



Nexus between land development and the value of ecosystem services in Ethiopia: A contingent valuation study

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Abstract

In Ethiopia, the state owns all lands within the territory of the country. Cities are incorporating large parcels of land from their surrounding rural agricultural areas through land expropriation. However, these land developments do not consider the nonmarket value of ecosystem services (ES), which is causing a deterioration of the existing ES and reduction on the potential supply of ES from agricultural land. The aim of this study was to estimate the monetary value of nonmarketable ES from the agricultural land using a double-bounded dichotomous choice contingent valuation method. A survey of 524 smallholder farmers was conducted. In the survey, respondents were asked to state their willingness to pay for the improvement of some of the nonmarketable ES: erosion control, air and climate regulation, water regulation, and soil fertility. The estimation was carried out using a bivariable probit model. The results revealed that farmers are willing to pay on average 276 ETB (7.9 USD) per hectare per year for a period of 10 years. We found that individual characteristics such as age, family size, and a recent land expropriation experience adversely affect the willingness to pay by the farmers. On the other hand, individuals with higher income and larger land size are willing to pay more. In general, the study indicated that the non-market ES, which are affected by the land expropriation for urban expansion, are valuable for the farmers. Therefore, we recommend that the government consider the value of non-marketable ES in its land use decisions and hence achieve sustainable land development.

Keywords Ecosystem services · Contingent valuation · Willingness to pay · Land expropriation · Land development · Ethiopia

1 Introduction

In Ethiopia, the state owns all lands within the territory of the country. However, the Ethiopian constitution granted farmers who decide to live in rural areas and want to farm a lifetime use right of the land, as well as passing the land use right to generations through

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inheritance, and gift (FDRE, 1995). On the other hand, according to Proclamation no. 721/211, urban dwellers have only leasehold rights for a limited period depending on the type of land uses. For individual housing, for instance, individuals have a 99-year leasehold right, but for investments and other business projects the lease period is up to 50 years depending on the type of the investment projects. The constitution also allows the government to take the land use rights of individuals without the consent of land users by paying “commensurate compensation.” Even though it is not clearly specified what is called “public purposes,” the compulsorily acquisition or expropriation should be for “public purposes” (FDRE, 2005). The government justifies the compulsory acquisition of the land from the land users as a solution for the land “hold out” problems that may be caused by the monopoly power of individuals when the land is needed for the provision of public goods to the society. Expropriation power is needed to secure land for the provision of several infrastructures such as roads, public services, and small- and large-scale land-based investments projects. These are goods and services that should be provided by the government or private sectors. Since these services have characteristics of public goods as they are non-excludable and no-rivalry, the private sector mostly fails to provide (Ambaye, 2013).

In Ethiopia, which is still a highly agricultural state, 79% of the people live in rural settings. However, a major urban expansion trend has been manifesting itself in the cities in recent decades. An average urban population growth rate of 4.6% between 1995 and 2018 puts Ethiopia, together with other Sub-Saharan countries, among the nations with the fastest growing urban areas on the planet (World-Bank, 2018). The economic transition that the government of Ethiopia needs to implement through its Growth and Transformation Plans (GTP I and II) focuses on the importance of more economic and industrial density in the urban areas (Schmidt, 2018). In order to address this urban growth and provide the population with necessary facilities, the Ethiopian government relies mostly on the conversion of rural land situated in the periphery of cities (Adam, 2014; Nigussie et al., 2012). The government is taking rural land from the farmers through land expropriation and this practice has been the core of the state’s strategy to facilitate the urban expansion (Adam, 2014; FDRE, 2005).

Based on previous studies on Ethiopia’s land development practice, it is acknowledged that environmental issues have not received much attention. In the case of land expropriation for urban expansion, little or no concern has been given for nonmarketable ES, which indirectly contributes the benefits that people obtain from the land uses. This is manifested in the exclusion of the value of nonmarketable ES such as regulating, supporting, and cultural services in the land development process. The cost–benefit analysis has been only based on the value of marketable ES (Admasu et al., 2019). On the other hand, the Ethiopian government has recently initiated many activities related to environmental protection. Ethiopia is involved in international discussions on climate change and related issues representing Africa. In August 2019, in the name of protecting the environment, more than 350 million trees were planted within a day in different parts of the country (breaking the official world record previously held by India, with 50 million trees in a day). This is an example of Ethiopia’s commitment to environmental protection (UN, 2019). In addition, Ethiopia accepted the Voluntary Guidelines on the Responsible Governance of Tenure (VGGT), which was developed by the Food and Agricultural Organization of the United Nations (FAO). The VGGT advises the valuation for compensating the affected people should include the nonmarket values of ES (FAO, 2017).

Studies recommend the integration of the value of the nonmarket ES with the land development practices for environmental sustainability (Admasu et al., 2020;

Grêt-Regamey et al., 2017). However, the absence of the monetary value of nonmarketable ecosystem services makes it challenging to persuade their importance for the land use policy and decision makers (Ribaudo et al., 2010). Valuation of nonmarket ES requires valuation methods that are beyond the market valuation techniques. This contributes greatly to the inability to integrate the value of ES, especially in developing countries, like Ethiopia where application of nonmarket valuation techniques is limited or absent.

The two major approaches used to estimate the monetary values of nonmarket ES are stated and revealed preference approaches. One of the most widely used stated preference method of valuing nonmarket ES is the Contingent Valuation Method (CVM), in which the value of the ES is derived from the willingness to pay (WTP) or willingness to accept (WTA) of the respondents for hypothetical scenarios of future improvement measures. It uses a questionnaire in which respondents are required to state their preferences and how much they are willing to pay (the maximum) or willing to accept (the minimum) for the changes in the environmental goods like improvements of ES from agricultural land, etc. (Champ et al., 2017). A significant number of contingent valuation studies have been conducted on environmental valuations (see Table 1). Most of the studies used WTP rather than WTA because it is argued that respondents may overstate the value they assign to the environmental goods. Affected people may consider the hypothetical situation as a real situation and may seek more as a compensation for the losses (Sayman & Öncüler, 2005). CVM studies use either a single- or double-bounded referendum. A single-bounded referendum refers to the situation where respondents are provided with initial bid and the open-ended follow-up questions, whereas in a double-bounded referendum both initial and follow-up bids are decided in advance and presented to the respondents. Double-bounded contingent valuation is preferred over single-bounded referendum since the latter assumes the respondents' lower willingness to pay to "zero" if they go against the initial bid. The double-bounded referendum might produce more correct estimates using the follow-up bids for those who are against the initial bid (Dahal et al., 2018).

This study applied a double-bounded dichotomous choice CVM to estimate the value of nonmarket ES associated with agricultural lands in the city of Bahir Dar. The study includes four rural kebeles (Zenzelema, Addis Alem, Weramit, and Wereb) in which land expropriation for urban expansion is common. This study contributes to the existing body of literature in four ways. First, it gives a chance for local land policy and decision makers to recognize the influence of communities' characteristics and ecosystem service value attributes on land policy preferences. The study estimated the value of the nonmarket ES: erosion control, air and climate regulation, water regulation, and soil fertility. The study also examined the association between the socioeconomic characteristics of the respondents and their willingness to join the program and willingness to pay for the improvement measures. Second, only limited studies have investigated the association between land development and the value of ecosystem services (Huang & Wang, 2015; Jianjun et al., 2013), and they have not seen the case in relation to land expropriation or land allocation decisions. Third, this study augments to the growing literature that employs double-bounded contingent valuation to estimate community valuation of nonmarket ecosystem services of agricultural land. Fourth, it could be taken as an additional case study to the limited literature on the use of contingent valuation method in estimating the value of ecosystem services in developing countries in general and Sub-Saharan Africa in particular.

The rest of the paper is organized as follows. Section 2 describes the methods and materials used, Sect. 3 deals with the results, and Sect. 4 discusses the main findings of the study. Finally, Sect. 4 describes the conclusion and policy recommendations.

Table 1 Review literature on CVM studies

No.	Authors	CVM characteristics	Object of valuation
1	Dahal et al. (2018)	Double-bounded CVM	Waterfront open space
2	Gelo and Koch (2015)	Double-bounded CVM	Community forest programs, China
3	Jianjun et al. (2013)	Single-bounded CVM	Cultivated land protection
4	Chien et al. (2005)	Double-bounded CVM	Air quality improvement
5	del Saz-Salazar and Guaita-Pradas (2013)	Single-bounded CVM	Drovers' routes as an environmental asset
6	Tao et al. (2012)	Single-bounded CVM	Forest ecosystem services
7	Huang and Wang (2015)	Double-bounded CVM	Total economic value of cultivated flower land
8	Carlsson et al., (2004)	Single-bounded CVM	Valuation of community forest plantations
9	Dribek and Voltaire (2017)	An interval payment card payment	Valuation of beach erosion control
10	Sergio Colombo et al. (2006)	Single-bounded CVM	Social benefits of soil conservation
11	Gaglias et al. (2016)	Open-ended	Valuation of wastewater management
12	Amadu et al. (2021)	Open-ended	Forest value

2 Methods

2.1 Study area

The study was conducted in the peri-urban areas of Bahir Dar, the capital of the Amhara National Regional State. The city is situated in the North-Western highlands, on the southern shore of Lake Tana, a UNESCO biosphere reserve (UNESCO, 2015). With an average altitude of 1,801 m, the area is located in the Weyna Dega (sub-humid) climate zone and has a yearly rainfall of 1,000–1,600 mm and an average annual temperature of ca. 20 °C (Abebe, 2017). The primary source of livelihood in the areas surrounding the city center is still agriculture, but smallholder farmland is under pressure as the city is quickly expanding its borders. Bahir Dar is one of the fastest growing cities in Ethiopia in terms of inhabitants and urban area. According to the Central Statistical Agency of Ethiopia, Bahir Dar's population increased from 155,428 inhabitants in 2007 to an estimated 348,429 inhabitants in 2017. Analysis of satellite images of the city over the years shows that the amount of urban built-up area has increased drastically, from 635 hectares in 2007 to 2740 hectares in 2015 (Gashu & Gebre-Egziabher, 2018), and is predicted to be 5276 hectares in 2045 (Fitawok et al., 2020). Furthermore, over the last 10 years, a total farmland surface of 1,500 hectares has been dispossessed in the peri-urban zone of the city (Admasu et al., 2019).

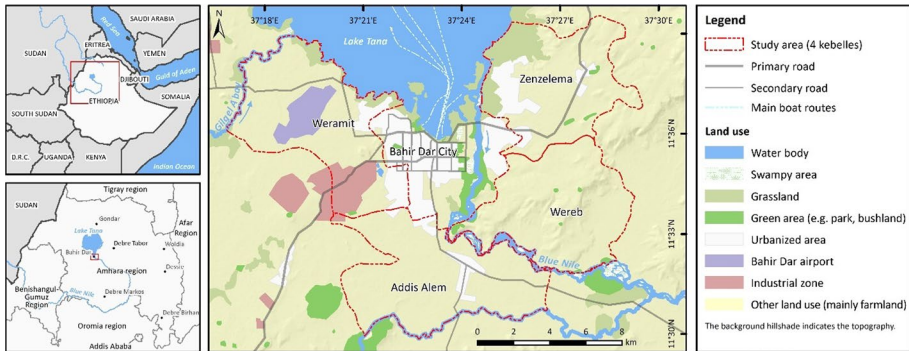


Fig. 1 Map of the study area

The study area includes the four kebeles¹ surrounding the city center: *Addis Alem*, *Weremit*, *Wereb*, and *Zenzelema* (Fig. 1). Given that these kebeles are comparable in terms of their rural/urban area, the general attitude toward the government and its expropriation policy is expected to be relatively similar among the inhabitants in the different areas. Most farmers in these kebeles cultivate a variety of crops at the same time. The major crops are wheat, barley, finger millet, teff, sorghum, and maize. The lake shored crop lands in *Zenzelema* and *Weremit* have easier access to irrigation than the inland areas. Farmers that have access to enough water often install more profitable fruit (such as bananas and mangoes), vegetable, and khat² plantations in addition to their rainfed crops.

2.2 Data collection

Data for this study were collected from the four rural *kebeles* (*Addis Alem*, *Weremit*, *Wereb*, and *Zenzelema*). A total of a randomly selected 524 household farmers were surveyed in September and October 2019. Respondents were selected from each kebele proportional to their number of households in the population (see Table 2) using stratified random sampling technique by taking a kebele as a stratum. Of the 524 surveys, 513 were filled in correctly and were taken for further analysis. Since the survey was conducted face to face, there was no refusal from the respondents' side; that is, the non-response rate was zero.

The CVM questionnaire starts with a brief introduction to the proposed program, explaining the environmental good and the activities to be undertaken by the project that would improve the ES from the environmental good. The activities mentioned in the introduction include making terraces, planting trees around the cropland, establishing water irrigation schemes, and taking measures to increase land fertility. In addition, this part of the questionnaire contained the statement about a lack of funding from the government and the need to contribute to the implementation of the proposed project. It also reminds of the possibility of using respondents' budget for other purposes. Moreover, it includes some cheap talk scripts that describe the reasons given by "yes"- and "no"-saying participants

¹ A kebele is the lowest administrative unit in Ethiopia.

² Plant whose leaves are consumed by chewing them, which stimulates the consciousness.

Table 2 Number of household respondents per Kebele

Kebele	Number of household respondents		Number of households in population	
	<i>N</i>	%	<i>N</i>	%
Addis alem	103	(20)	1,077	(20)
Weramit	117	(22)	1,125	(20)
Wereb	128	(24)	1,343	(24)
Zenzelema	176	(34)	1,986	(36)
Total	524	(100)	5,531	(100)

of a similar hypothetical program. The inclusion of these scripts was suggested by several scholars to avoid hypothetical biases (Johnston, 2006; Ladenburg & Olsen, 2014).

The questionnaire included a contingent valuation question to elicit respondents' WTP for improvements of the nonmarketable ES. The studied nonmarketable ES are erosion prevention, air regulation, climate regulation, water provision, and soil fertility; these services are in the category of regulating and supporting services (MEA, 2005) and were identified as most important nonmarketable ES in the study areas (Admasu et al., 2020).

This survey makes use of a double-bounded dichotomous choice (DBDC) method to elicit the WTP. With this approach, a respondent is asked whether he/she is willing to pay a certain amount (starting bid). If he/she agrees, he/she will be presented the same question with a higher bid amount. If he/she refuses the starting bid, the second question will contain a lower bid. This elicitation method was first proposed by Hanemann (1985) and has since been applied in contingent valuation studies all over the world. It was developed in order to overcome the loss in econometric precision that occurred with the use of the closed-ended question format of the single-bound dichotomous choice (SBDC) method, compared to the open-ended questions (Hoyos & Mariel, 2010). The follow-up question in the DBDC approach sharpens the boundaries of the respondents' WTP and thus provides more information than the SBDC method (Hanemann, 2001). The second question appears to work as insurance for poor choice of the initial bids (Hanemann et al., 1991). At the same time, adding a third or a fourth follow-up question provides little efficiency gain and can increase the chance of inducing response effects (Cooper, 1994).

This study does not make use of payment card method although it may generate results with less time and efforts (Gürlük, 2013), especially as compared to open-ended approach (Alhassan, 2012). The payment card method provides an approach for increasing efficiency over dichotomous choice, but it may also introduce several biases. For instance, Schuman (1996) argues "presenting respondents with a set of values to choose from is now seldom used because of recognition that this kind of framing and anchoring is quite likely to create bias to and away from certain values." Similarly, Mitchell & Carson (2013) criticized the approach for having a range and centering biases, which are caused by inappropriate payment scale design. In addition, in developing countries where most of the respondents do not have formal education or illiterate the payment card approach may have a cognitive burden to be able to scan through and select their bids and will need to be provoked by the interviewer (Alhassan, 2012). Following this, it may be difficult to use the payment card method in this study area where most of the farmers are illiterate, more than 50% of the sample respondents are illiterate.

Table 3 Double-bounded dichotomous choice bid levels in Birr (ETB) per qada (q) per year

	Initial bid	Lower bid	Upper bid
Bid set 1	10 ETB/q	5 ETB/q	15 ETB/q
Bid set 2	20 ETB/q	10 ETB/q	30 ETB/q
Bid set 3	40 ETB/q	20 ETB/q	60 ETB/q
Bid set 4	70 ETB/q	35 ETB/q	105 ETB/q
Bid set 5	110 ETB/q	55 ETB/q	165 ETB/q

1 qada = 0.25 ha

Ethiopian currency. 1 USD = 34.7 ETB and 1 Euro = 39.20 ETB on 24/06/2020

A qada is an Ethiopian square measure. One qada is equal to 0.25 hectares.

Table 3 shows the list of the five starting bids, which were randomly³ assigned to the respondents. The prices were chosen with the information from a focus group discussion, pre-tested in the field with a small sample of farmers (30 people), and consequently improved. The lower and upper follow-up bids represent 50% and 150% of the initial price, respectively. The respondents were asked their willingness to pay for the improvements for the next consecutive 10 years at the end of the main crops harvest time. Governmental projects in Ethiopia, like this one, usually have a time frame of 10 years. In addition, the compensation paid to farmers who lost their land due to land expropriation has been calculated based on a 10-year period (FDRE, 2005). In this study, land tax is taken as a payment vehicle, which is one of the commonly used payment vehicles in many contingent valuation studies (Dahal et al., 2018).

The questionnaire also includes a section that asks respondents about their knowledge and perception of the considered ES. In the final section, the respondents were asked to respond to a few simple questions about their own characteristics (age, gender, family size, etc.). These were useful for the further analysis, characterizing people who are willing to join and willing to pay more than others for the project. A pilot survey was conducted with 30 farmers in August 2019. The actual survey was conducted in September and October 2019 in a face-to-face interview using Qualtrics Software. In order to get in touch with farmers, local agricultural development experts of each kebele were contacted. These people accompanied the research team throughout the data collection process and proved to be very helpful. Their presence helped to reduce suspicion among the farmers and made them trust the interviewers more, resulting in more deliberate answers to the survey questions.

2.3 Estimation strategy

The random utility provides the theoretical basis for the contingent valuation method. Assume v to be an indirect utility function, Y the income of a respondent, A the offered bid and thus the fee to be paid to participate in the project, s the other characteristics of the respondent (age, family size, etc.) and ε_1 and ε_2 the identically and independently distributed

³ The Qualtrics software contains a function that can randomly draw one of several questions.

random variables with zero mean. A respondent will then choose to pay the annual fee to participate in the program, rather than not pay it, under the following condition:

$$v(q^1, Y - A, s) + \varepsilon_1 \geq v(q^0, Y, s) + \varepsilon_0 \quad (1)$$

Thus, individuals compare their utility from the proposed program (that is, with q^1 environmental quality), given a compulsory payment to participate, with the current situation (that is, with q^0 environmental quality). They will participate and are willing to pay if they feel that the program will increase their utility (Hanemann, 1984).

In the literature, three main models are commonly used to estimate the parameters and derive the mean willingness to pay from double-bounded contingent valuations. Which model is advised to be used depends on the correlation coefficient ρ between the error terms of the WTP of the first and second bid (Hanemann, 2001). When the $\rho=0$, functions behind the answers to each question should be considered as entirely different, and the use of the random effects probit model is recommended (Alberini et al., 1997). If $\rho=1$, a respondent would refer to the same underlying WTP value in both the first and second question and the interval data model can be used (Hanemann et al., 1991). Finally, Cameron and Quiggin (1994) found that respondents might form different implicit WTP values when asked the first and second bid questions, although they also noted that these values are likely to be correlated, without needing to be identical. Therefore, they proposed the use of the bivariate probit model in the case of imperfect correlation ($|\rho| < 1$). In the present paper, it was found that $|\rho| < 1$, which means the bivariate probit model is appropriate.

The most general model for the WTP through double-bounded questions falls back on the following equation:

$$WTP_{ij} = X'_{ij}\beta_i + \varepsilon_{ij} \quad (2)$$

where WTP_{ij} represents the willingness to pay of individual j , and $i=1,2$ denotes the first and second questions, respectively. X'_{ij} is a vector of independent variables related to the respondents' characteristics and β_i is a vector of parameters that should be estimated with the help of a statistical model. The WTP also depends on a non-observable random component ε_{ij} (Cameron & Quiggin, 1994). In a DBDC survey, a respondent is first given an initial bid (B_j) and asked whether he/she is willing to pay it. If the answer on the initial bid is "Yes," a second question with a higher bid is presented (B_j^u). However, if the answer is "No," the second question will contain a lower bid will (B_j^d). This means there are four possible outcomes:

- (i) $d_j^{nn} = 1$ if respondent j answers "No" to both bid questions (0 otherwise)
- (ii) $d_j^{yy} = 1$ if respondent j answers "Yes" to both bid questions (0 otherwise)
- (iii) $d_j^{ny} = 1$ if respondent j answers "Yes" and "No" to the first and second bid questions, respectively (0 otherwise)
- (iv) $d_j^{yn} = 1$ if respondent j answers "No" and "Yes" to the first and second bid questions, respectively (0 otherwise)

Following Haab & McConnell (2002), the probability that $WTP_{1j} < B_j$ and $WTP_{2j} < B_j^d$, which is the probability of a No-No response, is given by

$$P\left(X'_{1j}\beta_1 + \varepsilon_{1j} < B_j \text{ and } X'_{2j}\beta_2 + \varepsilon_{2j} < B_j^d\right) = \Phi_{12}\left(\frac{B_j - X'_{1j}\beta_1}{\sigma_1}, \frac{B_j^d - X'_{2j}\beta_2}{\sigma_2}, \rho\right),$$

where $\Phi_{12}(\ast)$ represents the standardized bivariate normal cumulative distribution function with zero means, unit variances, and correlation coefficient. The probability of a Yes-Yes response is

$$P\left(X'_{1j}\beta_1 + \varepsilon_{1j} \geq B_j \text{ and } X'_{2j}\beta_2 + \varepsilon_{2j} \geq B_j^u\right) = \Phi_{12}\left(\frac{B_j - X'_{1j}\beta_1}{\sigma_1}, \frac{B_j^u - X'_{2j}\beta_2}{\sigma_2}, \rho\right).$$

The probability of a Yes-No response is

$$P\left(X'_{1j}\beta_1 + \varepsilon_{1j} \geq B_j \text{ and } X'_{2j}\beta_2 + \varepsilon_{2j} < B_j^u\right) = \Phi_{12}\left(-\frac{B_j - X'_{1j}\beta_1}{\sigma_1}, \frac{B_j^u - X'_{2j}\beta_2}{\sigma_2}, -\rho\right),$$

and the probability of a No-Yes response

$$P\left(X'_{1j}\beta_1 + \varepsilon_{1j} < B_j \text{ and } X'_{2j}\beta_2 + \varepsilon_{2j} \geq B_j^d\right) = \Phi_{12}\left(\frac{B_j - X'_{1j}\beta_1}{\sigma_1}, \frac{B_j^d - X'_{2j}\beta_2}{\sigma_2}, -\rho\right).$$

The log-likelihood function, which needs to be maximized in order to approach the unknown population parameters as close as possible,

$$\begin{aligned} \ln L = & \sum_{i=1}^N d_j^{yy} \ln \Phi_{12}\left(\frac{B_j - X'_{1j}\beta_1}{\sigma_1}, \frac{B_j^d - X'_{2j}\beta_2}{\sigma_2}, \rho\right) + d_j^{yn} \ln \Phi_{12}\left(-\frac{B_j - X'_{1j}\beta_1}{\sigma_1}, \frac{B_j^d - X'_{2j}\beta_2}{\sigma_2}, \rho\right) \\ & + d_j^{ny} \ln \Phi_{12}\left(\frac{B_j - X'_{1j}\beta_1}{\sigma_1}, \frac{B_j^d - X'_{2j}\beta_2}{\sigma_2}, -\rho\right) + d_j^{nn} \ln \Phi_{12}\left(-\frac{B_j - X'_{1j}\beta_1}{\sigma_1}, \frac{B_j^d - X'_{2j}\beta_2}{\sigma_2}, -\rho\right) \end{aligned}$$

This estimation was done by bivariate probit using the biprobit command in the STATA 15 software. Consequently, the mean WTP is calculated by

$$\text{meanWTP} = \frac{-X\beta'}{\beta_{bid}}$$

where \bar{X} represents the mean of the explanatory variables, β' the vector of the parameter estimations of the variables, and β_{bid} the estimated coefficient of the bid. The confidence interval is obtained with the method suggested by Krinsky and Robb (1986).

2.4 Variable description

Table 4 shows descriptions of the variables that were used to estimate the WTP. There are two continuous and eight categorical or dummy variables. The dummy variables have categories with a range of 2–5.

3 Results

3.1 Demographic and socioeconomic overview

A summary of the socioeconomic and demographic characteristics of the household respondents is presented in Table 5. The average respondent is 44 years old and the average family size is six. Most of the respondents were male heads of households (87%). Most of the farmers (58%) did not attend any kind of education and only 12% had a secondary or higher degree. In the data, we found that the younger generations are relatively more educated than the older ones. Where 70% of the respondents younger than 31 had some education, only around 26% of the people above 60 years old went to school. Regarding the estimated annual income of the households, many of them (64%) reported an income level greater than 50,000 ETB. We also tried to see the income of the respondents in relation with their location. The share of people earning more than 70,000 ETB is the highest in Addis Alem (32%), followed by the kebele of Zenzelema (26%). The kebeles distance themselves in this way from Weramit and Wereb where this share is only 21% in each kebele. At the same time, Addis Alem and Zenzelema have the highest share (both 20%) of respondents earning less than 40,000 ETB.

3.2 Willingness to join to improve the ecosystem services of agricultural land

After providing the information about the proposed project, the respondents were asked whether they would like to participate in the project. Those who were not willing to join were asked to explain their reasons. Of the 513 respondents (with complete information), 451 were willing to take part in the project. Only 62 respondents (12%) declined the offer. The most frequent reasons provided by the farmers for not being willing to participate were: (i) preferred to use their money for another purpose (such as a small business); (ii) preferred to implement the improvements by themselves; (iii) not want to continue as an agriculturalist; (iv) were too old and did not want to get involved in a long-term project.

An attempt has been made to associate the willingness to join with the characteristics of the respondents using a probit model. The results are presented in Table 6. The negative coefficient of Age indicates that younger people are more eager to join the project than the elderly. Furthermore, farmers in Addis Alem and Weramit are more likely to participate than farmers in Zenzelema. Also, the lowest income class has a lower probability of answering yes than the highest-earning respondents. Having a secondary or higher degree appears to have a statistically positive impact on the willingness to join. The hypothesis that people who have already been expropriated are less likely to join the project is confirmed in this model. From the people who chose not to participate, 62% had already been expropriated in the past.

Table 4 Type, categories, and description of the variables which were used to estimate WTP

Variable	Type	Categories	Description
Bid 1	Dummy	2	The answer to the first bid question: "Yes" (= 1) or "No" (= 0).
Bid 2	Dummy	2	The answer to the second bid question: "Yes" (= 1) or "No" (= 0).
Age	Continuous	–	Respondent's age in years.
Gender	Dummy	2	Respondent's gender, i.e., "Male" (= 1) or "Female" (= 0).
Family Size	Continuous	–	The number of people the respondent takes care of, as a household head. These household members can either be actively cooperating in the activities of the farm or not.
Location	Dummy	4	The kebele where the respondent's land is located.
Income	Dummy	5	The yearly income of the respondent.
Land surface	Dummy	3	The size of the respondent's land.
Education	Dummy	3	The education that the respondent has enjoyed. This can either be no education, elementary school, or secondary school and higher.
Expropriated	Dummy	3	This variable represents whether a respondent has never been expropriated, has been expropriated in 2010 or after (considered as recently), or has been expropriated before 2010 ("in the past").

3.3 Willingness to pay to improve ecosystem services of agricultural land

Before estimating the probit model, we tried to observe the data regarding the respondents' responses for the initial and follow-up bids (see Table 7). From the total 451 respondents who voted in favor of the project, around 63% agreed to pay the first bid that is randomly provided for them. Remarkably, a high share (40.3%) of the respondents answered

Table 5 Main demographic and socioeconomic characteristics of the sample households

Characteristics	Frequency or average	% in the sam- ple ($N=513$)	Characteristics	Frequency	% in the sam- ple ($N=513$)
Age (average)	44	–	Income (in ETB)		
Sex			Below 40,000	88	17
Male	448	87	40,000–50,000	96	19
Female	65	13	50,001–60,000	107	21
Family size (average)	6	–	60,001–70,000	92	18
Education			More than 70,000	130	25
Illiterate	300	58	Land size (in ha)		
Elementary	150	29	Less than or equal to 0.5	93	18
Secondary and above	63	12	Between 0.5 and 1	224	44
			1 and above	296	38
Expropriation					
Recent (after 2010)	109	21			
Past (before 2010)	76	15			
Never	328	64			

Table 6 Results of the probit model used to estimate the association between respondents' willingness to join the project and their characteristics

Variable	Coef.	Std. Err.
Age	−0.015**	0.008
Gender (male = 1, female = 0)	−0.228	0.256
Family size	−0.005	0.051
Addis alem	0.75***	0.266
Weramit	0.593**	0.239
Wereb	0.264	0.216
Income 1 (<40,000 ETB)	−0.623*	0.318
Income 2 (40,001–50,000 ETB)	−0.413	0.311
Income 3 (50,001–60,000 ETB)	0.004	0.326
Income 4 (60,001–70,000 ETB)	−0.444	0.284
Small land (0–0.5 ha)	−0.264	0.274
Medium land (0.5–1 ha)	0.651**	0.253
Elementary	0.205	0.203
Secondary or higher (Ref.)	0.595*	0.358
Expropriated recently	−1.048***	0.220
Expropriated in the past	−0.445*	0.233
Constant	2.795***	0.531
Number of observations:	513	
LR chi ² (16) (prob > chi ²)	85.57 (0.000)	

*** $p > 0.01$; ** $p > 0.05$; * $p > 0.10$

positively to both WTP questions, which means no fixed upper bound for their WTP could be determined. Only a small share (15%) of “No-No” answers was recorded.

Table 7 Respondents responses for initial and follow-up bids

		Follow-up bid					
		Yes		No		Total	
		N	%	N	%	N	%
Initial bid	Yes	182	40.3	99	22.4	281	62.7
	No	101	22	69	15.3	170	37.3

Results of the bivariate probit model estimations are presented in Table 8. Before analyzing the coefficients, it is important to take a look at ρ , the correlation coefficient between the error terms of the first and second response equations. First of all, the likelihood-ratio test of $\rho=0$ is rejected, which proves that the decision behind the second answer is endogenous in the system and that estimating individual probit models would generate inefficient results. At the same time, the value of ρ is -0.321 and thus not equal or near to 1, which justifies the use of the bivariate probit model instead of the interval data model. The Wald statistics indicate that the variables in the bivariate probit model are jointly significant. The variance inflation factors (VIF) of the variables indicated that there was no multicollinearity, so in the initial model (not shown) all variables were included. In estimating the model, “Zenzelema,” “income more than 70,000ETB,” “land size greater than 1 hectare,” and “never expropriated” were taken as references to their respective categories.

The results of the estimation of the bivariate probit model show that both the initial bid and the follow-up bid have the expected negative signs and are statistically significant. This result is consistent with the economic theory that states that the respondents’ willingness to pay decreases as the bid amounts increase.

In most of the variables, the estimation results are similar in Models 1 and 2 in terms of significance. Some of the variables, such as sex and education, turned out to be insignificant and are not included in Table 8. There are also variables in which the two models resulted into differences in significance. In the case of Family size, for example, it is significant in the first model, but insignificant in the second model. In the first model, Family size is negatively related to WTP at the 10% level of significance, which indicates that farmers with large family size are less likely to pay for the initial bid amount. Similarly, the variable Age is significant in the second model, but not in the first model. In Model 2, respondent’s age is negatively related to WTP, which shows that respondents who are older are less willing to pay for the second bid. On the other hand, in both models the estimation of variables including location of the respondents, income level, land size, and status of expropriation were related to WTP at different levels of significance. Respondents living in Zenzelema are more likely to pay for the initial and follow-up bids than those in other kebeles. Household income is positively related to WTP, which indicates that households with an income level above 70,000 ETB are willing to pay more than those who have annual income less than that. Similarly, respondents with large parcels of land are more willing to pay than those who have less. Respondents who were affected by expropriation are less willing to pay than those who were not affected by expropriation.

The mean WTP of Models 1 and 2 are presented in Table 9. The mean WTP for Model 1 (the first bid) was estimated to be 68.91 ETB per qada per year – that is, 275.64 ETB per hectare per year – with a 95% confidence interval of 62.88–75.64 ETB. The mean WTP for Model 2 (the second bid) was estimated to be 88.29 ETB per qada per

Table 8 Estimations results of the bivariate probit model for the initial and follow-up bid responses

Variable	Model 1 (WTP 1st bid)		Model 2 (WTP 2nd bid)	
	Coef.	Std. Err.	Coef.	Std. Err.
Initial bid	-0.027***	0.000	-	-
Follow-up bid	-	-	-0.010***	0.002
Age	-0.000	0.008	-0.011*	0.007
Family size	-0.103**	0.051	-0.013	0.041
Addis alem	-0.847***	0.235	-0.570***	0.197
Weramit	-0.877***	0.236	-0.655***	0.201
Wereb	-1.824***	0.239	-1.160***	0.198
Income 1 (< 40,000 ETB)	-1.044***	0.281	-1.049***	0.230
Income 2 (40,001–50,000 ETB)	-0.600**	0.243	-0.550***	0.203
Income 3 (50,001–60,000 ETB)	-0.617***	0.223	-0.117	0.198
Small land (0–0.5 ha)	-1.172***	0.305	-0.623**	0.253
Medium land (0.5–1 ha)	-0.800***	0.216	-0.297	0.184
Expropriated in 2010 or later	-0.421*	0.215	0.091	0.187
Constant	4.285***	0.503	2.470***	0.408
ρ	-0.321			
Likelihood-ratio test of $\rho = 0$	chi ² (1) = 6.932	Prob > chi ² = 0.0085		
Observations	451			
Wald chi ² (Prob > chi ²)	218.44 (0.000)			

*** $p > 0.01$; ** $p > 0.05$; * $p > 0.10$

Ref.: Reference category

Table 9 Estimates of the mean WTP (ETB/ha) of models 1 and 2

	Mean WTP	95% Confidence interval	ASL*
Model 1	275.64	(251.52 302.56)	0.000
Model 2	353.16	(288.84 490.12)	0.000

* Achieved significance level for testing $H_0 = WTP \leq 0$

year – that is, 353.16 ETB per hectare per year – with a 95% confidence interval of 72.21–122.53 ETB.

4 Discussion

This study showed how the socioeconomic characteristics of the farmers affect their willingness to join and willingness to pay for the proposed agricultural land management project, which aims to improve the quality and quantity of ES. We have shown that there were some people who did not want to participate in the proposed project. The analysis of association between the socioeconomic characteristics and the respondents’ willingness to join revealed that older respondents were less willing to join the proposed project than younger respondents. This result is consistent with the findings of previous studies (Dahal et al., 2018; Del Saz-Salazar et al., 2009). As the results of the present study and other

studies have shown, older people may also think that their remaining life would not allow them to participate in the long-term project and may have also a different understanding of the environment (Del Saz-Salazar et al., 2009). The respondents' willingness to join is also affected by the size of the land they have. We found a direct relationship between the size of the farmers' land and their willingness to join; this has also been shown in other studies. Expropriation, which causes the farmers to lose their land, is negatively related to willingness to join. This could be because: (i) practice of expropriation causes tenure insecurity and hence lower motivation on land management activities; or (ii) expropriation leaves farmers with small land size. In the study area, a significant number of farmers lost their land through expropriation and were forced to live with the remaining small land, as the compensation amount does not allow them to purchase the same size of land (Admasu et al., 2019). Moreover, the farmers with higher educational and income level are more willing to participate in the proposed project, which is in line with other similar studies (Asrat et al., 2004).

The results of Model 2 indicated that the age of the respondents has a negative relationship with the WTP for the land management activities like the one proposed in this study. This result agrees with the findings of other studies that showed that willingness to pay for the environmental improvements decreases as age increases (Dahal et al., 2018; Dribek & Voltaire, 2017; Lo & Jim, 2010). Similarly, in Model 1, having a larger family appears to have a negative impact on the WTP for land management activities that can improve the ES. This result is consistent with similar studies, which found that having to maintain a larger family comes with a higher cost, which might reduce the monetary means that can be freed up for this kind of project (Carlsson et al., 2004; Chang & Ying, 2005). Studies have also argued that the location where the respondents live has an impact on the willingness to pay for such kinds of projects (Aizaki et al., 2006). Thus, people who are living in an area with higher productivity and enjoyment of many of the environmental benefits are willing to pay more than others. In the present study, respondents of *Zenzelema* showed their willingness to pay more for the proposed project than other study *kebeles* (*Addis Alem, Weramit, and Wereb*). In an earlier study on the assessment of the use and potentials of ES of the four study *kebeles*, *Zenzelema* appeared to be highest in terms of use and potentials of ES, as perceived by farmers (Admasu et al., 2020).

The results also indicated that respondents with higher income have a greater WTP than others with lower income. This result agrees with the economic theory and most of the Contingent Valuation studies conducted on environmental valuation studies (Majumdar et al., 2011). For instance, more than 75% of respondents who were not willing to pay for the initial and the follow-up bids are farmers who reported an annual income less than 50,000 ETB. These respondents were willing to participate in the project, but their income level restricted their ability to proceed with the project. Similarly, farmers with bigger land size showed a higher WTP than others with smaller land size. Other studies have found a positive relationship between land size and willingness to pay ES (Bogale, 2011). Farmers with large numbers of land parcels may benefit from such kinds of projects because the individual farmers may not have the enough labor capacity and finance to conserve their land to improve the benefits they are obtaining from the land. Larger land size is also related to higher income, which in turn positively impacts the willingness to pay for ES.

Most studies have indicated that educated people are more aware of the benefits of the ES and willing to pay more for projects that are proposed to improve ES (Dahal et al., 2018; Jianjun et al., 2013). The present study, by contrast, found an insignificant relationship between a higher educational level of the respondents and their willingness to pay for the improved ES. We did not see significant differences between the WTP of respondents

with secondary or higher education and those with no or little education. It may not be feasible to conclude from our results that there is an inverse relationship between education and WTP. This may be due to the small number of respondents with secondary or higher education, which is only 12% of the sample population. As expected, respondents who experienced recent land expropriation were willing to pay less than others who were not affected by expropriation. This is related to the remaining land size of the farmers because, in our previous study, we found that most of the farmers who had their land expropriated in the study areas lost most or of all their land (Admasu et al., 2020).

Of the two models used to estimate the mean WTP, Model 2 resulted in a higher mean WTP than the estimates of the mean WTP of Model 1. The difference between the mean WTP of the two models is 77.52 ETB per ha per year. In the double-bounded dichotomous choice model, there is a need to decide the final mean WTP for further decision makings. To make such a decision, we used the estimated mean WTP of the interval data that was run before we estimated these models and tested the data with the estimation of interval data model with the same set of variables. We found the mean WTP, which is lower than the mean WTP of Model 1. We have taken this into account to avoid overestimating the mean WTP and recommend using the mean WTP of Model 1 for further decision making. Other studies also used avoidance of overestimation as a criterion to choose between the two mean WTP estimates of a bivariate probit model (e.g., Echeverría et al. (2014)). In addition, the mean WTP of Model 1 has a narrower confidence interval than that of Model 2, which can also be taken as an additional criterion in selecting the mean WTP from models (Dahal et al., 2018). Therefore, by considering the mean WTP of 275.64 ETB per hectare per year, total number of households in the study areas (5,531) (Bahir Dar City Administration, 2019), 7% discount rate,⁴ the 10-year payment period, and the average land size of the household (1.46 ha) (Alemu et al., 2017), the aggregate WTP is estimated at 16,727,892 ETB.

The results of this study have several implications in the process of land expropriation for urban expansion and for future agricultural land development in the study areas. The results could be used to modify the compensation scheme being implemented by local government. Currently, the government is paying a displacement compensation that is calculated based on the value of the three crops: maize, teff, and finger millet. Between 2007 and 2017, the local government expropriated 1500 ha of land from the study kebeles (Admasu et al., 2019). Based on the results of this study, the government saved more than 4.1 million ETB (= 1500 ha*2,756.4 ETB per ha*10 years), which should have been compensated. However, the inclusion of the monetary value of nonmarket ES would help to reduce the environmental problems that may arise as a result of not considering the nonmarket ES during the land expropriation process. If the farmers are compensated for the proper management of their land and the improvements made to increase the quality and quantity of ES, they would be encouraged to protect and conserve their land. The results of this study also revealed that the farmers clearly have value for the indirect benefits, which in turn means they have a price. Therefore, there should be a system that could enable the local government to compensate and keep some of the ES from being depleted after expropriating the land (that is, during the land development phase). In this regard, the results of this study would provide a monetary value of the nonmarket ES that could be used as input for the sustainable land use development.

⁴ This represents the rate that the Ethiopian banks pay for deposits.

In addition, the results of this study provide relevant information about the possibility of implementing the land management projects in collaboration with the local community. This is very important for the future development of the agricultural land. In Ethiopia, although the productivity of the agricultural sector is improving over time, more remains to be done to further increase the productivity of the agricultural land. This could also not be possible with government financing alone. Society should also support the projects both in kind and cash. In this regard, as indicated in their willingness to join and willingness to pay responses, most of the farmers are happy to join and contribute to the proposed project. Therefore, the results of this study could be used as a baseline information to prepare such projects. The results would help the project preparation by providing information about the potential contribution by the local community and the characteristics of the community that are important for willingness to join and pay.

This study has certain limitations apart from the general criticisms on the contingent valuation method. The survey used a double-bounded dichotomous choice in which the lower and upper bids are provided for the respondents. In this case, the survey did not give an option for the respondents to state the maximum or minimum amount they could contribute, which might have caused overestimation or underestimation of the WTP. This would have been possible by adding open-ended questions after the lower and upper bids. This study focused only on some of the nonmarket ES from the regulating and supporting services. However, there are ES from the family of regulating and supporting ES that were not included in this study. In addition, the agricultural landscape is providing cultural services, but these were not studied. Therefore, future studies that include many of the non-market ES are recommended.

5 Conclusions and policy recommendations

The study was conducted in Bahir Dar City, where local government has been engaged in the incorporation of large parcels of rural land as a response to the rapid population growth in the city. The city planners and land use decision makers are confronted with urban land development on one hand and sustainability of the environment on the other. An important piece of information for the sustainable development of the land would be the monetary value of the environmental benefits, which in most cases is difficult to quantify. This study estimated the monetary value of nonmarket ES from agricultural land using a double-bounded dichotomous choice contingent valuation. A total of 513 smallholder farmers were surveyed. More than 85% of the respondents were willing to participate and willing to pay for the proposed project. The hypothetical project presented to the respondents aimed to improve the ES, such as soil erosion control, air regulation, climate regulation, water provision, and land fertility. The study applied a bivariate probit model to analyze the survey data.

In general, the results of this study revealed that farmers have value for the ES included in the study. On average, the farmers were willing to pay 275.64 ETB per ha per year to improve the ES. The value they assigned to the ES is also influenced by their socioeconomic characteristics. Age, family size, income level, and size of the land affect the farmers' decisions regarding their willingness to pay. Younger farmers are willing to pay more than older ones. On average, a farmer who takes care of more people shows a lower willingness to pay. Income level and land size are positively related to WTP. The practice of land expropriation, which is common in the study areas, has an adverse impact on WTP.

The results of this research could help achieve sustainable urban development in Bahir Dar City and in other cities with similar situations. The city planners and land use decision makers may use this information in several ways. They can use the aggregate estimated value of the ES in their cost–benefit analysis of further land expropriation decisions. Based on this, they can allocate an additional compensation payment for the affected people that would be paid, with certain criteria, such as keeping terraces, trees, and others in their land. Setting a compensation amount to all affected people may not ensure sustainability. The local government should also allocate some budgets to maintain some of the ES. Rural land use managers can use the results of this study to design a land management project where both the government and the community share the costs of the project.

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Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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