

Perspectives on Drivers of Biodiversity and Environmental Changes in the Keta Lagoon Ramsar Site of Ghana

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Abstract: There is a general decline in biodiversity and the environment of coastal wetlands world-wide. Reasons for the decline obviously include overexploitation of wetland resources, climate change and industrialization, to mention but a few. This study used a purely qualitative approach using mainly focus group discussions (FDGs) in the framework of Driver–Pressure–State–Impact–Response (DPSIR) to examine the changes occurring in the largest coastal wetland in Ghana—the Keta Lagoon Complex Ramsar Site (KLCRS). The results indicate that the state of the environment is bedevilled with species loss, increases in salinity, decreases in the physical size of fish species and many others. Pressures and related drivers were noted by the respondents. The results point to the fact that communities are not oblivious to the adaptation measures to implement in order to overcome the degradation of KLCRS. Overall, this study points to the fact that local communities have a good knowledge and understanding of their environment and are always in a position to offer ideas related to managing the environment if given the chance.

Keywords: biodiversity; drivers; pressures; environmental; change



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1. Introduction

Biodiversity decline is a global phenomenon threatening the ability of ecosystems to provide the services on which humanity depends. Mainstreaming biodiversity into the plans, strategies and policies of different economic sectors is key to reversing these declines [1]. The importance of biodiversity mainstreaming is reinforced by the global mission of the Convention on Biological Diversity (CBD) and its Aichi targets, which were adopted at the 10th meeting of the Conference of Parties (COP) in 2010. Individual countries agreed to “address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society” [2] through their national policies, which aim to support the mainstreaming of biodiversity into the policies of key economic sectors, such as agriculture, forestry and fisheries, among others [1,3]. A general overexploitation status of commercial fish and shellfish stock has been reported across various ecosystems on small-scale and large-scale bases [4].

Wetland fisheries are often considered a ‘safety valve’ for people who cannot access other sources of livelihood [5]. Small-scale wetland fisheries provide nutritional security to poor households that lack adequate supplies of animal protein and sustain the livelihood of landless fishers who scarcely survive by fishing in depleted water bodies [6]. Although wetlands provide habitat for 40% of all fish species [7], 20% of their biota fall under the most

threatened components of global biodiversity, largely due to human-induced environmental degradation [8]. In Ghana, wetlands along the country's 550 km coastline form the basis for important small-scale fisheries. They serve as nursery grounds for some marine fishes, molluscs and crustaceans. Cichlid fishes of the genus *Sarotherodon* contribute significantly to the fresh and brackish water fishery of West Africa [9]. The Keta Lagoon Complex Ramsar Site (KLCRS) is the largest wetland in Ghana with a size of about 1010 km². The KLCRS stretches 40 km along the eastern coast of Ghana [10,11] and across six districts and municipal areas with an estimated human population of about 900,000 in the last population census in 2021 [12]. The KLCRS covers part of the Volta River estuary, several small islands and a complex of lagoons, streams, rivers and creeks. The vegetation in the area is predominantly swamps, scrublands, and mangrove forests forming microhabitats for a variety of species. The site is a biodiversity hotspot in Ghana, with records of sea turtles, shorebirds, reptiles, mammals, fish and macroinvertebrates [11,13–18].

The lagoon complex supports livelihood opportunities for inhabitants, serving as considerable natural capital. Notable among the livelihood options are fishing, farming, mangrove harvesting and salt mining as the main occupations of inhabitants along the lagoon complex. However, the Keta Lagoon Complex Ramsar site is bedevilled with the natural threat of erosion and siltation in addition to anthropogenic threats to the environment and biodiversity. The most effective and sustainable option to reduce the rate of biodiversity loss is to mitigate pressures on biodiversity by modifying the underlying socio-economic drivers [19]. Recognising that this ecosystem is complex and provides services to a wide range of biological organisms as well as riparian communities, this research used a systems approach to achieve its objectives. This approach allowed for the appreciation of the interlinkages between various human and natural processes. This research therefore was guided by the Driver–Pressure–State–Impact–Response (DPSIR) framework by [20]. This approach is useful in describing the origins and consequences of environmental problems [20]. The DPSIR framework (Figure 1) effectively links environmental and economic factors together, making it an important indicator framework [21]. It is also acceptable across several disciplines of research because of its practicability in assessing causes, consequences, and responses to changes caused by environmental stressors [22,23]. As stated in Mateus and Campuzano [24], the framework provides a better context for integrating various types of indicators, allowing for the consideration of not only environmental but also socio-economic consequences of changes in the state of coastal systems. Also, the framework is able to combine socio-economic and ecological impacts, therefore addressing not just the repercussions of human activity on the system but also its feedback.

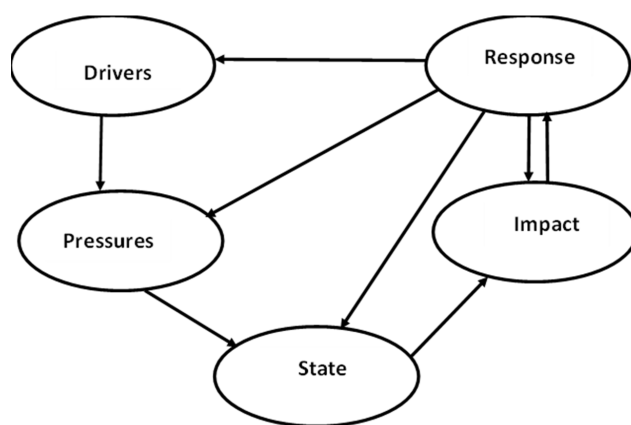


Figure 1. Schematic diagram of the Driver–Pressure–State–Impact–Response (DPSIR) framework. Redrawn from Gari et al. [25].

In addition, the DPSIR framework is thought to have the strength of capturing key relationships between factors in society and the environment in a simple manner and thus can be used as a communication tool among researchers from various disciplines, as well as between researchers, policymakers and stakeholders [26]. Describing the causal chain from driving forces to impacts and responses is a complex task and tends to be broken down into sub-tasks, e.g., by considering the pressure–state relationship. Several authors [21,27,28] have explained the application of the DPSIR framework in the understanding of natural ecosystems. In the context of the KLCRS, the framework could be looked at as follows: Drivers—economic sectors and human activities (e.g., food supply, fuelwood, climate change); Pressures resulting from these drivers (e.g., persistent fishing, farming, erosion and flooding, etc.); changes in States of the natural system (e.g., high salinity, limited freshwater inflow); Impacts on ecosystems, human health and functions (e.g., a decline in fish diversity, smaller fish sizes, etc.); and Responses from government or society, which feedback to all other elements.

Most studies on the KLCRS have drawn inferences from the ecological status of the lagoon. This study explored the perceptions of people regarding the status of biodiversity as well as the changes that have occurred over the years as observed in ecological studies [15,29,30]. It is important to understand the perceptions of people, as these influence their actions and inactions and form a basis for policy development and management planning towards safeguarding livelihoods and biodiversity within the natural environment. This study sought to understand, from the perspective of communities, the status of biodiversity as well as the changes that have occurred over the years, as observed in ecological studies, to facilitate biodiversity mainstreaming in the KLCRS and in Ghana at large.

The following research questions were formulated to address the objectives of this study:

1. What is the state of biodiversity and environmental change in the KLCRS?
2. What was it like in the past?
3. What are the drivers of the changes in biodiversity?
4. What are the key impacts of the observed changes on the socio-economic life of communities?
5. Which adaptation measures or responses are being pursued?

2. Methodology

Study Area

KLCRS is located in the Southern part of the Volta Region (Tufour, 1999). The wetland is located between latitudes 5°45' N and 6°05' N and longitudes 0°50' E and 1°08' E. It is bordered on the west by the Volta River, on the south by the Gulf of Guinea and on the north by the highway linking Accra to Lome in the Republic of Togo. The KLCRS is made up of an area of open lagoon with brackish water, floodplain, marshland and a wide range of mangrove stands (Lamptey et al., 2013). The KLCRS is generally separated from the sea by a narrow coastal ridge. It was designated as a Ramsar site in 1992 due to its abundant coastal and marine wildlife. People living in the southern part of the lagoon are involved in both sea and lagoon fishing, salt winning and vegetable farming, while those in the northern sectors are mainly farmers with some freshwater fishing in the areas along the rivers and streams.

3. Data Collection and Analysis

A qualitative approach was used to collect data for this study. Specifically, focus group discussions (FGDs) [31] were used to collect data on residents' perceptions of the drivers of biodiversity and environmental changes within the Keta Lagoon Complex Ramsar Site. The choice of FGDs as a qualitative approach for data collection was to gain an in-depth understanding of the subject of the factors responsible for biodiversity and environmental changes and also afford participants the opportunity to freely talk about their experiences [32]. A total of seven (7) FGDs were conducted in five communities within the study area. They were all organized in the local dialect of the participants. Study participants

were purposively selected [33]. They were selected because their primary livelihood was dependent on the wetland through fishing, farming, fish processing and mat and handcraft weaving, among others. Participants in the FGDs were grouped on a gender basis and selected from five (5) communities, as indicated in Figure 2. Issues discussed bordered on the types of resources they derived and depended on from the environment of KLCRS. Discussions were also on family resources or assets at the participants' disposal, which provided a source of livelihood. This study explored, from the perspectives of the respondents, key drivers determining the prevailing conditions of the general environment and biodiversity of KLCRS. The questions asked related to perceived pressures on environmental resources and the entirety of KLCRS. The respondents also discussed the current state of KLCRS as well as the impact of human activities on the ecosystem, human health and general functions of the environment relating to the availability of species they depend on. Finally, respondents were engaged in discussing the various responses by communities and governments to the environmental problems being experienced in KLCRS. Permission was sought from the participants to record the proceedings in order to avoid the adulteration of the core issues raised during the discussions.

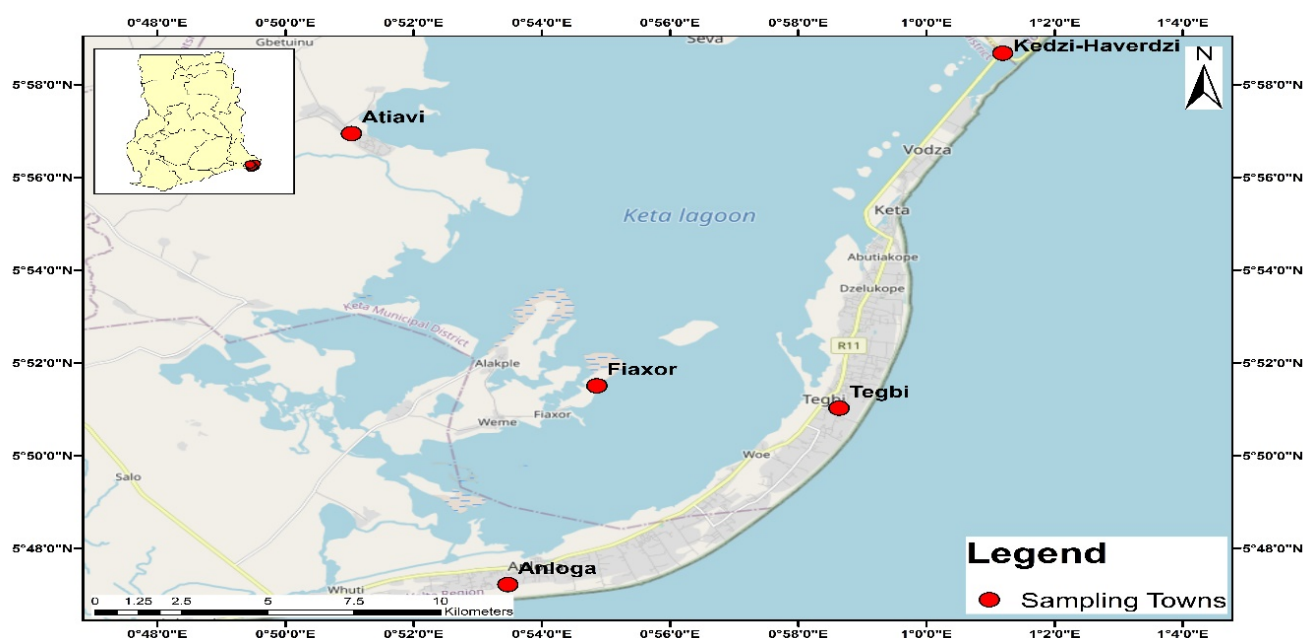


Figure 2. Map of the study area showing sampling communities.

The recorded version of the focus group discussions was transcribed, and the data were analysed manually using thematic analysis [34,35]. The analysis of the data collected followed the deductive approach [36,37] using the DPSIR framework to identify the themes. The thematic analysis involved copious reading of the transcribed data, assigning specific codes to pieces of texts that describe particular phenomena [38]. The codes were then applied consistently and repetitively to the text from all the FDGs and grouped under corresponding themes. Bearing in mind the bid to understand the factors that influence biodiversity and environmental changes in KLCRS, themes such as the state of environment and biodiversity, key drivers of change and pressures and degradations as well as responses and adaptation measures were used to summarise this study.

4. Results and Discussion

Using the DPSIR framework [39], this paper examined the key drivers of biodiversity and environmental changes in the largest coastal lagoon ecosystem in Ghana. The approach related human activities and other natural factors to the state of the environment [40]. It determined the prevailing conditions of biodiversity and the entire environment of

KLCRS as compared with what existed in the past from the perspectives of the riparian communities. Essentially, the types of changes that have occurred or are occurring and the drivers of the change as well as the impacts of the changes on the lagoon system and various adaptive measures being used by communities were explored. Effectively, this Results and Discussion section begins with a narrative on the state of biodiversity and the environment of KLCRS as well as the identified pressures exerted by both human activities and natural phenomena (Figure 3). It continues with the key drivers of change as well as the impact of the environmental change on communities and responses from the various actors. Information on the respondents including gender, age group, educational background and occupation as well as religion are provided at the end of the section. This is to enable readers to properly contextualise the perspectives shared in the study.

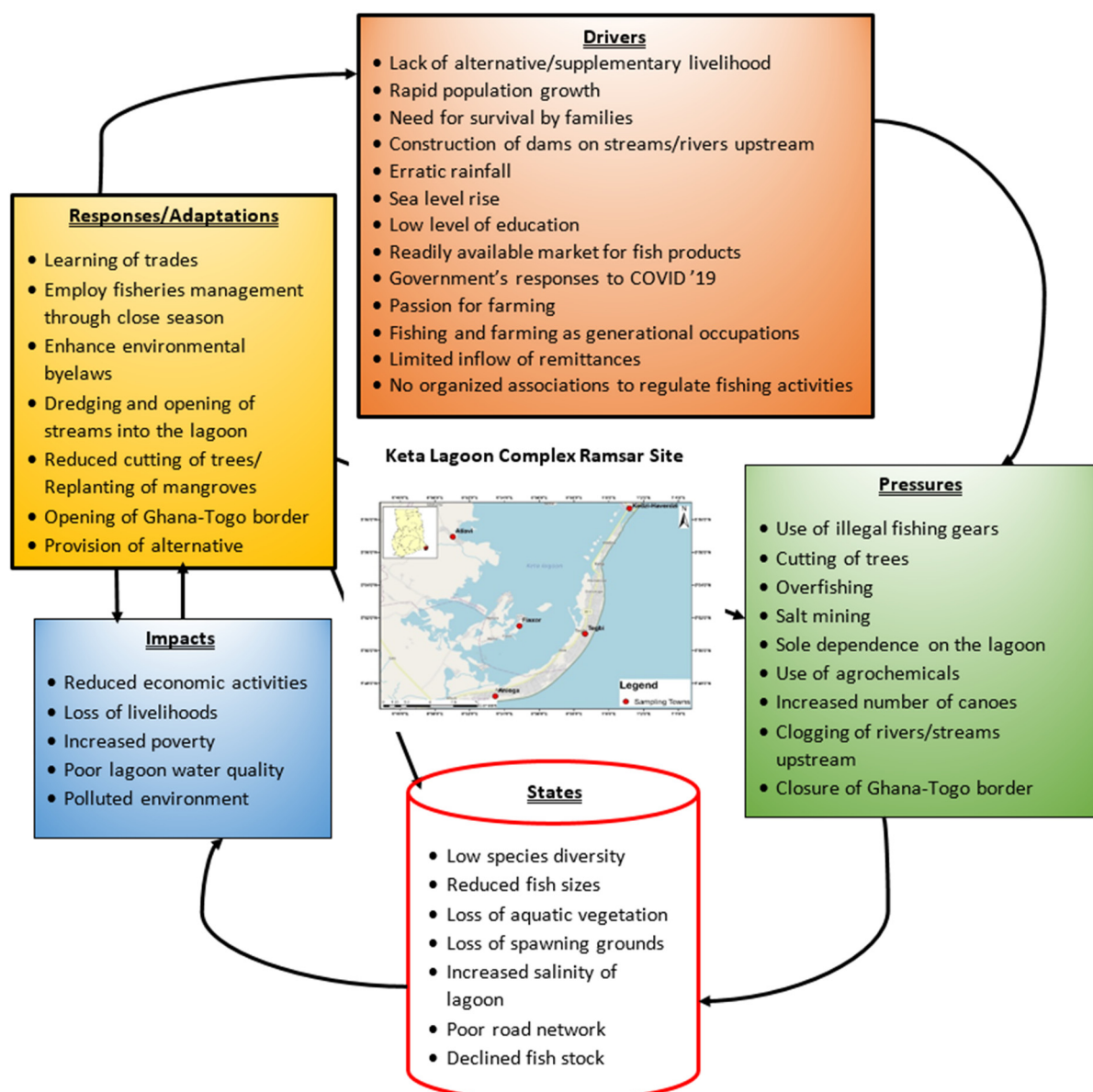


Figure 3. DPSIR model of the findings from the FGDs organised into the areas of this study. Source: from field data.

4.1. The State of Biodiversity and Environmental Change Caused by Identified Pressures in the KLCRS

According to Keddy [41], wetlands are known and distinguished from other ecosystems by the availability of water bodies and the biodiversity, especially the distinctive species of flora and fauna, as well as its highly productive soil. Being the largest wetland in Ghana, the KLCRS is known to support a large proportion of almost 900,000 people living in six (6) administrative districts in south-eastern Ghana (Figure 4). Duku et al. [42] conservatively put the figure of people dependent on the lagoon at over 100,000, whereas the entire district/municipality of Anloga and Keta, the southern portions of Akatsi South, Ketu North and South Tongu districts as well as the fraction of Ketu South municipality have their livelihoods or daily needs connected to the lagoon. The KLCRS was designated as one of the six (6) Ramsar sites in Ghana because it supports a huge amount of biodiversity including 72 resident and migratory bird species, between 12 and 15 finfish species, different sea turtles and several other mammals as well as scrublands, swamps and mangrove forests [42,43]; however, changes have been observed over the years [16,42].

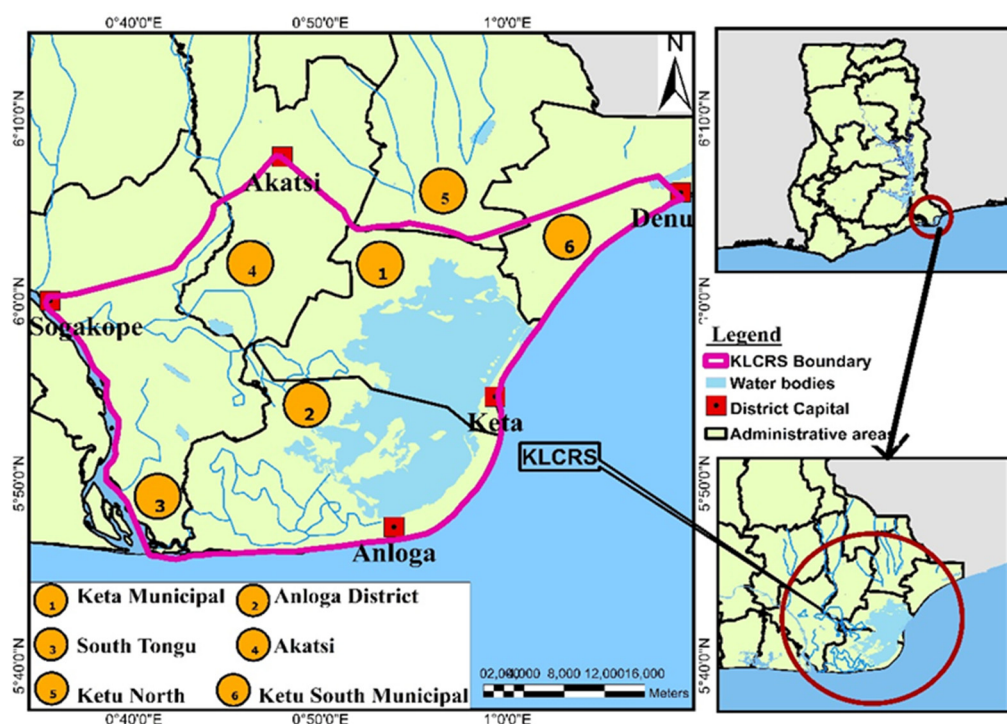


Figure 4. Map of the KLCRS showing the six administrative districts and municipal areas.

Engagements of communities on the state of biodiversity and the environment revealed eight (8) characteristic features that were used by the respondents to describe the state of biodiversity and the environment at the time of the study. The features included (i) low species diversity, (ii) reduced fish sizes, (iii) loss of aquatic vegetation, (iv) loss of shelter and breeding grounds for lagoon fishes, (v) increased salinity, (vi) poor road networks, (vii) declining fish stock and (viii) infertile agricultural land (Figure 3). These characteristic features unfortunately portend destruction instead of improvement in biodiversity and the environment. Respondents stated that the diversity of fin fishes, shellfish, scaleless fish, mammals, birds and vegetation/tree species in the lagoon and its environs have declined from what it used to be in the past. Certain fishes like the catfish/mudfish species and shellfish species that were previously caught in the lagoon were no longer in existence. Male and female respondents in Fiakor submitted that:

From men:

"We actually harvested different species of fish in this lagoon. Some were (Catfish (Blolo), Cockles (Mikpa) and certain species of crabs and others) which are no longer in existence hence, are no longer harvested from the lagoon".

From women:

"In the days of old, we used to harvest multitudes of fish (tilapia, shrimps and others) using a single fishing mechanism but nowadays we go for fishing only to realize a small catch. Both the quantity and variety of fishes we used to catch have reduced, including shellfish".

Respondents also took note of the fact that certain grass/weed species that were associated with the lagoon were no longer available. The respondents pointed to the interdependence among the species such that the extinction of one led to the drastic reduction in or extinction of others.

The loss of various species from the lagoon and its environs, according to the respondents, culminated in reduced diversity of the species they used to depend on. The reduced diversity of species was important to and mentioned by the respondents from Atiavi, Fiakor, Tegbi and Anloga as changes that have occurred in the lagoon and its environs.

Respondents also noticed that the sizes of the various species of fish caught in the lagoon have changed over the years. This issue of reduced fish sizes was noticed and reported on by the respondents from all five communities. The changes were revealed in the growing diminutive nature of the fish in the lagoon, as observed by respondents. Respondents in Anloga and the men's group stated:

"Nowadays, weeds/grasses that used to grow in the lagoon, providing shelter for fishes don't grow due to increased salinity of the lagoon. Sometimes, fishes are found dead on the shores of the lagoon leading to reduction in multitude of the fishes we catch".

"The fishes have grown so small that currently, we mostly harvest fingerlings".

The loss of aquatic vegetation, especially certain weeds/grasses and plants, was mentioned as a pointer to a reduction in plant diversity; the respondents identified them as one of the major changes that have occurred in the KLCRS and its environs. The disappearance of bulrush and sedge species that were used for weaving mats and baskets in certain areas of the lagoon was topical. Some residents (both men and women) found their livelihood in harvesting these grasses as raw materials for their cottage industries. In fact, respondents from Fiakor commented that the presence of bulrush and sedge species not only supported their community alone but also other neighbouring communities such as Alakple, Kodzi, Genui and others. The loss of vegetation included various economic trees such as mangoes, coconuts, mangroves and others, which could no longer grow well in certain portions of the lagoon environment. Respondents from Atiavi, Fiakor and Anloga passionately reported on the loss of aquatic vegetation in the lagoon.

Respondents believed that there are some linkages between the identified characteristic features that are the pointers to biodiversity and environmental changes in the KLCRS. Respondents pointed to the fact that the loss of aquatic vegetation resulted in the degradation of shelter and breeding grounds for the lagoon fishes. A particular sea grass, which is locally known as "Totroyi" and is identified as *Ruppia maritima* [43], was mentioned by the respondents to have provided shelter and congenial breeding grounds for fishes in the lagoon. To the respondents, the extinction of this seagrass resulted in the complete destruction of areas known to be suitable for the assemblage and breeding of various fish species in the lagoon. This issue of the loss of shelter and breeding grounds for fish species was noticed and reported by the residents of Atiavi, Fiakor and Anloga.

Another noticeable change in the environs of the lagoon was the tremendous increase in the salinity of the lagoon. Respondents of Fiakor, Tegbi and Anloga noticed an increase in the salt content of the lagoon. Also related is the salinisation of the soils around the lagoon, which were hitherto rich farmlands. To the respondents, an indicator of the high saline

content of the lagoon is the increasing invasion of “sea pig-like” insects, scientifically known as Scotoplane species in the lagoon waters. These insects eat fish as well as wood products, especially the canoes of fishermen. Another indicator of the high saline content of the water is that the fish in the water are very lean and mainly not fleshy. Lamptey and Armah [43] discovered that salinity and other environmental parameters were responsible for the assemblage and abundance of species in the Keta Lagoon. Similarly, Yidana et al. [44] and Atta-Quayson and Baidoo [45] found increased salinity levels in water systems including groundwater and surface water systems in the Keta Basin.

Also, the surrounding soils were no longer able to support the farming of various crops in the study areas. In Fiakor, for example, the respondents bemoan their inability to grow crops and also the destruction of coconut trees as well as certain notable less salt-tolerant vegetation of the areas. There was also a noticeable extinction of reptiles such as various species of lizards in certain communities. Male respondents from Fiakor described the situation as follows:

“We used to see lizards and different species of trees around but currently they are no more”.

Another observation by the respondents was the increasing number of bad road networks in the study areas. The issue of poor road network was reported by the residents of Atiavi. Lack of accessibility to communities and market centres has been an age-old problem in the study areas; however, the concern of the respondents was the rapidly deteriorating nature of road networks in the areas. This comes with numerous economic and social ramifications as residents were not able to send their fish and farm products to market centres for sale or visit health facilities when indisposed.

An important characteristic feature signifying biodiversity and environmental change was declining fish stocks. This has to do with the quantity of fish being caught from the lagoon. It was one of the important characteristics mentioned by the respondents of all the communities. In addition to the seasonal changes in fish catch, relating to the drying off and filling up of the lagoon during the dry and rainy seasons, respectively, respondents noticed consistently that the quantity of fish caught from the lagoon has drastically reduced. This reduction in the quantity of fish catch was reported by Entsua-Mensa et al. [46] and Abban et al. [47] in the Keta and other lagoons in Ghana. According to the respondents, the decline in fish catch has led to the adoption of numerous newly devised and mainly unapproved techniques for fishing. The men of Fiakor described the situation as follows:

“.....fishing in those days was far better than it is now because we could harvest very large quantities generating more incomes than now.....”.

Another indicator of environmental change mentioned by the respondents was the fact that the soils surrounding the lagoon, which were used for various forms of agriculture, have become infertile compared with the past. They indicated that infertile soils have led to crop failures and, in certain areas, crops, grasses and shrubs do not grow on the soils any longer. The surrounding lands are consistently becoming less fertile for agricultural purposes.

The values and benefits derived from coastal lagoon ecosystems are increasingly under threat by human societies. Finlayson et al. [16] stated that the maintenance of the basic ecological character of lagoons was necessary for societies to continue to benefit from the values of coastal lagoons. In other words, changes in lagoon environments reduce the benefits that communities derive from its (lagoon) resources. In this study, communities that were engaged specified the changes occurring in the Keta Lagoon and its vicinity. In addition to the poor road networks and increasing infertility of agricultural lands, all other changes noticed by the respondents were related to the various species of the lagoon and the nature of the lagoon. The respondents (both males and females) were adults (aged 23 to 82) with primary occupations including mainly fishing and farming from the lagoon and its environs, respectively. The respondents therefore had full knowledge of the environment and understood all the indicators they mentioned as portraying changes they observed in the lagoon and its environs.

Another important issue was that both men and women groups unanimously agreed to the indicators. Similar to this study, Sanon et al. [48], Mol [49] & Stuart-Smith et al. [50] discovered that low species diversity, reduced fish sizes and declined fish stock were some changes in various water bodies around the world. In another study, fragmentation and increased coverage of water were changes observed in lagoons [42,51]. However, these studies did not consider the perspectives of local communities but used other physical data analysis techniques such as geographic information systems/remote sensing (GIS/RS) techniques to unravel such changes.

The respondents' view that poor road networks contributed to the changes in the environment is worth expanding on. This observation was made by the women group in Atiavi, and though it could not be directly linked to the deterioration of fisheries and other resources in the lagoon, it could be connected to other economic activities they engaged in. For example, poor road conditions possibly led to the high cost of fuelwood for fish processing and could also be responsible for the high cost of processed fish, which eventually may put the respondents out of business. Being women, the high cost of transportation to market centres as a result of poor road network meant a lot to them.

The ability of the respondents to connect the growing infertility of agricultural soils in the environs of the lagoon is also worth mentioning here. While further enquiries from the respondents suggested that occasional flooding of such farmlands by the lagoon was the cause of increasing infertility, it could also be true that excessive use of agrochemicals, especially chemical fertilizers, may have contributed seriously to the decline in fertility of the soils [52] as well as the ecosystems of the lagoon [53]. Nevertheless, it was evidently clear that the respondents observed and noted changes that were mainly negative with a resultant decline in their livelihoods and sources of income. It was also important to observe that issues of land use and land cover changes as documented by some researchers [42,54] including expansion/growth of communities or urbanization, increased agricultural activities and salt production, etc., were not mentioned by any of the respondent groups. Meanwhile, some authors have noticed changes being caused by land use and land cover phenomena.

Contrarily, all these assertions mentioned above are in contrast to the findings of Issaka et al. [55], who used numerical analysis to prove that the KLCRS and its biodiversity have a unique positive equilibrium point with continuous stability of both good biomass and fish populations for a long period to come. According to the authors, this means that the KLCRS environment is sustainable.

The biodiversity and environmental changes observed by the respondents were possibly caused by various pressures mainly from the persistent use of varied forms of the lagoon and its environment. The uses were not only the extraction of resources but in certain cases, the methods of extraction.

Pressures cited by the respondents from all the communities were the varied fishing gears being used with the purpose of maximizing capacity. These varied fishing gears were partly meant to exploit different species of fish. The difficulty, however, according to the respondents, was the inability of the gears to discriminate between mature and juvenile species; hence, the exploitation of all types of fish species. Using varied fishing gears came with inappropriate fishing equipment such as bottles, mosquito bed nets, small-size fishing nets, the use of mud to separate portions of the lagoon, drag nets and bottom trawling using ropes, among others. Respondents averred that some of this inappropriate fishing equipment turns out to be life-threatening to humans. For example, broken bottles left in the lagoon have caused life-threatening injuries to many fishers. In another respect, the varied fishing gear brought about conflict among fishermen, especially where some used their fishing equipment to destroy that of other fishers, as reported by the respondents of Tegbi:

“.....This is because everyone wants to harvest the fish thereby a lot of nets were casted into the lagoon, making the lagoon overcrowded and choked. This most often resulted in disputes. A case in point was between the people of Tegbi and Anyako. Where the people of Tegbi were seriously beaten by the natives of Anyako after the former had complained of their nets being destroyed by the later. The fishers of Anyako went on further to seize the fishing equipment of their compatriots from Tegbi. The issue was reported to the municipal council but the natives of Anyako refused to appear before the council, so we had to sue them in the high court...”.

Other related pressures mentioned by the residents included overfishing, cutting of trees and the use of agrochemicals including chemical fertilizers and pesticides in the farms adjoining the lagoon. These chemicals, according to the respondents, affect the eggs of the fishes and the fishes in the lagoon. Salt mining in portions of the lagoon, an increased number of canoes for fishing and a lack of financial support to enhance fishing activities were also mentioned by the respondents. The only non-wetland-related factor mentioned as providing enormous pressure on the lagoon was the closure of the Aflao border to Lome in Togo. In another respect, the closure of the border between Togo and Ghana pushed the residents into persistent fishing and use of lagoon resources; hence, the undue pressures on the resources of the lagoon. The forces that led to the negative environmental changes in the KLCRS are mainly connected to the desires among the residents to generally meet their basic biological and physiological needs such as food, shelter, self-reliance and basic care, as documented by El Mahrad et al. [56] and Takyi et al. [57]. Limited sources or a lack of alternative and/or supplementary livelihoods pushed the residents to continuously depend on the lagoon and its environment for food, shelter and other biological and physiological needs. Continuous dependence on the resources over the years possibly led to the rampant degradation, unsustainable use and individual-level management of the resources of the KLCRS and the changes tantamount to declined fish harvest, declined fish sales and the polluted environment, among others. The results confirmed that the present and future vulnerability of the KLCRS is dependent on the intensification of human uses and prolonged ecological degradation, as observed in certain areas by Thanh, Tschakert & Hipsey [58].

4.2. Key Drivers of Biodiversity and Environmental Change

Key drivers are the underlying reasons as well as inherent forces (which may be social, economic, political, demographic, cultural, technological, etc.) that contribute to human activities in the environment [59]. Usually, the drivers may be natural or human-induced, direct or indirect, global, regional or national and or local in nature and mainly involve happenings caused by several actors operating from different sectors [60]. The forces of the drivers are observed through the activities of communities, and they provide the basis for the assessment of the pressures prevailing in any particular environment. The key drivers of biodiversity and environmental change mentioned by respondents included the lack of viable alternative or supplementary livelihood options, limited remittances from relatives who live outside communities, unpredictable or erratic rainfall, dams constructed on streams that connect to the lagoon, lack of a united front of fishermen and farmers, rapid spread of COVID-19 and its resultant effects on societies, inability to pursue formal education and general economic hardship in Ghana as well as incessant passion for farming. The first of the drivers mentioned was the lack of viable alternative or supplementary livelihood options. In low-income districts, limited employment avenues or low-diversified income sources affect the environmental resource use by communities [61]. Thus, the continuous over-dependence on the lagoon is a driver for biodiversity and environmental change. The driving force in this is the communities' desire to economically fend for themselves through sustainable sources of income, which were, however, lacking, and hence, the persistent exploitation of resources from the lagoon and its environs.

Extreme natural phenomena such as erratic rainfall reminiscent of climate change were mentioned as a driver for biodiversity and environmental change in the KLCRS.

Respondents held the view that unpredictable rainfall in this part of the country limits the amount of freshwater that mixes with the lagoon, thereby raising its salinity level. High salinity levels affect the availability of fishery resources and other biodiversity [43]. Communities also held the view that the increase in salinity of the lagoon affected their agricultural activities as well.

Another economic driver mentioned by the respondents was the dwindling remittances from relatives who lived outside their communities or the districts. Remittances to home villages from migrants to urban areas are known to contribute immensely to poverty reduction and human capital development back in the villages [62]. Respondents averred that in the past, remittances were regular and supportive; however, the general economic hardships in the country affected the receipt of this support. In fact, the general economic hardship in Ghana, from the perspectives of the respondents, was not only affecting remittances but their very existence. Respondents were therefore virtually forced by circumstances to survive on the resources provided by the lagoon and its environs, especially with the understanding that their daily meal could be assured through the exploitation of the resources. This is why respondents stated that the need for survival pushes them to exploit the lagoon and hence, the pressure on the system daily.

In complex coastal wetland ecosystems, inter-connecting rivers and streams are responsible for perennial enrichment of the entire system through regular transportation of nutrients, sediments and fresh water to nourish the system [63]. The authors established that freshwater flow into wetlands affects the physical aspects of wetlands as well as the flora, fauna and habitats of organisms in the system. Respondents in this study decried the blockade of rivers and streams that nourish the KLCRS system. The inhibition of the regular flow of streams into the KLCRS, according to the communities, was through both human interventions and natural causes. Dams have been constructed upstream of some of the rivers to enhance agriculture. In certain cases, the natural deposition of sediments at the mouth of streams also prevented the regular flow of freshwater into the lagoon. Gillanders and Kingsford [64] established that various factors could be responsible for the reduced inflow of freshwater into wetlands including climatic, physical and anthropogenic as well as perturbations in coastal systems. According to the respondents, the restricted flow of fresh water into the lagoon was responsible for the reduced diversity of fish in the water. Women of Fiakor attested to this in the following sentence:

“...the river channels have been blocked, they need to unblock them to allow for free flow of freshwater...”.

Respondents of Tegbi were more specific in mentioning the major rivers and streams that had restricted flow into the lagoon:

“...rivers and streams including, Aka, Todzi, Kplikpa and Dzor flow directly or indirectly (through Avu lagoon) in to the Keta lagoon, but now, various irrigation dams and other blockades have been built which hinder the flow of the water into the lagoon, thereby preventing variety of fishes to live in the lagoon...”.

Leibowitz et al. [65] established that the connectivity between wetlands and adjoining rivers and streams is so important that it is good if regular flow in the connectivity is maintained. Gillanders and Kingsford [64] categorized the impact of the restricted flow of freshwater into wetlands into two including pulse events, where there is a rapid but not sustained change and press events where changes are prolonged and sustained. They maintained that the effects of restricted flow of freshwater into wetlands may include mortality, changes in growth and development patterns and, in many cases, the relocation or migration of organisms.

Respondents from all five communities cited the lack of a united front of fishermen and farmers in the study areas as a disservice to their operations and hence, a driver for the changes observed in biodiversity and the environment. This lack of a united front is revealed in the absence of organised associations or cooperatives for fishing and farming. Respondents felt that with such cooperatives, their leaders could lobby banks

and other financial institutions for financial support for their fishing and farming activities. Organised associations could promulgate rules and regulations to direct their members and prevent them from doing things that are not acceptable, for example, using illegal fishing methods. Lack of leadership for fishers and farmers was also a factor that affected the respondents economically, especially because they could not negotiate effectively the prices of their products. Cooperatives are known to aim at reducing poverty among low-income communities with the identification of economic opportunities, empowerment of the less endowed people in societies, provision of security to the poor by allowing them to convert their risks into collective risks, regulating the operations of individual members and regularly mediating member access to assets they use to earn living [66].

Another important driver was the emergence and rapid spread of COVID-19 and its resultant effects on societies. Until the government of Ghana's closure of the land border in early 2020, which was part of efforts to stem the cross-border spread of the COVID-19 pandemic, some residents of the study area engaged in cross-border trade, buying various products from Lome, the capital of Togo, and selling in various communities around the Keta lagoon in Ghana. Some of the residents engaged in cross-border trade as alternative livelihood options during off-seasons, and others used it as supplementary, engaging in trading alongside fishing and farming. The closure of Ghana's southernmost border with Togo for almost three years actually intensified economic hardship in the communities of the study area and necessitated the over-dependence on the lagoon for sustenance. This result seems to suggest that the advent of COVID-19 and its management methods by the government of Ghana was a contributory factor to the pressures on the KLCRS. This is not in agreement with Yunus, Masago and Hijioka [67], who discovered that the emergence of the pandemic contributed to reduced use and improved water quality of the Vembanad Lake in India.

Respondents also stated that their inability to pursue formal education to high levels was a driver for environmental change. This is because they do not have alternative jobs to fishing and farming. Similar to the earlier point mentioned on the lack of alternative or supplementary livelihoods, respondents depend greatly on fishing and farming since there are no alternatives as a result of low educational attainments. This assertion was confirmed by van der Land and Hummel [68], who observed that formal education is key to reducing peoples' dependence on environmentally sensitive economic activities such as fishing and farming.

There was also the incessant passion for farming among the residents of the area, which drove their intensified use of the adjoining lands to the lagoon for agricultural purposes. Farming around the lagoon is not without environmental implications for biodiversity and the general environment.

4.3. The Impact of the Environmental Change on Communities

The pressures exerted on the resources of the lagoon and its surroundings have greatly impacted the environment and society, especially the communities at large. The first of the impacts mentioned by the respondents included the decline in the harvest of fishery resources. Respondents attested to the fact that the quantity of fish harvested in the lagoon has drastically declined. Another important but related impact was the decline in fish sales and fish trade in the study areas. The fishers do not catch enough fish to sell. Similarly, there was a huge decline in the fish processing businesses, for example, frying, drying and the smoking of fish have declined drastically among members of the communities.

There was the mention of general environmental degradation or pollution as a result of numerous unregulated human activities. Related to environmental pollution was the plastic menace noticed by the respondents. According to the respondents, plastic products make the environment of the lagoon clumsy and, though not currently a major issue when fishing, the respondents noted its increasing presence in the environment. The respondents could clearly establish the connection between negative environmental practices and the yield of farm crops as well as the inability of certain economic plants to thrive in the study

areas. All these negative impacts led to general economic hardship in the study areas, as listed by the respondents of all the communities.

Related to the overexploitation of resources is poor waste management and pollution from communities in the study area. Just as de Graft Johnson et al. [10] found that pollution to lagoons and coastal environments comes from municipal, agricultural and industrial waste, this study strongly established that plastic-laden wastes enter the KLCRS environment from domestic and commercial (local market) sources, while agricultural activities served as sources for chemical pollutions in the area. Despite the fact that solid waste pollution in the area is minimal, studies pointed to increasing chemical pollution in the area [42,69].

It was also clear from the study that weak institutional and governance structures contributed or are contributing immensely to biodiversity and environmental change in the KLCRS. In spite of the presence of institutions such as the wildlife division, the district assemblies, traditional authorities, non-governmental organizations (NGOs) and others, which are supposed to regulate the use of the wetland and its resources [70], access to the lagoon and its resources are open to inhabitants every day of the week. Also, despite the KLCRS being a Ramsar Site, there is virtually no enforcement of rules and regulations governing the area; hence, the negative environmental changes as observed in the Songor area by Fianko and Dodd [71]. Despite the existence of some customary laws that restrict access to the lagoons on certain days (taboo days) of the week in some communities, these are not uniform for all the communities as found in all communities surrounding Muni Lagoon, as documented by Adu-Boahen, Dadson & Atubiga [72]. Again, the prevalence of poverty has made it difficult for the communities to comply with customary laws.

In addition to the human-induced phenomena stated above, natural phenomena such as climate change-related factors are contributing to biodiversity and environmental changes in the KLCRS. Erratic rainfall, increased atmospheric temperature inuring to intense evaporation, strong winds and storms, sea level rise and related tidal waves and storm surges are some factors affecting the environment of the KLCRS. Boateng et al. [73] alluded to the fact that climate change-related phenomena may impact heavily on lagoon ecosystems. In their study, they stated that rainfall-induced flooding from the hinterland may be injurious to coastal lagoon ecosystems.

4.4. Responses from Communities and Government in the KLCRS

In the DPSIR framework, responses are the actions being taken or intended activities to be pursued by the various actors (local, national or regional) as a stopgap or permanent solution to the prevailing situation. In most cases, the responses depict the tenacity and resilience of the society in question. The responses also show the adaptive capacity of the communities and are targeted at the state, drivers, pressures and impact sections of the framework. In the DPSIR system, it is only the impacts that induce responses [25]. The results revealed that the first adaptation measure among the respondents was to learn or encourage the younger generations to pursue various trades, e.g., carpentry, masonry, dressmaking and tailoring, among others. However, the respondents decry the lack of financial resources to learn these trades. In fact, the discussions revealed that some of those who learnt these trades could not equally practice them because they lacked the necessary capital to establish the necessary working environment. Generally, the respondents called for support from government and non-governmental organisations (NGOs) to provide more livelihood options for communities. The provision of more livelihood options in itself was one of the identified responses suggested to curtail the over-dependence on the KLCRS. Another response suggested by the respondents was that the municipal and district assemblies be strengthened to promulgate and enforce new bylaws to further regulate the use of the lagoon and its environs. At the time of this study, the Ghana–Togo border at Aflao was still closed, and the respondents suggested that the border should be opened so the vibrant cross-border trade could pick up again so as to reduce the pressure on the KLCRS. The border was subsequently opened after almost two years of closure. Meanwhile,

respondents stated emphatically that the exploitation of the lagoon resources will continue since it is the only reliable source of readily available income for sustaining their homes. This is how respondents of Anloga explained the situation:

“... fishing help to get quick money which often helps us to fend for ourselves. . . . , we like fishing as compared to farming because fishing provides quick money. . .”.

It was also noted that a few who could afford tried to learn trades like hairdressing, dressmaking, fitting mechanics, etc., which they use as support for their homes.

4.5. Socio-Demographic Characteristics of Respondents

Two (2) focus group discussions (FGDs) along gender lines were purposed to be organized in each of the five (5) communities. In three (3) of the communities, however, some scheduled female participants could not attend the interviews. Nevertheless, the few women that came were joined to their male counterparts to provide the female content required for this study. Overall, seven (7) FGDs were successfully held instead of ten (10). In Havedzi, Tegbi and Anloga, combined male and female FGDs were held. Table 1 shows the socio-demographic characteristics of the participants in the FGDs. The age of participants ranged from 23 to 82 years with slight variations with respect to gender. While the males ranged from 25 to 82, the females ranged from 23 to 80. The female groups were therefore slightly younger than the male groups. Among the individual communities, Havedzi presented a more youthful group of respondents for both males and females combined (23 to 53) as compared with the other communities. Respondents in Fiakor were older and had a wider age range (females: 26–80 and males: 25–82) compared with the rest of the communities.

The majority of the respondents in all the communities had some form of formal education. Over half of the respondents in all the communities were educated to at least a basic level or beyond. Regarding occupation, the respondents were mainly engaged in primary activities including fishing, farming and fish processing. In certain communities, respondents, especially the males, engaged in artisanal occupations such as masonry, carpentry and tailoring/dressmaking among others. The females, on the other hand, were involved in petty trading and mat/basket weaving, among others. The two main religious denominations in the area were African Traditional Religion (ATR) and Christianity. The respondents were dominantly affiliated with ATR; however, in the communities of Atiavi and Tegbi, female participants were predominantly Christians.

Table 1. Socio-demographic characteristics of the respondents in the focus group discussions.

Community	Group Size	Gender	Age	Education	Occupation	Religion
Fiakor	26	Female	26–80	Nine (9) respondents were educated to the basic level and beyond	Fishing, fish processing, trading	ATR/Christianity *
	19	Male	25–82	Eight (8) respondents were educated to the basic level and beyond	Fishing, driving, civil service, mechanic, welding, masonry	ATR/Christianity
Atiavi	10	Female	36–70	Six (6) respondents were without any formal education	fishing, mat/basket weaving, farming, cottage, food vending	ATR/Christianity
	12	Male	28–70	Nine (9) respondents were educated to the basic level and beyond	Fishing, farming, masonry	Christianity/ATR **
Havedzi (combined male and female group)	14 3	Female Male	23–57 34–53	Eleven (11) respondents in the combined group were educated to the basic level and beyond	Fishing, fish processing, trading, tailoring/dressmaking	ATR/Christianity
Tegbi (combined male and female group)	4 8	Female Male	50–60 35–66	Ten (10) respondents in the combined group were educated to the basic level and beyond	Trading, fishing, farming, fish processing, piggery	Christianity/ATR
Anloga (combined male and female group)	5 11	Female Male	30–55 31–69	Twelve (12) respondents in the combined group were educated to the basic level and beyond	Fishing, trading, fish processing, farming, carpentry, tailoring/dressmaking	ATR/Christianity

ATR—African Traditional Religion: * The group had more members affiliated to ATR than Christianity; ** Group had more members affiliated to Christianity than ATR.

5. Conclusions, Suggestions and Recommendations

The biodiversity and the environment of the Keta Lagoon Complex Ramsar Site are perceived as being intensely exploited by riparian communities. The overexploitation of the resources has resulted in changes in the flora and fauna of the KLCRS. Certain species are no longer in existence, and others have changed form and no longer grow in size but remain diminutive. Salinity levels of the environment are on the increase, leading to the loss of certain fish and plant species and also the increase in certain pests in the water. Communities identified the pressures, drivers and impacts as well as the responses from communities, district assemblies and the government of Ghana. This study supports the claim that local communities have a clear knowledge and understanding of their environment and all problems associated with it; hence, local communities could be in a better position to proffer solutions and management options to their environment [74].

We hereby suggest a further study to examine the drainage system of the Keta basin, especially with respect to all rivers, rivulets and streams that flow from the north of the basin. The study should be geared towards unravelling the hindrances to the flow of freshwater into the basin. We also recommend that the government of Ghana, private business entities and NGOs should intervene in providing alternative livelihoods to the inhabitants of the basin to regulate their overdependence and overexploitation of the wetland resources.

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