Thesis By

KOBINA ESIA-DONKOH

UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

FISHING COMMUNITIES' ADAPTATION TO CLIMATE CHANGE AT KOMENDA-EDINA-EGUAFO-ABREM MUNICIPALITY, GHANA

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BY

KOBINA ESIA-DONKOH (PH.D. in Endogenous Development)

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AUGUST, 2017

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result if my own original work and that no part if it has been presented for another degree in this University or elsewhere.

Candidate's name: Kobina Esia-Donkoh

Signature: …….. Date: ……

Supervisors' Declaration

We hereby declare that the preparation and presentation of this thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies, Tamale.

Principal Supervisor's name: Professor David Millar

Signature:  Date: 30 – 07 - 2017

Co-Supervisor's name: Professor Albert M. Abane

Signature: …….. Date: ……

ABSTRACT

Adaptation to climate change in local contexts and fishing communities in Ghana has not received the desired attention even though these contexts are considered the most-at-risk and vulnerable. The objective of this study was to assess how fishing communities in the Komenda-Edina-Eguafo-Abrem Municipality adapt to climate change. The study was guided by the crisis management and timeline model, and the endogenous development adaptation system framework. Four fishing communities were purposively selected based on their community characteristics and observable evidence of a changing climate. Both primary and secondary data were collected for complementary reasons. Sixteen fishermen participated in in-depth interviews while 12 focus group discussions were conducted. In addition, a survey was conducted with 222 fishermen who had at least one decade or more experience in fishing and had stayed in their respective communities for two decades or more. A set of secondary data comprising temperature (1993-2011) and rainfall records (1980-2009), and satellite images of land cover change (1986-2002) from Landsat were also accessed. From observation and experiential knowledge, over 80 percent of the respondents expressed that temperatures and the sea level have increased while rainfall has decreased as observed over the last three decades. Spiritual factors were used to explain the reasons for the change in temperature, rainfall and sea level. The secondary data, however, did not show any consistent increase or decrease in temperatures and rainfall characteristics. Impacts of the changing climate were adverse on habitats, fish catch and indigenous knowledge in fishing. Temporary relocation, adaptive fishing practices and alternative livelihood strategies were implemented to adjust to the changing climate. These strategies reflected the local beliefs and practices in indigenous knowledge, although most of which did not yield

the desired results expected. The co-evolution of knowledge and innovations towards adaptation to climate (based on the endogenous development adaptation system framework) was weak due to poor linkage between the indigenous and the conventional institutions. The Municipality and the local fisherfolks need to engage to develop a locally appropriate and applicable framework to guide and promote effective adaptation.

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DEDICATION

To my wife

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CHAPTER ONE

INTRODUCTION

1.0 BACKGROUND TO THE STUDY

A phenomenon, which, since the start of the 21st century continues to challenge both international and local development, is climate change. Available evidence indicates that climate change has the potential to stagnate or reverse the gains Africa has chalked over the recent decades. The Intergovernmental Panel on Climate Change (IPCC) defines climate change as any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 1996). Climate change studies have been focused on three main areas: temperature, rainfall and sea level variations.

Since the 20th century, the global average near-surface air temperature has increased by $0.6 \pm 0.2^{o}C$ while sea level has risen by 10-20cm over the same period (Graßl et al., 2005). The IPCC anticipates a further increase in temperature by 1.4-$5.8^{o}C$ and sea-level rise between 9cm and 88cm over the period 1999 - 2100 depending upon the behaviour of humans. In Ghana, the Environmental Protection Agency (EPA) (2008) has predicted an average sea level rise of 5.8cm, 16.5cm and 34.5cm by 2020, 2050 and 2080 respectively, based on scenarios of sea level changes. Human activities have been observed as the main factors responsible for the occurrence of climate change.

Realising the ramifications of climate change, four main policy options were prescribed at the Bali Climate Change Conference in 2007. These are adaptation, mitigation, technology development and transfer, and resource provision through funding and investment. Among these, adaptation was judged as an immediate and

crucial short term strategy. Adaptation has been part of the UNFCCC deliberations for a couple of years, but the magnitude of the impacts from climate change and risks they pose to development gains adds urgency for further action. Thus, adaptation becomes no longer a mere policy option but an imperative strategy (Denton et al, 2008; Mead, Gitay & Noble, 2008; United Nations, 2008).

Adaptation is conceptualised as series of actions taken to cope with changing environments or situations. The IPCC (2007) defines it as adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Ray (2008) also defines it as adjustments, whether passive, reactive or anticipatory, that is proposed as a means of ameliorating the anticipated adverse consequences associated with climate change. These definitions underscore the point that climate change presents both adverse consequences and potential opportunities. Therefore, the available capacity of individuals, communities and countries will determine the extent to which these consequences and opportunities can be managed and taken advantage of respectively.

Adaptation to climate is not new. Pre-historical and historical accounts indicate that some communities had used their local knowledge to adapt to climate successfully while others collapsed under a similar challenge (Burton, Diringer, & Smith, 2006). There is a dearth of research in this area though. This is because, studies that focus on views, knowledge and experiences of local people cannot be situated within the context of universalism; a philosophy that derives global attention and local interventions. However, the argument that relative information is critical to local development resonates (Boedhihartono, 2010; Macchi, 2008; Vandana, 2000).

The IPCC (2007) has indicated that studies must also focus on how local knowledge has been used to adapt to the changing climate. This call is appropriate

because local or indigenous knowledge that has been used in farming in 'harsh' conditions in Africa has largely been successful (Denton et al, 2008; Oskal, 2008). Whereas a few studies have been conducted in this regard, a handful has been conducted in fishing communities in Ghana in particular and Africa in general.

Fishing communities are relatively more vulnerable to impacts of climate change in Ghana. The Environmental Protection Agency (EPA) of Ghana classifies inhabitants residing in these communities as 'most-at-risk' populations. By extension, their habitats, livelihoods and health are all at risk. With the country experiencing manifestations of climate change with variations (Ministry of Environment, Science and Technology, 2012), how fisherfolks currently adapt, and the knowledge system that underpins the adaptation strategies have research significance. Taking inspiration from the Pred's behavioural model, it can be argued that the availability and reliability of information provided by their local knowledge could determine how useful the local adaptation would be to the fishermen, fishmongers and the communities at large.

1.1 STATEMENT OF THE PROBLEM

The reality of an environmental change cannot be doubted. However, there are perspectives about climate change. Most of these perspectives revolve around the reality of climate change, causal factors, timelines of impacts and how to adapt and mitigate. It can be deduced that all these perspectives fall within the domains of positivist and intepretivist perspectives. While the former have gained enormous attention globally, a few studies have focused on the latter (Ajani, Mgbenka & Okeke, 2013).

Different perspectives also exist in relation to how the global community must respond to climate change. There is the view that adaptation is critical in the sense that

the impacts are inevitable even if mitigation is achieved now (Parry, Palutikof, Hnason & Lowe, 2008). A second perspective posits that adaptation is a lazy option but mitigation is imperative and demands strong commitments and actions (Ayers & Forsyth, 2009), whilst the third constructs and frames that adaptation and mitigation are two contrasting but interrelated perspective on climate change (Dewulf, 2013).

The focus on adaptation has, however, gained attention. The call for studies to reflect local contexts and among vulnerable groups has been made. For instance, the 2000 UNFPA's report, subtitled "Facing a changing world: women, population and climate" called for a redirection of focus of climate change and adaptation issues from the 'what' and the 'where' to the 'who'. This, in principle, justifies studies that reflect the perceptions, knowledge and adaptive practices of vulnerable people.

People's perceptions are usually formed as a result of their interactions with an event or phenomenon. For instance, in theory, symbolic interaction and phenomenology have extensively been used to explain perceptions. Symbolic interactionism explains that people act toward things based on the meaning those things have to them; and these meanings are derived from social interaction and modified through interpretation (Blumer, 1969). Phenomenology on the other hand, describes what people experience and how it is that they experience what they experience (Patton, 1990). These perceptions, to a large extent, form the basis of knowledge, and by extension, indigenous knowledge of local communities.

However, the general applicability of local studies developed around local people's perceptions and knowledge about climate change and adaptation has been a challenge. This is because studies based on perceptions and experiences are usually considered as subjective. With indigenous knowledge being a context-specific knowledge system, it becomes limited in scope and usage owing to its relativity. This has contributed to its

pervasive silence in the world of study that is dominated by the philosophy of universalism (Weber, 2010). But if local people are those that will be more affected by climate change, and do not have the adequate adaptive capacity, and are most vulnerable as suggested by the literature (Ajani, Mgbenka & Okeke, 2013; Boedhihartono, 2010; IPCC, 2007; Salik & Byg, 2007), then the focus and attention must be placed on such people. And how can one really understand issues of climate change and adaptation in local communities if their perceptions and experiences with the changing climate are sidelined (see also Women's Environment and Development Organization (WEDO) (2007, 2008)?

Therefore, the call by IPCC in 2007 recommending that researchers study the use and application of indigenous knowledge of local communities was not only timely but also instructive. Unfortunately, the institution itself and its affiliated bodies have done very little in this regard (Boedhihartono, 2010, Macchi, 2008; WEDO, 2008). For instance, the 384-page Human Development Report for 2007/2008 and the 2010 World Development Report failed to emphasise the relevance of indigenous knowledge, and ignored the worldviews and perceptions of local people on the subject. Thus, there is still the lack of recognition of indigenous knowledge and adaptation of local communities in the literature available.

The situation is not different in Ghana. Apart from isolated studies that have been conducted with respect to farming, climate change and adaptation issues in fishing have received less attention. Although specifically, the National Climate Change Policy (NCCP) did not express much on fishing, one of its policy actions is to document and promote appropriate indigenous knowledge and best practices (Section 4:4-2) (Ministry of Environment, Science and Technology, 2012)

The KEEA Municipality does not have any local policy action on this subject, and does not have any results from the ground to guide it to develop a climate change adaptation action plans. In response to the need of the Municipality, the national policy option directive, the global call, and the reason to contribute to addressing the gap in the literature, this study was conducted. Guided by the endogenous development paradigm, the study investigated and assessed strategies in selected fishing communities in the Komenda-Edina-Eguafo-Abrem (KEEA) Municipality in the Central region of Ghana. The study admits that indigenous knowledge and participation of local people are of essence in every facet of human and community development (Kendie & Guri, 2010).

1.2 RESEARCH QUESTIONS

The main research question that the study addressed was: how do local fishermen adapt to climate change in the KEEA Municipality, and what results have been achieved? The specific research questions formulated to answer the main research questions were:

- How do fishermen at the KEEA Municipality perceive climate change? This question is premised on the basis that perceptions form the basis of a community's understanding of a phenomenon which are usually underpinned by cultural ontology.
- Incidence of climate change varies with regard to space and time. What factors suggest the incidence of climate change at the KEEA Municipality in the past and now? To what extent have changes occurred in temperature, rainfall and sea level?

- Fishing activities have different dimensions: social, economic and cultural. Again, there is a chain of activities (from fish-catch to fish-sale) that relate to fishing. How does climate change affect fishing activities in the study area?
- Past and present adaptation practices provide understanding about the changing climate within a setting. How have fishermen adapted to climate variation in the past and present?
- A review of an adaptation strategy provides the basis to underscore the strength and weakness of the strategy for revision, and the development of appropriate intervention. How successful have been the results of adaptation strategies of fishermen in the study area?

1.3 RESEARCH OBJECTIVES

The main objective of the study was to assess the adaptation of local communities to climate change in the KEEA Municipality. The specific objectives were to:

- Analyse the perceptions of fishermen on issues about climate change;
- Explore the incidence of climate change in the selected fishing communities;
- Analyse the effects of climate change on fishing;
- Assess adaptation measures that have been used to address similar effects; and
- Assess the effectiveness of the adaptation measures to addressing effects of climate change.

1.4 RELEVANCE OF THE STUDY

Rapidly changing climatic conditions have not only been recorded in the Polar Regions but have equally been observed in both temperate and tropical spheres. It has been predicted that climate change is likely to disproportionately affect rural and

coastal communities in the developing world (IPCC, 2001). The adverse effects of climate change and its implications on food production, socio-economic security and income make researches into climate change issues relevant in developing countries such as Ghana.

Undoubtedly, climate change is a threat to development. However, if this is perceived from a general global dimension, the picture is less clear. This is why emphasis on climate change studies in local areas is critical to provide the needed information about the coping and adapting behaviours of most-at-risk populations for intervention development (United Nations, 2008). This research is the first of a kind to be conducted in the KEEA Municipality to contribute to knowledge and policy direction.

Adaptation is not a new phenomenon. Available literature explains that indigenous knowledge has been able to adapt to harsh environmental conditions especially in local communities. However, the literature available has, most often concentrated on 'western scientific' analyses on climate risks and physical adaptations based on external models and frameworks. The IPCC, for instance, has recommended that studies must also centre on the use of indigenous knowledge in adaptation. The present study responds to this call to assess the resilience of indigenous knowledge in fishing to climate change.

Closely related to the above is the framework within which this research is situated. To a large extent, studies of such content are skewed toward science of senses. This narrows the focus and denies indigenous and other local practitioners the opportunity to make significant input at the local, regional and national levels (Oskal, 2008). This study is therefore significant in the sense that it appreciates worldviews and respects cultural values of communities regarding adaptations to climate change. This shift

makes the study holistic in content and acceptable in context to inform local policy on issues of adaptation to climate change at the KEEA Municipality.

Studies that focus on local people become important when they are, not only context-specific but, as prescribed by the endogenous development (ED) paradigm, people-centred, participatory in nature and locally-driven. This diverts from the common reality that climate change adaptation measures are centrally planned by those who often do not understand or empathise with the poor rural people (Boedhihartono, 2010). Whilst this study brings to the fore the perceptions and experiences of local people, it also assesses the strengths and weakness of the ED paradigm for theory-building.

This study becomes one of the few studies to be done within the coastal and fishing contexts making it relevant to policy makers, academic institutions, intervention planning and implementation organisations such as the Environmenal Potection Agency, and other non-governmental organisations.

1.5 OUTLINE OF THESIS

This thesis is divided into five chapters, with the present chapter providing the introduction to the research topic. The second chapter is, primarily, divided into two main sections. The first section reviews existing literature on perception, knowledge and impacts of climate change and adaptation. The second section reflects on the theoretical, empirical and conceptual issues in adaptation to climate change. It also focuses on adaptation to changing climate in fishing communities. The latter part of the second section presents the conceptual frameworks that guided the research. The frameworks are the crises management and timeline model, and endogenous development production systems framework.

Chapter Three mainly describes and explains methodological issues. It outlines and discusses the methodological framework of the study such as study setting, research design, sampling, pretesting of instruments, community entry processes and reconnaissance surveys, methods of data collection and management and data analyses. Ethical issues that underpinned the study are also presented in this chapter.

The fourth chapter analyses the results of the study and discusses the results. It is divided into four sections. The first section presents analysis on the perceptions of respondents about climate change. The section first profiles the background characteristics of both the qualitative and survey respondents. It also presents the cosmovision that influences the perception of the respondents in relation to their demographic and experiential backgrounds.

The second section examines on the incidence of climate change in the study communities. The results are based on both primary and secondary data. From the primary data, the results are based on the experiential interactions of the respondents with their local climate and the sea. The findings from the secondary data are based on temperature and rainfall data over the last two to three decades.

The third section presents results about the effects of climate change in fishing. In presenting the issues, the section emphasises the effects on sea inundation, changing temperature and rainfall patterns on fish harvest. Extraneous variables such as methods and purpose of fishing as well as technology used which can have possible impacts on fish harvest were also explored.

The final section explores the local adaptation measures that have been adopted to address the effects of climate change presented in the previous section. The discussion is done in relation to the existing literature and the theoretical and conceptual frameworks that underpinned the study.

The final Chapter of the thesis is made up of the general conclusion and recommendations. It deals with the implications of the methodological approaches and techniques adopted and adapted in the study. It also underscores the extent to which the research questions have been addressed. Lastly, the Chapter recommends to policy implementers and local level development practitioners in the Municipality the essential role co-evolution and innovations play in climate change adaptation.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

The chapter is divided into two main sections. The first section focuses on the perceptions, incidence and impacts of climate change and adaptation. The section reviews literature on the climate change and variability debate, perceptions, incidence, impacts as well as adaptation to climate change. The second section presents the philosophical and theoretical perspectives on the subject as well as the conceptual frameworks that guided the study.

2.1 CLIMATE CHANGE AND VARIABILITY DEBATE

The debate about which terminology to use to explain the current experiences with respect to the climatic system continues to rage on in the literature. Issues debated border on definition or conceptualisation of the occurring phenomenon, availability and adequacy, accuracy of data, and analysis of the phenomenon.

2.1.1 Definitional issues

The changes occurring in the climatic systems have been referred to by some as climate variability (Carter, 2009) and climate change (IPCC, 1996). According to the World Meteorological Organisation (WMO) (2009), climate variability refers to the averaged weather conditions that are used to describe a region.

Such conditions can be weak or strong depending on the extremes of conditions. Thus, from freezing to hot conditions or from extremely wet to extremely dry conditions denote strong variability and vice versa. Such variability occurs at the local

and regional levels within every day, week, month or year. This, to the proponents of variability, does not necessarily cause a change; just a normal and natural variability that occurs in the climatic system.

Occasionally, such extreme weather conditions or hazards that have never been experienced before in a local or regional community may occur. If the hazard does not reoccur at least within the next 30 years, it is regarded as a one-off or exceptional event in that particular period (WMO, 2009). Therefore, it has been argued that the weather events being recorded are just natural occurrences that are common to all climates (Cater, 2007).

Other research groups including the IPCC and UNFCCC deviate from the above proposition. They define climate change as any change in climate over time, whether due to variability or as a result of human activity. Though largely, UNFCCC attributes the change to only human-induced causes, both institutions agree that there is a change. They argue that variability can take hazardous forms such as floods, droughts, heat-waves and cyclones. Such extremes are related to climate change. Hence, though no single extreme event indicates climate change, it can become part of a trend depicting increased climate variability as a result of climate change.

To those in the local communities, the 'variability' and 'change' debate may not be the critical issue. Rather, what would be of concern are the effects or impacts of the phenomenon on the natural context, and the implications on their social and spiritual lives.

2.1.2 Data availability, adequacy and accuracy for analysis

There has also been the concern of the accuracy and adequacy of data to support the argument of climate change. From a general atmospheric science perspective, a place

needs to record weather conditions for over 30 years to be able to determine climate and same period to describe a change in a climate. So it can be argued that issues of climate change can best be understood as a localised phenomenon than a global event.

To substantiate the above argument, doubts can be placed on the credibility and adequacy of data from developing countries. For instance, for a country to indicate that it is experiencing climate change, such a country must have credible and adequate data sets of thirty years interval to conduct a trend analyses to make such a conclusion. Similarly, others believe that global temperatures have been dropping rather than what have been predicted based on computer models which have been used as the main drivers of the phenomenon (Carter, 2009; Booker, 2008). Specifically to Booker, research shows that temperatures were higher in the Mediaeval Warming period than they were in the 1990s. Again, data show that the 1930s was the hottest decade in the 20th century. Similarly, current winter characteristics as well as those between the years of 2003-2004 in the United States, for instance, indicate that winters have been getting colder.

Additionally, based on satellite records which began in 1979, the ice-cover at the Antarctic region reached its highest level; an assessment contrary to that held by IPCC. It has been further argued that computer climate models indicate that increasing amounts of greenhouse gases should cause slightly greater warming above the surface. On the contrary, the IPCC argues that measurements show that the Earth's climate has warmed overall over the past century, and in all seasons, and in most regions. Thus, the winter temperature characteristics of the eastern part of United States between the years of 2003-2004 are isolated incidences in one small region. Then again, winter temperatures have been getting warmer globally including the consistent melting of ice at the Polar Regions.

Moreover, recent researches have corrected problems that led to the underestimates of the warming trend in earlier analyses of satellite data. The new results show an atmospheric warming trend slightly larger than at the surface. Again, before the Industrial Revolution, the amount of carbon dioxide emitted from large natural sources closely matched the amount that was removed through natural processes. That balance has now been upset by anthropogenic activities, which since the Industrial Revolution have put twice as much carbon dioxide into the atmosphere as can be readily removed by the oceans and forests.

In most developing countries like Ghana, data availability is scanty, while its accuracy is in doubt. For instance, the country has less than a-century-old data sets to be able to do effective analysis to describe such phenomenon as climate change. At the KEEA Municipality, the temperature and rainfall data availability at the time of the data collection was not more than four decades old. But perhaps, the impacts on local fishing activities have already been experienced. Thus, whether the event is a 'change' or 'variability' would best be described if contextualized.

2.2 PERCEPTIONS OF CLIMATE CHANGE

Generally, perception is the organisation, identification and interpretation of information gathered by the sensory organs to represent and make a meaning out of the environment. Hoffman (n.d.), in one of his evolutionary works titled *Interface theory of perception* points out that the goal of perception is to estimate the true properties of the world. Theoretical models that have been used extensively to explain individual and public perceptions are the symbolic interactionism and phenomenology.

Symbolic interactionism explains that people act toward things based on the meaning those things have to them; and these meanings are derived from social

interaction and modified through interpretation (Blumer, 1969). Phenomenology as a study in philosophy, and usually used in qualitative research, describes what people experience and how it is that they experience what they experience (Patton, 1990). Thus, individuals, groups and organisations tend to use their perceptions, experiences and interactions to explain complex phenomena such as climate change based on their own interactions and experiences with the climate.

One of the key factors that influences perception (of climate change) is one's belief (Weber, 2010). Belief can either be personal or communal and diverse in each case. In a communal setting, the community perception may differ from those of certain individuals. Again, it is possible to have a common perception but different interpretations. For instance, in a study by Weber (1997, cited in Weber, 2010), farmers in Illinois were asked to recall salient temperature or precipitation statistics during the growing season of seven preceding years. Those farmers who believed that their region was undergoing climate change recalled temperature and precipitation trends consistent with this expectation, whereas those farmers who believed in a constant climate, recalled temperatures and precipitations consistent with that belief. Hence, Weber argues that only statistics must form the bases to understanding the issue of climate change to avoid errors. But how can statistics form the basis if data availability and accuracy in local communities in particular and developing countries in general are lacking? How can one really understand people's perceptions and experiences with a changing climate if these and their knowledge system are sidelined?

This is why the perceptions of local people are necessary in this discourse. This is because local people interact with and experience the realities of their changing climate. Thus, irrespective of the possibility of diversity or consistency, the

perceptions of local people matter in climate change and adaptation studies not only as a means to understanding the phenomenon but also as basis for the development of appropriate adaptation approaches (Boedhihartono, 2010; Salik & Byg, 2007; Vandana, 2000). Some writers (Ajani, Mgbenka & Okeke, 2013; Nakashima et al, 2012; Boedhihartono, 2010; Macchi et al., 2008; Kendie & Ghartey, 2000), therefore, support the use of indigenous knowledge as basis for climate change adaptation in local communities. This does not, however, mean that indigenous knowledge has any clues to the climate change menace.

As the debate continues, local communities in particular and developing countries in general also continue to bear the brunt of the change or variation and its effects. This research is of the view that the strengths of other knowledge systems can be used to complement the weaknesses of indigenous knowledge and vice versa. This is because perceptions and experiences alone cannot form sufficient bases for adaptation. Likewise, statistics do not reveal experiences and explanations that are relevant in adaptation studies and practices in local communities. Therefore, the co-evolution of indigenous and other appropriate knowledge system(s) becomes relevant for a holistic understanding.

2.3 INCIDENCE OF CLIMATE CHANGE

Literature on climate change is as enormous as the reality and incidence of the phenomenon. Indeed, the recognition of environmental change had been acknowledged even before the publications of Rachael Carson's *Silent Spring* in 1962, Garret Harding's *Tragedy of the Commons* in 1968, Paul Ehrlich's *The Population Bomb* in 1971, as well as Meadows et al.'s *Limits to Growth* in 1972 (Adams, 2009; IPCC, 2001; Pepper, 1984). This section cannot exhaust the list of the liberal and

radical environmental authors and publications. But what is evident is that these publications and other environmentalist activities prior and especially in the 1960s contributed immensely to the first United Nations Conference on the Human Environment in Stockholm in 1972 (Adams, 2009; Pepper, 1984).

Subsequently, the IPCC reported not only about the dangers of global warming but also its reality and incidence in enormous magnitude (Easton and Goldfarb, 2004). As confirmed by Crossland et al. (2005), the magnitude and rates of changes now occurring in the global environment are unprecedented in human history, and probably in the history of the planet (p 16). Indeed, this makes Brown's (1996) earlier opinion that the global community requires a mobilisation of efforts on a scale comparable to the Second World War convincing.

Incidence of climate change is difficult to contest, at least, given the recent publications by IPCC (see the Third and Fourth Assessment Reports). Even though in the publication of Taking Sides: Clashing Views on Controversial Environmental Issues, Easton and Goldfarb (2004) mention authors such as Kerr (2001) and Michaels and Balling (2001) to show that opposing views exist (at least in 2001) on the issue of global warming. Despite the IPCC report (that is, the Third Assessment Report), excerpts from Shapiro's (2001) 'Too Darn Hot' point to the fact that 'the only scientists who do not believe global warming is happening are paid by big oil, coal, and gas companies to find the results that will protect business interests' (cited in Easton and Goldfarb, 2004, p 251).

Since the last three decades, governments including developing economies and particularly those who are members of COP have instituted measures to mitigate, adapt and develop technology interventions to address the issues arising from environmental change in general and climate change in particular. This has been

necessitated by evidence from IPCC and other credible sources about the growing incidence of climate change. The three most discussed phenomena that relate to the incidence of climate change are changes in temperature, precipitation and sea level rise.

2.3.1 Changes in temperature

Global temperatures have increased since 1900 and it is projected to rise even up to 2030. Reports show that from the baseline to the year 2005, temperatures have increased by 0.4 - 0.6^{o}C with some regions already experiencing a rise of 2^{o}C or more (German Advisory Council on Climate Change (WBGU), 2008, 2005; IPCC, 2007a, 2001; Crossland et al., 2005). Similar incidence has been recorded in Africa with temperatures predicted to increase by 1.5^{o} – 3^{o}C and more after 2050. In Ghana, a historical climate data observed by the Ghana Meteorological Agency across the country between 1960 and 2000, (a forty-year period), show a progressive and discernible rise in temperature. It has further been estimated that temperatures will continue to rise on an average of 0.6^{o}C, 2.0^{o}C and 3.9^{o}C by the year 2020, 2050 and 2080 respectively (Environmental Protection Agency (EPA), 2009).

The incidence of changes in temperature leading to global warming has been recorded over time. The years 1998 and 2005 were the warmest since data records began in 1850 with 1995-2006 ranked among the twelve warmest years on record. Also, heatwaves have increased in duration since the latter half of the 20th century with the summer heatwave over western and central Europe in 2003 regarded as a recent extreme event. Again, the summer months of June, July and August in 2003 were recorded as the warmest since comparable records began in 1780 thereabout (Toulmin, 2009; WBGU, 2005).

The cause of the increase in temperatures is the increasing concentration of human-induced gases that have been introduced into the atmosphere since the industrial revolution. Over the period, there has been a consistent and increasing concentration of carbon dioxide and other greenhouse gases in the atmosphere. Since 1750, about two-thirds of man-made carbon dioxide emissions has resulted from the burning of fossil fuel with land use change contributing about one-third (Toulmin, 2009; WBGU, 2005). The incidence has become alarming over the recent past partly due to the human 'onslaught' on forests which are natural carbon sinks (Toulmin, 2009). The six main greenhouse gases listed by UNFCCC are carbon dioxide, methane, nitrous oxide, hydroflourocarbons, perflourocarbons, and sulphur hexafluoride.

Increases in temperature have implications on fishing. As the surface of the sea gradually warms, certain fish species tend to move towards lower depths or migrate towards areas where the temperature conditions are favourable (Gyampoh & Asante, 2011). In extreme cases, there is an extinction of certain species. These implications also affect the chain of fishing activities and livelihoods of the local people in such context. Coping, and subsequently, adaptation become the critical decisions and practices in fishing either temporarily or permanently.

2.3.2 Changes in rainfall

With regard to rainfall, the incidence of change is not globally uniform. For instance, the analysis of WBGU (2008) and IPCC (2007a) show that higher temperatures increase evaporation and rainfall and flooding. In the report of the National Wildlife Federation (2009) and the WBGU (citing IPCC, 2007a), they estimate that there would be a 1-2 percent increase for every degree of warming. The

shift in rainfall change has led to increasing torrents of precipitation in some regions and dry spells in other regions.

The National Wildlife Federation (2009) reports that incidence of floods in the United States over the last few decades can be attributed to climate change. The Federation adds that because warmer air can hold more moisture, heavier precipitation is expected in the years to come. At the same time, shifts in snowfall patterns, the onset of spring, and river-ice melting may all exacerbate risks of flooding. Toulmin (2009) writes that there has been a substantial increase in heavy rainfall events, even in those regions where there has been a reduction in total rainfall (p 18). From WBGU, the issue with precipitation is not just annual and seasonal amounts that are of concern, but also extreme weather events such as periods of drought and unusual intense precipitation events which occur over few days, accompanied by a simultaneous increase in the duration of periods without rainfall (p 59).

The case of Africa is as varied as the change. Already, incidences of flood have been recorded across the continent in recent times. For instance, Mozambique in 2000 recorded its worst flooding in half a century. Flood waters rose to 8 metres, submerging substantial parts of Maputo, its capital (Toulmin, 2009). Toulmin explains that the shift of the Inter-tropical Convergence Zone (ITCZ) and the El Nino Southern Oscillation (ENSO) determine the seasonal pattern of rainfall on the continent. As such, while North Africa, southern Africa and the Sahara are expected to be drier, East Africa is expected to be wetter, but evidence of changes of rainfall patterns in West Africa is much less certain. In Ghana, rainfall is predicted to decrease on the average by 2.8 percent, 10.9 percent and 18.6 percent by 2020, 2050 and 2080 respectively in all agro-ecological zones except the rainforest zone, where rainfall may increase (EPA, 2009).

Rainfall plays a role in fishing. It contributes to the temperature characteristics of the sea. It increases the volume of water in lagoons and estuaries which serve as fertile grounds for breeding of certain species of fish. Therefore, the reduction of rainfall with a corresponding increase of temperature has the potential to warm the sea along the coast of Ghana. It is, however, instructive to state that the extent of the changes in rainfall (and even temperature) over the period would vary from coast to coast, and from community to community.

2.3.3 Changes in sea level

Sea level change is a major concern particularly in the coastal zone and low-lying communities and small islands. The coastal zone is a zone of transition between the purely terrestrial and purely marine components on earth's surface (Crossland et al., 2005). From the global perspective, the common causes of sea level rise as explained by IPCC in the Second, Third and Fourth Assessment Reports are basically thermal expansion of the oceans and the melting of land ice and glaciers. But the dominant driver of sea level change is sea and air temperature. Other drivers are man-made such as coastal engineering including port development interrupting the longshore transport of protective beach sediment. Locally, it is caused by the retention (by damming) of river-borne sediments formerly discharged at the coast as in the case of the Nile delta (National Disaster Management Organisation (NADMO), 2007; Crossland et al. 2005; Arthurton et al. n.d.)

As pointed out by Crossland et al. (2005), given the estimates of 0.6^{o}C in average global sea surface temperature during the 20th century and a further predicted rise between 1.5^{o}C and 4.5^{o}C (citing Houghton et al. 2001) over the next century, sea level rise becomes a vital phenomenal concern to both natural systems and human society,

now and through the next 100 years. In support, the WBGU emphasises that the sea level rose by 15-20cm in the 20th century. This is not comparable with any sea level rise thousand years prior to this. Toulmin (2009) and others (Church, White, Hunter, & Lambeck, 2008) indicate that over the 1961 to 2003 period, global mean sea level rose by 1.8 $\pm$ 0.5mm per year owing to thermal expansion, and this expansion will contribute to sea level rise over the next century even if the concentration of atmospheric greenhouse gases stabilise at present levels. With many of the world's major cities built in low-lying coastal regions, sea-level rise will essentially lead to inundation of coastal areas, coastal erosion, salt water intrusion into aquifers, loss of coastal wetlands and mangrove areas, and impacts on biodiversity.

Compared to other regions, Toulmin (2009) underscores how threatened the African coastline in general and that of West Africa in particular are to sea level rise and the associated impacts. She indicates (by citing McGranahan et al., 2007) that a percent of Africa's coastal zone is less than ten metres above sea level, and 12 percent of its urban population live in this zone. But in West Africa, 40 percent of the population resides in coastal cities. The situation of Senegal is more extreme. This is because, not only is the coast of Dakar less than ten metres above sea level, but two-thirds of the population of Senegal live in the Dakar coastal zone with 90 percent of industry also located in this area. Similarly, half of the population in Benin lives on the coast, in the capital Cotonou and the surrounding communities.

In Ghana, a projected sea level rise of 1m by 2100 could lead to the loss of over 1000km^2 of land, with 132000 people likely to be affected. The east coast is particularly vulnerable to flooding and shoreline recession owing to its sandy nature (EPA, 2009). As a result, some communities along the Keta coastline have already been resettled due to coastal inundation. Elsewhere along the central coast, the

incidence of inundation would differ owing to the geomorphological composition of the coast. This further explains that the adaptation practices at the central coast will also differ from the east and west coast of Ghana.

2.4 PERSPECTIVES ON CAUSES OF CLIMATE CHANGE

Climate change has currently become one of the most popular global issues in human history. Over the early past, the debate initially and unfortunately was more of a blame game between the developed and the developing countries as to who to bear the cost of it based on the quantum of contribution to the phenomenon. Currently, the issues now bother on cooperation to enhance mitigation and adaptation.

Three main causes have been identified in the literature. These are natural causes, anthropogenic or human-induced causes, and supernatural or spiritual causes. Available literature indicates that natural factors cause climate variability (Carter, 2009) but climate change is largely caused by anthropogenic influences (IPCC, 1996). These two causes dominate the literature in climate change discussions. The third cause which is mostly ignored because of its lack of quantification relates to the cosmovision of a people. Rationally, the factors that lead to spiritual causes are similarly anthropogenic. However, the analysis given is based on spirituality.

The Fourth Assessment Report (AR4) of the United Nations IPCC assesses scientific, technical and socio-economic information about climate change, the possible effects, and opportunities for adaptation and mitigation. The report provides detailed and comprehensive information on pertinent issues of climate change. It comprises three Working Group Reports and Synthesis for Policymakers (SYR). The Working Group I Report (WGI) titled ‘Climate Change 2007: The Physical Science

Basis' and the SYR discusses into detail the natural and anthropogenic causes of climate change.

Atmospheric scientists have assessed that both external and internal factors constitute basic components that are responsible for the natural cause of change or variability. Apart from these external factors or extraterrestrial systems such as solar output and earth-sun geometry, and internal factors influenced by ocean, atmosphere and land, studies have proved that there are many other natural factors that can cause a change or variability in the climate. Primarily, natural factors that are extensively discussed in the literature centre on variation in atmospheric constituents, variation in solar output, continental drift, volcanoes and the tilting of earth (see Acheampong, 2016; IPCC, 2007).

Anthropogenic causes which have largely been blamed for the incidence of climate change can be traced to the Industrial Revolution era, and related activities since the 18th century. The quest by Europe to industrialise saw a large scale use of fossil fuel, clearing of vast vegetation for the construction of housing and industries. This trend, although now being checked to some extent, is still disturbing. For instance, atmospheric concentrations of greenhouse gases continue to increase since the pre-industrial era due to human activities, reaching their highest recorded levels in the 1990s (IPCC, 2002). Greenhouse gases such as carbon dioxide, methane and nitrous oxide as well as aerosols have contributed immensely to change in the climatic system (Hume, Doherty, Ngara, New & Lister, 2001).

Consequently, the global climate has been experiencing unprecedented warming resulting in melting glaciers, rise in sea levels, changing patterns of precipitation coupled with drought and floods, and increasing temperatures. For instance, it has been emphasised based on observations that global average air and sea temperatures

are increasing steadily. In the same way, the widespread melting of glaciers increases sea level. Similar changes have been recorded in Africa. With a decadal temperature increase of 0.5^{o}C, the continent has recorded increasing temperatures with the five warmest years being 1988, 1995 and 1998. These changes will and are having negative impacts on the ecosystem and biodiversity, coastal settlements, water accessibility, human livelihoods, health and wellbeing (IPCC, 2007).

These impacts have necessitated the call to urge countries to reduce their greenhouse gases emissions. The Human Development Report (2007) shows that while some countries have reduced their carbon dioxide emissions between 1990 and 2004, others have done contrary. For instance, there has been considerable and marginal reduction of carbon dioxide by Russia, United Kingdom and France. However, United States, Canada, China and other middle and developing countries such as Brazil, Egypt, Viet Nam, India, Nigeria and Bangladesh have increased the carbon dioxide emission over the period of review.

Spirituality is the bedrock of indigenous knowledge. It permeates all perspectives of traditional lives of local people. Thus, natural and human activities are interpreted with spiritual understanding. Such is why issues in climate change gain spiritual analysis in traditional contexts. In traditional settings, rules and regulations given and endorsed by spiritual deities need to be observed and adhered to strictly. A breach of any of such rules and regulations is a 'sin'. Consequences such as poor rains, poor harvest, diseases and other punishments are associated with anger of the gods and ancestors (Mbiti, 1991). For instance, farming along river banks, polluting the river and land with chemicals and unwholesome substances, degrading the forest and other sacred trees as well as failure to perform various sacrifices and rituals to gods and ancestors can warrant anger of such deities. Therefore, the increasing temperatures,

unreliable precipitation patterns and consequent poor yields have, in some contexts in Ghana for example, been attributed to punishment by supernatural forces (Esia-Donkoh, 2007).

It must be explained that spirituality in this argument is not in isolation. Again, knowledge about events and life is not limited to a single knowledge system, hence, the call for inter and trans-disciplinary studies. With respect to climate change, spirituality becomes crucial in traditional settings because of anthropogenic breach of the natural order. This destabilises the natural system of which deities have divine jurisdiction over and therefore have the authority and power to punish offenders.

Such an explanation is usually contested erroneously by western knowledge practitioners with the reason that it is not objective (and scientific). This is quite understandable because indigenous or traditional knowledge goes beyond sciences. It accumulates knowledge from all forms and sources from natural, human and spiritual dimensions (Esia-Donkoh, 2011).

A community's perspectives on the causes of climate change to a large extent will suggest the possible adaptation practices to be adopted. That is, if the community believes that the cause of climate change is spiritual, its adaptation activities will be based on spiritual knowledge. The different perspectives available raise the objective and subjective knowledge or universal and relative knowledge arguments. Local communities' knowledge is largely placed in relativism and therefore their actions to adjust to climate change will accordingly be subjective and context-dependent. This has contributed to the pervasive silence with regard to indigenous knowledge and climate change and adaptation studies.

2.5 IMPACTS OF CLIMATE CHANGE

Studies into impacts of climate change have been enormous. Apart from the comprehensive studies and publications by IPCC, the subject has received regular attention largely from positive researchers. There are diverse methods that have been employed to analyse the impacts of climate change by researchers. Whilst some of the findings have empirical understanding, others are predictions and projections.

Global evidence of incidence and impacts of climate change has been documented vividly in the Fourth Assessment Report of IPCC. From the report, there have been emerging trends as well as projections of general and specific impacts from both global and regional perspectives. In addition to the Report are other studies in specific regions and countries which confirm these impacts in various discourses on biodiversity and ecosystems.

Scheraga and Grambsch (1998) identified six main (potential) impacts of climate change as:

- health impacts – weather-related morbidity and mortality, infectious diseases, and air-quality-respiratory illnesses;
- agricultural impacts – crop yield and irrigation demands;
- forests impacts – change in forest composition and shift geographic rage of forests;
- water resource impacts – changes in water supply and water quality, increases competition on water;
- impacts on coastal areas – erosion of beaches, inundation of coastal areas, costs to defend coastal communities; and
- species and natural areas – shift in ecological zones and loss of habitat species (cited in Cuevas, 2011, p 49).

Nagy, et al. (2006) on the other hand, analysed the impacts of climate change and classified them into impacts on income, human development and the environment. The present study reviews the impacts of the phenomenon to reflect core issues in environmental and human dimensions. Specifically, the review touches on impacts on the biodiversity and ecosystem particularly in coastal areas, livelihood, gender, migration, health and indigenous knowledge of local people. All these are similar and embedded in both Scheraga and Grambsch (1998), and Nagy, et al.'s (2006) analyses of impacts of climate change except the impact on indigenous knowledge.

2.5.1 Impacts on biodiversity and the ecosystem

The Convention on Biological Diversity (CBD) defines biodiversity (biological diversity) as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems' (UN, 1992:3). In its policy, CBD defines ecosystem as a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. Further, it describes biological resources as genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity (UN, 1992).

The role of humanity as a modifier of nature has daunting effects on biodiversity and ecosystem survival and sustainability. As discussed by Mappes and Zembaty (1997), there are three main approaches to human-nature relationships. These are anthropocentric, sentient and biocentric approaches. The anthropocentric approach, as a human-centred approach, identifies interests and welfare of human beings as human

rights. Thus, any activity that affects public welfare is unacceptable. Human life, according to this approach, crucially depends on necessities such as breathable air, drinkable water and eatable foods. Any activity that is likely to harm the well-being of these necessities amounts to infringement on human rights. If an activity geared toward the welfare of human beings will affect the environment negatively, then the cost-benefit analysis should be employed to make the best decision.

It has actually been argued that overreliance on this approach has resulted in land use and land cover change, soil, water and air pollution as well as degradation and desertification, habitat fragmentation, selective exploitation of eco-species and introduction of non-native species (Slingenberg et al., 2009; Gitay, Suárez, Watson & Dokken, 2002). Currently, the rate of biodiversity loss is greater than the natural rate of extinction.

Two major critiques can be levelled against this approach. Firstly, the approach does not place emphasis on relevance of fauna and flora as part of ecosystem but only a source for anthropocentric satisfaction. Lastly, cost-benefit analysis is not adequate to make decisions that affect humanity and nature because it fails to account appropriately for spirituality and other axiological aspects of the ecosystem.

The sentient approach, according to Mappes and Zembaty (1997), presents two primary values which are usually considered in preservation and conservation. These are the inherent values and instrumental values of nature. Whilst the inherent values have values in themselves, instrumental values are to be used to satisfy the needs of aspects of nature that has inherent values. Human beings (and at times animals) are often considered as sentient with inherent values. Critically, this approach is not only discriminatory, but defeats indigenous sciences which emphasises interrelatedness and holistic harmony within the ecosystem of which humans are pasrt. This is because

indigenous knowledge recognises all environmental resources as life-form objects which are not only living but also constitute aspects of spirituality and divinity.

The perception of the biocentric approach is that all objects that relate to life are inherently valuable. Life is viewed from a broader sense to include both biotic and non-biotic resources. This approach fits into indigenous sciences. It considers life as a process that revolves around all natural and social resources to make relationship harmonious and cordial.

Nevertheless, with the event of increased concentrations of greenhouse gases in the atmosphere since the pre-industrial era, climates have been modified with resultant increases in temperatures, spatial and temporary changes in patterns of precipitation and related events, rise in sea level and increased events associated with El Nino. These changes have, and will affect the timing of reproduction and migration of plants and animals, species distribution and population sizes, and the frequency of pest and disease outbreak (Nicholls et al., 2007; IPCC, 2002).

The impact, either by natural or human activities may not be globally uniform. Species will be affected differently in relation to space and composition. For instance, the impact of sea level rise on coastal ecosystems such as mangroves, wetlands and sea grasses will vary with space depending on erosion and deposition processes from the sea and the depositional features of the land. Certain species are also very vulnerable due to limited climatic ranges or/and restricted habitat requirements. For example, endemic mountain species and species restricted to islands, peninsula and coastal areas tend to be most vulnerable to extinction due to climate change (Boko et al., 2007; Nicholls et al., 2007; IPCC, 2002).

Possibly, the loss of ecosystem species would result in the emergence of new ones. That is, the disturbances that will be created by climate change can increase the rate of

species loss and create opportunities for the development and establishment of new species. Notwithstanding, there is inadequate evidence to support the suggestion that climate change will slow species losses. On the contrary, ample evidence point to the fact that species losses will increase due to the phenomenon (IPCC, 2002).

As estimated, the 500 km of coastline between Accra and the Niger delta is expected to become a continuous urban megalopolis with the potential of inhabiting over 50 million people by 2020. With about 40 percent of West African population living along the coast, a global rise of sea level leading to increased coastal inundation will affect ecosystems and biodiversity, and consequently livelihoods (Nicholls et al., 2007; Hewawasam, 2002; Klein et al., 2002).

The impact on the biodiversity and ecosystem also affects fishing. For instance, the loss of mangrove vegetations will affect the breeding of certain species of fish from the sea and fresh water, and consequently fishing in most local communities in some countries such as Ghana. Questions that can quickly be asked include to what extent have local communities been affected, and how can they adjust?

Ghana, over the years has experienced consistent inundation at some portions of her coastal communities. The east coast comprising the south of Volta Region continues to face inundation attributable to factors such as rise of the sea level. Similarly, the periodic inundation of part of the central coast, specifically at the KEEA Municipality raises concern for coastal settlements in the Municipality. For instance, oral literature indicates that the 2009 flood in the Municipality, particularly in Elmina and its surrounding villages was the worse since the 1940s. The flood brought fishing activities to a halt for more than a week.

2.5.2 Impacts on livelihood

Livelihood has been conceptualised to comprise people, their capabilities, activities and assets (tangible and intangible) that contribute to a means of living (Elasha-Osman, et al. 2008; Chambers & Conway, 1992). In its definition, an Advisory Panel of the World Commission on Environment and Development (WCED) (1987) looked at livelihood as adequate stocks and flows of food and cash to meet basic needs. The Department of Foreign and International Development (DFID) (2000) incorporates these tenets and defines livelihood to constitute the capabilities, assets (including both material and social resources), and activities required for a means of living.

It must be emphasized that livelihoods, particularly in rural and local communities are not only dynamic, but also complex in the sense that it is multifaceted. The interplay of natural, human, physical, financial, social, cultural and more important to local people, spiritual resources are always deployed to make or provide a means to living. As such, when there is an influence from any internal or external stressors on one or more of these resources, people adapt and modify their livelihoods accordingly. Some livelihoods, including local farming, pastoralism and fishing are climate-dependent. A shift in weather events results in livelihood ramifications. The available knowledge is that adverse impacts of weather and climatic conditions increasingly threaten capabilities and available assets, and also erode basic needs and gains from livelihoods and potential livelihoods of poor and disadvantaged people and communities (Huq, Huge, Boon, & Gain, 2015; Cinner et al., 2011; Quinn et al., 2011; UNDP, 2007).

Unlike the previous reports, the Fifth Assessment Report by IPCC devoted a chapter on impacts of climate change on livelihoods and poverty. The report explains that observed climate variability, climate change, and extreme events constitute an

additional burden to rural and urban poverty, and that climate-related hazards are often associated with negative outcomes for livelihoods. It however emphasises that climate change is rarely the only factor that affects livelihood activities and subsequently poverty because of its interactions with numerous non-climatic factors, and this presents a challenge to detection and attribution. What is not clear is whether climate change influences some of the non-climate factors or vice versa.

Fishing as a livelihood is made up of series of activities that connect to the economic, social, cultural and spiritual lives of the fishermen and fishmongers in local communities in Ghana. Documented evidence shows that some of the fishermen use indigenous and non-indigenous methods to catch fish. The question that comes to mind is whether the introduction of some of such methods has been influenced by changes in climatic elements or facilitated climate change? Perhaps, the views, experiences and observations of local people in such communities can serve as basis to understanding the issues.

Nonetheless, climate change has impacted on fishing and fishmongering activities, and by extension, economic and socio-cultural livelihoods. For example, the Convention on Biological Diversity's (CDB) (2009) study among indigenous and local people in the Arctic region reveals that lakes and ponds in the tundra are draining underground due to climate change. As a result, this has reduced access to fish and waterfowl. In Ghana, Gyampoh and Asante (2011) have documented in detail how climate change has affected economic and socio-cultural livelihoods of local communities along the east coast of the country. The situation leads to the suggestion that co-evolution of knowledge systems where, for instance, the limitations of indigenous knowledge is addressed by the strengths of 'western' knowledge and vice versa is not only desirable but also imperative.

2.5.3 Impacts on gender

From humanitarian and rights perspective, social inclusion is critical. In traditional communities and societies, social inclusion needs to be context-specific owing to the plurality and complexities associated with culture and indigenous practices (Benson, 2009). Gender, which depicts the roles, responsibilities and benefits societies attach to the sexes (male and female) is a socio-cultural construct which differs from one society or group to another. It is therefore suggestive that universal approach to implementing gender-based interventions may not always be successful owing to cultural pluralism even within one traditional area.

In traditional communities, both men and women engage in practically different socio-economic activities but within the concept and context of complementarity. From the perspective of the 'outsider' such relationships are often misconceived as superior-subordinate, or expressed as a 'power-over' relation. Therefore, a careful gender analysis with reference to appropriate cultural values is of essence in gender contextualisation especially in risk reduction interventions.

Nevertheless, the detrimental effects of climate change in many contexts put women at most vulnerable conditions. Constituting the majority of the global poor, women's reliance on natural resources makes their livelihood threatened by floods, drought and other unfavourable effects associated with climate change. Thus, there seems to be a direct relationship between environment and women's livelihood. That is, if the environment becomes threatened as a result of climate change, it leads to a threatened livelihood of women in particular.

Consequently, as indicated by United Nations WomenWatch (2009) women face social, economic and political barriers that restrict their ability to cope. In their view, even though both men and women in rural and developing countries are especially

vulnerable, women are more hit when adverse conditions occur. This is because women have the mandated socio-cultural roles and responsibilities to secure water, food and fuel for cooking and heating. Politically, they are less involved in decision making while economically, they are less paid and are engaged in low-remunerated activities.

The disproportionate ramification of climate change does not only make the subject worth studying but also its impact on women makes it crucial. As shown by UN WomenWatch (2009), food availability, accessibility, utilisation and sustainability would be endangered. This would have repercussions on women farmers who account for 50-80 percent of all food production in developing countries. Also, with about two-thirds of the global workforce and more than 90 percent engaged in agriculture including fisheries, any disturbing conditions in the environment is an affront to the world's poor labour force.

Most importantly, the unpredictability of rainfall pattern coupled with inaccuracy in using indigenous knowledge to predict onset of farming and periods of effective fishing would make traditional foods availability and traditional fishing methods equally scarce and unreliable respectively. The associated rippling effects of food scarcity can undoubtedly be myriad. Notably, reduced incomes as a result of increases in prices of foods may be experienced. This has implications of survival of the poor as food becomes inaccessible to them due to poor yields and price hikes. Subsequently, and particularly, women's health which has been found to deteriorate more than that of males will be affected.

It has also been discussed that effects of climate change would prompt migratory actions leading to resettlement, rural urban drift and change in livelihood. Decisions of such nature are usually taken and implemented by household heads or individual

males. In situations of adverse effects caused by a change in climate, it is expected that women would not be engaged to participate in decision making about how to cope or adapt to the changing conditions. More likely also is the case that socio-cultural, political and economic restrictions would inhibit their capacity to resettle and/or switch livelihood to survive with their children. Placing gender issues in climate change discourse therefore becomes critical and imperative (WEDO, 2008; Nicholls et al., 2007). It must be concluded that in local fishing communities in Ghana, women depend on men for fish to sell. Thus, if climate change affects fish catch, it directly affects the livelihoods of women as well. With inadequate capacities, their adaptation options will be restricted too.

2.5.4 Impacts on migration

Throughout history, internal and international movements of people have been intimately related to economic, social and cultural development. Assessments of the influence of migration can be beneficial or detrimental to development in both sending and receiving states. Commonly, push and pull factors are the driving elements that influence the type and pattern of international migration of three percent of the world's population from global south to north, as well as between countries (Sørensen, Hear & Engberg-Pedersen, 2003). Estimates indicate that there is a larger flow of people internally particularly in developing countries in the patterns of rural-rural, urban-rural, urban-urban and especially rural-urban (Development Research Centre DRC) on Migration, Globalisation and Poverty (2008).

Over the recent past decades, critical among the push factors which influence people to migrate has been environmental change. Harsh climatic conditions with corresponding impacts of natural resource and agricultural opportunities have

necessitated internal movement of people usually from rural communities to areas of economic prospects. As pointed out by DRC (2008), climate change as a migration push factor interacts with other causes of, or constraints to, movement of people either internally or across national borders. For instance, given the dynamics of a population, young people are more likely to migrate.

Theoretically, people are likely to move from places of unfavourable ecological conditions which give limited economic opportunities and create threatened livelihoods and survival to areas with relative prospects of livelihood and survival. Records of past ecological events are few to provide a model to make convincing argument about how climate change will impact migration. In its analysis, the DRC (2008) is of the view that there are uncertainties associated with the scale of migration as a result of climate change. The tsunami and hurricane Katrina in Asia and United States provide evidence of context-specific migration flows, but limited within the national borders concerned.

Previous and recent certainties in climate change predictions such as rising temperatures and sea levels will threaten low-lying coastal communities when expected effects of coastal inundation and livelihood disruptions occur. Predictably, these uneven impacts could compel rural and poorer people to have limited structural, political and financial capacities to move. Conversely, the aged, women and children, or those with strong cultural and spiritual attachment to their communities may be unable to move. Their adaptation activities will therefore differ. In the absence of best adaptation practices or externally-influenced interventions, the vulnerability and sufferings of such people will be exacerbated (DRC, 2008).

Two case studies concerning Bangladesh and Ghana by DRC show similar projections. In Ghana, like in Bangladesh, projections and its effects of climate change

in the northern, central and southern parts of the country could lead to varied climatic consequences. For instance, a decline in rainfall coupled with increasing temperatures in the southern parts of the country could lower river levels which could reduce the nation's hydro-electric power production by 60 percent by 2020. These evidences are confirmed by Stanturf et al. (2011) who profiled Ghana in relation to climate change based on scientific evidence collaborated by qualitative and anecdotal evidences. The study revealed that sea climatic changes have resulted in changes in temperature and durational patterns of fish catch. They however did not hasten to include occupational practice such as pair trawling and over-fishing as contributory factors to the change.

2.5.5 Impacts on health

The health of the population of every country is very important for its sustainable development. Therefore if the well-being (physical, social, psychological and spiritual) of a human population becomes affected, its implications are varied and consequential on sustainable development. In the case of developing countries and those in Africa specifically, the phenomenon is projected to erode the significant strides made in their development.

Climate change presents a considerable and emerging threat to public health, with a growing contribution to the incidence of global disease and its associated burden. The incidence of climate change has brought and is projected to bring emerging and projected trends and variations of health of human populations. From both direct and indirect dimensions, the changing weather conditions have exposed human populations to more intense and extreme weather conditions, changes in the quality and quantity of air, water, food and other life-sustaining resources (Kumaresan, Narain & Sathiakumar, 2011).

These direct and indirect consequences can lead to morbidity and mortality which affect human capacity to effectively adapt. For instance, emerging evidence shows that climate change has altered the distribution of infectious disease vectors and increased heat-wave related deaths. Similarly, projections point to an increase in morbidity and mortality due to an increase in malnutrition, extreme weather variations, malaria, infectious disease vectors, diarrheal and cardio-respiratory infections (Boko et al., 2007; Confalonieri et al., 2010).

Reports by IPCC show that major environmental issues relate directly or indirectly to greenhouse gas emissions that impact human health. For instance, outdoor pollution accounts for 800,000 annual global deaths while traffic accidents, physical inactivity and indoor air pollution are responsible for 1-2 million deaths globally (World Health Organisation (WHO), 2004, cited in Kumaresan, Narain & Sathiakumar, 2011).

Evidence available indicates the diverse impacts of climate change on infectious disease dynamics. The WHO in 2009 estimated that about 150 000 deaths occur in low income countries each year, due to four main climate-sensitive health outcomes. These are crop failure and consistent malnutrition, diarrheal disease, malaria, and flooding (WHO, 2009, cited in Kumaresan, Narain & Sathiakumar, 2011).

The case of Africa is relatively critical because of her vulnerability and inadequate capacities towards prevention and management of transmission of malaria. Analysis of the Fourth Assessment Report on Africa shows that the incidence of climate change will lead to variations of malaria transmission by 2020, 2050 and 2080 as a result of variations in temperature, precipitation and flooding. Highland areas which hitherto did not experience malaria transmission would do so moderately by 2050 with conditions of transmission becoming highly suitable in 2080.

Climate change, however, is only one of many drivers of change. Its effects cannot be isolated from the multiple social, political, economic and environmental changes confronting present-day local communities. These impacts interact together and induce exacerbating and cascading effects that lead to adjustments (Nakashima et al., 2012).

2.5.6 Impacts on indigenous knowledge

Indigenous knowledge has been defined by many (Ocholla, 2007; Nakashima, Prott & Bridgewater, 2000; World Bank, 1998; Warren & Rajasekaran, 1993) without variations. It is the knowledge that local and indigenous people have held onto and used in all facets of their lives and livelihoods in social, economic, political, cultural and spiritual affairs. For instance, Warren and Rajasekaran (1993) defines indigenous knowledge as the systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments and intimate understanding of the environment in a given culture. Ocholla (2007) also describes it as a dynamic heritage of the sum total of knowledge, skills and attitudes that belongs to, and practiced by, a community over generations, and expressed in the form of actions, objects and language for communal use. Its strengths have well been admitted in the area of ecosystem or environmental sustainability, and in recent studies, adaptability to harsh or unfavourable weather and climatic conditions. But its weakness lies in its oral transmission that has distorted some aspects and lost valuable portions, as well as other facets that cannot be subjected to objective inquiry.

Although a few studies have been conducted, evidence shows that climate change has affected indigenous knowledge application and its reliability to a large extent. In a detailed study in Ghana by Gyampoh and Asante (2011), it was observed that the changing patterns of rainfall and temperatures have modified or led to the extinction of

certain plants, birds and other animals that play significant roles as climatic indicators. Such plants and animals served as predictive indicators in indigenous knowledge for livelihood activities in local communities. Timing and appearances of lunar objects that guide onset of farming and fishing activities have been modified as a result of the changing climate. Local people therefore find it a challenge to predict outcomes of their economic endeavours accurately and precisely based on their local knowledge (Boedhihartono, 2010).

Indigenous knowledge is largely climate-dependent. Plants, animals and lunar objects play significant roles in prediction of outcome based on indigenous knowledge. With climate change modifying the appearances of these indicators, and facilitating the extinctions of other biological species, indigenous knowledge becomes less attractive in terms of economic livelihoods. This is why it has been argued that the scale of climate change may be beyond the adaptive capacity or resilience of indigenous knowledge. This study consents to the call for co-evolution of knowledge systems even in local communities to adapt effectively to climate change.

2.6 ADAPTATION TO CLIMATE CHANGE

Although not new in human existence, adaptation to climate change has gained attention recently particularly at and after the 13th Session of the Conference of the Parties (COP) to the UNFCCC at Bali in 2007. It actually formed the basis of the Bali Road Map (Preston, Westaway & Yuen, 2011). The IPCC, in its Glossary of Terms (2012) defines adaptation as the process of adjustment of the actual or expected climate or its effects, in order to moderate harm or exploit beneficial opportunities. Compared to mitigation, adaptation is still in its infancy stage. Notwithstanding, having been placed as an equal option to mitigation (a human intervention to remove

the source or improve the sinks of greenhouse gases) at COP 13, adaptation has significantly been observed, but at the national policy level.

Earlier, the argument about whether adaptation as a short-term priority was urgent has raged on for a while. The fear was that placing emphasis on adaptation which is a simple task has the potential to negatively affect the complex efforts needed to achieve mitigation. For instance, in 1992, Al Gore wrote in his book 'Earth in the balance' and likened the craze for adaptation to a lazy option and an arrogant faith in humans' ability to react in time (Ayers & Forsyth, 2009). However, after observing the slow progress in mitigation, and the rapid impacts of climate change particularly on vulnerable groups and communities beyond the previous estimations by IPCC, adaptation has now been widely accepted (Parry, Palutikof, Hnason & Lowe, 2008).

Currently, the debate has centred on the approach to adaptation more than its essence. Like climate change, the attention of adaptation has been placed at the national scale with the development of National Adaptation Programmes of Actions (NAPAs) as intended frameworks to prioritizing adaptation needs (Agrawal, 2008; Tompkins, 2005; Tompkins & Adger, 2004); a top-down approach. Perhaps, the universalist view that an 'objective' framework can be adopted or adapted to fit into regional and local scales of adaptation needs a relook. These national scale-dependent programmes tend to focus on the impacts of climate change rather than the process of adaptation by those much affected; an approach considered in academic circles as 'pollutionist' view (Ayers & Forsyth, 2009).

The critical question to ask is that how can adaptation be effectively developed if we do not know how the vulnerable are adapting, and exactly what they are adapting to? Perhaps, this explains why many resources have not been committed at the local level. Again, most countries often place attention on large-scale engineering or

technological investments (Ayers & Forsyth, 2008) which, in less developing countries, is a challenge to the national budget. As a result, the delay of such investments rather tends to increase the vulnerabilities of local communities in the long run. In fact, it has even been argued in the literature that such long term investments are not cost-effective ways to reducing vulnerability. The reason being that risks posed by natural hazards/disasters more often than not affect the social, economic, and political lives in different settings rather that the magnitude of physical hazards (Janssen, Schoon, Ke & Borner, 2006; Smit & Wandel, 2006; Burton, Huq, Lim, Pilifisovo & Schipper, 2002).

Currently, there is a growing interest in community-based adaptation. Arguably, this approach can address not only the pervasive silence but also increase local communities' participation towards effective adaptation. Community-based adaptation in principle recognises that environmental knowledge and resilience to climate impacts lie within societies and cultures. The focus, therefore, is to empower communities to address their vulnerability to climate change based on their own social, economic, political, cultural and spiritual structures and decision-making processes (Nyasha, Murray, & Chambwera, 2012; UNDP, 2010; Mitchell & Tanner, 2006).

What is not really clear in the existing literature is what constitutes an effective adaptation. Even though some authors have attempted a prescription of forms of adaptation, these are insufficient in the sense that they are not only vague, but lack indicators to be assessed. From the available literature, three forms of adaptation are evident: public or private (Matthew et al., 2008), planned or autonomous (Food and Agriculture Organisation (FAO), 2007) and anticipatory or reactive (Osman-Elasha et al., 2006). Autonomous adaptation refers to any adaptation that is practiced without reference to any local or national policy guideline or framework while reactive

adaptation refers to any adaptation that is put in place because an impact has been noticed or experienced. Usually, autonomous and reactive adaptations are also private adaptation (to address the interests of individuals or a group).

The other idea is that if adaptation is public, planned and anticipatory, it is likely to yield effective outcomes. This is because it is situated within a local or national adaptation framework, considers the interests of a larger space, communities and people, and focuses on the future by assessing the possible impacts of climate change. This avoids the possibility of secondary adaptation. Secondary adaptation occurs when previous adaptations further exacerbate the effects of climate change leading to a further modified adaptation.

For Pethick and Crooks (2000), space and time matter in assessing adaptation. They indicate that an adaptation measure may achieve its objective in the short-run but not in the long-run and vice versa. Again, in one context adaptation may seem to be effective to a group or a person but can create negative externalities and spatial spillover with rippling effects that can reduce the capacities of others to adapt or increase their vulnerabilities.

Some also hold the view that adaptation can be evaluated using generic principles of policy appraisal that seek to promote equitable, effective, efficient and legitimate actions that are harmonious with broad sustainability (Burton et al., 2002; de Löe, Kreutzwiser & Moraru, 2001). But Adger, Arnell and Tompkins (2005) oppose this view and indicate that adaptation needs to be looked at from both spatial and temporal scales, and not necessary be assessed with regard to stated objectives.

Anderson (2011), on the other hand, posits that effective adaptation can be looked at from three broad perspectives: that which addresses existing adaptive deficits; that which manages incremental changes in climate-related risks; and that which addresses

long term climate change impacts by modifying available systems and practices. However, he concluded by saying that it is a difficult task to measure how effective an adaptation is in the sense that the domain of change (i.e. adaptive capacity or climate resilience) that needs to be measured is not well defined. What it means is that it is difficult to detect any occurrence of a significant change.

If these assessments present difficult complexities which are even beyond regional and national scopes, then it is appropriate to point out that such an exercise in local communities will not only be fruitless but a waste of time. Nonetheless, this study is of the conviction that any adaptation measure must achieve a holistic purpose. What it means is that whether in the short term or long term, adaptation must reduce risks or exploit opportunities for the good of the social, cultural, political, economic and spiritual well-being of the adopters. Therefore, how effective an adaptation is or can be, must also be contextualised. For instance, in Alaska, the early melting of ice in the spring has made hunting dangerous, hence, restricting the activity to once a year instead of twice (****). However, unlike low adaptation, high adaptation does not necessarily translate into the selection of the best options to reduce vulnerability because there are potential factors including economic and natural resources, social networks, entitlements and attachments, institutions and governance, human resources, and technology that limit or constrain opportunities (Adger et al., 2007; IPPC, 2001).

2.7 CLIMATE CHANGE AND ADAPTATION IN FISHING COMMUNITIES

Climate change with its discernible impacts is expected to increase the vulnerability of disadvantaged regions and communities in the world (IPCC, 2002). This is because such communities (including coastal communities, particularly those in poor countries

and rural areas) have also been struggling with other socio-economic challenges including poverty and diseases (Mycoo, 2015). Thus, the impacts of the climatic shocks will exacerbate the plight of these communities.

Currently, the general trend of changes in marine environments due to climate change has been observed in many regions in the world (Putten et al., 2014). These changes have, and in future, will affect coastal sector activities such as fishing, tourism and aquaculture (Nagy, Seijo, Verocai & Bidegain, 2014; Alpine, 2010). For instance, the biological impacts from climate-driven change include the alteration of the marine species abundance, distribution, physiology and phenology (Simpson, et al., 2011; Last et al., 2011; Dufour et al., 2010; Nye et al., 2009; Perry et al., 2005). Grafton (2010) earlier predicted that climate change will affect future fish catch and subsequently, the profitability associated fishing. Similar impacts will face commercial fishing including increases in cost of fishing and decreases in fisheries yield (Caputi, et al., 2010).

Critical to the livelihood and incomes of fishermen and others who depend of fishing is the impact on the human system in these disadvantaged contexts. Mycoo (2013) is of the view that the impacts of climate change on the human system is of broader consequences; that is, the impacts will affect the number of 'fishable' days, cost of insurance and social capital. Commonly, rural contexts and local (fishing) communities have a 'traditional' human system that is usually communal in structure. This system regulates fishing activities including the number of 'fishable' days and utilisation of social capital (Marshall et al., 2011; Marshall, 2010). In the Ghanaian context, fishing activities are governed locally by a chieftaincy structure which relies on the prevailing indigenous knowledge and practices (Gyampoh & Asante, 2011). Any impact on the human system in such vulnerable contexts will not only distort the

human system but may as well disorganise the cultural and socio-economic dynamics in the affected fishing communities.

Societies are fundamentally adaptive (Adger, et al, 2003). Historically, marginalised and local including fishing communities have adapted to environmental changes and similar risks but with varying degrees of success. Given the complexity of climate change and the multidimensionality of the impacts and implications, the call for societies to enhance their adaptive capacity is therefore, imperative. The ability of a community to adapt effectively depends on its adaptive capacity to face both present and future climatic shocks. To Reid et al., (2009), societies can only adapt if they are aware of and understand the concept of climate change and its potential impacts. A similar position is held by others (for example, Huq et al., 2014; Nagy et al., 2014) who further indicate that adequate information is required for an effective adaptation to climate change; hence, their call for the engagement of different people with diverse backgrounds, knowledge, experiences and expertise to produce adequate information.

Unfortunately, fishing communities in developing countries face a challenge to adapting to climate change due to inadequate information to address their adaptation needs. For instance, much research and other related studies have not focused on fishing communities to assess their vulnerabilities and adaptive capacities, and to improve upon their existing technologies to adapt effectively (Gyampoh & Asante, 2011; Marshall et al., 2011; Adger, et al, 2003).

Nonetheless, fishing communities have adopted various approaches to adapt depending on the severity of the impacts of climate change and the worst affected areas. Two main aspects of adaptation are common in fishing communities: adaptation to sea erosion and livelihood adaptation (Gyampoh & Asante, 2011; Toulmin, 2009). Adaptation to sea erosion or inundation usually focuses on two main approaches. The

first is the development of physical sea defense infrastructure, which is often engineered and constructed by the government due to the associated financial and technological capacity. The second is retreat (Bijlsma et al., 2007; Duxbury & Dickinson, 2007). Retreat is both an individual and a community-based social adaptation. Its adoption is usually challenged by the reluctance of residents to let go the socio-cultural and occupational attachments they have developed in an area over time (Gyampoh & Asante, 2011; Adger et al., 2007).

Livelihood adaptation options may abound in fishing communities for fishermen, fishmongers as well as coastal residents to select from to reduce risks and vulnerabilities. However, the inability, refusal or intention not to select the best options due to established preferences for, or/and aversion to, certain options and cannot be de-emphasised (Adger et al., 2007; IPCC, 2001). A few studies conducted in local fishing communities show that there are partial successes with regard to adaptation. In Ghana, some fishermen and fishmongers have adopted farming and petty trading as alternative livelihood options due to limited fish catch even in the bumper season (Gyampoh & Asante, 2011; CDB, 2009). These can be attributed to the fact that indigenous knowledge upon which local fishing communities' adaptation is premised has been challenged, perhaps, by the scale of the changing climate.

2.8 PHILOSOPHY, THEORETICAL PERSPECTIVES AND CONCEPTUAL FRAMEWORKS FOR THE STUDY

Philosophy explains the fundamental nature of knowledge, reality and existence of human and nonhuman events and disciplines. It is usually composed of tested ideas and experiences that make meaning which are further made easy to understand with conceptual frameworks. This section presents the philosophy of indigenous knowledge

and sciences in climate change, perspectives of vulnerability, adaptive capacity and local community, and the conceptual frameworks for the study.

2.8.1 Philosophy of indigenous knowledge and sciences in climate change and adaptation

Philosophy underpins and rationalizes the basis, structure and content of every knowledge system, language, culture and context or any discipline. The disputes over which discipline or knowledge system can be categorised as philosophical in the academia have been entertained for a while. Some are of the opinion that since all knowledge is human-centred or driven by human interests, they are both philosophical and indigenous. As Masolo observes, 'philosophy is always about the familiar and the indigenous, whatever its form or epistemic status: it interrogates, deconstructs, analyses, and tries to explain' (2003:27). In certain instances, philosophy is likened to theory especially when it explains an attitude that informs behaviour. Broadly, we have philosophy or theory of universalism (objectivity) and relativism (subjectivity).

It can be argued that aspects of indigenous knowledge fall within the domain of objectivity. For instance, indigenous crop farming is noted for its organic relevance generally. Again, experiential learning and knowledge acquisition in modern day indigenous communities follow scientific processes that are universally acceptable. Nevertheless, the core of indigenous knowledge in Africa and beyond centres on the interrelationship and interdependence of the three dimensional worlds: spirit, social and material. This portrays to a large extent the internal structures of the knowledge system that are relative given the contexts, practitioners and their practices.

More so, the reliance on the metaphysics makes indigenous knowledge system fall within the philosophy of relativism more than universalism. For instance, the African

indigenous knowledge philosophy has a hierarchical structure with the supreme spirit (God) at the apex, and other spirits (gods and ancestors) below it. These spirits, in the philosophy of indigenous knowledge, are central and superior in knowledge application and transfer. In fact, they permeate all the other aspects of social and economic endeavours of the adherents. For instance, the philosophy of knowledge among the people of Zarma in Niger, tells that one does not buy nor gather knowledge, but rather, it is a gift from the sky (Keane, 2004). Such a knowledge system is relative and context-dependent.

With the growing challenge the millennium brings to humanity's development, and the quest to promote global agenda to address issues such as climate change, it has been argued that local milieus can no longer rely solely on their relativist approaches. This is a challenge to indigenous knowledge in general and addressing local environmental changes in particular. The call to downplay meta-physics and develop empirical approaches has been made, but Gyekye (2013) disagrees to an extent. Gyekye posits that philosophy is indeed widely believed to be essentially a cultural phenomenon. Thus, if one analyses philosophy of indigenous knowledge within the context of philosophical concepts, then the present study agrees with Gyekye that issues of climate change and adaptation cannot be discussed and pursued entirely in isolation because they connect with the cultural or social contexts and experiences. Certainly, experiences and observations of local people constitute a broad domain for empirical as well as a priori analyses with respect to adaptations to climate change. These constitute science.

Science has its root meaning from the Latin word 'scientia' which means 'knowledge'. Science has therefore been described as a systematic way of acquiring knowledge. The current understanding about science relates to a systematic

observation and experimentation to explain natural phenomena. Until recently, the subject was limited to one dimensional mode of knowledge acquisition, that is, pure science or positive science. This has influenced national and global understandings about (environmental) events including climate change. For instance, the IPCC is made up of 2500 scientists from around the globe who provide findings about the extent of heating of the globe and more importantly information about climate change; based on the philosophy of universalism.

Although knowledge expansion has over the years broadened the scope to encompass other branches such as behavioural science, the focus of science, largely categorised as 'western science' has always been acknowledged within the ambit of human knowledge. But both human-known sciences and spirit-given sciences comprise the indigenous knowledge system that is practiced in different contexts. It must be noted that indigenous knowledge has existed and still exists in all parts of the world including Europe and America. Writing on the topic 'Climate change and indigenous knowledge', Simonelli (2008) summarises six main features of indigenous thought in native (or indigenous) American paradigm in relation to climate change. Similarly, in his attempt to explain the science of indigenous knowledge, Little Bear, a Native Educator and proponent of indigenous knowledge in the United States of America identified six variables that characterise indigenous philosophy. These variables, as discussed below, are consistent with the philosophy of indigenous knowledge and sciences in Africa and elsewhere, and similar to Simoneli's. The variable are:

- Change: Within the perspective of indigenous knowledge, everything is constantly changing, breaking down, transforming and coming back in a different shape. This point explains the cyclical nature of human and natural

events as prescribed by a superior body of actors in the spiritual domains. It is traditionally philosophised that every natural or human change, including climate change has spiritual underpinning. This explains why some communities still hold the strong view that the changing weather events are God-made.

- Spirituality: Everything is related to a source of energy beyond matter. Spirituality is the 'envelope' in which all other aspects of human and natural phenomena evolve and revolve. The above tenet explains that the core of indigenous knowledge is its spiritual dimension which permeates all facets of humanity and nature. That is, spirituality is the source of energy that brings life in both animate and inanimate objects. Such energy carries the divinity of the source of the energy along. Such is why some humans, flora and fauna, and water bodies, rocks, land including other environmental resources are regarded as divine carriers, and these, at times, guide human behaviour towards known and unknown events like climate change.
- Everything is alive: Within the ontology and epistemology of indigenous knowledge, all resources have their perfect functions to contribute to the natural order. Thus, every resource, human or non-human, living or non-living has a role to play in the life of nature. Thus, everything is alive, and has life. In a study among the people of Bongo in the Upper East region of Ghana, Millar (1996) recounts that both human and trees have life in the Bongo cosmovision (worldviews). Similarly, the Bishnoi of India regard all environmental resources; a belief that has endured the sustainable of such resources over time. By extension, there is life in climate change and adaptation must reflect the life in this change.

- Everything is interrelated: The concept of cosmovision in indigenous knowledge explains that everything is related to everything. Since everything is alive or has life, so are they related within the spiritual, natural (or material) and social order to ensure, achieve and promote a perfect intra and interrelationship for cordial harmony. Bear (2008) (cited in Simonelli, 2008) summarises that there is no such thing as something happening in isolation. It is not accurate to look at just one thing in a vacuum. If this philosophy is extended to the domains of climate change, it explains that the event does not happen in a vacuum, therefore, to respond to and adjust to its consequences, all the related aspects of life (natural, social and spiritual) must be engaged as well.
- Renewal and repetition: The understanding of events and occurrences of natural and social phenomena is experienced by repetition of cycles and seasons rather than linear observations. Depending on the interrelationship through social activities and natural occurrences as manipulated by spiritual forces or energies, such repeated events or phenomena come with renewal observations and not entirely an exact past events. Thus, climate change is not an isolated event, but a renewal of similar climatic conditions that keep changing given variations in cycles and seasons. Such concept explains the time dimension in indigenous knowledge which is cyclical (see Mbiti, 1996).
- Holistic thought: The concepts or features explained point to one fundamental paradigm in indigenous knowledge - holistic thought. Broadly, there are three interrelated worlds (as explained earlier). Because these worlds do not operate in isolation but in unity, the relationship produces a holistic thought or view to be perpetuated. This informs indigenous analysis of issues, gathering of

information, research and evaluation of phenomenal occurrences including climate change. Climate change therefore cannot only be discussed or studied from only the physical or social perspectives, but the holistic understanding of the physical/natural, social and most importantly the spiritual dimensions.

The six principles discussed above portray three main types of indigenous sciences: Physical/natural science, behavioural science and spiritual science. Usually, observations, experiences and perceptions (based on belief) constitute the sources of (unrecorded) data. The accuracy, objectivity and reliability of indigenous knowledge have always been questioned by positive researchers. Nonetheless, this does not affect its relevance in climate change studies in the sense that local people are equally positioned to present data based on their observation of events, perceptions and interactions with their local climates. Their adaptation practices will subsequently be based on their knowledge and effects of the changing climate.

Information about knowledge, perceptions and experiences of local people with respect to events such as climate change, and adaptation can be placed under four major perspectives: ontology, epistemology, gnoseology and axiology. From the ontological perspective, local people perceive nature in tri-sectional whole. These are the spirit, physical/material, and the human/social worlds. As depicted by the constellations of cosmovision related knowledge model (Lammerink & Otterloo-Butler, 2010), the intersection of these worlds reveal a perfect harmony between spirit-nature-human interconnectedness.

The epistemology is also of three dimensions: ancestocentrism, experientialism and empiricism. Ancestocentrism explains that data or information flows from the ancestors of a community to the living (Millar, 2003). The belief is that the ancestors have both divine and acquired human knowledge Experientialism deals with

knowledge that is acquired through depth of experience with an event, or interactions with a phenomenon such as the climate change. Empiricism deals with information or knowledge that is acquired from a series of observations conducted procedurally to arrive at deductive or inductive conclusions (Lammerink & Otterloo-Butler, 2010; Sarantakos, 2005). An example is the observations of the appearances of lunar objects and their associations with events in fishing.

The gnoseology entails the basis, forms and processes of learning. Every knowledge system has its own ways of knowing. Indigenous knowledge for instance, derives its basis, forms and processes of learning from its epistemology. Thus, there are ancestral, experiential and observational sources of learning. A combination of these also exists (Boedhihartono, 2010; Esia-Donkoh, 2007). Until recently, transmission of indigenous knowledge was oral from the older generation to the younger ones. Lastly, axiology refers to the values and aesthetic references that are inherent in a body of knowledge. Indigenous knowledge is value-inherent and value-centred (Vandana, 2000). It is therefore expected of communities which practice this system of knowledge to be value sensitive.

These four interrelated perspectives present the core areas in indigenous knowledge and sciences which can be studied in relation to any field of endeavor in local communities. In climate change and adaptation, the perspectives establish the pathways for data generation and interpretation. The challenge, however, is that, the perspectives are closely interrelated, and how to segregate local information along the philosophies of objectivism and subjectivism has been a bane to some researchers. To overcome this challenge, research 'lenses' used to study events (such as climate change and adaptation) in local communities must be free from biases and judgements (Vandana, 2000). Nonetheless, the recommendation is that studies in local

communities must be holistic to encompass all these perspectives if they are based on indigenous philosophy. This is the reason qualitative research design is appropriate.

2.8.2 Perspectives on vulnerability, adaptive capacity and local community

The diverse incidence and impacts of climate change coupled with the unequal consequences and varying capabilities of regions, locales, groups and even individuals to respond to these challenges raise concerns about vulnerability and adaptive capacity. Even though etymologically, vulnerability can be traced to the Latin lexicon, its popularity gained grounds in research domains in risks and hazards assessment, climate impacts, livelihood, coping strategies and resilience (Maxim & Spangenberg, 2003).

There is no single or best conceptualisation of vulnerability owing to the various frameworks that have evolved around the concept. For example, climate scientists generally regard vulnerability in terms of the probability of occurrence and impacts of the hazard while social scientists opine that the concept deals with socio-economic and cultural factors that influence people's or a group's ability to adapt to changes or hazards (Fussel, 2005; Maxim & Spangenberg, 2003). But the widely accepted definition is that of IPCC which conceives that vulnerability is the degree to which a system is susceptible to, and unable to cope with adverse effects of climate change, including climate variability and extremes.

The above conceptualisations provide two types or sources of vulnerability, namely, biophysical (natural) and social (socio-economic). Biophysical vulnerability refers to the potential of loss from natural hazards as a result of climate change or variability (Cocklin, 1998, cited in Cuevas, 2011). Conversely, social vulnerability

entails the social and institutional capacities that determine the susceptibility to cope and adapt to climate change.

The argument, as to which of these types (i.e. biophysical vulnerability and social vulnerability) influences or is the determinant of the other is worth making. From a general perspective, each of these two types can be a determinant of the other. That is, the natural vulnerability can be a determinant of social vulnerability and vice versa. But Fussel (2005) considers both concepts as independent from one another. While the study agrees with Fussel to an extent, it also perceives that biophysical vulnerability tends to increase social vulnerabilities. An example is the occurrence along the east coast of Ghana where as a result of biophysical vulnerability, social capital and even community ties and networks have been affected especially after the resettlement of some of the communities (Boateng, 2012; Oteng-Ababio, Apeaning-Addo & Owusu, 2011; Stanturf et al., 2011)

Current climate shocks and stresses already test, and sometimes exceed the ability of many developing and local communities to cope and adapt. This is because developing countries are socially vulnerable. For instance, existing institutions in Ghana (and the KEEA Municipality) have been unable to deal with occasional floods and other social hazards. The adverse effects of climate change have the potential to worsen the weak institutional structures available and undermine adaptation. Without action to reduce exposure and improve the capacity to cope, the gradual and sudden changes associated with climate change will increase vulnerability in many such areas.

Crucial to reducing vulnerability to climate change is to understand how individuals, groups and natural systems can prepare for and respond or adapt to the outcomes posed by the phenomenon. Undoubtedly, effective adaptation will manage and reduce the risks associated with changes in climate. The potential to adjust in

order to minimise negative impacts and maximise any benefits from changes in climate is conceptualised as adaptive capacity. Adaptive capacity entails the whole of capabilities, resources, and institutions of a community or country to implement effective adaptation measures (IPCC, 2001). Some of the variables that determine the adaptive capacity of an area include economic resources, technology, information and skills, infrastructure, institutions, and equity (Thornton et al., cited in Cuevas, 2011) Adaptive capacity has also been discussed to mean the same as adaptability, management capacity and resilience (Smit & Wandel, 2006).

Local communities in Ghana tend to be more communal than economic enclaves. Participation in activities in such communities, especially those in the rural parts, is communally driven. The local institutions, of course, usually rely on indigenous knowledge, skill and technology to address unfavourable conditions. The extent to which institutions in local communities are amenable to new and effective knowledge and technology from external sources lack evidence. Although social infrastructure may be strong due to social network and capital, communal arrangements and cultural ties, existence of physical infrastructure to reduce risks associated with climate change, and/or facilitate effective adaptation is lacking in local communities (Measham et al., 2011; Adger et al., 2007; Boko et al., 2007).

Hence, with the types of climate-related events in the past different from the present weather events, it would be hard to say that local communities have the capacity to adapt effectively. Since it is difficult to immediately reduce the incidence of climate change, the study agrees with Cuevas (2011) that to adapt effectively, means to reduce or eliminate vulnerability or improve adaptive capacity in local communities.

The concept of 'community' has been used differently in the literature depending on purpose of use and at what level. Either in the general body of knowledge or its own literature, what constitutes a 'community' has been contested and argued even after Hillery's (1955) ninety-four definitions of the sociological term was published. Common features or components of community are area, common ties and social interaction; territorial, interests and attachment; and a locality with all the elements of common life such as political, economic, social and religious life (Samah & Aref, 2011; Hillery, 1995; Willmott, 1989; Worsley, 1977).

Basically, a review of the components and features places community into two main perspectives: horizontal community and vertical community. Horizontal community relates to geographical space or a defined location/area while the vertical community refers to group of people with common interests in socio-economic, cultural and religious life. The word 'local' indicates the level of affairs which can be related to that of the national level or different from it. In this study, local community is conceptualised as a social unit or a group of people in a defined area with similar interests in life whose activities are different from or related to the national scope of affairs.

2.8.3 Conceptual frameworks for the study

Conceptual frameworks constitute a critical part in research. They are a set of coherent ideas or concepts that are organised to serve as a guide to a study (Creswell, 2012). Embodied in conceptual frameworks are variables that show interactions or interrelationships that are relevant for analysis. Their relevance to research studies stem from the fact that they serve as 'building blocks' upon which a research study is conducted. Specifically, the research is guided by two complementary conceptual

frameworks, namely, the crisis management and timeline model (Craddock, 2006), and endogenous development production systems (based on Millar, 2010).

2.8.3.1 Crisis management and timeline model

The ultimate objective of adaptation is to manage imminent crises by developing mechanisms or interventions to manage and minimise impacts. Craddock (2006) identifies four phases that are crucial in crisis management. These are the pre-incident, incident, post- occurrence and post-incident.

The pre-incident phase precedes the actual incident. Pre-cursors to the incident may exist, the detection of which can warn an incident, and enable prediction, prevention and preparation to avert the incident or face it. With respect to climate change, pre-cursors include increasing carbon concentration in the atmosphere, visuals of depleting ozone layer, and rates of deforestation. The associated impacts were predicted several decades ago. Humanity now needs to develop interventions to face it because we have reached the point of inevitability.

At the incident phase, the crisis occurs or begins to occur if it has not been prevented. If not predicted, this phase marks the detection of the incident which will evolve during the next phase. It is an undeniable fact that climate change has occurred. Scientific, observational and experiential evidences prove it. Evidences include increasing exposure to melting of ice at the Polar Regions, consistent rising of temperatures and sea levels, floods, irregular patterns of rainfall as well as drought across the globe (IPCC, 2007; UNDP, 2007).

At the post-occurrence phase, the incident may get worse (for example, triggering other incidents), it may stay the same, or things may improve especially if emergency services intervene. The phase consists of four other activities. The first is recognition.

By recognising the incident and establishing a profile for it, the best response can be devised and the effects of the incident minimised. The recognition stage continues throughout the entire post-occurrence phase. The second activity is response. Using the output of recognition an appropriate response can be formulated which involves both initial response and full scale response. The third and final activities under post-occurrence are recovery and investigation. At recovery the incident subsides, draws to conclusion and normality returns. At investigation, as soon as an incident is detected, evidence is gathered for any future enquiries that may occur.

Catastrophic impacts of climate change have occurred, are occurring and will continue to occur in the future. Because such impacts are inevitable, sustainable adaptation strategies (public, planned and anticipatory) have been prescribed. Drawing eclectically from various knowledge systems is crucial to adopt a sustainable strategy to avoid a secondary adaptation: an adaptation which is necessitated by worsened crisis due to ineffective adaptation.

The last phase of the model is post-incident. The incident at this phase is likely to have a finite lifetime. Most incidents are likely to conclude without intervention. However, without any intervention the effects of the incident may get worse and/or the incident may last longer. At the end of its lifetime, the incident concludes and normality starts to return. Three activities are involved at this phase. These are restoration, investigation and post-incidence discussion of activities.

There are limitations to the crisis management and timeline model. Firstly, there is an underlying assumption that crisis goes through a linear dimension which can be curtailed or addressed along the continuum. However, there are possibilities that an incidence such as a climate hazard can have its lifetime only at one phase on the continuum with no further graduation. Secondly, the model assumes that every crisis

has a timeline. However, it was silent about the duration between the phases of the lifetime of the crisis as well as the indicators of effects. Therefore, it is difficult to determine when each phase of the crisis begins and ends. Nonetheless, the model is appropriate for this study which focuses on people's 'relative' perceptions, experiences and knowledge about an evident crisis. The model's inherent limitations did not affect any aspects of the study.

For purposes of this study, the first three phases will be considered. The reason is that climate change discourse is at the moment scarcely discussed at the post-incident phase. Rather, the debate and discussions centre mainly at the incident and post occurrence phases. These phases are very crucial in the sense that adaptation issues are more relevant especially at awareness of climate change level (incident) and emergency intervention practice stage (post-occurrence phase) than the post-incident phase. The level of preparedness will depend on the various interventions that would be considered and implemented.

2.8.3.2 Endogenous development production systems framework and endogenous development adaptation system framework

The endogenous development production systems framework was developed by Millar (2010) to explore the various aspects of indigenous knowledge system employed in crop production. The framework identifies two main aspects of knowledge utilised by farmers, namely ethnoecology and agroecology (Figure 2.1). Ethnoecology entails ecological knowledge that is relative to a particular (cultural) community. It encompasses the cosmovision and culture, indigenous knowledge, folk taxonomies, knowledge of natural and climatic cycles, knowledge about varieties and species adaptation and inter-/intra uses strategies.

The knowledge of agroecology deals with knowledge characterised with farming practices to promote and enhance productivity and adaptation. Some of the practices include multi-stage strategies, traditional resource management techniques, local farming systems, design and techniques, use of crop and non-crop vegetation, selection, management and in-site conservation of local varieties and species and inter/intra uses strategies.

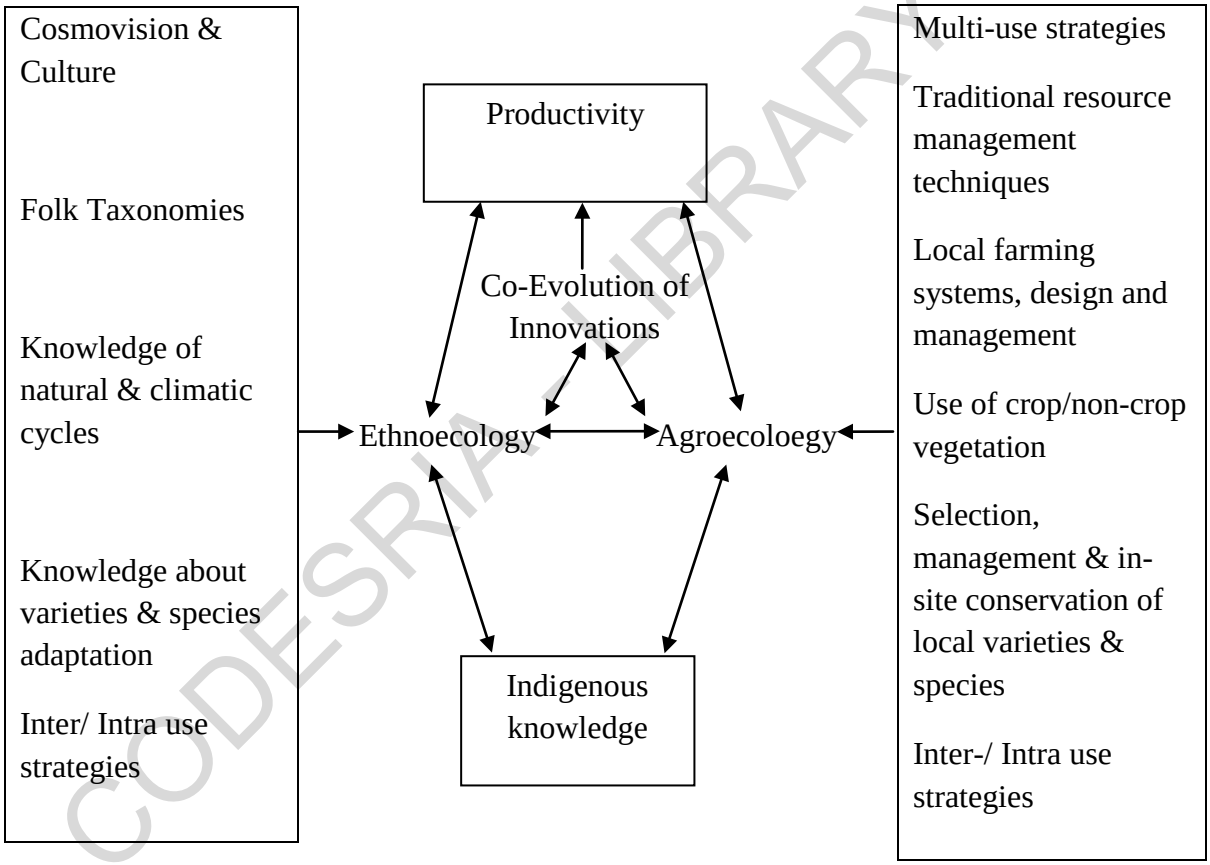

Figure 2.1: Endogenous development production systems framework

Source: Millar (2010)

The framework explains that when agroecology is based on the indigenous knowledge of the users, its integration with ethnoecology can co-evolve to produce innovations that can lead to productivity. Millar underscores the significance of co-

evolution of knowledge but advocates that such co-evolution must be underpinned by the indigenous knowledge of the users.

The study adapts the endogenous development production system framework. Similarly, the adapted framework, titled 'endogenous development adaptation system framework' identifies indigenous and conventional aspects of knowledge as the main knowledge base in a community. However, with this, each of the aspects comprises three variants namely institution, knowledge and methodology (Figure 2.2). The institution refers to the main agents responsible for knowledge transmission in a locality. The knowledge comprises the cosmovision of the institution while the methodology constitutes the processes adopted to access and utilise knowledge to adapt to and address issues that relate to climate change.

The co-evolution of indigenous and conventional knowledge systems, accordingly, is expected to produce an innovation that can define an appropriate type and form of adaptation essential in the study communities. A trans-disciplinary approach is therefore necessary not only to explore the co-evolution of knowledge but also assess, and if applicable, develop a comprehensive and holistic adaptation framework suitable to local communities. This makes the adapted framework appropriate for the study.

The endogenous development adaptation system framework (and also the endogenous development production system framework) is premised on the endogenous development paradigm (ED). The ED paradigm posits that development must emanate from 'within'. That is, development must come from and with those intended for. The argument is that such a development process enhances participation and ownership, which subsequently could lead to sustainability because it is based on local and existing political, economic, spiritual, social and cultural structures (Millar, 2010; Kendie & Guri, 2007; Hooft, 2006).

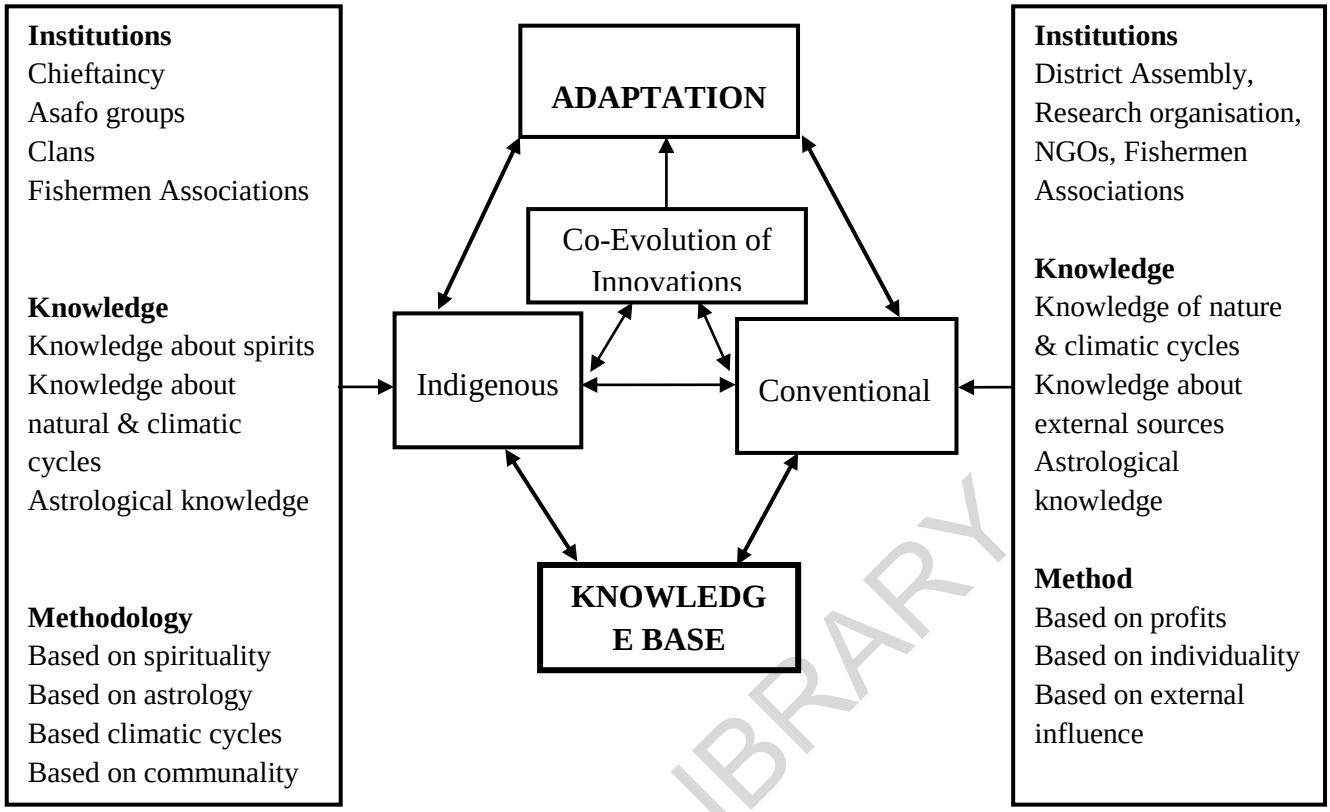

Figure 2.2: Endogenous development adaptation system framework

Source: Based on Millar (2010).

The main tenets of the ED paradigm are that: the development process must be led by the local people; the cosmovision and cultural values of the local people must be appreciated and respected; and there must be the selective use of external resources to avoid conflict of worldviews and culture and community interests (Millar, 2010; Lammerink & Otterloo-Butler, 2010; Kendie & Guri, 2007).

The endogenous development adaptation system framework inherits the limitations of the endogenous development production system framework. The frameworks are underpinned by indigenous knowledge and the philosophy of relativism. As such, they are context-specific frameworks. Thus, its applicability is restrictive to indigenous or traditional contexts. Since this study is based on indigenous knowledge, and also the

worldviews, experiences and knowledge of local people about climate change adaptation, the endogenous development adaptation system framework is appropriate.

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.0 INTRODUCTION

This chapter entails the description of the study area and the methodology for the research. The methodology consists of the research design, sampling procedures and sample size generation, sources of data, instruments used to collect the data, community entry process and reconnaissance survey, data collection process as well as workshop activities. Other issues presented in this chapter are how the data were analysed, ethical issues observed and challenges encountered. These are grouped under two main sections, namely, the qualitative and quantitative/survey sections.

3.1 THE STUDY AREA

The KEEA Municipality with Elmina as its capital is the study area. It consists of four traditional areas namely Komenda, Edina, Eguafo and Abrem traditional areas. Komenda and Edina (Elmina) are notable fishing communities. Eguafo and Abrem are however mainly farming settlements. A profile of the municipal as provided by the Ministry of Local Government and Rural Development (2006), provides the location, socio-economic and environmental description of the Municipality.

3.1.1 Location, climate, vegetation and drainage

The KEEA Municipality is located at the south of Ghana in the Central Region, bounded by the Atlantic Ocean. It shares boundaries with Cape Coast Metropolis to the east, Twifu-Heman-Lower-Denkyira District to the north, and Mpohor-Wassa East District to the west (Figure 3.1). On the globe, the study area is located between

longitude 1^{O} 20’ W and 1^{O} 40’ W and latitude 5^{O} 05’ N and 5^{O} 15’ N. It covers an area of 1,372.45 square kilometres (919.95 square miles).

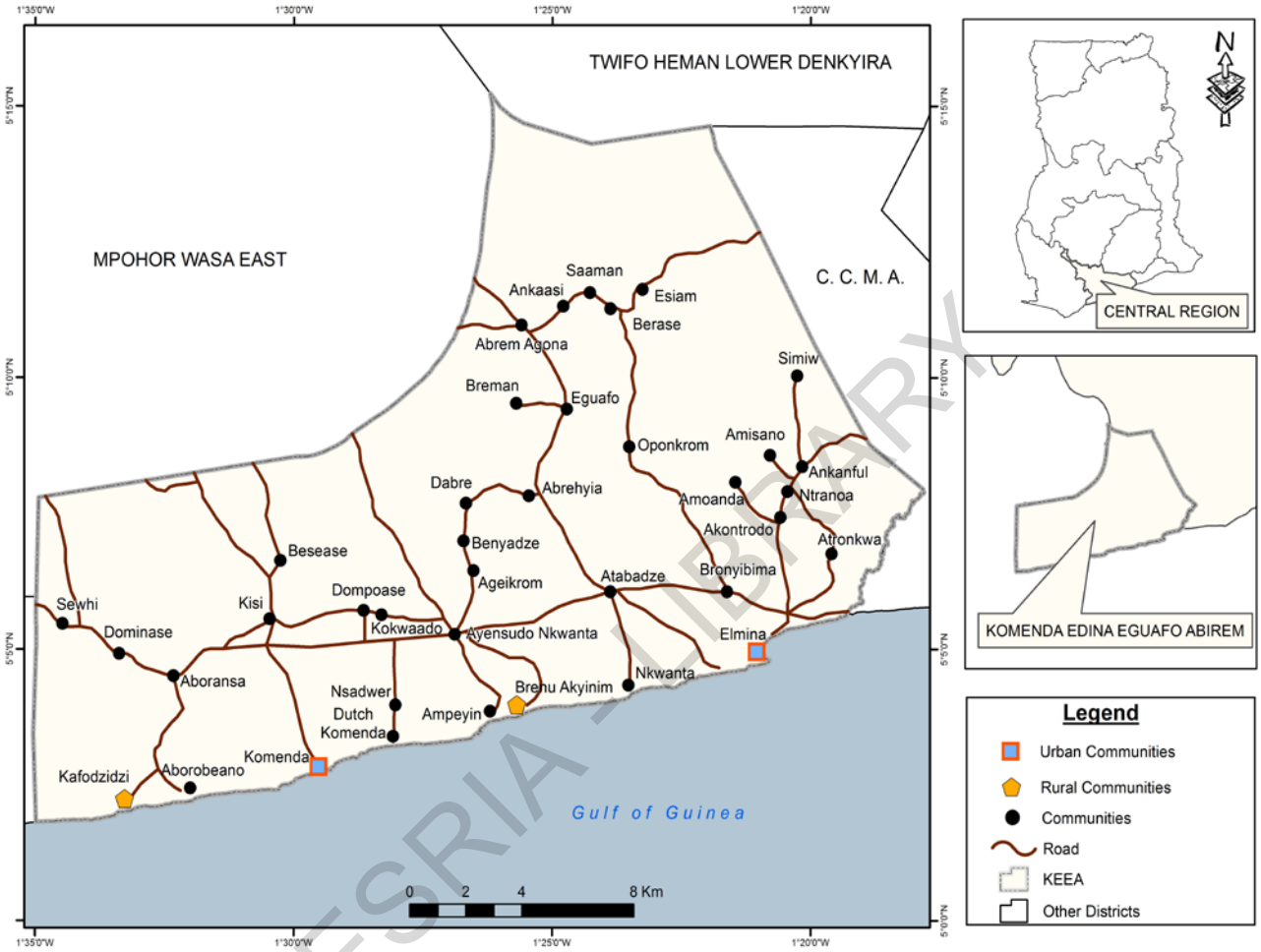

Figure 3.1: Map of Ghana showing the KEEA Municipality (insert) and study Area

Source: Remote Sensing and Cartographic Unit, Dept. of Geography and Regional Planning, UCC, Cape Coast (2013).

The coastline of the Municipality is located within the central coast of Ghana. The coastline is partly sandy and rocky. Projections by the EPA indicate that the entire central coastline is at risk of sea inundation due to climate change. However, about 28 percent of the population living along the central coast is considered as ‘most-at-risk’

of sea inundation. At the moment, evidence shows that part of the central coast is affected by sea inundation.

Vegetation characteristics of the study area vary due to the differential rainfall amount and pattern with regard to geographical locations. For instance, the scanty annual rainfall (less than 80cm) at the coast supports mangrove and palm fronds. Beyond this are the coastal scrub and grassland type. But further inland where annual rainfall is comparatively higher, vegetation cover transcends to savannah forests with a substantial number of timber species which are of economic value. Farming is extensive in this particular area of the Municipality.

The KEEA Municipality is richly endowed with a considerable number of lagoons and wetlands which include the Benya, Brenu, Susu, Abrobi and Ankwanda. Again, further inland, between most of the hills are valleys with various streams which drain into the coastal lagoons and the Atlantic Ocean. These streams include the *Iture* and *Ante* in the west and the *Udu* and *Suruwi* in the east. The ontology and epistemology regarding the use of these water resources are based on the indigenous knowledge of the local people. No studies have been conducted in the Municipality to assess the extent of climate change, and how the local people along the coast have, and are adapting to the change.

3.1.2 History

Historically, the people of the KEEA Municipality have been in existence for over seven hundred (700) years. Irrespective of its earlier contacts and interactions with European merchants and missionaries, the Municipality in general, and Elmina, its administrative capital in particular, still hold on to their cultural values and heritage;

these guide their interactions with natural resources, most of which are regarded as abodes of spirits.

The Municipality and Elmina, have a rich history in relation to pre-independence interactions and events with Europeans. These are evident with the existence of the heritage structures such as the Elmina Castle and other trading posts built by the Portuguese in 1482 for their trading activities including slavery (Dickson & Benneh, 2004; Adu-Boahen, 1966). These edifices, history and a rich cultural heritage and festival (Bakatue) attract a substantial number of domestic and international tourists. This has influenced the establishment of the best hotel facilities in the region. Most of these are situated close to the sea for both aesthetic and recreational purposes.

3.1.3 Demographic and socio-economic characteristics

According to the 2010 Population and Housing Census (Ghana Statistical Service, 2013), the population of the KEEA Municipality was 144,705 comprising 69,665 males and 75,040 females; a sex ratio of 92.8. The age sex structure of the Municipality is almost like that of the region and the nation at large, comprising a youthful population with a substantial segment (about 40 percent) under the age of 15 years. About 54 percent constitutes the working population while more than 6 percent are dependent. A bulk of the population (64.3 percent) lives in rural settlements. Ninety-eight percent of the population were nationals by birth while 93.4 percent constituted the Akan ethnic group. Christians constituted 93.4 percent of the population with 5.3 percent made up of Moslems (Ghana Statistical Service, 2013).

Fishing, which is the second major socio-economic activity in the study area, takes place in towns such as Elmina and Komenda, and other smaller communities including Iture, Bronyibima, Brenu Akyinmu and Kafodzidzi. Both inland and marine fishing

are practised with dug-out canoes of which about half the number is motorised. Elmina serves as the only town with modern landing facilities. Women complement the fishing activity via trading. Fish gets to consumers in its raw state, roasted form, fried and salted (Britwum, 2009). Currently, the use of mobile phones has been introduced to complement the fishing activities (Esia-Donkoh, 2007, 2011). The sea is regarded as god (*Nana Bosompo*). Fishing is prohibited on Tuesdays according to the cultural ontology of the fisherfolk.

The changing climate in the local communities is expected to affect socio-economic activities in the study area. Oral evidence points to the fact that fish catch have been affected. In the past, lagoon fishing and migration were the main adaptive practices during the lean season of sea fishing. What is unclear is the success of adaptive practices currently.

3.1.4 Governance

Ghana adopts the duality approach to governance, and this permeates in all the regional, metropolis/municipal/district and community structure of governance. The duality structure of governance comprises the conventional governmental structure the traditional chieftaincy structure. These two governance structures work hand-in-hand to promote development especially at the local level. The decentralization system is the model of development adopted where the development process is determined by the local people and the approach is the bottom-up.

The KEEA Municipality is similarly governed by the Municipal Assembly and the four traditional councils in the traditional areas in the Municipality, namely, the Komenda, Edina, Eguafo and Abrem Traditional Areas/Councils. Elmina is the seat of

the local government while Komenda, Edina, Eguafo and Abrem constitute the seats of the traditional areas mentioned.

3.2 RESEARCH DESIGN

From a social science research perspective, the study is inclined to both interpretive and critical thinking philosophies (Sarantakos, 1998; 2005). It presents the views and experiences of the local people with respect to climate change and adaptation, and critically assesses their capacity in relation to adaptation. As a participatory research, the study engaged the research, comprising the local fishermen and fishmongers from the beginning to the end of the study.

3.3 QUALITATIVE METHODS

This section presents the various activities that were conducted to collect the qualitative data as well as analysis and dissemination of the related findings. The activities are sampling and sources of data, community entry and engagement processes, pretesting of data instrument, data collection including validation and stakeholder workshops, data analysis and dissemination of findings.

3.3.1 Sampling, sample size and data sources

The Central Region was selected as the study Region based on two reasons. Firstly, the region has more than half (52.3 %) of its population engaged in agriculture and fishing. This figure is the second highest along coastal Ghana. About 10 percent of the population is involved in fishing and fishing-related activities (Ghana Statistical Service, 2005). The Region is also at risk of climate change but has received little attention with regard to research.

The KEEA Municipality was also selected because the Municipality does not only have the largest fishing ground in the region, but also employs diverse settlements which are engaged in subsistence and commercial fishing activities. Compared to the Mfantsiman Municipality and Gomoa West District in the Region, the KEEA Municipality is suitable for the study given its socio-economic and cultural characteristics, as well as the visible impacts of climate change in communities along its coastline.

Four settlements were selected for the study: two rural and two urban. The rural settlements comprised Brenu Akyinmu and Kafodzidzi while the urban settlements were Elmina and Komenda (comprising Dutch Komenda and British Komenda). The selection took into cognisance urban and rural characteristics, geographical locations, and visible effects of climate change in the communities. The rationale was to identify and assess variety of local knowledge practices used to adapt to climate change in these communities.

Purposive sampling was adopted to select local fishermen and fishmongers from the four settlements to constitute the main respondents to source the qualitative data from. These fisherfolks were considered as those with in-depth knowledge in fishing and fishing-related activities. Based on the diachronic model (see Stoffle, Toupal & Zedeño, 2003), three generations of respondents from a household (or a family) were selected for individual-based in-depth interviews (IDIs) from each of the four communities. The categories were first generation (father), second generation (son) and third generation (grandson) respondents. The reason was to collect a set of data to show a trend of change with respect to the local climate and adaptation practices by the fishermen. The first generation respondents were aged 60 years or above. The

second generation respondents were aged 40-59 years while the age of the third generation fell below age 40. In all, 12 individual-based interviews were conducted.

In addition, one male group and one female group of fishermen and fishmongers were constituted in each community for focus group discussions (FGDs). The members in each of the groups were selected based on their recent and past experiences and knowledge in the field of fishing, and also to assess also the gender dynamics in adaptation to climate change. Fishermen and fishmongers with three decades (or more) of experience in their respective occupations were selected. The three-decadal benchmark was informed by the definition of a climate (see IPCC, 2011). The reason for selecting this category of respondents was to generate adequate data to describe the trend of change in climate and adaptation in the local communities.

Other respondents that were purposively selected were officials from the Regional Meteorological Department and the KEEA Municipal Assembly. The official from the Regional Meteorological Department was selected based on his in-depth knowledge and understanding about weather and climate indicators, climate variability and climate change. The other official from the KEEA Municipal Assembly was also selected because he was directly in charge of planning and implementation of activities in the Municipality including those that relate to climate change and adaptation.

The source of the qualitative data was basically primary. The primary data were sourced from the local fishermen and fishmongers from the four communities during the IDIs and FGDs. Informal interviews and observations were also conducted with some of the FGD participants before and after the discussions.

3.3.2 Community entry and engagement

Community entry and engagement was crucial in this research. It facilitated the acceptance of the study by the community leaders, and by extension, the entire community, and also paved way for the data collection. The community entry and engagement also complemented the research process. For instance, the interactions provided additional information which was useful to the development of the schedule for the data collection. This exercise is not only a pre-requisite in community-based and participatory research, but it also conforms to ethical attitude.

The community entry and engagement was done at two levels: one with the chief and elders of the community, and two, with the *apofohen* (chief of fishermen) and his elders. The first step was to identify one of the opinion leaders in each community who, thereafter, took the research team to the chief's palace. At the palace, the purpose of the study was explained, and permission was sought to conduct the study subsequently. In each community, the chief granted the research team the permission, but further asked that the *apofohen* also be contacted for further interaction since he has direct jurisdiction over the fishermen. After interacting with the *apofohen* and his elders, permission was subsequently granted, and a schedule was developed for the actual data collection. The same process was followed during the pretesting of the instrument.

3.3.3 Data collection

The data collection exercise comprised three main activities: training of field assistants, pretesting of instrument, and the main fieldwork. The study selected two graduate students from the Faculty of Social Sciences, University of Cape Coast, to assist in the qualitative data collection. These field assistants have been engaged in

field work at their respective departments and therefore have gained considerable experience in research work. A two-day training was organised for the field assistants to acquaint themselves with the instruments. The issues in the instruments were discussed thematically and thoroughly. Role plays were conducted to further deepen the general understanding of the issues in the instrument, and also to enhance the accurate and precise translation of the questions from English to the local languages (Fante and Ewe).

The pretesting of the instrument preceded the main fieldwork. The main reason the instruments were pretested was to ensure that it is appropriate for use during the main data collection. The in-depth and focus group interview guide (and the questionnaire in the case of the survey) were the instruments that were pretested. The pretest was conducted at Otuam (urban) and Imuna (rural) all in the Ekumfi District. The District bears features of fishing characteristics similar to the communities in the KEEA Municipality that were selected for the study. The rationale for selecting Otuam and Imuna is similar to the reasons behind the selection of the four communities in the Municipality. After the pretest, all the mistakes and inappropriate use of concepts in the instrument were corrected. After the pretesting, the research team understood the protocol arrangements and challenges that were likely to be faced during the main fieldwork.

The in-depth and focus group interview guide had five sections. The first section touched on the background characteristics of the respondents. The second section focused on the worldviews and experiences in fishing. Section C dealt with the incidence, awareness, perceptions and effects of climate change while section D discussed the adaptation to climate change and its effectiveness. The last section centred on the production, storage and transmission of knowledge on adaptation.

The main fieldwork took place during the lean season where fishing and fishing-related activities were less active; that is, the period between January and May 2013. The timing was effective because most of the respondents were reached at homes and at the beach mending their nets and putting their canoes into good shape. However, at Kafodzidzi and Komenda, this approach was not successful because most of the fishermen had, at the time migrated internally to Half Assini and Axim, and externally to Cote D'Ivoire and Liberia to fish. This delayed the data collection process considerably. As a result, data collection activities began and ended in August 2013 in these two communities.

Two main methods were adopted to collect the data: in-depth interviews (IDIs) and focus group discussions (FGDs). The participants of the IDIs comprised the three generations of individuals (i.e. the father, son grandson). All the IDIs were conducted in the houses of the respective respondents. On the average, an IDI lasted for one hour. The FGDs on the other hand were made up of adult males and females who had had substantial experience in fishing and fishing-related activities. A minimum of six and a maximum of twelve members constituted each focus group participants. The number enhanced cordiality and allowed effective management of responses and group behaviour (Sarantakos, 1998, 2005). On the average, an FGD lasted for one and half hours.

Observation and informal interview techniques were also used to collect the qualitative data (see Dapaa, 2012). Areas and structures where sea inundation had occurred were observed. The informal interviews became critical during the observation process. The study used the technique to further interrogate issues that emerged during the observation. In one of such informal interviews, it was revealed

that fishermen were conversant with vertical distances (the depth) of the sea rather than horizontal distances.

Radio discussions relating to fishing and its related activities were also followed to get in-depth understanding about artisanal fishing. One radio station where much of the data was collected was Shama Radio on Frequency Modulation of 92.9. The radio station is located in the Western Region. The station discusses such issues with fishermen as panel and contributors on every Tuesday between 12:00 noon to 1.00 pm. As a phone-in programme, other listeners (usually fishermen) make input and contribute to the programme.

Other gadgets were used to complement the instruments. These are electronic recorder and a camera. Daily coding and transcription of responses were done to allow for further responses or clarifications on the responses whenever the need arose. This enhanced effective cleaning of the data (Babbie, 2004). Electronic devices such as the computer and external storage devices were used to manage and store the data.

The method-linked approach was also adopted. That is, the FGDs were conducted before the IDIs (and the survey). The rationale was to collect a bulk of data to provide adequate basis and understanding of the contextual issues before the collection of the IDI data and survey data. This approached enabled the study to interrogate further the views on the changing climate, and the historical and contemporary adaptive practices. The data collection process began at the rural study sites. Rural communities are generally well noted as the 'reservoir' of traditional knowledge. The approach actually helped in understanding the issues from a rural perspective and partly served as basis in some of the discussions in the urban sites to assess the trend of changes and variations in knowledge use.

3.3.4 Validation workshop and stakeholders' workshop

The study organised a validation workshop. The purpose was to ensure that the qualitative data collected and analysed were actually what was reported by the respondents. During the exercise, all the transcripts of the IDIs and the FGDs were read and interpreted to the hearing of the respective respondents in Fante, their local language. The purpose was to allow the communities, from which the data were collected to confirm, correct and accept the validity of the data. Few corrections were made particularly about the pronunciation and spelling of certain names of stars and fishing activities. The workshop also provided a platform for clarity of issues. Particularly, indigenous knowledge and certain practices which were provided by some of the communities during the data collection were also confirmed by fishermen from other communities. This ensured the uniformity.

A minimum of three and a maximum of six fishermen from each community studied participated in the validation workshop. At least two members who participated in the focus group discussions were selected by each group from each community to participate in the validation workshop. Again, one member from each community who did not take part during the focus group discussions was also selected. The participants were selected by the *apofohen* (chief fisherman) in each of the four communities.

The workshop also served as grounds to deepen the understanding and share ideas about issues of adaptation. For instance, experiences about how local technologies have been adopted to deal with sea erosion were shared and discussed. Also, possible alternative livelihoods were discussed. Views were shared about the feasibility of such local technology and challenges and prospects of alternative livelihoods which included farming and learning of other trades. In all, seventeen (17) participants took

part in the validation workshop comprising three (3) participants each from Kafodzidzi and Elmina, four (4) representatives from Brenu Akyinmu, six (6) from Komenda, and one (1) personnel from the Centre for Environmental Impact Assessment (a local NGO in Cape Coast). The venue for the workshop was the office of the Fishermen's Association at Komenda.

A stakeholder workshop was also organised. Participants comprised two representatives from each of the four communities studied, as well as personnel from governmental and non-governmental organisations. There were five (5) representatives from the KEEA Municipal Assembly, four (4) officials from the Central Regional Offices/Departments, three (3) lecturers (including two Professors) from the University of Cape Coast and one (1) official from a non-governmental organisation (see Appendix C).

The main purpose of the stakeholder workshop was to provide a platform for the fishermen (with background indigenous knowledge) to interact with other experts (with backgrounds in conventional knowledge), and to deepen the understanding of participants on climate change and adaptation issues from diverse perspectives. The other reason was to initiate a course for participants to appreciate the relevance of co-evolution and innovations of knowledge for adaptation to climate change.

3.3.5 Data analysis

The analysis of the qualitative data was done during and after the data collection. During the data collection period, some of the data collected were coded, thematically organised and analysed. The early analysis was done to serve as a spring-board for further inquiry on some of the issues that emerged. The final analysis was conducted after all the responses were listened to and transcribed. The analysis took into account

the incident and post-occurrence phases of climate change as described by the crisis management and timeline model, and the extent to which diverse knowledge systems have co-evolved for adaptation purposes.

Relevant and specific quotes from the respondents were presented to buttress the general findings with regard to the views and experiences about climate change and adaptation. In this thesis, the focus was to complement the qualitative data with the quantitative data.

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3.4 QUANTITATIVE METHODS

This section presents the methods that were adopted to collect the quantitative or survey data. They include the sampling procedures adopted, sample size generation and sources of data, data collection and analysis. Pretesting of the quantitative instrument and qualitative instrument was done simultaneously.

3.4.1 Sampling, sample size and data sources

The adaptive stratified sampling procedure was employed to draw respondents from the four communities. With this procedure, respondents with similar characteristics such as years of experience in fishing and length of stay in community were identified and selected (Babbie, 2005; Sarantakos, 1998, 2005). Those who had one decade or more of fishing experience, and had stayed in the community for two decades or more were selected. It was observed during the pretesting of the instruments and the community entry and engagement processes that most of the leaders of fishing canoes had more than a decade of work experience and had stayed in the community for two decades or more. Only the indigenes were also selected. The

assumption was that they could best explain the local worldviews and practices relating to climate change and adaptation in their communities.

Oral screening was conducted and those who were eligible were selected and interviewed. At Kafodzidzi, a sample frame was provided which was used to contact the leaders. At Elmina and Komenda, the leaders who were available during the period of the data collection were screened and sampled. The sample frames in these two communities were not made available to the research team. The leadership indicated that the list of all the names of canoes were yet to be validated. At Brenu Akyinmu, there were a few canoe leaders (15) at the time of the data collection. As a result, all the fishermen who were eligible (based on the other inclusion criteria) were selected. It was realized that the leaders who were not available at the period of the data collection had migrated to other local and international communities to fish. Forty-five respondents were sampled from Brenu Akyinmu whilst 26 respondents were selected from Kafodzidzi, At Elmina and Komenda (Dutch and British), 106 and 45 respondents respectively were reached. In total, 222 respondents were interviewed from the four communities (Table 3.1).

In addition to the primary data, secondary data that were available at the time of the study were sourced. These are temperature (1993-2011) data and rainfall (1980-2009) that were obtained from a local weather station at Komenda (through the office of the Regional Meteorological Department, Cape Coast), and satellite images on the vegetation cover of the KEEA Municipality (1986-2002) from Lansat. The satellite images were computed with Geographic Information System (GIS) to assess the extent of change of the vegetation cover in the Municipality. The secondary data were used to complement the primary data.

Table 3.1: Settlement, settlement type and sample size of respondents

	Settlement type		
Settlement	Rural	Urban	Total
Brenu Akyinmu	45	*na	45
Kafodzidzi	26	Na	26
Elmina	na	106	106
Komenda (Dutch and British)	na	45	45
Total	81	151	222

*na (not applicable)

Source: Fieldwork (2013)

3.4.2 Data collection

Three quantitative data sets were collected. These are the survey, temperature and rainfall and satellite images data sets. The survey data collection was conducted after the qualitative data collection exercise. The data collection was done on Tuesdays and Sundays. These are the days that most of the fishermen were available. Four graduate students from the Faculty of Social Sciences at the University of Cape Coast were trained to collect the data. The questionnaire was used to collect the survey data. The instrument had five modules similar to that of the qualitative instrument. The interviews were conducted at the beach because most of the respondents were at the time mending their nets. A few were also conducted at the homes of the respondents. On the average, an interview lasted for half an hour.

The questionnaire had seven sections, namely, Sections A, B, C, D, E, F and G. The first section touched on the background characteristics of the respondents. The second section focused on the worldviews, knowledge system and experiences in fishing.

Section C dealt with the perceptions and incidence of climate change. Section D discussed the contributions of local activities to climate change. Questions on the impacts of climate change on fishing and adaptation to climate change were presented in Sections E and F respectively. The last section centred on the transmission of knowledge on adaptation.

The temperature and rainfall data were collected in 2013 from the Regional Meteorological Department at Cape Coast. The Department manages and generates such data including other climatic element data such as humidity and wind vane from a locally established weather station at Komenda. The study limited the scope of the data to the KEEA to reflect the focus and objectives of the study. It took the Department three weeks to provide the available data (temperature: 1993-2011; rainfall: 1980-2009) upon submission of a request.

The satellite images were also generated in 2013 from Lansat. The data was generated by the Remote Sensing and Cartographic Unit, Department of Geography and Regional Planning, at the University of Cape Coast. The generation of the available satellite image data (1986-2002) was done in one month.

3.4.3 Data Analysis

The analysis of the survey data comprised three stages, namely, screening, coding and data entry and thematic analysis. The screening stage was conducted at three levels. At the first level, each field assistant screened the completed questionnaire immediately after an interview was conducted (during the data collection period) to correct errors, seek clarity and confirm responses when necessary activity. At the second level, post-field peer review was conducted to ensure that the data collected was well screened. The last screening was done at the data entry and coding stage.

After the screening, the data were coded based on the main concepts and themes of the study. Finally, the data were thematically analysed descriptively to draw out differences and similarities of views and ideas, as well as interpret the information accordingly. These were presented with cross-tabulated figures and percentage narratives. The Statistical Product for Service Solutions (version 17) software was used for the analysis.

The temperature and rainfall data were also analysed similarly. The data sets were screened, coded and analysed. Trend analysis was conducted to show the pattern of change in temperature and rainfall characteristics of the study area. The Microsoft Excel software was used to do the trend analysis. Line and bar graphs were used to present the temperature and rainfall findings.

Lastly, the satellite images were analysed with the ArcMap software. The overlay function was conducted to ascertain the combinational 'And' of two respective images and year periods. The approach revealed any land cover changes that have occurred in a period of about two decades ago. The description centred on the changes in wetland, waterbody, vegetation and built-up/bare surfaces and their implications on the local communities and their livelihoods. Subsequently, the changes were calculated into figures and presented in a tabular form.

3.5 DISSEMINATION WORKSHOP

The final lap of the research was the dissemination of the findings to the key stakeholders. This was to inform policy to an extent and promote planning of activities with respect to adaptation issues. Owing to the diverse needs, challenges and possible opportunities, the stakeholders were categorised into two main classes: the

administrative group and the fisherfolk group. Thus, two separate interactions were organised for each group.

The administrative group comprised personnel from the KEEA Municipal Assembly and other regional offices and departments whose activities touch on climate change and fishing. The forum was held at the conference hall of the KEEA Municipal Assembly to inform implementing agents and officers about the results from the study and the need to implement appropriate measures to ameliorate the plight of fishing communities in general and the specific communities in particular.

The second forum was held with the fishermen at each of the communities studied. The purpose was to reveal the specific issues regarding each of the communities to inform their immediate and future actions. The need to consistently relate and liaise with the KEEA Municipal Assembly and also other offices such as National Disaster Management Organisation, Meteorological and Fisheries Departments was strongly emphasised during the interactions. This was to foster cordial relationships for knowledge and experience sharing for co-evolution of knowledge to facilitate effective adaptation.

3.6 ETHICAL ISSUES

The study complied with the basic ethical standards and practices in social science research (Sarantakos, 2005) from the planning stage to the publication stage. These included compliance to informed consent, privacy, anonymity and confidentiality as well as objectivity. In addition, ethical standards in endogenous studies (Millar, 2010) were not compromised.

Practically, the proposal with all the instruments was submitted to the School of Graduate Studies and Research at the University for Development Studies for

approval. The purpose and objectives of the study were fully explained to the respondents in the language they best understood to seek an informed consent and emphasise confidentiality. Interviews were also conducted at places conducive and convenient to respondents without compromising privacy. Author-related materials were dully acknowledged both in text and at reference list section. It must be emphasised that contributions of local people especially the respondents were also acknowledged as partners to the study.

The study also strictly adhered to the cultural and customary dictates and orientations of the settlements and communities within which the study was conducted. Firstly, all the protocols in these traditional settings were respected and followed. For instance, permission was sought from the traditional leadership in the settlement and that of the fishing communities too.

Crucial to the ethical consideration was the validation workshop that was organised. This allowed the respondents not only to own the information but also to ensure that the analysis and discussions reported are objective and reflected exactly their responses. Similarly, the stakeholder workshop also created a platform where the voices and ideas of local fisherfolks as well as other meaningful actors in the fishing industry were heard and shared; a tool that is relevant and useful in cultural ethics and participatory research.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 INTRODUCTION

This chapter presents the results and discussions of the study. The chapter is divided into five specific themes based on the specific objectives of the study. The themes are: perceptions about climate change, incidence of climate change, impacts of climate change on fishing and adaptation strategies. The background characteristics of the respondents are first presented before the results.

4.1 BACKGROUND CHARACTERISTICS OF RESPONDENTS

The background characteristics of the respondents covered their age, religion, level of education, years of stay in community and years of experience in fishing activities (Table 4.1). For the IDI participants, all the respondents who constituted the first generation category were aged above 60 years. All of them were traditionalists and none of them ever had any form of formal education. All the respondents in the first and second generations had stayed in their respective communities for more than four decades and had more than three decades of fishing experience. With respect to the second generation respondents, all of them were aged above 50 years. The last category among the three generations was made up of respondents who were less than 40 years old, stayed in their communities for two decades or more, and had two of more decades of fishing experience.

The FGD participants were made up of 57 participants comprising 28 fishermen and 29 fishmongers. Fifty-six percent of the participants were aged 40-59 years while about 30 percent were aged sixty years of more. Majority (60%) were Christians, and

more than 68 percent had no formal education. More than 90 percent had stayed in their communities for three or more decades while 79 percent had two or more decades of fishing experience.

As presented in Table 4.1, 222 respondents constituted the survey respondents. The majority (66.2%) were aged between 30-49 years. Eighty-seven percent of the respondents were Christians, and more than 60 percent had ever attended basic education. Again, 85 percent of the respondents had lived in their communities for 20 years or more while 69 percent had engaged in fishing and related activities for two decades or more.

Table 4.1: Background characteristics respondents

Variable	IDI Generation (N)			Total (N)
	1st (Father)	2nd (Son)	3rd (Grandson)	
Age				
Less than 40 years	0	0	4	4
40-49 years	0	3	0	3
50-59 years	0	1	0	1
60+	4	0	0	4
Religion				
Christianity	0	3	4	7
Traditional	3	0	0	3
Christianity and Traditional	1	1	0	2
Education				
None	4	2	1	7
Primary	0	1	2	3
Middle/JHS	0	1	1	2
Years of stay in community				
30-34 years	0	0	0	0
35-39	0	0	4	4
40+	4	4	0	8
Years of experience in fishing activities				
20-24	0	0	1	1
25-29	0	0	2	2
30+	4	4	1	9

Table 2 cont'd

Variable	FGD			Survey	
	Sex		Total		
	Male	Female	N (%)	N	%
Age					
Less than 30 years	1	0	1 (1.8)	19	8.5
30-39 years	3	4	7 (12.3)	78	35.1
40-49 years	10	7	17 (29.8)	69	31.1
50-59 years	6	9	15 (26.3)	34	15.3
60+ years	8	9	17 (29.8)	22	10.0
Total	28	29	57 (100.0)	222	100.0
Religion					
No religion	2	0	2 (3.5)	16	7.2
Christianity	13	21	34 (59.6)	193	86.7
Traditional	7	5	12 (21.1)	9	4.1
Christianity/Traditional	6	3	9 (15.8)	0	0.0
Islam	0	0	0 (0.0)	4	1.8
Total	28	29	57 (100.0)	222	100.0
Education					
None	15	24	39 (68.4)	84	37.8
Basic	13	5	18 (31.6)	134	60.3
Secondary	0	0	0 (0.0)	4	1.9
Total	28	29	57 (100.0)	222	100.0
Number of years lived in community					
0-9 years	0	0	0 (0.0)	11	5.0
10-19 years	0	0	0 (0.0)	22	10.0
20-29 years	3	2	5 (8.8)	73	33.0
30+ years	25	27	52 (91.2)	115	52.0
Total	28	29	57 (100.0)	222	100.0
Years of experience in fishing activity					
10-14	0	0	0 (0.0)	34	15.3
15-19	1	1	2 (3.4)	33	14.9
20-24	2	3	5 (8.8)	46	20.7
25-29	3	2	5 (8.8)	33	14.9
30+	22	23	45 (79.0)	74	33.3
Total	28	29	57 (100.0)	222	100

Source: Fieldwork (2013)

4.2 PERCEPTIONS ABOUT CLIMATE CHANGE

There was a general view from all the IDI, FGD and survey respondents, irrespective of their background characteristics, that the local climates in their communities had been modified. They explained that over the last decade or more ago temperature, rainfall and the movement of the sea had all been modified. This view is

consistent with available literature (IPCC, 2001, 2007). From the qualitative findings, the IDI and FGD respondents observed that whilst temperatures had increased, the amount of rainfall had decreased with modified patterns. They also indicated that sea inundation had been recurrent. These were some of the views that were shared during the discussions:

> In the past the sea was colder than presently. In fact if you compared the coldness of the sea in August in the past and now, I will say that presently, the sea is getting warmer. I really think that the sea is getting warmer. We even feel it in the community in that the sunshine these days are more severe and we experience that more often compared to the time I was in my teens [Elmina: IDI Participant, male, 71 years].

> The rainfall patterns had changes if you consider the seasons. In the past, we experienced more rains for longer durations compared to present rainfall patterns [Komenda: FGD participant, female, 63 years].

> The sea was not destructive in the past compared to recent times. It was far bearable in the past. Look, when I was born, I was even told that the sea had even moved closer to us. But now, it has taken over almost all the beach. We had coconut along the entire stretch of the beach. They have been destroyed by the sea. You can come to see for yourself in June, and you will not see

some of the buildings here. They would have been submerged

[Brenu Akyinmu: FGD participant, male, 57 years].

Throughout the discussions with the FGD participants, only two of the participants at Kafodzidzi, who had completed formal basic education mentioned the term 'climate change' in their expressions. One of them said that '*I think it is as a result of the climate change people have been talking about*.' The other concluded: '*I have heard on air a couple of times, and read from the papers that the current changes we are experiencing is known as climate change*.'

The views of the survey respondents were consistent with those held by the respondents who participated in the IDIs and FGDs. From the findings, more than 64 percent of the respondents indicated that temperature characteristics had been modified, and about 82 percent expressed that the temperatures have increased. Concerning rainfall characteristics, 86 percent indicated that the fall and pattern of the climatic element had changed with a similar majority testifying that the amount of rainfall has decreased especially within the last three decades. Also, 87 percent indicated that the sea was getting warmer as observed over the last three decades. Again, 63 percent of the respondents confirmed that the sea level in their respective communities has changed, and close to universal (98%) indicated that the level of the sea was rising.

4.2.1 Causes of climate change

Unlike the perceptions about the changing climate, views about the causes of climate change were varied although consistent with available literature. Three main causes were mentioned and articulated. These are natural causes designed by the spiritual world, human-induced causes such as deforestation and mining activities, and

spiritual causes as a result of punishment from the spirit world. During the IDI and the FGD discussions, all these three causes were articulated. Some of the expressions include the following:

> Whatever happens in the atmosphere and the skies is designed by God. Whether it will rain or not, whether the sun will shine or not has already been structured by God from the time He created the earth. Therefore, I can say that what we are experiencing is a natural phenomenon [Brenu Akyinmu: IDI participant, male, 87 years].

> I have heard on air a couple of times, and read from the papers that the current changes we are experiencing is known as climate change. They explain that it is as a result of our human actions such as felling of trees. It could be true in the sense that we often hear that the forest cover of the country is being degraded without being replaced. It has been explained that this has affected the rainfall and temperature patterns [Kafodzidzi: FGD participant, 53 years].

> In the past we were very obedient to our elders and gods. We obeyed all that they told us about how to fish. We observed two sacred days. These were Sundays and Tuesdays. We performed all the rituals and sacrifices especially to appease the gods. Now, we have stopped all these practices. The young ones think they are too wise. You cannot be wiser than your father nor the gods.

> Until we change, the rains will totally cease and temperature will be unbearable in the next ten years [Komenda: IDI participant, 74 years].

It must, however, be emphasised that most of the participants who were traditionalists and had no formal education held the view that the cause of the changing climate is spiritual. Again, those who attended basic education (Primary and Middle School), opined that human actions are to blame.

The results from the survey data showed that majority of the respondents were of the view that natural factors were responsible for the changes in the local climates. For instance, 97 percent, 94 percent and 87 percent were of the view that the changes in temperature, rainfall and sea level respectively are due to natural causes. However, the explanations they offered about the natural causes were similar to that posited by some of the IDI and FGD respondents. That is, results show that 62 percent, 80 percent and 55 percent of the respondents explained that the changes in temperatures, rainfall and sea level respectively were as a result of God's own work.

Whether the changes in the temperature characteristics, rainfall and sea level can be referred to as climate change or climate variability was a subject of debate particularly among the IDI and FGD participants. These terminologies were not specifically used. However, deducing from their responses about the causes of the changing climate, the three perspectives prevailed. These are the nature-induced-cause, spirit-induced-cause and human-induced-cause. For instance, these are how some of the respondents expressed their views about the warmness of the sea:

> The warmness of the sea depends on the seasons. Currently, [*in October*] the sea is warm. It is not the sun's doing, but God's. He [God] has structured the universe and all its elements to

> operate in a manner He thinks best. So it is an issue of seasonality determined by God during the creation of the universe [Kafodzidzi: FGD participant, male, 68 years].

> I don't think there is any cause apart from nature itself. This is because when the period for the sea to be warm is due, the sea becomes warm and the same applies to its coldness too. That is how God structured it [Elmina: FGD participant, male, 63 years].

The nature-induced perspective is buttressed within the cultural ontology about the cosmos. The indigenous philosophy in relation to this view is connected with the concept of change. The concept explains that everything is constantly changing as determined by a superior body of actors in the spirit world. Therefore, to some of the respondents, such a change is beyond the manipulation of man. This view is consistent with Thales and Anaximander's position that there is something behind change which itself does not change (Palmer, 1996).

Although it was not pervasive among the respondents, the spirit-induced perspective was largely held by the IDI participants who were the *apofohemfo* (chief fishermen) at the rural communities studied (that is, Brenu Akyinmu and Kafodzidzi). Their view is reflective of their indigenous knowledge and philosophy which explains that there is a cause to every event, and a corresponding reaction to every cause because everything is interrelated (Bear, 2008, as cited in Simonelli, 2008).

Those who held the human-induced perspective considered certain actions of individuals and groups, and explained that these actions are not only detrimental to the ecosystem, but have led to inadequate inflow of water into the sea through the

diversion of rivers. Illegal mining was one of such actions. Some of the proponents argued this way:

> Illegal mining or *galamsey* activities are contributory factors. As a result of such activities, some of the rivers which used to flow directly into the sea to reduce its warmness have either been blocked or diverted thereby impeding its flow into the sea [Kafodzidzi: FGD participant, male, 48 years].

> We can also talk about *galamsey* activities as one of the human factors affecting the conditions of the sea. You see, all rivers flow into the sea. So if the flow of any river is restricted, it affects the inflow into the sea, thereby making the sea warm. The more waters the sea receives, the more it gets cold, less water it receives, the less it gets cold [Komenda: IDI participant, male, 66 years].

The view held by a few of the respondents that the cause of climate change can be attributed to human activity is partly consistent views by the UNFCCC and IPCC, and it is also pervasive in the literature available. Toulmin (2009), for instance, has stressed that deforestation in Africa is a concern. This is because the destruction of forests (which serve as carbon sinks) contributes to the concentration of greenhouse gases in the atmosphere. The other common knowledge is that forests regulate rainfall through the evapo-transpiration process. Hence, the reduction in rainfall in general, can also be attributed to deforestation. *Galamsey,* in Ghana contributes to deforestation as well.

The study further observed the land-cover change from 1986-2002 and realized that the natural components on the land-area in the KEEA Municipality have been modified. For instance, the sizes have reduced while artificial or built-up surfaces have increased substantially. For instance, in 1986, wetland coverage was more than 27km^2. The size was, however, reduced to 8.4km^2 in 2002. On the other hand, built-up surfaces which were a little over 11km^2 have increased considerably to more than 15km^2 (Table 4.2). The images (Figures 4.1 - 4.3) provide pictorial evidence to the land-cover change.

Table 4.2: Land-cover change in the KEEA Municipality: 1986-2002

	Area (m)^2			Area (km)^2		
Class name	1986	1991	2002	1986	1991	2002
Water bodies	2,798,100	3,237,300	2,212,200	2.7981	3.2373	2.2122
Built-up/Artificial surfaces	11,264,400	13,364100	15,239,700	11.2644	13.3641	15.2397
Wetland	27,117,900	7,281,000	8,443,800	27.1179	7.2810	8.4438
Vegetation	370,404,000	387,666,000	385,688,700	370.4040	387.6660	385.6887
Total	411,584,400	411,584,400	411,584,400	411.5844	411.5844	411.5844

Source: Remote Sensing and Cartographic Unit, Dept. of Geography and Regional Planning, UCC, Cape Coast (2013).

It was also observed that the coverage area of water bodies and vegetation had also reduced between the 1991-2002 year period. Inadequate rainfall as well as expansion of built-up surfaces could be attributed to the situation. The loss of vegetation in the

Municipality and particularly along the fringes of the coast can affect the breeding of certain species of fish in the mangrove vegetation along the estuaries.

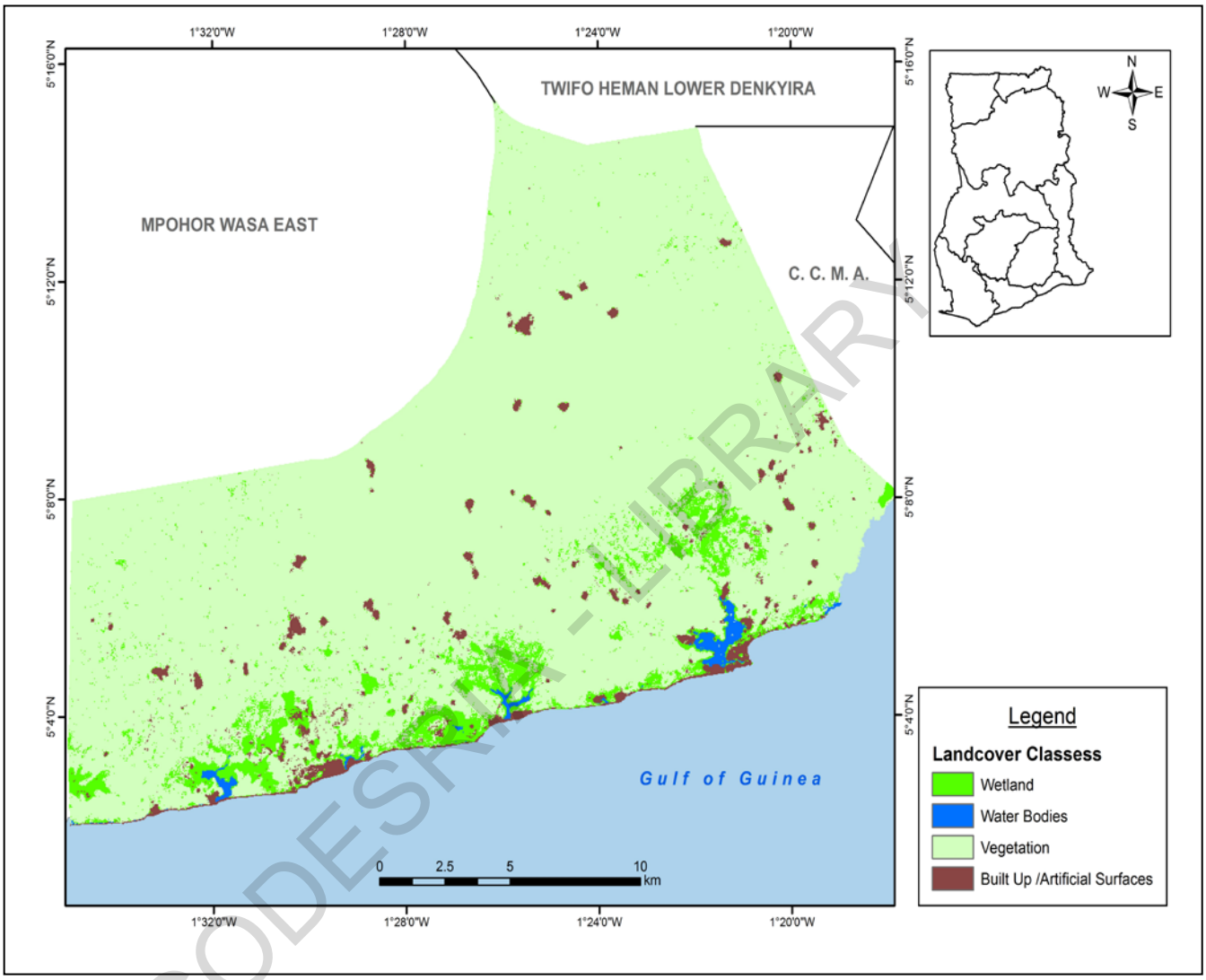


Figure 4.1: Land-cover description: 1986

Source: Remote Sensing and Cartographic Unit, Department of Geography and Regional Planning, UCC, Cape Coast (2013).

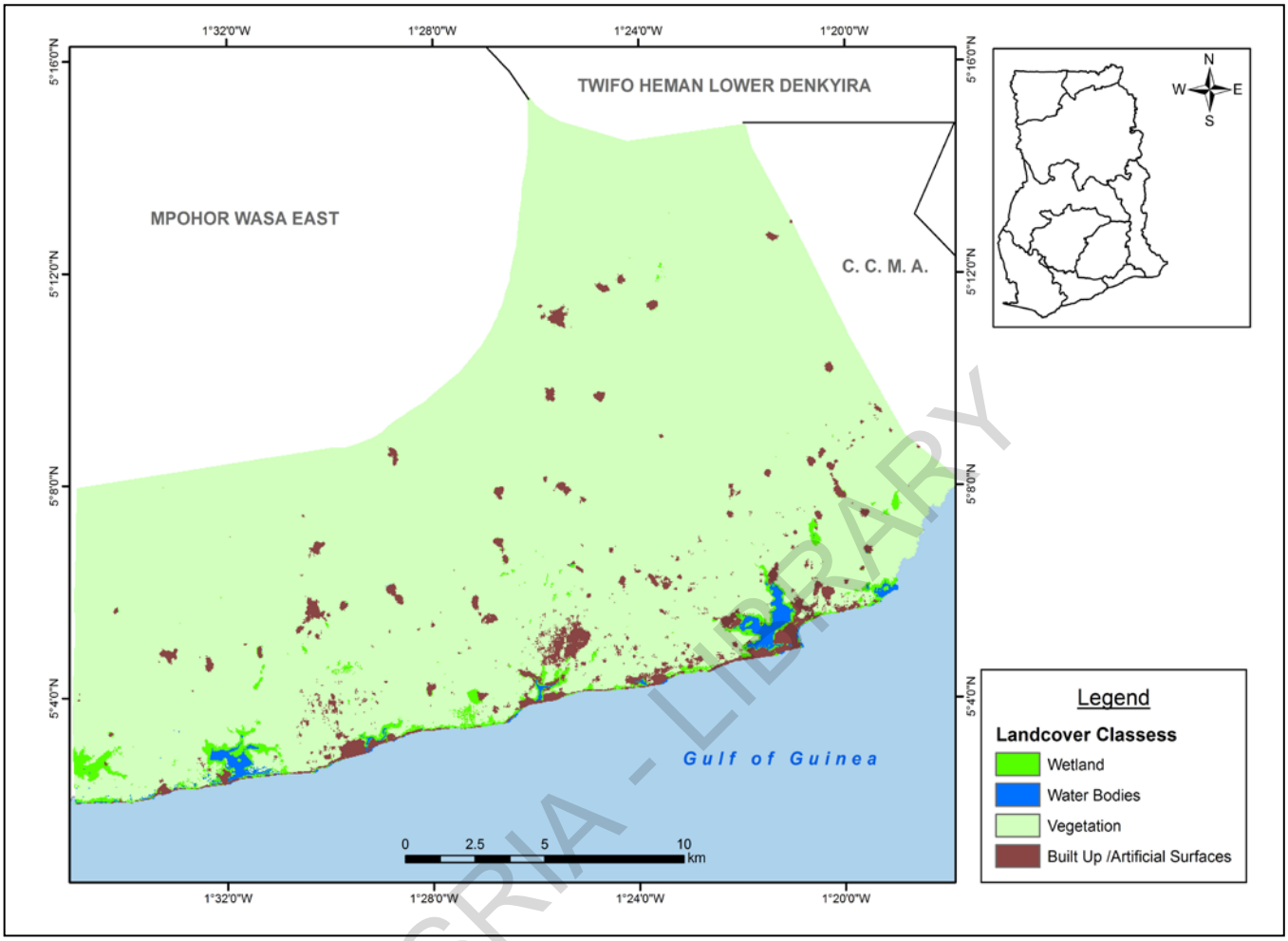


Figure 4.2: Land-cover description: 1991

Source: Remote Sensing and Cartographic Unit, Department of Geography and Regional Planning, UCC, Cape Coast (2013)

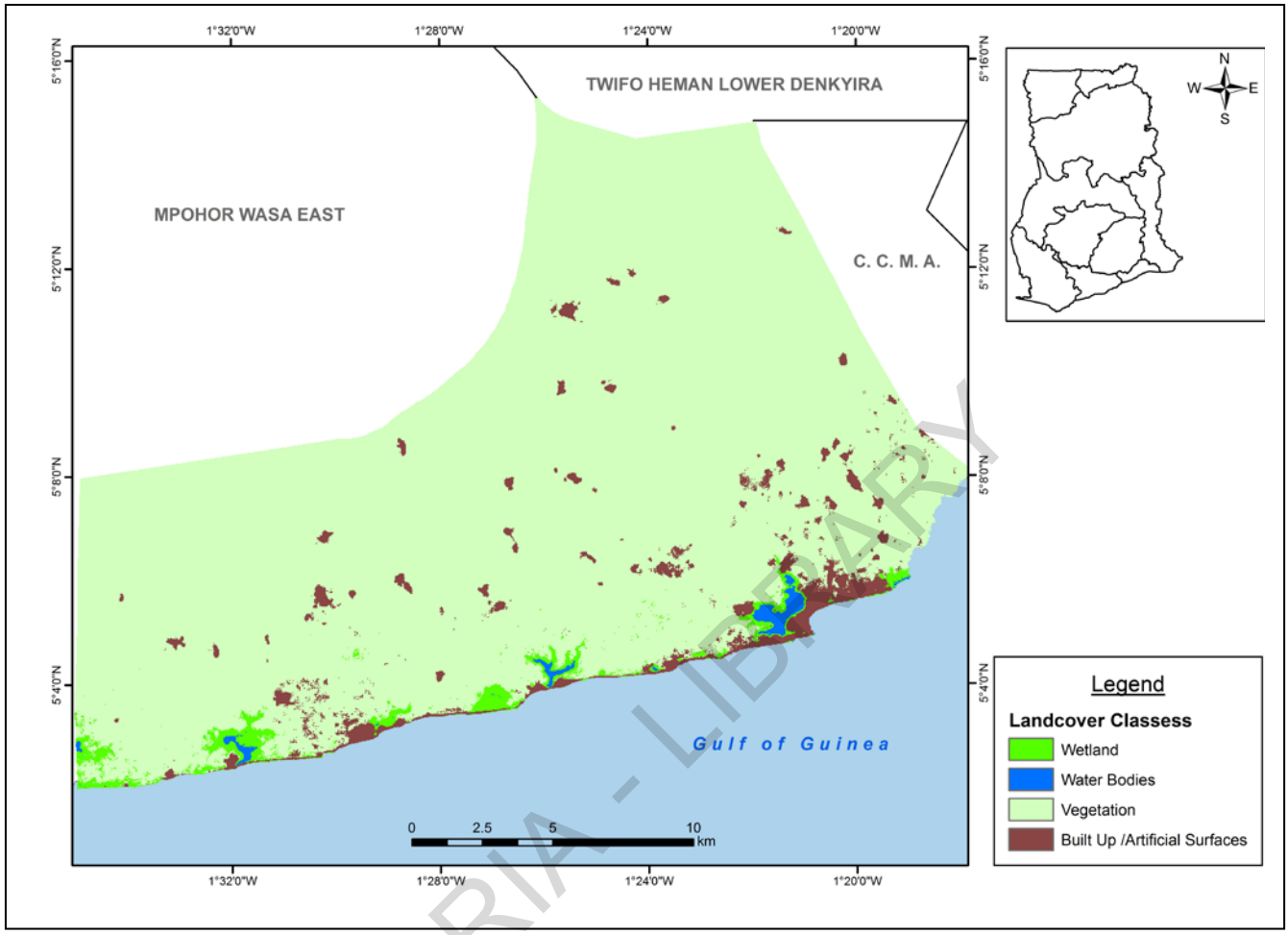


Figure 4.3: Land-cover description: 2002

Source: Remote Sensing and Cartographic Unit, Department of Geography and Regional Planning, UCC, Cape Coast (2013)

4.2.2 Conclusion

Local communities' cultural ontology, experiences gained and observations made about their local climates over a long period of time informed their perceptions about increases in temperature characteristics, decrease in rainfall and rise of the sea level as indicators of climate change. The theories of symbolic interactionism and

phenomelogy, and the concept of belief provide the understanding underpinning these perceptions (Weber, 2010; Patton, 1990; Blumer, 1969). Whilst these perceptions and experiences may not be necessarily be objective, they provide the bases to understand community's cosmovision regarding climate change as well as for further inquiry.

Three perspectives (nature, spirit and human-induced perspectives) were identified in relation to causes of climate change. These perspectives were connected and interrelated. For instance, the natural cause of climate change was perceived to be a design structured by God (spirit-induced perspective). Again, the human-induced perspective explains the actions and inactions of man as the cause of climate change, but the driving force behind the adverse experiences was largely perceived to be punishment by the spirits (God, the gods and ancestors).

These perspectives are not only consistent with indigenous philosophy (Gyekye, 2013; Simonelli, 2008), but also the literature (Boedhihartono, 2010; Keane, 2004). The philosophy explains that everything (nature, spirit, and human) is interrelated and alive and has a role to play in the life of nature. As a result, the destruction of an aspect of life of nature affects the existence of other aspects of nature's life.

4.3 TEMPERATURE, RAINFALL AND SEA LEVEL CHARACTERISTICS

This section uses the results from the temperature (1993-2008) and rainfall data (1980-2009) as well as views of the respondents to determine the extent of change in temperature and rainfall in the Municipality. Again, observations and experiences of the respondents based on their interactions with the local climate and the sea were used to assess the extent of warmness and coldness of the sea.

4.3.1 Incidence of change in temperature

The findings show, generally, that there was an average temperature of 27.6^0 Celsius (C) over the period 1993-2007. The year 2003 was observed as the hottest year with the highest average temperature of 29.5^0C which was recorded in May and November. Again, high temperatures were recorded from January to June with consistent average temperatures of 28^oC or more over the period (Figures 4.4-4.6).

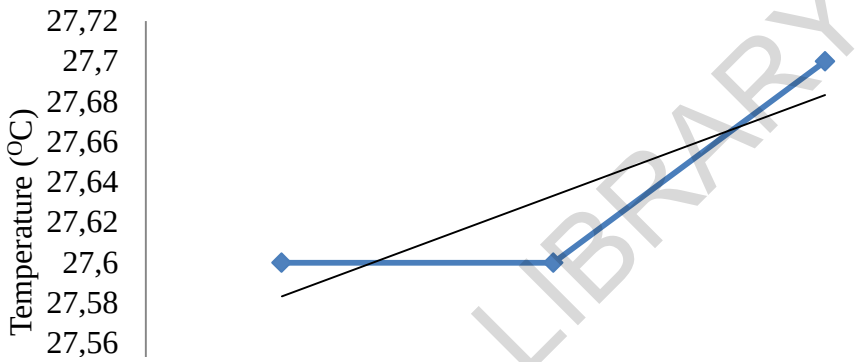


Figure 4.4: Mean annual temperatures: 1993-2007

Source: Fieldwork (2013)

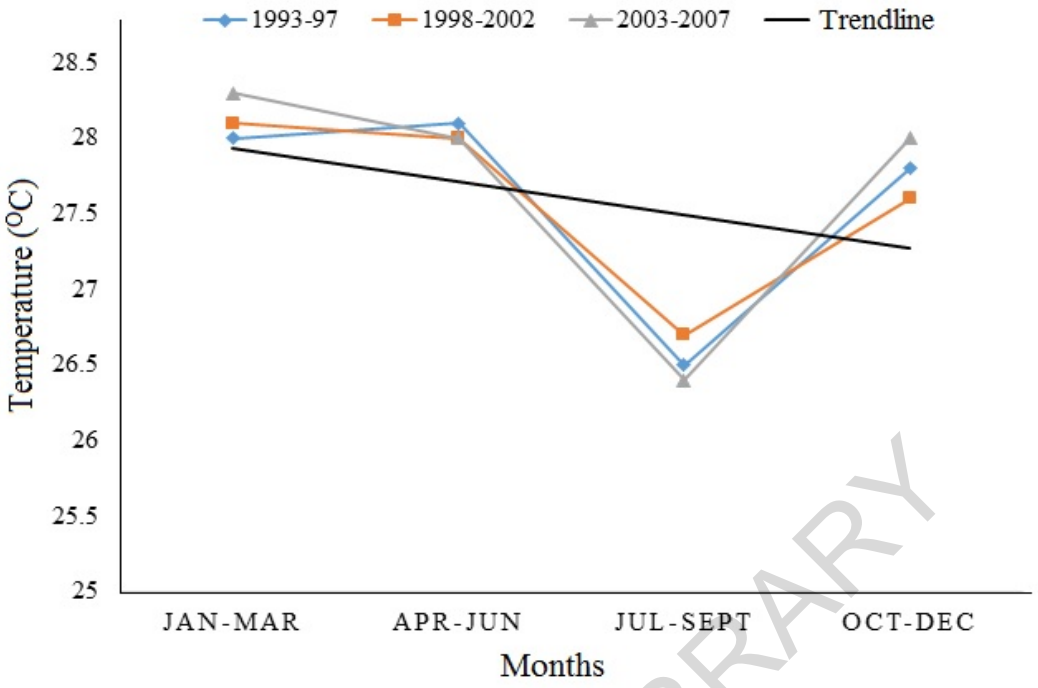


Figure 4.5: Mean annual monthly temperatures: 1993-2007

Source: Fieldwork (2013)

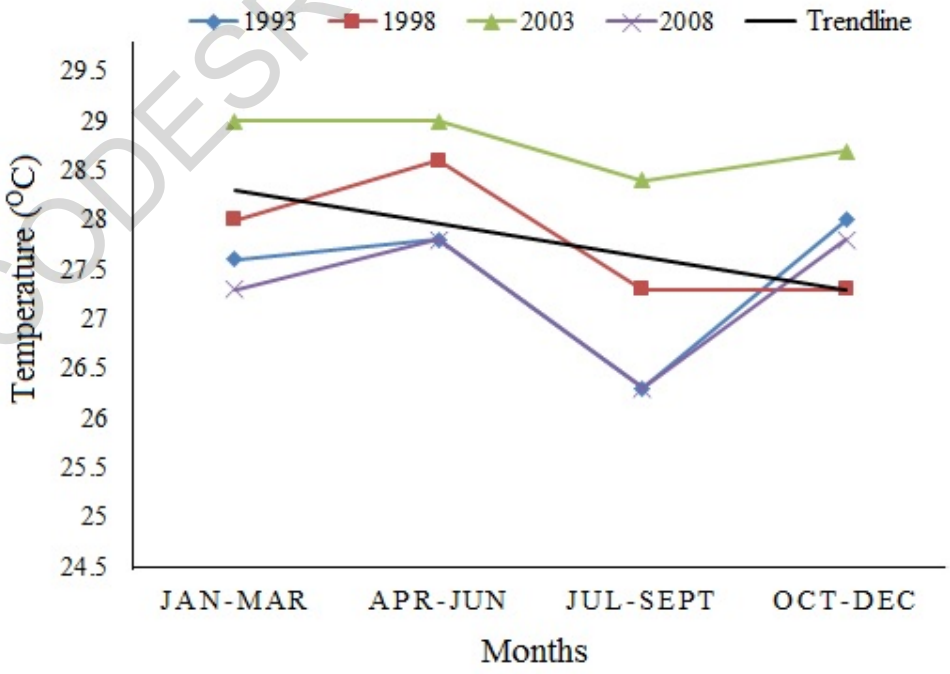


Figure 4.6: Mean annual monthly temperatures: 1993-2008

Source: Fieldwork (2013)

An official of the Regional Meteorological Department in an interview indicated that the prevailing temperature characteristics are consistent with the national and global analysis based on available and estimated figures. He observed:

> The temperature records available show that temperatures, that is, minimum and maximum temperatures, are high. Again the mean daily temperatures have been around 29^{o}C and sometimes about 30^{o}C almost throughout the past years in the Municipality. These figures are relatively high. Well, that is the trend nationally.

Ghana's climate is warming though. Stanturf et al. (2011) in their nationwide assessment on Ghana's climate change vulnerability and adaptation shows that since 1960, mean annual temperature in the country rose by 1.0°C; an average rate of 0.21°C/decade (cited in McSweeney et al., n.d.). Similarly, a presentation by Ghana at the expert meeting on National Adaptation Plans in 2011 in Laos estimated that temperatures will continue to rise by an average of about 0.6^{o} C, 2.0^{o}C and 3.9^{o}C by the year 2020, 2050, and 2080 respectively.

Although the local people could not provide objective data, their perception about the fact that temperature characteristics in their localities have changed, and have increased, is consistent with the results from the temperature data generated from the local weather station at Komenda. This result is also consistent with other studies conducted elsewhere in Ghana (Gyampoh & Asante, 2011; Gyampoh et al., 2009).

4.3.2 Incidence of change in rainfall

The importance of rainfall to local communities that are engaged in primary activities is crucial. It is the most significant climatic element that affects agriculture

and fishing. Rainfall influences temperature characteristics of a place and that of the sea, which is the main source of fishing in the study area. The three decade old rainfall data provides a varied picture of an incidence of change. The analysis shows that in the last ten years rainfall has been varied. For instance, in 1980-89, rainfall records from July-September were the highest. During the same period, the amount of rainfall in January-March and October-December were the lowest in 1990-1999 and 2000-2009 (Figure 4.7). This analysis may be crude in the sense that it uses summative figures of ten years which does not give a clear picture of the actual daily situation.

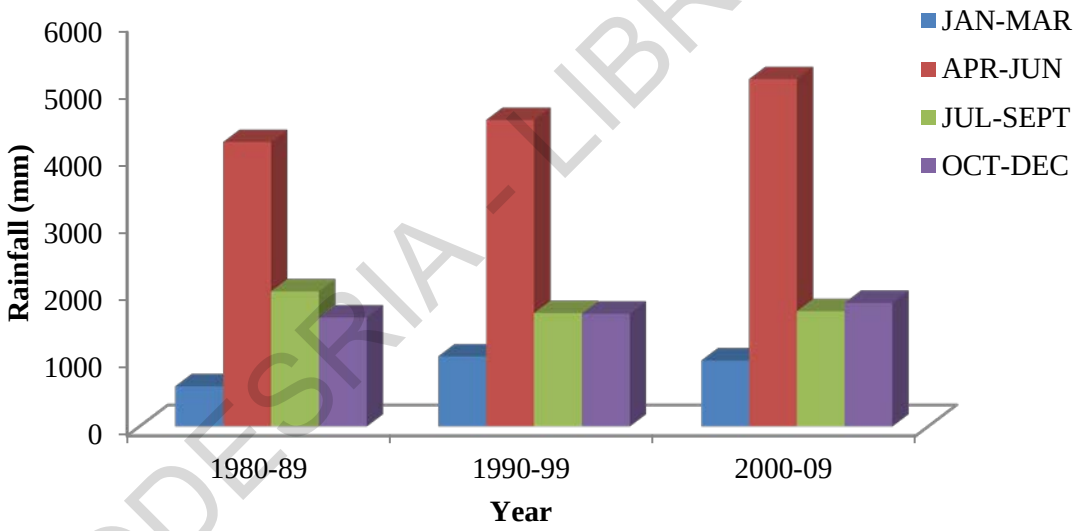


Figure 4.7: Total annual rainfall: 1980-2009

Source: Fieldwork (2013)

However, if the analysis above is conducted using a five-year period, the picture is different. As shown in Figure 4.8, rainfall figures in 1984-89 were comparatively high from April-December in all the years except from April-June in the year 2000-04. The period of 1984-89 nevertheless, experienced the lowest rainfall from January-March. Apart from these, there were no significant variations in the rainfall pattern even

though in the years 2000-04 and 2005-09, October-December and July-September respectively gained marginal increases in rainfall.

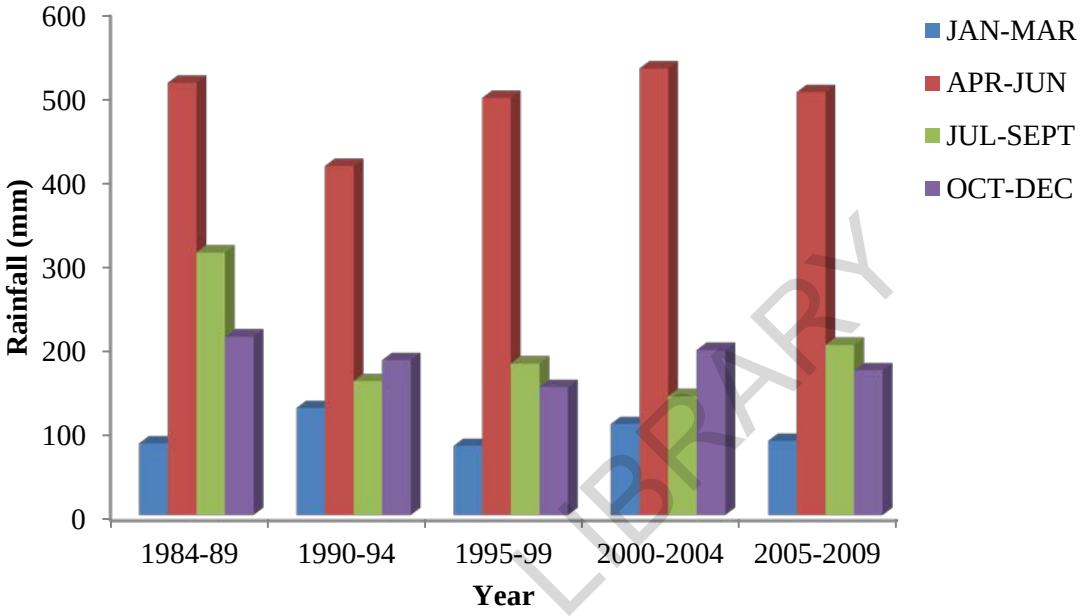


Figure 4.8: Mean annual rainfall: 1984-2009

Source: Fieldwork (2013)

In local communities, seasons are used as basis to predict the amount and duration of rainfall. The two main seasons in the Municipality and Ghana (except the northern parts) are the minor season (April-June) and the major season (September-October). The study observed the rainfall patterns of these seasons to determine if there had been any distinct change in rainfall. As shown in Figure 4.9, over a five-year interval period from 1980-1986 to 2007-2011, there was no obvious trend to show a reduction or increase of rainfall. For instance, the wettest periods during the major season were 1980-1986 (198cm), 2002-2006 (183.7cm) and 1987-1991 (183.6cm). The trend in the minor season also did not show a consistent trend.

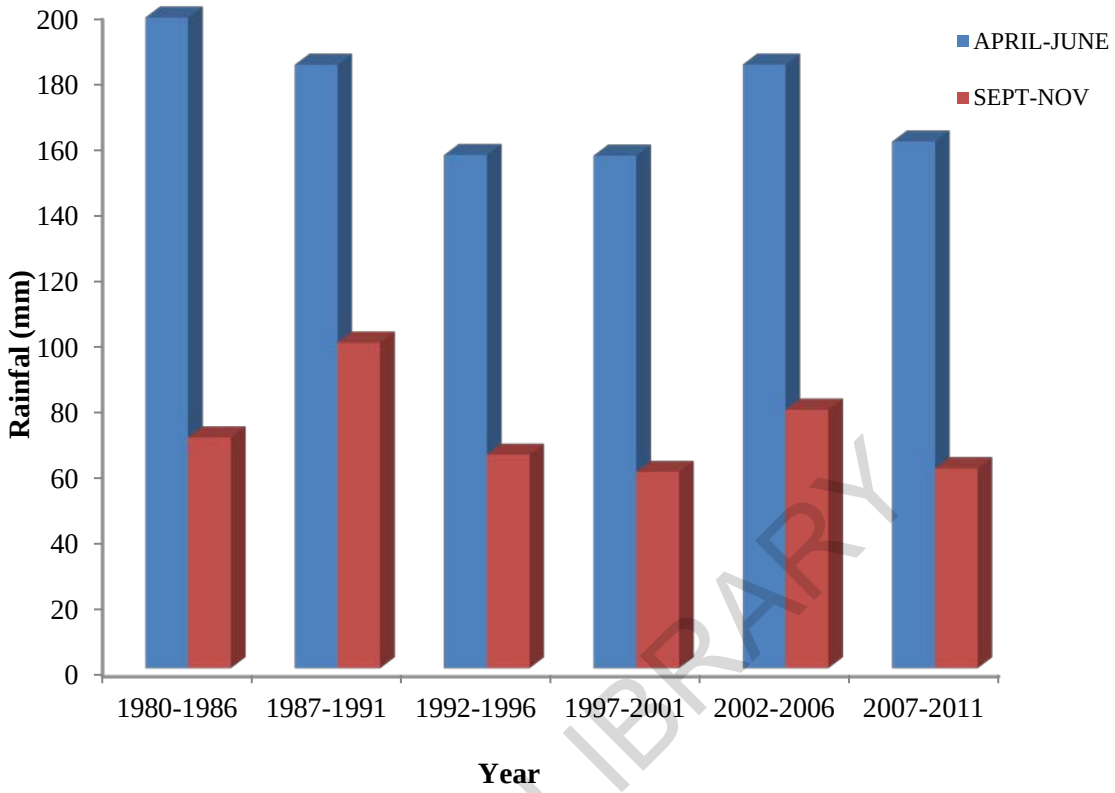


Figure 4.9: Mean annual rainfall: 1984-2009

Source: Fieldwork (2013)

* There were no data in 1981 and 1985.

The results as shown in Figures 4.7, 4.8 and 4.9 show marginal variations of amount of rainfall received at the local communities. The variations are not convincing enough to suggest that there is markedly a reduction of rainfall in the Municipality. This can be attributed to inadequate data available for the analysis. It must also be emphasised that rainfall data capture does not take into account the duration of fall in terms of number of hours per day, but a torrential fall within a few minutes could be captured by the rain gauge with corresponding high figures. This is the reason views of people who have interacted with their local climates become relevant in this regard.

However, evidence shows that Ghana's climate is drying up gradually since 1950. Information provided by the EPA (2008) on behalf of the government as well as other climate change-related studies suggest that rainfall has decreased. For example, a

report on *climate change impacts assessment in Ghana* under the Netherlands Climate Change Studies Assistance Programme (NCAP 2) indicates that the highest rainfall was recorded in 1968 (1142.6 cm) and the lowest in 1983 (335.2 cm) with the most significant decreases occurring in 1968-69 and 1997-98 although there was a recovery in the last decade (EPA, 2008).

What has been discussed as the causes of the changing patterns of rainfall globally, regionally and nationally have consistently focused on natural and anthropogenic factors largely based on positivist epistemology. This is not surprising since indigenous ontology and epistemology have not been well researched into or have not had considerable space on the global literature platform dominated by western knowledge system.

Even though natural factors have been identified to explain the case (see Carter; 2009; Acheampong, 2010), the scale (intensity and rate of change) at which the 'variability' occurs and the impacts associated with it makes the perspective of human factors as a cause to rainfall variability convincing. For instance, an analysis by a former Director of the Centre for Remote Sensing and Geographical Information (Ghana) (Ghana Television (GTV), 3rd November, 2013) confirmed the anthropogenic influence of climate change and its effects on rainfall in Ghana.

The anthropogenic cause of rainfall variability was not contested by the respondents. Some of the qualitative responses were consistent with the existing literature. For instance, indiscriminate felling of trees which is one of the reasons for rainfall variability was mentioned by some of the IDI and FGD respondents. Some of the respondents had these to say:

> If I would use our case as an example, we have rivers here like River Pra. There are rivers in the forest zone too. In the past,

> they never felled trees along the river and in the forest at a scale we see now. As such, much rains filled these rivers which ultimately flowed into the sea. But now, we are told that the forest cover of Ghana has reduced accounting for the decrease in rainfall [Kafodzidzi: IDI participant, male, 53 years].

> The reason the rains are not falling as it used to is that most of the trees in the forested areas have been cut down. The trees bring rains so as long as these trees are cut down it reduces the extent of rainfall [Komenda: FGD participant, male, 48 years].

The views of the respondents on the issue of rainfall and its pattern over the last recent decades (about four decades), point to a changing pattern which is not only irregular but inadequate to reduce the perceived warming of the sea. Here again, the study focused on responses from those who had lived in the community for a decade or more, and particularly, those of the first and second generation respondents.

The responses confirmed that rainfall has decreased in terms of duration and quantity. The double maxima rains between April and June (major rains), and September and October (minor rains) were perceived to have been altered. They indicated that rainfall pattern was not only being inconsistent but torrential in certain times with shorter durations. They explained further that the phenomenon was not only restricted to their local communities but a general observation in the coastal communities in the Municipality. They observed that rains that used to send volumes of water into the sea via rivers and streams have decreased in volume. The following experiences were shared:

> In the past it rained consistently and predictably too so the sea was comparatively cool. The onset of rains was experienced earlier and reliably...It is difficult to explain the phenomenon now. It is difficult to explain why the rains have been altered currently [Brenu Akyinmu: IDI participant, male, 73 years].

> In the past there were regular and heavy rains which kept the sea to be cold. Today we don't even get the rains. That is why the sea is getting warmer and warmer [Elmina: FGD participant, male, 63 years].

> The rains everywhere have been affected. In this community, we used to experience adequate rains for farmers to plant and for us too to ensure fishing because the sea will cool. For the past ten years, things have changed here. Now, you cannot know when it will rain let alone its quantity [Kafodzidzi: FGD participant, male, 53 years].

> The rains have decreased. It now falls in smaller quantities and shorter duration. I am not too old, but I remember when I was a child, my father could accurately predict when the rains will fall. Today, I cannot do so because I will be a liar to my children [Komenda: IDI participant, male, 48 years].

The survey results were consistent with those of the IDI and FDGs. Generally, about 86 percent of the respondents indicated that there has been a change in the

incidence of rainfall and almost the same proportion of the respondents pointed out that the amount of rainfall has decreased. There were no variations in responses with respect to the background characteristics of the respondents and their views on the issue. For instance, responses from those who had lived in their respective communities for 0-4 years and more than 30 years were similar. Again, the views from the four study communities were similar (Table 4.3).

The results (Table 4) show that all the respondents at Komenda and four in five of those in the other communities except Brenu Akyinmu (73 percent) were of the view that there has been a change in the rainfall characteristics. They also admitted that there has been a reduction in the quantity of rains they have received in the last decade.

Table 4.3: Views of respondents about change in rainfall

	What is the change in rainfall % (N)			
Community Name	Rainfall has decreased	Rainfall has increased	Rainfall has been variable	Total
Brenu Akyinmu	73.2 (30)	22.0 (9)	4.9 (2)	100 (41)
Elmina	85.6 (78)	6.6 (6)	7.7 (7)	100 (91)
Kafodzidzi	88.0 (22)	0 (0)	12.0 (3)	100 (25)
Komenda	100 (32)	0 (0)	0 (0)	100 (32)
Total	85.7 (162)	7.9 (15)	6.3 (12)	100 (189)

Source: Fieldwork (2013)

The IDI and FGD respondents further emphasised that the sea was getting warmer. Based on their interactions with the sea, the fishermen indicated the extent of change of the sea temperature. Some of them respondents shared the experiential knowledge:

> The sea is getting warmer compared to the past. I started fishing in the early seventies. In those days, you could not even bath/swim in the sea in July. We only dipped ourselves in it once and that was all you could do as bathing after using the sand to clean yourself. We could not even dip twice. The situation is changing currently in the sense that today you can conveniently swim in the sea even in July which you could not about forty (40) years ago [Kafodzidzi: IDI participant, male, 53 years].

> In the past the sea was colder than presently. In fact if you compared the coldness of the sea in August in the past and now, I will say that presently, the sea is getting warmer. I really think that the sea is getting warmer. We even feel it in the community in that the sunshine these days is more severe and we experience that more often compared to the time I was in my teens [Komenda: FGD participant, male, 63 years].

> In the past the sea was cold...But over the last twenty-five years that I started fishing I can say that the sea is getting warmer in all the seasons. We bath in the sea everyday so we can determine its coldness or warmness over time. For instance, in

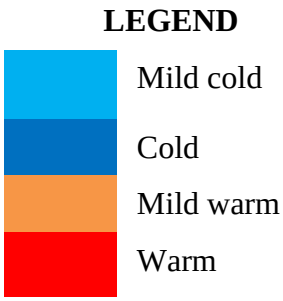
> the past, the sea was very cold in January – February as a result of the harmattan. But presently, you only experience such cold conditions only in two or three days, and then it is over. This is a change [Brenu Akyinmu: IDI participant, male, 76 years].

Based on their experiential knowledge, the respondents established a cognized or mental seasonal calendar that depicted the seasons of coldness and warmness of the sea (Table 4.4). To them, this seasonal trend is changing as a result of changing trends of rainfall. For instance, in their description, the sea used to be cold during the months of April and May. However, the current observation and experiences show that the sea is getting warmer even in these months (see Table 4.4).

The survey results were not different from the qualitative findings. About 82 percent of all respondents indicated that temperatures over the last three decades had increased with only about 13 percent opining that there has been a variability of temperatures within the same period of reference (Table 4.5). In Komenda, Elmina and Brenu Akyinmu for instance, over 93 percent, 66 percent and 61 percent of the respondents respectively indicated that the sea was gradually getting warmer. However, in Kafodzidzi, less than half of the respondents indicated that the sea was gradually getting warmer than before while about one-fourth were of the view that the sea was gradually getting cooler. Generally, more than 67 percent of the respondents observed that over the last three decades the sea has gradually become warmer (Table 4.5).

Table 4.4: Seasonal calendar showing periods of coldness and warmness of the sea: Past and present

Month	Past trend (Four decades ago)	Current trend	Month
January			January
February			February
March			March
April			April
May			May
June			June
July			July
August			August
September			September
October			October
November			November
December			December



Source: Fieldwork (2013)

Table 4.5: Views of respondents about change of sea surface temperature

Settlement	Temperature description of the sea (10-30 years ago)				
	Sea warming increasingly % (N)	Sea warming gradually % (N)	Sea getting cold increasingly % (N)	Sea getting cold gradually % (N)	Total % (N)
Brenu Akyinmu	39.1 (9)	60.9 (14)	0 (0)	0 (0)	100 (23)
Elmina	17.9 (12)	65.7 (44)	14.9 (10)	1.5 (1)	100 (67)
Kafodzidzi	25.0 (5)	40.0 (8)	5.0 (1)	30.0 (6)	100 (20)
Komenda	6.7 (2)	93.3 (28)	0 (0)	0 (0)	100 (30)
Total	20.0 (28)	67.1 (94)	7.9 (11)	5.0 (7)	100 (140)

Source: Fieldwork (2013)

The above analyses (both qualitative and quantitative) do not deviate from the literature entirely. Nationwide studies (Stanturf, et al., 2011; EPA 2008; WEDO, 2008) and localised studies (Gyampoh & Asante, 2011; Gyampoh et al., 2009) have provided available and estimated evidences to show that rainfall has decreased in quantity and in duration; a situation that is not different from information from IPCC and Toulmin (2009) on (West) Africa in general.

4.3.3 Incidence of change in sea level and inundation

Globally, the rise of the sea level has been determined. The melting of icecap and the warming of the sea are reasons given to explain this phenomenon (Laffoley & Baxter, 2016; Mimura, 2013; Barnes & Kaiser, n.d.). As such, coastal settlements and communities have been named as more vulnerable and prone to sea inundation. In Ghana, the east coast zone is undergoing sea inundation. The case of the east coast zone has been more rapid than the central and western coast zones because the former

coastline is generally sandy. The west coast zone is rockier compared to the central coast zone. This makes the central coast zone the second vulnerable coastline in Ghana (EPA, 2009).

In this present study, there were evidences to show that the communities were experiencing sea inundation. In Komenda (especially Dutch Komenda), there was evidence of human habitats that have been affected by sea inundation. Figures 4.10a and 4.10b depict the extent to which the sea inundation have affected and destroyed houses along the coastline in Komenda. Currently, these houses have been rendered inhabitable.

Figure 4.10a: Buildings affected by sea inundation at (Dutch) Komenda

Source: Fieldwork (2013)

Figure 4.10b: Buildings affected by sea inundation at (Dutch) Komenda

Source: Fieldwork (2013)

The case of Kafodzidzi was equally critical. The respondents explained that about three decades ago, a specific location (shown with the arrow in Figure 4.11) marked the point where fishermen landed their canoes. The location is about one hundred metres from the current landing site. Presently, the unmotorised canoes use a naturally-constructed rocky surface as the landing site because the sea has inundated the previous landing site (Figure 4.12).

Figure 4.11: Landing site affected by sea inundation

Source: Fieldwork (2013)

Figure 4.12: Current landing site for unmotorised canoes

Source: Fieldwork (2013)

Some of the respondents had these to say:

> Look at the stone ahead (*see arrow in Figure 4.11*), we used to walk on bare sand to the stone. The sea retreated at that location. For about 15 years now, we have not been able to see the sand or walk up to the stone. This means that the sea level has risen and this makes it difficult to land our canoes [Kafodzidzi: FGD participant, male, 43 years].

> We hold the view that the sea level has gone up. Look, in the past, we walked for a while on the beach and on sand before getting into the sea to bath or push our canoes to fish. Now look [pointing to the sea], there is no sand on the beach to walk on [Kafodzidzi: FGD participant, male, 57 years].

> The sea level has risen. We are experiencing it. In the past we had a large expanse of sand at the beach where we landed the canoes. All this part has been taken over by the sea [Kafodzidzi: IDI participant, male, 90 years].

> Look, when I was born, I was even told that the sea had moved closer to us. But now, it has taken over almost all the beach. We had coconut along the entire stretch of the beach. They have been destroyed by the sea. You can come to see for yourself in June, and you will not see some of the buildings

here. They would have been submerged [Brenu Akyinmu: FGD participant, male, 57 years].

The interpretation from Figure 4.11 indicates that the sea has inundated portions of the coastline, which hitherto, was bare and used to land the canoe after fishing. The implication is that the local fishermen could no longer land their canoes at that location. The option for the manual canoe operators was to use the rocky surface of the opposing cliff for landing purposes as shown in Figure 4.11. The topography of the cliff poses challenges to the landing of canoe especially during high tides.

The views about the recent trend of the sea level rise and inundation were, however, varied among the participants at Komenda. While some believed that the sea was moving towards the land, others raised historical and experiential knowledge to disagree with this observation. It was realised that while the younger respondents (in both IDI and FGD participants) believed that there was a rise in the level of the sea which has resulted in the incidence of sea inundation, the older ones contested such views. Some of the views include the following:

> The sea erosion is severe at Komenda. A lot of buildings have been destroyed; not even the public toilet has been spared. Wherever you go you see that there is an inundation of the sea here [Komenda: FGD participant, male, 40 years].

> Let me tell you this; the sea used to be closer to us in the past than now. Then it receded. As it receded we also occupied the land. That is why we were able to walk to the stone there [*points to a stone about 100 metres away into the sea*]. In the past, you could not easily swim to that stone. But now, we can

> easily walk to that stone. But currently, we are also experiencing the 'coming back' of the sea which is trying to take-over that land which it hitherto occupied many years ago. That is why some are saying that the sea is coming close to us. Well, history tells us that that is its original position [Komenda: FGD participant, male, 60 years].

> I asked my elders about the movement of the sea and I was told that more than a century ago the sea used to be closer to us. They explained that the sea was very close to the fort (defunct) so boats and canoes could easily be used to cart goods and humans (slaves) to the ship. However, the sea retreated more than half a century ago, but currently it is advancing towards the community [Komenda: IDI participant, male, 47 years].

The case of Komenda was further explored. The location of a defunct Fort built by the British in the 15th century which was used by the respondents as a landmark to explain that the Fort was built very close to the sea was also observed (Figure 4.13). Currently, the distance between the Fort and the sea is about 100 metres. It was observed that around the defunct structure were local houses that have been built. Some of these domestic houses were located less than 30 metres from the beach.

Further reflections by participants during the validation workshop revealed that at Elmina, the sea once occupied parts of the land which are now being habited by residents. Participants from Kafodzidzi also consented to the observation. One of them described his experiences and observations about five decades ago and related them to the current situations.

> I remember when I was very young...about eight years old, the sea was very close to us like it is now. But after some years it receded. I remember we used to play football at the beach. Now, it is back. It has come to occupy its original position. But I think the current occupation is more forceful because it disturbs landing of canoes [Kafodzidzi: Validation Workshop participant, 58 years].

Figure 4.13: Defunct Fort (with plants on the wall) and other local structures at (British) Komenda

Source: Fieldwork (2013)

The survey results were partly consistent with the narratives. About 63 percent of the respondents indicated that there has been a change in the sea level rise in the last 10-30 years. However, almost the same number of respondents in Komenda indicated that there has not been any change in the sea level rise. These responses were

somewhat consistent with the qualitative results from that community. In Elmina, more than 44 percent of the respondents were also of the view that there was no change in the sea level. This result was not surprising because during the FGDs and IDIs, most of the older participants admitted that the sea inundation the community was experiencing is not really about a rise in the sea level, but rather, the presence of a sea defense wall which was constructed to prevent sea intrusion into the settlement.

Although the rising of the sea level in the country, in general, has been estimated, factors such as the construction of breakwaters at Tema harbour and the Keta sea defense have accelerated the sea inundation in the east coast zone. Observations at Pampram beach and the adjoining coastline of Keta, as evidenced at Horvi and Brekusu have been recorded (NADMO, 2007). In the current study too, the respondents' views from the survey about the main causes of sea inundation were partly consistent with the existing literature in Ghana. For instance, close to 40 percent specifically indicated that constructional works including the expansion of the Takoradi harbour has contributed to the sea inundations being experienced especially over the last one to three decades (see Boateng, 2012; Oteng-Ababio, Apeaning-Addo & Owusu, 2011).

The qualitative responses were, to some extent, varied in some of the communities with respect to the actual causes of the inundation. Some could not actually point out any cause except to say that it is a natural phenomenon (God's own design). However, others stated a number of factors responsible for the sea erosion and inundation. Common causes that were identified include the construction and extension of the Sekondi/Takoradi harbor and sand-winning. Some of the views shared include the following:

> We are having two main thoughts here. One is that we think that climate change as the cause. I have read about that and at times share with my colleagues. The other thought is related to the sea defense wall or the construction of the Sekondi-Takoradi harbour. That is why all those along the coast such as Komenda, Abrobeano and Kafodzidzi are experiencing inundation [Kafodzidzi: FGD participant, male, 53 years].

> We are aware that the sea is coming closer to the land as we have indicated earlier. It is difficult to explain the cause. But there is the knowledge that sand-winning is a cause. Here, we use the sand for construction of building; others sell it too. The sand-winning contributes to the inundation of the sea here [Brenu Akyinmu: FGD participant, male, 60 years].

> Some have indicated that sand winning at our beaches is a contributory factor. The sand serves as defense against sea waves and erosion. But we tend to dig and fetch for building purpose. Those from the Meteorological Department have advised us not to do sand-winning here but we don't comply. We keep winning the sand and the sea keeps coming [Komenda: FGD participant, male, 63 years].

Sand winning is not an uncommon activity in Ghana. Almost all communities along and near the coast use the beach sand as a natural resource in constructional activities particularly in building of houses. The practice, undoubtedly, lowers the

immediate coastline thereby enhancing sea inundation (Gibbons & Nicholls, 2006, cited in Nicholls, 2007; Zhang et al., 2004).

4.3.4 Conclusion

Although there were evidences of increase in temperature and sea inundation, inadequate data in local communities restricts in-depth analysis to determine a change in climate. That notwithstanding, experiential and historical knowledge of local people are relevant to providing the necessary information, and to suggest a changing climate in these contexts. It therefore points to the fact that to understand some aspects of climate change in local communities, one needs to focus on the historical, experiential and observational knowledge of the people as bases for analysis (Nakashima et al., 2012; Boedhihartono, 2010).

Nevertheless, the subjective views call for deeper inquiry, especially, to explain the rising levels of the sea. That notwithstanding, the literature available (Boateng, 2012; Oteng-Ababio, Apeaning-Addo & Owusu, 2011; Zhang et al., 2004) support the opinions that the construction and expansion of the Sekondi-Takoradi harbor, sand mining at the beach contribute to sea invasion and inundation in coastal and fishing communities.

Craddock's (2006) crisis management and timeline model (see Chapter Two) becomes applicable in discussing the incidence of climate change at the study area. Given the data collected and the issues discussed, the pre-cursors to the change in the local climate include deforestation and illegal mining. The local communities lacked the capacity to develop interventions to avert the pre-cursors, hence, the manifestation of the incident stage. Based on the model and the results, it is evident that the study

area is characterized by the incident stage owing to the changes in temperature, rainfall, sea level rise and periodic sea inundation.

4.4 EFFECTS OF CLIMATE CHANGE ON FISHING

The impacts of climate change are usually analysed within two main dimensions. These are impacts that relate to opportunities and impacts that relate to constraints. The latter has usually been emphasised owing to the intensity and magnitude of the consequences which far outweigh the exploitation of opportunities (IPCC, 2007). This section focuses on the effects of climate change on fishing in the local communities studied. It presents the impacts at three levels. It assesses the effects of climate change on vegetation, habitats of the local people, livelihoods, local knowledge in fishing and migration. For the purposes of this study, 'effects' and 'impacts' are used interchangeably with the same meaning.

4.4.1 Effects on coastal vegetation and other structures

The commonest plant along the coast of Ghana in general, and the Municipality in particular, is coconut. The coconut plant provides shade for the fishermen and aids in fishing activities. The 'dead' branches are also for domestic fuel use. The study observed that the plant has been affected in all the study communities. From the respondents, the continuous destruction of the coconut trees as a result of sea erosion and inundation has also exposed their houses to wind attack. This was how one of the FGD participants put it:

> The sea was not destructive in the past compared to recent times. It was far bearable in the past. Look, when I was born...we had coconut along the entire stretch of the beach.

> They have been destroyed by the sea...now our buildings are exposed to the wind and storm. It is serious now [Brenu Akyinmu: FGD participant, male, 57 years].

To justify that climate change is real, others used the effects of the sea inundation on the coconut trees along the beach. For instance, during the stakeholders' workshop, one of the academics explained that the coconut at the beach of Cape Coast used to be in seven rows, but now in three rows as a result of the effects of sea inundation.

The results also show that there was an impact of the sea inundation on movement and landing of canoes particularly at Kafodzidzi and Komenda. According to the respondents, some of the rocks which, hitherto, were visible are now submerged. As a result, it is difficult for fishermen to avoid them while approaching the shore. It also emerged that the sea level rise at times prevented the fishermen to land their canoes on time while accidents have been recorded, some of them resulting in the death of some fishermen due to collision with submerged rocks. These were how some of the FGD participants put it:

> All the beaches along Komenda, Abrobeano, Kafodzidzi, etc. are at risk. At times it is pathetic. There are instances where fishermen would intend to land their canoes but would have to wait from about 11am till 5pm to allow the sea to recede a little before they can land. Meanwhile, they would have fish too in the canoe to offload for sale or processing; imagine the loss associated with it [Kafodzidzi: FGD participant, male, 53 years].

> Now because of the inundation, rocks which hitherto were deeply hidden underneath the sea have been exposed making it difficult to move the canoe to sea or dock the canoe after fishing. There have been instances of accidents as a result of canoes colliding with some of these exposed rocks. This has resulted in death and serious injuries in recent times [Komenda: FGD participant, male, 43 years].

Studies in other parts of Ghana and elsewhere in Asia and America also confirm that the impacts of climate change have been adverse on coastal vegetation. Areas where the coastlines are low-lying have severely been affected, and predictions indicate that the situation would be exacerbated in the future (Garner et al., 2015; Addo, Larbi, Amisigo & Ofori-Danso, 2011; Hsu, Lin & Tseng, 2005).

4.4.2 Effects on domestic habitats

The inundation of the sea has affected the habitats of some of the local people especially at Komenda. Other structures such as public toilets, and local community centres located at the beach were also affected. Again, places where fishermen used to mend their nets, relax after work and meet for discussions as groups have all been affected. For instance, one of the FGD respondents in Elmina indicated that '*the sea is coming towards the community forcefully. That is why some buildings have been destroyed along the other side of the beach*'. Other respondents stressed that the inundation was worse usually between June and August. Some of the respondents explained further:

> The sea has taken over almost all the beach. You can come to see for yourself in June, July or August, and you will not see

> some of the buildings here. They would have been submerged [Brenu Akyinmu: FGD participant, male, 57 years].

> The sea erosion is severe in Elmina and Dutch Komenda. A lot of buildings have been destroyed. In Dutch Komenda, the public toilet has been inundated. Wherever you go you see that there is an inundation of the sea [Komenda: FGD participant, male, 40 years].

There are associated implications that can be deduced from the effects of the climate change on the domestic habitats. Firstly, there is an economic cost. All households who were affected had lost their houses due to the inundation. Again, the households that were affected and had to rent new houses incurred additional expenditure. Secondly, there are communal or social cost and economic cost to the affected communities which lost public places such as toilets. Thirdly, the social attachments that the affected household had with their previous places of residence were likely to be impaired. Fourthly, there is also an implication on social status or prestige associated with family and individual ownership of properties. To explain the loss of social prestige, one of the respondents had this to say:

> Imagine leaving in your own house, and just a moment you are forced to move out of your own house with all that you have…It is not an easy thing. I was a landlord for almost a decade, and all of a sudden, my status had to change to become a tenant [Komenda: FGD participant, male, 58 years].

The sandy composition of the coastlines of these communities increases their vulnerability to sea inundation. Unlike Kafodzidzi where about two-thirds of the

coastline is rocky, Brenu Akyinmu, Elmina and Komenda coastlines are predominantly sandy. Other studies in the country such as that of Addo et al., (2011) which was conducted in three communities in Dansoman in Accra, show that 650,000 people, 926 buildings and a total area of about 0.80 km2 of land would be vulnerable to permanent inundation by the year 2100. Currently, Dansoman is undergoing sea inundation and a considerable number of households and buildings have been affected.

4.4.3 Effects on livelihoods of local fisherfolks

Sea fishing comprises a chain of activities. Traditionally, the main activities include fish harvesting, processing and marketing. Within this chain are sub-activities that are both economic and non-economic. An impact on fish harvest will have rippling effects on all the other activities within the chain. Discussion of the impacts of climate change on fish harvest centred on four main factors: the size of fish, the quantity and frequency of fish harvest, the distance covered during fishing and extinction of fish.

Generally, it was expressed that the sizes of fish harvested in the past (three or more decades ago) were bigger compared to current sizes of fish. Arguably, overfishing, fishing with illegal mesh sizes of nets, pair trawling and light fishing are attributable factors too. Nevertheless, the impacts of climate change cannot be underestimated especially with the incidence of increasing sea temperatures that contribute to further movement of certain species of fish offshore and into deep sea. Some of the respondents who are in active fishing had these to say:

> In general terms, I can say that there were bigger fishes than presently. There were bigger fishes onshore but fishermen in the past could not reach them owing to distance, type of canoe, and nets that were in use. Now that we have bigger canoe and

> motor as well as nets for such types of bigger fish too, we cannot get these fishes. These fishes are running further into deep sea [Brenu Akyinmu: IDI participant, male, 73 years].

> We fished for bigger fishes in the past. Our mesh sizes were bigger; more than two inches...We picked the fishes one by one into our canoes because they were of large sizes. One thing was that our nets were not as long as we have now; about 600 yards compared to about 1200-1500 or more yards now. We now use longer nets and cover extensive distances in seach for fish. This is because the fishes are now very further away [Kafodzidzi: IDI participant, male, 48 years].

> In the past, fish was not scarce and there was never a time that fish was scarce. Hardly did we finish smoking than our husbands [fishermen] brought another stock of fish catch. So, as for the past, there was nothing like fish being scarce. But now, we don't get the desired quantity and the frequency too has been affected [Kafodzidzi: FGD participant, female, 69 years].

Although overfishing and foreign pair trawling by foreign trawlers impact adversely on fish stock and fish harvest in recent times in coastal Ghana (United Nations Conference on Trade and Development (UNCTAD), 2016; Thomas, 2009), climate impacts on fisheries cannot be doubted. Although Toulmin (2009) indicates that the model for predicting changes are much less advanced than for land-based systems such

as crop production, she writes that a rise in temperature of 2^{o}C will have an economic impact on the fisheries sector. The results from the survey also showed that fish catch per person was higher in 2003 compared to a decade later. As shown in Table 4.6, more than 34 percent of the respondents harvested, on the average, six pans of fish per trip in 2003 compared to only a little over eight percent in 2013. Those with manual canoes harvested much fish in both periods of observation. Again, they had more harvests per fisherman, and experienced less costs. One possible reason could be that those who operated the manually-powered canoes largely constituted the older generation who made use of their local knowledge to determine the success of fish catch. They, therefore, did not go fishing everyday; they usually responded to evidence from nature in most cases before fishing. Reliance on nature puts such category of fishermen into the domain of vulnerability as a result of adverse effects of climate change on indigenous knowledge.

On the contrary, the motorised canoe operators almost always went fishing. Each canoe had a worker-population of about 15-25. Again, they always set aside quantity of fish catch to cover the cost of operation per trip. It must be emphasised that they are also liable to variable fuel prices, inflation, over-fishing by both local and foreign (pair) trawlers which over the last few decades have increased generally. The study further observed that average earning per person per trip of fishing increased in 2013. For instance, as shown in Table 4.7, about 72 percent earned more than GH¢51.00 in 2013 compared to more than 80 percent who earned GH¢ 50.00 or less a decade ago.

Table 4.6: Average catch per person per trip of fishing

Canoe type	Catch per person in 2003 (in kg) percent 1-3 pans	4-6 pans	6 pans +	Total %	Catch per person in 2013 (in kg) percent 1-3 pans	4-6 pans	6+ pans	Total %
Motorised	21.1	46.1	32.8	100.0	87.1	5.9	7.0	100.0
Manual	15.7	45.1	39.2	100.0	76.4	11.8	11.8	100.0
Total	19.8	46.0	34.2	100.0	84.6	7.3	8.1	100.0

Source: Fieldwork (2013)

Table 4.7: Average earning per person per trip of fishing

Canoe type	Earning per person in 2003 (in GH¢*) % GH¢ <10-50	GH¢ 51+	Total %	Earning per person in 2013 (in GH¢*) % GH¢ <10-50	GH¢ 51+	Total %
Motorised	80.1	19.9	100.0	26.5	73.5	100.0
Manual	82.0	18.0	100.0	33.3	66.7	100.0
Total	80.5	19.5	100.0	28.1	71.9	100.0

Source: Fieldwork (2013)

*In 2003, GH¢0.9 = US$1; 2013 GH¢2.0 = US$1 (Source: www.ghanaweb.com)

Actually, the marginal increase in earnings could be attributed to increases in prices of fish due to cost of fishing or/and inflation, but not necessarily the worth of the fish harvested. This is because the value of the Ghanaian currency has depreciated against its major trading currencies over the period. Hence, it could be deduced from Table 4.7 that the average earnings per person per trip were more in 2003 than in 2013 in terms of the value of their earnings if estimated using the US currency.

The trend of marketing of fish has also been affected. Previously the fishmongers bought the fish from the fishermen at wholesale market prices and sold at the market usually after processing. The profit accrued was for the fishmongers. But currently, the arrangement has changed. The female respondents indicated that the fishermen, who are mostly their husbands, sell the fish to them at the retail market prices. This makes it difficult for them to even break-even at times if all costs including labour and transport were factored in the computation. To them, the change of the arrangement is largely due to inadequate fish catch and the cost of fuel for fishing.

Cost of fuel for fishing is critical to fishermen who operate the motorised canoes. A comparative analysis shows that fishermen currently move further offshore for fishing while the motorised ones currently use more fuel at sea. The findings show that in 2003, less than three percent of fishermen fished at a depth (distance) of more than 50 metres. Currently, more than 72 percent of them fish at the same depth. It must be noted that to the fishermen, distance covered is not horizontally estimated but rather vertically (depth of the sea). Similarly, in 2003, a little over 12 percent of the respondents said they used more than 60 gallons of (premix) fuel for a fishing trip compared to about 74 percent at the time of the study. With predictions of impacts of climate change on fisheries, the related cost would be higher and this will further exacerbate the socio-economic vulnerabilities of both fishermen and fishmonger.

Changes have also occurred with respect to the depth at which certain fish types were harvested in the past and present. Specific mention was made about certain fish species and the depth at which they were harvested. For instance, *wriwriw* was harvested at a depth of 50-60 metres, but presently, the catch is done at a depth of 60-120 metres. Again, the catch of herrings (the commonest fish harvested) occurred

mostly at a depth of 30 to 40 metres, but now harvesting occurs at a depth not lower than 60 metres.

The extinction of some fish species were also highlighted during the in-depth interviews and focus group discussions. There is the belief among the fishermen that every type of animal on the land (or in the forest) has a corresponding type (not necessarily the same kind) in terms of the size in the sea. To them, that accounts for the species and size diversity of fish in the sea which are believed to be similar to that of animals in the forest. Some fish species were said to have been in extinction. The respondents indicated that these species are scarce or have not been harvested over the past three decades. Some shared their observations as follows:

> We have fishes such as *epokwesi*, *epokɔtɔkɔ* and *epoapetibi* [types of sea fish]. These are fishes that have their kind of animals in the forest too. We used to harvest all these species here and elsewhere in Monrovia and Abidjan. But now all these fishes are no more [Komenda: IDI participant, male, 47 years].

> There is a fish called *ewure* [a type of sea fish]. We were even discussing it last three days that it is in extinction. This fish took over the country's markets about twenty to thirty years ago. Currently, we do not have it anymore in our sea [Brenu Akyinmu: FGD participant, male, 50 years].

> All the types of fish there were in the sea in the past are still there only that we don't get it in the quantity they used to be in the past. But *ewure* is the only fish that we cannot now account

> for in the sea. It has totally ceased to appear again. There are no traces of it presently [Brenu Akyinmu: FGD participant, male, 34 years].
>
> There is a type of fish called *kokora* [a type of sea fish]. In the past this fish swam even into the rocks just close to the beach. In the past, one could harvest the fish in less than two hours. Presently, we don't even see *kokora* [Elmina: FGD participant, male, 66 years].
>
> When I was growing up, I came to meet my parents in the fishing business. If it were to be in the past, you would have seen plenty *epeii* [a type of sea fish]. But now you don't even see them. They are in extinction [Kafodzidzi: FGD participant, Female, 79 years].

These observations and experiences shared by the fishermen and fishmongers are not so different from predictions of impacts of climate change on coastal communities in general and fisheries in particular. For instance, the warming conditions of the sea lately and the loss of some species of zooplankton is said to be responsible for migration of fish into deep seas or other seas with favourable conditions. Similarly, the extinction of certain fish species corresponds to animal extinction predictions as a result of climatic change (Toulmin, 2009).

The impacts of climate change on coastal livelihoods may not be limited to Ghana and the study area. Studies in other parts of Africa and the world including the arctic provide evidences (Huq et al., 2015; Lyimo, Ngana, Liwenga & Maganga, 2013;

Cinner et al., 2011; Koivurova, Tervo & Stepien, 2008). What is critical, however, is that, such impacts have the potential to stall poverty reduction strategies or erode gains of these strategies in these contexts.

In fact, developing countries (including Ghana) are considered vulnerable to impacts of climate change due to lack of adequate financial, capital and technological capacities. This partly explains the reason UNFCCC advocates that developed countries contribute to develop the endogenous capacities of developing countries and vulnerable communities (see Article 4, clause 5 of UN 1992). With coastal communities in these countries regarded as most-at-risk, the plight of the local people in the study areas can be worsened by these impacts if effective adaptation is not implemented.

4.4.4 Effects on local knowledge for fishing

Indigenous knowledge plays a key role in fishing. It permeates all the facets (before, during and after) of fishing. Indigenous knowledge in general, and like fishing, is climate-dependent. As a result, any change or persistent variability in the local climate would have subsequent impacts on the knowledge that underpins it. The study observed that climate change has affected indigenous knowledge used in fishing in various ways: prediction and detection of fish, and detection of storm.

The results from the qualitative data show that the activities of animals, appearance and smell of the sea and appearance of lunar objects were used to predict and determine successful fishing activity. The respondents indicated that the movement of flamingo at sea and the activities of crabs at the shore were used to predict and determine the likelihood of fish catch. However, currently, the success associated with

the use of the local knowledge cannot be predicted. Some of the respondents expressed that:

> We have certain periods [usually harmattan] that we know that fish abound. But we also watch the movement of birds on the sea. If we see these white birds circle around a particular portion of the sea, it indicates that there are fishes around that area, so we row our canoes to reach that portion anytime we see such a phenomenon. The case is quite different now in that today we see the birds but very far away. Again, they hardly hover around a particular portion in the sea as they used to do in the past indicating that they do not see fish [Elmina: participant, male, 55 years].

> We also know that if we find a lot of holes created by crabs at the beach, it signals that we would experience good catch that particular period of the season. Our elders have told us this. The crabs and the holes serve as a guide to fishing. Now we don't see these phenomena often [Brenu Akyinmu, FGD participant, male, 60 years].

Again, the appearance and the smell of the sea were also used to predict and determine the availability of fish. The results show that if the sea appeared darker, there is the possibility of adequate fish harvest. Again, the indigenous knowledge has it that when one experiences the strong wind that blows from the sea to the land it meant that fishing would be successful. The use of these aspects of the local knowledge has

waned because they are not reliable. Some of the respondents shared their experiences and thought:

> If the seawater looks darker, it indicates that fish catch will be plentiful in the night. We rely on this knowledge and got fish with minimal efforts...The situation is a bit different currently in that we do not often see such description of seawater like we did in the past. Again, it is difficult to get results now if you apply this knowledge. Look around here, all the coconut we had in the past along the beaches have been inundated by the sea now. This to an extent justifies that something wrong is happening making it difficult to rely on this knowledge to fish nowadays [Brenu Akyinmu: IDI Participant, male, 56 years].

> After preparation for fishing, we used to determine the flow of the wind. We relied on the wind which blew onshore to sail. To return, we relied on the wind to sail home. But if the wind operates in the reverse in each sail, we used the paddle. The wind that helps to sail blows from the forest; we call it *bofon* and the one which blows from the sea to the land is called *ahoo*. The former is stronger than the latter. It is called *bofon* because it carries the scent of vegetation which is nauseated, hence, the name. The latter smells like fish. We were able to determine that there is much fish in the sea by the smell of *ahoo*. Currently, this knowledge is not really reliable nowadays [Elmina: FGD participant, 75 years].

It was also noted that lunar objects were used to determine whether a fishing expedition would be successful or not. The moon, for instance, was used for this prediction. The respondents indicated that a full moon signified a possibility of good catch few days ahead if the brightness of the moon begins to dissipate. From the respondents, the current results associated with the practice of this local knowledge are not rewarding. Some of them explained:

> When there is a bright moon it becomes difficult to see the movement of the fish because the brightness makes the sea also white so you find it difficult to see the fish which are usually white and shiny in the sea. In such a situation we say that 'the moon has taken over the market'. But when darkness is the case, we see the whitish shoal of the fish. Usually, the darkness and brightness occur two weeks each in a month. So when there is full moon or brightness of the moon, we do not go fishing. In such a situation it becomes preferable to go fishing in the day. But currently, even though the appearance and disappearance of the moon have not changed, the resultant outcome with respect to fish harvest is not consistent. Thus, we can have two weeks of darkness (no moon) even in June but we will not get any significant catch [Kafodzidzi: FGD Participant, 48 years].

> In the past we used the brightness of the moon also to determine the availability of fish in the sea. If the moon was full and very bright it indicated that there would be adequate fish to catch. In fact, August is the month which the brightest

> moon comes up, hence, it is our month of great harvest...Now, we can have full moon but the associated harvest will be comparatively less [Elmina: IDI Participant, male, 74 years].

During the validation workshop, the participants underscored that generally the moon appears for duration of two weeks, usually the first and last weeks of the month. Thus, conservatively, two weeks is normally available for effective fishing in the sense that there would be less or no illumination from the moon to affect the monitoring of the movement of fish(es). It was further explained that the attainment of a full moon indicated that subsequent days would be without full light from the moon, hence, the possibility of fishermen being able to monitor the movement of fish and consequently having adequate catch.

Another climatic condition that, according to the local knowledge, affects fishing is the incidence of storm. Storms make fishing difficult and life threatening. Such was the reason fishermen relied on their local knowledge to predict the possibility of an incidence of a storm, and hence, to enable them plan effectively. Generally, there has been a change in stormy conditions in the last thirty years. According to the respondents, over the last three decades it has been observed that incidence of storm at sea had decreased. Indeed, more than 67 percent of them said that there has been a change in the incidence of storm. Further, 52 percent indicated that incidence of storm has reduced with 22 percent indicating that it has been irregular. However, the respondents explained that the changes in the local climate as well as the sea level rise have affected their ability to predict an incidence of storm at sea. One of them elaborated that:

> In the past, our fathers relied strictly on the stars and the winds to predict stormy weather. Anytime the clouds looked dark,

> they placed their feet into the sand at the beach. If the sand was warm, it indicated the likelihood of stormy weather. If it was cold, the prediction is that the weather would be calm; hence, fishing can be embarked upon. But now most of the coconut trees which gave shade at the beach have been destroyed by the sea. Therefore, we feel the heat of the sun more than previously. This makes this aspect of indigenous knowledge used to predict stormy conditions at sea not always reliable here even though we still practice it [Brenu Akyinmu: IDI participant, male, 34 years].

Nonetheless, indigenous knowledge continues to form an integral part as far as fishing in the local communities is concerned. From the survey results, half of the respondents indicated that indigenous knowledge regulated fishing in the study area, while 48 percent said that both indigenous and western knowledge systems regulated fishing (Table 4.8). It was further observed that the use of indigenous knowledge in fishing was prevalent in Brenu Akyinmu (69%) than in the other communities. This can be attributed to the fact that Brenu Akyinmu is the most rural community, and with the highest percentage of fishermen who used the manually-operated canoes compared with those in Kafodzidzi (23%), Elmina (13%) and Komenda (13%).

It was further noted that indigenous knowledge was always available (99.5%), affordable (95%) and accessible (98.6%). It was also found that some aspects of the knowledge were effective (92.3%) and reliable (77.5%). In all, 55 percent of the survey respondents indicated that they would continue to use indigenous knowledge in their fishing activities although more than half in Kafodzidzi and Elmina used aspects of both indigenous and western knowledge systems (Table 4.8).

Table 4.8: Knowledge system that regulates fishing in the study area

	Knowledge system			
Community	Indigenous	Western	Both	Total
	% (N)	% (N)	% (N)	% (N)
Brenu Akyinmu	68.9 (31)	0.0 (0)	31.1 (14)	100.0 (45)
Elmina	44.3 (47)	3.8 (4)	51.9 (55)	100.0 (106)
Kafodzidzi	38.5 (10)	0.0 (0)	61.5 (16)	100.0 (26)
Komenda	51.1 (23)	2.2 (1)	46.7 (21)	100.0 (45)

Source: Fieldwork (2013)

The local knowledge used in fishing in the study area seems to be losing its effectiveness currently. Although available literature suggests that indigenous knowledge has been used in the past during similar unfavourable climatic conditions, it could be argued that the scale and intensity of climate change have affected its effectiveness to an extent. Studies conducted elsewhere (Nakashima et al., 2012; Boedhihartono, 2010; Gearheard, Pocernich, Stewart, Sanguya & Huntington, 2010) also show that climate change has affected the effectiveness of some aspects of indigenous knowledge which were previously used in fishing. This, perhaps, explains the reason some of the respondents combined both indigenous and western methods in fishing.

4.4.5 Effects on migration

It is not an uncommon practice to see fishermen migrate. Indeed, almost all the IDI and FGD participants indicated that they had travelled to places such as Apam, Tema, Axim and Half Assini all in Ghana, and Monrovia, Abidjan and Dakar West Africa.

Migration therefore characterises fishing. Even though the fishermen migrated, and at times with their households for economic purposes, the fundamental reason and frequency of migration have been modified. Previously, the purpose for which fishermen in the study setting migrated were mainly two: to fish during the lean season at place of origin; and to be able to save enough money for future investments at home. Those who had the intention to work and save money usually migrated with their households. A few however migrated because they worked in boats owned by foreigners. Some of the respondents explained why they migrated.

> When my father died, it became difficult to have a place to lay my head with the household. I had to move to Abidjan with my household to start a livelihood there. We first moved to Half Assini before taking a boat to Abidjan. I worked in a boat….a very big foreign boat. I worked in Abidjan for twenty six years before coming back home [Brenu Akyinmu: IDI participant, male, 76years].

> Our elders started fishing in Abidjan. They then moved to Monrovia, Freetown, Guinea etc. I was born in Monrovia. It was easy to save outside Ghana because there, I had the ambition to make investment at home. Again, I did not get disturbed by relatives for financial support. We put up wooden structures in Monrovia in order to build block houses at Komenda [Komenda: IDI Participant, male, 77 years].

Impact of climate change on migration was not clearly determined from the study. The findings were consistent with the available literature on the score that migration is

influenced by varied and related factors including climate change. However, the study discovered that recent migration among some of the fisherfolks could be linked to poor fish harvest even during the bumper season; a phenomenon that climate change is perceived to have contributed to. Currently, the main reason for migration by those in Kafodzizi and Komenda is due to poor harvest of fish in recent times.

Migration is not only limited to the fishermen. Over the past decades fishmongers also migrated to Cote d'Ivoire, Liberia as well as other places with their husbands (who were fishermen). Even though recently, household movement scarcely occurs, there are individual females who migrate to some of these countries mentioned. Some of them expressed that their mobility patterns were influenced by the changing seasons associated with poor fish harvest. One of them shared her experience.

> When I grew up and was working with my mother, we could work for three days or more and there will be a lot of herrings to process. Currently, if, for instance, we get fish today, we stay idle for about two weeks to one month. So I usually go to Abidjan during the bumper harvest in August to trade in fish. I process the fish by smoking and sell it at the various markets in Abidjan [Kafodzidzi: FGD participant, female, 48 years].

The case of Brenu Akyinmu and Elmina were quite different. Fishermen in Brenu Akyinmu scarcely migrated in recent times. Formerly, they travelled but internally to places such as Apam, Half-Assini, Moree and Tema, all in Ghana. Currently, the fishermen, who mostly used the manually-operated canoes, fish in and around locally. Even the few who operated the motorised canoes rarely travelled outside the country. The reason given was that most of the relations who used to live in cities outside Ghana, such as Abidjan are now back home. Thus, it becomes expensive to travel

outside the country to settle and work; hence, the preference to manage the situation at home.

4.4.6 Conclusion

The impacts of climate change are diverse and adverse in the study area. There were tangible (economic) costs and intangible (socio-cultural costs) on the individual, households or families as well as the community at large. Although economic costs associated with loss of properties and effects on economic livelihoods are easily quantifiable, costs associated with the waning of indigenous knowledge, loss of biodiversity, losing touch with cultural contexts, loss of social networks, prestige and status cannot be monetized and subsequently quantified satisfactorily due to their intangibility. This largely explains the reason such costs have rarely been studied and assessed in climate change discourse. Because these intangible assets are predominant in rural and local contexts, impacts of climate change affect the holistic lives of people in these communities, and make them become most vulnerable.

Relating the impacts of climate change to the crisis management and timeliness model, it is notable that climate change is at the post-occurrence stage, and at the recognition phase of the post-occurrence stage (Craddock, 2006). This is because of the noticeable impacts on the communities in general, and fishing in particular. At the moment, climate change has triggered adverse effects on vegetation at the coast, the habitats of the local people, their livelihoods, their local knowledge in fishing and migration. The model predicts that without the appropriate interventions, the adverse impacts may aggravate.

The impacts of climate change in the study communities are common to other areas according to available literature (Yusuf, et al., 2015; Shaffril, Samah, D'Silva &

Yassin, 2012; Toulmin, 2009). What are of essence to discuss are the implications of the impacts particularly in the near future. Undoubtedly, adaptation and mitigation are key to the reduction of the impacts of climate change now and the future. Nevertheless, predictions show that other ramifications or opportunities would emerge. For instance, the loss of prevailing coastal ecosystem or biodiversity would lead to the emergence of new ones (Nicolls, et al., 2007; IPCC, 2002). The extent to which the new biodiversity cover would be beneficial or non-beneficial to the fishes and the people's livelihoods would be a challenge to the local people determine. This is because the knowledge system which actually guides their fishing and other socio-political system have been weakened by the impacts of climate change.

Another critical issue to discuss is how the local people can observe, interact and understand the new milieu the impacts of climate change present. If the tools to use are indigenous, then, the outcomes could be ineffective. This is because the cumulative impacts and the subsequent ramifications will not only undermine the application of the weakened local knowledge system, but also, restrict its renewal. It would therefore require a long period of time for the local knowledge system to renew and become relevant, by which time the impacts would have aggravated, and made livelihoods distorted and worse (Craddock, 2006). What, could possibly, save the situation is a co-evolution of a knowledge system to guide and influence effective adaptation.

4.5 ADAPTATION TO CLIMATE CHANGE IN THE STUDY AREA

The practice of adaptation strategies in the study area was not uniform. The underlying factors of the diversity related to the composition of the coastlines, cultural values, age, and economic ability. This section presents how the local communities

have adapted to the impacts of climate change. It also discusses the outcomes of the various adaptation strategies that have been implemented.

4.5.1 Adaptation strategies to deal with sea level rise and inundation

Sea level rise with its associated inundation is a bane to fishing activities in the study communities. As discussed previously, stretches of vegetation, houses and landing sites along the coast have been affected. Locally, use of sand bags, reliance on available rocky coastline and relocation constituted the adaptation strategies to address the sea level rise and inundation.

Although it was reactive and autonomous, the use of sand bags was common especially in Komenda. It was also realized that in the past, Elmina and Brenu Akyinmu used this strategy but achieved little success. With this strategy, empty sacks were filled with the beach sand and these bags placed at locations that are threatened by the sea. This was observed at Komenda during the period of the data collection. One of the respondents said:

> There was a time the sea came so close to even where we have our offices. So we put sand in sacks and placed them at the highly vulnerable areas to serve as 'barriers' to prevent the sea from taking over the beach and the structures here. These are not too strong and permanent strategies to prevent the sea's destructive nature [Komenda: FGD participant, male, 58 years].

The use of the sand bags was not sustainable. The locally devised adaptive tool was not only temporary, but also, could not serve as a barrier to restrict the advancement of the sea water and its associated inundation. The respondents explained that the strategy was not effective. Some of them had these to buttress their position:

> We tried sometime ago to use sacks filled with sand to serve as barriers to its erosion but the sea eroded all the sacks. Our beach is made up of only sand so it is difficult for us to control the waves but easy for the sea to erode [Brenu Akyinmu: Validation workshop participant].

> …It is beyond our capability to restrict the intrusion of the sea waters onto the land. We cannot. At the beach close to the castle were thick pillars that were constructed by the whites [colonial Europeans]. Now go and see, all have been destroyed. The force of the sea waves have pulled all of them down. Only God can stop the sea's inundation [Elmina: Validation workshop participant].

The second strategy to adapt to the sea inundation of habitats was relocation. Permanent and temporary relocations were used anytime the sea inundated sizeable portions of the land including habitats. A sixty-two year FGD participant at Komenda commented that '*in such times, we only have one option; relocate to join friends and relatives at unaffected parts in the communities*.' It was observed that those who relocated temporarily came back to their houses after the sea waves had subsided. This adaptive tool was commonly used at Komenda.

> Last year and last two years for example, some of us had to relocate to stay with other relatives close to three weeks in wait for the sea to recede. Others too left to stay in neighbouring communities [Komenda: IDI participant, male, 59 years].

> One of my relatives had to come and stay with me because the sea waves attacked them [household]…the husband also had to put up with a relative. The husband took with him two sons and my relative came to stay with me with her three daughters [Komenda: FGD participant, female, 55 years].

The third adaptive strategy to adapt to sea level rise and inundation was using the surface of rocks as a land site for manually-powered canoes. This strategy was used at Kafodzidzi. One of the youngest (38 years) respondents at Kafodzidzi explained that '*Anytime the sea becomes full preventing us to land at our usual landing site, we use the rocky surface to land our canoes*'. However, the motorised canoes could not use the rocky surface area as a landing site due to the size and weight of such canoes. Although the rock could withstand the impact of the sea inundation, the areas where the motorised canoes used as landing site was vulnerable to inundation. This, partly, explains the reason most of the fishermen who operated the motorised canoes tend to migrate often at Kafodzidzi compared to those who operated the unmotorised canoes.

4.5.2 Adaptation strategies to deal with impact of climate change on livelihoods

Various strands of adaptive livelihood options were activated in the study area. Some of the factors that determined the selection of these adaptive options by the respondents include the age of the respondent, the context in question and economic ability. The adaptive livelihood can be categorised into two. These are adaptive fishing strategies and alternative livelihood strategies.

The adaptive fishing strategies comprised lagoon fishing, crab-fishing, light-fishing, ownership of multiple canoes and gears, and migration. Lagoon fishing is an old fishing practice. According to the respondents, lagoon fishing was done in the past,

especially in May, and whenever the rains were heavy and the storms and tidal waves were also intense. Fishermen, therefore, fished in the lagoon temporarily in wait for the good fishing periods. It was, however, realized that as a result of long period of lean season coupled with poor fish catch currently, the lagoon has now been overly relied upon. As a result, the stock of fish in the lagoon lasted for only a few months. This adaptive strategy was very common at Brenu Akyinmu, partly because most of the fishermen operated manually-powered canoes. Some of the respondents explained that:

> The lagoon still provides us with fish. But now, we have increased the intensity of fishing in it largely due to long span of lean season and scarcity of fish in most months of the year. Again, we get people from Ampenyi (a neighbouring village) who come to fish because of similar challenges. As such the stock of fish in the lagoon is always inadequate throughout the year [Brenu Akyinmu: IDI participant, male, 73 years].

> We fish in the lagoon a lot nowadays. You can come and see for yourself; both the youth and the aged all struggling to catch a fish or two for food. This has become the practice because we do not get enough fish from the sea. I am not too old, but even about a decade or two ago the situation was not like this. We got at least what we could live on from the sea. But now, this is rare [Brenu Akyinmu: FGD participant, male, 34 years].

The second adaptive fishing strategy was crab fishing. Like lagoon fishing, crab fishing is equally an old practice during the short-lived lean season. Because it is not a

tedious task, young people and even some children engaged in crab fishing on behalf of their parents. In almost all the communities, crab-fishing was done particularly in June when the rains were heavy and the tidal waves were rough. With the current prolonged lean season, crab-fishing has not only become intense but it has become an activity for both the old and the young. Thus, a temporary adaptation strategy which was adopted in the past in June has now become a regular fishing practice almost all the year round. Some of the respondents shared their concerns:

> At our ages, we should not have been fishing. I should not have been engaged in any form of fishing because of my condition [disabled in one leg]. But things are not the same anymore. In the past I would have sat in the house; my children would be fishing for me. Now we all fish for crabs. There is almost fish scarcity [Elmina: FGD participant, male, 75 years].

> I still fish but only for crabs. Most of us the elderly usually do crab fishing for living. It is expected that our children must take care of us but things have changed...they themselves are struggling to make ends meet. As a result if you the father fail to act decisively you will die early out of hunger [Brenu Akyinmu: IDI participant, male, 76 years].

A reflection on the African culture explains that the young needs to take care of the old. In fact, this is reinforced in the adage '*the old takes care of the child to grow teeth and when he/she becomes an adult, he/she takes care of the old to lose the teeth*'. This, to an extent, explains the reason at a certain age, the old needs to stay at home for the young to work [fish] and take care of them. This cultural practice might be waning in

some of the fishing communities given the experiences and observations shared by the older generation.

The third adaptive strategy was light fishing. This strategy, although illegal, was widely and commonly adopted in the urban communities (Elmina and Komenda) that were studied (see also Bannerman & Quartey, 2004). Light-fishing is the process of harvesting a shoal of fishes that have been attracted by an artificial light (Ogunola, Onada, 2016; Hua & Xing, 2013). The common practice in Ghana is the use of purse seine gear and a generator which powers an incandescent bulb that is lighted and dropped into the sea at night to attract the fish (Bannerman & Quartey, 2004).

Light fishing, mostly, attract the pelagic fishes which usually swim at the surface and midwaters at temperatures below 25^{o}C. Thus, when temperature begin to rise, the pelagic fishes tend to swim deeper the ocean (Ogunola, Onada, 2016; Bannerman & Quartey, 2004). As such, light fishing was common within the period of September-December when the sea surface temperature begins to rise. If the rise in the sea surface temperature of 2^{o}C will have an economic impact on the fisheries sector (Toulmin, 2009), then, the incidence of climate change which has altered and increased the sea temperature characteristics over the last four decades could be the main cause of the increasing practice of light fishing in Elmina and Komenda. One of the respondents, however, justified the reason some of them adopted light fishing as an adaptive strategy. This is what he said:

> When the sea is cold we get more catch. But currently, the sea is warm. It is just by technology of using light to fish that now we get fish other than that we would have nothing to catch [Komenda: FGD participant, male, 40 years].

It was, however, realized that other factors including commerce and greed contribute to light fishing. The oldest (90 years) respondent stressed, during a FGD at Kafodzidzi, that '*...today, the mantra is 'what can I get now' as opposed to 'how can we sustain fishing*?'

Light-fishing is a disturbing (adaptive) practice because it contributes to overfishing of both fingerlings and harvestable fishes, thereby, destroying the future stock of fish. With the advent of climate change, such a practice can exacerbate the plight of unmotorised canoe users especially in the rural communities. Although the Fisheries Act, 2002 (Act 625) prohibits light fishing, all efforts, according to the respondents, which have been put in place including the use of marine police to halt the practice have been unsuccessful (see also Agyekum, 2016).

The fourth adaptive fishing strategy was the ownership of multiple canoes and fishing gears in an attempt to increase fish catch to reduce possible losses in fishing. This adaptive strategy was particularly common among the motorised canoe owners, who, compared with the manually-powered canoes, had economic power. While in the past, very few fishermen owned at most three manually-powered canoes which were not at sea simultaneously, the situation was different currently. There were fishermen who owned four or more motor-powered canoes which were used to fish daily. This adaptive strategy was common in Elmina, Kafodzidzi and Komenda. Some of the respondents had these to say:

> It is a common practice here for a fisherman to own more than two canoes. Some even own more than four...One of the reasons is that now it is difficult to rely on only one canoe because fish in the sea is scarce to find. So if you have many canoes, there is the probability that at least one of the canoes

will bring good news [Elmina: FGD participant, male, 65 years].

> One strategy we have adopted, or some of us have adopted is to buy more than one canoes and its accessories for fishing. This reduces costs in the sense that no matter what happens, at least, one canoe would bring a fortune to cover the costs incurred on the other canoes. I, for example, have four canoes...I have to do this because the sea is near empty but we must also survive, hence, this strategy [Komenda: IDI participant, male, 47 years].

> Currently, one way to adapt is also to increase the number of canoes. So now you can have one fisherman with more than three canoes. So if one canoe does not get fish, it may be possible that the others may get fish to reduce or offset the losses incurred [Kafodzidzi: FGD participant, male, 38 years].

The ownership of multiple canoes and gears, as an adaptive strategy, provides a form of insurance or economic protection based on probability. The other implication is that there is the possibility of overfishing which could exacerbate the adverse consequences posed by climate change. That is, in an attempt to address costs associated with fishing owing to unpredictability of fish harvest, such an adaptation strategy can have ramifications on the stock of fish. The present study agrees with McLean et al. (2001) that the principal impacts of climate change have been compounded by overfishing.

The last adaptive fishing strategy was migration. Migration has always been a social or economic adaptation strategy for most fishermen in almost all the communities. Although, some of the respondents indicated that poor fish catch has necessitated regular but temporary migration currently even during known bumper seasons, other factors such as social relations and economic conditions at the places of destinations were contributory factors. For instance, in the past, fishermen in Kafodzidzi and Komenda migrated internally to Tema and Accra, and externally to Cote D'Ivoire and Liberia mainly for social and economic reasons. Internal migration has now become common and the duration spans from three to six months contrary to one to three months about two or three decades ago. One of the respondents explained that:

> We have always travelled to Tema, Accra and Half Assini during the lean season at Kafodzidzi. The difference now is that we stay in these places for longer months...say three or more months; sometimes even six months. This is all because fishing is no more economically satisfying at home [Kafodzidzi: FGD participant, male, 53 years].

The complex factors that account for migration therefore make it difficult to assign climate change as the only factor. Nevertheless, its contribution cannot be overlooked. New trends of fishing seasons have emerged, while seasonality of fishing has also been affected (see Table 4.4). The changing seasons have consequently affected economic activities in fishing (see also Marine Climate Change Impacts Partnership (MCCIP), 2012; Roessig, Woodley, Cech, & Hansen, 2005; Dontwi, Dontwi, Buabeng, Ashong, et al., n.d.; Williams & Rota, n.d.).

The alternative livelihood strategies that were employed in the study communities were farming, petty trading and transport services. Farming was common in the rural

communities especially at Brenu Akyinmu. Farming was, in the past, a livelihood for the non-indigenes in that community. Crops such as vegetables, groundnut, tiger-nuts and tubers were cultivated and sold at the local markets. However, given the recent poor fish harvest largely attributed to the incidence and impacts of climate change (and pressure on the lagoon), some of the fishermen have adopted farming activities as an alternative livelihood strategy.

> In the past we had non-indigenes here who were farmers while the indigenes were fishermen. That is, while the farmers depended on us for fish we also depended on them for food. For instance, those of us who started fishing from childhood, we do not have lands to farm, so we don't farm. But now, most of us have acquired lands to farm because the sea is now empty [Brenu Akyinmu: FGD participant, male, 57 years].

> ...There was food such as cassava, maize, etc. which were cultivated by the farmers in the community. Most of the farmers were non-indigenes. Currently, things are not the same now. My son who is very active in fishing is also engaged actively in pineapple farming to take care of the household and myself. This is new to me because we never combined occupations because we all had our harvest sufficiently [Brenu Akyinmu: IDI participant, male, 76 years].

> I fish and farm too. Fishing is not as lucrative as the days of my father. In their era they only fished whilst the *adesefo* [people

> from farming villages] who settled here engaged in farming. Now we (fishermen) all farm because we cannot always get our daily bread from the sea. Fish is scarce so farming now becomes an alternative. I even think I am now more of a farmer than a fisherman because I go to farm more than to the sea. If the situation continues farming may become our first occupation and not fishing [Brenu Akyinmu: IDI participant, 34 male, years].

Like Brenu Akyinmu, farming was a key alternative option at Kafodzidzi too. According to the respondents, it was not uncommon to see fishermen farm in the past and now. However, the only variation between the past and present farming activities relates to the purpose. Whilst it was purely a subsistent activity in the past, currently, it is a commercial activity. It was deduced that the prolonged lean season has contributed to this phenomenon. Some of the respondents shared their views:

> What we do now is to farm to complement our livelihoods. We now grow cassava, vegetables (pepper, garden eggs) and fruits (pineapple and watermelon). Again, during the rainy season when fishing activity is less active, we farm to survive [Kafodzidzi: FGD participant, male, 55 years].

> There are dynamics in our livelihoods now... It is not advisable to rely only on fishing especially where currently, getting adequate fish is a difficulty. So farming helps. Some traders come from neighbouring and far off towns to buy some of the

> produce from our farms [Kafodzidzi: FGD participant, male, 48 years].

Farming seems somewhat sustainable. However, with the reduction in rainfall coupled with its erratic pattern and increasing temperatures, this alternative livelihood may yield less result. Additionally, the introduction of fishermen into farming has the potential to reduce fallow periods for the land to regain its nourishment. The use of fertilizer also has economic cost and climate change implications. Other aspects of indigenous knowledge in farming were not reliable due to the changing climate (Mawunya & Adiku, 2013; Müller-Kuckelberg, 2012).

The second alternative livelihood strategy was petty trading. It was observed that some of the fishmongers have adopted this strategy. Petty trading (also known as 'provisions' store in Ghana) includes the sale of household consumables usually done by hawking and at fixed locations in kiosks. It must be indicated that females who engaged in petty trading were generally, the spouses of fishermen.

Lastly, some of the fishermen engaged in transport services as an alternative livelihood and/or to complement other economic livelihoods including fishing. This livelihood option was common in Elmina, Komenda and Kafodzidzi. At Kafodzidzi, for example, operating a taxi business by some of the fishermen was common. It was further observed that those who owned and operated the transport service also owned motorised canoes. Two of the respondents who owned and operated such a business had these to say.

> When I realised that depending on fishing alone could not support my family, due to inadequate fish catch, I decided to look for other options that can yield 'fast results'. That was the reason I got into the taxi business because there is always a

> demand for such services and the returns are immediate ad more reliable compared to fishing. At the moment, I have one taxi cab [Kafodzidzi: FGD participant, male, 48 years].

> I have two taxi cabs as of now...I pray to have more, and that is understandable. Even though I am not too old, I can testify that fishing nowadays is not lucrative. As indicated by my colleague, there is no way people will not board a taxi. It is the only source of transportation in this community, hence, it is reliable. Unlike at sea where we go searching for the fish that are not readily available and seen, on the land, passengers look for taxis here [Kafodzidzi: FGD participant, male, 38 years].

Some of the respondents from urban communities shared similar views although none of them owned and operated such a business. Respondents from Elmina indicated that it is also a common business operated by some of the fishermen. They explained that some of their colleagues owned and operated taxis.

Compared with fishing, operating a vehicle for economic purposes may be lucrative. This is because, unlike fishing, this activity targets a demand which can be predicted. The initial capital needed to by a taxi cab is not as high as an outboard motor. This is because usually the taxis bought are locally used cars (some cost about GH¢3,000 (or $1500; if $1 is equivalent to GH¢2)) but outboard motors bought were usually brand new (costing about GH¢40,000 (or $20,000) at the time of data collection). This, perhaps, explains why this strategy was mostly adopted by the fishermen who owned and operated motorised canoes.

4.5.3 Institutional response to adaptation in the study communities

Two institutions play active role in fisheries in Ghana: the traditional institution and the conventional or political institution. At the local level, the traditional institution comprises the chiefs and the elders of the communities whilst the conventional institution is represented by the Metropolis/Municipal/District Assemblies such as the KEEA Municipal Assembly. These institutions are mandated to play coordinated roles in all fishing and related activities to promote local development (Britwum, 2009; Overa, 2000). The expectation is that these institutions would play similar roles to promote adaptation to climate change.

The current study found out that there was some form of coordination at the KEEA Municipality. For instance, during the stakeholders' workshop, it came to light that the Meteorological Department used to educate members of the communities about sand mining and its effects on sea inundation. Also, the personnel from the National Disaster Management Organisation (NADMO), liaised with the Meteorological Department to communicate to fishermen through a local radio station about effects of climate change and how to adapt. Some of the officials from NADMO shared these:

> We have a system in place where we educate the public including specific groups such as fishermen on issues of climate change. One of the media we use is a local radio station in the Municipality. For instance, we quickly inform fishermen through this medium about any potential and impending weather hazards such as storms and heavy rains that are likely to put activities at sea and the lives of fishermen in danger. This is a form of an early warning system.

> The need to educate people to understand such issues to be able to make informed decisions is part of our mandate. As a result, we have developed a community-radio interactive programme on one of the radio stations. Every Saturday, between 7am and 8am we interact with fishermen in particular about the basics of climate change and its impacts on their activities. Issues about adaptation are paramount in the discussions.

The establishment of an early warning system and the community-radio interactive programme on issues relating to climate change and adaptation seem to be relevant and appropriate. However, further discussions during the workshop revealed that the fishermen were not aware of these activities of NADMO. In fact, all the fishermen who participated in the stakeholders' workshop did not have any knowledge about neither the early warning system nor the radio programme. This was how they put it:

> It is a good thing to have such an early warning system to caution us before any unfortunate incident is experienced at sea...we are grateful for that. Unfortunately, I have not heard from colleagues nor have I tuned in to such a radio station for such information. Perhaps, we do not usually tune in to that radio station [Kafodzidzi: Workshop participant].

> I think we have not heard much about what we are discussing here. If the day for the radio programme is a Saturday, then it will be difficult for us to tune in and receive the information because we will all be at sea. Tuesday will be appropriate

> because most fishermen do not go fishing [Brenu Akyinmu: Workshop participant].

Although an appropriate innovation, it appears the fishermen in the study communities were not involved in the planning and implementation of the programme. Current developmental practice shows that if the intended beneficiaries of any development become part of the intervention design, implementation and evaluation, it facilitates achievement of objectives and ownership of intervention (Kumi-Kyereme et al., 2006; Arnstein, 1969).

Coordination of activities between departments at the regional level, with the intention to promote education on adaptation to climate change in the communities was also not adequate. The KEEA Municipal Assembly is mandate to coordinate with both conventional and traditional systems and structures in this regard. It was, however, realised that the Municipal Assembly has neither a system nor a structure in place to coordinate with these institutions, and to support fishermen to adapt to climate change. Some of the respondents expressed their concerns, and these were buttressed by an official from Municipal Assembly.

> We do not have any relationship with the Assembly [KEEA Municipal Assembly]. They never come here to do anything with us…we have never had anyone come to discuss issues relating to fishing in this community before [Kafodzidzi: FGD participant, male, 55 years].

> We only see government officials during national elections. Immediately they win, they forget about us. Even the Assemblymen do not mind us let alone the Municipal

> Assembly... At least twice a year, such an interaction [FGD] must be organized so the Assembly will know what is going on so that we can reason together to see how we can all address such issues [Brenu Akyinmu: FGD participant, male, 50 years].
>
> In the whole Municipality, we can say that all communities have and are having some levels of experience as far as issues of climate change are concerned, but the degree of impacts varies from one community to the other...Putting in place the appropriate measures is necessary at addressing the (climate change) issues but the sufficiency of such measures touch on the commitment of leadership to ensure that these measures are actually developed and implemented. But I say without any iota of doubt that the current (political) system makes it very difficult for us to implement any measure when we even try to gather resources to research into areas and to come out with those measures [Official, KEEA Municipal Assembly].

Further discussions during the stakeholders' workshop showed that resource constraint was a challenge to the KEEA Municipality and by extension, most of the departments. As a result, it became difficult for these departments to discharge their mandate. For instance, the Department of Food and Agriculture is mandated to educate local communities about adaptive technologies in alternative livelihoods such as farming, while the Department of Fisheries is also obligated to liaise with the fishermen to address their challenges, including those posed by climate change. Perhaps, that explains the reason the Mid-Term Review Plan of the KEEA Municipal Assembly did not specifically focus on climate change and adaptation.

Due to this passive relationship between the formal and traditional institutions, sources of information about adaptation to climate change to the local communities were also limited. The survey results show that the sources of knowledge on climate change were mainly from experience (57.2 percent), other adults in the communities (24.3 percent), parents (15.3 percent) and friends (1.8 percent). The only external source was the media (1.4 percent). More than 94 percent of the respondents indicated that they did not receive any new information or knowledge about adaptation strategies in fishing apart from the locally acquired ones.

This goes to explain why the local communities lacked improved knowledge and technology to address challenges associated with the changing climate (see also Jenkins, 2013; Shemdoe & Kihila, 2012; Boulding, 1966). Since the Municipality has not translated the national climate change framework into a workable framework for the fishing communities, any interaction with the fishermen based on adaptation will not be planned although will be public. At the stakeholders' workshop, it was agreed unanimously that a locally developed adaptation framework was critical.

4.5.4 Conclusion

The purpose of adaptation in the study communities was to reduce risks. With respect to the study communities, the risk-reduction approach was adopted to meet the adaptation needs of individuals, groups and the communities as well. However, attempts were made to meet only three of these needs: biophysical and environmental, social and financial needs (Huq, et al., 2014; Burton et al., 2006) with partial successes. For instance, the use of sandbags to reduce beach erosion, lagoon and crab fishing (especially among the aged) and the other alternative livelihood strategies such as ownership of multiple canoes and gears were tailored to meet the biophysical and

environmental, social and financial needs respectively. No attempts were made to address institutional, information, capacity and resource needs although these are also and very critical to the success of the former.

Adaptation requires adequate information. The lack of adequate information largely accounted for the inability of the study communities and the fishermen to achieve their adaptation needs, and the same reason most of the adaptation options yielded inadequate results. This explains why the adaptation practices were not effective, efficient because they were autonomous and reactive (FAO, 2007; Osman-Elasha, et al., 2006).

The adaptation options and practices in the study communities also point only to the first perspective of Anderson's (2011) analysis of effective adaptation; that is, to address existing adaptive deficits. Perhaps, because the prevailing knowledge system and the information available in the communities were inadequate, to focus also, on the incremental changes in climate-related risks as well as long term climate change impacts was either a challenge or not comprehensible.

Finally, the framing of the adaptation approach in the study communities is worth highlighting. Because climate change and the associated impacts it presents are complex, the call has been made to engage people with different knowledge, experience and backgrounds to tackle and reach a share approach to reduce current and potential risks (Huq, et al., 2014; Eaking et al., 2012; Tompkin et al., 2010). This arrangement was missing in the study communities. This was the reason the indigenous strategies (except temporary relocation) could not yield any appreciable results because the local knowledge itself was weakened by climate change. This, eventually, could lead to maladaptation (Huq, et al., 2014)

In relation to the endogenous development adaptation system framework, it was evident from the study communities that the co-evolution of innovations necessary to generate adequate information for effective adaptation was passive or weak. Although the two blocks of institutions, comprising the traditional (chieftaincy, fishermen associations) and the governmental (municipal assembly) institutions with their indigenous and conventional knowledge systems are available, neither specific nor identifiable attempts were put in place to engage with each other. This is a gap in the adaptation approach at the KEEA Municipality. This, primarily, is the reason for the lack adequate information on the subject in the study communities, hence, the ineffective adaptation. The reason being that both the knowledge available and the methods adopted to apply the knowledge were limited to addressing the adaptation needs of the fishermen and the communities.

In fact, the conceptual framework also reflects the tenets of the decentralisation system of governance in the country where the governmental and the traditional systems or institutions are to engage and participate in the local development. Climate change and adaptation also constitute a developmental issue which needs to be address by engaging people with different knowledge, experience and backgrounds to co-evolve and develop innovative approaches for effective adaptation. Since this approach is missing, the study agrees with the crisis management and timeline model (Cradock, 2006) that the possibility of worsened adverse impacts of climate change awaits the study communities.

To conclude, the current adaptation practices and options cannot promote legitimate actions that are harmonious with broad environmental and socio-economic sustainability (see also Burton et al, 2002; de Löe, Kreutzwiser & Moraru, 2001) without the co-evolution of knowledge and innovations for effective adaptation.

CHAPTER FIVE

GENERAL SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 INTRODUCTION

The main objective of the study was to assess local fishing communities' adaptation to climate change in the Komenda-Edina-Eguafo-Abrem (KEEA) Municipality. This was to provide baseline empirical information on adaptive practices employed by fishermen and fishmongers, and co-evolution of knowledge innovation for effective adaptation in the fishing communities in particular.

The specific objectives were to:

- Analyse the perceptions of fishermen on issues about climate change;
- Explore the incidence of climate change in the selected fishing communities;
- Analyse the effects of climate change on fishing;
- Assess adaptation measures that have been used to address similar effects; and
- Assess the effectiveness of the adaptation measures to addressing effects of climate change.

Various theoretical and conceptual issues in climate change and adaptation in general, and in coastal, fishing and local communities were reviewed. The was, however, underpinned by the endogenous development paradigm and indigenous philosophy. It was also guided by Craddock's (2006) crisis management and timeline model and the endogenous development adaptation system based on Miller (2010).

This chapter focuses on five main sections. Firstly, it describes the summary of the study. This comprises, firstly, the description of the theoretical, philosophical and conceptual frameworks that were adopted and adapted for the study. Secondly, it provides the summary of the methods employed to collect and analyse the data as well

as the summary of the main results of the study. Thirdly, it outlines the main conclusions from the study.

The chapter, subsequently, highlights the contributions of the study to both knowledge and practice. Finally, it presents a number of recommendations that are pertinent to improvement of existing adaptation practices as well as the development of 'new' approaches towards effective adaptation in the fishing communities in particular and the Komenda-Edina-Eguafo-Abrem Municipality.

5.1 SUMMARY

5.1.1 Summary of theoretical, philosophical issues and conceptual frameworks

The pertinent theoretical and philosophical issues, as well as the conceptual frameworks used for the study centred on both indigenous and conventional arguments. The theoretical issues touched on the debates on climate variability and climate change as well as the causes (natural, human and spiritual) of climate change. Other theoretical issues that were discussed include climate change vulnerability, resilience and adaptive capacity, incidence, impacts and adaptation to climate change in general and in coastal communities in specific.

Again, the philosophical bases of indigenous sciences which form the bases of indigenous knowledge were discussed. Simonelli's (2008) six features of indigenous philosophy were reviewed and presented. These are: everything is changing, breaking down, transforming and coming back in a different shape; everything is connected to a supernatural force; everything is alive; everything is interrelated; renewal and repletion of natural and social cycles; and holistic thought. These features form the bases of the endogenous development paradigm which underpinned the study.

The first conceptual framework that the study adopted was the crisis management and timeline model (Craddock 2006). The model has phases, namely, the pre-incident, incident, post- occurrence and post-incident. The pre-incident is characterized with pre-cursors of the incident. The incident phase comprises the occurrence of the crisis. At the post-occurrence phase the incident aggravates, stalls or reduces depending on the interventions instituted. At the post-incident phase, the crisis reaches its finity. The study considered the first three phases of the model in the sense that the incidence of climate change and related issues have not transcended beyond the post-occurrence phase.

The second conceptual framework that was adapted was the endogenous development adaptation system framework which was based on Miller's (2010) endogenous development production systems framework. The framework identifies two main knowledge systems (indigenous and conventional) and argues that the co-evolution of these knowledge systems can promote innovations for effective adaptation to climate change in local communities.

5.1.2 Summary of methods of data collection and analysis

The ontological (nature of knowledge), epistemological (body of knowledge), gnoseological (ways of learning) and axiological (values and aesthetics) perspectives informed the methodological design of the study. The design comprised the selection of the respondents, methods of data collection and analysis. Both primary and secondary data were collected for complementary reasons, and analysed accordingly. Qualitative and quantitative data constituted the primary data while temperature and rainfall data and satellite images were collected from a local weather station and Lansat respectively. A purposive sampling technique was adopted to select two urban

(Elmina and Komenda) and two rural (Brenu Akyinmu and Kafodzidzi) communities from the KEEA Municipality. The selection was based on settlement characteristics, geographical locations, traditional dynamics as well as discernible impacts of climate change. Again, an adaptive stratified sampling procedure was used to select the respondents from these communities.

Focus-group discussions (FGDs) and in-depth interviews were conducted to collect the qualitative data. In each of the four communities, two focus group discussions (one male group and one female group) were conducted to assess the incidence, impacts and adaptation to climate change from contextual and gender perspectives. The inclusion criterion was a three-decadal experience in a fishing related occupation in one of the four communities selected. In all, eight FGDs were conducted. On the other hand, the Stoffle et al.'s (2003) model was used to categorise the IDI participants into three generations: first generation (father; 60 years and above), second generation (son; 40-59 years) and third generation (grandson; below 40 years). The purpose was to examine the knowledge as well as trend of incidence and adaptation to climate change. Three in-depth interviews, were thus, conducted in each selected community. In total, 12 IDIs were conducted. The IDI and FGD guides were the research tools.

To complement the qualitative data, a survey was conducted to collect quantitative data too. The inclusion criteria that were used to select the respondents were as follows: that a respondent must be an indigene; s/he should have worked as a fisherman/fishmonger for at least one decade; or occupy a leadership status a canoe. In total, 222 respondents were interviewed with a questionnaire. All the research tools were structured according to the objectives of the study. The thematic analysis was employed to analyse the qualitative data.

The secondary data that were collected were the temperature and rainfall data and satellite images. The trend analysis was used to analyse the temperatures (1993-2011) and rainfall (1980-2009) data and to determine the extent of change(s) that have taken place. Similarly, the overlay function technique was adopted to analyse the satellite images (1986-2002) to determine the extent of vegetation-cover change over the period within the Municipality.

In addition, two workshops were organised. The first workshop was the validity workshop. The participants of the workshop comprised fishermen who represented their respective communities. The purpose was to present the qualitative data to them four validation and authentication. The workshop was also used as a platform for clarification of issues and concepts. The second workshop was the stakeholders' workshop. The participants for the workshop comprised representatives from the fishing communities (fishermen), KEEA Assembly, Regional departments (NADMO, Fisheries, Meteorology), academia (University of Cape Coast), the media and an NGO. The rationale for the stakeholders' workshop was to engage people from diverse background to deliberate on issues relating to adaptation of climate change. The workshop served as a platform for a co-production and co-evolution of knowledge on adaptation.

5.1.3 Summary of major findings

The study set out to achieve five specific objectives. In relation to these objectives, five research questions were stated. The results from the fieldwork achieved all these objectives and responded to the questions accordingly. This section provides the major findings from the study.

The first objective of the study was to analyse the perceptions of fishermen on issues about climate change. There was a general view from all the IDI, FGD and survey respondents, irrespective of their background characteristics, that the local climates in their local communities had been modified in the last three decades. For instance, 82 percent said that the temperatures have increased; 86 percent indicated that the fall and pattern of rainfall had changed with a similar majority perceiving that the amount of rainfall had decreased; 87 percent indicated that the sea was getting warmer; 98 percent indicated that the level of the sea was rising.

The departure of perception, however, was related to the cause(s) responsible for these changes. It was observed that the IDI and FGD participants who were traditionalists and had no formal education held the view that the cause of the changing climate is spiritual while those who have had ever attended basic education opined that human actions are to blame. The results from the survey data further showed that (majority) 97 percent, 94 percent and 87 percent of the respondents were of the view that the changes in temperature, rainfall and sea level respectively were due to natural causes. However, 62 percent, 80 percent and 55 percent of the respondents explained that the natural causes were as a result of God's own work. The three perspectives that were identified relating to the causes of climate change were nature-induced-cause, spirit-induced-cause and human-induced-cause.

Secondly, the study explored the incidence of climate change in the selected fishing communities. The findings based on the analysis of the secondary data did not reveal any obvious trend of change in temperature and rainfall. The study attributed this to the inadequacy of data that was available to the study. The satellite images, however, showed changes to the vegetation cover. It was observed that sizeable portions of vegetation including wetlands have been modified. For instance, wetland cover

reduced from 27km^2 to 8.4km^2 whilst built-up surfaces expanded from 11km^2 to 15km^2 within the period 1986-2002. Loss of vegetation cover has implications on rainfall and temperature characteristics.

The experiential and observational knowledge from the respondents showed that the study communities were experiencing climate change. Evidences that were used to show that there is the incidence of climate change include changes in the patterns, amount and duration of rainfall, increasing temperature characteristics, seasonal changes of the surface temperatures characteristics of the sea from cold to warmer conditions, beach erosion, sea level rise and inundation.

The study's third objective was to analyse the effects of climate change on fishing. The increasing temperatures, consistent warming of the sea and reduction in rainfall have impacted on fishing in diverse ways. For instance, the indigenous knowledge in fishing has been affected making it unreliable in its application. Again, the increasing sea surface temperatures have affected fish catch, particularly pelagic fish. Sea level rise has hampered fishing and landing of canoes at Komenda and Kafodzidzi whilst beach erosion and flooding were pronounced at Brenu Akyinmu and Elmina. The impacts have eventually affected revenue and incomes associated with fishing and fish processing and marketing businesses in these communities. The findings revealed that eight percent of the respondents harvested an average of six pans of fish per fishing expedition in 2013 compared to 34 percent in 2003. Again, 72 percent and 28 percent earned an average of GH¢51 or more (or $25 or more; GH¢2=$1) and up to GH¢50 (or up to $25) respectively in 2013, compared to about 20 percent who earned GH¢51 (more than $51; GH¢0.9=$1) and 81 percent who earned up to GH¢50 (or more than $50) respectively in 2003. The study, however, admits that other responsible factors could include overfishing and inflation.

The fourth objective of the study was to assess the adaptation measures that have been used by the fisherfolks to address the effects of climate change. Two main adaptation strategies were adopted. The first strategy was to adapt to sea level rise and inundation. In all the communities except Kafadzidzi, sand bags were used to check the impact of beach erosion. The fishermen at Kafodzidzi relied on an available natural rocky surface to land their canoes due to sea level rise while at Komenda, temporary relocation was used during severe sea inundations. The second adaptive strategy was to adjust to the impacts of climate change on socio-economic livelihoods. Both adaptive fishing strategies such as crab fishing, lagoon fishing (particularly at Brenu Akyinmu and Komenda) and light fishing and ownership of multiple canoes and gears (particularly at Elmina, Kafodzidzi and Komenda) were implemented. Again, alternative livelihood strategies such as vegetable and pineapple farming (especially at Brenu Akyinmu and Komenda), transport-related business (especially at Kafodzidzi) and migration among fishermen and fishmongers (especially at Kafodzidzi) were also implemented.

Lastly, the study sought to assess the effectiveness of the locally developed strategies and adaptive practices. Generally, all the adaptive practices except the temporary relocations and transport related business did yield partial successes. Two main reasons accounted for the partial successes. Firstly, the impacts of climate change exceeded the adaptive capacity of the fishing communities and fisherfolks. Secondly, the knowledge base which underpinned these strategies and adaptive practices was the local knowledge which had already been affected and weakened by climate change. The study observed that there was a weak co-evolution of knowledge to promote innovations towards effective adaptation. As such, there was inadequate information since there was no engagement between the fisherfolks and other people from different

backgrounds from the Municipality and beyond. In addition, the institutional responses to the impacts of climate change in the study communities were equally weak. For instance, educational programmes and early warning signals were provided through a local radio station which has a few or no listenership in the study communities.

The findings indicate that the crisis of climate change is at the post-occurrence phase as described by the crisis management and timeline model. Although adaptive practices have been adopted, these interventions are not effective to promote neither desirable adjustments nor effective to reduce the impacts of climate change. Again, since there was no or weak co-evolution of innovation for adaptation (see the endogenous development adaptation framework), the possibility of maladaptation, re-adaptation or secondary adaptation is envisaged.

5.2 CONCLUSIONS

The study identified a number of related factors that contributed to the partial or no successes with respect to the adaptive practices that were adopted in the study communities by the fisherfolks to adjust to the impacts of climate change in the KEEA Municipality. The following conclusions were subsequently drawn.

There is no policy framework or action plan to guide the Municipality and the fishermen to adapt effectively. The expectation of the development of the National Climate Change Policy is that local governments develop their own local and context-based climate change adaptation policies. Indeed, the availability of a locally-developed adaptation policy is a precondition for effective adaptation. This is the reason some authors have argued and advocated that there is the need to empower local communities to address their vulnerability to climate change based on their own social, economic, political, cultural and spiritual structures and decision-making

processes (Nyasha, et al., 2012; UNDP, 2010). This is because resilience and adaptive capacity lie within societies and cultures (Mitchell & Tanner, 2006). Thus, due to the lack of a local policy, the community-based adaptation practices in the fishing communities studied were autonomous, reactive and largely private.

There is a lack of engagement between the KEEA Municipal Assembly and the fisherfolks in the study communities. Based on the decentralisation concept, the District/Municipal/Metropolitan Assemblies are mandated, obliged and responsible for the engagement with communities and groups to foster local development process. Unfortunately, such engagement is lacking as far as issues about climate change and adaptation in the study communities. While the fisherfolks are naïve about this mandatory engagement, the KEEA officials said resource constraint was the bane.

As a result of the lack of engagement between the Assembly and the fisherfolks and the communities, there was also inadequate information to promote adaptation. Huq et al. (2014) argues that adequate information forms the bases of adaptation; and adequate information is generated when different people from different backgrounds engage to develop innovate ways to adapt; this is also the rationale of the endogenous development adaptation system framework. Thus, the knowledge base in the local communities was not adequate to address the complexities associated with the impacts of climate change.

There was also a weak adaptation capacity in the study communities and among the fisherfolks. This was because the knowledge base that enhances knowledge to underpin adaptive capacity was the indigenous knowledge. Unfortunately, the local knowledge, which, largely, informed the adaptive practices, was equally weakened by the changes of the climatic elements and other natural and lunar objects as well as the loss of vegetation species such as the coconut trees. A weakened knowledge system

cannot, therefore, serve as the basis for effective adaptation. According to Mycoo (2013), the blend of different knowledge systems, typically, the traditional and modern technologies, and the communication of the integrated technologies provide effective platforms for effective adaptation in rural communities. This view is also held by other authors (Baul & McDonald, 2015; Huq et al., 2014). A weak adaptation capacity is, by extension, similar to an increased vulnerability or weak resilience.

Again, there was a weak institutional response towards adaptation to climate change in the four communities that were studied. There was no regulatory framework to serve as a guide to adaptation. There is a National Climate Change Policy in place, but at the time of the data collection, the Municipal Assembly had not developed any local policy or framework that could provide pathways to effective adaptation in the fishing communities in particular, and the entire coastal and municipality in general. The national policy advocates for the assessment and integration of indigenous knowledge with other conventional knowledge to inform adaptation. Even though at the regional level, the NADMO in collaboration with the Meteorological Department had instituted interventional programmes to educate fishermen about climate change issues and also provide early warning signals. Unfortunately, the medium of communication (local radio station) and the day of the broadcast were unknown to the respondents.

Due to the lack of engagement and inadequate information leading to a weak adaptive capacity, there was autonomous and reactive or 'panic' adaptation. This partly explains the consistent lagoon fishing, light fishing and ownership of multiple canoes and gears particularly among the motorized canoe operators. Overfishing is likely to be the consequence associated with these [mal]adaptive practices. The

possible effect will lead to re-adaptation or secondary adaptation in the near future due to the maladaptation.

Finally, there has not been any study conducted in the Municipality on climate change and adaptation. Again, none of the fishing communities studied had ever been involved in any research study that touched on the challenges they face in fishing and its related activities. As a result, the knowledge about their perception about climate change, the incidence of climate change in these communities, the impacts and how the fishing communities adapt to climate change was unknown to the KEEA Assembly and others outside these fishing communities. This has restricted knowledge development and innovations, and has also limited the fishing communities' accessibility to knowledge outside the fishing communities.

5.3 CONTRIBUTION TO KNOWLEDGE

The study enhances the theories of perception, and by extension, the perception about climate change. The present study enhances the understanding about how people's cultural ontology becomes the basis of their perception about climate change, and subsequently, the adaptation to this change. Thus, cultural ontology becomes relevant if, for instance, the theories of phenomenology and symbolic interactionism are used to explain the concept of perception.

5.4 RECOMMENDATIONS

The recommendations for this study are divided into four sections. The first section touches on policy. It focuses on how the KEEA Municipality, and by extension, how the KEEA Assembly can adopt policy-related measures to promote effective adaptation in the fishing communities studied in particular. The second section deals

with practical steps the KEEA Assembly and the fishing communities can engage to foster effective adaptation. The third section suggests new areas for research while the last section recommends a community-based adaptation framework which can serve as a guide to the KEEA assembly for co-production of knowledge and co-evolution of innovations to promote effective adaptation in the study communities, and possibly, beyond.

5.4.1 Policy direction

- The study observed that there was neither a local government climate change adaptation policy nor action plan(s) to guide and promote effective adaptation in the Municipality even though there is a National Climate Change Policy. The study recommends that the KEEA Municipal Assembly should develop a local climate change and adaptation policy for the Municipality based on the national policy. The Assembly can engage experts from within the Municipality (for example, technocrats from the KEEA Assembly, fishermen, farmers, NGOs, etc) and outside the Municipality (Regional department and offices, academia, etc) to review existing policies and develop a locally-sensitive climate change and adaptation policy to promote effective adaptation in the fishing communities.
- Although there is a strong advocacy for community-based adaptation because resilience and adaptive capacity lie within societies and cultures (see UNDP, 2010; Mitchell & Tanner, 2006), the study found out that community-based adaptation in the fishing communities were not based on any guidelines. It is, therefore, recommended that the KEEA Assembly, with its relevant agencies, departments and offices, lead the process to engage fishermen and fishmongers

in the fishing communities to develop context-specific policies and action plans to underpin their adaptation practices. This recommendation is based on the fact established in the literature that public and planned adaptation plans provide the basis for effective adaptation (see Matthew et al., 2008; FAO, 2007; Osman-Elasha et al., 2006).

5.4.2 Practice

- The practice of the decentralisation system of governance requires that the local government adopts the bottom-up approach to development, and to address challenges that confront development at the local level. Since climate change is a bane to fishing and socio-economic lives of fishermen, fishmongers and residents in fishing communities, the expectation of the study was for the KEEA Assembly to engage the fishing communities in this regard. The study, however, found out that there was no engagement that touched on climate change and adaptation. As a result, there were no information, experience and knowledge sharing to serve as basis for co-production and co-evolution of knowledge and innovations to inform effective adaptation in the fishing communities. It is recommended, therefore, that the KEEA Assembly develops a plan and schedules to engage the fishing communities in order to understand the extent of climate change incidence, impacts and how effective practices can be developed and adopted to reduce risks and vulnerability.
- It was also realised that the adaptive capacity of the fishing communities and the fishermen was weak. As a result, the adaptive practices that were adopted to adjust to the impacts and reduce the risks associated with climate change did not achieve the desired results. One of the reasons is there was a lack of

adequate information. However, evidence shows that adequate information is a pre-condition to addressing adaptation needs (see Huq, et al., 2014). In view of this, the study recommends that the KEEA Assembly with its relevant departments and agencies and the fishing communities engage with the purpose of developing a knowledge bank from which fishermen, fishmongers and fishing communities can draw out adequate information to enable them adapt to climate change desirably.

- The best approach to adaptation to climate change in local communities is the integration of technologies. For instance, Baul & McDonald (2015) argues that the blend of different knowledge systems, typically, the traditional and modern technologies, and the communication of the integrated technologies provide effective platforms for effective adaptation in rural communities (see also Mycoo, 2013). Because there was no engagement of people with different backgrounds, the co-evolution and innovation of integrated technologies for adaptation was also lacking. The study, therefore, recommends that the KEEA Assembly see this approach as a need by drawing experts from diverse fields and backgrounds including local and traditional fishermen to develop integrated technologies that will respond to the economic, socio-cultural, political and institutional needs of fishing communities especially.
- One the aspects of the adaptive practices adopted in the fishing communities is alternative livelihood practices. The study observed that there were alternative livelihood practices including farming and lagoon fishing which were equally affected by the impacts of climate change. Again, certain types of adaptive practices that were employed have the tendency of increasing the vulnerability of the fishermen in particular. The study recommends that the specific

departments, agencies and offices such as the Departments of Food and Agriculture, and Fisheries that are mandated to provide services to fishing communities particularly on alternative livelihood practices must relate with these fishing communities. Officials from these departments can use the meeting days (Tuesdays in particular) of the fishermen in these fishing communities to relate share expertise about the best alternative livelihood practices.

5.4.3 Areas for further research

- Data is critical in research. Whilst the study inclines its perspective towards qualitative data which, when analysed, reveals the reasons to social behaviours and based on perceptions, experiences and interactions, other types of data are relevant to produce rich results through triangulation of data, methods and respondents. The present study observed that secondary data available were inadequate. For instance, there is no secondary data on sea surface temperature and sea level rise. Academic institutions, research institutes and related organisations should support the KEEA Municipal Assembly to collect data particularly on sea level rise. This will facilitate in-depth and corroborative analyses.
- The call for local-context research has been made since the global and regional findings on issues about climate change are general and not usually focused on disadvantaged and rural contexts. For instance, the study found out that there has not been any research on climate change and adaptation conducted in the fishing communities studied. The study recommends that research institutions, groups and individuals whose studies touch on issues about climate change and

adaptation should redirect their focus of research towards rural and disadvantaged contexts in the Municipality. Studies of this kind would reveal the strengths of local knowledge, endogenous development as well as the gaps to address.

5.4.4 Towards community-based adaptation

In view of the lack of an adapation framework and the need for one in the fishing communities in particular and the Municipality in general, the study recommends the community-based adaptation framework (Figure 5.1). Four main stages are described in the community-based adaptation. These are institutional arrangement and assessment, community assessment, adaptive capacity and technology development. The first leg of the institutional arrangement and assessment describes the key institutions to be assessed to promote co-production of knowledge and co-evolution of innovations. These institutions constitute the drivers of the duality of governance in Ghana (Centre for Indigenous Knowledge and Organisational Development (CIKOD), 2008). While the traditional institution is equipped with experiential and cosmo-ontological knowledge, the conventional institution has wide range of personnel with diverse know-how and expertise. These institutions also relate with other organisations and institutions such as the NGOs and the academia.

The second leg of the institutional domain is assessment. Each of the two dominant institutions (traditional and conventional) comes with its own capacity. Firstly, the assessment is necessary to advance plans for capacity development. This is important in co-evolution of ideas and innovations (Millar, 2010). Secondly, it is critical to the pooling of resources (both human and capital) and allocation of tasks and responsibilities that are expected to be executed in the second stage.

The community assessment constitutes the second stage in the framework. The stage comprises the assessment of the biophysical structure and characteristics in the study communities (of the Municipality) as well as the social, cultural, spiritual, political and economic dynamics. These may vary from one community to the other. The community assessment includes data collection and analysis to influence effective decisions. Data collection covers a wide range of issues including the sea level rise, beach characteristics, incidence and intensity of inundation, and the characteristics and dynamics of the social, cultural, spiritual, political and economic domains. The assessment is to serve as basis to determining a community's adaptive capacity.

The third stage of the framework explains the results based on the community assessment in stage two of the framework. A community's adaptive capacity can either be high to adjust to climate change or low to increase vulnerability (Baul & McDonald, 2015).

Each community has some level of vulnerability and resilience. This will be evident from the analysis of data collected at the community assessment domain. The analysis will show the adaptive capital of each community; either a dividend or deficit. Estimating the adaptive capacity is crucial for the development of intervention to sustain and/or increase the adaptive capacity through community institutional strengthening. planning, implementation and evaluation purposes. It provides room to further assess the human and capital resource needs of a community to address its adaptation needs.

The development of an appropriate technology forms the last stage. The adaptive capacity of a community is critical here. As such, the technology to be developed must be context-specific. Even if the technology is the same, its application must be contextualised, taking into account its natural, social and spiritual domains. Since no

condition is permanent, the technology, when developed, must be revised to meet changing needs. This is explained by the double arrow-line connecting the adaptive capacity and the technology development domains. If there is an existing technology, it has to be reviewed and improved to meet the adaptation needs of a community.

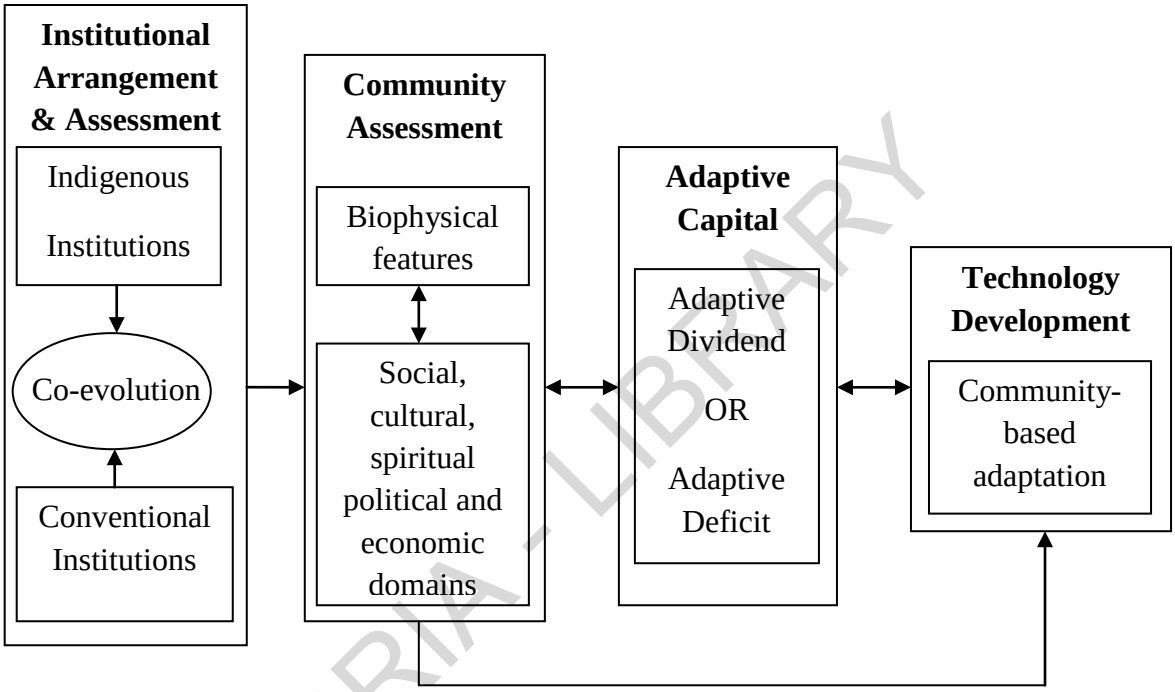


Figure 5.1: Community-based adaptation framework

Source: Author's construct.

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APPENDIX A

LOCAL COMMUNITIES' ADAPTATION TO CLIMATE CHANGE AT KOMENDA-EDINA-EGUAFO-ABREM MUNICIPALITY

IN-DEPTH INTERVIEW/FOCUS GROUP DISCUSSION GUIDE

Informed Consent Form

A. Introduction

Good day Sir/Madam. I am a student of University for Development Studies, Tamale. I am conducting a research with the topic 'Local communities' adaptation to climate change in Komenda-Edina-Eguafo-Abrem (KEEA) Municipality.

B. Purpose and Consent

The study seeks to assess the awareness and knowledge of fishermen about climate change and also the various indigenous methods that have/will be employed to adapt to the consequences associated with climate change. This exercise is purely for academic purposes. Therefore, information gathered will highly be confidential and anonymous. I will therefore like to seek your consent to participate in this exercise.

Consent of Respondent

…… Date: ……..

(Signature/Thumbprint)

Section A: Background characteristics

Demographics

1. a) What is your current age, ethnicity, religion, marital status, number of children, etc.

   b) How long have you stayed in this community?

   c) What are your secondary occupations?

History of fishing

2. When did you start fishing? (Probe for how it started)
3. For how long have you been fishing? (probe whether there were breaks of activity and why)
4. What type of fishing have you/were/are you engaged in? (probe for reasons and in variations)
5. Who do/did you regularly fish with in the same canoe? (Probe for demographics of relations and non-relation and reasons)

Section B: Worldviews and experience in fishing

Past situation: A-three decadal reference point

6. a) Which worldviews underpinned the fishing activities in this community? (probe for specific worldviews: indigenous and endogenous worldviews)

   b) What were the bases of the worldviews? (Probe for natural, social and spiritual bases)

   c) How did each of the bases influence fishing activities in this area? (Probe for interrelationships and harmony between the bases. Also probe for specific and practical examples)

d) Who constituted the custodians of the worldviews? (Probe for reason for specific roles of each custodian and sex variations in roles)

7. a) What were the main types of fishing undertaken in this settlement? (Probe for description of each type of fishing)

   b) Which of these types used indigenous methods to operate? (Probe for reasons and those involved, e.g. sex, age, years of experience, ethnic characteristics, etc.)

   c) Which of these types used conventional methods to operate? (Probe for reasons and those involved, e.g. sex, age, years of experience, ethnic characteristics, etc.)

   d) Which of these types used both indigenous and conventional methods? (Probe for reasons and those involved, e.g. sex, age, years of experience, ethnic characteristics, etc.)

   e) When was the peak season for fishing? (Probe for main types and quantity of fish)

   f) Which factors enhanced fishing during this season? (Probe for climatic, spiritual, human factors)

Current Situation:

8. a) Which worldviews underpin fishing activities in this community? (probe for specific worldviews: indigenous and endogenous worldviews)

   b) What are the bases of the worldviews? (Probe for natural, social and spiritual bases)

   c) How does each of the bases influence fishing activities in this area? (Probe for interrelationships and harmony between the bases. Also probe for specific and practical examples)

d) Who constitute the custodians of the worldviews? (Probe for reason for specific roles of each custodian. Also probe for sex variations in roles)

9. a) What are the main types of fishing undertaken in this settlement? (Probe for description of each type of fishing)

   b) Which of these types use indigenous methods to operate? (Probe for reasons and those involved, e.g. sex, age, years of experience, ethnic characteristics, etc.)

   c) Which of these types use conventional methods to operate? (Probe for reasons and those involved, e.g. sex, age, years of experience, ethnic characteristics, etc.)

   d) Which of these types use both indigenous and conventional methods? (Probe for reasons and those involved, e.g. sex, age, years of experience, ethnic characteristics, etc.)

   e) When is the peak season for fishing? (Probe for main types and quantity of fish)

   f) What have accounted for changes (if any)? (Probe for climatic, spiritual, human factors)

Section C: Incidence, awareness, perception and effects of climate change on fishing

10. a) What climatic events affect fishing (probe for climatic factors such as rainfall and sunshine, seasons, cloud patterns)

    b) How do these factors affect fishing? (Probe for effects (positive/negative) of each factor in all fishing activities: prior, during and post)

c) Have there been changes in these natural factors (e.g. rainfall and sunshine) over the last three decades? (Probe for evidence)

d) What are the causes responsible for these changes (Probe for natural, social and spiritual causes)

e) Do you think these changes have continued to occur over the last three decades? (Probe for reasons)

11. a) Which lunar objects help you in fishing? (Probe for use and/or influences of stars and moon)

b) Have there been changes in the appearances of these lunar objects (e.g. stars and moon) over the last three decades? (Probe for evidence)

c) What are the causes responsible for these changes? (Probe for natural, social and spiritual causes)

d) Are these changes in appearance periodic/seasonal? (Probe for persistence of changes)

Effects of climate change on fishing

11. a) How do changes in rainfall/temperature/lunar objects affect fishing (probe for effects on catch, income, etc over period of reference)

b) How do these changes affect knowledge system/worldviews in fishing? (Probe for effects natural, social and spiritual dimensions as well as specific activities e.g. use of phonological events like appearance of lunar objects)

c) What have been the effects of the changes on the entire community? (Probe for inundation, ecosystem loss, harvest loss, etc.)

d) Are there any health implications associated with these changes? (Probe for specific health issues and how they address it)

e) What are the effects of these changes on water supply? (Probe for availability and accessibility of potable water, lagoons, rivers, sea, etc and how they address these effects)

Section D: Adaptation to climate change and its effectiveness

12. a) How did fishermen adapt to climatic variations thirty years or more ago? (Probe for description of specific adaptation: e.g. forms (indigenous, conventional), types (anticipatory, reactive), methods (migration, farming, etc.)

    b) What knowledge system(s) informed these adaptation methods? (Probe for natural, social and spiritual interconnectedness)

    c) How effective were these methods? (Probe for both quantitative and qualitative outcomes)

    d) What knowledge system(s) informed these adaptation methods? (Probe for indigenous and conventional methods)

    e) What methods are currently in place to adapt to changes in climate (Probe for indigenous and conventional knowledge system)

    f) How effective are these methods? (Probe for both quantitative (measurable) and qualitative outcomes)

    g) What knowledge system(s) informed these adaptation methods? (Probe for indigenous and conventional knowledge systems)

Section E: Production, storage and transmission of knowledge on adaptation

13. a) How is knowledge produced in this community? (Probe for various types and how each is produced; e.g. knowledge in relation to fishing)

b) Who are the main stakeholders in indigenous knowledge production in this community? (Probe for status and depth of knowledge of stakeholders (e.g. clan heads, chief fishermen, chiefs, etc)

c) Who are the main stakeholders in knowledge production in relation to fishing? (Probe for roles in fishing)

d) Specifically, how is knowledge on adaptation to climate change produced? (Probe for experiential, spiritual and cognitive modes)

e) Who are the main stakeholders in the production of knowledge in relation to adaptation to climate change? (probe for status and depth of knowledge of stakeholders (e.g. clan heads, chief fishermen, chiefs, etc)

14. a) How is indigenous knowledge on adaptation stored? (Probe for effectiveness and reliability of storage sources including human memory)

b) What are the challenges associated with the storage of such knowledge?

c) What measures can be and have been adopted to address these challenges? (Probe for 'who' to do 'what')

15. a) Generally, how is knowledge transmitted in this community? (Probe for various modes and processes)

b) Specifically, how is knowledge on adaptation to climate change transmitted? (Probe also for intergenerational modes and processes)

c) Who are the stakeholders in transmission of knowledge on adaptation to climate change? (Probe for human and spiritual stakeholders)

Conclusion

- Are there other issues you will like to share in relation to what we have discussed?

Closing courtesies

Thank you very much for your time.

APPENDIX B

LOCAL COMMUNITIES' ADAPTATION TO CLIMATE CHANGE AT KOMENDA-EDINA-EGUAFO-ABREM MUNICIPALITY

QUESTIONNAIRE FOR FISHERMEN

RESPONDENT IDENTIFICATION						
001	Community Name					
002	Community Type (Rural=1, Urban=2)					
003	Canoe Name					
004	Reason(s) for canoe name					
005	Canoe Type (Motorised=1, Manual=2)					
005	Number of Members in Canoe					
006	Name of Respondent					
007	Position/Title in Canoe					
008	Consent Obtained (Yes=1, No=2)					
Code	**INTERVIEWER VISITS**					
	Period	1st	2nd	3rd	Final	
011	Date (dd/mm/yyyy)					
012	Time (start / end)					
013	Result*					
014	Next Visit (date / time					
015	Interviewer's Name					
*RESULT CODES: 1 COMPLETE 2 PARTIALLY COMPLETE 3 POSTPONED 4 REFUSED 5 NOT FOUND 7 OTHER (SPECIFY)						

021	LANGUAGE OF INTERVIEW*		*LANGUAGE CODES 1 ENGLISH 4 GA 2 FANTE 5 EWE 3 TWI 6 NZEMA 7 OTHER (SPECIFY)
022	NATIVE LANGUAGE OF RESPONDENT*		
023	TRANSLATOR USED (Yes=1, No=2)		

SECTION A: BACKGROUND INFORMATION

No	Questions	Coding Category	Skip
1	Date of birth	Month…….. Year: …….. Age: …..…..	
2	Place of birth	Name:……..……. District/Region: ……... Type: 1. Rural [ ] 2. Urban [ ]	
3	Hometown	Name: …..……. District/Region: ……... Type: 1. Rural [ ] 2. Urban [ ]	
4	Religion	1. Traditional [ ] 2. Christianity [ ] 3. Islam [ ] 4. Other (specify):……	
5	Marital status	1. Single/Never married [ ] 2. Living together [ ] 3. Married [ ] 4. Divorced/Separated [ ] 5. Widowed [ ]	
6	Highest level of formal educational attainment	1. No formal education [ ] 2. Primary uncompleted [ ] 3. Primary completed [ ] 4. Secondary uncompleted [ ] 5. Secondary completed [ ] 6. Higher (specify): ……	

7	Number of children		
8	Years of fishing experience		
9	Number of years lived in community		
10	Main occupation of father	1. Fishing [ ] 2. Farming [ ] 3. Trading [ ] 4. Artisan (specify): …….. 5. Formal employment (specify): ……..…..	
11	Main occupation of mother	1. Fishing [ ] 2. Farming [ ] 3. Trading [ ] 4. Artisan (specify): 5. Formal employment (specify):	
12	Main occupation of spouse	1. Fishing [ ] 2. Farming [ ] 3. Trading [ ] 4. Artisan (specify): …….. 5. Formal employment (specify): ……...	
13	Canoe description	1. Name:…… 2. Length: Yards: …….. 3. Width: Yards: …….. 4. Number of persons carried……..	
14	Main role/duty during fishing		

SECTION B: WORLDVIEWS, KNOWLEDGE SYSTEM AND EXPERIENCES ABOUT FISHING

No	Questions	Coding Category	Skip
15	Which knowledge system regulates fishing activities in your community?	1. Traditional knowledge only [ ] 2. Western (or modern) knowledge only [ ] 3. Both traditional and western/modern [ ] 4. Other (specify): ……	
16	Is the knowledge system always available in this community?	1. Yes [ ] 2. No [ ]	
17	Give a reason to your answer		
18	Is the knowledge system always affordable?	1. Yes [ ] 2. No [ ]	
19	Give a reason to your answer		
20	Is the knowledge system always accessible?	1. Yes [ ] 2. No [ ]	
21	Is the knowledge system always effective?	1. Yes [ ] 2. No [ ]	
22	Give a reason to your answer		
23	Is the knowledge system always reliable?	1. Yes [ ] 2. No [ ]	
24	Give a reason to your answer		
25	Do you have intention to change the knowledge system?	1. Yes [ ] 2. No [ ]	
26	Give a reason to your answer		
27	Which lunar objects do you use in fishing?	1. Moon only [ ] 2. Stars only [ ] 3. Both [ ] 4. Other (specify): ……..	

28	Have there been changes in the time of appearance of any of these lunar objects?	1. Yes [ ] 2. No [ ] ⟶	**No. 32**
29	If **Yes**, which one?	1. Moon only [ ] 2. Stars only [ ] 3. Both [ ] 4. Other (specify): ……..	
30	What factor **MAINLY** accounts for such change(s)?	1. Natural factors [ ] 2. Spiritual factors [ ] 3. Human factors [ ]	
31	Briefly explain your answer in **No.30**		

Tick [ ] the indigenous knowledge dimension(s) (i.e. spiritual, social, natural) related to the period of fishing activity you engage in.

No	Activity	Spiritual	Social	Natural/Physical/Material
32	Before fishing			
33	During fishing			
34	After fishing			

SECTION C: PERCEPTIONS, INCIDENCE AND AWARENESS OF CLIMATE CHANGE ON FISHING

No	Questions	Coding Category	Skip
35	Which climatic elements **MOSTLY** affect fishing? (Tick as many as apply)	1. Rainfall [ ] 2. Sunshine [ ] 3. Lunar objects (e.g. moon, stars) [ ] 4. Sea level [ ] 5. Other (specify): …….	

36	Does rainfall affect fishing?	1. Yes [ ] 2. No [ ] ⟶	**No. 38**
37	Which of the following rainfall patterns **MAINLY** affect fishing negatively?	1. Increase rainfall [ ] 2. Decrease rainfall [ ] 3. None of the above [ ]	
38	Has there been a change in the rainfall pattern in the last 10-30 years?	1. Yes [ ] 2. No [ ] ⟶	**No. 42**
39	What is the change?	1. Rainfall has decreased [ ] 2. Rainfall has increased [ ] 3. Rainfall has been irregular [ ] 4. Rainfall has been torrential [ ] 5. Any other (specify): ……	
40	What is the **MAIN** cause of change in the rainfall pattern?	1. Spiritual [ ] 2. Natural [ ] 3. Human [ ]	
41	Explain your answer in **No. 40**		
42	Does sunshine affect fishing?	1. Yes [ ] 2. No [ ] ⟶	**No.44**
43	Which of the following sunshine characteristics has negative effects on fishing?	1. Increase sunshine [ ] 2. Decrease sunshine [ ] 3. None of the above [ ]	
44	Has there been a change in sunshine (or temperature) characteristics in the last 10-30 years?	1. Yes [ ] 2. No [ ] ⟶	**No.49**
45	What is the change?	1. Temperatures have decreased [ ] 2. Temperatures have as increased [ ] 3. Temperatures have been variable [ ] 4. Any other (specify): ……	

46	What has been the temperature description of the sea in the last 10-30 years?	1. Sea getting warmer increasingly [ ] 2. Sea getting warmer gradually [ ] 3. Sea getting colder increasingly [ ] 4. Sea getting colder gradually [ ]	
47	What is the **MAIN** cause of change in the sunshine characteristics?	1. Spiritual [ ] 2. Natural [ ] 3. Human [ ]	
48	Explain your answer in **No. 47**		
49	Does sea level affect fishing?	1. Yes [ ] 2. No [ ] ⟶	**No.51**
50	Which of the following sea level characteristics has negative effects on fishing?	1. Rising sea level 2. Decreasing sea level 3. None of the above	
51	Has there been a change in sea level in the last 10-30 years?	1. Yes [ ] 2. No [ ] ⟶	**No.54**
52	What is the **MAIN** cause of change in the sea level rise?	1. Spiritual [ ] 2. Natural [ ] 3. Human [ ]	
53	Explain your answer in **No. 52**		
54	Do the stars have effect on fishing?	1. Yes [ ] 2. No [ ] ⟶	**No.56**
55	Which of the following patterns of appearance of stars affect fishing negatively?	1. Groups of stars [ ] 2. Isolated stars [ ] 3. No stars [ ] 4. None of the above [ ]	
56	Has there been a change in the appearance of stars in the last 10-30 years?	1. Yes [ ] 2. No [ ] ⟶	**No.60**

57	What is the change? (Tick as many as apply)	1. Delay in appearance of stars [ ] 2. Early appearance of stars [ ] 3. Appearance of different stars at a time[ ] 4. Appearance of new stars [ ] 5. Early exit of stars [ ] 6. Delay exit of stars [ ] 7. Other (specify): ……	
58	What is the **MAIN** cause of change in the stars appearance?	1. Spiritual [ ] 2. Natural [ ] 3. Human [ ]	
59	Explain your answer in **No.58**		
60	Has the incidence of storm on the sea changed over the last 10-30 years?	1. Yes [ ] 2. No [ ] ⟶	**No.64**
61	What is the change? (Tick as many as apply)	1. Storm has decreased [ ] 2. Storm has increased [ ] 3. Storm has been irregular [ ] 4. Storm has been more destructive [ ] 5. Storm has been unpredictable[ ] 5. Any other (specify): ……	
62	What is the **MAIN** cause of change of storm?	1. Spiritual [ ] 2. Natural [ ] 3. Human [ ]	
63	Explain your answer in **No.62**		
64	Has there been any other major environmental change(s) in this community?	1. Yes [ ] 2. No [ ] ⟶ Specify: …….	**No.69**
65	What is the change(s)		

66	What is its **MAIN** effect on fishing?		
67	What is the **MAIN** cause of this change?	1. Spiritual [ ] 2. Natural [ ] 3. Human [ ]	
68	Explain your answer in **No.66**		

SECTION D: CONTRIBUTIONS OF LOCAL ACTIVITIES TO CLIMATE CHANGE

No	Questions	Coding Category	Skip
69	Does any local activity here affect sea level rise?	1. Yes [ ] 2. No [ ] →	**No.75**
70	What **MAIN** local activity here contributes to sea level rise?		
71	Who are **MAINLY** involved in this activity?		
72	What has been done in the past to address it?		
73	What can be done to address it now?		
74	Who must take the responsibility to address it? (Tick as many as apply)	1. The Chiefs and elders [ ] 2. Fishermen [ ] 3. Municipal Assembly [ ] 4. NGOs [ ] 5. Any other (specify): ……	
75	Does any local activity here contribute to temperature increase?	1. Yes [ ] 2. No [ ] →	**No. 81**
76	What **MAIN** local activity here contributes to temperature increase?		
77	Who are **MAINLY** involved in this activity?		

78	What has been done in the past to address it?		
79	What can be done to address it now?		
80	Who must take the responsibility to address it? (Tick as many as apply)	1. The Chiefs and elders [ ] 2. Fishermen [ ] 3. Municipal Assembly [ ] 4. NGOs [ ] 5. Any other (specify):	
81	Does any local activity here contribute to decrease in rainfall?	1. Yes [ ] 2. No [ ] ⟶	**No.87**
82	What **MAIN** local activity here contributes to decrease in rainfall?		
83	Who are **MAINLY** involved in this activity?		
84	What has been done in the past to address it?		
85	What can be done to address it now?		
86	Who must take the responsibility to address it? (Tick as many as apply)	1. The Chiefs and elders [ ] 2. Fishermen [ ] 3. Municipal Assembly [ ] 4. NGOs [ ] 5. Any other (specify):	
87	In your estimation, what is the level of fish stock in the sea now?	1. Level has increased [ ] 2. Level has decreased [ ] 3. Level has not changed [ ]	
88	What **TWO MAIN** local activities here contribute to reduction in fish stock?	1. 2.	

89	Who are **MAINLY** involved in this activity?		
90	What is the **MAIN** motive people engage in these activities?		
91	What has been done in the past to address it?		
92	What can be done to address it now?		
93	Who must take the responsibility to address it? (Tick as many as apply)	1. The Chiefs and elders [ ] 2. Fishermen [ ] 3. Municipal Assembly [ ] 4. NGOs [ ] 5. Any other (specify):	

SECTION E: IMPACTS OF CLIMATE CHANGE ON FISHING

No	Questions	Coding Category	Skip
94	**10 YEARS AGO (2003): <u>BASED ON MAJOR SEASON</u>** What was the total average catch of fish **per person** about **10 years ago** in one fishing trip?	…… pans Specify other scale: ……..	
95	What was the estimated distance covered in one trip?	…… yards Specify unit: ……..	
96	How many gallons of premix fuel were used in one trip?		
97	What was the **MAIN** fishing net used for this trip?		
98	What was the average mesh size?		

99	What was the average canoe size?	Length: ……yards Width:……..yards	
100	What was the total number of canoes in use in this community at the time?	Motorized: …….. Manual:……..	
101	What was the total number of active fishermen in this community 10 years ago?		
102	What were the **MAIN** types of fish caught?	List:	
103	On the **average**, how much did you personally earn about 10 years ago from fishing only?	1. Per trip Gh¢ 2. Per week Gh¢ 3. Per month Gh¢	
104	**CURRENTLY (2013): <u>BASED ON MAJOR SEASON</u>** What is the average total catch of fish **per** one fishing trip **CURRENTLY**?	…… pans …… metric tonnes/kg Specify other scale: ……..	
105	What is the estimated distance covered in one trip?	…….. metres …… yards	
106	How many gallons of premix fuel are used in one trip?		
107	What is **MAIN** fishing net used for this trip?		
108	What is the average mesh size?		
109	What is the canoe size?	Length: ……cm Width: ……..cm	

110	How many canoes are in used **now** in this community?	Big (motorized): Small (manual):	
111	What is the total number of active fishermen in this community **now**?		
112	What are the **MAIN** types of fish caught now?	List:	
113	On the average, how much do you earn currently from fishing only?	1. Per trip Gh¢ 2. Per week Gh¢ 3. Per month Gh¢	

SECTION F: ADAPTATION TO CLIMATE CHANGE

No	Questions	Coding Category	Skip
114	In the past, what did you do in fishing whenever temperatures increased beyond expected?		
115	Who were **MAINLY** involved in planning and implementing this action?	1. Personal [ ] 2. Household/clan [ ] 3. Community fishermen [ ] 4. Traditional Authorities [ ] 5. Public institution [ ] 6. CBOs/NGOs [ ] 7. Other (specify): ……	
116	How long did it take you to implement this action?	1. …… minutes 2. …… hours 3. …… days	
117	Which institution regulated this action?	1. Indigenous [ ] 2. Conventional [ ] 3. Both [ ] 4. None [ ]	

118	Did you **ALWAYS** achieve effective results whenever such an activity was conducted?	1. Yes [ ] 2. No [ ]	
119	Explain your answer in **No.122**		
120	**CURRENTLY**, what do you do in fishing if temperatures increase beyond expected?		
121	Who are **MAINLY** involved in planning and implementing this action? (Tick as many as apply)	1. Personal [ ] 2. Household/clan [ ] 3. Community fishermen [ ] 4. Traditional Authorities [ ] 5. Public institution [ ] 6. CBOs/NGOs [ ] 7. Other (specify): ……..	
122	How long does it take you to implement this action?	1. …… minutes 2. …… hours 3. …… days	
123	Which institution regulates this action?	1. Indigenous [ ] 2. Conventional [ ] 3. Both [ ] 4. None [ ]	
124	Do you achieve effective results whenever such an activity is conducted	1. Yes [ ] 2. No [ ]	
125	Explain your answer in **No.121**		
126	In the past, what did you do in fishing whenever rainfall pattern had negative impacts on fishing?		

127	Who were **MAINLY** involved in planning and implementing this action? (Tick as many as apply)	1. Personal [ ] 2. Household/clan [ ] 3. Community fishermen [ ] 4. Traditional Authorities [ ] 5. Public institution [ ] 6. CBOs/NGOs [ ] 7. Other (specify): ……..	
128	How long did it take you to implement this action?	1. …… minutes 2. …… hours 3. …… days	
129	Which institution regulated this action?	1. Indigenous [ ] 2. Conventional [ ] 3. Both [ ] 4. None [ ]	
130	Did you **ALWAYS** achieve effective results whenever such an activity was conducted?	1. Yes [ ] 2. No [ ]	
131	Explain your answer in **No.131**		
132	Currently, what do you do if rainfall patterns affect fishing?		
133	Who are **MAINLY** involved in planning and implementing this action? (Tick as many as apply)	1. Personal [ ] 2. Household/clan [ ] 3. Community fishermen [ ] 4. Traditional Authorities [ ] 5. Public institution [ ] 6. CBOs/NGOs [ ] 7. Other (specify): ……	

134	How long does it take you to implement this action?	1. …… minutes 2. …… hours 3. …… days	
135	Which institution regulates this action?	1. Indigenous [ ] 2. Conventional [ ] 3. Both [ ] 4. None [ ]	
136	Do you **ALWAYS** achieve effective results whenever such an activity was conducted	1. Yes [ ] 2. No [ ]	
137	Explain your answer in **No.137**		
138	In the past, what did you do whenever there were difficulties using the stars for fishing purposes?		
139	Who were **MAINLY** involved in planning and implementing this action? (Tick as many as apply)	1. Personal [ ] 2. Household/clan [ ] 3. Community fishermen [ ] 4. Traditional Authorities [ ] 5. Public institution [ ] 6. CBOs/NGOs [ ] 7. Other (specify): ……	
140	How long did it take you to implement this action?	1. …… minutes 2. …… hours 3. …… days	
141	Which institution regulated this action?	1. Indigenous [ ] 2. Conventional [ ] 3. Both [ ] 4. None [ ]	

142	Did you **ALWAYS** achieve effective results whenever such an activity was conducted?	1. Yes [ ] 2. No [ ]	
142	Explain your answer in **No.143**		
143	Currently, what do you do whenever there are difficulties using the stars for fishing purposes?		
144	Who are **MAINLY** involved in planning and implementing this action? (Tick as many as apply)	1. Personal [ ] 2. Household/clan [ ] 3. Community fishermen [ ] 4. Traditional Authorities [ ] 5. Public institution [ ] 6. CBOs/NGOs [ ] 7. Other (specify): ……..	
145	How long does it take you to implement this action?	1. …… minutes 2. …… hours 3. …… days	
146	Which institution regulates this action?	1. Indigenous [ ] 2. Conventional [ ] 3. Both [ ] 4. None [ ]	
147	Do you **ALWAYS** achieve effective results whenever such an activity was conducted?	1. Yes [ ] 2. No [ ]	
148	Explain your answer in **No.149**		
149	In the past, what did you do whenever the sea level increased to affect fishing?		

150	Who were **MAINLY** involved in planning and implementing this action? (Tick as many as apply)	1. Personal [ ] 2. Household/clan [ ] 3. Community fishermen [ ] 4. Traditional Authorities [ ] 5. Public institution [ ] 6. CBOs/NGOs [ ] 7. Other (specify): ……	
151	How long did it take you to implement this action?	1. …… minutes 2. …… hours 3. …… days	
152	Which institution regulated this action?	1. Indigenous [ ] 2. Conventional [ ] 3. Both [ ] 4. None [ ]	
153	Did you **ALWAYS** achieve effective results whenever such an activity was conducted?	1. Yes [ ] 2. No [ ]	
154	Explain your answer in **No.155**		
155	Currently, what do you do whenever the sea level rises to affect fishing?		
156	Who are **MAINLY** involved in planning and implementing this action? (Tick as many as apply)	1. Personal [ ] 2. Household/clan [ ] 3. Community fishermen [ ] 4. Traditional Authorities [ ] 5. Public institution [ ] 6. CBOs/NGOs [ ] 7. Other (specify): ……..	

157	How long does it take you to implement this action?	1. …… minutes 2. …… hours 3. …… days	
158	Which institution regulates this action?	1. Indigenous [ ] 2. Conventional [ ] 3. Both [ ] 4. None [ ]	
159	Do you **ALWAYS** achieve effective results whenever such an activity is conducted?	1. Yes [ ] 2. No [ ]	
160	Explain your answer in **No.161**		
161	What **MAIN** practices are adopted in this community to adapt to changing climate?	1. 2. 3.	

SECTION G: TRANSMISSION OF KNOWLEDGE ON ADAPTATION

No	Questions	Coding Category	Skip
162	Where do you mostly get information on climate change?	1. Experience(or personal) [ ] 2. Parents [ ] 3. Friends [ ] 3. Other adults [ ] 4. Spiritual leaders [ ] 5. Government workers [ ] 6. Media (print and electronic)[ ] 7. Other (Specify): ……...	
163	How do you get the information?	1. Orally 2. Written 3. Other (Specify): ……..	

164	Where do you mostly get information on adaptation?	1. Experience(or personal) [ ] 2. Parents [ ] 3. Friends [ ] 3. Other adults [ ] 4. Spiritual leaders [ ] 5. Government workers [ ] 6. Media (print and electronic)[ ] 7. Other (Specify): ……...	
165	Do you have any knowledge of adaptation strategies on fishing in this community?	1. Yes [ ] 2. No [ ] ⟶	**END**
166	If Yes, what major adaptation strategies have ever been implemented to deal with climate change in relation to fishing?	1. 2.	
167	How is knowledge on adaptation strategies in fishing mainly generated in your community?		
168	Who are the **main** stakeholders of knowledge about adaptation in fishing?	1. Traditional authorities [ ] 2. Older fishermen [ ] 3. Government workers [ ] 4. NGOs/CBOs [ ] 5. Other (specify): ……..	
169	How is knowledge on adaptation in fishing mainly transmitted?	1. Older to younger fishermen[ ] 2. Younger to younger fishermen[ ] 3. Government to local fishermen[ ] 4. NGOs/CBOs to local fishermen[] 5. Other (specify):……	

170	Who are the main stakeholders in transmission of knowledge on adaptation in fishing?	1. Traditional authorities [ ] 2. Older fishermen [ ] 3. Government workers [ ] 4. NGOs/CBOs [ ] 5. Other (specify):	

End of Interview: Time: ……

GENERAL OBSERVATION /COMMENTS

APPENDIX C

LIST OF PARTICIPANTS AT THE STAKEHOLDERS' WORKSHOP

Participants from fishing communities: Two fishermen representatives each from:

1. Brenu Akyinmu
2. Elmina
3. Kafodzidzi
4. Komenda

Participants from KEEA/Region

5. Coordinating Director
6. Planning Officer
7. Public Health Officer
8. Environmental Officer
9. Ministry of Food and Agriculture (MoFA) Coordinator (in charge of crops)

Participants from Central Regional Office

10. NADMO Officials (2)
11. Coordinator, Fisheries Commission
12. Director, Meteorological Department
13. Officer, Environmental Protection Agency

Participants from University of Cape Coast

14. Professor (Climatology)
15. Professor (Planning)
16. Lecturer (Planning)

Participant from a Non-Governmental Organisation

17. Officer (in charge of public education)

APPENDIX D

PUBLICATION OF OUTCOME OF STAKEHOLDERS' WORKSHOP BY GHANA NEWS AGENCY (UNEDITED CONTENT)

Thursday 15th May, 2014

http://www.ghananewsagency.org/science/climatology-professor-calls-for-concerted-efforts-to-mitigate-climate-change-impact-74808

Climatology Professor calls for concerted efforts to mitigate Climate Change impact

Cape Coast, May 15, GNA - A Professor of Climatology, Nana Professor Peter Kwabena Acheampong, of the University of Cape Coast Department of Geography and Regional Planning, has called for concerted efforts in adapting and mitigating the impact of climate change.

He mentioned draught, absence of migratory birds, drying of river bodies, temperature change and the rise of the sea level in some parts of the country, as indications of the reality of climate change, and said there was the urgent need to mitigate its impact which was felt, especially in coastal communities.

The Professor was addressing participants of a day's stakeholder's workshop on "Local Communities' adaptation to climate" held in Cape Coast to develop a framework to guide fishing communities on how to adapt to sea level rise and its effects, as well as ways to adjust to economic dynamism in fishing.

It was attended by representatives of the Environmental Protection Agency (EPA), National Disaster Management Organization (NADMO), Ghana Metrological Service, Komenda Edina Eguafo Abrem (KEEA) Municipal Assembly and some Canoe owners and Chief Fishermen from KEEA

Nana Prof Acheampong recalled that some years back, coconut trees along the Cape Coast beaches were in seven roles, but due to climate change, they were now in three rolls adding, some rocks which used to be far from the sea had now been submerged.

He expressed worry that even though climate change had become a topical issue, especially in temperate areas where its impact was mostly felt, highly educated persons doubted its reality, and were therefore unconcerned.

He, therefore, commended the organizers for the initiative and members of the fishing community for realizing the need to seek knowledge to mitigate the impact of the phenomenon, and urged fishermen whose livelihood was dependent on the sea to endeavor to venture into other areas of interest so that they would not be in crisis when the effects of the climate change worsened.

Mr. Kobina Esia-Donkoh, Lecturer at UCC Department of Population and Health, and the brain behind the workshop, said he identified the challenges the local communities faced in respect to their adaptation to climate change during an academic research and decided to help them to find alternative measures.

He said his quest to help them led to the organization of a number of validation workshops with the local people held in the various communities, with support from the professors who supervised his academic work, and he believed his efforts would help improve the living standards of the communities, especially during this period of climate change.

The Central Metrological Director, Mr. Percy Ato Brown, noted that the Ozone layer which blocked the intensity of the sun had been destroyed by human activities, and that was the reason why the full impact of the sun was currently felt.

Mr Brown indicated that records available showed that there had been some changes in temperature and this had resulted in extreme sunshine during the day, and extreme coldness during the night in some communities.

He said the rising tide of the sea was making fishing difficult, and therefore condemned the use of pair trawling machines and dynamites in fishing, since they drove the fishes further away from the shores of the country.

The Central Regional Director of the Fisheries Commission, Mr. Papa Yaw Atobrah, indicated that the phenomenon was likely to amplify natural variations, and worsen existing stress on marine fish stock, and that diminishing wetlands and nursery area, increased sea surface temperature, change in salinity, wave conditions and ocean circulation were also effects of the phenomenon on marine ecosystem.

He called for improvement in technologies used in fishing to reduce fuel use, since quantity of fuel used in overcapitalized fisheries contributed to high carbon dioxide emissions, as well as the elimination of over-aged vessels with poor or low fuel efficiency.

The Planning Officer of KEEA, Mr. Fuseini Labaran, said some of the climate changes in the municipality were temperature increase on land and water, sea level rise, change in seasons , increase in intense rainfall or large in annual rainfall and decrease in annual rainfall in arid and semi- arid area.

He said the change had resulted in heat on livestock, worsened availability of fish stock, coastal erosion , farming uncertainty about when to cultivate , sow and harvest, crops damaged by unseasonal downpours, increased severity of floods and droughts.

Mr Labaran said some of the interventions the assembly had put in place were tree planting, conversation of coastal mangrove and other vegetations, sustainable aquaculture, such as fish farming in ponds and crop diversification and mixing.

Others include sustainable agricultural techniques to improve drainage, improved water and sanitation projects, rainwater harvesting, community water management committees and access to more drought tolerant crops as well as the construction of sea defense along the major coastlines of the municipality.

On alternative ventures the fisher folks could explore aside fishing, some participants suggested fish farming, taxi driving, pineapple, tiger nut, watermelon and cassava farming, while others insisted that they were more conversant with fishing and that efforts should be made to protect their sources of livelihood.

GNA