditure (Non-food household expenditures) of 1041.984 ETB for willing respondents and 978.1 ETB for non-willing respondents per month (table 5). However, the statistical result of t-value shows that the mean difference in monthly non-food expenditure between willing and non-willing respondents was not a significant influence on their willingness for the sanctuary conservation program.

3.1.3 Contribution of Senkele Swayne Hartebeest Sanctuary for Local Community

As data on the value of biodiversity and ecosystem services has become more widely available, and increasingly incorporated into financial and economic analyses, these surveys were beginning to be used to justify protected area budgets as part of development spending, and to make a case for investment in sanctuary for poverty reduction. People's access to these environmental goods and services and the concrete contributions that they make in bringing people out of poverty, still needs to be properly measured and better understood(table 6).

Table :-6 Contribution of sanctuary for local households

Rank	Fodder production and grazing		Thatching the grass		Fire wood collection and collecting medicinal plant		Wild life view and other	
	N	%	N	%	N	%	N	%
1st	155 [1st]	88.57	9	5.14	7	4	4	2.29
2nd	5	2.9	140 [2nd]	80	11	6.3	19	10.86
3rd	10	5.7	11	6.3	151 [3rd]	86.3	3	1.7
4th	5	2.9	15	8.57	6	3.43	149 [4th]	85.14
Total	175	100	175	100	175	100	175	100

N = frequency, %= percent, $_{1, 2,3\& 4}$ rank of contribution in order Source: computed from survey data

As table 6 indicated, respondents benefit from the Senkele sanctuary displayed in the majority of sample households were said to benefit from a lot of resources from the sanctuary, which includes that the local farming community uses the SSHS for various purposes such as for grazing, fodder production, grass for house construction (thatching the grass), and wild life view, fire wood grazing and collecting medicinal plants. Likewise, based on respondents, ranked, were benefited ranked first fodder production and grazing, 2nd thatching the grass for house construction, 3rd fire wood grazing and collecting medicinal plant and 4th wild life view and others use.

3.1.4 Major Causes of the Reduction of Senkele Swayne Hartebeest Sanctuary Area Cover

Deforestation and deterioration of sanctuary covers directly or indirectly result in various environmental, economic and social problems in places where it occurs. To mention few, there will be limited rainfall, water points, loss in biodiversity, soil erosion as a result of which productivity falls. A fall in productivity of land in rural communities whose livelihood is almost entirely based on farming causes a fall in income which consequently results in various social problems (table 7).

Table :-7 Sanctuary area cover reduction problems

Rank	Demand for grazing and fire wood collection		Natural and man-made fire		Limited rainfall and shortage of water		Destroyed wild life because of resource conflicts	
	N	%	N	%	N	%	N	%
1st	151 [1st]	86.3	5	2.9	10	5.7	9	5.1
2nd	13	7.4	20	11.4	137 [2nd]	78.3	5	2.9
3rd	9	5.14	92 [3rd]	52.6	18	10.3	56	32
4th	2	1.14	58	33.1	10	5.7	105 [4th]	60
Total	175	100	175	100	175	100	175	100

N = frequency, %= percent, [1, 2,3& 4] rank of problems in order of severity, Source: computed from survey data

The first ranked some of these uses demand for grazing land and fire wood collection ,like tree cutting to make household charcoal, utensils firewood collection are environmentally unsustainable. Taking this into account and in the interest of identifying the most important degrading factors, respondents were asked to rank the various factors responsible for degradation and deforestation of the sanctuary. This indicates that households in the study area, as in other areas of Ethiopia, depend on fire wood for their energy needs, which is destructive to natural forests in sanctuary.

The second most degrading problem is limited rainfall and shortage of water. The local households have no facility to clean water and thus use water for drinking, cooking, animal watering and other home consumption. The survey result reported in table 7 shows limited rainfall is the most critical environmental problem the local people are suffering from. Based on FGD and KII ideas, limited and seasonal rain also negatively affects productivity and makes life more uncertain, particularly for the farming community and loss of biodiversity.

The 3rd main sanctuary problem is natural and manmade fire. Locals intentionally burn the sanctuary to convert old grass into new grass. Illegal fire has been overwhelmingly clearing the grass. This problem is ranked 3rd because respondents believe that the sanctuary regenerates very soon after the fire stops.

The 4th main environmental problem is destroyed wildlife because of resource conflicts. Hyena predation occurred both inside and outside SSHS, which predated cattle, goats, sheep, donkeys and horses. Based on FGD and KII ideas, grazing does not kill the Swayne's Hartebeests and other co-inhabiting wild animals directly. However, it is very difficult for Swayne's Hartebeests and other grazing wild animals to compete with several thousand cattle roaming in the sanctuary. This can be considered as indirect poaching for the Swayne's Hartebeests and other grazing animals in the sanctuary. The noise made by the people and the livestock inside the sanctuary was anxious for the wild animals.

3.2 Response Patterns of the Double Bounded Dichotomous Choice

In the double-bounded dichotomous choice (DB-DC) elicitation method, the response patterns inclined towards the two extremes of “Yes -Yes” and “No – No”. As table 8 depicts, majority (58.28%) of the sampled households accepted both the initial and follow-up upper bids. On the other hand, 13.72% of them rejected both bids offered. In between these extremes, 21.71% and 14.29% of the responses in the DB-DC elicitation method were “Yes- No” and “No-Yes”, respectively. In agreement with the finding of[26], such a high level of acceptance of the offered bids signifies that most of the sampled households have an interest to participate in the conservation sanctuary.

Table :-8 Patterns of WTP response for the two offered bids

Possible outcome	Frequency	%
Yes – Yes	88	50.28
Yes – No	38	21.71
No –Yes	25	14.29
No – No	24	13.72
Total	175	100
Source: Own survey result, 2022		

“Yes-Yes” and “No –No” are if respondents accept or reject all the offered bids, respectively. The others are if the respondents accept either the first or the second bid, which is mostly the lower, and reject the other (the higher).

3. 3 Reasons for Accepting or Rejecting the Offered Bids

Households' decision to accept or reject the offered bids is contingent on different demographic and socioeconomic factors. Deforestation and deterioration of sanctuary covers, directly or indirectly result in various environmental, economic and social problems in places where it occurs. To mention a few, there will be limited rainfall, drying up of springs and water points, loss in biodiversity, flooding and soil erosion as a result of which productivity falls.

A fall in productivity of land in rural communities whose livelihood is almost entirely based on farming causes a fall in income which consequently results in various social problems. Limited rainfall is the most critical environmental problem the local people are suffering from. Limited and seasonal rainfall negatively affects productivity and makes life more uncertain, particularly for the farming community.

The local households have no facility to clean water and thus use water for drinking, cooking, animal watering and other home consumption.

Protection from human and animal intervention, plantations and teaching the local community to raise environmental awareness were suggested solutions by the respondents to restore or maintain the sanctuary. Moreover, during FGD, one of the, discussions stated as follows, “The local community has a long lasting history of conservation and protection of SSHS”. During the downfall of the Dorgue regime, Imam Worana was Aba Geda of this area. During the Dorgue regime, the Sanctuary was protected by military forces. Aba Geda assumed Swayne hartebeest to his tribe Anbentu. So they agreed that someone who kills Swayne hartebeest was considered as killing a person of the Anbentu tribe. Thus, he/she had to punish 100 cattle, the same as the one who killed one person of the Anbentu tribe by the law of Guma.

Therefore, communities refrain from killing wildlife. So, currently the population of Swayne hartebeest is estimated to be about 800. Hence, the Swayne hartebeest is our heritage and to conserve for the next generation as Imam Worana contributed to the survival of this species from extinction.

There are variety of bird species and the presence of different wild mammal species. However, foreign and domestic tourist flow to this site is very limited by different factors. To investigate the main factors accountable for limited recreational experience at the site, respondents were asked to prioritize these problems. Accordingly, FGD and KII indicated that problem of infrastructure such as electricity, road, regular transport and clean water, is the main reason for limited tourist flow and recreational experience. Resting facilities like hotels and lodges were reported as the second main problem which hindered tourist flow and stay in the site. FGD and KII indicated that limited advertisement of the site as a historical place and recreational amenity as one of the constraining factors.

FGD and KII indicated the existence of sanctuary in their area as local identity which indicates their positive attitude toward Sanctuary. However local community access to the sanctuary especially for grazing due to lack of alternative grazing land not to destruct Sanctuary. Majority of surrounding households have high number of cattle which is 10–20 in average. As data shows the size of land that respondent’s holding is small. Household survey indicates majority of local community depend on sanctuary for livelihood particularly for grazing.

As summarized in table 9, the sampled households accept were willing to contribute in favour of the proposed conservation activity. These willing households had different reasons or motivations to pay for the program and most of them (56.34) were motivated to fodder for livestock grazing, and grass for house construction, (35.73%) for job opportunity for family members and as material and source of income by wicker work and sell them for female students.

In addition, the sanctuary is a good source of fodder, thatch and different grass species locally called Sindedo and Sebez that used as wicker work. In this regard, the FGD and key informant interview also indicate that the harvested Sindedo and Sebez is a good source of cash income for students, landless youths and for most female-headed households. These individuals sold Sindedo and Sebez two times

per week with an average of 50 ETB per sell. Besides the existing benefits, these households are motivated to support the conservation activity in order to enhance the potential future benefits after implementation of the protection. The remaining households also support the mainly to conserve such important sanctuary and bequeath for the next generation (7.93%). All these magnify how households in the study area are dedicated to the conservation of Senkele sanctuary. Currently access to the sanctuary is medium and local people mainly extract benefits like fire wood, grass for house construction, grazing and fodder and medicinal plant from sanctuary.

Table :- 9 Motivations for accepting the offered bids

Reasons for maximum WTP	Frequency	%
Fodder for livestock, grazing and grass for house construction.	71	56.34
Job opportunity for family members and as material and source of income by wicker work and sell them for female students.	45	35.73
Wild life view and to sustain it for future generation and medicinal plant.	10	7.93
Total	126	100
Source: Own survey result, 2022		

The majority of respondents, KII and FGD said we are motivated for pay more to that solved problem of clean water for both local community and sanctuary animals' consumption. However, households might reject the offered bids either from their protest or from genuine behavior (table 10).

Table :- 10 Reasons for rejecting the offered bids

Reasons	Frequency	%
Valid zero bidder		
(i) I do not have extra income but otherwise would contribute for sanctuary conservation	25	46.27
(ii) I satisfied with the existing situation of sanctuary	24	44.43
Protest Zero bidder (Rejection of contingent market)		
(i) It is the government's responsibility or I don't care	5	9.3
Total	54	100
Source: Own survey result, 2022		

Accordingly, 9.3% of the non-willing households were protest zero bidders and the remaining were genuine zero. For the genuine zero responses, their main reasons for rejecting the offered bids were their financial constraint and satisfaction with the current state of the sanctuary. On the other hand,

households protest the payment for conservation activity with the reasons of “it should be the government's responsibility” and mistrust on budget allocation during implementation in the future. They are interested if government supports them and allowed free access to grazing assumes non-willing households.

3.4 Application of Econometric Models and Its Estimates

3.4.1 Determinants of Household's WTP Decision

Apart from descriptive analysis, econometric analysis was used to present the major determinants of households willingness to pay and to estimate the coefficient of socio-economic variables that affect households willingness to pay for sanctuary conservation and restoration. Before running the econometric model[27] the independent variables were tested for the presence of multi-collinearity. The result showed that there were no multi-collinearity problems between the variables less than 0.8. The explanatory variables were checked for multi-collinearity and the degree of association through Variance inflating factor (VIF) and Contingency coefficient (CC). Based on the VIF, the data had no serious problems of multi co linearity. That is, the VIF of the continuous variables was less than 10 and 1/VIF also greater than 0.1so, that all the continuous variables were part of the regression analysis. The extent of association between dummy variable was also computed using coefficient. The value of Contingency Coefficient in for the dummy variables was less than 0.75. The analysis shows that there is weak association between the dummy explanatory variables. Therefore, all the dummy variables were included in the regression analysis.

Estimated results of the binary probit model are reported based on the theoretical model that has already been developed in chapter three. The model was used to examine whether WTP for sanctuary conservation of surveyed households is related to the explanatory variables or not. A total of 10 explanatory variables were considered in the econometric model out of which five variables were found to significantly influence the probability of willingness to pay among the farm households at less than 5% probability level.

The result shows that the probability of the Chi-square ($\chi 2$) distributions is 176.64 indicating the significance of the binary probit model in explaining the determinant of willingness to pay for conservation of Senkele sanctuary fits the binary probit model and cheek goodness-of-fit test by link test then done Hosmer-Lemeshow chi2 test when prob > chi2 > result is more than 0.05 (5%) it is the model is good fitted model when the result is 0.9991.

The estimate result of factors affecting the households WTP for sanctuary conservation and restoration is presented in (table 11).

In the determinants of willingness to pay estimation of the binary probit model, the non- significant explanatory variables were less important in explaining the variability in the willingness to pay in sanctuary. Thus, in this study only the significant explanatory variables were discussed below. However, it

is noticed that the non-significant variables have also contributed to the log likelihood function of the binary probit model.

Education level of the respondent (EDUC):- Education of the household head is also statistically significant at 1% level of significance. An expected education had a positive relationship with WTP. That means household heads with higher education levels were more likely to state positive WTP, and on average, they actually stated higher conditional and unconditional WTP than household heads with lower educational levels. This result suggests that investing in the resources of people might help to restore resources in the degraded environment. Keeping the influences of other factors constant, the marginal effect of the result shows that the household head increasing formal education increase by one year, the probability of willingness to pay for sanctuary conservation and restoration increases by 0.41%. Respondents with higher levels of education had a better understanding of environmental management and relatively knew more about the negative impact of natural resource degradation. The result agrees with the work of [10, 17].

Table :-11 Coefficients and marginal effects result of the binary probit model

Number of obs = 175

LR chi2 (10) = 176.64

Prob > chi2 = 0.0000

Pseudo R2 = 0.8511

Log likelihood = -15.44671

Variables	Coef.	Std. Err.	Z	P > z	MFX dy/dx
Sex	0.40805	0.56144	0.73	0.467	0.00659
Age	-0.0027	0.02294	-0.12	0.907	-0.0004
Education	0.29278	0.09489	3.09	0.002**	0.00413
M status	-0.0842	0.31555	-0.27	0.790	-0.0012
Livestock holding	0.71921	0.26716	2.69	0.007**	0.01014
Distance	-0.0485	0.01814	-2.67	0.008**	-0.0007
Land area	0.66566	0.23685	2.81	0.005**	0.00934
Benefit from conservation service	0.56648	0.6192	0.91	0.360	0.01205
Social position	0.56023	0.66877	0.84	0.402	0.01023
Initial bid	-0.2241	0.05721	-3.92	0.000**	-0.0032
_cons	4.77767	2.50951	1.9	0.057	

y = Pr (wtp) (predict) = .99513996 dy/dx = is for discrete change of dummy variable from 0 to1, ** and * shows significant variables at 1% and 5% probability levels respectively.

Source: Own survey result, 2022

Distance of the homestead from the protected area (DIST)

In line with the prior hypothesis, as the distance from home to the sanctuary increases by one minute of walk, the probability of participation for willingness to pay in favor of the conservation of sanctuary decreases by 0.07%, keeping the influences of other factors constant. As expected, this variable showed a negative relationship with the WTP for sanctuary conservation and is statistically significant at 1%. This is because the farther the family residence and the more inaccessible the benefits from the sanctuary is, the lower the probability of WTP for conservation and restoration of this sanctuary. This is due to the fact that those households who decide who are situated at a distance from the sanctuary might perceive they are less beneficiary from the sanctuary compared to the nearest.

It might also be associated with freeriding behavior and poor understanding of the ecological and hydrological functions of the sanctuary. This finding appears to be well substantiated by the findings of [26, 28] that being from the sanctuary has a negative influence on the WTP decision than those who are situated around the sanctuary.

Livestock holding (TLU):- The total number of livestock of the households head and convert in to tropical livestock unit. Household livestock is also found to have a positive sign and statistically significant at below 1% level of significance. Holding the influences of other factors constant, the marginal effect

estimates also show a one unit increase in the tropical livestock unit of household head, increasing the probability of willingness to pay for sanctuary conservation decisions by 1.014%. This is probably due to the fact that the main source of their animals' food gets from the sanctuary. The result agrees with the work of [27, 28]).

Land area (LARE):- Total area land owned by household heads and willingness to pay has a positive relationship and statistically significance at less than 1%. The significant result indicates that households who have higher land area were more likely to say yes a response to the proposed bid than the respondents with small land area. Sufficient size of land holding is the basic requirement for good income. It could be that farmers who have larger farm sizes would get higher income from the practice than those of smaller farm sizes. The marginal effect estimates also show, that keeping the influences of other factors constant, a one hectare increase in the land of household, the probability of willingness to pay for sanctuary conservation also increase by 0.9%. This is probably due to the fact that a larger farm size earns more. The result agrees with the work of with [29] [28].

Bid amount (BID):- The result of binary probit model shows that the initial bid level affects households' willingness to pay at less than 1%, with a negative sign which indicates that the increase initial bid reduces the probability that households are accepting the proposed bid price. As demand theory suggests, bid value (price) and willingness to pay (demand for) have relationships if the good in question is normal good. The marginal effect shows that, keeping all other variables constant, a one birr increase in the bid amount will decrease the probability of accepting the proposed bid price by 0.32%. The result agrees with ([27]).

3.4.2 Determinants of Household’s Maximum WTP Amount (Intensity)

The result of the Tobit model indicated that educational level, livestock holding, monthly non-farm income, annual farm income, land area and Participation for conservation (Plec) have statistically significant and positive effects on households willingness to pay. This implies that the above variables increase the willingness to pay for respondents’ contribution, is also positive and the distance from sanctuary the negative effect on households willingness to pay for sanctuary conservation and restoration.

In non-linear econometric models, such as logit, probit, Tobit and double hurdle, the coefficients have no meaningful and direct interpretation. Thus, the marginal effect is used for the interpretation. However, for Tobit, running the marginal effect is optional because the first coefficient and the marginal effect have identical values.

Education Level (EDUC)

The result of the Tobit model shows that the education level of the respondents is positively and significantly related to WTP. The possible reason could be that attending formal education; individuals

are more concerned about sanctuary than not attending formal education. Educated individuals relatively know more about the significance of resources, and they are more about environmental resources. Holding other factors constant, households' head education levels increased by 1 year the amount that the household could pay increases by 2.21 ETB at a below 1% level of significance(table 12). The result agrees with the work of [29].

Distance of the homestead from the protected area (DIST)

Holding other factors constant, the household distance is also found to have a negative and a one minute increase in distance decreases the amount that the household could pay by 0.57 ETB at a below 1% level of significance. This is due to the fact that those households who are situated at a distance from the sanctuary might perceive they are less beneficiary from the sanctuary compared to the nearest. The result agrees with the work of [10][28].

Table :- 12 Result of Tobit model

Log likelihood = -538.13462					
Number of obs = 175					
LR chi2(11) = 293.42					
Prob > chi2 = 0.0000					
Pseudo R2 = 0.2142					
Variables	Coef.	Std. Err.	T	P > t	dy/dx
Sex	-0.2056	2.66656	-0.08	0.939	-0.2056
Age	0.05719	0.10898	0.52	0.600	0.05719
Education level	2.20604	0.39506	5.58	0.000**	2.20604
Family size	-0.3733	0.44895	-0.83	0.407	-0.3733
Livestock holding	4.13445	1.01822	4.06	0.000**	4.13445
Distance from sanctuary	-0.5682	0.16105	-3.53	0.001**	-0.5682
Land area	2.87555	1.25923	2.28	0.024*	2.87555
Participation in environmental conservation	9.06988	3.01441	3.01	0.003**	9.06988
Monthly non-food expend	-0.0026	0.00187	-1.4	0.163	-0.0026
Monthly non-farm income	0.02297	0.00418	5.49	0.000**	0.02297
Annual Farm income	0.0011	0.0002	5.39	0.000**	0.0011
_cons	-23.868	9.03616	-2.64	0.009	
/sigma	14.5216	0.93406			
49 left-censored observations at max < = 0, 126 uncensored observations, 0 right-censored observations, ** and * shows significant variables at 1% and 5% probability levels respectively					
Source: Own survey result, 2022					

Livestock holding (TLU)

In consistency with prior expectations, livestock holding measured in tropical livestock units is found to have a significant and positive influence on households' WTP pay amount.

Thus, holding other factors constant, a one-unit increase in livestock holdings in TLU increases the amount that the household could pay by 4.13 ETB at a significant at 1% significant level. The possible reason is that livestock holding is a proxy for households' wealth and serves as a main source of income and the sanctuary is also the main source of fodder for animals. In addition, the sampled households, the sanctuary as the main source of grass for their livestock. Therefore, more TLU holders' WTP might not

only arise from their interest in conservation of its former beauty. Rather, it might also be associated with the expectation of improvement in the quality/quantity of grass for their livestock. This study is also consistent with previous studies by[17] .

Participation in environmental conservation:- This is a dummy variable which takes a value of “1” is the respondent has ever participated in voluntary plantation campaigns and “0” if not. Holding other factors constant, participation in voluntary activities related to natural resource conservation increases the household’s WTP amount by 9.06 ETB compared to those who do not participate in conservation at 1% significance level. The variable participation of the respondent is positively related to the probability of respondents WTP for sanctuary conservation. The result revealed that households who were participating in voluntary plantation campaigns were more willing to for Senkele sanctuary protection. This is probably due to the fact that households who participate in voluntary plantation campaigns have positive environmental opinions and pay more for that. The rationality is that households who participate in natural resource conservation become well informed about the environmental and ecological benefits of sanctuary conservation. This finding is also consistent with the findings of [17, 30]) which affirm that participation in natural resource conservation practice determines the WTP amount positively.

Land area (LARE):- The household’s average total land area has a positive sign as expected and is statistically significant at 5% level of significance. This positive effect indicates that households with higher land area had more payment than households with lower land area. The result also shows that keeping the influences of other factors constant at their mean value by one hectare increase in land area of the household’s payment, the amount also increased by 2.9 ETB. The result agrees with the work of [29].

Non-farm income of the household (NONFARM)

Holding other factors constant, as the monthly nonfarm income increases by birr, the amount that the household could pay will also increase by 0.022973 ETB at a 1% significant level. This implies that having more income from non-farm practices could solve the financial constraint and encourage them to contribute more to the proposed intervention. The motive here is, the sanctuary has more meaning for the surrounding community besides the direct benefits derived from it. Hence, more nonfarm income can be associated with a more WTP amount. The results agree with the work of [17].

Annual On-Farm Income (FARM INCOME): In agreement with the prior expectation, annual on-farm income was found to have a positive and significant 1% influence on the willingness to pay. The possible reason is that households may realize the consequences of deteriorating such sanctuary on their on-farm practices. In addition, households may conceive that improvement in the state of the sanctuary is also a way to improve their future on-farm income. This finding is also consistent with previous studies because the result agrees with the work of[10] [10, 26]).

3.4.3 Estimation of Mean Willingness to Pay

The mean willingness to pay can be estimated using both close ended double bounded dichotomous choice question and open ended question formats. The results from the two formats are given below.

A. Mean willingness to pay from double bounded dichotomous choice question

As table 11 depicts, the positive and significant sign of Rho (ρ) indicates the existence of a positive relationship between the two WTP responses.

In addition, the correlation coefficient (ρ) being less than unity indicates that the random components from the first and follow-up WTP equations are not perfectly correlated. This significant but imperfect correlation between the two error terms verifies that a seemingly unrelated bivariate probit model (SUBPM) is the correct econometric model to estimate the mean WTP amount. It is a good agreement with this claim ([17, 27]. Also illustrate that using SUBPM gives efficient and unbiased mean WTP estimation for the conservation program. In agreement with the finding of such convergence in mean WTP values among the two elicitation methods could arise from the rightness in setting the initial bids and the plausibility of the constructed market scenario.

Mean WTP 31.89 to 37.3 birr per month so the mean of WTP is $\frac{\mathrm{WTP1}+\mathrm{WTP2}}{2}$ = $\frac{31.89+37.3}{2}$ =34.59 ETB

The result indicated that both the initial bid and the following bid (second bid) were statistically significant at less than 1% probability with negative signs. The result, therefore, revealed that the higher the initial and follow-up bid, the less the probability of that bid being accepted/ the less willing to pay the proposed amount of bid. The result is consistent with the economic theory of demand for environmental and natural goods. Finally, the mean willingness to pay for (WTP) from bivariate probit model for the double bounded elicitation format was computed using the formula proposed by[14] as follows: that means: Mean WTP =, where α is a coefficient for the constant term, and β is a coefficient for offered bids to respondents (table 13). Using Eq. (8), the estimated mean WTP amount for the conservation of SSHS ranges from WTP (initial bid) bid1 = 31.89 and the mean WTP (second bid) bid2 = 37.3 ETB means that households in the study area can pay up to 34.59 ETB per a month for to conserve SSHS.

Table :-13 Seemingly unrelated bivariate probit model parameter estimates.

Number of obs = 175

Wald chi2 (2) = 50.29

Log likelihood = -185.5403 Prob > chi2 = 0.0000

Variable	Coef.	Std. Err.	Z	P>|z|
Initial bids	-0.0932	0.01379	-6.76	0.000**
Constant	2.97339	0.40279	7.38	0.000**
Second bids	-0.0532	0.01676	-3.17	0.002**
Constant	1.98395	0.46855	4.23	0.000**
ρ (Rho)	0.48728	0.2181	2.23	0.025*
LR test of rho = 0: chi2 (1) = 5.97448 Prob > chi2 = 0.0145				
** And * shows significant variables at 1% and 5% probability levels respectively				
Source: Own survey result, 2022				

B. Mean WTP estimation from the open ended format

To determine the mean willingness to [27]pay from the open ended follow up questions simply average maximum WTP figures across respondents as follows:

Mean WTP = $\sum$n iyi/n

Mean MWTP = 5550/175 = 31.71

Where n = total sample size, $\sum$n iyi = summation of households maximum amount of cash to pay for sanctuary conservation

In the open ended question, respondents were asked to state the maximum amount in cash they would like to pay for sanctuary conservation. The amount of cash that the households would contribute to the conservation ranges from 5 to 100 ETB per month to be extended for one year.

From the total of 180 sample respondents, only 5 households were not willing to contribute any cash for Senkele sanctuary conservation (protests zero bid) the other 49 respondents were have minimum contribution that is " below offered bids" and 126 respondents were already willing respondents. So 175 respondents were willing to contribute some amount of money that they already stated during the survey despite the amount of money they willingly contribute differs from one respondent to the other. The average amount of money that respondents were willing to contribute for Senkele sanctuary conservation activity from the open ended format was 31.71 ETB per month. The information obtained from the household maximum willingness to pay result can also be used to draw a frequency curve and to make aggregation for the willingness to pay for conservation of sanctuary resource activities. The frequency curve for willingness to pay for conservation of sanctuary resource is derived to see the extent of cost recovery. The frequency curve can be derived in terms of the total number of households observed and their associated maximum WTP. Figure 2 below shows the frequency curve of the sampled households for the conservation of sanctuary resources. For this, measure the number of the households along the

vertical axis and the birr stated by the households per month along the horizontal axis. The frequency on the maximum willingness to pay by (table 14) is adding class by class. The frequency in a specific class can then be clearly indicated by the number of households that are below or above the class. In other words, from cumulative frequency tables a curve can be drawn, to reflect data in a graphic manner.

Table :-14 Sampled households' conservation demand

Amount of cash	Number of respondents(frequency)	Percent
5–24	58	33.14
25–44	56	32
45–64	27	15.43
65–84	19	10.86
85–100	15	8.57
Total No of Obs	175	100
Source: Own survey result, 2022		

As shown in Fig. 2, the demand curve sloped down indicating as the bid amounts increases the demand for conservation of sanctuary resources decrease, cetris paribus.

3.5 Estimating Total (Aggregate) Willingness to Pay

Mean WTP is used as a measure of aggregate value of sanctuary conservation in this study. In this study, the proposed intervention is to conservation of sanctuary, which is a quantity and quality improvement in goods and services emanating from the sanctuary. Mean was used as a measure of aggregate value of sanctuary conservation in this study. The mean is perhaps better than the median since the good dealt with is not a pure public good as there are purely private benefits from sanctuary conservation measures. Here, the welfare gain indicates the level of utility or satisfaction that the household derived from the proposed intervention [17]. In this case, the aggregated welfare-gain is the sum of individual's WTP amount for the welfare gain through quantity increase and quality improvement in the state of the sanctuary[14].

The mean WTP estimated from SUR bivariate probit model average mean of households in the study area can pay up to 34.59 ETB and from open ended survey the average mean of households in the study area can pay up to 31.71 ETB per month. The aggregate WTP value was calculated by multiplying the mean WTP by the total number of households who are expected to have a valid response in the selected peasant associations. This shows that there is high level of motivation willingness to pay for sanctuary conservation in the study area.

There are 32,504 households in the study area (Siraro Woreda). It is also possible to calculate the total aggregate value of Senkele sanctuary conservation. After deducting the protest zeros (903) the expected total households with valid responses are 31,601 households. The total willingness to pay in the study area is simply the multiplication of the respective means and the number of expected households to have valid responses [27].

Hence, the aggregate value of sanctuary conservation in the study area from the double bounded and open ended formats are 13,116,943.08 ETB and 12,024,812.52 ETB per year respectively (table 15).

Table :-15 Aggregate willingness to pay of households for conserving senkele Swayne's hartebeest sanctuary

	Total household in Siraro woreda	Expected households to have a protest zeros	Expected households with valid responses	Use different mean results	Total WTP for sanctuary conservation per month (ETB).	Total WTP for sanctuary conservation per year (ETB).
double bonded result	32,504	903	31,601	34.59	1,093,078.59	13,116,943.08
Open ended result	32,504	903	31,601	31.71	1,002,067.71	12,024,812.52
Source: Own survey result, 2022						

4. CONCLUSION AND RECOMMENDATION

This research paper contributes to the existing non-market valuation literature in estimating households' WTP using a CVM to support the improvement of management and conservation of protected areas, especially where the conservation funding is inadequate. The study provides insights on the application of WTP in sustainable financing to develop market-based conservation approaches in developing countries to reduce the on-going biodiversity losses and preserve the iconic wildlife species. The study also provides an empirical investigation of the effect of different factors, which helps to model households WTP. The data for this purpose came from 175 rural households who live in the three kebeles surrounding Senkele sanctuary. Majority of the sampled households showed their support towards the conservation intervention by contributing cash based on their financial capability

Based on welfare gains from the sanctuary intervention, results show that the aggregate value of Sanctuary from an open-ended question format (12 million ETB per year) was underestimated as compared to a double bounded dichotomous choice format (13.12 million ETB per year).

This result shows that the value of SSHS in an open-ended format was underestimated as compared to a double bounded format. This indicates that there may be the existence of free reading problems and a

lack of a basis for households for valuing SSHS in an open-ended format. This implies that, in the valuation of environmental resource services, using a double bounded dichotomous choice format is preferable to an open-ended format.

Based on the main findings of the study, the following recommendations are forwarded. Educational level, livestock holding and total land size are statistically significant and positive results, whereas distance from sanctuary statistically significant and negative result on households decision and magnitude of willingness to pay for sanctuary conservation . Thus, for successful conservation of the Senkele sanctuary, policymakers and other concerned parties should consider the following determinants critically."

EWCA, government, local people, researchers and non-governmental organizations are working together to minimize deforestation and deterioration and develop a sustainable management system for the Senkele sanctuary.

Moreover, this research paper could be a good reference for further valuation research in wildlife sanctuaries, biosphere reserves, and control hunting areas in Ethiopia and other developing nations. However, the study is subject to sampling and scope limitations. Only 175 respondents were intercepted though the sample size fairly met the assumption of sampling adequacy in CV studies. Therefore, it would be important for further valuation studies to consider an adequate sample size by taking many PAs as case studies to improve the generalization of the results and its implications.

Future studies need to continue to estimate the non-market valuation of other beneficiaries in different PAs in Ethiopia. This is an interesting topic for further studies in modelling the WTP by considering other variables which were not included in the current study, such as choice of experiment methods of use of guides to improve the model's fitness.

Declarations

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Authors' information (optional)

Dimim Wogayehu: Write up, data collection, supervision; contributed reagents, materials, analysis tools or data, wrote the paper.

Desalegn Amanuel: Data collection, supervision analyzed and interpreted the data.

Getachew Tadei : Data collection, supervision analyzed and interpreted the data.

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Availability of data and materials

Data will be made available on request.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Ethics approval and consent to participate

The study was approved by Wachemo university ethical board and all experiments were performed in accordance with relevant guidelines and regulations. Informed consent was obtained from all the participants and/or their legal guardians. All works were performed in accordance with relevant guidelines and regulations (such as the Declaration of Helsinki).

Consent for publication

With the consent, the author gives the publisher license of the copyright which provides the publisher with the exclusive right to publish and sell the research findings in all languages, in whole or in part.

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Figures

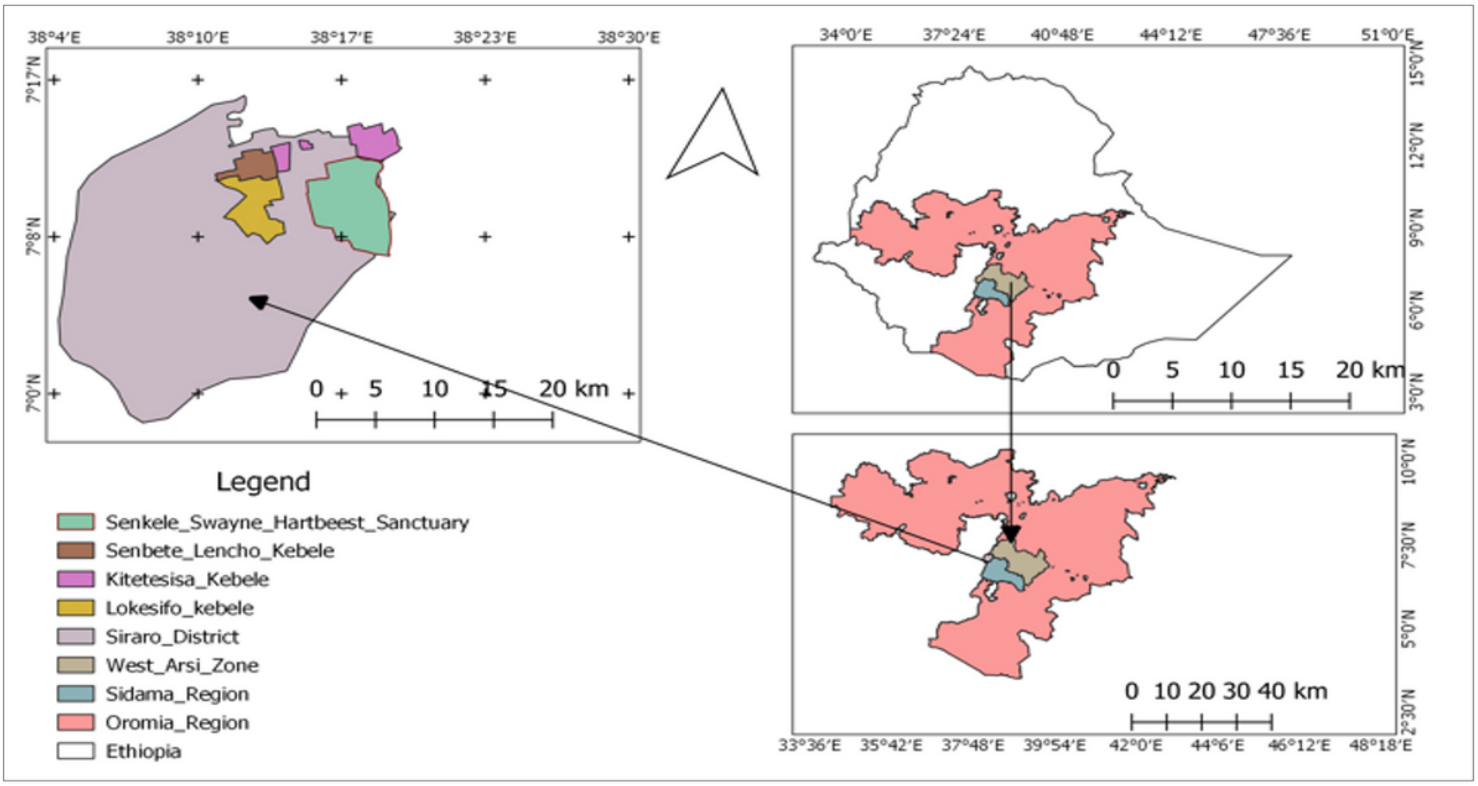

Figure 1

Map of the study area

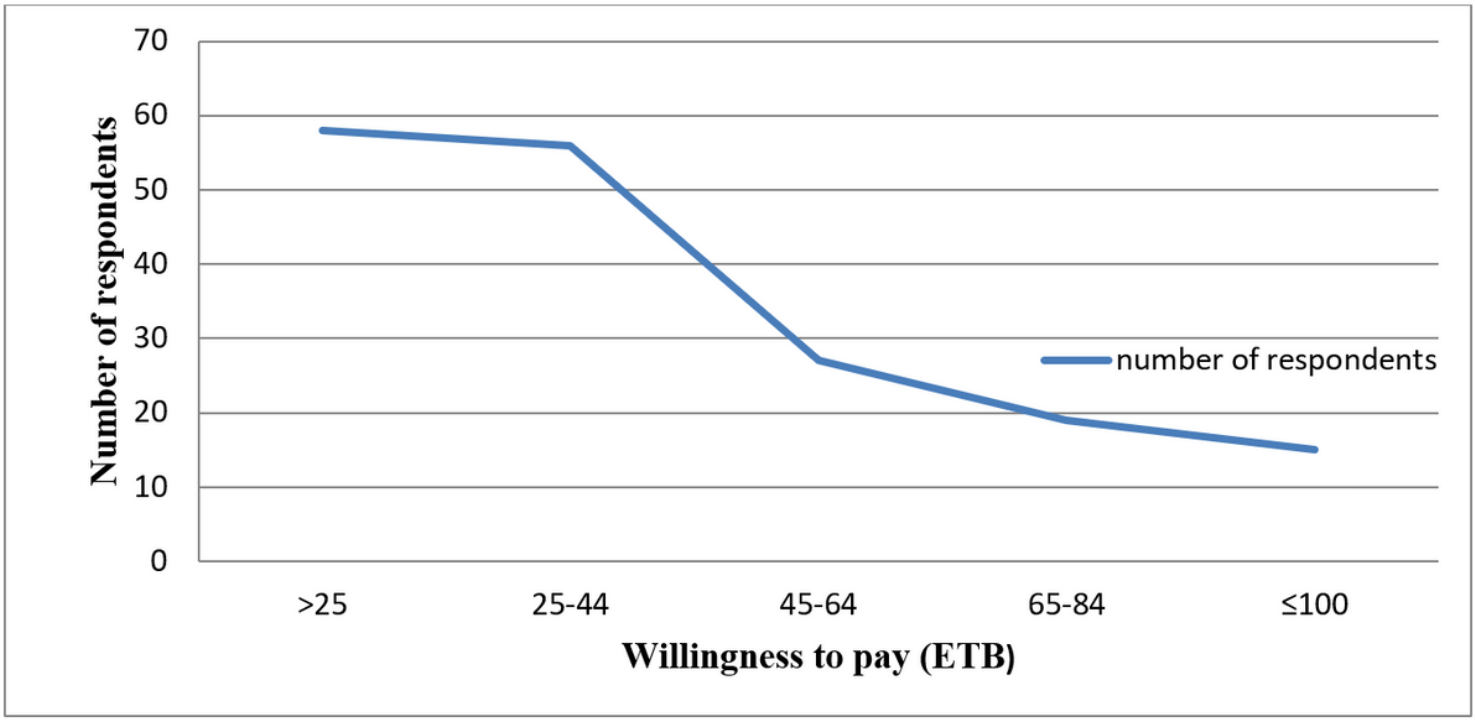

Figure 2

Demand curve of 175 households WTP”