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Willingness to Pay for the Conservation of Lake Chamo Ecosystem, Ethiopia

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Abstract

Lake Chamo ecosystem is an important reserve area for plants, animals and microbial communities that used to ensure the existence of biodiversity in a harmony. But currently, it is highly threatened by human activities that is already causing considerable ecological problems. Community based conservation method is considered as a remedy. This study was therefore conducted in three kebeles, namely Zeyse Elgo, Zeyse Wezeka, and Genta Kanchama Ochole in Arba Minch Zuria wereda using interview method with structured and semi-structured questionnaires to generate primary data, and find out the willingness of beneficiaries to pay for a hypothetically prepared conservation plan of Lake Chamo ecosystem and the factors that triggers respondents to decide on their willingness to pay (WTP). Results indicated that the mean WTP was found to be 2.04 ETB (Ethiopian Birr)/month/household, with an aggregate benefit of 775,980.99 ETB per year for the wereda. Majority (94.6%) of the respondents voted for the hypothetically planed conservation activities. Seven important factors were identified and their impacts on WTP were studied with logistic regression analysis. Two of the variables i.e., the concerns of respondents about the needs of future generations and ages of the respondents were found to be statistically significant in influencing the probability of WTP for the conservation of the Lake Chamo ecosystem. Total community based ecosystem management that balances conservation, economic and social needs was considered as a fast remedy for the current problems in the study area.

Keywords

Willingness to Pay, Contingent Valuation Method, Lake Chamo, Ecosystem Conservation

1. Introduction

Lake ecosystems have enormous economic and aesthetic values and are largely responsible for positive contributions towards maintaining and supporting overall environmental health. They can serve as source of food, medicines, and materials as well as for recreational and commercial purposes. Lake Chamo and its surrounding areas, being large and productive ecosystem, provides different services/uses such as fishing, livestock grazing and watering, for irrigation (agriculture), source of fire wood and thatch grass, and domestic use of water, supporting the economic and social development of dwellers of the adjacent *kebeles*. Besides, it provides hydrological and ecological functions through maintaining water quality, ground water recharge, flood mitigation, nutrient recycling, microclimate stabilization and wildlife habitat. However, Lake Chamo ecosystem is facing major threats as a result of human induced activities and climate change including siltation, irrigation (high water demand and diversion of tributaries), illegal fishing, lake shore farming (farmland expansion), deforestation/vegetation clearance, land degradation, and overgrazing [1, 2]. Pollution as a result of increasing human and livestock populations was reported as another threat to Lake Chamo and the surrounding ecosystem [3]. Overfishing is a real danger in Lake Chamo whereby intensive fisheries or non-sustainable, destructive fishing practices exist [4, 5]. The aquatic biodiversity resources are also threatened by lake level changes and associated limnological alterations [6]. Therefore, a holistic conservation plan is badly needed to mitigate the currently existing environmental threats in Lake

Chamo and the surrounding ecosystem. Moreover, a mechanism that studies the willingness of the local people to participate in any conservation works with contribution (cash) highlights the success of any proposed conservation schemes in the area in the future. The value of Lake Chamo ecosystem should come first while considering any activity of its conservation. Economic valuation is defined as the attempt to assign quantitative values to the goods and services provided by environmental resources [7]. But some goods and services may have no market values, therefore in such a situation where by environmental resource simply exists and provides with products and services at no cost, it is willingness of the people alone which describes the value of the resource. Economic valuation, as a tool, can serve a number of purposes including assessing the impact of specific development activities, making choices between options and setting regional or national policy. This study is, therefore, planned to value the willingness of beneficiaries to pay for a hypothesized Lake Chamo ecosystem conservation activities in monetary terms and identify the factors governing their willingness to pay.

2. Materials and Methods

2.1. Study Area

Arba Minch Zuria *wereda* is located in Gammo Gofa zone of the Southern Nation's Nationalities and People Regional State. The households and human population of the Wereda are 33,508 and 163,955, respectively [8]. Three kebeles *(Figure 1)* in the *wereda* used as study sites were: *Zeyse Elgo*, *Zeyse Wezeka*, and *Genta Kanchama Ochole*. Lake Chamo is one of the most economically important fishing grounds in Ethiopia. The lake watershed, which covers an area of about 2205 km^2 is situated at an altitude ranging from 1,105 m asl (lake level) to 3,546 m asl with in a distance of 39.94 km [6]. It has a climate that varies from semi-arid to afro-alpine, with bimodal rainfall pattern having two peak rainy seasons. Lake Chamo is eutrophic and harbours *Hippopotamus amphibious* populations, giant crocodiles, *Crocodylus niloticus* and variety of bird species including migratory ones [6].

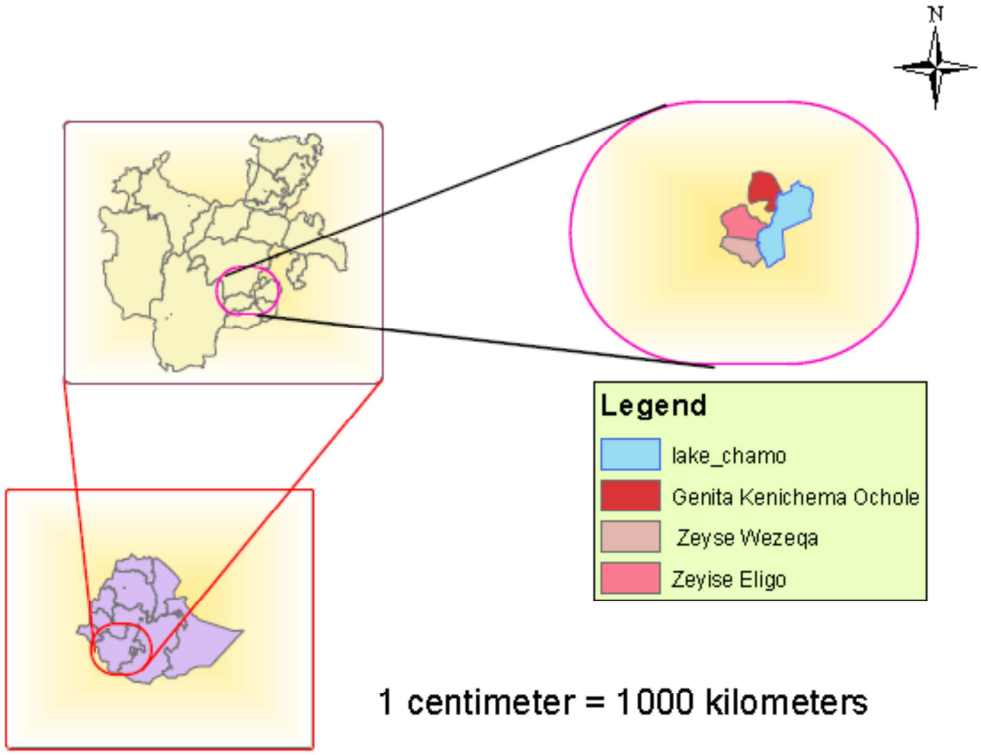

Figure 1. *Map of the study area.*

2.2. Objectives

This study was conducted to determine the Willingness to Pay (WTP) of beneficiaries of Lake Chamo ecosystem to its conservation and to identify the major factors determining the WTP of the sampled population benefiting from the ecosystem.

2.3. Methodology

2.3.1. Contingent Valuation

Contingent Valuation (CV) is a method that involves in finding an individual's WTP for the goods by constructing a hypothetical market [9]. It is a method of recovering information about preferences or willingness to pay from

direct questions. A number of research results that applied CV as a method have been reported. CV is used to define policy strategies in biodiversity conservation and protected areas management, to estimate environmental values, to analyze cost-benefit and environmental impact assessment [10, 11, 12, 13]. It is also used to place an economic value upon species conservation and protected areas [14, 15].

2.3.2. Willingness to Pay (WTP) Scenario

The importance of Lake Chamo ecosystem, in relation to the livelihood of the people around it, and the strong need of conservation activities that need to be implemented in the area were thoroughly explained to the respondents. Community based association was hypothesized with a mandate to look after conservation activities aimed at tackling the below listed major threats being observed in the area and caused by human activities, vis-à-vis water pollution (e.g., from agricultural chemicals), water abstraction from the lake and from inflowing rivers (e.g., Kulfo and Sego rivers), forest destruction in the catchment, siltation of the lake and inflowing feeder rivers, habitat destruction (e.g., ditch or narrow channel dug at the side of the farm land near the lake that hinder the movement of large mammals like Hippopotamus, livestock…etc.), lake level and surface area recession, decline in fisheries resources, introduction of alien plant species, overfishing, agricultural expansion (lake shore being ploughed), irrigation of banana farm, and poor law enforcement regarding mesh size restriction. After the objectives of the hypothetical community based association was made clear to the respondents, they were asked to contribute to it through monetary means (payment vehicle proposed as money). The bidding price for the WTP were 4, 8, 12 and 16 Ethiopian currency, which is Birr; (ETB) per month per household to be collected by officials of the kebele and the would be association going to be elected by residents of the area. If a respondent voted no to the proposed conservation activities, he/she was asked to give the reason behind his/her decision.

2.3.3. Data Collection and Analysis

The study was based on primary data collected from household survey. Before the survey, a group discussion with members of *wereda* Livestock and Fisheries Office was held and three *kebeles* located near the lake were identified, assuming that the majority of the respondents from these *kebeles* relied more on the Lake Chamo ecosystem for their livelihood than respondents in far off places. Before conducting the formal field survey, local enumerators (university graduates) residing in the respective *kebeles*, were selected and oriented on administering household survey questionnaire and WTP scenarios. The enumerators were familiarized with all the questions of the survey to avoid any confusion, and then randomly selected people (N=149) were interviewed. The questionnaire included the socioeconomic characteristics of the respondents, their willingness to pay for the proposed Lake Chamo ecosystem conservation plan, and the possible determinants of their WTP. Descriptive statistics (mean, median…etc.) was calculated with a software SPSS [16]. The study area was mapped with ArcGIS [17] software, and a chart was done with Microsoft excel [18]. The explanatory variables used in the regression for respondent's WTP for community based conservation activities in Lake Chamo ecosystem were respondents concern about the future generation needs from Lake Chamo and its ecosystem (FUTURE), anthropogenic pressure on the lake (PRESSURE), age of the respondents (AGE), number of household members (NOHMEM), average monthly household income (INCOME), threats the lake and the surrounding ecosystem are facing (THREAT), and economic activities respondents are involved in (ECONACT). The logistic regression has been carried out using the above mentioned factors as independent variables and WTP as dependent variable. The binary choice model was set on whether the respondent is willing to pay or not (1 = Yes, and 0 = No), and because of this nature of dichotomous structure of the dependent variable (WTP), in this study, the most widely used model in contingent valuation studies i.e., binary logistic regression analysis was used, with a model that helps in estimating the probability of occurrence of an event [19], represented as:

$$\ln [P(Yi = 1)/1\text{-}P(yi=1)] = \beta 0 + \beta 1(\text{FUTURE}) + \beta 2(\text{PRESSURE}) + \beta 3(\text{AGE}) + \beta 4(\text{NOHMEM}) + \beta 5(\text{INCOME}) + \beta 6(\text{THREAT}) + \beta 7(\text{ECONACT}).$$

3. Result

3.1. Socioeconomic Characteristics of the Respondents

In this study, 149 respondents participated from three systematically selected *kebeles* bordering the lake, i.e., *Zeyse Elgo* (49, 32.9%), *Zeyse Wezeka* (50, 33.6%) and *Genta Kanchama Ochole* (50, 33.6). Their educational status is categorized as illiterate (46, 30.9%), attended informal school (8, 5.4%), elementary (70, 47.0%), high school (21, 14.1%) and college (4, 2.7%) levels. In the same way, their age is also categorized into three groups, 20 – 35 years of age (60, 40.3%), 36 – 51 years of age (78, 52.3%) and 52 – 70 years of age (11, 7.4%). In this study, proportion of males and females was 140 (94%) and 9 (6%), respectively. Majority of the respondents (132, 88.6%) are married, very few single (15, 10.1%), and only (2, 1.3%) divorced. The number of household members of the respondents ranged from 1 to 14, with an average value of 6.54 (Standard Deviation 3.340). The average monthly household income of the respondents varied from below 100 (ETB) (22, 14.8%), 101-200 ETB (25, 16.8%), 201-300 ETB (22, 14.8%) to greater than 300 ETB (80, 53.7%). Out of the total 118, (79.2%) of the respondents are a member of organization working on environmental issues while the rest 31 (20.8%) of them are

not a member of any organization. The time required to cover the distance between Lake Chamo and respondents home was framed as less than 30 minutes (15, 10.1%), 30 minutes to one hour (49, 32.9%), one hour to one and half hour (83, 55.7%), and more than one and half hour walk (2, 1.3%). The livelihood of the respondents depends on farming (126, 84.6%), trade (14, 9.4%), fishing (4, 2.7%) and other (5, 3.4%). The respondents have listed the functions/uses they are getting from Lake Chamo and its watershed as fishing (106, 71.1%), livestock grazing and watering (26, 17.4%), for irrigation (13, 8.7%), source of fire wood (2, 1.3%), and domestic use of water (2, 1.3%). Almost all of the respondents (137, 91.9%) reported that they believe Lake Chamo and its surrounding is not properly taken care of and it is under high pressure. They prioritize the existing major threats as siltation (45, 30.2%), illegal fishing (26, 17.4%), lake shore farming (24, 16.1%), deforestation and overgrazing (21, 14.1%), pollution (8, 5.4%), illegal settlement (8, 5.4%) and irrigation (5, 3.4%), while the other 12 (8.1%) believed that there is no threat. Asked about their concern for the future generation needs associated with the lake and its watershed, 144 (96.6%) of them responded that they are highly concerned and 5 (3.4%) reported that they are not concerned.

Table 1. *Socioeconomic characteristics of the respondents.*

Variables	Frequency	Percent (%)
Age Group		
25 – 35	60	40.3
36 – 51	78	52.3
52 - 70	11	7.4
Sex		
Male	140	94.0
Female	9	6.0
Marital status		
Married	132	88.6
Single	15	10.1
Divorced	2	1.3
House Hold Members	Average 6.5	Range; (1-14)

3.2. Willingness to Pay

Respondents' willingness to pay for the proposed project was very high. Out of the total 149 people, 141 (94.6%) of the respondents agreed to vote for the proposed conservation activities of Lake Chamo and its surrounding area, while the other 8 (5.4%) voted no to the program. The mean willingness to pay and median are 2.04 and 2.00 ETB/month/household, respectively. Reasons stated by the respondents that are not willing to pay ranged from: "I do not believe that the money I will pay actually be used for the conservation of Lake Chamo and its surrounding area (5, 3.4%)", I do not earn enough money to pay for the proposed program (1, 0.7%), only people who directly benefited from Lake Chamo and its watershed should pay for this program (1, 0.7%), and only those who have higher income should pay for this program (1, 0.7%). The statistical mean, median, standard deviation, minimum and maximum of willingness to pay in ETB per month (N =141) were 2.04, 2.00, 1.136, 4 and 16, respectively. The mean willingness to pay is estimated at 24.48 ETB per year per household with an aggregate benefit of 775,980.99 ETB per year for the *wereda*. The fitted linear trend line (*Figure 2*) shows that on average the frequency of the respondents decreases with increase in the level of payment, which is in consistent with the principle of demand.

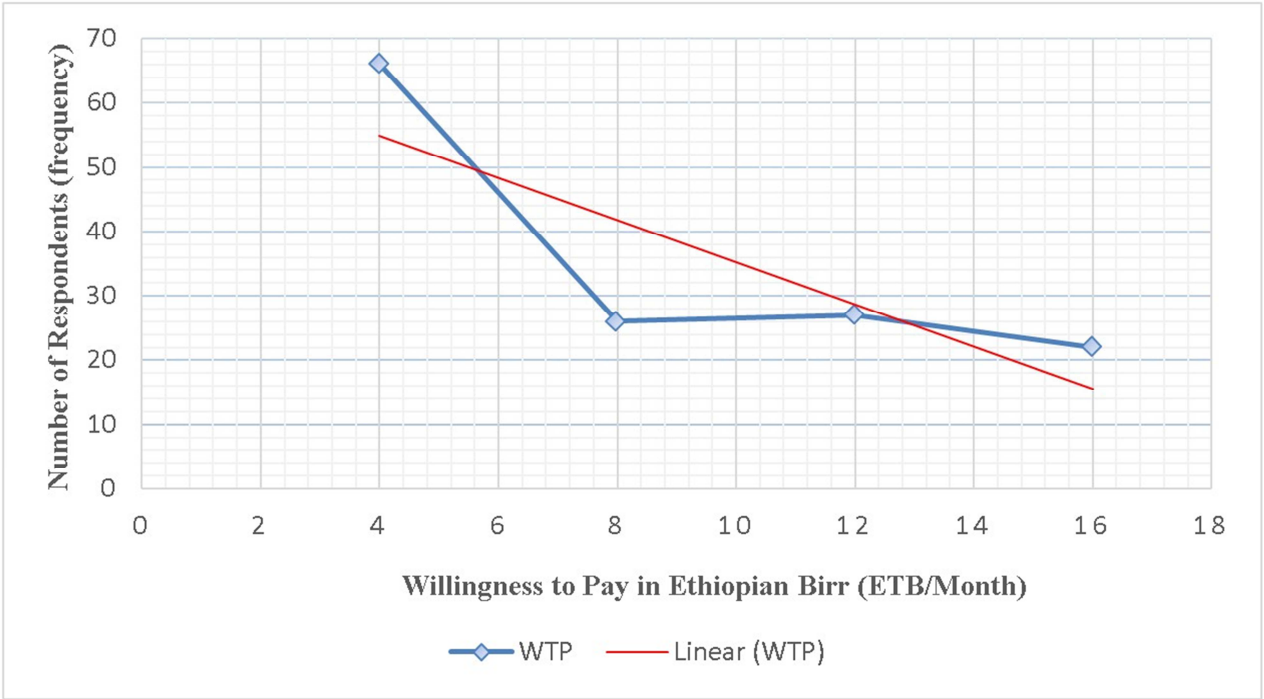

Figure 2. *Frequency of Respondents with Different Levels of WTP.*

3.3. Determinants of Respondent's WTP Amount

Result of the logistic regression model is presented in Table 2. Among the group of respondents who were willing to pay, two variables, the concern of respondents about the future generation needs from Lake Chamo and its ecosystem, and age of the respondents affected their WTP significantly. The other variables, though not significant, also affected the WTP positively except Econact (economic activities respondents are involved in), which had a negative impact on WTP. The percentage of correct prediction of the logit model, which is a measure of goodness-of-fit of model or prediction accuracy was 95.3%.

Table 2. *The results of logistic regression analysis (N=149), * = significant at 0.05.*

Variables	B	S.E.	Wald	Df	Sig.	Exp (B)
Future	5.011	2.146	5.451	1	.020*	150.042
Pressure	.587	1.305	.203	1	.653	1.799
Age	-2.969	1.476	4.044	1	.044*	.051
Nohmem	.351	.213	2.719	1	.099	1.420
Income	.343	.472	.529	1	.467	1.409
Threat	.029	.232	.015	1	.901	1.029
Econact	-16.190	4204.800	.000	1	.997	.000
Constant	7.979	4204.801	.000	1	.998	2920.330
-2 log likelihood	40.805					
Percentage of Correct Prediction	95.3					

Note; Future (the concern about the needs of future generations), Pressure (the amount of pressure being exerted on the ecosystem), Age of the respondents, Nohmem (Number of household members), Income (monthly household income), Threat (different threats to the ecosystem), Econact (economic activities respondents are involved in)

Table 3. *Economic Value of Lake Chamo Ecosystem Conservation.*

Wereda (A)	Total households (B)	Percent of protest zero (C)	Expected households to have a protest zero (D)	Expected households with valid responses (E)	Mean (WTP) (F)	Aggregate benefit (in Money) (G)
Arba Minch Zuria	33,508*	5.4	1809.43	31,698.57	24.48	775,980.99

A. Wereda (district) included in the study
B. Total households of the Wereda/district
C. Percent of protest zeros (not willing to pay) in the Wereda/district for the planned Lake Chamo ecosystem conservation activities
D. 8 (5.4%) of our 149 sampled households were protest zeros, so they were excluded from further analysis. It is calculated by multiplying the percentage of sampled protest zeros with the total households (C*B)
E. The expected number of households which are expected to protest for the proposed project. It is calculated as (B – D)
F. The mean willingness to pay in cash (ETB) that a respondent could pay for Lake Chamo ecosystem conservation activities in a year
G. Mean multiplied by expected households with valid responses to the proposed program measured in cash (F*E) * [8]

4. Discussion

The result of this study indicated that the respondents are highly willing to pay (94.6%) for the hypothesized conservation activities. They said so, perhaps they understood the high pressure that is being exerted in the Lake Chamo ecosystem. 91.9% of the respondents believed that Lake Chamo, its watershed is not properly taken care of and is under high pressure. A number of environmental threatening activities including siltation, irrigation, illegal fishing, lake shore farming, deforestation, water abstraction from the lake and its tributaries, diversion of the tributaries and overgrazing are going on exposing the environment for further destruction. These environmental threats have also been reported for the same lake some years ago, and still the destruction is going on affecting the ecosystem [6]. In addition to these physically observed threats, there are also some variables which might indirectly indicate the accelerated environmental destructions. The household size in the study area averages 6.5 showing the number of people directly or indirectly contributing to the destruction in the area. Besides, the illiteracy rate in the study area, which is most likely related to respondents' knowledge in environmental conservation, is 30.9% showing a considerable number of people possibly with no or limited know how about environmental conservation. Regardless of all these, 94.6% of the respondents agreed to contribute an average of 24.48 ETB per year per household for the hypothesized Lake Chamo ecosystem conservation activities, which has an aggregate benefit of 775,980.99 ETB per year for the *wereda*, indicating how willing they are in saving the ecosystem. In this study, the positive and significant coefficient (0.020, $P < 0.05$) of the variable (FUTURE) indicated that the more the respondents are concerned about the needs of future generations, the higher their WTP to conserve the ecosystem and to let future generation benefit from the lake and its ecosystem. Age affected the WTP of respondents to Lake Chamo ecosystem conservation negatively and significantly (0.044, $P < 0.05$). Holding other things constant, the higher the age of the respondents, the lower their WTP was, probably the older group expressed a

strong preference for lower-cost scenarios or they may have thought that priority should be given to other activities related to the immediate well-being of their household. It may also be so, because that older individuals do not directly participate in the ecosystem conservation activities. Findings of the present study is in line with what has been reported for salmon where by age negatively and significantly affected the willingness to pay of respondents for its recovery in Oregon [20]. In the same manner, it has been reported that willingness to pay for improved water services was negatively affected by age of the respondents [21, 22]. Number of household members (NOHMEM), the amount of pressure being exerted on the ecosystem (Pressure), monthly income of the respondents (INCOME) and the different threats to the ecosystem (THREAT) had insignificant contributions to the WTP, but their positive signs indicated that as they increase, respondents are more willing to pay for the conservation activities. In line with these, there is a result which indicated that household size positively influence small holder farmers' WTP for watershed conservation [23]. In estimating willingness to pay for improvements in drinking water quality in Pakistan, household income significantly affected the WTP [24]. Many threats have been identified and prioritized by the respondents in the Lake Chamo ecosystem; siltation, illegal fishing, lake shore farming, deforestation and overgrazing, pollution, illegal settlement and irrigation. Though they insignificantly affected the WTP of the respondents, their increased presence concerns the respondents, hence positive sign observed indicating that their WTP would likely increase as a result of the presence of the treats. In this study, increases in the number of options of economic activities (ECONACT) people are involved in, did not appear as a significant predictor of WTP, but the negative sign of it indicated that as options increased, WTP decreased. In the same way, alternative income negatively affected WTP of respondents in a study conducted to value the economic benefit of irrigation water in south Gondar (Ethiopia) [25].

5. Conclusion

This study estimated households' WTP for conservation of Lake Chamo ecosystem and identified its determinants. The mean WTP was found to be 2.04, with an aggregate benefit of 775,980.99 ETB per year for the *wereda*. Majority (94.6%) of the respondents voted for the hypothetically planned conservation activities. Seven important factors were identified and their impacts on WTP were studied with logistic regression analysis. Two of the variables were found to be statistically significant in influencing the probability of WTP for the conservation of Lake Chamo and its ecosystem.

6. Recommendation

Lake Chamo ecosystem beneficiaries showed a high willingness to pay in order to better protect the ecosystem, suggesting that there is scope to introduce a conservation project in the area. Therefore, it is worthwhile proposing and implementing a project that allows participation of the local people and others (Government, NGOs, community based organizations) working towards sustainable ecosystem management that balances conservation, economic and social needs. Besides, establishment of realistic buffer zone that balances the problem of scarcity of farm land in the area and the threats to the lake is needed, and proper implementation of law enforcement in this regard is considered important.

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