

ASSESSMENT OF ANTHROPOGENIC ACTIVITIES, ENVIRONMENTAL LITERACY AND MANAGEMENT PRACTICES IMPACTING LAKE BOSOMTWE

Godfred OWUSU-BOATENG¹, Thomas Kwaku AGYEMANG², Akwasi AMPOFO-YEBOAH³, Kofi SARPONG⁴

^{1,2}Faculty of Renewable Natural Resources, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

³Department of Fisheries and Aquatic Resources Management, University for Development Studies, Tamale, Ghana.

⁴Faculty of Science and Environment Education, University of Education, Winneba, Asante-Mampong, Ghana.

Corresponding author: Godfred Owusu-Boateng

E-mail: goboateng.irnr@knust.edu.gh

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Abstract:

The communities in the Bosomtwe basin depend on Lake Bosomtwe for their livelihoods. However, the lake has continued to experience human-driven degradation in recent times. We conducted a survey of the main anthropogenic perturbations of the lake, the level of awareness of the communities of anthropogenic interventions and their effects on lake health, and the effectiveness of its management practices using a structured questionnaire administered to 350 respondents. Data were analyzed using non-parametric Kruskal Wallis and Mann Whitney U-tests. Crop farming, fishing, fish mongering, animal rearing, timber harvesting, hospitality operations, washing, other trades, and illegal mining were the anthropogenic interventions of the most devastating consequence, promoted by a low level of education and environmental awareness. Although the regard for directives of the traditional authority to govern the lake declined subtly, the situation is worsening due to inadequate resources for the Bosomtwe District Assembly, the government agency responsible for coordinating the stakeholders of the lake and providing an adequate decision-making basis for its conservation. The results, which have direct practical implications for water management, suggest the need for well-coordinated policies and strategies for law enforcement and education of basin communities on the causes and effects of lake degradation.

Keywords: Lake, Degradation, Anthropogenic, Survey, Education



INTRODUCTION

The globe faces severe challenges in equilibrating environmental conservation and socioeconomic development (White & Hunter, 2009; Wu et al., 2020). The interface between socioeconomic development and resource conservation has been difficult to build. This challenge has been a function of education on resource infiniteness and behavioral change.

The availability of good quality water on a sustainable level is necessary for disease prevention and social stability (Van Vuuren, 2013). However, anthropogenic factors for economic growth, demographics, and climate change cause extensive degradation in many parts of the world. For sustainability, an effort to reverse the phenomenon is essential. The protection of aquatic systems is crucial if life can be sustained. In response to the survival needs of the ever-growing global population, the water used has become a critical environmental commodity that needs to be carefully considered (Oki & Quiocho, 2020). In the present circumstance, the tendency is for people, in their critical need of domestic water, to use all kinds of water in all states they lay their hands on. In most cases, the only factor to consider has been 'availability' (Bluma, 2020). It has direct and

indirect profound health implications on individuals and society since such developments negate their contribution and exert an undesirable toll on socio-economic development.

Proper environmental protection behavior of communities near water bodies is one of the measures believed to promote this global desire for sustainability. Educational activities are known to be significant in approaches directed to permanent solutions for environmental problems (Safari & Zahraghasemi, 2014). Education of individuals on awareness of their surroundings and environmental consciousness is an effective way of dealing with these problems. Instructing individuals may not help the conservation goal, but inform them about the effect of their actions (Ata, 2018) on the benefits of the environment and hence the need for positive attitudes towards the environment.

It has been presumed that lack of development and understanding is the underlying cause of the degradation of the lake. To close this gap of presumption, we undertake this social survey to solicit the views of communities on the understanding and perception of communities of the regeneration capacity of Lake Bosomtwe. Shaughnessy et al. (2011) noted that a social survey enables the target group's thoughts, opinions, and feelings to be evaluated. Exploring such perception, which is crucial in policy-making, is the goal of this paper.

METHODS

The Bosomtwe District, inhabited by about 70000, is located near the center of the Ashanti Region, covering about 718 km². Formed over one million years ago as a crater lake, the lake is situated in the Bosomtwei meteorite impact crater, which describes a circular depression with a radius of about 5.25 km. Formed over one million years ago as a crater lake, the lake is situated in the Bosomtwei meteorite impact crater, which describes a circular depression with a radius of about 5.25 km. Limnologists have given accounts of some of the physical dimensions of the lake itself: a hydrologically closed basin (Figure 3.1) with a diameter and depth of 8 km and 78 m, respectively (Whyte, 1975). It covers an area of approximately 48.6 km² (Turner et al., 1996). The lake, lying in a rocky depression (Abban, 1988), has a blend of forest and wetland ecosystems within which a broad spectrum of flora and fauna reside, including the endemic tilapia species *T. busumanna*.

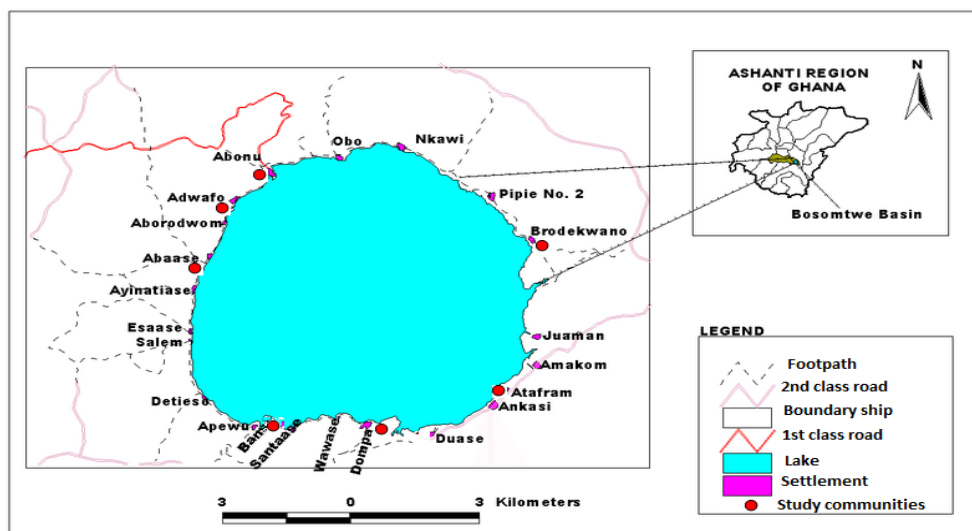


Figure 1. A Map of Lake Bosomtwe and its Catchment Area

The area was characterized by low development of infrastructure and social amenities. Although a few residents in the communities in the catchment speak English, Akan is the primary language. Residents uphold cultural values and are subjects of governance by indigenous chiefs. Several sacred sites exist in communities around the lake. Seven (7) of the basin communities, namely Abono, Adwafo, Abaase, Benso, Atafra, Domba and Old Brodekwan (Figure 1), along the lake that depend on the lake for their livelihood, were selected for the study. In selecting the communities, factors including the following were noted prior to community engagements: location of the communities, ease of accessibility of the communities, level of cooperation of the communities, and the possibility of livelihood activities relating to the lake's health.

Both structured and semi-structured interviews of contextual relevance were used to ensure that the data collected is associated with limited assumptions (Bhattacharjee, 2012) and focus group discussions were used to obtain information on the causes and effects of degradation of the lake and the practices adopted for management and protection of the lake by critical stakeholders. Personal observations were also employed to verify the responses' validity where appropriate and possible. Therefore, emphasis was laid on the socio-cultural context. The questionnaire was administered to a sample (n) of 350 people from the total number of households (N) at a margin of error (e) of 5% according to the relation $n = N / (1 + N(e^2))$ in conforming to (Gomez & Paul, 2010). While some of the areas were easily accessible, others were not. Assistance was sought from some community members who operate wooden planks variously described in the local parlance as 'Padua' and 'Ponkor' for a fee (GH¢ 30 per day) for the trips to access the designated areas.

According to Pandey (2004), some traditional knowledge has proven to be efficient in resource conservation. For this reason, the opportunity for local communities to share their knowledge on how the lake and its resources have been impacted was also explored. The participatory Rural Appraisal (PRA) was also adopted to enrich the information gathered and identify any outliers that could not reflect the actual situation for discussion. The Participatory Rural Appraisal approach was used to gather information on social variables such as observation of buffer zones, forbidden and taboo days, sacred grooves and bylaws (Mascarenhas et al., 2003). It was to ensure that the strength of the technique, which considers the inclusion of local people in the planning, implementation, and management of the lake and its resources, is explored. While the benefits of localization, inclusiveness, empowerment, and respect in using the PRA were explored, the associated drawbacks, such as hijacking, formalism, and disappointments, were kept in mind.

The responses to these questions were organized and analyzed using statistical software (Statistical Package for Social Sciences (Version 20) and GraphPad Prism (Version 5.01)). Results were displayed in tables, graphs and charts and trends and observations were interpreted and explained to form the basis for recommendations for conservation considerations (Obioha, 2024). The relative prevalence of major anthropogenic activities, the possible impact and Rank (sum of prevalence and impact) in the Lake Bosomtwe catchment were determined.

RESULT AND DISCUSSION

Anthropogenic activities impacting the Lake Bosomtwe. Results indicate that the main anthropogenic activities that occur in the study communities in the lake basin are animal rearing, carpentry, crop farming, fishing, fish mongering, formal education, hairdressing, hospitality operation, health work, illegal mining (commonly referred to as 'galamsey'), timber harvesting, transport business and washing dishes, clothes and vehicles. These anthropogenic activities occurred in varying proportions, the most dominant among them crop farming (44.2%), followed by formal education (16.0%) and fishing (14.0%) (Figure 2).

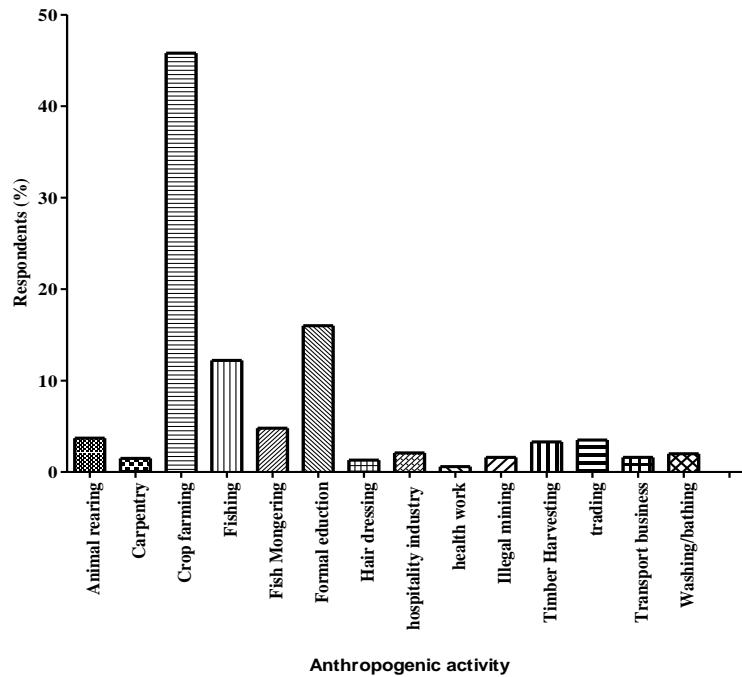


Figure 2. Distribution of Anthropogenic Activities in the Lake Bosomtwe Basin

The dominance of crop farming may result from several factors, including land availability, traditional inheritance, and the limitation of options (Bjornlund et al., 2020). The significance of formal education, which is ranked second among anthropogenic activities, is expected as the school provides employment (Cervone, 2017). According to Lyson (2002), small rural schools are essential to social and economic viability and vitality.

Dominant anthropogenic activities. In order of decreasing devastation among the identified anthropogenic activities that affected the lake directly, the activities may be arranged as crop farming (62.6%), fishing (14.4%), fish mongering (5.7%), animal rearing (4.4%), timber harvesting (3.9%), hospitality industry operations (3.2), vehicles, clothes and dishes and bathing (3.1%), Other trades (2.7%), washing and illegal mining commonly known as ‘galamsey’ (1.4%) (Figure 2). The emergence of crop farming as the most devastating anthropogenic effect on the lake is not surprising, as it is the dormant livelihood among the studied communities (Stein, 2021).

In the past, fishing was the dominant activity for the livelihoods of the communities in the catchment of Lake Bosomtwe), but with time, as the stock of fish continues to stretch towards depletion, communities have resorted to farming as the primary occupation (Watson & Pauly, 2001) with a high inclination to stock depletion. It is a socioeconomic cost of overfishing (Somma, 2003) in the lake. It involves harvesting under-sized fish pollution, disease infestation, more significant fishing effort, and using unapproved fishing gear and fishing technology that have thrown fishermen and fishmongers out of the fishing business. These may be promoted by high customer patronage (Saltelli et al., 2000). The drift of most fishermen into farming may increase the production of food crops in the catchment communities and beyond for increased income. However, the possibility of accelerated deterioration of the lake water quality also exists, given the current poor farming practices adopted by the communities (Baruwa et al., 2011).

Crop farming (Plate 1), animal rearing, fishing, fish mongering, hospitality industry management, illegal mining and washing (Plate 2) affect the lake directly, while carpentry, hairdressing, health work and formal education do not. For example, carpentry indirectly affects the

lake because the wooden plank 'Ponkor' or 'Padua' used for fishing and transport is a carpentry handicraft. Boat operations have been reported to be banned on the lake due to the devastating effect of noise that it produces (Popper, 2009), which is believed to disturb the 'children' of the lake, hence the use of 'Ponkor.'



Plate 1: A farm cited at the banks of the Lake Bosomtwe at Dompaa



Plate 2: Fishing nets and clothes washed at the bank of the Lake Adwafo being dried

Again, schoolchildren were sometimes organized and sent to the lake for lessons on environmental education by non-governmental organizations and schools in the communities. It aims to expose schoolchildren to sound environmental practices and inculcate the habit of harmonious existence with nature in them (UNESCO, 2008).

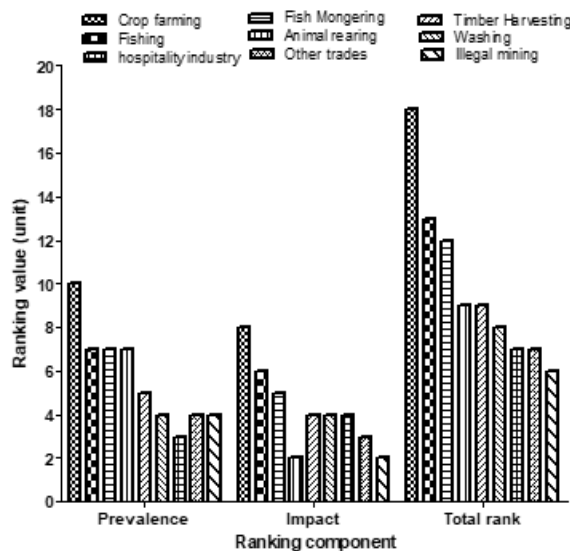


Figure 3. Ranking of Major Anthropogenic Activities in Lake Bosomtwe Catchment

Communities-Related Impacts. Generally, the primary anthropogenic impacts were highlighted at Abono, the most populous among the community. With Abono as the reference point, a general trend emerged: fishing, fish-mongering, and hospitality operations increased at the expense of farming activities. This observation may be accounted for by the strategic position that the Abono occupies in the basin. The relatively improved road networks leading from Kumasi, with other social amenities such as electricity, make the community the most accessible and open to

tourism and businesses, promoting visits to the lake (DFID, 2002). These observations are also supported by Warr (2010) and Runsinarith (2011), who recounted that excellent road networks and electricity are among the amenities that promote business operations, improving income, farming systems, living standards and poverty reduction (Dercon, 2004).

Understanding communities and the causes and effects of water quality degradation. Understanding the communities' demography helps explain the anthropogenic activities in the lake basin. The characteristics considered were gender, age, marital status, occupation, length of stay in the community, length of stay in the occupation and education (Table 1).

Table 1. Distribution of demographic characteristics of communities in the Lake Bosomtwe basin

Demographic Variable	Characteristics	Number (n = 3 50)	%
Gender	Male	205	58.6
	Female	145	41.4
Age Group (years)	18	25	7.14
	19 - 30	44	12.7
	31 - 40	88	25.0
	41 - 50	79	22.6
	51 - 60	58	16.6
	> 60	56	15.9
Marital Status	Single	56	15.9
	Married	211	60.3
	Divorced	28	7.94
No. of years of stay in the community	Widowed	56	15.9
	1 -10	36	10.3
	11 - 20	35	9.9
	21 - 30	54	15.5
	31 -40	57	16.3
	41 - 50	56	15.9
	51- 60	74	21.0
No. of years in a small occupation	> 60	38	11.1
	Animal rearing	50	14.3
	Crop farming	111	31.8
	Fishing	83	23.8
	Fish mongering	56	15.9
	Illegal mining	8	2.4
	Hospitality industry	11	3.2
	Timber harvesting	17	4.8
	Transport operation	14	4.0
	< 5	10	2.8
No. of years in a small occupation	6 - 15	20	5.8
	16- 25	31	8.7
	>25	290	82.7
Educational attainment	No. formal education	151	43.3
	Basic Cert. of Edu.	93	26.6
	Middle Sc. Cert of Edu	56	16.1
	Senior High Sch	38	10.7
	O'and 'A' Level	8	2.2
	Tertiary Education	4	1.2

Gender. Gender is a critical factor in the exploitation of natural resources. Strategies that aim at resource conservation need to consider the gender dynamics of the population, which is quite gender-elastic. Based on this, there was a fair representation of gender in this study: males (58.6%) and females (41.4%). Although the culture of the communities encourages males to hold in trust assets, e.g., farmlands of the families and was therefore considered a repository of the history of the communities, the female respondents demonstrated endowment with substantial knowledge about the lake and the general basin resources. Based on this, the fair gender representation in this study generated vital information for achieving the research goal.

Age of Respondents. The minimum age of the respondents was 18 years, which formed the minority (7.1%) (Table 1). Many respondents were 51 to 60 (16.7%) and over 60 (15.95%). The economically active population is considered to consist of all persons, irrespective of gender, who are in an age class and offer a contribution positively to the defined course (European System of National and Regional Accounts, 1995). The majority (57.6%) of the respondents were aged between 31 and 50 years and were the most energetic and actively engaged in manual anthropogenic activities in the lake, with the tendency to negatively impact the lake. The age group 20-34 years forms the most active population in China, India, Europe and the US. On the other hand, older people, 51 years and above, were endowed with vital information that could be drawn on for effective conservation schemes.

Marital Statuses of Respondents. Respondents were married (60.32%), single (15.87%), divorced (7.94%), or widowed (15.87%). (Table 1). A large percentage of married couples use the lake resources significantly. Hoang and Yabe (2012) reported that households with more members use more of their home labor to boost the exploitation of natural resources. Holding all other factors constant, the married raise families of larger sizes, exploring the advantage of the high family labor. The result is the likelihood of the lake being impacted more than the singles. On Lake Bosomtwe, families set their traps for fish harvesting. It suggests that large family sizes offer some advantages at the expense of the resource itself, highlighting the concepts of 'the tragedy of the commons' (Hardin, 1968).

Length of Stay in the Community. Respondents had lived in their respective communities for at least 5 years. Two hundred and seventy-nine (279), representing 80% and the majority had lived in the lake catchment for more than 25 years (Table 1). More than 11% (11.11%) of the respondents, who were over 60 years old, had lived in the lake basin since birth and had been in their occupation, mainly farming and fishing, as sources of their livelihoods and could explain the human-driven changes and also the recovery potential of the lake. Respondents of this age class could contribute to the current state of the lake resources. According to Ajewole (2010), a direct relation exists between the number of years of experience and the possibility of maintaining the status quo and remaining risk-averse unless the effects are well understood or are directly felt by the offenders.

Occupations of respondents. Many respondents engaged in crop farming (31.7%) and animal rearing (14.3%). Fishing (23.8%) and fish mongering (15.9%). Other anthropogenic activities in the study communities that may significantly impact the lake were timber harvesting, hospitality operations, illegal mining, and transport business operations. With the current trend of catch reduction, as most respondents recounted, fishing efforts have been increased to maintain profit. It was characterized by undersized nets, increased frequency of fishing, and increased fishing time (Paradila et al., 2022). There was also the possibility that the proportion of community members engaged in farming would increase. Again, the widespread occurrence in the scope of illegal mining activities and timber harvesting, particularly by chainsaw operators, in communities in the catchment may also be inevitable, as predicted by (Nyame & Grant, 2007). These may exert significant adverse effects on the lake by removing vegetation cover that causes land and soil

exposure for increased lake siltation during runoff and physiological stress and metabolic during periods of high temperature.

Educational Attainment of Respondents. Generally, respondents had a low level of education. More than forty-three (43.3%) of respondents needed an education. Although other respondents had some form of education, levels were generally low. Only 1.19 % had tertiary education, while 10.71% had been educated up to the secondary level. The educated were dominated by Basic Certificate of Education (26.58%) followed by Middle School and Tertiary Education (16.06%) (Table 1).

Only 13.1% and 8.6% knew of humans as a factor of general environmental degradation and water pollution, respectively. The remaining 86.9% and 81.4% attributed the decline in fish productivity to curses from the gods. This perception might have promoted the range of environmental degradation (Christy et al., 2023). Knowledge of people about a phenomenon is a prerequisite for the desired adjustments in their behavior paradigm (Evert et al., 2021). The relatively high proportion of uninformed people in the community may hamper understanding of the causes and effects of degradation of the lake. Education helps individuals and groups adjust to disequilibrium and the propensity to sustainably adopt innovations for resource utilization (CruzGarcía & Howard, 2013; Reed & Taylor, 2007). For instance, it may be difficult for the uninformed to understand the causes and effects of some environmental phenomena. For instance, linking the removal of fringe vegetation, temperature elevation and de-oxygenation. Abdin and Gaafar (2009) reiterated that people's attitudes are linked to education.

Managing Authorities and Protection Practices. Results showed that the lake management was mainly by traditional authority, with peripheral support from the District Assembly. Most respondents (93.8%) indicated that the traditional systems in individual communities carried out all management operations, which needed better coordination. A few respondents (6.2%) noted that the District Assembly plays some role in periodically monitoring the lake environment for illegal activities such as timber harvesting and illegal mining. Essential management elements, such as the drawing of the yearly program, budgeting, schedule of the visits, and warning of dangers, needed to be included. There were varying views on the effectiveness of the management (Figure 4).

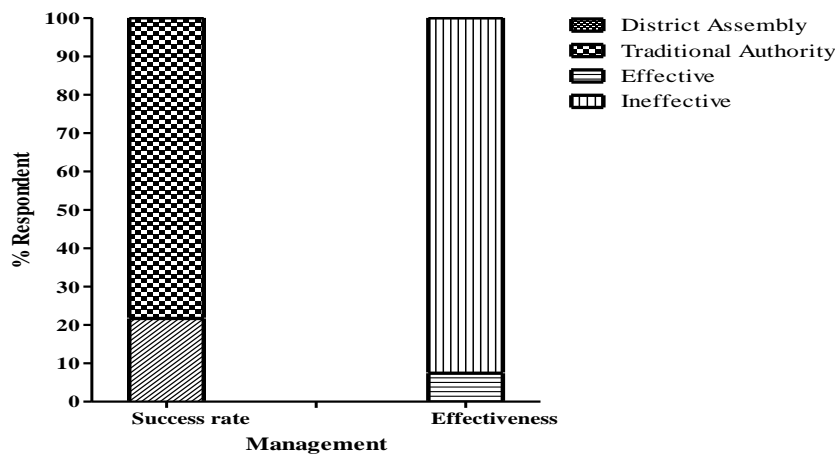


Figure 4. Distribution of managing authorities and practices for the protection of Lake Bosomtwe

A system of respecting sacred groves in forests in the communities surrounding the lake has been adopted to manage the lake and its environment. Most sacred grooves in the sensitive ecological areas around the lake enjoy strict protection due to their religious, cultural and

conservation importance (Kalanda-Sabola et al., 2007). These aim to curb anthropogenic perturbations by observing the taboos, forbidden days, and bylaws that ban non-traditional fishing methods in the lake (Gylfason, 2001; Heberlein, 2012; Angsongna et al., 2016). Motorized boats were prohibited to maintain tranquility on the lake, and transportation was conducted using hand-carved planks. The effectiveness of the traditional method of managing the lake has continued to decrease in recent times due to a reduction in traditional beliefs (Tahirindraza, 2015; Chivasa, 2017), leading to encroachment at a very rapid rate. With attempts to extend this disregard of laws to the ban on motorized boats on the lake, amid a rapidly growing population in the lake communities, fear of rapid degradation of the lake can be expressed.

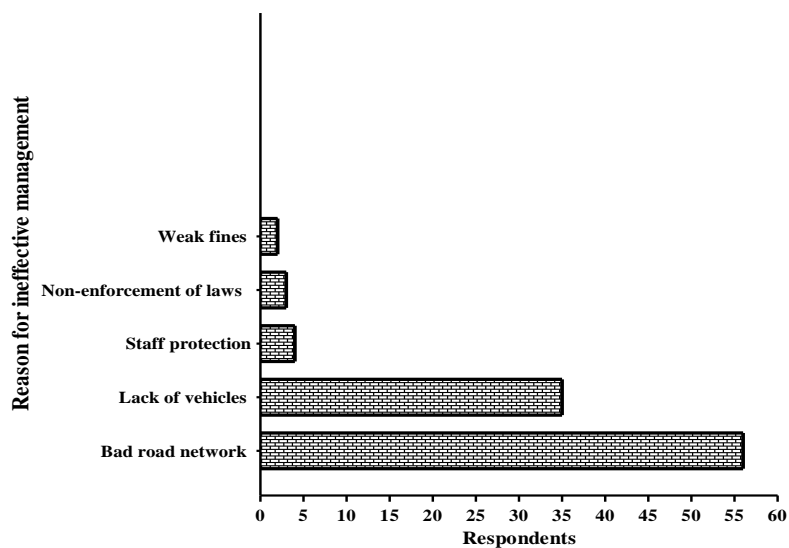


Figure 5. Distribution of the reasons assigned for the ineffective management of Lake Bosomtwe

Officials from the District Assembly indicated a need for more logistics and motivation as the main reasons for the low participation in the lake management. The logistics mentioned included road network (56%) and availability of vehicles by which the communities can be accessed (35%). Lack of protection of staff against assault (4.2 %), non-enforcement of laws (2.9%) and weak fines, which are an ineffective deterrent to violations (1.9 %) (Figure 5) are factors that de-motivate the District Assembly in protecting the lake (Ball & Bell, 1991; Downs, 2013; Faroque & South, 2020) and are the reasons for the aggravated threats to the lake.

CONCLUSION

In order to decrease devastation, the primary anthropogenic interventions in the Lake Bosomtwe basin are crop farming, fishing, fish mongering, animal rearing, timber harvesting, hospitality, washing, trading of other goods, transportation and illegal mining. Although the inhabitants, who generally have a low level of education and environmental awareness, had generally lived and engaged in their occupation in the lake basin for many years and observed degradation, they do not appreciate human-driven degradation of the lake but attribute it to spirituality. It has obscured the communities' contribution to the lake's degradation, therefore debunking the possibility of unequivocal behavioral change as a possible solution. There was a subtle decline regarding directives by the traditional authority, such as observing and avoiding fishing and farming in taboo and forbidden periods and observing sacred grooves, which helped

control fishing efforts. These trends have to do more with ineffective policies and strategies for educating the communities of the catchment on the causes and effects of the degradation of aquatic systems and the enforcement of environmental laws. Resourcing governing authorities, including the Bosomtwe, for active participation, promotion of traditional system of protection of the lake, strict enforcement of environmental laws, Establishment of Community Resource Management Areas (CREMAs) in collaboration with other stakeholders, including water resources commission, Ghana EPA, the Ghana Tourist Board Opinion Leaders and environmental NGOs are needed measure to stop degradation and promote conservation of the lake.

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