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Wetlands or Wastelands: A Water Resource in Crises. Assessing the Levels of Pollution and Degradation in the Fosu Lagoon in Ghana

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ABSTRACT: Coastal lagoons and water resources provide numerous services to communities which are situated within their catchment area. These services ranges from food production to cultural heritage. This has made demand for them to increase thereby putting pressure on the resources. However, within the last few decades most lagoons have been turn into wastelands instead of servicing as a wetlands. Most of these lagoons have degradation by for settlement and polluted by industrial and domestic waste. One of such lagoon in Ghana which is under threat from human activities is the Fosu lagoon. This study therefore investigate the levels of degradation and pollution of the Fosu lagoon and how such incident could affect the livelihood of people who depend on the lagoon.

The study employed questionnaire in the data collection process in four communities using a sample size of 40. Some respondents were also selected for the in-depth interview. The interview comprises fishermen, EPA etc. The data was analyzed using SPSS for the quantitative data and content analysis for the qualitative data. Result were generated in a form of frequency tables and charts. From the result obtained, it was observed that the lagoon has witnessed a decline in size and vegetative cover. This is attributed to mostly anthropogenic activities. As a result, it has affected the services provided by the lagoon which has led to loss of biodiversity as well as loss of livelihood. It is recommended that measures should be put in place to stop all forms of activities within the lagoon catchment area in order to restore the ecological integrity of the lagoon.

KEYWORD: Lagoon catchment area degradation pollution heavy metal.

INTRODUCTION

Globally, about 75% of the world population depends on the coastal resources for their livelihoods. This has made demand for these resources to increase rapidly over the last two decades (Paerl, 2006). The ecosystem of the coastal environment is dotted with several lagoons, salt marshes and mangrove, estuaries etc (see Kwame-Bibey, 2019). According to Hobbie (1987) wetlands serve as an immediate water basins connecting inland water bodies to the oceans, purifying the riverine and watershed discharge worldwide. Wetlands also act as a site for hydrologic, geochemical and biological works in the natural environment (Hart, 1995; NRC, 1995). Further, they provide a fertile land for agricultural activities, nesting site for migratory birds, habitat for wildlife, trees for timber and fuel wood, recreational site etc for human benefits (Martinez, 2014).

Wetlands all over the world are under heavy pressure from destruction despite the crucial role they perform. The Millennium Ecosystem Assessment (MEA) (2005) opined that, the rate of degradation of wetlands globally has increased rapidly than any other ecosystem. As a result, a significant number of wetlands have been degraded over the years for human settlement, pollution from industries waste, degraded for agriculture activities etc (MEA, 2005; McCartney et al., 2010). The impact of this destruction affects the health and production of these natural water bodies (Atubiga and Donkor, 2022). These have the potential to reduce groundwater level of these wetlands as well as the quality of water obtained from these natural resources.

Wetlands or Wastelands: A Water Resource in Crises. Assessing the Levels of Pollution and Degradation in the Fosu Lagoon in Ghana

The coast of Ghana is characterized by numerous wetlands dotted along the shoreline. There are more than 90 wetlands and other water resources along the 550km shoreline of the country of which many are serving as key habitats for diverse and endangered species of international importance (Olaniyan, 1981; Atubiga and Donkor, 2022). Due to this, the government through the Ramsar Convention has designated six of these wetlands as "Ramsar sites" (wetlands of international importance, especially for waterfowls). They include; Muni-Pomandze, Keta, Sakumo, Songor and Densu delta (Armah, et al, 2005; Adu-boahen, et al., 2018). Since the designation of these wetlands as Ramsar sites, several laws, both formal and informal have been enacted to ensure their conservation. Some of these laws are;

1. Ghana Coastal Wetlands Management Strategy,
2. Coastal Wetlands Management Project (CWMP) in 1994,
3. National Wetlands Conservation Strategy and Action Plan in 1999 and revised in 2007.

The essential element of these laws outlined the need to conserve these water resources by restoring and maintaining their ecological integrity of vulnerable biotopes. However, wetlands and other natural resources which are outside this designated zone have been degraded and polluted over the years (see Armah et al, 2005). The Fosu lagoon which is located in the central region of Ghana is a typical example which has seen several forms of pollution and degradation over the years (see Baffour-Awuah, 2014a; Baffour-Awuah, 2014b).

The wetland has been identified by the Environmental Protections Agency (EPA) as the most polluted water body in the country as it serves as a reservoir for all forms of polluted substances including heavy metals within the Cape Coast Metropolitan Assembly and beyond (Fetzer, 2000; Armah et al., 2010). The polluted nature of the lagoon came into the lamplight years ago after it was detected that the water quality contains metallic substances. As a result of this, in 2008, the Environmental Protection Agency (EPA) recommended that, all forms of activities in and around the lagoon should be put on hold (Eshun, 2011). The EPA revealed that, a test carried out in the lagoon indicated that, the water contained highly polluted substances with the common ones being cations and anions (Eshun, 2011).

Several areas have been identified as the means by which waste substances are discharged into the lagoon. However, the most common ones include, waste from the Cape Coast Metropolitan Hospital, automobile garages, waste from palm kernel producers in Adisadel College etc (Armah et al., 2012). Again, the catchment area of the lagoon is inundated with human settlement which generate large quantity of waste on daily basis, and these pollutants end up in the wetland without any treatment. The human activities increase the metals influx which found their way into the lagoon as a result of wind or water thereby increasing the metal concentration in the area (Armah et al., 2012). Continuous accumulation of these heavy metals ends up in large quantity and pose serious health hazards to both human and other living organisms (Ray, 1990).

As a result of the polluted nature of the lagoon coupled with high rate of encroachment of the catchment area of the lagoon, it is now considered as one of the water bodies referred to as "Dead zone" (UNEP, 2006; Akoto et al., 2014). According to Armah et al (2010), dead zones comprise of areas where the water in the lagoon floor contains very limited amount of oxygen. The classification of the lagoon as a dead zone could has a serious repercussion for people who depend on it for their livelihood and other agencies that manage and conserve the lagoon (Armah et al., 2010).

Several studies have been carried out in the Fosu lagoon over the years. Some of these studies examine the amount of metal composition in the lagoon (Adokoh et al, 2011; Akoto et al., 2014; Adjei et al., 2017). Other studies focus on the sources of pollutants into the lagoon and how that has contributed to the heavy presence of these substances in the lagoon (Armah et al., 2010; Bentum et al., 2011; Eshun, 2011). The findings of the above studies therefore indicated that over the years, several quantity of metals generated from the surrounding communities are deposited either directly into the lagoon or carried by water or wind into the water body. This has impeded the ecological function of the lagoon as a tourist attraction and a place of fishing by many individuals for their livelihood. What remain unclear is how the lagoon catchment area has dwindled over space and time resulting in ineffective management of the natural resource. It is prudent to note that, Ghana is facing water security challenges both in the rural and urban areas, which is expected to get worsen especially as the various water bodies in the country are polluted by the activities of small-scale mining (see Asamoah, 2018). It is also intriguing to add that, the country is also confronted with climate change with drought and dry spells being the most prominent. These issues are affecting water bodies in the country which will further worsen the already dwindling lagoon under investigation.

STUDY AREA AND METHODOLOGY

The Fosu lagoon is located within the Cape Coast metropolitan Assembly in the central region of Ghana. The area occupied by the metropolitan is about 122km^2 with the underlying rock being batholith (Eshun, 2011). The lagoon falls within the geographical coordinates of 5^0 7'N and 1^0 16'W (Eshun, 2011). The metropolis is drained by many streams, both small and large. According to

Armah, et al. (2005), the largest of these streams drain into the Fosu lagoon at Bakano, a suburb of the Cape Coast metropolis. Again, the lagoon catchment area is surrounded by industrial and institutional organizations which serve as an end point for the discharge of their pollutants. Both domestic and industrial toxic waste from the metropolis as well as waste from transport stations and other workshops are discharge into the lagoon (Dodoo and Adjei, 1995). Also, drains from institutions such as Adisadel College and the Cape coast Teaching Hospital drained off their waste into the lagoon.

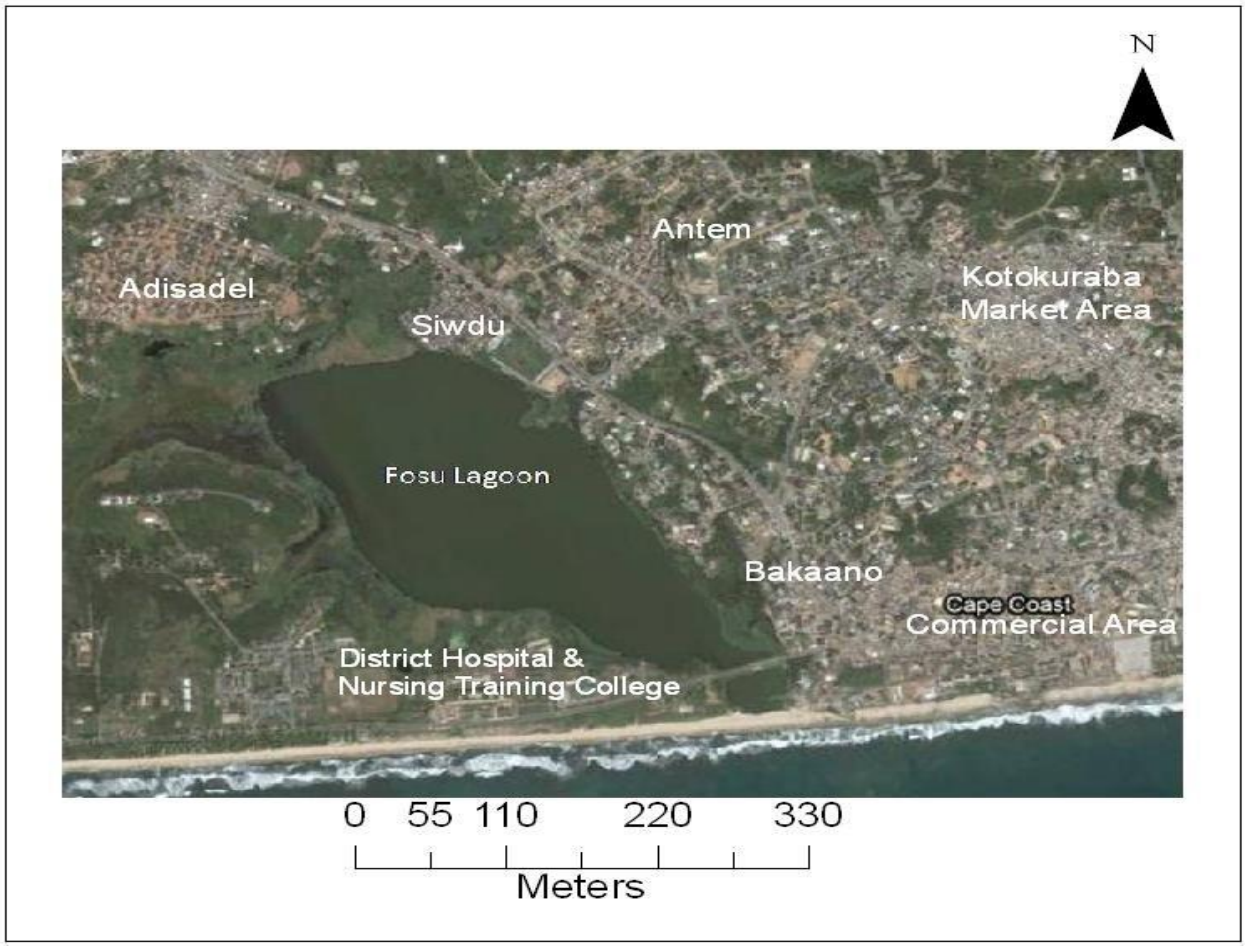

Fig Satellite image of the Fosu lagoon
Source: Adopted from Eshun (2011)

The basic economic activity that takes place in the lagoon is fishing. Other economic activities also take place very close to the lagoon. These include a palm kernel oil production in Adisadel College and automobile garages at Siwdu where the waste from their companies are discharge directly or indirectly into the lagoon (UNEP, 2006). Besides these companies, there are residential settlements which are situated around the catchment area of the lagoon. These settlements also discharge their waste into the lagoon thus, aggravating the polluted nature of the waterbody (UNEP, 2006). As indicated earlier, due to the polluted nature of the lagoon, it has now been considered as one of the water bodies with a “dead zone”.

DATA COLLECTION

The first part of the data collections employed interview and self-administered questionnaires for the study. The questionnaire investigated the nature of the lagoon pollution, health risk of the lagoon on residents and pollution mitigation. A total of 40 respondents were sampled for the questionnaire survey which was made up of open and close-ended format. According to Gay and Airasian (2003) the sample size was adequate since a large population size was almost irrelevant in this context. A pre-test data collection was carried out in a nearby community around the catchment area of the lagoon to test the validity of the instrument. Errors which were identified in the questionnaires were corrected for the main data collection.

Simple random sampling was used to identify the respondents. The respondents were mainly fishermen who were from these communities-; Coronation, Amanful, Cape Coast and Brofofyedur. These communities are situated around the catchment area of the lagoon and therefore interact with the wetland on daily basis. The respondents were made up of both men and women.

Key informant interview was also organized. Participants included Environmental Health Assistants, Leader of sanitation Guards, Chief fishermen, opinion leader of the area and the Environmental Protection Agency department.

DATA ANALYSIS

Responses from the survey were analyzed using Statistical Package for Social Sciences (SPSS) version 21. Responses were categorized and coded numerically to facilitate the analysis of the SPSS. Descriptive statistics such as frequencies and percentages were generated from the analysis. This was done to generate themes the levels of degradation and pollution. Data on the in-depth interviews were transcribed into English Language. It was sorted into meaningful classification. A coding system was developed for the data. After the coding was done, the data was put into themes to the research questions which guided the study.

RESULTS

The results of the study which investigate how the Fosu lagoon has dwindled over time were discussed thematically.

Spatial extent of the Fosu lagoon

From the result, it was evident that the lagoon has witnessed a massive declined in size and vegetative cover which brings about the reduction of the lagoon size. The vegetative cover of the lagoon was analyzed to ascertain how the built-up in the area has affected the landscape within the lagoon.

Description of vegetation classes

Mangrove vegetation. To ascertain the level of degradation of the lagoon, vegetative cover such as the present of mangrove along the catchment area of the resource. To estimate the number of mangrove species in the lagoon, the buffer zone of the resource was taken into consideration. The buffer zone identified in the lagoon catchment area was 50m around the Siwudu side of the lagoon. From the observation and counting process, it was noted that most part of the lagoon was made up of fewer mangroves with predominant area covered with grass. According to Blay and Asabere-Ameyaw, (1993) the lagoon covered a total area of about 61 ha. Accessing data about the density of the mangrove was not readily available, both past and present. Hence, the study relied data obtained from researchers who have conducted studies in area as some scholars at the University of Cape Coast and some fishermen about the coverage of the mangrove. During the interview sessions, it was noted that in the past the lagoon was covered with mangrove trees but in recent times there are fewer trees in certain parts of the lagoon. Respondents were asked to account for what causes the destruction of the mangroves. Their responses are shown in Fig 2 below.

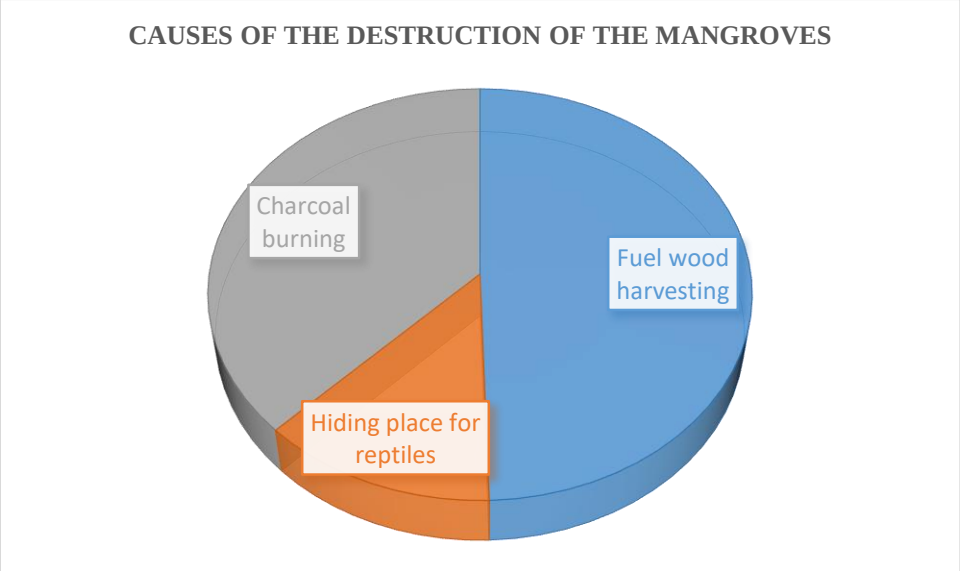

Fig 2. Causes of the destruction of the mangroves
Source: Field work (2023)

As shown in Fig 2, it was observed that most of the respondents indicated that the destruction of the mangrove was as a result of the people interest to satisfy their needs for fuel wood and charcoal. This desire led to a significant number of these species being cut off. From the interviews with the fishermen, they explained that one of the reason why the mangroves have been cut is for use as charcoal and firewood. They espoused that the demand for fuel wood and charcoal has increased due to growing population

and this has made some people to rely on the mangrove as a source of fuel. Their views collaborate with previous studies report which revealed that many people in the Cape Coast metropolis engage in fish mongering and palm kernel oil production as a livelihood which all depend on the mangroves as fuel wood for their activities (Kendie and De-Graft Johnson, 1999 cited in Adjei et al., 2017). Also, some of the respondents noted that the mangroves serve as a hiding place for dangerous creatures. According to them, some people have lost their lives from through the bite of these reptiles such as snakes.

Despite the alarming rate of destruction of the mangrove, the respondents observed that the mangrove species serve many purpose to living creatures inhabiting in the lagoon. This ecosystem services provided by the mangrove has declined drastically due to their destruction. As observed in Fig 3, majority of the participants stated that the mangroves provide a habitat for fishes and also serve as a spawning ground for many water organisms.

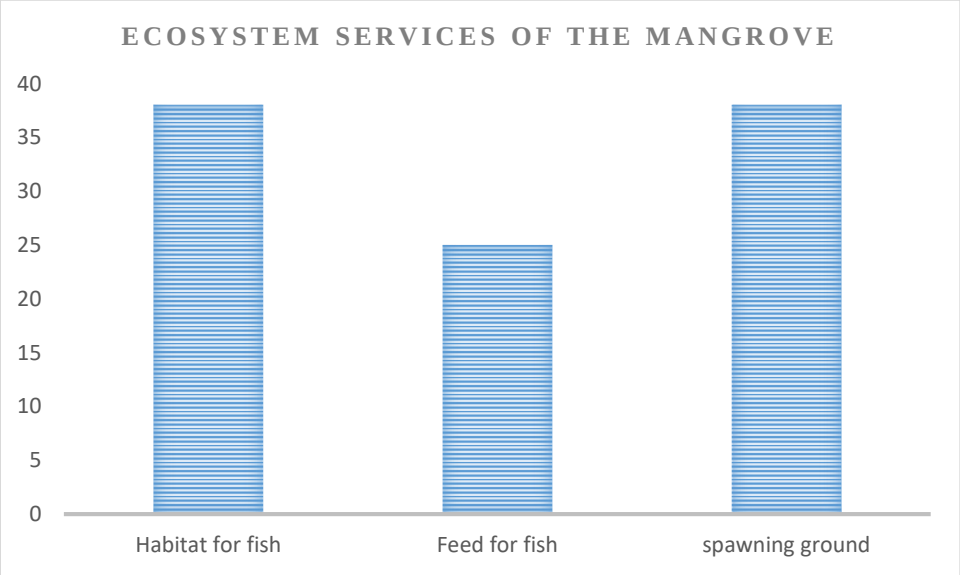

Fig 3 Mangrove ecosystem services
Source: Field work (2023)

The fishermen during an in depth interview recounted that the mangroves provide a conducive environment for fish to spawn. Other respondents believed that the young fish which are spawned feed on the propagules and breathing roots of these mangroves, and so when the roots were abundant they used to catch big fish, but this does not happen now that most of the mangroves are gone.

Semi natural salt marsh. The coastal salt marsh vegetation of the lagoon was assessed to determine its density over the years. From the field observation it was observed that this particular vegetation is intermingled with fruit plants and vegetable crops. It was cleared from the field observation and interactions with the respondents that the coastal salt marsh vegetation is gradually turn into agricultural activities like vegetables farming.

Weeds. As a result of the destruction of the mangroves and the salt marsh vegetation, the catchment area of the lagoon is predominantly covered with weeds. According to Essel, et al. (2017) the weeds cover about 38.7% of the total vegetation cover. It was evident from the field survey that the weeds is the largest vegetation cover in term of size. The weeds were seen within the lagoon and its fringes. During an interview with an old man in the area, he indicated that, lately, the weeds found in the area are invasive weeds. According to him, these species of weeds are relatively new to them and that for the past decades they have growth in size and proportion. His views confirm a study by Essel, et al. (2017) when they espoused that non-native weeds have developed steadily in the lagoon over the past four decades and that these weeds are mainly polyspecific; where two or more species coexist. The existence of these weeds is considered as a greatest threats to the decline of inhabitation of biodiversity in the lagoon.

Lagoon encroachment

According to Collar et al., (1994) encroachment of the lagoon catchment area is being threatened by anthropogenic activities and geomorphology processes. The anthropogenic factors include; pressure from population growth, rapid rate of urbanization, waste pollution, inappropriate farming practices, logging, etc. The natural threat to lagoon includes land degradation and desertification. From the study, it was observed that the catchment of the lagoon was heavily populated by human settlers. During an interview with the town and country planning officer in the metropolitan, assembly he indicated that; "the lagoon catchment has been

zoned and protected. However, in recent times, there are a lot of unapproved buildings coupled with human activities are sprinkling in the area. He indicated that the demand for accommodation is on the increase due to the expansion of the educational institutions within the metropolis which calls for the intake of more students. These activities have destroyed the vegetative cover of the area. It is important to note that the vegetation of the lagoon was initially dominated by mangroves as stated earlier. But as a result of anthropogenic activities it has resulted in the fragmentations of the lagoon.

Lagoon habitat fragmentation

According to Adu-Boahen, et al (2018) fragmentation of habitant is one of the main causes of biodiversity loss worldwide. From the study it was noticed that the lagoon habitat has been fragmented over the years and this resulted in a greater proportional loss of species as well as a reduction in the total landscape of the lagoon. The reduction in the habitant has limited the free movement of biodiversity between patches of the lagoon's vegetation. During an in-depth interview with 78 year old retired fishermen in Cape Coast, he lamented that-; *in olden days the catchment area of the lagoon was covered dense vegetation which housed all manner of wildlife. Hunting in the lagoon was a livelihood activity for most in the area. However, the destructions of the lagoon vegetation has led to the extinction of majority of these animals. This has made many people who to depend on the lagoon for their survival jobless.*

Also, the fragmentation and modification of the lagoon has resulted in the reduction of the ecosystem services provided by the lagoon. Atubiga and Donkor (2022) opine that habitat fragmentation and modification have the potential to negatively affect the services provided by a natural resource. From the interviews with the respondents it was obvious that there has been a reduction in the services provided by the lagoon over the years. As shown in table 1 the lagoon provides a wide range of services to the inhabitants of in and around the resource. One of such service is the provision of food. The respondents stated that the lagoon serve as fishing ground for many people. Again, others engage in irrigation farming around the catchment area of the lagoon. These services provide livelihood for these people. However, the fragmentation of the lagoon has affected the provision of food in the area. According to Armah, et al. (2012) there has been a significant reduction in the in the quantity of fish in the lagoon. This reduction has affected the quantity of fish caught by many fishermen on a daily basis.

Table 1. Lagoon ecosystem services

Lagoon service	**Frequency**	**Percentage**
Food system	13	32
Culture	15	38
Wave action	12	30
Total	**40**	**100**

Source Field work (2023)

Further, the cultural service provided by the lagoon was also identified as shown in table 1. This cultural services take the form of beautiful landscape which promote tourism, cultural heritage which defined the people and a provision of conducive environment which promote healthy living. But, the respondents were quick to explain that all these services have been affected negatively as a result of the fragmentation of the lagoon. It is important to stress that the level of fragmentation of the lagoon's lagoon is enormous and poses a greater threat to the sustainability of the lagoon and biodiversity habitat as well.

Threats of metals and plastic pollutants in the lagoon

Literature has identified the Fosu lagoon as one of the most polluted lagoons in Ghana. This stem from the levels of pollutants discharge into the lagoon. The threat of metals and plastics was also to find out how they contribute to the pollution of the lagoon.

Plastic and heavy metal pollutants

One of the main threat identified during the study is plastic waste being discharge into lagoon. The lagoon is a major receiver of large quantity of plastic waste generated from the inner city of the metropolis of Cape Coast. The study observed that the waste were generated from improper waste disposal into drains and indiscriminate domestic waste management. From the interview, it was revealed that the metropolitan drains enter up in the lagoon. These drains carry huge waste generated from the inner city activities. According to the respondents, the most of the drains pass through communities which do not have access to proper means of waste disposal, hence, they end up depositing their domestic waste into the drains as well. In effect, all these waste materials end up affecting the aquatic lives in the lagoon. As was indicated by the Kwame-Bibey (2019) that massive discharge of waste materials into waterbodies untreated has the potential to affect aquatic organisms and may alter their reproductive cycle. The issue of plastic waste in the lagoon is a serious problem that needs urgent attention from authorities considering the number

of years these plastic take before they decompose. Continuous discharge of these plastics into the lagoon will increase their accumulation in the lagoon bed.

Heavy mental concentration was also assessed in the lagoon to identified effect on aquatic lives and livelihoods activities. The shown that huge amount of metals were deposited into the lagoon. This is evident from the fact that a mechanic shop was situated right at the edge of the lagoon. This mechanic shop attract and accommodate large among of vehicles on a daily basis. Heavy metal from this mechanical shop are wash directly into the lagoon during run off. This was corroborated by Eshun (2011) report that there are high metal concentration such as iron, zinc, lead and manganese in the lagoon sediments and in fish sample. These heavy metal such as lead if accumulated in large quantity can lead to lead poisoning.

CONCLUSION AND RECOMMENDATION

This study concludes that there has been a drastic decrease in the land size of the lagoon over the years resulting in habitat lost, lagoon's ecosystem fragmentation, reduction in lagoon ecosystem services, increase in the level of heavy metal and plastic pollution. The degradation of the lagoon catchment area has adversely affected the livelihood of many people living in the surrounding communities especially those who are engage in fishing and fish processing. It is recommended that as a matter of urgency, the metropolitan assembly and the Environmental Protection Agency should haul forms of activities within the catchment area of the lagoon and put measures that can be taken to restore the ecological integrity of the lagoon. Drains which empty their waste materials into the lagoon should be diverted, if not treated before discharging the product into lagoon. This will help to reduce the quantity of plastic into the lagoon.

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DATA AVAILABILITY

The primary data used to support the findings of this research are available with the corresponding author upon request.

Conflict of interest: The authors declare that there is no conflict of interest regarding the publication of this manuscript.

Credit author statement: All authors contributed to carry out the study. Author JAA Conceptualize the study and wrote the introduction of the work. Authors LTN and ABA wrote the methodology and as well collected the field data for analysis. Authors JAA, EO and PAA did the analysis of the data and wrote the first draft of the manuscript. Both authors did the proofreading and the final editing of the manuscript.

Ethics: The study maintained high level of integrity, transparency, and confidentiality and so there is no conflict of interest to be declared.

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