Harnessing local community preferences for biodiversity conservation in developing countries: Evidence from Ghana's Lake Bosomtwe basin

Jonathan D. Quartey
Department of Economics
Kwame Nkrumah University of Science and Technology
Kumasi, Ghana.
E-Mail: jdquartey@yahoo.com

This paper assesses the extent to which the preferences of local communities around Lake Bosomtwe contribute to conservation of biodiversity, particularly when it is regarded traditionally as their god. It also assesses through a Contingent Valuation Model, the local trade-off between the Total Economic Value and the primary value of the lake. The economic implications of this trade-off are analysed for the conservation of the lake, and also serve as useful lessons for biodiversity conservation in developing countries. The results indicate that the lake is on its way to eutrophication. The government of Ghana, the international community, together with other conservation minded organizations need to act through the provision of livelihood support packages for the communities around the lake. Site-specific conservation policies based on local community preferences would also be needed to save Lake Bosomtwe.
JEL CODES: Q51, Q57.
Keywords: Biodiversity conservation, Local communities' preferences, Contingent Valuation, Lake Bosomtwe, Ghana.

Background of the study

In the midst of social and economic progress, global biodiversity continues to depreciate at an accelerated rate, largely due to human activities. A review of progress toward achieving the Aichi Biodiversity Targets of the current Strategic Plan for Biodiversity 2011-2020, projected that out of 53 target elements, only 5 were on track to be reached by 2020. The recent regional assessment reports issued by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) found biodiversity to be declining in all regions of the world (IPBES, 2018).

Biological diversity represents the extent of variety in nature. This variety is made up of species of plants, animals, microorganisms and ecosystems and ecological processes of which they form part (Turner et al., 1993). Due to the complexities inherent in biodiversity, as well as its vastness, there is so much of it that has not been examined as yet. The extent of species diversity though not known, has been estimated to range from 5 to 50 million, of which, perhaps only 1.4 million have been described (Turner et al., 1993). However, many decisions made in resource allocation trade off large amounts of this unexamined resource. The danger in this is that many of these alterations are irreversible, signifying a perpetual loss of unknown (unexplored) ecological resources.

Developing nations are custodians of many environmental assets deemed to be of global significance. However, complex interests exist in how developing countries have managed parts of their environments, creating an asymmetry in the relationship between global interests in developing country biodiversity and those of local inhabitants, whose preferences might not be the same (Russell, 2001).

To this effect, there has been a wide range of means to try to affect environmental behavior, through policies in developing countries. Some of these have involved carrots, such as aid to particular policies, while some have been stick-like and others generated at the grass-roots level (Russell, 2001). However, these measures appear not to have any lasting effects, since they never stick in the communities where they are eventually implemented, because they are always associated with the originators.

A clear example has been the ban on the trade in ivory, to stop the trade in endangered species. Even though this ban followed internationally accepted rules, it appeared to local communities in Africa to be a reflection of some external perspective, indicating that the poaching of elephants had reached really dangerous levels and was not being controlled by countries hosting the elephants (Russell, 2001). However, to local communities in these areas this may not have been the case. Under such circumstances achieving the purpose of the ban becomes a near impossibility. Local communities' preferences thus appear to matter to a very large extent for global biodiversity conservation, and these will have to be identified and understood for successful biodiversity conservation.

Local communities inhabit nearly 22% of the Earth's surface, containing around 80% of the planet's biodiversity. These millions of people who manage land, hold an important key to global biodiversity conservation. With increasing populations and changing consumption patterns, food production and productivity need to increase considerably over the next decades, placing additional pressure on ecosystems (UN-DESA, 2018).

More than 75 percent of Earth's land areas are substantially degraded. Species extinction rates are historically high while the threat of invasive species and pests increases. Climate change further enhances risks of ecosystem degradation and is a leading driver of biodiversity loss in the next decades, along with agriculture and infrastructure development. The damage to livelihoods is huge, undermining the well-being of at least 3.2 billion people and, in many cases, forcing people to fight or abandon their land (UN-DESA, 2018).
The World Wide Fund for Nature International finds that the earth's wildlife populations have declined by a third over the past 35 years alone but by even more, 60%, in poorer tropical regions (World Wide Fund for Nature International, 2010). The rate and magnitude of these losses will define the earth's sixth mass extinction period unless steps are taken to quickly reverse this decline (Barnosky et al., 2011).

Problem Statement

Local and indigenous communities appear to be drivers of solutions to protect, restore and promote sustainable use of ecosystems to halt and reverse biodiversity loss. They largely depend on these ecosystems for their livelihoods, and recognizing their rights and responding to them effectively could stimulate greater progress in all dimensions.

Inadequate empirical understanding of coupled systems predictably is manifested in projects and policies that have short-lived effects but do not fundamentally change where the human or natural subsystems are headed. At this stage, what is needed first is enhanced understanding of the deep inter-linkages among ecological and socioeconomic processes in order to better grasp the key parameters and behaviors of the closely coupled human-managed ecosystems that give rise to biodiversity conservation or loss (Barrett et al, 2011).

Because the rural poor disproportionately earn a living by mixing their labor power with the fruits of nature, the returns to labor depend on the quantity and quality of the complementary natural resources available to them. When the human population grows but the stock of complementary resources does not grow as quickly, marginal labor productivity and, with it, standards of living fall (Barrett et al, 2011). Institutional failures could also exacerbate ecosystem destruction through the human population issue.

In light of site-specific complexities, there exists skepticism about the prospects for single strategies to reconcile biodiversity conservation objectives across the globe. Common interventions, such as payments for environmental services, protected areas, and resource commercialization, for example, might prove to be valuable components of holistic approaches to these coupled problems. However, the practical impacts of such components might differ markedly depending on the mechanisms that guide coupled human and natural system dynamics in a locale (Barrett et al, 2011).

Thus, biodiversity loss largely occurs at local community levels in developing countries where much of the resources used to satisfy the daily needs of whole communities are directly derived from the ecosystem. While it may not be possible to prevent this alteration, it is possible to minimize the loss through responsible management principles, which must form the basis for local community actions. These actions would normally be influenced by their preferences. Where local community preferences are such that they promote efficient management of biodiversity, it will generate a win-win situation where local communities' needs are met, without endangering the ecological functions of the earth.

Unfortunately, in many developing countries, large amounts of biodiversity are traded for very little value. Identifying local community preferences and their influence on biodiversity conservation is therefore one way of knowing how this relationship can be harnessed for conservation of biodiversity.
However, research about local community preferences on biodiversity remains very scanty particularly for developing countries. This study therefore sought to uncover and assess the extent to which local community preferences could influence biodiversity within the Lake Bosomtwe basin in Ghana. It also assesses the extent of policy support which will be needed to enhance local community actions towards biodiversity conservation.

Justifying biodiversity conservation

Much as local protected sites like Lake Bosomtwe play a crucial role in biodiversity conservation, they are more often than not perceived by some local residents as restricting their ability to make ends meet (Wells and Brandon, 1993). Thus with growing population and its attendant environmental practices which are usually unsustainable, tremendous pressure tends to be exerted on sites like the Lake Bosomtwe. Such pressures have normally been controlled by local authorities who mainly use taboos, policing and penalties to ensure compliance to sustainable practices. However, the efficiency of the reliance on traditional enforcement has been questioned as a long-term answer to the conservation of many critical ecosystems like Lake Bosomtwe.

There is a wide recognition of the fact that the successful conservation of protected areas ultimately depends on the cooperation and support of local residents. This is due to the fact that denying the residents whose incomes are normally low, access to these sites without providing them with alternative means of livelihood would be ethically wrong and politically unfeasible (Wells and Brandon, 1993). Local residents rely on their value judgments when they have to choose between voluntary conservation and current use of a non-renewable resource. The value an individual attaches to the resource will, to a large extent, determine whether the person will liquidate it or prolong the benefit from it through conservation.

Conservation might be better used to describe options in which the essential features of the natural habitat are maintained but some of the habitat area or some of its features are traded off for development benefits. Alternatively, the natural habitat is maintained but the resource itself is used for commercial purposes. A conserved natural resource might therefore be a national park in which visitors are encouraged but efforts are made to keep the natural features that attract visitors. In the same way, wildlife may be maintained for the benefit of tourists or hunters, as with wildlife areas in many African countries, wild fowl and game shooting areas in some developed countries. Some preservationists see conservation as making too much compromise between development and preservation. In many cases, the conservation option does not really arise, since either a given habitat is preserved because it is the minimum critical natural area needed for species survival, or it is destroyed for development.

Conservation means to postpone the use of a resource – to consume less today in order to consume more tomorrow. Some resources, like sunshine and permanent facilities like rivers and harbours, and perhaps labour, whose services can only to a negligible extent be either accelerated or postponed, pose no "conservation" problems, since man is not at liberty to choose between present and future use of their services. On the other end of the scale reside the fund or stock resources like oil, and other minerals, which the earth contains in fixed amounts. With such resources it is an arithmetic truism that to use any amount at any one time is to forego the use of that amount at any other times. It is therefore clear that the choice that has to be made with respect to fund resources is the time-distribution of their use. The same is true, though it is rather more complicated, with renewable or self-generating resources such as forests (Gordon, 1958).

Eco-Economic arguments have been advanced for the conservation of natural sites like Lake Bosomtwe. The ecological argument has been that for conservation of a non-renewable resource, the rate of extraction must be optimal (El Serafy, 1989; Costanza and Daly, 1992). This is against the background that the resource will definitely get extinct one day. Thus the best approach is perceived as the optimal harvest rate, which presupposes that once the optimal harvest rate of extraction occurs, the best use would have been made of the resource. Similarly, for renewable resources, ecological management for conservation prescribes the harvest rate which is less than the biological or natural replenishment of the resource.

The ethical issues arising from wholly ecological approaches are that the use of the resource is considered for current generations benefit without regard to the welfare of future generations. This suggests a requirement for sustainable use which caters for both current and future generations' welfare. To this end, various sustainability paradigms were proposed, ranging from the very weak sustainability (VWS) paradigm to the very strong sustainability or preservation paradigm (Turner et al., 1993). Sustainability therefore becomes a link between ecological and economic ideas for the conservation of natural resources. The weak sustainability paradigms advocate the maintenance of some critical natural capital or a constant capital stock (Hartwick, 1977 cited in Tietenberg and Lewis, 2009).

The difficulty of putting up with the weak sustainability ideas stem from the possibility of uncertainties, irreversibility, loss aversion and the inability to determine the exactness of the needed critical capital stock. This makes the recognition of critical natural capital and the constant capital rule for sustainable economic development impeded by ethical considerations. Support for intergenerational social contracts advocates the passing on of adequate capital (of all forms) as an inheritance to future generations, with special emphasis on sufficient critical natural capital stock.

Economic Value versus Local Community Preferences

The ability of ecosystem services to provide for present and future generations is threatened because of ecosystem degradation and biodiversity loss through human activity and economic development (De Groot et al., 2012). In this context, the value of biodiversity and ecosystem services should be considered in monetary terms, not as inexhaustible and free public goods. Further, the expressed monetary value of biodiversity and ecosystem services is not only an important tool in decision making to obtain a general consensus on more equitable and sustainable policies, but also a way to understand public preferences for ecosystem services (Christie et al. 2012).

Advances in economic thought have improved processes of economic valuation of biodiversity, it is however, also necessary to be aware of the continuing limitations of economic approaches to valuing biodiversity. These valuations are influenced by cosmological and normative premises, and their empirical limitations are often overlooked (Tisdell, 2011). Traditionally, economists have placed a heavy weight on the preferences of individuals in determining social choices about resource alternatives. However, a number of considerations make this approach to determining a socially optimal path for biodiversity problematic. For example, social values alter with the passage of time and they both shape and are shaped by communal values (Tisdell, 2011). Passmore (1974) shows how Western ethical attitudes to nature have changed and Myrdal (1958) stressed the importance of circular causation in relation to the formation of social values. Furthermore, attitudes toward nature often differ between cultures and they also reflect variations in cosmological views.

Even if it is accepted that the preferences of all citizens about biodiversity should count, the problem remains of how to derive an acceptable social ordering from these, as was illustrated by Arrow's Social Impossibility Theorem (Arrow, 1951). But the stated preferences elicited from individuals are unlikely to remain constant. If the initial stimuli are not reinforced, their impact on

valuation weakens so that, for example, willingness to pay for the survival of a species (or accept compensation for its loss) falls, even though no material changes occur other than the passing of time (Tisdell et al., 2008). It is instructive and useful to consider the value of biodiversity conservation from different angles before making a social decision about it. One should not rely solely on economic measures even though they are an important consideration (Tisdell, 2011). While at the local level the monetary value of ecosystem services is useful for decision makers evaluating policies on biodiversity conservation, the value varies widely according to the location because of differences in local circumstances and socioeconomic conditions (De Groot et al., 2012).

Lake Bosomtwe

Lake Bosomtwe lies in a meteorite crater in the forest zone of Southern Ghana (06º30´N, 01º25´W). It is located at about 30 km Southeast of Kumasi, Ghana's second most urbanised city. The lake covers an area of about 52 km^2 (Turner et al., 1995) and has a diametre of about 11 km at its widest part with a maximum depth of about 78 m (Prakash et al., 2005). The lake is estimated to be about 1.3 million years old and yet it is considered one of the youngest and best preserved meteorite craters in the world (Grieve et al., 1995 cited in Prakash et al., 2005). It is considered scientifically as a highly sensitive recorder of palaeo-climatic and palaeo-environmental conditions in West Africa (Shanahan et al., 2007). Plans to carry out conservation activities for the preservation of the lake as a world heritage site are being implemented, with the United Nations Educational Scientific and Cultural Organisation (UNESCO) providing the Government of Ghana US$1.5 million for the conservation project (Xinhua, 2011). Also, in 2006, a 10 km wide buffer zone was established around the lake within which it is prohibited to carry out mineral exploration or mining activity (Boamah and Koeberl, 2007).

Ashanti traditional beliefs regard Lake Bosomtwe as a god (Bosom) born on Sunday and which provided an avenue for the departed souls of the land to converge and bid farewell to the world after their existence on earth. The story of how a wounded antelope (otwe) was said to have transformed itself into the lake, earned it the name Bosomtwe (Antelope god). A local festival for the celebration of its deity exists among the Ashanti people of Ghana. In times of poor fish harvests, usually considered as bad omen, the "abrodwum stone" believed to be the spiritual centre of the lake, is pacified with a slaughtered cow at a ceremony graced by his majesty, the Ashanti king (Owusu, 2009).

Lake Bosomtwe is one of the main sources of livelihood for the 24 communities in its catchment area. The communities with estimated population of 30,000 depend on the Lakes' fish stock for income and their protein needs. It is estimated that about 1200 professional fishermen depend on the Lake for their livelihood activities (Boamah and Koeberl, 2007). Apart from fishing, the lake serves many other purposes. It provides the people water for irrigation and domestic use, The Lake also serves as a means of transport and recreation for the people. Residents also derive some income from the visits of tourists to the lake even though its full tourism potential has not yet been realised. Despite the chain of useful roles the lake plays, not just among local residents but for the benefit of a wide range of international seekers of knowledge and pleasure, it faces serious pollution challenges.

The current state of Lake Bosomtwe is a major concern to many environmental minded national and international citizens. This lake has experienced massive overfishing over the years. Pollution has also remained a major problem threatening the existence of the lake. The use of agrochemicals around the lake, contamination from livestock, the use of detergents, the burning of organic and inorganic waste and the disposal of solid wastes in and along the shore of the lake are causing immense havoc to the lake (Boamah and Koeberl, 2007). Since these hazardous activities continue unabated, the continuous existence of services on the lake are at a great risk, since the above mentioned activities are recipes for eutrophication of the resource.

The communities along the lake are Akans and have developed a close association with it. There are several laws and taboos in place to protect the lake and fishes. For instance there is no fishing on Sundays. The traditional wood plank ("padua") is used as a boat for fishing. Also, women in their menstrual period are not to enter the water.
Increasing demand for fish from the rapidly growing Lakeside communities causes a conflict between the aspirations of the local people and the aim of protecting and conserving the lake as a sustainable resource (Dontwi et al, 2008).

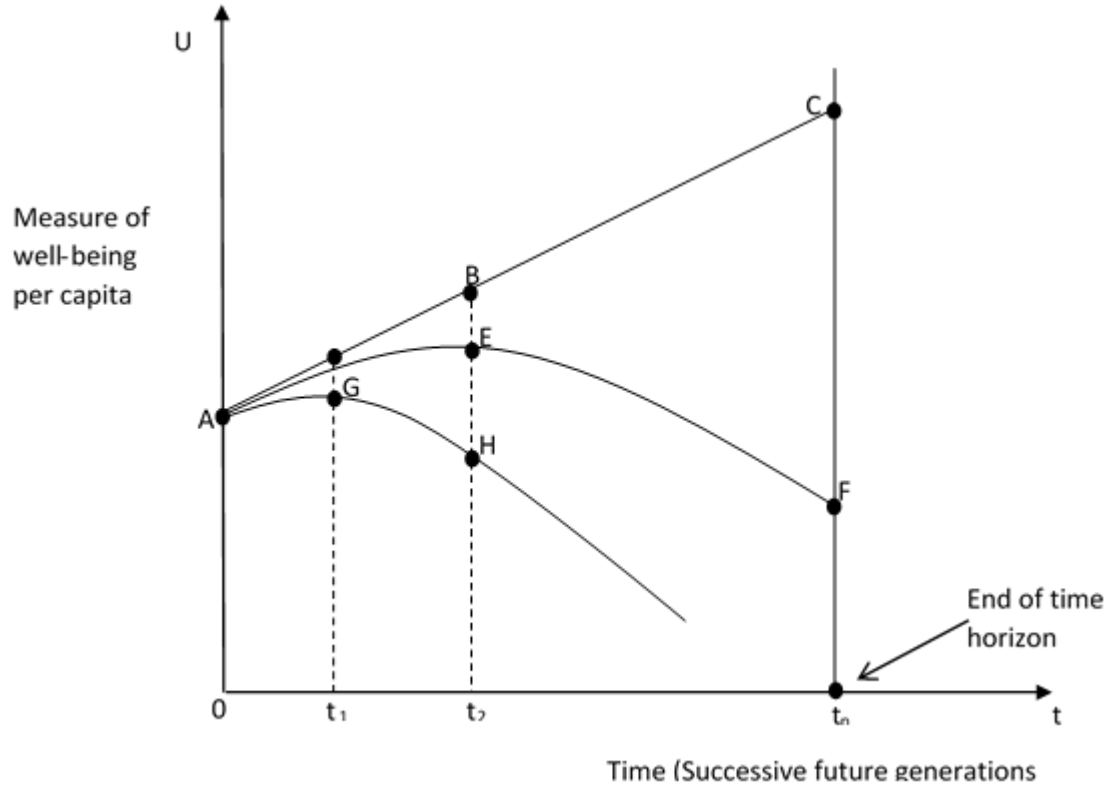
Theoretical Framework

Community preferences could dictate the possibilities of avoiding biodiversity paths that are apparently inferior to alternative paths, based on accepted criteria for choice of biodiversity. It is local communities which eventually determine the outcomes for the several species embedded within the ecosystems of developing countries. Thus winning the biodiversity conservation battle at the community level appears to guarantee the possibility of achieving the global biodiversity goal.

This paper therefore proposes a relationship between local community preferences and biodiversity conservation in developing countries, to the effect that a situation of no biodiversity loss ensures higher well-being per capita than a situation with biodiversity loss. From Figure 1, we argue that the absence of biodiversity loss will lead developing countries' communities along the path to higher well-being ABC. The paths AEF and AGH represent pathways where biodiversity loss exist, here, even though biodiversity loss could enhance well-being to some extent (up to E for AEF and up to G for AGH), the effects are short lived and the feedback effect results in eventual declining well-being paths. The correct identification of community preferences that are harnessed for biodiversity conservation will help to lift the paths AEF and AGH to the level of ABC, restoring the communities to their optimum well-being paths.

Rawls' assertion that equality of income (well-being) of individuals is desirable unless inequality benefits all (Rawls, 1971), does not fully apply for developing countries. This is because the feedback effect of inequality has always resulted in declining well-being in developing countries on aggregate. This is also the case for biodiversity loss, due to the almost excessive dependence on nature for all forms of well-being improvement in these countries.

Figure 1: Biodiversity and well-being paths in Developing countries



Thus in Figure 1, alternative pathways for biodiversity conservation through local community preferences are depicted based on general evidence so far, if t_n is assumed to be the end of the time horizon.

The Analytical Model

Conservation of Lake Bosomtwe certainly implies a strict adherence to a set of rules, regulations, procedures and processes. Local residents are to a large extent aware that conservation means a loss of the resource use as the status quo permitted. Some evidence to this fact is attributing the dwindling fish stock to the various scientific exploration activities that have been permitted by the Government in the lake. Somehow, they foresee losing the lake if conservation plans are carried out. This scenario brings to the fore the need to assess the cost of conservation to the communities whose livelihoods will be affected adversely by conservation. This cost is in the form of their willingness to accept (WTA) compensation for losing the lake (based on the status quo or current usage) to the state or international community.

Willingness to pay (WTP) here means the amount of income an individual would give up to make him indifferent between the original state with income y and the natural resource at q and the

revised state with income reduced to y-WTP and the natural resource increased to q* due to conservation.

Willingness to accept (WTA) is the change in income that makes an individual indifferent between the original natural resource q, with income at y + WTA and the new level of the natural resource, q*, but income at y.

It is common to find that for the same goods in the same setting, WTA exceeds WTP. Horowitz and McConnel found the mean ratio of WTA to WTP to exceed 5 in a summary of 45 studies (Haab and McConnel, 2003). In very poor countries, changes in access to natural resources can induce large changes in income, and lead to substantial differences in WTA and WTP.

The determination of compensation is obtained through an expressed preference approach by the Contingent Valuation Method (CVM). The question posed to local residents was "Suppose the government wants to alter the current form of the lake so that it will spiritually be irrelevant but can still offer some services, how much compensation would you demand from the government every month to allow this to happen?" Responses elicited here were to indicate the price at which they were willing to forfeit their control over the lake. The spiritual twist was a way of ascertaining their maximum valuation since that has to do with higher order values among their hierarchy of needs. Generally, people who believe in a deity hold that once they please it, all their other needs will be taken care of. The aggregate WTA was thus used as an estimate of the cost to government of conservation which would also be a guide for comparison with the benefits of conservation for policy purposes.

A second value elicited was local residents' Willingness to pay (WTP) for the use of the lake as pertained currently. This was an indication of the value they currently attach to the lake. The question posed to residents was "On the other hand, if it is possible to pay to ensure that government does not tamper with the lake, how much would you be willing to pay every month to ensure that the lake is maintained for spiritual purposes?"

The progression to the decision rule then was to subtract the Total Willingness to pay (TWTP) from the Total Willingness to accept compensation (TWTA). This would indicate whether the cost of conservation exceeded the current worth of the lake to local residents, which is actually the net conservation benefit to local residents.

A further econometric step to analyse the local community preference was carried out by running a probit regression to ascertain the significance of the competing preferences and the extent to which they influence biodiversity conservation.

Econometric estimation of the model

The information that is directly elicited from individual i, when contingent valuation questionnaire is applied using the dichotomous choice model, is a dichotomous answer ($y_i = 0$ if the individual

answers no and $y_i = 1$ if the answer is yes), given a question about paying a previously determined amount (t_i, that varies randomly across individuals). It is possible to estimate the WTP assuming that it can be modelled as the following linear function:

$$WTP_i(z_i, u_i) = z_i\beta + u_i \qquad (1)$$

where z_i is a vector of explanatory variables, β is a vector of parameters and u_i is an error term. It is expected that the individual will answer yes when his WTP is greater than the suggested amount, i.e., when $WTP_i > t_i$. In that case, the probability of observing a positive response given the values of the explanatory variables is given by:

$$\begin{aligned} Pr(y_i = 1|z_i) &= Pr(WTP_i > t_i) \\ &= Pr(z_i\beta + u_i > t_i) \\ &= Pr(u_i > t_i - z_i\beta) \qquad (2) \end{aligned}$$

Using the probit command in Stata, and including t_i as an additional explanatory variable provides the required estimates. Doing so we obtain estimates of β/σ and $-1/\sigma$. That is to say, the results that we get from the probit command are: $\hat{a} = \hat{}\beta/\hat{}\sigma$ (the vector of coefficients associated to each one of the explanatory variables) and $\delta\hat{} = -1/\sigma\hat{}$ (the coefficient for the variable capturing the amount of the bid). In general what we have is:

$$E(WTP|\tilde{}z, \beta) = \tilde{}z^1 [- \hat{}\alpha/\delta\hat{}] \qquad (3)$$

where $\tilde{}z^1$ is a vector with the values of interest for the explanatory variables (i.e., the value for each individual, the value for a certain group or the average).

Sampling and data collection

A sample of 210 households was taken from the 24 communities living around the lake. This was done through a first stage random sample of 6 communities and then followed by a second stage systematic sampling of heads of the households in each sampled community. Trained field assistants from the Department of Economics of the Kwame Nkrumah University of Science and Technology (KNUST) were used to administer the questionnaire, eliciting responses from the local community residents. The sampled communities were Abono, Obo, Apau, Nyinatiase, Abease and Abrodum.

The CVM study

The use of the CVM in this study thrived on a three-step procedure namely: designing and administering the CVM survey to elicit household values for the lake, an analysis of the WTP responses and an estimation of the benefits. These were followed by an analysis of the results obtained.

The CVM questionnaire was made up of three parts in which household heads were provided with a hypothetical description of the terms under which the lake was to be assessed. This was designed

to involve government coming in to alter the current form of the lake to make it better to offer the economic services the households enjoyed, but which might diminish the spiritual significance of the lake. This provided sufficient information for respondents to consider the value of Lake Bosomtwe.

Responses on the value of the lake were elicited through open-ended questions about the lowest amount of money household heads were willing to accept and the highest amount of money they were willing to pay for conservation or development of the lake as stated in the previous section. To use the probit model analysis, the responses were assigned random values to convert them to a dichotomous choice format. The order in which this was done was to avoid the possibility of bias based on the assigned random bids.

The CVM survey also included questions about the socioeconomic and demographic characteristics of households. These questions were on respondents' sex (G), age (A), marital status (M), the number of immediate dependents (DEP), religious affiliation (Rel), level of education (E) and household's use of the Lake (U). Specific questions were also asked about the history of the Lake (Kh) and whether the household heads believed in the divinity of the lake (Dd).

Results and Discussion

From Table 1 about 33 % of local residents were not willing to pay anything for the lake to be left in its current state for their use. This implied that the value they hoped to derive from the lake was negligible. This is not a strange discovery because it falls in line with the theoretical argument about common property resources.

Table 1: Frequency distribution of WTP and WTA bids

WTP (in Ghana Cedis)	Frequency	Frequency Percentage	WTA (in Ghana cedis)	Frequency	Frequency Percentage
0	69	32.86	0	45	21.43
0.1 - 1	62	29.52	0.1 - 30	51	24.29
1.1 - 2.0	26	12.38	30.1 - 60	54	25.71
2.1 - 3.0	3	1.43	60.1 - 90	19	9.05
4.1 - 5.0	32	15.24	90.1 - 120	21	10
5 and Above	18	8.57	120.1 - 150	2	0.95
			150.1 and Above	18	8.57
Total	**210**	**100**	**Total**	**210**	**100**

Source: Fieldwork

Thus, 33 % of local residents knowing that the lake is common property were not prepared to fund its continuous use in the current state. The most substantial characteristic of (some) natural resources which leads to their excessive exploitation is that it is difficult to alienate them from common use into exclusive private property.

Table 2: Cross-tabulation of WTP and WTA results

Variables	Categories	Observations	Mean WTP (in Ghana cedis)	Mean WTA (in Ghana cedis)
Age (in years)	20-30	63	2.94	72.50
	30-40	64	2.88	89.56
	40-50	41	1.73	78.46
	50-60	22	3.89	116.95
	60-70	9	1.10	115.44
	70-80	11	0.34	14.27
Education	No-Formal Education	54	3.71	133.61
	Primary Level	114	2.55	72.89
	Secondary Level	40	1.21	36.77
	Tertiary Level	2	0.00	145.00
Sex	Male	119	2.47	73.43
	Female	90	2.73	94.96
Marital Status	Not Married	67	3.03	85.61
	Married	141	2.38	81.84
Religion	Non-Christian	207	2.49	76.67
	Christian	3	8.33	82.39
Length of Stay (mid-points, in years)	1	6	2.55	56.67
	3	32	4.88	78.13
	8	36	5.12	101.25
	13	20	4.07	85.00
	18	116	0.89	78.45
Income (in Ghana cedis, monthly mean)	20	94	2.65	71.17
	35	72	2.95	83.73
	65	32	1.78	91.16
	100	3	0.00	60.00
	125	2	11.00	505.00
	150	2	0.00	35.00
	160	1	0.00	200.00
	200	4	0.00	47.50
Lake Usage (number of uses)	1	46	1.69	79.20
	2	111	2.73	58.10
	3	41	3.70	141.24
	4	8	0.84	29.08
Lake History	No	37	0.49	18.30
	Yes	173	3.02	96.00
Divinity	No	28	0.00	2.86
	Yes	182	2.97	94.53

No single local user of the lake can "conserve" the lake's resources since he does not own it, and what he may decide to leave for another day can be taken by other users. Over-expansion of fishing capacity as has been done now and over-fishing inevitably follows. The most direct solution of this difficulty is unitised control, if not exclusive ownership, of the lake.

Another crucial implication of the results emanates from the over 21% of household heads expressing WTA of zero. This is an indication that a significant number of local residents are not willing to give up the custody of their god. The accusation made by the local residents that the current state of the lake not being able to yield enough fish harvests was a result of the scientific experiments or explorations which had been conducted in the lake should be given very serious consideration. Many local residents seem to believe that the solution to the current state of the lake is to get traditional sacrifices performed to restore the lake to its former productive state. They appear to believe that only a spiritual solution through sacrifices to the lake can restore the former productive state of the resource.

The zero WTA shows how non-negotiable many local residents see the lake to be as their heritage and deity, which they will not accept to dispose of. It is worth noting that there is some demonstration of the primary value of the lake here, whose price is too high to quantify. This calls for highly skilful negotiating mechanisms if conservation plans are to be successful. It will certainly not be easy to dispossess the people of the lake in any substantial way, since by the results some are not going to accept any compensation or alternative livelihood package as payment for a transfer of the 'ownership' of the lake to the state or international community.

The cross-tabulation in Table 2 reinforces the results in the frequency distribution to the effect that there is a mean willingness to pay of zero from those who do not believe in the divinity (deity) of the lake. This is an indication of the lack of confidence in the fact that the lake in its current stat can provide sufficient value for their livelihood.

Table 3: Results of Probit Regression Analysis for WTP for conservation of lake

Res1	Coefficient	Std. Err.	Z	P-value
_Cons	-.1615619	.5550729	-0.29	0.771
Lower	-.2044639	.0487233	-4.20	0.000
Income	.0026817	.003575	0.75	0.453
Sex	.5156246	.2537899	2.03	0.042
Age	-.0058672	.0103141	-0.57	0.569
Marital_Status	-.1926589	.2395292	-0.80	0.421
Immediate_Dep	-.0816114	.0472209	-1.73	0.084
Religion	-.3112615	1.714205	-0.18	0.856
Education	-.1460181	.0461739	-3.16	0.002
Length_of_Stay	-.0880705	.0266817	-3.30	0.001
Lake_Usage	.4453289	.1331642	3.34	0.001
Lake_History	.1449655	.293061	0.49	0.621
Belief in_Divinity of_Lake	1.968284	.418163	4.71	0.000
WTA	.0026456	.0008897	2.97	0.003

Also, local residents with the highest levels of education and incomes had zero mean willing to pay for preservation of the lake. It therefore appears there is very high scepticism that local people can retain their right to the lake and its resources, hence their lack of interest in seeing to its conservation.

The probit regression results (Table 3) shows that Sex, Level of Education, Length of stay in the community, Extent of lake usage and belief in the deity of the lake were significant at the 1% and 5% levels of significance. Belief in the deity of the lake has a high likelihood of making people pay higher to conserve the lake. This confirms the existence of non-use value embedded in the spiritual regard local community members have for the lake. Here there is some hope that this positive relationship could be harnessed carefully for the conservation of the lake.

Table 4: Significance of bid for lake

Res1	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
_cons	.1700597	.097369	1.75	0.081	-.02078	.3608994
lower	-.0619646	.0219238	-2.83	0.005	-.1049345	-.0189947

As expected, the proportion of positive answers goes down as the bid amount goes up (Table 4). Now we proceed to econometrically estimate willingness to pay using the probit command. The first thing that can be observed with these results is that the bid variable is statistically significant and that as the bid goes up the probability of a positive answer goes down. To calculate willingness to pay we use Equation (3).

Table 5: Average willingness to pay for conservation of lake

Res1	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
WTP	6.254868	1.707884	3.66	0.000	2.907477	9.602259

From Table 5, the average willingness to pay for the conservation of the lake is 6.25 Ghana cedis a month. The willingness to accept compensation regression also shows a significant relationship between WTA and the bid. Table 6 shows that the average WTA is 0.002 Ghana cedis per month, which is effectively zero. Clearly, this rejection of compensation by local residents shows how unprepared local residents are to give up their custody of the lake. It demonstrates also that even though there is a substantial average WTP, which implies economic value, the local communities have a spiritual preference which supersedes their economic value and would not allow only economic minded policy to work. This signal about their preference is so strong that it will require serious attention to get the lake conserved. It is worth noting that if local community preferences are ignored, the average TWA from the probit estimation comes to 58.40 Ghana cedis per month which yields a net conservation benefit of about US$11.73 million per annum, confirming the outcome of an earlier study by Quartey (2014).

Table 6: Average willingness to accept compensation for lake

res1	Coef.	Std. Err.	z	P>z
WTA	.0018735	.0007127	2.63	0.009
_cons	-.1094138	.0983633	-1.11	0.266

The next issue is in connection with the quantum of net conservation cost that would serve as compensation to provide alternative livelihood services for local residents. Using the average WTA of 0.002 Ghana cedis which is less than the average monthly WTP of 6.26 Ghana cedis, the net conservation cost will be negative. This situation arises because of the emphasis placed on the average value, since it has been highly influenced by the preferences of the local residents shown through their WTA and WTP values. Thus from the expressed preferences of the local people, it will not make economic sense to conserve the lake biodiversity. To decide on whether to conserve the lake or not, policy makers will need to look beyond expressed net economic benefits.

Conclusion and Policy Implications

To conserve Lake Bosomtwe, conservationists would need to inject substantial resources into the local economy of the communities around the lake. This would provide the needed livelihood support to keep most residents from interfering with conservation measures. It is worth noting that these resources would need to be provided from outside the communities since they have a negative net conservation benefit, not because the lake has no value but because of the preferences of the local communities regarding the use of the lake.

Also, since about one-third (33%) of households have lost confidence in the lake as a source of livelihood, local conservation measures are not going to succeed since these community members will continue to undermine (free ride) the efforts of all others who may be interested in conservation.

The strong belief in the deity of the lake makes it unacceptable for over 21% of the local communities to hand it over to external conservationists, even though most traditional conservation methods have become ineffective. These are clear indicators that Lake Bosomtwe would be on its way to eutrophication if the status quo is maintained.

The government of Ghana, together with other conservation minded organisations need to intervene through the provision of alternative livelihood support packages, if the eventual eutrophication of the lake has to be averted. Also, strong and careful negotiation initiatives would be needed to persuade several local residents to accept modern conservation measures to save Lake Bosomtwe.

Most importantly, conservation minded institutions will need to extend their educational programmes on biodiversity and its conservation to the Lake Bosomtwe basin of Ghana. This will equip local residents on whom a major part of the conservation of the lake rests, for the conservation task. Education would empower them to apply their preferences about the lake towards conservation. Further research on the details of what should go into the educational package will need to be conducted, with particular emphasis on the specific needs and preferences for this special heritage of the world located in Ghana.

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