An Evaluation of Climate Change Effects on Fishermen and Adaption Strategies in Central Region, Ghana

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Abstract Government parastatals, nongovernmental organizations and civil societies in Ghana seem to have little access to detailed climate projections and seemingly little understanding of the uncertainties surrounding coastal climate change impacts and adaptations. The study examines climate change effects and adaption strategies of fishermen in the Central Region of Ghana. Through the application of mixed method qualitative and quantitative research, a sample of 116 fishermen were selected through multiphase sampling in three randomly selected administrative assemblies on the coast of the Central Region of Ghana. Respondents were sampled using accidental sampling technique from two randomly selected communities in each assembly. Face-to-face interviews were conducted using structured interview schedule. The data was analysed using descriptive statistics including frequency counts and percentages. The study revealed that erratic rainfall, strong wind/storm with high tides, hot sunshine and high temperatures, drought and flood and heavy precipitation were the main climate effects experienced by the respondents. The negative impacts of climate change experienced by respondents in the fishing business include increasing risk and uncertainty in fishing, fluctuation in fish and wild stock distributions, reduction in the duration of fishing seasons and high fish spoilage and mortality. These effects, the respondents opined, lead to low productivity, reduced income, food insecurity and labour emigration. The respondents have therefore resorted to changing fishing methods, seasonal migrations and livelihoods diversification as responses to the climate change effects. Under-capitalization, limited information, poor marketing systems, lack of research and extension services were the main constraints faced by the fishermen in responding to the climate change effects. More reliable, effective and accessible measures of adaptation are therefore recommended to improve infor-

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mation and knowledge through outreach on various platforms by stakeholders in ensuring sustainable fishing behavior among fishermen.

Introduction

From local to global levels, fisheries and aquaculture play important roles for food supply, food security and income generation. Some 43.5 million people work directly in the sector, with the majority in developing countries. Besides, those who work in associated processing, marketing, distribution and supply industries, the sector supports nearly 200 million livelihoods. Aquatic foods have high nutritional quality, contributing 20% or more of average per capita animal protein intake for more than 1.5 billion people, mostly from developing countries. They are also the most widely traded foodstuffs and are essential components of export earnings for many poorer countries (Cochrane et al. 2009).

Over the years, man has been able to predict the climate and its effects with some degree of precision because it has been relatively stable. Climate stability enables individuals and agencies to plan agricultural programmes for good yield. Global climate change is mostly felt among populations in developing countries. Their vulnerability to climate change comes both from being predominantly located in the tropics, and from various socioeconomic, demographic and policy trends limiting their capacity to adapt to change (Morton 2007). Sagoe (2006) indicated that climate change influences human health, agricultural yields, pest outbreaks, crop timing, flooding, and biological distribution and extinction. Understanding the impact of climate variability and adaptation strategies is therefore important for agricultural decision making at the farm, market or policy levels.

Climate change is a long-term shift in the statistics of the weather (National Oceanic and Atmospheric Administration 2007). Climate change is a multi-faceted challenge for today's societies through its impacts on human lives and the natural environment. Awareness and quality of knowledge on its existence and issues relating to climate change could reduce the impacts of the phenomenon (Acquah 2011).

In many parts of Africa, small-scale fisheries and related activities provide income to rural communities where alternative employment opportunities are scarce or even non-existent. In these situations, small-scale fisheries, fish processing and trade provide people with important, and sometimes crucial, form of safety-net that helps protect them against the effects of agricultural product price volatility, macro-economic crises, structural reforms, harvest failures, political turmoil and other factors that threaten rural stability and food security. In this way, small-scale fisheries substitute and/or complement other economic activities and help households sustain their standard of living and food purchasing power (Williams and Rota 2012).

Fish has always been and will continue to be an important source of protein in the diet of Ghanaians. The demand for fish has escalated because of rapid

population growth (Lokko and Anson 2006). Therefore, anything that affects fishing and the fishing community should be a matter of concern to the nation. Despite the importance of fish in Africa, the Sub-Saharan region is the only region of the world where per capita consumption of food fish has fallen (FAO 2009).

In the fishing industry, one of the major effects of climate change is occurrence of unpredictable storms. The most serious impact of storms in the fishery sector is the risk to the lives of the fishermen and/or destruction of their capital such as boats and fishing gear. Storm-related damage to capital assets, including boats and fishing gear, means the loss of income and livelihood, especially for poor fishing households. These victims may not have adequate savings to replace their capital assets, and are likely to face food insecurity unless these are replaced immediately through public support. The disruption of fishing activities of such households could also affect the livelihood and food security of others, for instance, small traders who buy and sell fish in small local retail markets (FAO 2007).

Individual fish actively select and rapidly change living areas based on suitable temperatures, oxygen concentrations, and food availability. Cold-water fish will actively avoid temperatures that exceed their preferred temperature by 2–5 °C and seek out refuge areas of cooler water such as groundwater or seepage areas and headwater streams (Meisner 1990; Gunn 2002).

Williams and Rota (2012), noted that there are many adaptation strategies to climate change effects available, which benefit or provide an advantage to small-scale fishers and fish-farmers. These include direct adaptations to specific changes as well as actions that increase the resilience and adaptive capacity of communities and ecosystems, and environmental (over-fishing, habitat destruction, pollution) stresses that can significantly increase vulnerability of communities and ecosystems to the impacts of climate change (Cheung et al. 2009; IPCC 2007; Walther et al. 2002). Many fishing communities are dependent on stocks that exhibit regular fluctuations and so have already developed considerable coping capacity (Easterling et al. 2007).

Climate change is acidifying the ocean, which increases dissolved CO_2 and decreases ocean pH, carbonate ion concentration, and calcium carbonate mineral saturation in the ocean (Cooley and Doney 2009). Johnson and Marshall (2007) asserted that ecological effects of climate change on tropical marine systems are predicted to be diverse and long-lasting. Observations are already supporting projections of increasing sea and air temperatures, rising sea levels, acidifying oceans, intensifying storms, and changing rainfall patterns and ocean currents (Marshall et al. 2010). Similarly, Fabricius et al. (2007) reported that widespread degradation of coral reef ecosystems will result from mass coral bleaching and ocean.

The potential impacts of global climate change (such as unpredictable rainfall, increasing temperatures, and longer dry periods) add to the vulnerability of Ghanaian coastal fishing systems. Although the general consequences of climate change are becoming better known, great uncertainty remains about how climate change affects specific locations (Nutsukpo et al. 2013) and more especially the coastal areas.

There is considerable uncertainty surrounding climate change, with a wide range of climate projections for Ghana (Arndt et al. 2015). The uncertainty in climate change and projections, especially for future coping strategies, brings to fore the need to highlight it for useful decision-making. Government parastatals, non-govenmental organisations, and civil societies in Ghana seem to have little access to detailed climate projections and seemingly little understanding of the uncertainties surrounding coastal climate change impacts and adaptations. Assessing the impact of climate change are critical components of poverty reduction programmes (Stanturf et al. 2011). Yet a major constraint to mainstreaming climate change within development policies is the lack of empirical evidence to inform decision making. Coastal level activities are critical for determining specific and individual effects and vulnerabilities, which either reduce or aggravate the eventual outcomes. It is essential to consider the range of potential climate realizations to identify major risks and to avoid incurring large opportunity costs if certain projections are not realized.

The rate of social, economic, and technological change in the fishery sector will gradually transform the setting in which climate change is likely to interact with sensitive features of the food system. The current state of the sector and important trends that would transform it provides a baseline against which to examine the potential consequences of climate change (Sagoe 2006). Public awareness and knowledge on climate change is crucial to managing climate change and its related problems. Ghana is faced with growing challenges in managing coastal and marine resources, such as the dramatic decline of fish stocks and the degradation of coastal resources. The capacity to utilize coastal and marine assets, while sustainably protecting them from degradation is woefully inadequate. This research therefore seeks to identify the effects of climate change on fishing and fishermen in the Central Region of Ghana and evaluate measures adopted by the fishermen to this climate change effects.

Study Objectives

The general objective of the study is to assess the effects of climate change on fishing and fishermen in the Central Region of Ghana. Specifically, the study sought to:

1. Determine the level of understanding of climate change among fishermen in the region.
2. Evaluate the impact of climate change on fishing and fishermen in the study area.
3. Examine the measures the fishermen employ to adapt to climate change situations.
4. Examine the challenges of adapting to climate change situations in relation to fishing in the study area.

This paper tries to address three main questions related to climate change and adaption in coastal areas by fishermen. First, what are the level of awareness of climate change and its effects among fishermen in the coastal areas of the Central Region? Second, what are the impacts of climate change and what adaptation strategies do fishermen in the Central Region adopt during their fishing expeditions? Third, what challenges do fishermen face in employing measures to adapt to climate change? Quantified estimations of climate change effects are beyond the scope of this paper, since it serves as a formative research and intends to bring to fore the issues about climate change from the fishermen's perspective. The study was undertaken with the view to determine the effects of climate change on fishing and adaptive measures among fishermen in major coastal fishing community in the Central Region.

Method

The setting for this study was the coast of Central Region in Ghana which comprises both urban and rural communities. It comprises of 17 administrative assemblies out of which more than half of them are along the coast of the sea; and Cape Coast, which is the regional capital, was one time seat of government for the then Gold Coast from 1830 to 1877 before the capital was relocated to Accra. The Central Region is along the coast of Gulf of Guinea; the region is characterised by predominant fishing communities. The region is bounded on the South by the Atlantic Ocean (Gulf of Guinea), the East by the Greater Accra Region, the North by the Ashanti and the Eastern Regions, and the West by the Western Region in Ghana.

Cross-sectional survey research design was employed for the data collection with a mixed method approach of qualitative and quantitative data. Cross-sectional design is deemed appropriate as data was collected from a section of fisher folks to explain the research problem. Zakour and Gillespie (2013) attest that this approach enables the researcher to assess different variables at the same time. Furthermore, Creswell (2013) also asserts that quantitative data yields numeric value and lends itself to statistical analysis while the qualitative item yields text data and is often analysed in themes. An advantage of the mixed method is that the respondents have the chance to individually justify their selection in the quantitative data with open ended questions.

In search for better ways of understanding the research problem, pragmatism philosophy guided the study to enrich research. It is believed that individuals come to know the world through the practicality or usefulness of objects (or concepts). Pragmatists, as their name would suggest, adopt a practical approach, albeit with varying emphases (Hookway 2016).

Pragmatism is mixed methods research approach that is increasingly becoming popular in modern researches (see Johnson and Onwuegbuzie 2004; Molina-Azorin and Cameron 2010). Iaydjiev (2013) contends that issues often arise in the world of

human practice with new problems; and these are more appropriately addressed through the pragmatic approach. From the pragmatic philosophical perspective, climate change and its implications turn out to be a complex and a sensitive issue to individuals (fishermen). Whereas some fishermen may wish to use whatever practices to get the maximum catch with no or little regards to economic, environmental and social consequences, some are of them have the conviction of practices that will enable them continue to utilize the available resources on sustainable basis. As occurrence of extreme climatic conditions rises steadily, many more people try to adopt different fishing systems that will enable them achieve better results amid the constraints associated with their livelihood activities. The prestige that is accorded best practices soon takes a different form when external factors such as precipitation and temperature leads to extreme drought, floods, or storms. This makes the farmers experience the effect of climate change differently. Essentially, this supports the pragmatic view calling for mixed methods for research on the climate change responses.

The theoretical population in this study comprised all the fisher folk resident in at the coastal communities in the Central Region of Ghana. Population has specific common characteristics; and in this study, the population is made up of adults who go for fishing on the Atlantic Ocean. It is this population that becomes vulnerable to climate change effects, more especially those related to the coastal zones. The assumption is that increased vulnerability through intrinsic factors in the phase of environmental hazards which form the extrinsic factors could result in livelihood threats in the fishermen.

Various methods of sampling have been recommended to access valid respondents in any research study. The choice however depends on the population and design of the study among other things. In order to get the nearest accurate population of the fishermen in the study area, it was necessary to use multiphase sampling in this study (Amoah and Eshun 2015). The demarcation of the administrative assemblies on the coast guided the stratification for the sampling. Stratified sampling was used to ensure that the respondents are obtained from representatives of the districts, municipal and metropolitan assemblies along the coast of the region. Simple random sampling was then used to select three administrative assemblies which forms a third of the number of administrative assemblies along the coast. Two coastal communities were then randomly selected form the sampled administrative assemblies. Due to the inability to access the list of the fishermen within the selected communities, accidental sampling was conducted to select 40 respondents from each selected community for the study. With the initial assistance of the Assembly Men/Women together with some opinion leading fishermen were identified in the communities. This exercise ensured that the right respondents were reached for the sample size. Data was then collected from 120 respondents in 6 communities. This number was not achieved although an appreciable number was obtained. The one-on-one interaction offered high response rate in the study. Reduction in the number was attributed to some of the research instruments which were rejected finally because of some inconsistencies detected during the data

cleaning and editing. At the end of the validation, 116 interview schedules were used for analysis, giving a response rate of 96.7%. Fryrear (2015) recommends response rate of 80% and above for surveys of this kind. The raw data collected was organized and analysed using IBM SPSS version 21. Descriptive statistical tools, mainly frequency counts and percentages, were used to analyse the data. The findings are presented in tabular and graphical forms below.

Results and Discussion

Background Characteristics of Respondents

Out of the 116 fishermen interviewed in the selected communities, 37.1% of the respondents were below 30 years of age while 55.1% were within the ages of 30 and 59 years. About 8% of the respondents were above 60 years of age (Table 1). This implied that most of the fishermen were in their early adulthood, an indication that most of the fishermen were in their active working age. About 80% of the fishermen been in their active working age group may be due to the demanding nature of the fishing activities such as carrying heavy tools and equipment like outboard motors, fishing nets and pulling of boats which required more physical strength.

While the majority of the respondents never had any formal education (55.1%), only 44.9% of the respondents have had some form of formal education (primary, junior high and senior high schools). The low level of education among the respondents is most likely to have influence on their level of awareness and adaptation strategies to climate change effects. The majority of the fishermen had been fishing for 15 years or more (63.86%). Meanwhile 19 (16.4%) had been in the fishing business for 5 years and below. It is therefore expected of the respondents to have a lot of experience in the fishing business. This is collaborated by the fact that, fishing is the main economic activity of most of the respondents. Just a few (8.6%) were into non-agricultural works (e.g. small scale mining, boat carving and carpentry, trade and security works) as their main occupation. The nature of the fishing business demands that the individual spend more time and resources to survive in the business. It is therefore not surprising that a lot of the respondents asserted that it is their main economic activity.

Fishermen's Perspectives of Climate Change

Doss and Morris (2001) opined that the perspectives of the indigenous people, the way they think and behave in relation to climate change, as well as their values and aspirations have a significant role to play in addressing climate change (Table 2).

Almost all of the respondents showed some level of understanding of climate change and its effect on fishing. Some of the indicators that respondents used to describe change in climate and its effect include erratic rainfall, extreme temperature (very low or very high), drought, flood and heavy precipitation, and strong

Table 1 Background characteristics of the respondents

Background	Frequency	Percent	Cum. percent
Age distribution			
< 30	43	37.1	37.1
30–39	26	22.4	59.5
40–49	23	19.8	79.3
50–59	15	12.9	92.2
> 59	9	7.8	100.0
Total	116	100.0	
Education levels			
No formal education	64	55.1	55.1
Primary	21	18.1	73.3
Middle/Junior High School	17	14.7	88.0
Senior High School	11	9.5	97.4
Others	3	2.6	100.0
Total	116	100.0	
Main occupation			
Fishing	102	87.9	87.9
Crop farmer	4	3.5	91.4
Non-agriculture jobs	10	8.6	100.0
Total	116	100.0	
Number of years in fishing business			
< 5	19	16.4	16.4
5–9	12	10.3	26.7
10–14	11	9.5	36.2
15–19	17	14.7	50.9
> 19	57	49.1	100.0
Total	116	100.0	

Source Authors' Construct, 2016 n = 116

Table 2 Respondents understanding of climate change

Climate change understanding	Frequency	Percent
Hot sunshine and extreme temperature	115	99.1
Erratic rainfall	114	98.3
Strong wind with high tides	112	96.6
Drought	107	92.2
Flood and heavy precipitation	106	91.4

Source Authors' Construct, 2016 n = 116

wind with high tides. This finding supports a report by Taderera (2010) that most Africans are aware that weather patterns are changing. Lefale (2003) also examined the utility of traditional Samoan weather and climate forecasting and found out that

the respondents were acutely aware of environmental signs leading to extreme events such as tropical cyclones.

Effect of Climate Change on Fishing and Fishermen

The study sought to find out form respondents the effects of climate change on fishing and fishermen. Table 3 presents the respondents' perception about the impact of climate change on the fishing and their livelihoods.

As shown on Table 3, the respondents affirmed that climate change has increased the risks and uncertainties associated with the fishing business in these communities. Some of them explained that due to changes in weather and climate, their prediction of when to go fishing, the kind of gears they must take along and the type of fish and amount can no longer be guaranteed. They mostly catch less fish than predicted. The uncertainties could partly be because there are fluctuations in fish and wild stock distribution. Thus, more than 8 out of every 10 respondents claimed they are experiencing fluctuations in fish and wild stock distribution. As corroborated by Cochrane et al. (2009), that climate change is affecting the seasonality of biological processes, altering marine and freshwater food webs, with unpredictable consequences for fish production.

On the issue of changing wild stock population due to the impact of climate change, Sumaila and Cheung (2010), reported that some fisheries have suffered declines in the number of fishers as the opportunities for fishing have diminished. Some specific fish species that have high market demand can be found in the waters only for a short period during the year. The time they would be expecting a particular type of fish, they cannot get it or only a few of such species will be caught. They stated that, the storm, the cold and the hot temperatures associated with the fishing business are because of the climate change and has a lot of implication on their livelihoods, food security and health. FAO (2007) reported

Table 3 Effect of climate change on fishing and fishermen

Effects	Frequencies	Percent
Increased food insecurity	111	95.7
Reduced revenue	110	94.8
Increasing risks and uncertainties in fishing	108	93.1
Reduction in productivity	107	94.0
Fluctuations in fish and wild stock distribution	95	81.9
Reduction in the duration of fishing season	93	80.2
Labour emigration	87	75.0
Decline in fish stock	84	72.4
High fish mortality	79	68.1

Source Authors' Construct, 2016 n = 116

similar result that rain storm damage capital assets, including boats and fishing gears. As many as 81.9% of the respondents said there were fluctuations in fish and wild stock distributions and that the duration of the fishing season has been shortened due to the effects of climate change (80.2%).

Food insecurity is the single greatest danger of climate change to vulnerable human populations and indeed to all humanity. That is, because there are multiple adverse impacts of global warming and climate disruption on agriculture—and these impacts will increase as the global temperature increases (Climate Change Emergency Medical Response 2013). As high as 95.7% of the respondents claimed that climate change effects increase their food insecurity levels. The results support the arguments by FAO (2007) and Kling et al. (2003) that the disruption of fishing activities by climate change effects could affect livelihoods and food security of the fishing households and others, such as the fishmongers and retailers, who are in the fish value chains. The world's poorest people are at risk of increased hunger, particularly those in the tropical and sub-tropical areas in the face of climatic change effect on agriculture (IPCC 2007).

Kling et al. (2003), posited that productivity of a fish population is related to the amount of water present and its thermal suitability and that the abundance and productivity of fishes increase with increased time spent at the optimal temperature. As high as 94.0% reported low productivity in their fishing business as a result of climate change effects. The results confirmed the findings of Sagoe (2006) that agricultural productivity has been found to be affected by climate change.

Changes in ocean temperatures, currents and productivity will affect the distribution and abundance of marine populations, with unpredictable consequences to marine ecosystems and fisheries. Increasing carbon dioxide levels could also trigger abrupt changes in thermohaline ocean circulation, circulation driven by differences in the density of sea water, controlled by the effects of temperature and salinity. This can result in massive and severe consequences for the oceans and for global climate (National Oceanic and Atmospheric Administration 2001).

Adaptation Strategies Adopted by the Fishermen

Cochrane et al. (2009), indicated that sea level rise, glacier melting, ocean acidification and changes in precipitation, groundwater and river flows will significantly affect coral reefs, wetlands, rivers, lakes and estuaries; requiring adaptive measures to exploit opportunities and minimize impacts on fisheries and aquaculture systems. To alleviate some of the negative impacts associated with climate change on the fishing business and the fishermen, the respondents have adopted a number of adaptations strategies. These are presented in Fig. 1.

As shown in Fig. 1, 86.2% of the fishermen interviewed in two communities seasonally travel to other locations to fish as an adaption strategy to poor catch in their locality. Most of these respondents change their methods of fishing (80.2%) due to the adverse effects the climate change is having on the normal fishing methods.

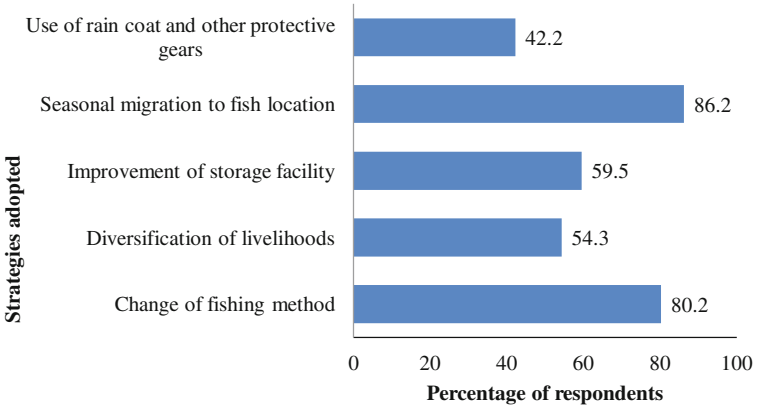

Fig. 1 Adaptation strategies adopted by the fishermen in the two communities *Source* Authors' Construct, 2016 n = 116

A publication by GNA (2013a) confirmed that some of the fishermen from Central Region are found in the Jomoro District of the Western Region due to bumper catch of fish in that region. Some of the methods employed as adaptation measures include changing of fishing nets, use of light (bulb) to attract the fish and use of machine to detect the presence of fish. Some of these methods are dangerous and illegal practices which can result in negative consequences in the near future (GNA 2013b).

As an adaptation strategy, the respondents claimed to have improved on their method of storing the fish so that the impact of the harsh temperature could be reduced. To this end, about 6 out of every 10 respondents used one or more methods of storing their catch to prevent fish spoilage before the fish get to their customers. This is achieved using deep freezers, ice blocks or covering the fishes with thick materials like cold jute sack to control the amount of direct sunshine and exposure to high temperature.

More than half of the respondents (54.3%) adapted to climate change by diversifying into other businesses as a livelihood strategy. Some of them do this by integrating fishing and aquaculture (40.5%) or leasing their fishing gears to others during periods when they anticipate low catch (37.9%). This finding is consistent with a revelation by Sumaila and Cheung (2010) that as fish stocks decline, some fishers in both developed and developing countries have attempted to diversify their income by engaging in other non-fishing livelihood activities like aquaculture.

Challenges in Adapting to Climate Change Effects

In their efforts to adapt to the climate change effects, a number of constraining factors prevent the respondents from attaining their optimum level of adaptation strategies. Challenges constraining the optimum adaption of appropriate adaptation strategies are presented in Table 4.

Table 4 Challenges faced by respondents in adapting to climate change effects

Challenges	Frequencies	Percent
Inadequate capital	114	98.3
Insufficient research and extension services	85	73.3
Poor fish marketing system	72	62.1
Limited information on climate change	64	55.2

Source Authors' Construct, 2016 n = 116

As Table 4 reveals, 98.3% of the respondents affirmatively responded that inadequate capital, mainly finance and other resources, is hindering their efforts to adapt to climate change effects. Other challenges that fishermen faced in adapting optimally to climate change effects in Central Region include insufficient research and extension services (73.3%), poor fish marketing system in such as price fluctuations, difficulty in transportation, and inadequate preservation and storage facilities (62.1%), and limited information on climate change and appropriate mitigation measures (55.2%).

Conclusion

The fishermen were relatively young but with substantial experiences in the fishing business. With the necessary extension and appropriate climate information system to provide localised and accurate climate intelligence, these fishermen will improve livelihoods, build resilience and use sustainable practices. Most of the respondents were highly aware of climate change and its effects on their fishing business and their livelihoods. These effects dispose the fishermen to low productivity, reduced revenue and food insecurity.

The difficulties facing the coastal fishermen are being aggravated by climate change and its effects. Extremes of weather are increasingly making fishing more and more risky business. To cope with these effects, the respondents resorted to seasonal migration of fishing locations, changing fishing methods, improvement in storage facilities, use of protective gears and diversification of livelihoods. However, a substantial number of respondents were unable to fully utilize the various adaptation strategies due to certain constraints. Some of these adaptations measures are detrimental to the sustainability of the fishing business in the area.

Government parastatals, non-governmental organisations and civil societies in Ghana should intensify non-formal education for the fishermen to enable them access current and relevant information on climate change, its effects and good adaptation strategies, and appropriate fishing equipment that will not have negative consequences on the sustainability of the fishing business in the area. Financial assistance, including saving, micro-credit and micro-insurance, should be extended to fishermen by both governmental and non-governmental organisations to enable

them better adapt to the impact of unfavourable climate change on their fishing business. These will empower them and enhance their adaptive capacities against negative shocks due to climate change in the future.

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