TOWARDS AN ECOSYSTEM-BASED DISASTER RISK REDUCTION (Eco-DRR) FOR FLOODS IN SOME DOWNSTREAM COMMUNITIES OF THE LOWER VOLTA, GHANA

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OKEKE CHERYL CHINWE CHRISTINA

(10435411)

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DECLARATION

I hereby declare that this submission is my own work produced from research under supervision, towards the award of M.Phil in Environmental Science, to the best of my knowledge the work has not been previously published nor accepted for the award of any degree in any university, except the duly acknowledged texts.

Okeke Cheryl Chinwe Christina	....	....
(10435411)	Signature	Date
Prof. Chris Gordon	....	....
(Principal Supervisor)	Signature	Date
Dr. Adelina Mensah	....	....
(Assistant Supervisor)	Signature	Date

ABSTRACT

Changes in river flows for hydro-electric power generation, agricultural purposes and water conservation, and other land use changes have had major ecological, social and economic consequences, which include but are not limited to disasters. The poor who mainly live in rural areas directly depend on most of these ecosystems and the services they provide for their livelihood, and so are more vulnerable to changes in ecosystems. This study was carried out to identify communities in the lower Volta basin of Ghana that are prone to flood disasters, assess Disaster Risk Reduction (DRR) measures in the identified communities, and the communities' knowledge on Ecosystems link with DRR. Based on the Volta River Authority inundation maps, four communities (Azizanya and Azizakpe Island in Ada East District of Greater Accra Region; Anyanui and Bomigo Island in Keta Municipality in Volta Region), were selected. Primary and secondary data collection methods were employed. Structured open and closed ended questionnaires were administered to 180 respondents. Focus Group Discussions and interview guides were also used for the socio-economic and disaster survey. Flood experience in the selected communities, flood risk reduction approaches already in place at the communities, human activities affecting the ecosystems and the feasibility of effectively managing the ecosystems as means of flood disaster risk reduction were assessed. Data were analysed using SPSS (version 20.0) and Microsoft Excel software. The findings revealed that though Bomigo Island would not be inundated at all levels of water discharge from Akosombo dam's spill-gates (from 3,000 m^3/s to 14,150 m^3/s), as indicated on the maps, flood disaster was identified by respondents as one of the prevalent disasters affecting lives and properties in the Island; minor flooding was also experienced while administering the questionnaires. The prevalent DRR measures in the communities were reactive rather than proactive. There was appreciable awareness of the link between functioning ecosystems and DRR. From the findings, the constructions of Akosombo dam and Kpong head pond have affected farming and agricultural practises which were the major occupation in the communities. The communities are willing and ready to conserve the ecosystems, especially mangroves and wetlands, if the Government would make provision for other sources of livelihood; there is high dependence on mangroves cutting and sales as the major source of livelihood, and most of the answers towards measures believed to mitigate disaster risk are geared toward resources' conservation The study concludes that policy makers should take advantage of the local knowledge as entry point to integrate Ecosystem-based disaster risk reduction to fight flood disasters in the communities. The study recommends, among others, that for an effective Eco-DRR, the costs, benefits and risks to all individual stakeholders and the society should always be assessed, as tradeoffs might not be accepted without involving the stakeholders; while tackling the underlying factors of ecosystems degradation and disaster risks (poverty).

DEDICATION

This work is dedicated to Baba God who is my Abba Father for making this journey a reality and a fulfilled destiny; I can never thank You enough, I'm forever grateful to You.

To my wonderful foster father, Rtd. Major Aleino Kane, who in total submission yielded himself to be used by God to finance my M.Phil programme. May God abundantly reward you for the great work.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF ABBREVIATIONS

AI	Azizakpe Island
AKRRP	Akosombo dam and Kpong head-pond Reoptimization and Reoperation Project
AN	Anyanui
APFM	Associate Programme on Flood Management
AZ	Azizanya
BI	Bomigo Island
CBD	Convention on Biological Diversity
CBO	Community Based Organisation
CCCD	Commission on Climate Change Development
CRED	Centre for Research on the Epidemiology of Disaster
DO	Disease Outbreak
DRR	Disaster Risks Reduction
ECO-DRR	Ecosystem-based Disaster Risk Reduction
EPZ	Environmental Protection Zone
FO	Fire Outbreak
GIS	Geographic Information System
GSS	Ghana Statistic Services
GWP	Global Water Partnership
HFA	Hyogo Framework for Action

IDNDR	International Decade for Natural Disaster Reduction
IFRC	International Federation of Red Cross
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
LVB	Lower Volta Basin
MDGs	Millennium Development Goals
MEA	Millennium Ecosystems Assessment
NA	Not Available
NADMO	National Disaster Management Organisation
NDRRMC	National Disaster Risk Reduction and Management Council
NDRRMP	National Disaster Risk Reduction and Management Plan
NGO	Non Governmental Organisation
NMP	National Mobilization Programme
RCS	Red Crescent Societies
RDAG	Relief Distribution Arm of Ghana
REDD	Reducing Emission from Deforestation and forest Degradation
SDGs	Sustainable Development Goals
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
USD	United States Dollar

WHO	World Health Organisation
WMO	World Meteorological Organisation
WRC	Water Resources Commission
WTP	Willingness To Pay

CHAPTER ONE

INTRODUCTION

1.1 Background

Disaster, triggered by natural hazards, destroys lives and livelihood and affect millions of people each year. The increasing trend in worldwide disasters, which is also aggravated by global environmental change, has posed a big challenge to low income and emerging economies in developing countries, within which the poor stand to suffer most (Keen *et al.*, 2003). According to the International Strategy for Disaster Reduction (ISDR, 2009), "disaster is a serious disruption of the functioning of the society; causing widespread human, material or environmental losses, which exceed the ability of the affected society to cope, using its own resources". Natural phenomena become disasters or risks only when they pose a threat to persons or property, when these hazards or risks occur, they result in disaster only if they coincide with vulnerable conditions.

Flood events have been identified globally, as one of the most perilous natural disasters, which have caused and is still causing extensive loss; affecting lives, property and the economy at large. According to the International Federation of Red Cross (IFRC) and Red Crescent Societies (RCS), close to half of the natural disasters that happened worldwide between 2002 and 2011 were floods. During the same period, natural disasters in general caused approximately 1.1 million fatalities, affected approximately 2.7 billion people and led to economic losses totalling approximately US$ 1.4 trillion. Of these damages, approximately 57,000 (5 %) of the fatalities, 1.2 billion (44 %) of the affected, and US$ 278 billion (20 %) of the economic damages were attributed to floods alone (Zetter, 2012).

Downstream flooding is usually caused by heavy rainfall on a portion of, or all sub-catchment, that falls at a faster rate than the capacity of vegetation and soil to absorb them or the drainage to discharge the water. This results in excess pulse of water entering into rivers or streams as surface run-off. In the event of persistent rainfall, the amount of water discharged downstream automatically continues to increase and eventually, the capacity of the river channel will be exceeded causing an overflow of the river bank (Nelson, 2002).

According to Costa and Schuster (1988), the failure of natural or man-made dams is another cause of downstream flooding. Dams fail as a result of overtopping, structural defects and failures, seepage of water under or through the dam and inadequate maintenance. The failure of Teton Dam, for example in Idaho in 1976 caused over US$ 1 billion in property damage.

Downstream flood events have significant effect on the communities, which includes but is not limited to property damage, endangering of lives of human and other living organisms, unwanted sediment deposition, pollution and destruction of spawning grounds for fish and other wildlife habitats, interference with farming and other land uses, impairment of structures and outbreak of infectious diseases (Giannico and Souder, 2004). Thousands of lives in several communities were affected by the 2014 downstream flood in Ada East and West Districts in Ghana that was caused by tidal waves from the sea, and exacerbated by sand winning practises in the lower Volta (IFRC, 2014).

Disaster risk reduction is about minimizing hazards and reducing susceptibility and exposure, by putting in place better early warning systems, education, environmental management, evacuation plans, sound land use planning and stronger building codes, it continues after disaster events (White *et al.*, 2005). It is about making communities and individuals aware of their risk to natural hazards and how they can reduce their vulnerability by moderating the potential damages, taking advantage of available opportunities, or coping with the consequences. This is achieved using both structural and non-structural measures to prevent or mitigate the adverse effects of hazards on lives and property. (UNISDR, 2002). Whiles tremendous effort and progress have been made in disaster risk management, the focus is mainly on early warning systems, disaster preparedness and emergency responses, and neglects the underlying factors (ecosystems degradations, fragile rural livelihood, lack of social protection and weak governance) and drivers (social, economic and environmental needs) of disaster risks. (CCCD, 2009; UNFCCC, 2008; UNISDR, 2009). With the increasing trends in flood disasters, despite the progress in disaster risk management, there is the need for new methods of hazards mitigation and risk reduction. One approach is through the use of healthy ecosystems and the services they provide to help reduce a community's risk to natural disaster.

Ecosystems are dynamic complexes of plant, animal, and microorganism communities and their non-living environment as a functional unit (MEA, 2005a). According to (Boyd and Banzhaf, 2007), ecosystems have certain advantages sometimes referred to as natural assets/capital and generally referred to as ecosystem service. Ecosystem services or the welfare people get from ecological processes include the following (MEA, 2005a):

- Provisioning services like the delivery of food, fresh water, wood and fibre, and medicine.
- Regulating services like carbon sequestration, erosion, windstorm and flood control, and pollination.
- Cultural services like recreation, ecotourism, educational and spiritual values,
- Supporting services like nutrient cycling, soil formation, and primary productivity.

Ecosystem services contribute to jobs, economic growth, health, and human well-being (Tallis *et al.*, 2008). Conversely, poorly functioning ecosystems increase risks, ridding a community of its natural protective barriers.

The term ecosystem-based disaster risk reduction (Eco-DRR) is the use of naturally occurring systems as a way to address the impacts of hazards by maintaining the resilience of that natural system, their integrity, services and species that support them, thereby helping people and communities adapt to changing conditions. It builds on ecosystem management principles, strategies and tools in order to maximise the services provided by ecosystems for the reduction of risks. It is a conservation action to protect people and their environment from, or reduce the impacts of hazards on them, through sustaining and restoring the services provided by ecosystem, by maintaining the natural ecological dynamics. Eco-DRR integrates social, economic and ecological systems while placing people at the centre of decision making (Kamble *et al.*, 2013). Whiles this Ecosystem-based disaster risk reduction is an important complement to other strategies for disaster risk reduction, it is often neglected (United Nations International Strategy for Disaster Reduction [UNISDR], 2009).

Ecosystem functions of mangrove forests and wetlands, for example, can support climate change adaptation planning in communities that may otherwise require the relocation of thousands of people. In an event of sea-level rise and increased flood events, these largely undervalued ecosystem services will play key roles in mitigating disasters and enhancing recovery. Wetlands serve as natural protective barriers or buffers which reduce physical exposure to hazards. Forests (primary, secondary, and plantation or agro forestry) protect soil from compaction and preserve infiltration rates than do other types of land cover. Mangroves can increase livelihood resilience for post-disaster communities that rely on natural capital, to provide ecosystem services like fishing support, building material and tourism activities for them (Adger *et al.*, 2005; Dolidon *et al.*, 2009; Hussain and Badola, 2008).

It is worth noting that disasters and flood risk management is multi-dimensional, so it requires multi-disciplinary and interdisciplinary approach (Pearce, 2003). Ecosystem management, the key to Eco-DRR (Kamble, 2013), requires the knowledge and acceptance of the local communities. Apart from the structural and compositional characteristics of ecosystems, the quality and quantity of the services they provide are affected by resource use decisions of individuals and communities. Many conservation practises have partially or completely failed because the ecosystems could not survive or they have been destroyed by the same pressure that caused the initial loss and degradation. This is as a result of negligence on the part of policy makers, ecologists and conservationist to identify the needs, aspirations, ideas and suggestions of the local communities on ecosystem conservation (Eckholm, 1979). Conservation projects often aim at encouraging or imposing reforestations without understanding why the ecosystems disappeared in the first place, in order to address the underlying factors. Ecosystem management for Eco-DRR requires expansion beyond technical view to include historical, social, cultural, political, aesthetic and moral aspects of the local community, to avoid conflicts (Higgs, 1997; Swart *et al.*, 2001). The understanding and attitudes of communities toward ecosystem conservation will be a basis for institutionalising an Eco-DRR strategy in the Lower Volta.

1.2 Problem Statement

For any country to be called “developed” there is need for the security of lives and property, and advancement in the socio-economic, political and cultural aspects of the nation. Natural and man-made disasters negatively impact on development plans of a country. Small and medium flood events can represent a significant blow on a developing country’s economy; this it does by wiping in minutes development that took years to be accomplished and destroying available resources that would have gone into further development. Disasters damage infrastructure, reduce human and material productivity, generate social tensions and limit communities to a cycle of disaster and response and disaster risk-poverty nexus (IFRC, 2014).

Ghana, a developing country striving towards a developed stage, has a recorded history of increasing frequency and intensity of disasters, indicated by the comparatively higher ranking amongst African countries most exposed to disaster risk (UNDP/NADMO, 2009). The unprecedented frequency and magnitude of these flood events have many explanations (Bouwer, 2011). The low-lying topography of river basins, dependency on and over-exploitation of available ecosystems by communities, and the construction of dams exposes such area to many coastal risk events (Biney, 2010; Manatunge *et al.*, 2008). This is the case of lower Volta communities.

Some well-intended measures to address a particular crisis result in unintended adverse consequences and a net increase in vulnerability. Most of these strategies have succeeded as temporal mitigating measures while creating greater problems in the long term than the ones they solved. The construction of Akosombo dam in 1964 and the subsequent construction of Kpong head pond few kilometres downstream of Akosombo in 1981, for hydro-electric power generation for the nation, have negatively altered most of the ecological processes of the river, affecting water flow, sediments, energy, and biota (Gordon and Ametekpor, 1999). Reduction in floodplain inundation has significantly reduced their importance to the ecology of some fish species that either spawn or take refuge from their predators within them; this has resulted in reduced standing crop of fish and consequently, reduced catch rate of fish; the virtual collapse of fishing and agriculture has led to increase in mangrove cutting as source of livelihood for these communities (Diop *et al.*, 2002; Ligon *et al.*, 1995). Like most estuarine ecology worldwide, the health of mangroves, wetlands and other ecosystems of Lower Volta basin have also been negatively impacted by the new flow regime caused by river impoundments. Prior to damming, the river flood, which began to rise in July, reaching its peak in August and falling in October was a source of fresh water to the creeks and low lands (Gordon and Ametekpor, 1999). As population increases, people are tempted to settle on floodplain with the assumption that they are no longer inundated periodically because of dams; this exposes them to risk of flood.

As the global climate is changing, communities in lower Volta are not spared the effects of climate change; it has resulted in increased variability of rainfall, sea level rise, extreme weather events with their attendant flood events, decreased fresh water flow, and the situation is further aggravated due to less fertile alluvium deposition and increased soil erosion and soil salinity (Adger *et al.*, 2005).

Ecosystem management is a well-tested solution to sustainable development which is being revisited for its inherent "win-win" nature and appeal to address the rising disaster issues. It is one of the approaches that can positively impact all components of disaster risk by:

- Alleviating risks
- Decreasing exposure and vulnerability
- Increasing the resilience of exposed communities.

Ecosystems, such as wetlands, dunes and marshes play important roles in attenuating storm surge (Arkema *et al.*, 2013). Other benefits provided by healthy, well-managed ecosystems, such as support to livelihoods, food and water security, biodiversity, cultural heritage and also contribute to the total value of ecosystems in building local resilience against disasters.

Tonga, a country with 70 % of its population living in islands, has a long history of disasters such as earthquakes, floods, tsunamis and volcanic eruptions (Oliver & Reardon, 1982). Like most communities in the Lower Volta, Tonga is a low-lying country with average altitude of

2-5 m above sea level. Eco-DRR is being used in this country, the citizens are already benefitting from the ability of mangroves to address coastal erosion, by slowing incoming waves, prevention of damages behind the mangroves and protecting shorelines as sediments are being deposited (Mavrogenis and Kelman, 2013).

Thailand and Ecuador are other countries that have benefited from Eco-DRR (Hoanh *et al.*, 2006). 'Making space for water' government strategy for flood and coastal erosion management in UK is another case for Eco-DRR. Bangladesh, one of the most vulnerable coastal countries has invested in coastal aforestation since the 1960s and has benefited from the natural buffer impacts of ecosystem restoration as a way of disaster risk reduction.

Ecosystem-based Disaster Risk Reduction cannot be effectively implemented in any society without the full participation of the people that depend directly of the ecosystems. When users of ecosystems are part of the management, and are the direct beneficiaries of management decisions, such ecosystems are likely to be well preserved and the services they provide would be assured. The combination of climate change, natural and man-made hazards, and economic forces cause uncertainty and risk for many communities across the world, especially those that depend mainly on the available natural resources and local infrastructure. In the face of a disaster, a stable and empowered community will respond with resilience and quick recovery (Eckholm, 1979; Higgs, 1997; Swart *et al.*, 2001).

According to the Millennium Ecosystem Assessment (MEA, 2005b), changes to ecosystems have contributed to a significant rise in the number of floods and major wildfires on all continents since the 1940s. These flood events have really overwhelmed the relevant institutions, as they often think of relocating members of these communities to other areas, relocation options are always objected to, largely due to the fact that community members usually lose sense of belonging in their new environment, and communal strife usually ensue as they compete for scarce resources in the their new settlement with the original inhabitants of those areas.

In an attempt to address the above issues, there is need for a shift in focus away from conventional fire-fighting approach to disaster management, and towards approaches that tackle the problems from their roots while at the same time building the capacities of communities to prevent, mitigate and cope with disasters effectively and efficiently. This study, as an academic work and a policy-support tool, therefore, aims at generating the necessary information and knowledge to facilitate the use of ecosystem-based disaster risk reduction as both an alternative and complementary method of reducing the impact of flooding in flood prone communities of the lower Volta.

The study therefore attempts to answer these questions:

- Which communities are prone to flooding in the lower Volta?
- What are the existing measures already in place for reducing disaster risk?
- What conditions are required for an alternative measure (Eco-DRR), do these requirements exist in those communities?

1.3 Hypothesis

$H_{0:}$ There is no significant association between preserving the wetlands and the study communities.

H_A: There is a significant association between preserving wetlands and the study communities.

1.4 Study Objectives

The goal of this study is to determine the feasibility of using ecosystem-based disaster risk reduction for floods in some downstream communities of the Lower Volta.

To meet the general objective, the study focused on the following specific objectives:

- To identify flood-prone communities of the Lower Volta
- To determine the available Disaster Risk Reduction (DRR) approaches, and sustainable alternatives that could complement or replace the existing flood disaster risk mitigation measures, and their feasibility.
- To determine the perception of communities on the relationships between ecosystems functions and disaster risk reduction, the values placed on those ecosystems and the services they provide, and tradeoffs.
- To make recommendations for sustainable management of flood and ecosystems DRR.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Thousands of lives, billions of dollars of property and habitats are being destroyed yearly by natural hazards like cyclones, windstorms, earthquakes, volcanic eruptions, fire outbreaks and floods. This is exacerbated by the rapid rate at which the global population is growing and the movement into high-risk zones. The vulnerability of these disaster prone areas are further increased by unplanned growth of settlements and its attendant environmental degradations; climate change and variability, non-preparedness and poor allocation of funds for disaster management; especially in the developing countries of the world (IPCC, 2001; WHO, 2007). For an effective flood management, information on flood prone areas and the causes of flooding should ultimately form part of the flood management database.

This chapter is a review of relevant literature on flood disaster, its management both globally and in Ghana; it deals with topics such as global flooding and flooding at deltas, global disaster risk reduction measures and ecosystem-based disaster risk reduction approaches.

The chance of something or somebody being endangered as a consequence of an event is regarded as risk (ISDR, 2005; Encarta, 2009). Risk can be expressed mathematically as the product of probability and consequence.

Risk = Probability x Consequence

This further reveals that hazards are not necessarily risks if there are no expected or actual losses (Gouldby & Samuels, 2005).

Consequences are determined by the degree of exposure, susceptibility and value of the receptors and elements at risk.

2.2 Flood Events: Hotspots, Types, Causes and Effects

Flood has been defined as high flow of water which oversteps its natural channel for runoff, thereby temporary overflowing and covering lands that are not usually submerged. It is an overflow of water or an expanse of water submerging a land, which is usually caused by intense precipitation onto the delta, river overtopping its bank and sea storms (Chow, 1956; Ward, 1978). As a natural process, flooding is among the most frequent hazards causing damages to lives and property. Studies have shown that between 1980 and 2011, hydrological disasters accounted for 23 % of all reported losses and 10 % of fatalities that were caused by natural disasters globally (Borga *et al.*, 2014). In addition to loss of lives and property, major flood events have brought about the displacement of people internally, and shortage of resources in the 2010 Pakistan flood affected 14 million people, (WFP, 2010).

Over the last half-century, the number of people in the African continent affected by flood disaster, with its associated economic losses has dramatically increased due to increased number of people living in flood prone areas (Di Baldassarre *et al.*, 2010). More than a million people were displaced and 500 lives lost in the 2007 floods in Burkina Faso, Ethiopia, Mali, Niger, Sudan, Togo and Uganda. The flood events were followed immediately by the 2008 Mozambique flooding. Another torrential rains and flooding in 2009 affected 600,000 people in 16 West African countries, with Burkina Faso, Ghana, Niger and Senegal being the worst hit nations (United Nation, 2009).

In Ghana, 243,988 people were affected in 2011. In the process 16,801 houses were seriously affected. The total cost of loss was US$ 6,533,463.00. Recently in 2013, the nation woke up to severe rainstorm in Central, Northern and Volta Regions of the country, respectively, the storm lasted for two weeks resulting in the displacement of people in their numbers, loss of farm produce and property, 24,000 people on the average were affected (IFRC, 2014).

2.2.1 Flood hot-spots

Deltas are the triangular or fan shaped deposit of sediments formed at river mouths where the rivers flow into the ocean or lake. Sediments of a river are deposited as the current of the river slows down at the entrance of the river into another water body. The size of the delta formed is dependent on currents in the receiving water body and the sediment load of the river: less deltas are formed if the currents of the ocean are strong, which sweeps away the sediments thereby preventing the formation of larger deltas and vice versa, With the receipt of new sediment, deltas grow, especially during seasonal floods when rivers split into many channels that meander across the deltas. This means that deltas can only exist where rivers discharge enough sand and mud to withstand and overcome the water movements that wash them away.

Since prehistoric times, people have dwelled in deltas by the seas or rivers for access to quick and cheap transportation, sources of food and trading. Without this human population near the water bodies, there would be less concern for flood disasters. Floodplains are nourished with fertile soil as river deltas are being inundated periodically, due to variations in precipitation and rise in river. Many of the world's deltas are densely populated and highly farmed with more than 500 million people worldwide living on deltas, while some are in the sprawling megacities like Bangkok, Dhaka and Lagos (Syvitski & Saito, 2007), others live in some remote deltas. These environments and their populations are hotspots for growing risk of coastal flooding, loss of infrastructure, shoreline retreat, and loss of wetlands and other ecosystems with the services they provide.

Globally, most of the deltas are less than two meters above sea level, this makes them vulnerable to flooding, especially from tropical storm surges which can raise the sea level by 3-10 meters; one of such example is the 2008 storm surge that flooded the Irrawaddy Delta

Myanmar at 3.5 meter rise, killing thousands of people, which was caused by cyclone Nargis. (Selth, 2008)

In Pakistan, one-fifth of the Indus delta plain has been eroded since the first damming of the river in 1932. In China, the northern shore of the Yellow River has also retreated 300 metres each year for the past 35 years. While the Indus delta, Nile delta and the Colorado River delta are some of the most ecologically devastated deltas, due to damming and water diversion; well preserved deltas reveals what is being lost as deltas are being degraded, for example, Danube delta: the most extensive wetland in the European Union and a global biodiversity hotspot. Deltas' muddle of channels, marshes, lakes and dunes are habitat for about 2,000 plants and 5,000 animal species, most of which are threatened. (Renaud and Kuenzer, 2012). The plunge in fluvial load and loss in ecosystem services are fates shared by most deltas worldwide (Syvitski and Saito, 2007).

With millions of communities being located near the coast, coastal hazards are major threats around the world, especially for the fact that more deltas are being drowned and sunk by these floods (IPCC, 2001), and the storm surges are moving inland hence making more lives and properties vulnerable to these disasters. Deltas around the world are sinking, in areas where flood defences are already in place, flood from seas sometimes overflow these defences causing damage to the lands behind the coastal defence. It has been estimated that 10 million people experience flooding yearly due to storm surge alone, most of which live on deltas (Overeem *et al.*, 2011).

The trend of deltas being mostly populated despite flooding is the same in Africa and probably a worse scenario. History has it that from the earliest recorded civilizations, as found in Egypt and Mesopotamia; development occurred in the fertile floodplains of Nile, Tigris and the Euphrates Rivers. Since then, cities tend to develop in flood-prone areas owing to the favourable conditions they offer for both human settlements and economic development (Vis *et al.*, 2003). The concentrated and unplanned settlement of greater population in Africa have consequently brought about the increase in adverse impacts of flooding which includes but not limited to the irreversible loss of lives (Hardoy *et al.*, 2001; Jonkman, 2005; Douglas *et al.*, 2008). The most recent and deadly floods in Africa have been identified in areas with high population increase, studies have shown that this increase in population occur more in floodplains (Douglas *et al.*, 2008; Hardoy *et al.*, 2001). Cases buttressing the point are seen in flood risk increase in Alexandria in Egypt, Ouagadougou in Burkina Faso and Lusaka of Zambia; due to the cities' fast growth into flood prone areas, (Nchito, 2007). Particularly, the poorest people have been affected by flood risk due to their limited choice of settlement apart from coastlines and river banks, low awareness level on the risks involved in living in such zones and ultimately unpreparedness for flood disaster response. This is of concern as the percentage of people residing in deltas keeps growing rapidly (Lutz *et al.*, 2008).

2.2.2 Types of flooding

Floods have been categorized into various types and this depends on the source of the flooding water, processes involved in their generation, causes of flooding and space-time scales; Flood has been classified by Hirschboeck (1987) based on precipitation, snowmelt and synoptic weather patterns, while Alila and Mtiraoui (2002) classified flooding based on decadal-scale climatic variability, El Niño-Southern Oscillation conditions and storm type. Merz and Blöschl (2003), categorized flooding according to their generating processes into long-rain floods, short-rain floods, rain-on-snow floods, snowmelt floods and flash floods.

Flood runoff generation and routing are also dependent on landscape types, soils, vegetation, characteristics of channel, vegetation and geology. Evapo-transpiration as a process also plays a significant role in determining the before-event soil saturation (hydrological pre-condition), and these processes vary globally and sometimes at the same location, they vary between events (Zlatanova, 2013).

For the sake of this study, flood types have been categorized, among others, into four groups: coastal (surge) flood, river (fluvial flood), pluvial (surface) flood and groundwater flood. Coastal flood events are serious problems along the coasts of nations, though they vary in magnitude and frequency. As the name implies, they occur in areas lying across the coasts, usually influenced by storm surge and high and long wave incidents on the coast; characterized by strong onshore winds with low barometric pressure, resulting in formation of dome of sea water which is forced towards, and inundating the low-lying land with its attendant destruction of lives and property. (Bariweni *et al.*, 2012). Several factors are considered in determining the severity of coastal flood events, which include direction of the storm, size, speed, strength and the topography of both onshore and offshore. This type of flood events can be forecasted with some accuracy; hence early warning systems can be employed to reduce their risk (Agrawala *et al.*, 2003; Jonkman, 2005).

Flood event is said to occur in floodplains when a river exceeds its capacity and overtops its banks, flooding the adjacent, low-lying lands around the river (Jha *et al.*, 2012). This is usually caused by excessive torrential down pour over an extended period. Fluvial flooding which occurs more than coastal floods can also be worsened by snow melt, obstruction of free flow of water or ice jams within catchment areas upstream. While the severity of river flood is determined by the amount of rainfall in an area, precipitation accumulation time, previous saturation of the soils, and the terrain surrounding the river system; the damage can be widespread as smaller downstream rivers are affected by the overflow. River flood can also be regarded as flash flood; it is a rapid and extreme rise in water above predetermined flood level and consequently flowing into a normally dry area, beginning six hours of the causative event. Though there might be variations in the actual time threshold; they are characterized by rapid rise in water, high velocity and large amount of debris. Ongoing flooding can intensify to flash flood as a result of rapid surge of rising flood water due to intense rainfall, it is also expected that flash flooding may become frequent in the face of climate change and over-development in floodplains. To curb this, the capacity of the river channel should be increased through dredging to make more room for the water, while keeping infrastructure away from floodplains (Jha *et al.*, 2012).

Pluvial flood, also known as surface flooding is an event experienced when heavy rainfall creates flooding that is independent of an overflow of water-body. Though people living and working at deltas are at high risk of being overwhelmed by flood disaster, the idea of those environments being the only flood prone areas is a misconception as flood can affect both rural and urban settlements (Jha *et al.*, 2012); that myth has also been demystified by surface flooding which mostly happens at urban areas with elevations above river floodplains and sea levels. Pluvial flooding can be witnessed in two forms: When an urban drainage system is saturated by heavy downpour, causing the system to be overwhelmed and results in overflow of water on the streets and nearby structures; and when hillsides, especially the one with recent forest fires are unable to absorb water from rainfall (Jha *et al.*, 2012), consequently the water flows as run-off to the suburban communities on the hillsides.

Flood events also occur when underground water levels rise above the water table and approach the surface, mainly caused by extended periods of rainfall, which is different from direct surface torrential downpour. They are referred to as groundwater flooding and can last for weeks or months. Groundwater flooding has been estimated to cause damage to thousands of property in UK (Directive of European Union, 2007).

Generally, flooding in deltas which are highly unpredictable could be in the form of any of the types mentioned above, with diverse names as tropical storms, downstream flood, storm surges, seiches, tsunamis and inland flash floods: from rivers and local rainfalls, a case in lieu of this is fractions of Tennessee and Cumberland River Basin which in 2010 experienced a 36 hour rainfall that resulted in a recorded flooding, the two-day storm was estimated by officials to be greater than a 1,000-year rain event. These intense and nearly stationary storm event caused by rare weather conditions created a large-scale flash flood along the Cumberland and lower Tennessee Rivers and their tributaries (Jha *et al.*, 2012).

2.2.3 Causes of flood

Flood events vary in frequency and seasons. They could be associated with seasons like autumn, spring, summer or winter. In Ghana, they mostly occur during the rainy seasons (Smith & Ward, 1998; UNDP/NADMO, 2009). Different scholars have come up with different theories on the causes of flooding. The underlying truth is that flooding can only be said to occur when a normally dried land is overwhelmed with water, which causes loss of life and infrastructure, no matter the source of the water.

Basically, flood events can be attributed to natural occurrence with factors like the topography of an area, the velocity, frequency and prolonged rainfall, which are the primary driving mechanisms of most flood events (Freeman, 2000); or to anthropogenic activities which worsen flood events impacts while also increasing their frequency.

Flood, described by White (1945) as the act of God, is said to be a natural hazard when the rate of rainfall exceeds the capacity of infiltration by soils; thereby causing the water to surpass its channel and overflowing the land as run-off. When river overtops its banks and spills over the plains of the riverbank, flooding as a natural event occurs. When rain falls at a faster rate, there is tendency that it would get to the river channel easily; this can lead to flooding depending on the nature of the landscape around that river. Natural flood events occur at shorelines when there is a surge of storm happening concurrently with high waves, storm water runoff in urban areas can flood local rivers and the urban areas too. While tropical floods are usually caused by hurricanes, also known as cyclones, tropical storms or typhoons; outburst floods and ice jams are major causes of flooding in northern latitudes (Jones *et al.*, 2005).

Though all these are naturally occurring and might not be stopped by man, research has shown that losses and damages from these flood events are the consequences of human activities. Human activities in floodplains, near river valleys, sea shores, and on waterways can induce flooding. Though humans are mostly affected by flood disaster; their presence in and near water bodies, mainly driven by socio-economic factors is a major contributor to flood disasters. Land use change by man, especially urbanization, has made lots of surfaces impermeable, resulting in low infiltration and accelerated runoff (Jones *et al.*, 2005). While dams and other hydraulic structures put up by man on water ways have caused tremendous flood disasters and displacements, their spillage and failures are bigger challenges.

Inappropriate agricultural practices which have resulted in river siltation and soil erosion; and the clear cutting of forests for wood and their by-products, settlements and land reclamations contribute immensely to flood disasters (Liu *et al.*, 2004). While the list might be inexhaustible, it is now known that the causes of flood events are complex, combining natural hazards and socio-economic factors that modify the environment, brings about negative or positive impacts which affects both man and the environment (Wisner *et al.*, 2004; Zhang *et al.*, 2008).

Failure of constructed and natural dams constitutes hazards to people and property and they usually occur suddenly and unpredictably. While some dams are naturally formed, others are barriers built for water management, for example hydroelectric dams, irrigation dams and flood control dams. Of all the numerous kinds of dams that form by natural processes, dams formed from landslides and glacial ice present the greatest threat to people and property, both upstream as the lake rises and downstream as a result of dam failure. Many of the landslide dams fail shortly after formation. Since the construction of the earliest dams, there have been dam failures (Costa and Schuster, 1988; Rico *et al.*, 2008). The upper 40 m of Lake Nyos, bounded on the north by a narrow dam of poorly consolidated pyroclastic rocks, was emplaced a few hundred years ago during the eruptive formation of Lake Nyos maar. The 50 metres wide natural dam is structurally weak and is being rapidly eroded. In the event of the dam's failure, there could be a major flood at an estimated peak discharge of 17000 m^3/s, which would have tragic impact on downstream areas as far as Nigeria, that is 108km away. The hazard could be eliminated by reducing the volume of water in the lake using drainage tunnel (Lockwood *et al.*, 1988). The catastrophic failure of IVEX Dam (Chagrin River, north-eastern Ohio), in 1994 is a case in point. The event was triggered by a 70-year rainfall (13.54 cm of rainfall within 24-hours), and released 38,000 m^3 (about 10 million gallons) of impounded water and sediment. It resulted in flows 1.9 m above the top of the spillway and impinging on the top of the dam. The failure was the result of seepage piping at the toe of the dam (Evans *et al.*, 2000).

2.2.4 Effects of flooding

Flood events, regardless of the types or causes, result in local and widespread impacts. These impacts could be positive or negative. The productivity of any river floodplain cannot be sustained without periodic flood water, though dependent on the depth, frequency, season, water quality and velocity; it accounts for ancient farming communities along River Nile, Tigris-Euphrates, Indus River, Ganges, and lower Volta River before its damming, among others (Smith & Ward, 1998). The effects of coastal storms depend on some characteristics of the population and community which include coping capacity, demographics, elevation, infrastructural design, livelihoods, location and planning in relation to flood events.

Primarily, the direct negative effects of flooding are seen in the outbreak of diseases, loss of lives and livestock, destruction of buildings and weakening of various structures. Over 8,000 people were directly killed by flood disaster globally, in 2010; while two-thirds of this direct death was as a result of drowning, one-third resulted from carbon monoxide poisoning, disease outbreak, electrocution, fire outbreak, heart attack, trauma or water borne diseases (Kunii *et al.*, 2002; Jonkman, 2005, as cited in Jha *et al.*, 2012), these can be regarded as secondary effects of flooding.

Flood events can alter the natural environment and their resources, hampering the ability of the poor; who directly depend on these resources for livelihood, to fend for themselves. The colossal effects of flooding can also be seen by the resultant floating debris becoming dangerous projectiles that can crash into other structures, and may start fires (Kohl *et al.*, 2005). Economic growth and development are also disrupted at the instance of flood disasters. Not only do flood events wipe away investments; they also divert finances meant for other development, to recovery responses like evacuation, relief and reconstruction efforts thereby jeopardizing long term developmental goals (UN/ISDR, 2005), this is the case of most developing countries, The estimated total cost in New Zealand's 2011 flooding was $46.5 billion, according to World Bank; while Togo spent and lost an estimate of US$ 15.5 million in social sector, and another US$ 19 million on infrastructure in 2010 flood disaster in Lome. In Ghana, conservative estimates from the National Disaster Management Organization reveal that the government spent about US$ 700 million in dealing with recovery, relief and resettlement efforts from 2007 to 2011. In fact, private individuals and businesses have lost almost US$ 3 billion from flooding between the year 2007 and 2011

(Amankwah-Ayaeh & Caputo, 2011 as cited in Jha *et al.*, 2012). With all these effects, especially the negatives, it is of utmost need that disaster risk reduction approaches should be prioritized in policy making, specifically, Ecosystem-based approaches, which takes care of the underlying disaster risk factors.

2.3 Flood Disaster Risk Management and Reduction Approaches

Water, which occupies 70% of the earth, is very crucial for replenishing many terrestrial and aquatic ecosystems, and also providing links between ecosystems. This is a major reason why most of the world population live close to water bodies. As the number of people living and working in flood-prone areas keeps increasing, more lives, economic investment and property are becoming vulnerable to flood disaster risk with increased trend in damages (Pielke Jr *et al.*, 2008; Raghavan & Rajesh, 2003).

Measures to reduce flood disaster risk are already in place, ranging from the use of remote sensing and Geographic Information Systems (GIS) to detect and forecast flood prone areas, for example, the call by the United State of America's congress in 1973 for the identification of flood prone and related hazards areas in recognition of the significance of flood disasters; using the flood disaster protection Act (Pub. L. No. 93-234; 87 Stat. 975), and recently according to Moel *et al.* (2009), the European Parliament adopted a new flood directive (2007/60/EC) ensuring that its members establish a framework for flood risk assessment and management with emphasis on magnitude, frequency and consequences, using maps, early warning systems, building and strengthening of flood defences, creating more rooms for deltas' feeding rivers and sea rises and raising safety standards.

The worst response to a disaster is to invest only in repairs, trying to rebuild everything as it was before. However, all too often, this is what happens. It is understandable, there is only ever a year to go until the next storm hits. To avoid this short-term reflex response, we need to take action before disasters strike (Government of Netherlands, 2014). It is also worth noting that most of the disaster risk reduction measures used globally is a combination of two or more approaches.

The dramatic limiting of flood damages in Jakarta's 3rd and 4th June, 2008 flooding, was as a result of timely and precise predictions and warnings of high water, based on extensive water level analysis, and the immediate and speedy building of provisional water defences using sandbags and bamboo by the government. (WMO, 2013).

Varying views have been postulated in literature, by researchers on the best strategies for flood disaster risk management and reduction, dominant among them are the three which have evolved from distinct paradigms: behavioural paradigm, developmental paradigm and engineering paradigm. Flood events are viewed by the behavioural paradigm school of thought as occurring due to the failure of engineering to deal with them, arguing that flood prevention authorities have neglected the implications of non structural alternatives such as early warning systems and forecasting, land zoning; and this has worsened flood disasters. They also attribute flood disasters to behavioural failure on the part of both resident and managers of floodplains; to assess the detailed risk of flooding in floodplain. This group of scholars suggest that full vulnerability and risk assessment of all floodplains should be carried out in order to develop human response plan for flood control (McEntire *et al.*, 2002).

The view of the behavioural school of thought has been criticized by another group of scholars called the development paradigm. They argue that the best approach to managing flood disaster risk is by incorporation public participation, especially the community members who are directly affected by flood disasters; in the planning of processes for rivers and flood management, while also educating them on the importance of adopting community based disaster responses (McEntire *et al.*, 2002).

Yet, another school of thought known as the engineering paradigm argues that the causes of flood disasters are extreme hydrological events, and can only be tackled by exerting physical control over flood flows. They believe in using all available physical techniques: building artificial flood banks, defence walls, dredging riverbeds to make it deeper and wider, thereby creating more room for water and straightening of river courses; to modify water flow (McEntire *et al.*, 2002).

Traditionally, disaster risk reduction methods have focused more on reactive approaches like relief distribution, response and recovery; instead of proactive methods (CRED, 2004). Reactive approaches give attention to disasters only when they occur (Ritchie, 2004), thereby frustrating efforts to reduce the underlying flood risk factors and encouraging reoccurrence of disasters.

It has been suggested that disaster risk reduction should start with prevention, followed by response, and then recovery. This was supported by Hyogo Framework for Action (HFA) 2005-2015; birthed at the World Conference on Disaster Reductions in Kobe, Japan, which was organised by the ISDR in 2005. In its outline of key areas that should be prioritized in disaster risk reduction were:

- Disaster risk reduction should be made a national and local priority with institutional basis for implementation
- Identifying, assessing and monitoring disasters risks, and enhancing early warning systems
- Using indigenous knowledge, innovation, and education to imbibe the safety culture and resilience at all levels

- Reducing the underlying risk factors: and strengthening disaster preparedness for effective response at all levels

All these aim at reducing, to a minimum level, the number of disaster occurrences, with their associated economic losses, while making the world safer from natural hazards (UN/ISDR, 2005). From HFA, it is worthy of note that local capacity building in terms of flood disaster knowledge, and some mitigation measures are highly recommended in ensuring a flood resilient community. Emergency aid, which is a reactive approach, has been identified as a topper on the funding lists, both by national governments and donor agencies; probably because emergencies are media friendly and people feel it is morally justifiable and humanitarian to help those that have been incapacitated by disasters (CRED, 2004): while millions of US dollars were spent in 2005 on famine relief in Niger by donor agencies during a drought situation, donor agencies seemed not to be interested in Senegal's proposal to build a green wall to fight desert encroachment which could bring about drought situation (O'Brien *et al.*, 2006).

Though reactive disaster management approach is highly patronized, it is unsustainable in the long-term: since the underlying risk factor is still in existence, there is every possibility that such disasters can always reoccur. Moreover, there is no assurance of adequate and satisfactory provision of the demands of disaster victims, as no amount of relief can compensate for the economic losses, emotional and psychological trauma; especially in the face of frequent and numerous disaster events being recorded (CRED, 2004).

Proactive approaches of disaster risk reduction are basically preventive in nature and should be the underlying principles in any disaster risk management systems, since it has been proved that hazards become disasters when people's lives and property are affected. Though majority of them are within the sustainability standard, they cannot be used in isolation; the

HFA preparedness for response should not be underestimated. It has also been seen that most nations set out with sustainable mitigation and reduction initiatives after an unfortunate disaster event, making disaster events the breeding place for proactive disaster risks reduction (Annan, 2003 as cited in O'Brien *et al.*, 2006)).

2.3.1 Flood risk disaster management in Ghana

To effectively manage disasters, local bodies should always be allowed to undertake planned intervention; this has propelled most nations to put in place ministries, institutions and bodies charged with the responsibility of managing disasters from preparedness to response, in the face of ever increasing disasters globally, and higher vulnerability in developing countries (Allen, 2003).

The main body charged with this responsibility in Ghana is the National Disaster Management Organization (NADMO). The organization was formed in response to the United Nations declaration (GAD 44/236 of 1989), mapping out the years 1990 to 1999, as the International Decade for Natural Disaster Reduction (IDNDR), which encouraged member states to establish disaster management agencies and to increase the awareness of their general public on the need for disaster prevention; in 1996, under the Act of Parliament No. 517.

As part of the Ministry of Interior and under direct governance of the National Security Council, NADMO was given the power to observe and investigate, the establishment and execution of plans for the management and reduction of the impacts of all disaster types in Ghana, by coordinating activities before, during and after emergencies, NADMO achieves this by registering disaster victims, providing relief materials and ensuring post disaster rehabilitation and reconstructions, as well as resettling people, where the need arises (UNDP/NADMO, 2009). With its National Secretariat in Accra, and having both Regional, Metropolitan, Municipality and District secretariats in every region and District of Ghana, decentralized system of discharging of duties are ensured.

Before NADMO was formed, the National Mobilization Programme (NMP) served as the implementing agency till 1994. NMP was set up after several crises like bushfires, deportation of about 1.2 million Ghanaians from Nigeria, droughts and famine which occurred between 1982 and 1983. Figure 2.1 depicts a diagrammatic representation of NADMO disaster management operational model.

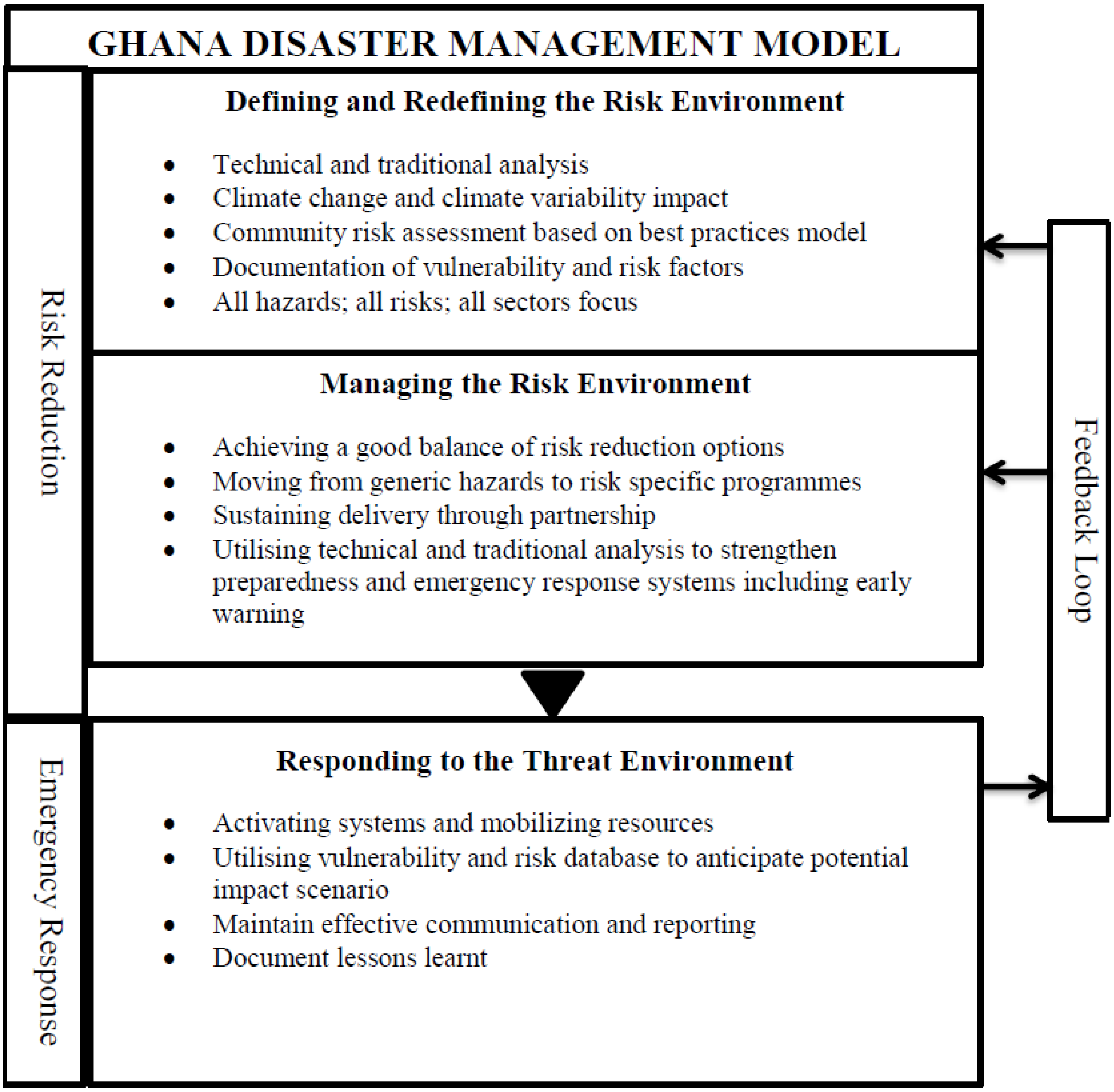


Figure 2.1 Disaster Management Model for Ghana (Source, Adopted from UNDP/NADMO, 2009)

2.4 Ecosystem-based Disaster Risk Reduction

The term “ecosystem-based disaster risk reduction” is the use of naturally occurring systems as a way to safeguard against the impacts of hazards by maintaining the resilience of the natural systems, their integrity, services and species that support them, thereby helping people and communities adapt to changing conditions. Whiles this Ecosystem-based Disaster Risk Reduction is an important complement to other strategies for disaster risk reduction, it is often neglected (UN/ISDR, 2009). It is not about prioritising nature over people and development, but about sustainable and optimal use of services provided by nature: as sources of important daily supplies and strengthening the resilience of the community in crises times: provisioning services of ecosystems for example, can be seen in marshes which stores large quantities of water thereby mitigating flood and mangroves acting as buffers against storms-regulating services. Ecosystem-based disaster risk reduction is simply a conservation action to protect people and their environment from, or reduce the impacts of hazards on them; it sets out to achieve a paradigm shift towards an approach of sustaining and restoring services provided by ecosystem, by maintaining the natural dynamics that underpin ecosystems health, besides other risk reduction approaches (Renaud *et al.*, 2013).

Ecosystem functions of mangrove forests and wetlands could help prepare for massive climate change adaptation planning in countries that may require the relocation of millions of people. In an event of sea-level rise and increased flood events, largely undervalued ecosystem services such as these will play key roles in mitigating disasters and enhancing recovery. Forests (primary, secondary, and plantation or agro forestry) appear to protect soil from compaction and preserve infiltration rates than do other types of land cover. Mangroves can increase livelihood resilience for post-disaster communities that can rely on natural capital to produce ecosystem services like food and building material (Adger *et al.*, 2005).

2.4.1 Ecosystem

The term ecosystem was coined in 1935 by the British ecologist Sir Arthur George Tansley, who described natural systems as constant interchange among living organisms and nonliving parts (Stepp *et al.*, 2003). Our Earth is populated by not just humans, but by millions of flora and fauna species, while a majority of these living things gain their energy directly from the solar system to support their metabolisms like plants; others like animals and microbes derive their energy from other organisms either through feeding on plants, parasitism, predation, symbiotically or decomposition. In order to survive and reproduce, living things use energy, nutrients and water. Water is obtained primarily from the soil by terrestrial plants, and from free-standing water in the environment or from food in animals' case. Nutrients, on the other hand are obtained by plants from soil or water, while animals' nutrient come from other organisms (Turner, 1988). Among these species that populate the earth, microorganisms are the most versatile, as they tend to obtain their nutrients from so many sources e.g. soil, their food, water, or other organisms. These organisms interact with one another in various ways such as predatory, competitive, seed dispersal, parasitic, pollination and provisions made available by their habitat (Flashman and Schofield, 2007). These basic relationships among organisms and their abiotic environment comprise an interacting and ever dynamic system which is referred to as an Ecosystem. As already mentioned, humans are part of these systems, dominant in many regions and highly dependent on ecosystem properties and the web of interactions among organism, within and among ecosystems for their sustenance; the same applies to every other species (Turner, 1988). Ecosystem therefore, as adopted by the Convention on Biological Diversity (CBD) is a dynamic complex of plant, animal and micro-organism communities and their non living environment interacting as a functional unit (Boyd and Banzhaf, 2007). These functions can be lost as ecosystems are degraded.

2.4.2 Ecosystem services

Ecosystem services are the benefits which could be goods and include food, seafood, forage, timber, biomass fuels, natural fibres, pharmaceuticals, industrial raw materials; or services which also include but not limited to regulation of disease, water, soil and air, waste assimilation, soil formation, cultural heritage and academic research materials, that humans derive directly and indirectly from the functioning of the ecosystem (Costanza *et al.*, 1998).

Different writers have categorized ecosystem services in a number of ways, which are summarized below. These are:

- Descriptive grouping which look at the renewable resource goods, non-renewable resource goods, physical structure services, biotic services, information services, biogeochemical services, social and cultural services (Moberg and Folke, 1999).
- Organizational groupings, these are services associated with species that regulate some exogenous inputs, or related to biotic entities (Norberg, 1999).
- Functional groupings such as production, carrier, information, regulation and habitat services (De Groot, Wilson and Boumas, 2002).

For this research work, based on operational purpose, ecosystem services are classified along the functional grouping into cultural, provisioning, regulating and supporting services. This is in line with the ecosystem service approach applied by the MEA (2003), which is also consistent with the Convention on Biological Diversity (CBD).

A detailed description of these ecosystem services with some examples specific to coastal ecosystems are shown in Table 2.1

Table 2 1 Some of the benefits derived from Ecosystems

Type	Goods/Services	Definition	Examples
Cultural	Recreation	Stimulation of the human mind and body through interactions with living organisms in their natural environment.	Vacation destinations, cruises and stay-over visitors, Ecotourism, Bird watching, Whale watching, Mangroves and ocean colour watching.
	Cultural heritage and identity	Benefits of biodiversity that is of utmost significance, or bears witness to multiple cultural identities from a community	Cultural heritage, sacred and sites.
	Cognitive benefits	Cognitive development including education and research, resulting more from living organisms.	Genetic resources, medical plants and pharmaceutical.
Provision	Food	Animals or plants obtained from ecosystems for human consumption	Food (fish), salts, minerals and oil resources
	Materials	Animals or plants by-products extracted from ecosystems for multiple purposes.	Construction materials (wood, sand, lime), Biofuels, fuel wood
	Options and use value	Unknown future use of ecosystems	Biodiversity genetic stock that has potential application for biotechnology and medicine
Regulation	Gas and Climatic	The balance and maintenance of the chemical composition of the atmosphere and oceans provided by forests, wetlands and other aquatic organisms	Climate regulation, Local micro climate (shades and surface cooling), Photosynthesis
	Disturbance prevention	Dampening of environmental disturbances by biogenic structures	Regulation of floods and diseases
	Bio recovery of wastes	Removal of pollutants by way of storage, burying or recycling	Regulation and recycling of wastes and improvement of water quality through filtering and water recycling (through evapo-transpiration and underground water recharge)

Type	Goods/Services	Definition	Examples
Supporting	Resilience and resistance	The extent to which ecosystems can absorb recurrent natural and human disruptions, and continue to regenerate without slowly degrading or unexpectedly flipping to alternate states.	
	Biologically mediated habitat	Habitats provided by living organisms Storage, cycling and maintenance of nutrients by living organisms	Pollinators, spawning habitats
	Nutrient cycling		Carbon cycle and nitrogen cycle.

Source: Adapted from MEA, 2003

2.4.3 Human well being as a function of healthy ecosystem

Ecosystems are often modified by people to increase the services they desire. This is based on the fact that humans are aware that their well being can comfortably be derived from these ecosystems. Consequently, ecosystem services are degraded by these actions taken to increase the supply of other services. Institutions are also developed to govern access and use of these services. The Akosombo dam and Kpong head pond on Volta river ecosystems are cases of these modifications to meet the need of hydroelectricity. Because ecosystems function jointly to produce ecosystem services, the trade-offs in human actions to increase the supply of one service can frequently lead to decline in other services, shifting the cost of degradation from one group of people to another or the cost could be deferred to a future generation. (Tamakloe, 1994; MEA, 2005a).

As shown by Millennium Ecosystem Assessment, human well being is strongly linked to the ability of ecosystems to provide their services. For these services to be provided by ecosystems, the healths of such ecosystems providing them are to be ensured (MEA, 2005b). The diversity and variability of species within and among habitats, known as a Biodiversity, is a contributing factor to how healthy an ecosystem can be. Established in literature is the fact that, different species respond to disturbances in their unique ways and some species seen as insignificant in an undisturbed ecosystem can be play critical roles in ensuring resilience. The cumulative effect of these is quick stabilization of such ecosystems and their services when threatened (Grifo and Rosenthal, 1997).

2.4.4 Role of communities in Ecosystem-based Disaster Risk Reduction (Perception of and Value of Ecosystem services)

Modern society has distinct advantages over those in the past who suffered and some collapsed for reasons linked to water, with vast knowledge available to us including our scientific leap that has improved weather forecasting, natural resource management, agricultural practises and disaster prevention, preparedness and management; with the capacity to disseminate the information, even to the most remote places. However, it takes rational and responsible political, social, cultural responses and public participation in all phases of disaster management cycle to reduce disaster vulnerability, while ensuring that hazards do not become unmanageable disasters (Annan, 2003).

With the understanding of the concept of ecosystems, the services they provide and the dependency of human well being on the health of these ecosystems and the services they provide, it has become expedient that these functions of ecosystems are used as necessary tools to identify and quantify the benefits of ecosystems and the full cost of their loss. These would also act as decision-support tool in communicating to and engaging the stakeholders with a constructive dialogue.

In the construction of dams, clear cut logging and other ecosystems' uses and conversion, the collaboration of economists, environmentalists, ecologists, and social scientists is a necessity for better insights in the trade-offs involved in these changes (Primmer and Furman, 2012), it has become clear that monetary cost-benefit analysis used traditionally in the valuation of these projects to determine their positive and negative effects is failing and hence need for a better instrument that give true reflection of all costs and benefits involved in ecosystems use and conversion. Some management systems that aim at sustainability are backed by some precautionary measures like the restoration of resources or sites (CBD, 1992, as cited in Primmer and Furman, 2012). Ecosystems have also been valued and appreciated for various reasons, ranging from aesthetic and experiential to the intrinsic value of pristine nature, while neglecting less direct values like climate change, disasters and disease regulations (Wallace, 2007). Also neglected are the interactions between the numerous uses of these ecosystems in the existing governance policies. This has undermined the sustainable use and the protection of ecosystems and ecosystems services (Carpenter *et al.*, 2009). To effectively manage ecosystems and sustain the services provided by ecosystems, there is need for the integration of stakeholders and actors, who understand, manage and benefit from ecosystems. The framing dichotomy of conservation and natural use of ecosystems has led to conflicts between communities where ecosystems exist, who see ecosystems as common pool resources, and government institutions, and sometimes, between sectoral institutions having different interests and cognition on the ecosystems, such as between environmental sectors targeting the ecosystems for protection and extracting and mining industries, who target the ecosystems as sources of income (Hukkinen, 1998). This has led to an abiding view of conservation as a constraint for the use of natural resources. In fact, nature conservation posing a constraint to economic activity has been shown to be a major obstacle for overcoming the stark segregation of administrative and governance arrangements. Eco-DRR requires local capacity, knowledge and a culture of decentralization so that the local community can function within a supportive structure of government and non-government organizations (Chen *et al.*, 2006).

2.5 Summary

For flood disasters to be managed effectively there has to be adequate knowledge of areas that are prone to flooding, types, causes and the effects of flooding in such areas.

It has been revealed that deltas are prone to flooding, with majority of the world population dwelling in deltas. Reactive flood disaster management approaches have failed world over, and the paradigm is being shifted to proactive solutions. The paradigm shift in the literature drives this study, which assessed the feasibility of an Eco-DRR in some downstream communities of the lower Volta, endowed with ecosystems proven to be effective in flood disasters management. The study area and research methods are discussed in the next chapter.

CHAPTER THREE

STUDY AREA, RESEARCH DESIGN AND METHODS

3.1 Study Area

The Lower Volta Basin (LVB) is the 80 km stretch downstream of Volta River which tends towards the South-East following the direction of the Volta River flow into the sea (Fig. 3.1). It is typically delineated by the Akosombo dam and Kpong Head pond towards the estuary of Volta River. It would have been referred to as a low land floodplain with a river channel that meanders gently and a number of small seasonally flooded water bodies along its banks, if not for the Damming of the river (Gordon and Amatekpor, 1999; Ayivor, 1999). The lower Volta basin covers nine Districts, out of two hundred and sixteen Districts in Ghana.

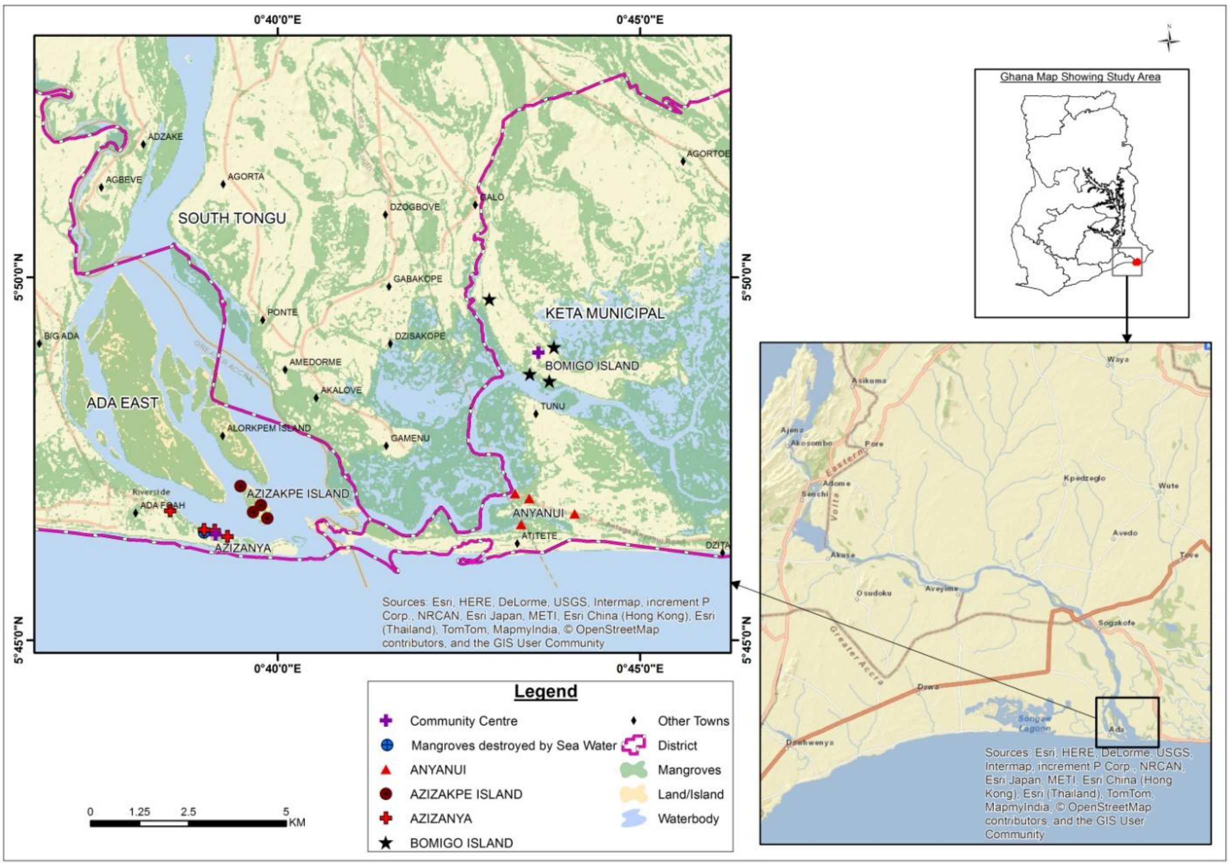


Figure 3.1 Map of the study areas (Source: Adapted from USGS, 2015)

The lower Volta basin is blessed with various ecological systems which include fresh water ecosystem, brackish water ecosystem, coastal ecosystem, mangroves ecosystem, grassland ecosystems and wetlands. The mangrove ecosystems of lower Volta has been described as being associated with low energy, estuarine and lagoon environments, and there is need for extensive flooding to disperse the large propagules (Chapman, 1976; Richards, 1952).

Having a relief below 100 m, the lower Volta is within the southern savannah climatic zone in Ghana, and experiences two rainy seasons like most coastal basins in Africa (Ayivor, 1999).

The two rainy seasons fall within March and November with May/June and October as the peaks of rainy seasons. The major economic activities in these areas are fishing and fish mongering, hats and mats making, farming, coconut oil production, mangroves harvesting and sales, and in some places, salt production.

3.1.1 Location

Four communities in the Lower Volta region were selected for the study: These are:

(i) Anyanui and Bomigo Island in the Keta Municipality of Volta region

(ii) Azizanya and Azizakpe Island in the Ada East District of the Greater Accra region. The locations of these are shown in Figure 3.1.

The Keta Municipality, carved out from the former Anlo District Area and comprised of Akatsi and Ketu Districts has a population of 147,618 (Ghana Statistical Services [GSS], 2010). It lies within Longitude 0^{o}30 E and 1^{o}05 E, and Latitude 5^{o}45 N and 6^{o}005 N, and is located east of the Volta estuary, about 160km East of Accra (the Nation's Capital). The Keta Municipality is bordered on the north by Akatsi South District, to the south by the Gulf of Guinea, on the east by Ketu South District and on the west by South Tongu District. The Keta Municipality has a surface area of 1,086 km^2, of which approximately 362 km^2 (about 30 per cent) is covered by water bodies creating potentials for tourism, fishing and water transportation (Keta Municipality, 2006).

Ada East District is one of the two Districts carved out of former Dangme East District and has a population of 71,677. It is located in the eastern part of the Greater Accra Region within Latitude 5^{o}45 South and 6^{o}00 North, and from Longitude 0^{o}20 W to 0^{o}35 E, about 20km off Accra-Aflao road along the coast and about 2 km from River Volta Estuary. The Ada East District shares common boundaries with North Tongu District in the North, South Tongu and Ada West in the East and West, respectively, while at the South is the Gulf of Guinea. The land area of Ada East is 525 km^2; it has other major settlements like Big Ada and Kasseh (Dangme East District, 2006).

3.1.2 Hydrology/Drainage and Relief

Keta Municipality

The Keta Municipality, like every other area in the lower Volta basin; is a low-lying coastal plain (Gordon & Amatekpor, 1999), with its highest point of 53 m above sea level around Abor in the North, and the lower point approximately between 1-3.5 m below sea level along the coast around Vodza, Kedzi and Keta Township. Three main belts are identified;

(i) Narrow Coastal strip, which is marked by sand bars and a few sea cliffs that border the coast and is severely affected by sea erosion with Vodza, Keta, Kedzi, Kedzikope and Horvi being the worst impacted areas.

(ii) Lagoon basin of the middle belt is made up of lagoons and islands like Dudu, Anyako, Seva, Bomigo, Alakple and Atiavi. With a general elevation below sea level, due to the sandy-clay geological formation underlying the lagoons, they are generally marshy.

(iii) Plains of the North are generally gently undulating with a relatively higher elevation of about 50 m above sea level, the eastern part of the strip has been exposed to intense sea erosion and occasional flooding due to the low lying nature, this notwithstanding, a high irrigation potential exist in the area.

The main drainage basins are the lagoons, with major lagoons such as Keta, Klomi, Nuyi, Angaw and Agbatsiyi. Some of the streams and distributaries of the Volta River drain into these lagoons e.g., Avida, Awafla, Angor, Nukpehui, Kplikpa and Tordzie drain into these lagoons. Many of the creeks are dwindling due to low rainfall, excessive evaporation, low flow of Volta River and siltation. This has resulted in the drastic decline and seasonal fluctuation of lagoons' water volume and the emergence of several islands in the Keta, Angor and Agbatsiyi lagoons, with Dudu and Seva being the biggest islands and partially inhabited (Keta Municipality, 2006).

Ada East District

The Ada East District depicts a topography that undulates gently, and forms part of the central portion of Accra plains with few permanent boulders scattered irregularly over the area. The highest part is about 240 m (800 ft) above sea level; the rest of the area is about 60 m (200 ft) above sea level. The Volta River, being the major river in this District, runs along south-eastern section to form part of the eastern boundary and enters the sea southwards, with other major water bodies like the Futue Creek, Sege River, Akplaba, Luhue, Kajah and the Songoor lagoons. These streams are mostly seasonal and dry up during the dry season. As a result, dugouts and ponds of varying sizes for the purpose of irrigation, domestic use and rearing of livestock have been created. The sea, which covers the southern part of this District feeds or drains the major lagoons depending on high and low tide periods. Though the sea has numerous social and economic values, the fact that it sometimes makes water from wells and dugouts unwholesome for domestic use due to increase in salinity cannot be overlooked (Dangme East District, 2006).

3.1.3 Vegetation and Climate

The vegetation of Ada East District is basically coastal savannah, characterised by short savannah grasses interspersed with shrubs and short trees; with stretches of coconut trees and patches of coconut groves found along the coast, According to Dickson and Benneh, (1980), a few stands of mangrove trees are found around the Songor lagoon and the tributaries of the Volta with waterlogged and salty soil. Some of the Islands in the District have this type of vegetation along their fringes. These mangrove trees can grow up to 15m in height, and are densely vegetated and appear green throughout the year, which are being cut for domestic and commercial fuel. The northern part of the District has forest-typed vegetation and the major trees are the Neem trees. The savannah also provides an extensive livestock grazing land (Dangme East District, 2006).

Keta Municipality

The Keta Municipality, with all its communities, falls within the coastal savannah zone. Though five vegetation zones can be reclassified:

(i) The northern part of the District marked by tall grasses and interspersed with medium sized trees with relatively higher density.

(ii) The mid-section of the District with short grasses and trees with occasional occurrence of Pamira Palm and Baobab trees.

(iii) The South-West part being characterized by mangrove plants along Volta Estuary and tall grasses used for fuel, and mat/hat weaving respectively.

(iv) The South-Eastern part along the coast from Whuti with short grasses and many neem trees, while majority of the coconut trees along the coast have been affected by the Cape St. Paul Wilt disease. These influence the pattern of rainfall in the District.

(v) Pockets of land majorly along the Dabala-Srogbe-Whuti highway that supports little or no vegetation (Keta Municipality, 2006).

Ada East District

The Ada East District forms part of the south-eastern coastal plains of Ghana. It is one of the hottest parts of the country, with high temperature throughout the year ranging between 23^o C-28^o C, and attaining a maximum of 33^o C during hot season. During major rainy season between March and September, rainfalls are very heavy with an average rainfall of 750 mm. During harmattan season with no rainfall, the area is very dry. Due to its proximity to the sea, the Volta River and other water bodies, humidity is very high, about 60 %, and the daily evaporation rate ranges from 5.4 mm- 6.8 mm (Dangme East District, 2006).

Keta Municipality

Keta Municipality falls within the Dry coastal Equatorial Climate with an annual average of less than 1,000 mm which reduces from the north to the coastal parts with about 800 mm being recorded; making the District one of the driest along the coasts of Ghana. While the major rainy season is between March and July, the minor rainy season begins in September and ends in November, which also coincides with the major and minor cropping seasons in the District (Keta Municipality, 2006).

3.1.4 Soil and Geology

Ada East District

The greater part of Ada East District is underlain by tertiary and recent deposits, a small section in the northern and eastern parts fall under the Dahomeyan complex rocks of Precambrian age. The unconsolidated sand, gravel and clay recently occur in the deltaic areas of the Volta River. While the rock of the basement is unknown, it is expected to be Dahomeyan, similar to the one cropping out to the north of the basin, and they consist of gneisses, schists, migmatities (Hilton, 1967) and weather into dark grey calcareous clay and silt that are slightly permeable.

Different soil types with peculiar characteristics, distributions and agricultural activities they support, are found in the Ada East District; and are as follows:

- Ada Association with mottled extremely acidic heavy clay is found at the estuary and the islands; it can support coconut trees, sugarcane plants, grasses for mat weaving, and mangroves.
- Red Earth with Reddish-brown Loamy texture, well drained, porous, and permit better vast development, mechanical cultivation and suitable mainly for the cultivation of maize, cashew, cassava and vegetables.
- Agawtow series with Grey brown soils, loamy on top with impervious clay below cracks when dry, they are low in nutrients and difficult to work on but good for grazing woodlot.
- Goi Association (Sundry clays) having sandy loam overlay heavy clays, easily eroded and often water-logged surface layers become droughty and would need draining, salt leach is also found in some communities and good for grazing, vegetables and cassava.

- Songor Association with red and grey mottled and extremely acidic compact clay is found in songor lagoon area and other coastal lagoons; they are suitable for grazing and are uncultivated.
- Tropical grey earth (Avejeme Association) also grey brown firm sand or silt loam overlaying compact clay with thin layer of gravel beneath is found in the District and supports cassava cultivation (Dangme East District, 2006).

Keta Municipality

The main soil type distributions follow the major geographic units already identified for Keta Municipality. The coastal strips are characterised by sandy soil often without any top layer of humus, and it naturally supports coconut cultivation, but when manured it can support okro, pepper, shallot and other vegetables. The strip is the leading shallot producing area in Ghana, though it covers about 11 % land mass of the District excluding lagoons. Soils in the lagoon basin (Ada-Oyibi Association) are very shallow, overlying a hard and compact clay formation. The soil is generally alkaline and supports mangroves vegetation, sugar-cane, and grasses for pasture. Due to the underlying clay, the area is liable to flood and not suitable for arable farming, though it covers over 75 % of the total dry land area of the District. The Toje-Alajo Association covers the Northern plains around Abor constituting about 14 % of the District excluding lagoons. This area is relatively deep and supports crops like cassava, maize, and legumes. Apart from severally constrained access to land, nearly 80 % of the land is covered by soils not suitable for cultivation, and the ranges of crops cultivated are limited due to poor soils and dry climatic conditions; this implies that crop farming is adversely affected making the District a net importer of food.

Owing to the high average temperatures (about 30^{o} C), and the low relative humidity, there is high evapo-transpiration, leading to relatively low amount of total rainfall (Keta Municipality, 2006).

3.2 Research Design

The study used a case study research design and involved qualitative and quantitative data, using in-depth study of flood disaster accounts, disaster management agencies and the reduction measures available in the four communities, their ecosystem and factors leading to the degradation of those ecosystems and their services. This was empirically useful as it allowed for the detailed exploration of individual experiences and perceptions, candour was also ensured based on the rapport between the researcher and the respondents. The data was systematically analyzed using Statistical Package for Social Scientists (SPSS) tools and excel software.

3.3 Data Collection Methods

Both primary and secondary methods of data collection were used in the study. For the primary data, structured open and closed ended questionnaires and interview guides were used for socio-economic survey and disaster related issues from households and relevant institutions (Volta River Authority [VRA], NADMO and Wildlife Conservation Agency); Focused Group Discussions were also used to elicit information from target groups, and coordinates were determined using a Global Positioning System (GPS) device; while the Secondary data were sourced through desktop review of existing scholarly works which includes maps, research articles and books on relevant topics.

3.3.1 Use of Inundation Maps

Maps showing inundations and their extents, as tools, have been said to be of tremendous importance in the operational setting and strategic planning of flood prevention and mitigations (Zlatanova, 2013). Based on this, inundation maps for communities prone to flooding at the different water discharge levels from the Akosombo dam were adapted from VRA inundation maps. This was done in order to achieve the first objective of this work i.e. to determine the communities that are prone to flooding. From the maps, various communities would be flooded at varying discharge unit per second, but some communities were identified as having high probability of being flooded, both at the least discharge of 3,000 m^3 and the highest level of 14,150 m^3 per second.

3.3.2 Direct Observation

A reconnaissance trip to the study areas in January 2015 shows that the selected communities, though prone to flooding and have actually experienced flood disaster once or more; are endowed with mangroves and wetlands that can be effectively used to manage flood disasters in the communities. These ecosystems were also found to be threatened with resultant depreciation in their values and the services they provide. The degradation has been attributed to some anthropogenic activities ranging from the construction of Akosombo dam and Kpong head pond and the felling of mangroves for fuel wood and other uses by the communities. These were observed while taking a transect walk along the shores of the sea and banks of River Volta in those communities. Photographs were taken in the process to assist in analyzing the extent of degradation in mangroves ecosystem.

3.3.3 Administration of Questionnaires

According to Babbie (2005), questionnaires are the best tool for data collection in survey research. Based on that, systematically structured questionnaires with both open and close ended questions were directly administered to a sample of households in the four communities. The questionnaire (Appendix 1) was developed by the student based on literature review, while ensuring that it meets with the objectives of the study. It was structured into two section:, Section A covered the socio-demographic information about the respondents, and Section B with three sub-units; (i) available disaster risk reduction measures (ii) respondents' knowledge on the ecosystems of their communities, the services they provide and the links between ecosystem services and DRR, and (iii) the values placed on ecosystems and tradeoffs to ensure reduction in degradation and possible restoration.

A pilot study was first conducted in February 2015 using 5 respondents to ascertain the validity: the extent to which an empirical measure satisfactorily reflects the real meaning of the concept it intends to measure (study objectives); and reliability: the extent to which an instrument would provide similar measurements in a similar condition (Babbie, 2005; Ofori and Dampson, 2011) of the questionnaires. This was to ensure that the respondents have a clear understanding of the questions. The data collected during the pre-test were not included in the main study.

After the necessary corrections were effected based on the pilot study, the main administration of the questionnaires was carried out between the months of March and April 2015. The researcher sought necessary permission both at the District/Municipality and at the community levels, for data collection and recruitment of field assistant, after introducing herself and the purpose of the study. One hundred and eighty (180) questionnaires were administered in four communities in the Ada East District and Keta Municipality, while 60 respondents were sampled respectively in Azizanya in Ada East District and Anyanui in Keta

Municipality; 30 respondents were sampled in two Islands respectively (Azizakpe Island in Ada East District, and Bomigo Island in Keta Municipality). Housing units comprising mainly of houses close to water bodies were sampled using random sampling technique. Criterion-purposive and accidental samplings were then used to select individual respondents from the sampled houses, who met certain criteria according to Given, (2008). The criteria were the first person that was met in a compound, who must be between ages 20 and above, and have stayed in the communities for at least 10 years, in cases where the first person did not meet the second and third criteria, the interviewers had to look for another person in the house. That was to ensure that they have a fair knowledge of disasters that have occurred in the study areas, especially flood disasters, and to ensure equal, unbiased and none zero chance to everyone. While four individuals, respectively, served as field assistants in two coastal communities, two persons, respectively, assisted in the two Islands, in administering the questionnaires, based on their fluency in English and the local languages. Due to language barrier, the researcher had to administer some of the questionnaires with a field assistants personally attached to her; this delayed the completion of each questionnaire.

The research assistants were given the necessary training for data collection: the expediency of explaining to participants, the purpose of the study, assuring the participants of privacy, anonymity and reducing every fear of the participants being taxed based on the responses to "willingness to pay" questions.

In addition, guided interview questions in both written and unwritten formats, and having formal and informal attributes, were used to elicit the necessary pieces of information from NADMO Coordinator in Keta Municipality and Wildlife Conservation Coordinator in Ada East District.

Focus Group Discussions (FGDs) were held in the four communities visited, though the number of participants in each community varies; while four people were involved at Bomigo

Island, three persons, respectively, were involved in the three other communities. The environment for these discussions were conducive, as it was non-threatening, permissive and without fear of ridicule and judgement for all participants (Hennink, 2007). Both male and female participation were ensured in FGDs, with the aim of eliciting in-depth understanding and interpretation of the selected participants of flood disasters in the communities, DRR measures, ecosystems in the communities and the linkages between the ecosystems and disaster reductions, based on their perspectives (Liamputtong, 2010).

The researcher, just like in the administration of the questionnaires, encountered some challenges during FGDs, basically, the challenge of language barrier, but with the help of field assistants, the challenges were reduced to a minimum.

The data for this study were triangulated, i.e., using different data gathering techniques listed above, to ensure accuracy and non contradiction of information (Ondrusek, 2004). Primary data were used to cross examine the information gotten from literature.

3.4 Data Analyses

The primary data gathered from the field were carefully examined using the statistical and computer analytical software- Statistical Package for Social Scientists (SPSS), version 20. The responses from households were coded and inputted into the SPSS database to ensure that answers are categorised meaningfully, while bringing out essential patterns that aided in making logical deductions and inferences from collated responses (Kalof *et al.*, 2008). With the combination of study objective, literature and facts gathered from the field, presentations were made in the form of charts, figures, graphs, narrative, and tables; with which enabling factors were identified using percentage and frequency tables as descriptive statistics. Pearson Chi-Square Test was used to analyse the hypothesis, where Chi-Square (χ) = $\sum \frac{(O-E)2}{E}$:

O= frequency observed; E= frequency expected; Ƹ = 'sum of'

The findings were used in drawing conclusions and making recommendations on issues of disaster risk reduction approaches, their effectiveness and limitations in the communities, ecosystems and ecosystem' services, and the inter-relationship between ecosystems and disaster risk reduction, and limiting factors for the preservation of the ecosystems.

3.5 Summary

This study was carried out in both Anyanui community and Bomigo Island, both in Keta Municipality of Volta Region, and Azizanya and Azizakpe Island in Ada East District of Greater Accra Region, all in Ghana. The description of the areas was expounded using map and discussions on their locations and sizes, climate, relief, hydrology, soil types in relation to their being prone to flooding.

Both primary and secondary sources were visited for data gathering in the course of this work, the primary data which involved questionnaires for household respondents, interview guide for relevant institutions and FGDs for selected members of the communities as investigative tools; were analysed using SPSS. Presented in the next chapter are finding from the research, in form of texts, tables and charts in the next chapter.

CHAPTER FOUR

FINDINGS AND RESULTS

4.1 Introduction

Results are presented according to the following:

1. Inundation maps to show the degree of inundation in the selected study communities, at different discharge rates from the Akosombo dam.
2. Descriptive statistics of information obtained from the household questionnaires.

4.2 Flood prone communities of the Lower Volta

The VRA 2010 inundation maps indicate that at a discharge rate of 3,000 m^3 per second from Akosombo dam, there will be no inundation at Azizanya community, Anyanui community and Bomigo Island, indicated with green dots on the map whilst Azizakpe Island would be flooded as shown by the red dot at the location of the Island on the map. (Figure 4.1 and Figure 4.2).

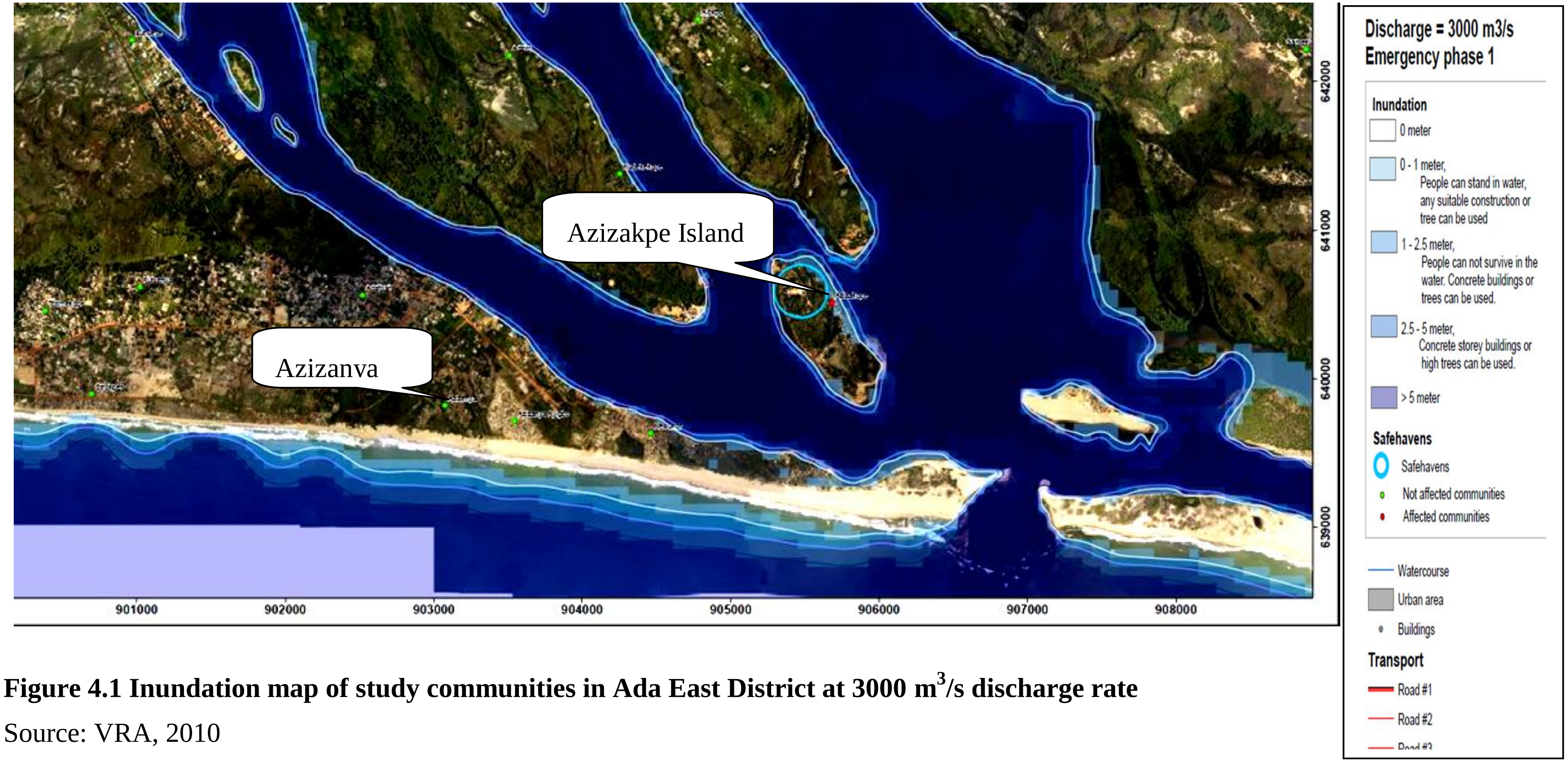


Figure 4.1 Inundation map of study communities in Ada East District at 3000 m^3/s discharge rate

Source: VRA, 2010

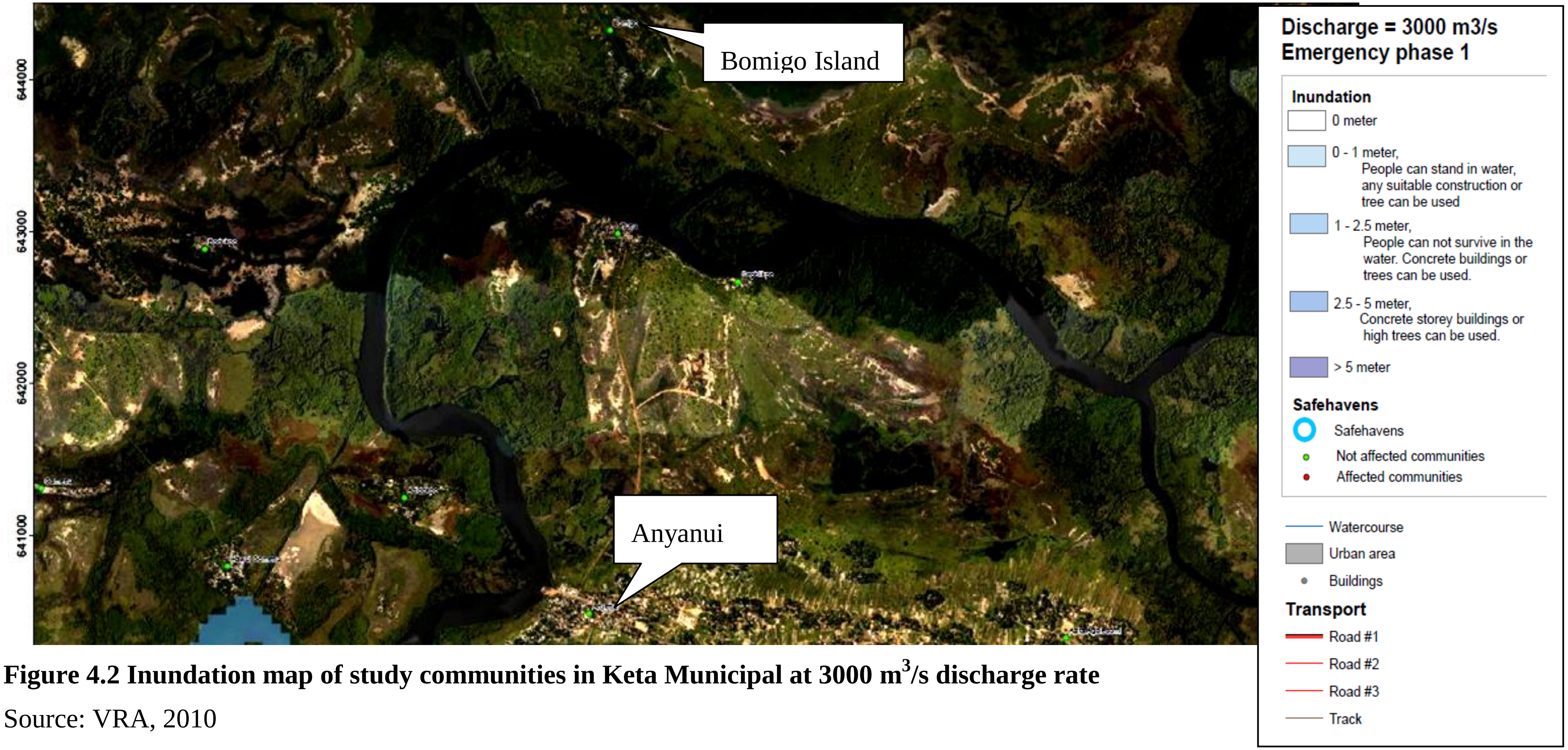


Figure 4.2 Inundation map of study communities in Keta Municipal at 3000 m^3/s discharge rate

Source: VRA, 2010

At a discharge rate of 9,000 m^3 per second only Azizakpe Island and Azizanya would experience flooding, as illustrated by the red dots on the map (Figure 4.3), while Anyanui and Bomigo Island will not be flooded, indicated with green dots on the map. (Figure 4.4).

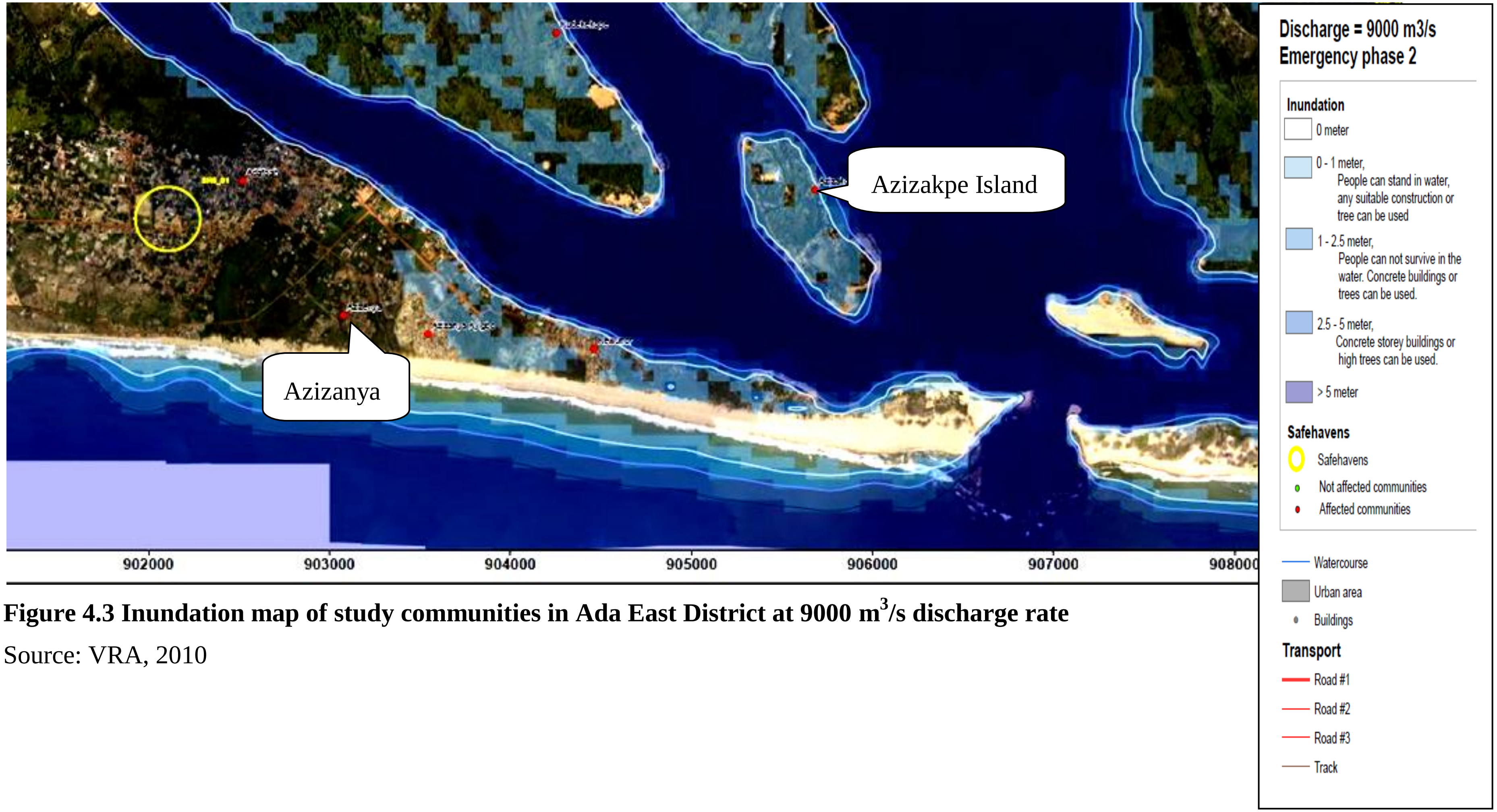


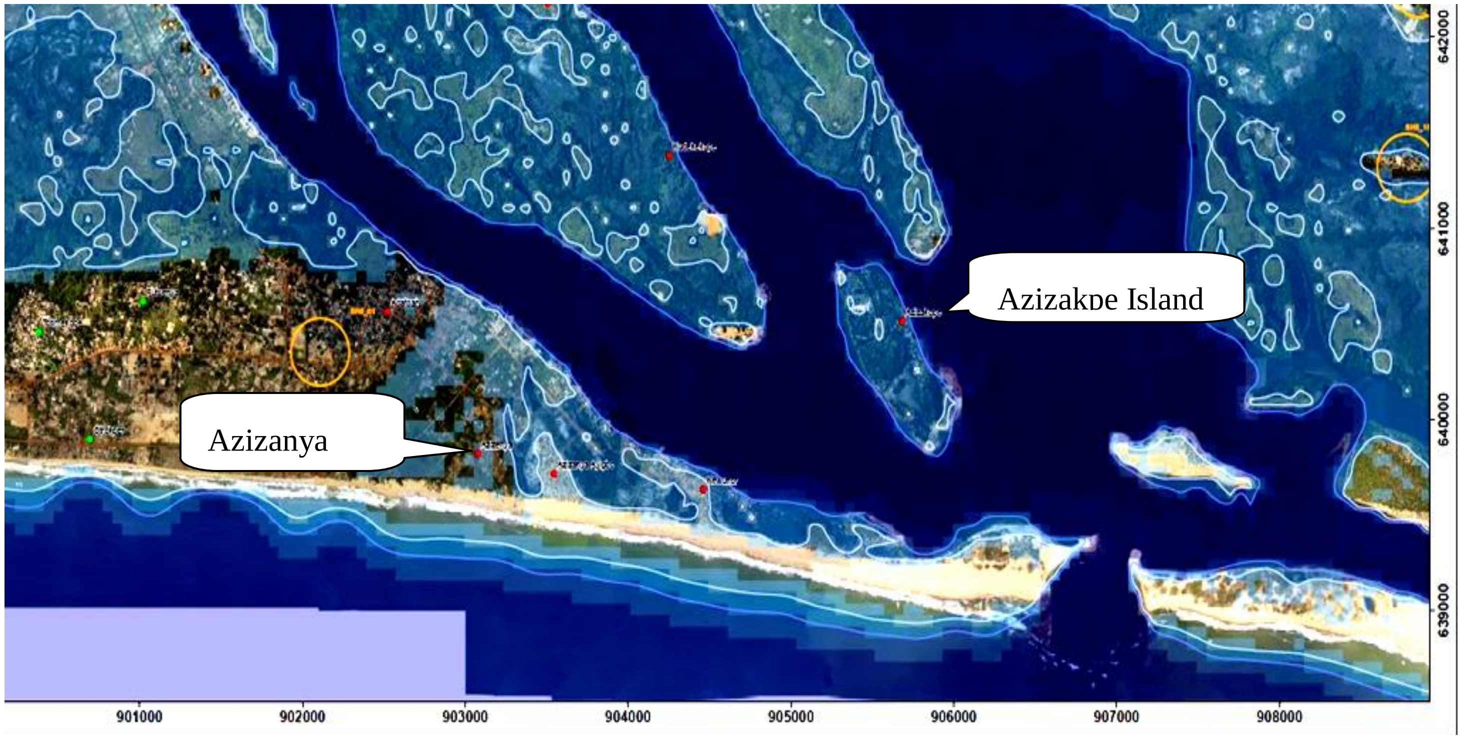
Figure 4.3 Inundation map of study communities in Ada East District at 9000 m^3/s discharge rate

Source: VRA, 2010

Figure 4.4 Inundation map of study communities in Keta Municipal at 9000 m^3/s discharge rate

Source: VRA, 2010

With a discharge rate of 14,150 m^3 per second, Azizakpe Island, Azizanya and Anyanui, with other communities like Aflive, Kewunor, Alorkpem Island, Tunu, Dzita, Fluveme would all be inundated, as shown with red dots at the various locations of the communities on the map while Bomigo Island will not be flooded, shown with a green dot at the Island's location on the map (Figure 4.5 and Figure 4.6).



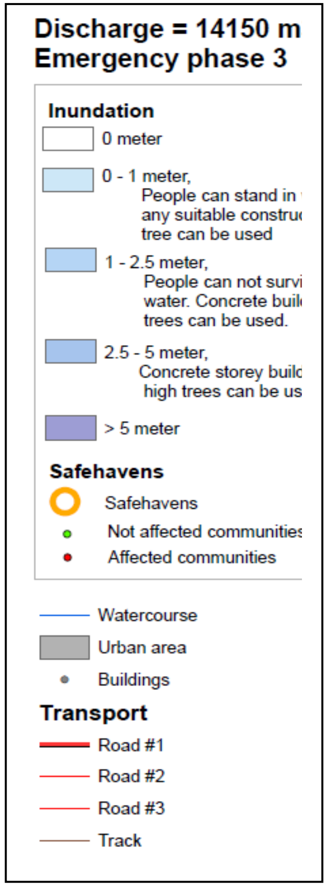


Figure 4.5 Inundation map of study communities in Ada East District at 14150 m^3/s discharge rate

Source: VRA, 2010

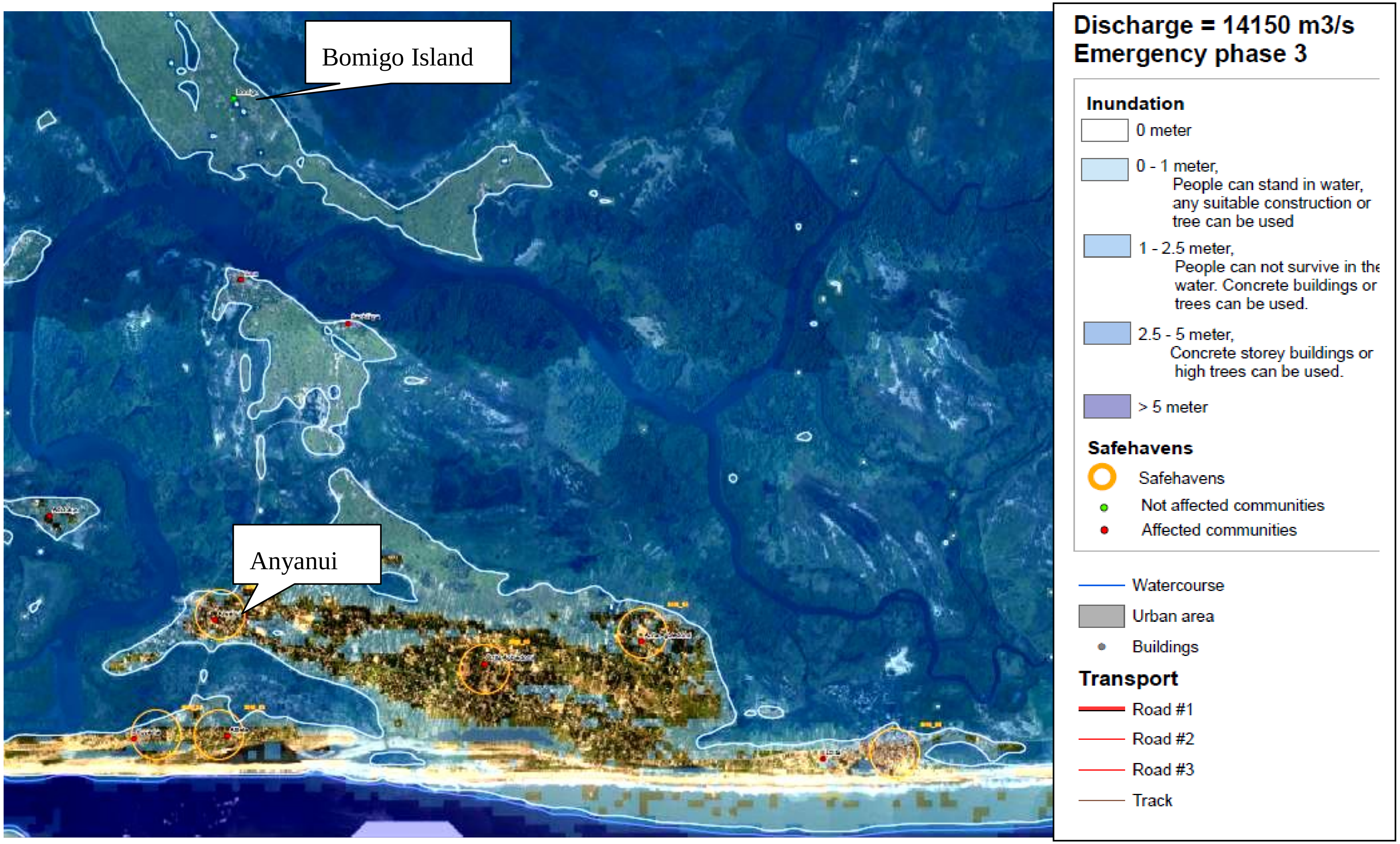


Figure4.6 Inundation map of study communities in Keta Municipal at 14150 m^3/s discharge rate

4.3 Survey results

The results of the household surveys, obtained from administered descriptive questionnaires, are presented.

4.3.1 Demographics

Out of a total of 180 questionnaires, 60 (33 %) each were administered in Anyanui and Azizanya, respectively, while 30 questionnaires, which represent 17% each, were administered in Azizakpe Island and Bomigo Island (Figure 4.7).

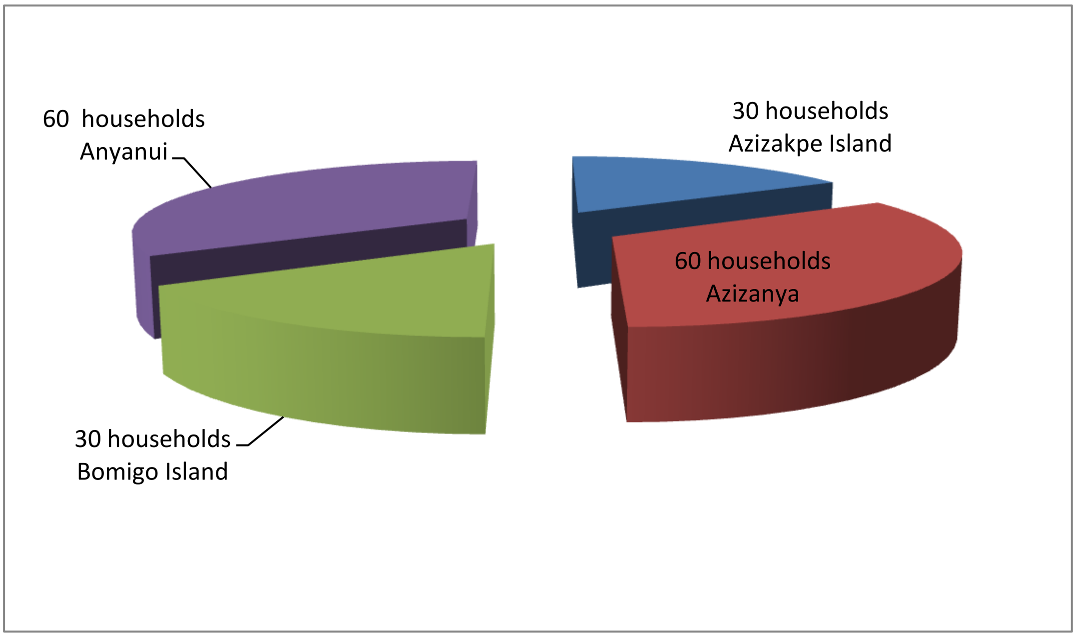


Figure 4.7 Questionnaire administration in study communities

Source: Field data, 2015

Proximity of sample houses to a water body

Proximity of the sampled housing units to a water body was assessed. The majority of the houses were located near (200 m) or very near (less than 100 m) to River Volta, with Anyanui having the highest percentage (72 %) of the houses around the Volta River; and

Azizakpe Island having 52 % of the sampled houses located less than 100 meters to River Volta and the estuary (Figure 4.8).

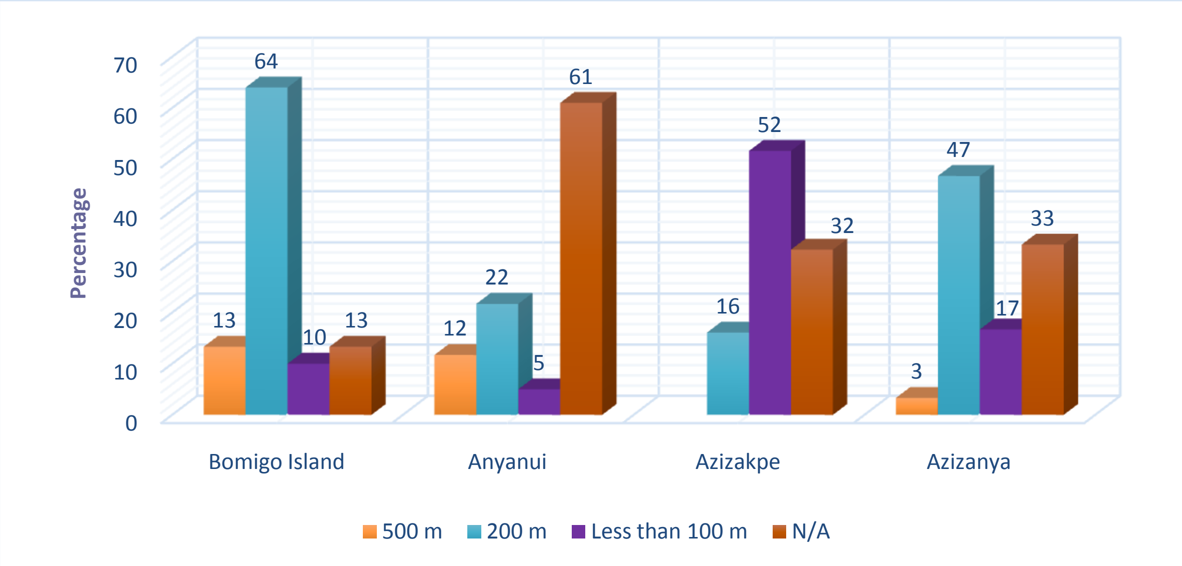


Figure 4.8 Proximity to a water body

Age of Respondents

The age distributions of respondents are between the ages of 20 and 90. Respondents between the ages of 81 and 90 were found only in Azizanya community in the Ada East District (7 %). This age group is an added advantage to ensure reliability of data, as most of the respondents have lived old enough to identify the changes that have occurred over the years, in their ecosystems and their services, and are also able to identify the impacts of these changes in ecosystems and their services. (Figure 4.9)

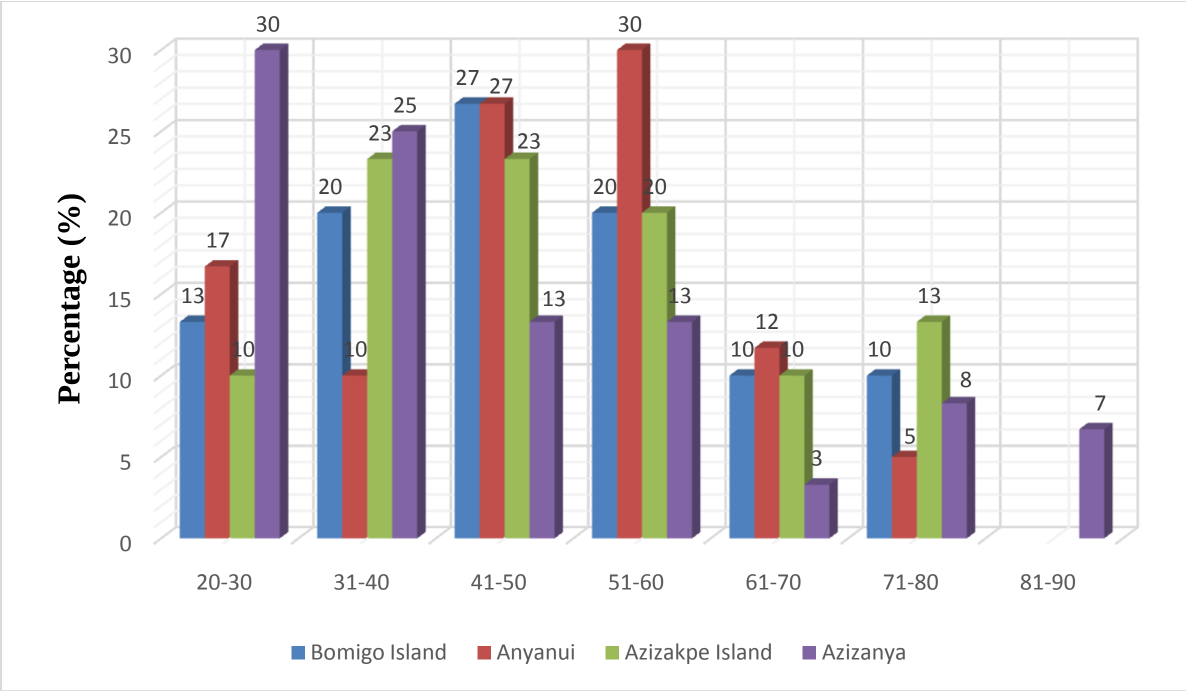


Figure 4.9 Age of respondents

Gender of the respondents

To avoid gender bias in the results of the survey, there was equal representation of both males and females in choosing respondents (Figure 4.10).

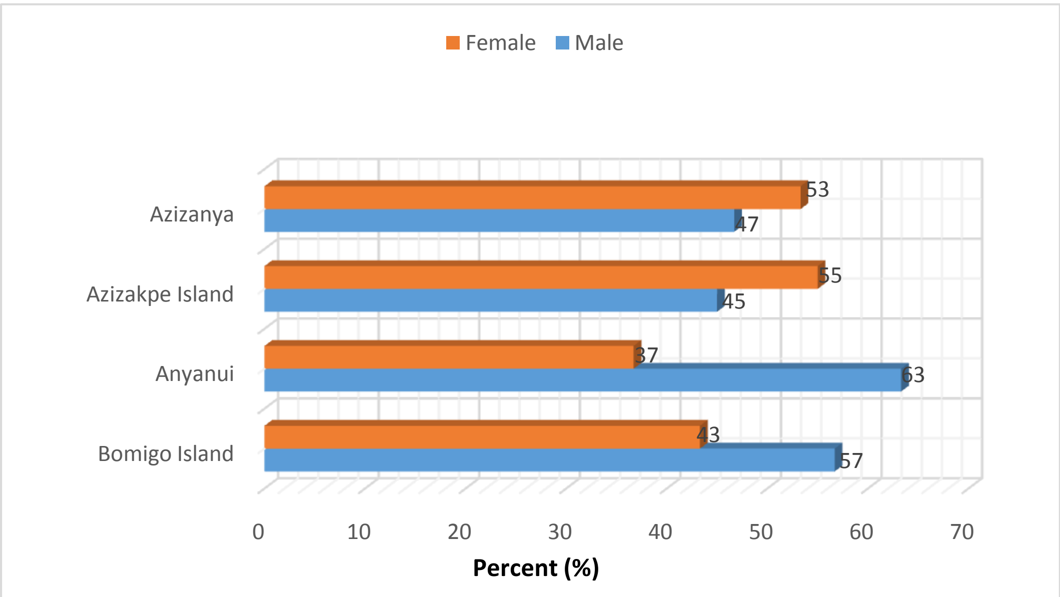


Figure 4.10 Gender of respondents

Educational Level

The majority of the respondents have either primary or no education in all the four communities; with the highest percentage of those in Azizakpe Island, (48 %) with no formal education and highest percentage in Azizanya (48 %), with primary education (Figure 4.11).

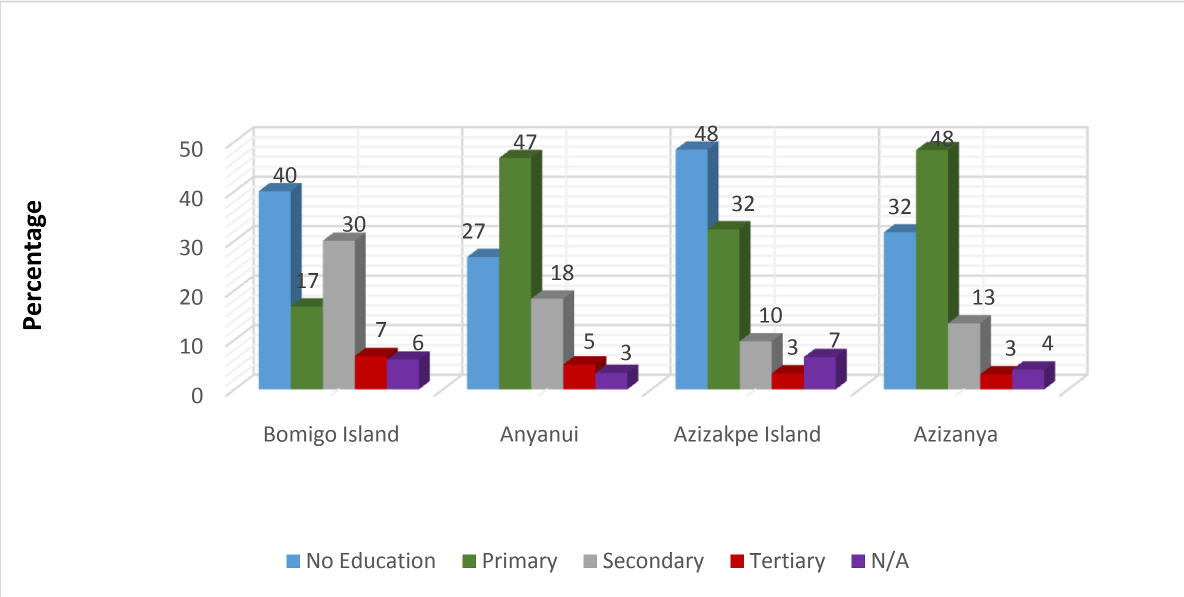


Figure 4.11 Highest education level of the respondents

Marital Status

The results show that most of the respondents are married; Bomigo Island has the highest percentage of married respondents (83 %), while Azizakpe Island has the lowest percentage at 39 % (Figure 4.12).

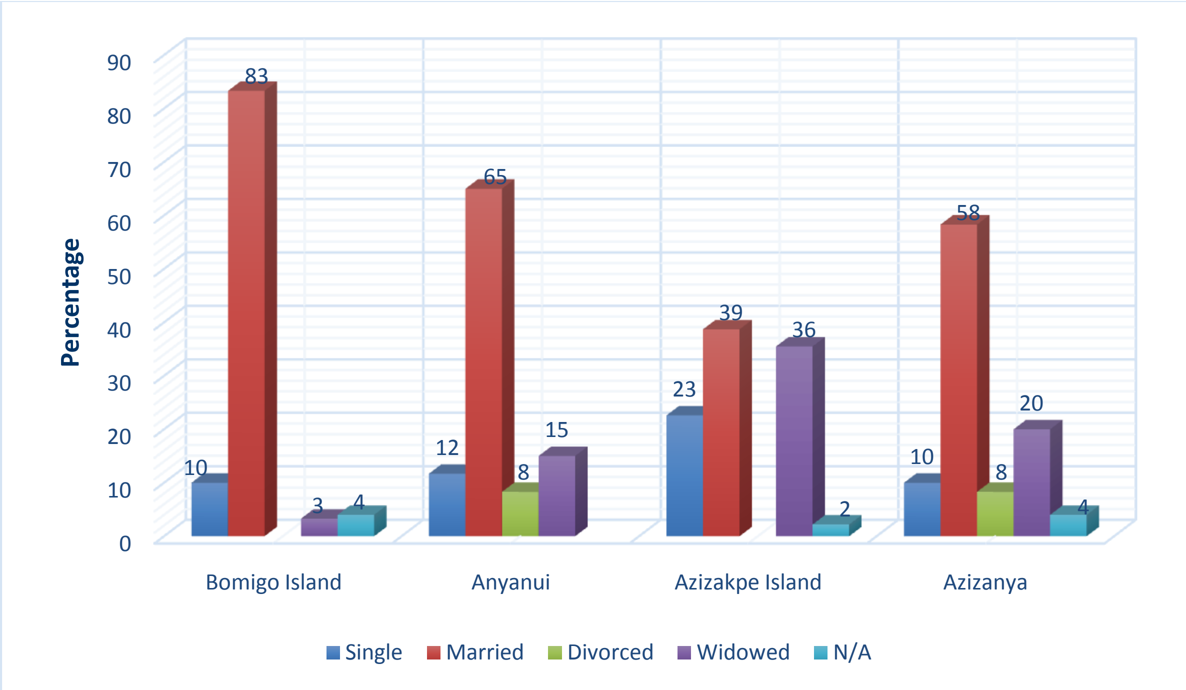


Figure 4.12 Marital status of respondents

Livelihood

With respect to sources of livelihood, many of the respondents are fishermen (32 %) of the four communities, with high percentage farmers (53 %) in Anyanui, and traders (32 %) in Azizakpe Island, who mostly sell mangroves (Figure 4.13). Those with other occupations, 17 % in Bomigo Island and 23 % in Azizanya, most of them were not willing to indicate the specific type of occupation. However, few women said they were self employed and were Fish Mongers (Figure 4.14)

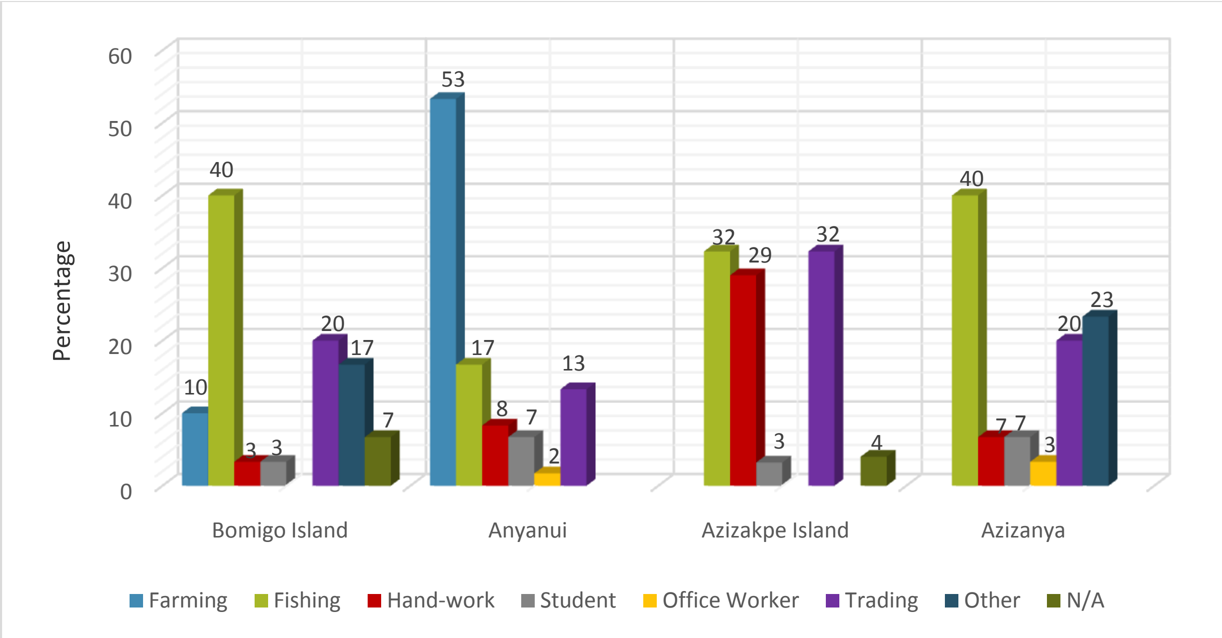


Figure 4.13 Occupation distribution of respondents

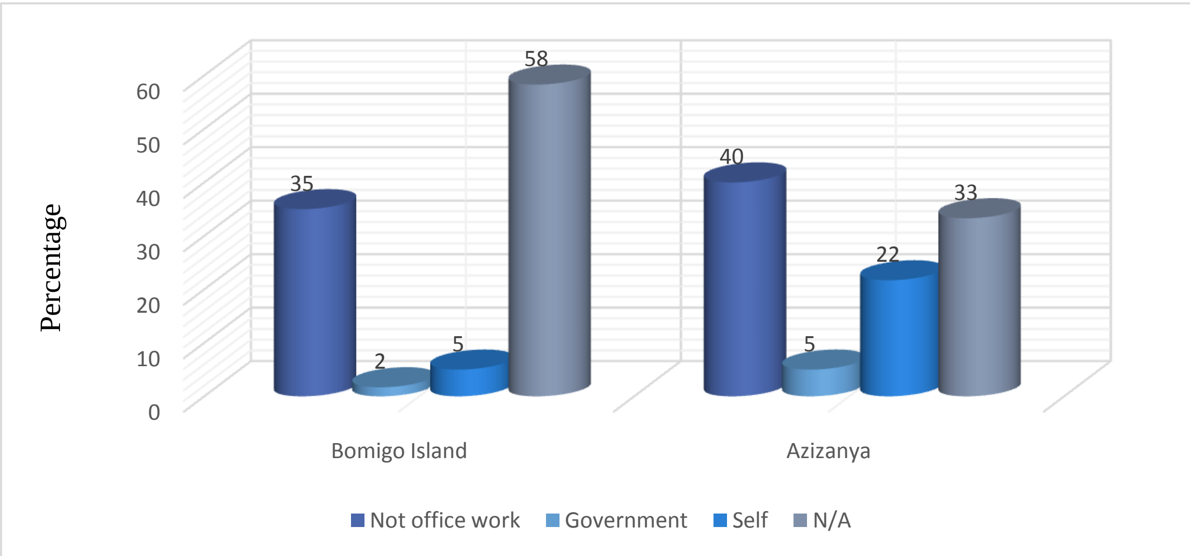


Figure 4. 14 Types of occupation

The Length of Residency in the Community

Most of the respondents have lived in the communities for more than 20 years and could provide adequate and reliable information about the communities: 86 % of respondents have lived in Bomigo Island for more than 20 years, Anyanui has 75 % of its respondents who have lived in the community for more than 20 years, Azizanya has 74 % of its respondents who have lived for more than 20 years in the community, and in Azizakpe Island (89 %) of the respondents have lived from 20 years and above in the community (Figure 4.15).

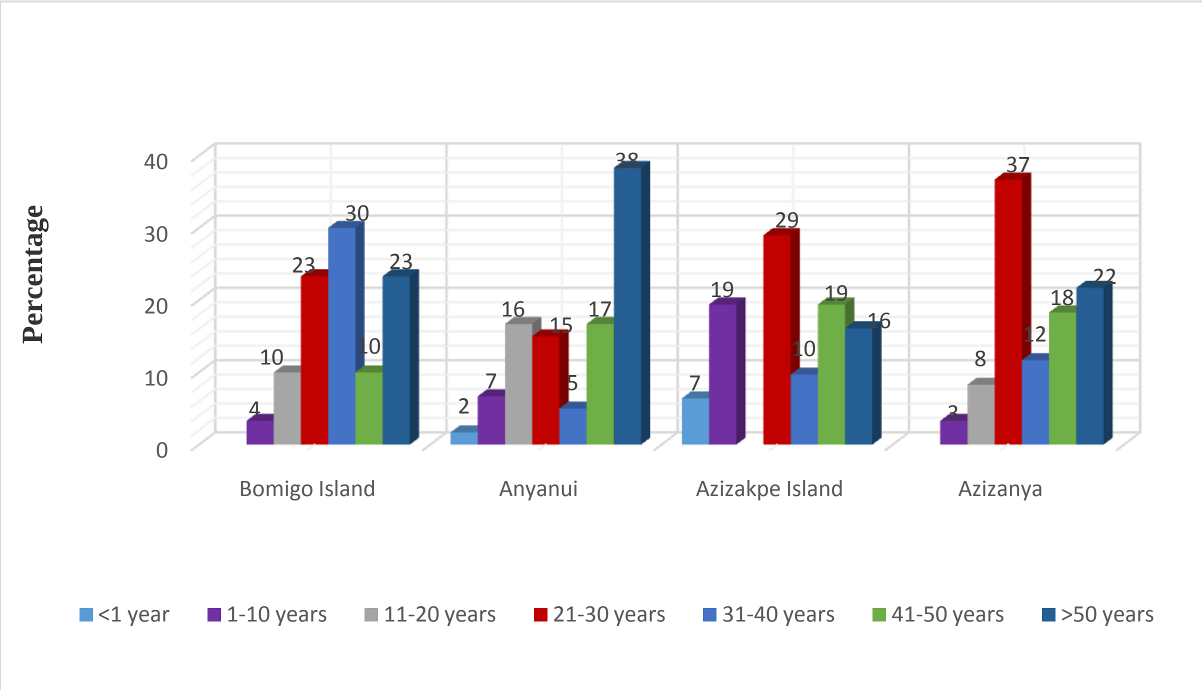


Figure 4.15 Number of years respondents have lived in the community

Residential Status

In the assessment of residential status, 10 % of the respondents from Bomigo Island indicated that they are settlers from Anloga, Galo-Sota and Tunu. In Anyanui 15 % are from Agbledomi, Agotoe, Anloga, Atiteti, Bomigo-Island, Cote d'voire, Dzita and Keta. In Azizakpe Island 26 % settled from Anloga, Dalive, Kpotameh, Lolonya, Tamatoku and Togo. At Azizanya 20 % are settlers originating from Adina, Akplabanya, Anyakor, Anyakpor, Big Ada, Keta, Ningo and Togo (Figure 4.16).

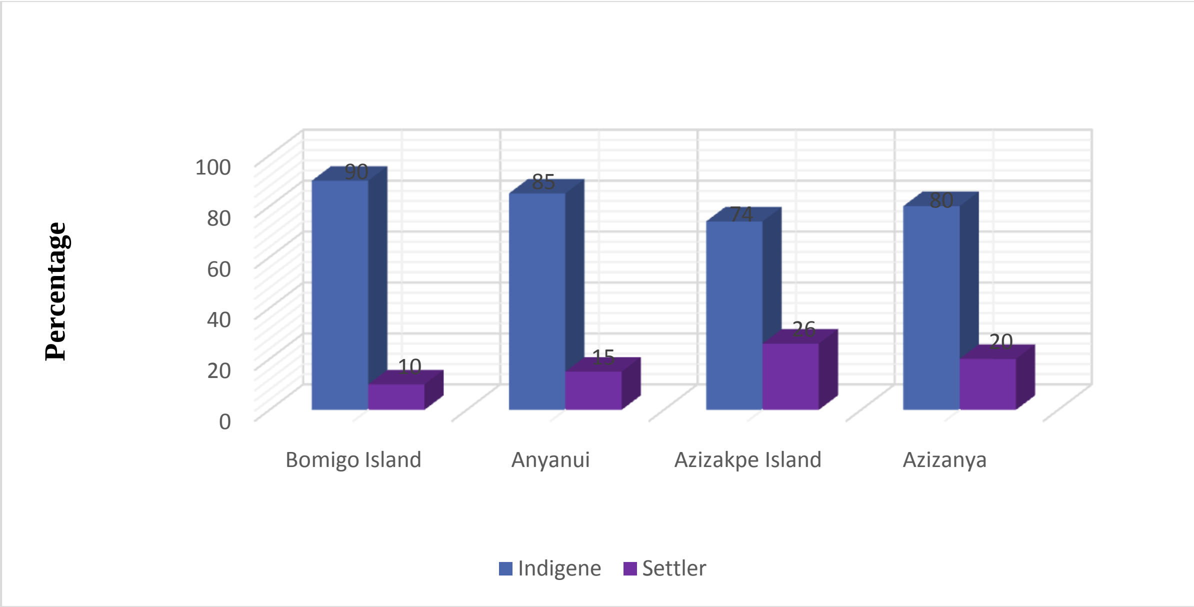


Figure 4.16 Residential status of respondents

In Keta Municipality (Anyanui and Bomigo Island communities), 95 % of the respondents live in their own or family houses, while in Ada East District (Azizanya and Azizakpe Island communities), an average of 45 % of the respondents live in rented houses (Figure 4.17).

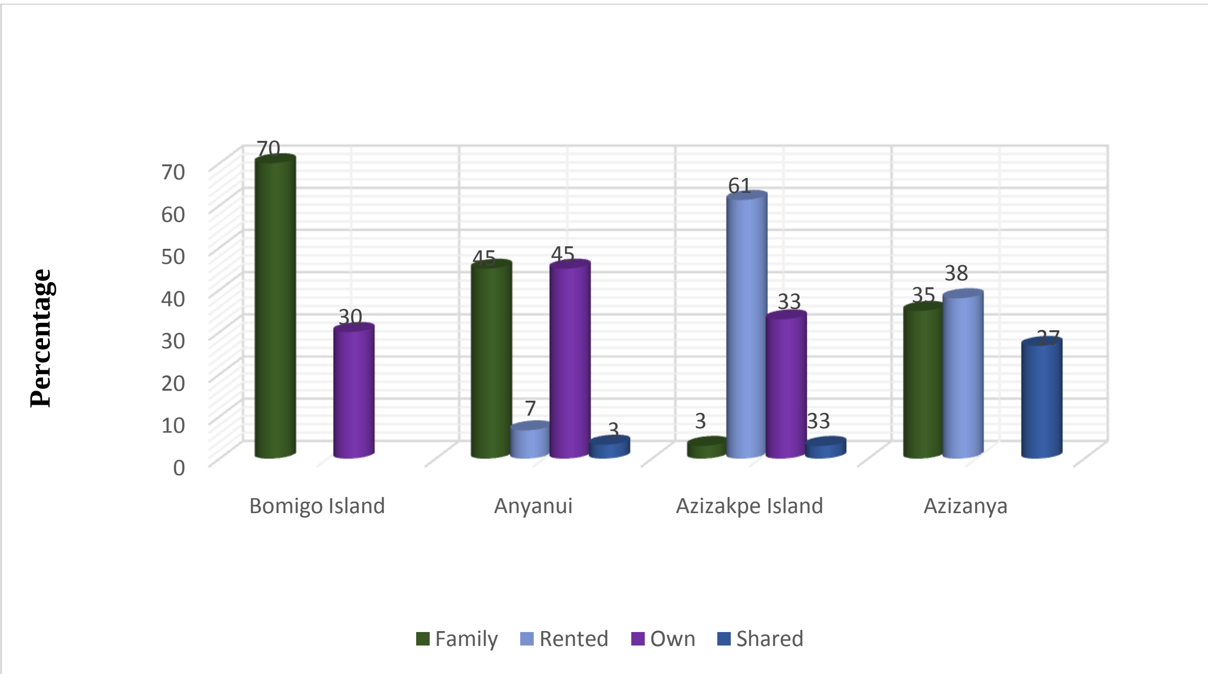


Figure 4.17 Kind of houses respondents live in

Number of Persons in Respondents Houses

The number of respondents living in each household was determined using Cumulative Frequency (CF). The CF value for each household was calculated by multiplying the number of occurrences of a particular number of persons in the household of each respondent, by the total number of respondents within each community. The values obtained were then summed to get the CF value for both male and female dependents, for each community. Azizanya had the highest number of persons in respondents' houses (with CF value of 305 males and 351 females and Bomigo Island had the lowest (CF value of 73 males, 83 females) (Figure 4.18).

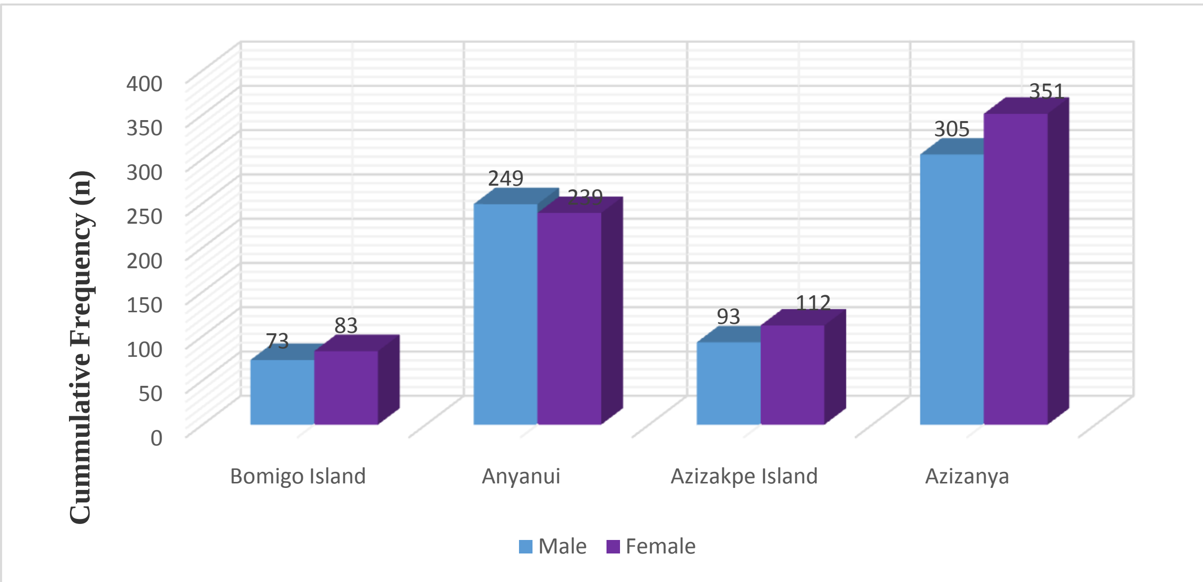


Figure 4.18 Number of persons in respondents' households

Number of Dependants on House heads

There is a high dependency rate (economic burden of family members) on household heads in the studied communities, with 80 % of all persons depending on the household heads in Bomigo Island and 58 % of some persons in households depending on household heads in Azizanya (Figure 4.19).

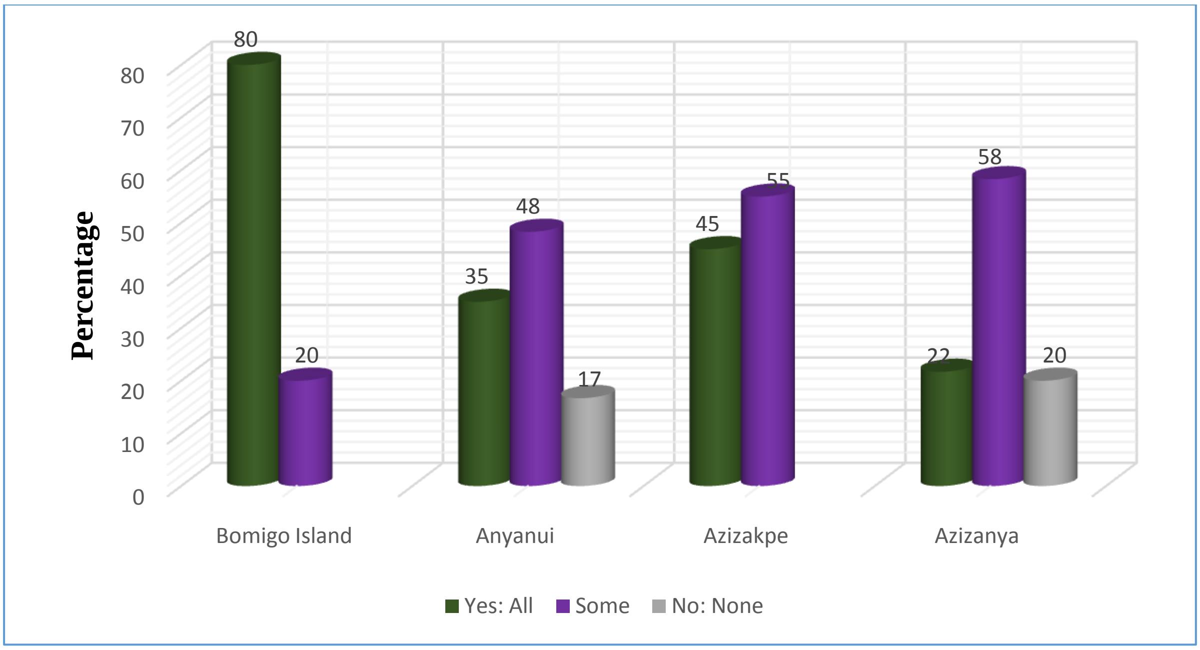


Figure 4.19 Dependants on househeads

Estimated Monthly Income of the Respondents (US$ 1 = GH₵ 3.5)

Sixty percent (60 %) of respondents in Azizakpe Island earn between GH₵ 101 (approximately US$ 29) and GH₵ 200 (approximately US$ 57) per month. In Azizanya, 40 % of the respondents earned between GH₵ 10 (approximately US$ 3) and GH₵ 100 (approximately US$ 28) per month, while a low percentage of respondents from Bomigo Island and Anyanui in Keta Municipal earn between GH₵ 900 (approximately US$ 257) and GH₵ 1,200 (approximately US$ 343) as estimated income per month (Figure 4.20).

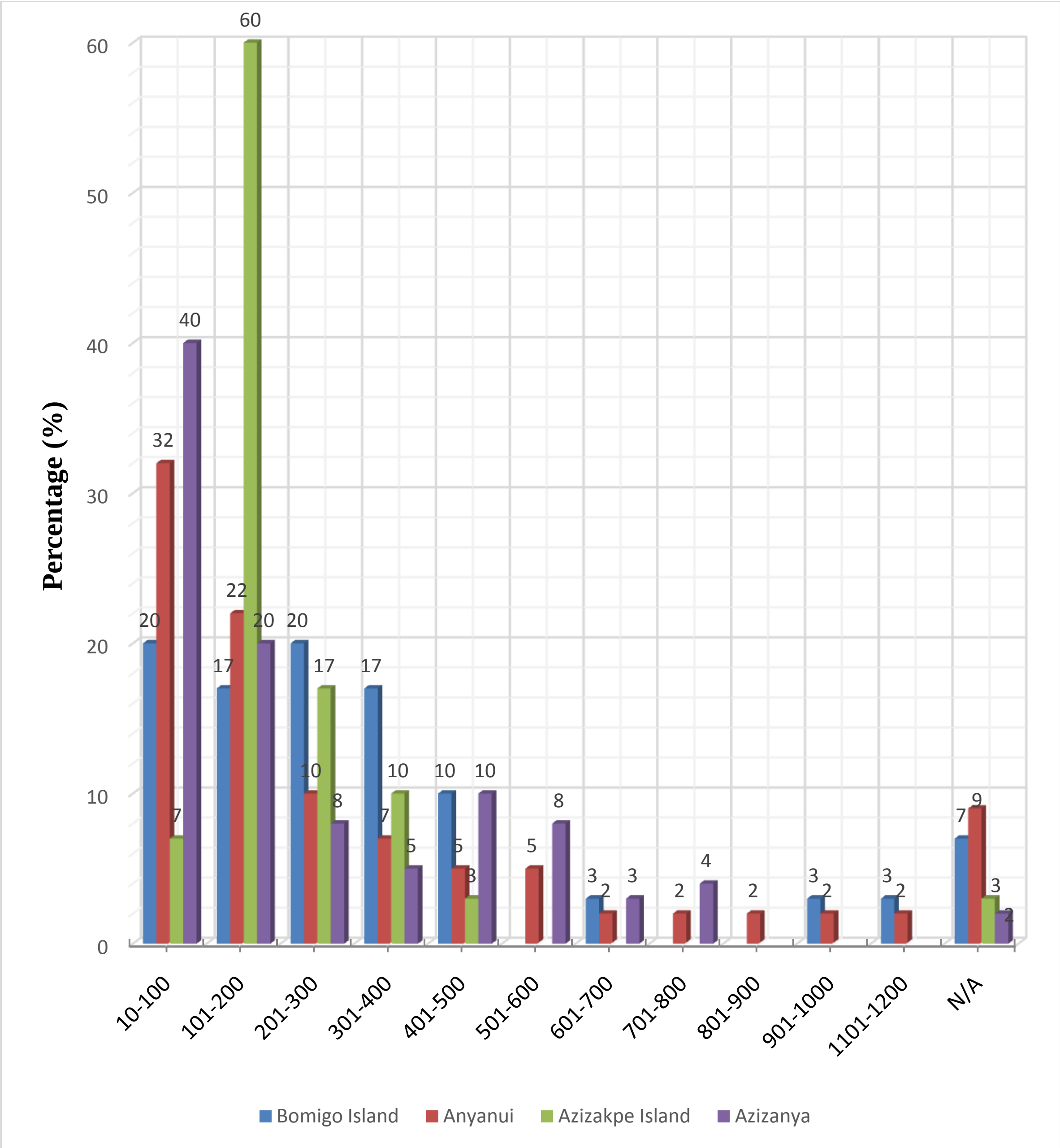


Figure 4.20 Estimated monthly income (GH₵) of respondents

4.4 Disaster Risk Information

Types of Disasters Experienced in the last 10 years

In the last 10 years, flooding is the most common disaster that has been experienced in the study communities. It is also the most frequently occurring disaster and has caused most damages; although in Anyanui, windstorm and flood events have equal impacts (Table 4.1)

Table 4.1 Types of disaster experienced in the last ten years, most occurring disasters and disasters that caused most damages

	Windstorm	Flood	F/O	D/ O	N/A	Total
AZIZANYA						
Disasters experienced in the last 10 years	0	75%	20%	0	5%	**100%**
The most occurring of the disasters	0	75%	25%	0	0	**100%**
Disasters which caused most damage	0	75%	25%	0	0	**100%**
AZIZAKPE ISLAND						
Disasters experienced in the last 10 years	0	97%	0	0	3%	**100%**
The most occurring of the disasters	0	97%	0	0	3%	**100%**
Disasters which caused most damage	0	97%	0	0	3%	**100%**
ANYANUI						
Disasters experienced in the last 10 years	35%	35%	20%	3%	7%	**100%**
The most occurring of the disasters	35%	35%	20%	2%	8%	**100%**
Disasters which caused most damage	35%	35%	20%	2%	8%	**100%**
BOMIGO ISLAND						
Disasters experienced in the last 10 years	30%	40%	27%	0	3%	**100%**
The most occurring of the disasters	30%	40%	27%	0	3%	**100%**
Disasters which caused most damage	33%	37%	27%	0	3%	**100%**

F/O-Fire Outbreak
D/O-Disease Outbreak
N-Not Available

Types of Damages caused by Disasters

Based on the assessment of the damages caused by the disasters indicated in the previous section (Table 4.1), shown below are the kinds of damages caused by the various disasters, according to the respondents' responses and represented with percentage (Table 4.2).

Table 4.2 Types of damages caused by disasters

DAMAGE CAUSEDBY DISASTERS	BI	AN	AI	AZ
Loss/ Collapse of houses and destruction of property	97%	67%	97%	98%
Removal of roofs of buildings	3%	0	0	0
Destruction of livestock, farmlands and produce	0	15%	3%	0
Disease outbreak	0	2%	0	0
Loss of human life	0	0	0	2%
Ecosystem degradation	0	6%	0	0
TOTAL	**100%**	**100%**	**100%**	**100%**

(Codes: BI-Bomigo Island; AN-Anyanui; AI-Azizakpe Island; AZ-Azizanya)

4.4.1 Disaster Risk Reduction Approaches

This section summarizes responses to questions on, efforts by institutions to reduce disasters and the impacts, name of the institutions, details of the efforts, most helpful measures and the efforts by the communities.

All the four communities indicated that there have been efforts by institutions to reduce the risk of disasters, especially flooding in the communities. Anyanui had the highest percentage of respondents who claimed that no institution made any effort to reduce disaster risk (63 %), while the majority of respondents in Azizanya (82 %), Azizakpe Island (73 %), and Bomigo Island (53 %) affirm that efforts have been put in place to reduce disaster risk (Figure 4.21).

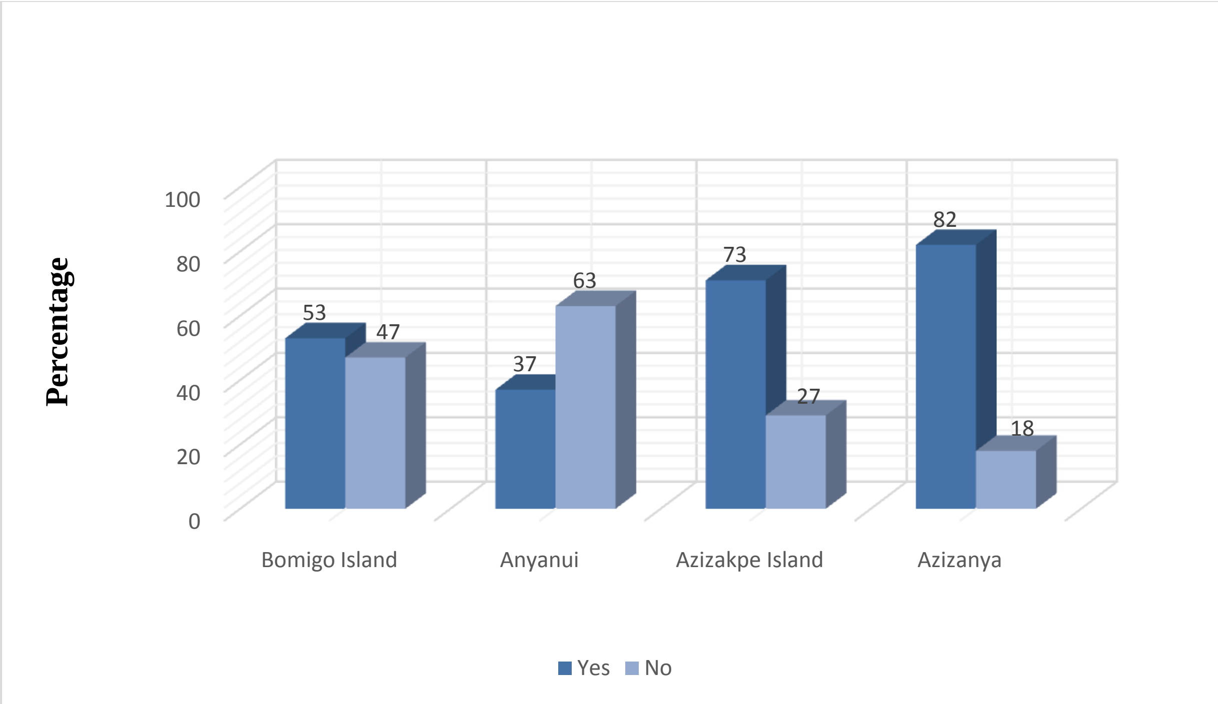


Figure 4 21 Has there been efforts by any institution to reduce disasters and their effects?

Institutions Engaged in Disaster Risk Reduction

The survey showed that the key institutions that were engaged in strategies for disaster risk reduction were the National Disaster Management Organisation (NADMO), Volta River Authority (VRA), Schools and Non Governmental Organisations (NGOs). NADMO, according to 30 % of the respondents in Azizanya, 50 % of Bomigo Island's respondents and 52 % of the respondents in Anyanui, was identified as the most prominent disaster risk reduction institution in these communities, while VRA has been identified as the disaster risk reduction institution in Bomigo Island (Table 4.3).

Table 4.3 Institutions engaged in disaster risk reduction

INSTITUTIONS	AZ	BI	AI	AN
CBO	0	0	0	0
Church	0	3%	0	0
Community effort	3%	0	0	2%

INSTITUTIONS	AZ	BI	AI	AN
NADMO	30%	50%	10%	52%
NGO	4%	0	0	0
School	0	0	0	2%
VRA	0	0	63%	26%
TOTAL	**37%**	**53%**	**73%**	**82%**

(Codes: AZ-Azizanya; BI-Bomigo Island; AI-Azizakpe Island; A-.Anyanui)

Prevalent and Effective DRR Measures

The measures to reduce the impacts of the disasters and the impacts of these measures, as described by the respondents, are summarized in Table 4.4. The most common and effective measures include dredging, (with a higher percentage in three out of the four study communities), early warning and distribution of relief materials.

Table 4.4 Prevalent and Effective measures

	Anyanui		**Bomigo Island**		**Azizakpe Island**		**Azizanya**	
	Measure	Effect	Measure	Effect	Measure	Effect	Measure	Effect
Compensation/ relief items	7%	5%	13%	0	7%	0	47%	17%
Dredging	0	0	43%	80%	61%	71%	12%	42%
Early warning	20%	20%	33%	3%		0	18%	17%
Engineering construction	2%	0	0	0		0	0	0
No answer	0	0	11%	0	32%	0	0	0
No measures	61%	0	0	0		0	20%	0
Public education	10%	0	0	0		0	3%	0
TOTAL	**100%**	**25%**	**100%**	**83%**	**100%**	**71%**	**100%**	**76%**

(Codes: AN-Anyanui; B-.Bomigo Island; A-.Azizakpe Island; AZ-Azizanya)

Respondents' self help

Anyanui

Concerning the efforts respondents at Anyanui are making on their own to reduce or cope with the disasters, about 27 % stated relocation whilst 35 % specified building stronger houses. In addition to that some respondents noted the need for building river defense, planting more trees and weeding around the house, provision of more treated mosquito nets and public education on bush burning and use of agro-chemicals. About 38 % had no idea.

Bomigo Island

Regarding the efforts respondents at Bomigo Island are making on their own to reduce or cope with the disasters, 17 % and 20 % have considered relocation and building stronger houses, respectively. The remaining 63 % did not respond to the question.

Azizakpe Island

As regards the efforts respondents at Azizakpe Island are making on their own to reduce or cope with the disasters, about 13 % considered relocation, and about 81 % considered building stronger houses. Just about 6 % did not respond.

Azizanya

In respect of the efforts respondents at Azizanya are making on their own to reduce or cope with the disasters, about 17 % thought of relocation, about 33 % have considered building stronger houses. About 13 % have made efforts such as proper arrangement of buildings, block fencing, periodic clean up exercises, composting (waste management), creation of defence walls for the water, heaping sand around houses (raised platform), quenching fire properly and wall construction. The remaining 37 % however, indicated that they have not made any efforts.

4.4.2 Knowledge of Ecosystem, Ecosystems' Services and the relationships with DRR

This section reports on the respondent's knowledge of ecosystems and services and its relationship to DRR. Information are provided on the respondents' knowledge of ecosystems, ecosystems in the communities, views on services provided by the ecosystems, views on whether the construction of Akosombo and Kpong dams have impacted on the ecosystems, the kind of impact, other human activities affecting the ecosystems, the last time flooding was experienced, the cause of the flooding, views on roles played by available mangroves, wetlands and other ecosystems to reduce flooding and other disasters, views on reduced services provided by the ecosystems, and causes of the reduction.

More than 80 % of all respondents in each of the communities had knowledge about what ecosystems are and their services provided: with the islands (Azizakpe Island and Bomigo Island) having a slightly higher percentage of knowledge as compared to the two riparian communities (Anyanui and Azizanya) (Figures 4.22).

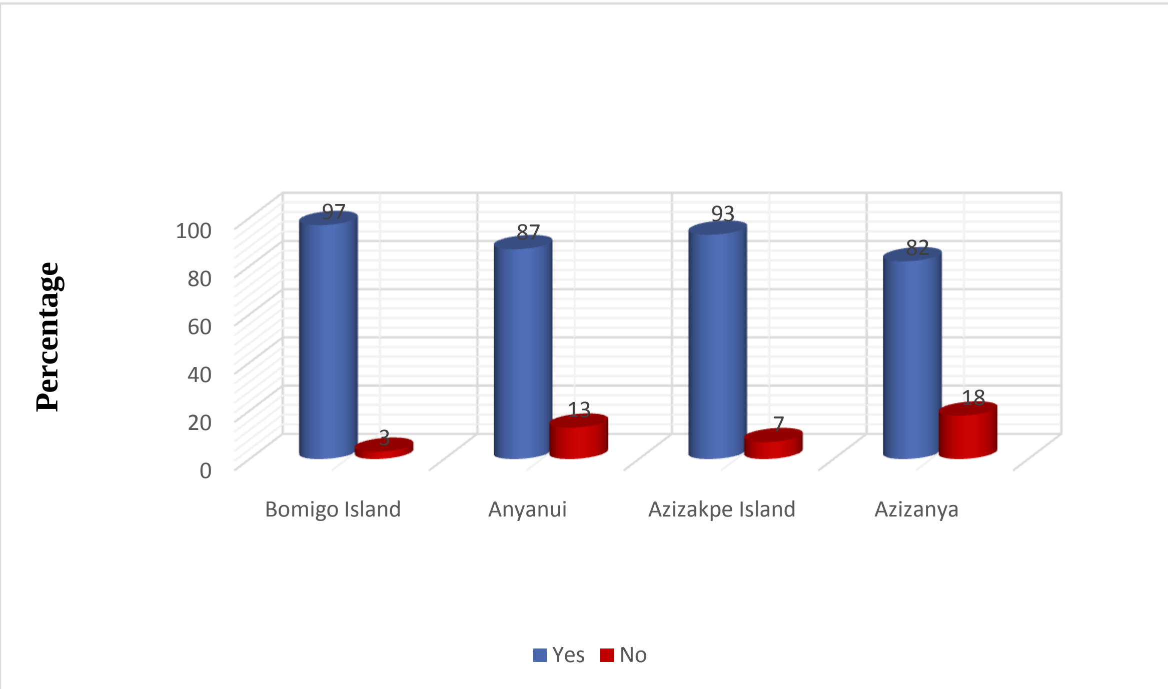


Figure 4.22 Respondents' knowledge on ecosystems and ecosystems services

Ecosystems found in the study communities

The ecosystems found in the study communities were mainly aquatic, for example wetland ecosystems, river ecosystem and mangrove ecosystems. The estuary was also identified as an ecosystem by the respondents in three communities, but was not mentioned as one in Bomigo Island. While the sea, as an ecosystem was identified only in Ada District communities (Azizanya and Azizakpe Island), grassland ecosystem was part of the ecosystems found in the two communities of Keta Municipal (Bomigo Island and Anyanui) (Figure 4.23).

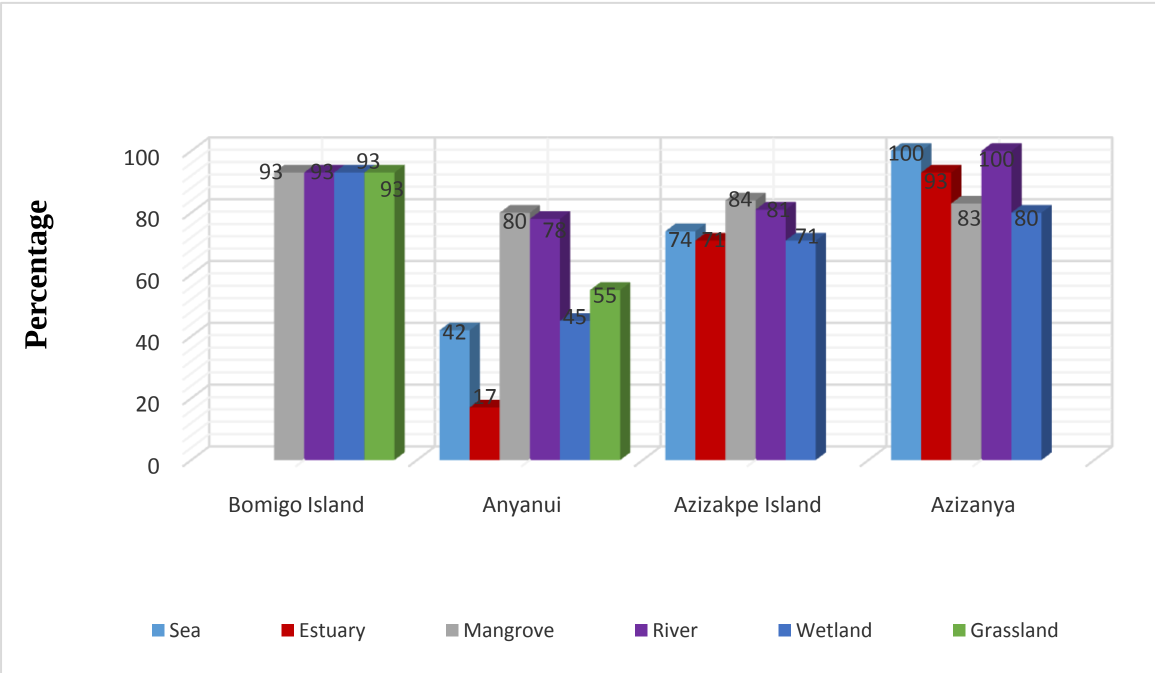


Figure 4.23 Ecosystems found in the study communities

Benefits

The benefits provided from the ecosystems in the respective communities were also specified by the respondents. The majority of respondents considered protection from windstorm as benefit in Bomigo Island (93 %), fishery in Anyanui (77 %), sightseeing/tourist attraction in Azizakpe Island (84 %), and fishery and water for domestic use in Azizanya, (100 %), respectively. Averagely, fishery was found to be the highest service provided by the ecosystems to the communities. Protection from flooding was not found to be an ecosystem service in Azizakpe Island (Table 4.5).

Table 4.5: Respondents view on services provided by ecosystems in their communities

	BI	**AN**	**AI**	**AZ**	**AVERAGE**
Fishery	87%	77%	71%	100%	**84%**
Protection from Erosion	83%	42%	61%	65%	**63%**
Protection from Flooding	87%	28%	0	83%	**50%**
Protection from Windstorm	93%	37%	74%	75%	**70%**
Sightseeing	37%	65%	84%	98%	**71%**
Water for domestic uses	90%	45%	71%	100%	**77%**

(Codes: BI-Bomigo Island; AN-Anyanui; A-.Azizakpe Island; AZ-Azizanya)

Effects of Dam on the Ecosystems

The majority of the 60 respondents each in Anyanui and Azizanya (Riparian communities) and 30 respondents each in Azizakpe and Bomigo (Island communities) indicated that the construction of Akosombo and Kpong dams has affected the ecosystems: Bomigo (97 %), Anyanui (78 %), Azizakpe Island (93 %) and Azizanya (77 %) (Figure 4.24).

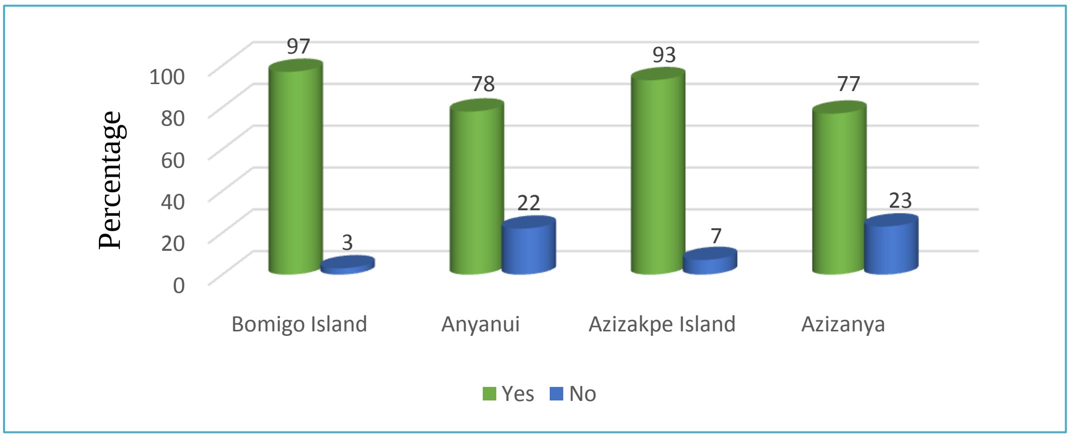


Figure 4.24 View on if the construction of dams affects the ecosystems

Impacts of dams and other activities on the ecosystems

Table 4.6 shows the impacts of the construction of Akosombo and Kpong Dams, and other anthropogenic activities impacting negatively on the ecosystems, according to the respondents.

Table 4.6 Impacts of dams and other anthropogenic activities on ecosystems

Impacts from the Dams	AN	BI	AZ	AI	AVERAGE
Drainage of creeks	16%	60%	0	0	**19%**
Flooding	13%	13%	27%	44%	**24%**
No response	28%	8%	33%	23%	**23%**
Reduced fish stock	30%	13%	30%	23%	**24%**
Reduced flow	3%	0	0	10%	**3%**
Salinization	10%	6%	10%	0	**7%**
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**
Other Anthropogenic impacts					
Bush fire	13%	13%	5%	0	**8%**
Climate change	3%	0	0	0	**1%**
Deforestation/ Indiscriminate cutting of mangroves and coconut palms	42%	67%	22%	10%	**35%**
No response	22%	20%	27%	37%	**27%**
Sand winning	7%	0	3%	7%	**4%**
Use of chemicals and other hazardous materials for fishing	2%	0	10%	3%	**4%**
Water pollution	11%	0	30%	10%	**13%**
Wetlands pollution/filling	0	0	3%	33%	**9%**
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**

(Codes: AN-Anyanui; BI-Bomigo Island; AZ-Azizanya; AI-Azizakpe Island)

Last time flood events were experienced

The respondents were asked of the last time they experienced flood events, this was to further elicit information on the causes of the flood events. From the responses, averagely, 45 % of the respondents in Azizanya and Azizakpe Island of Ada East District experienced flood event in 2015. In Keta Municipal, according to 27 % of respondents in Bomigo Island and 13 % of respondents in Anyanui, flood events were experienced last in June 2014. A number of respondents had no idea (Table 4.7):

Table 4.7 Views on when last flood events were experienced in the study communities (percent of respondents)

Year	Anyanui	Bomigo Island	Azizanya	Azizakpe Island
1963	0	June (3%)	0	0
1984	2%	0	0	0
1988	0	7%	0	0
1991	2%	0	0	0
1994	3%	0	0	0
2000	5%	10%	0	0
2001	7%	March (3%)	0	0
2002	0	10%	0	0
2003	0	March (7%)	0	0
2004	2%	3%	0	0
2007	3%	0	0	0
2008	June (2%)	0	0	0
2009	August (2%)	0	0	0
2010	3%	0	40%	30%
2011	2%	0	0	0
2012	June (5%)	0	0	0
2013	June (7%)	June (7%)	0	0
2014	June (13%)	June (27%)	0	0
2015	March (2%)	3%	50%	40%
No idea	40%	20%	10%	30%
TOTAL	**100%**	**100%**	**100%**	**100%**

Respondents'Kknowledge on the Causes of Flood Events

When the respondents were asked if the causes of flooding were known, of the respondents 83 % in Bomigo Island, 68 % in Anyanui, 97 % in Azizakpe Island and 83 % in Azizanya, answered in the affirmative (Figure 4.25)

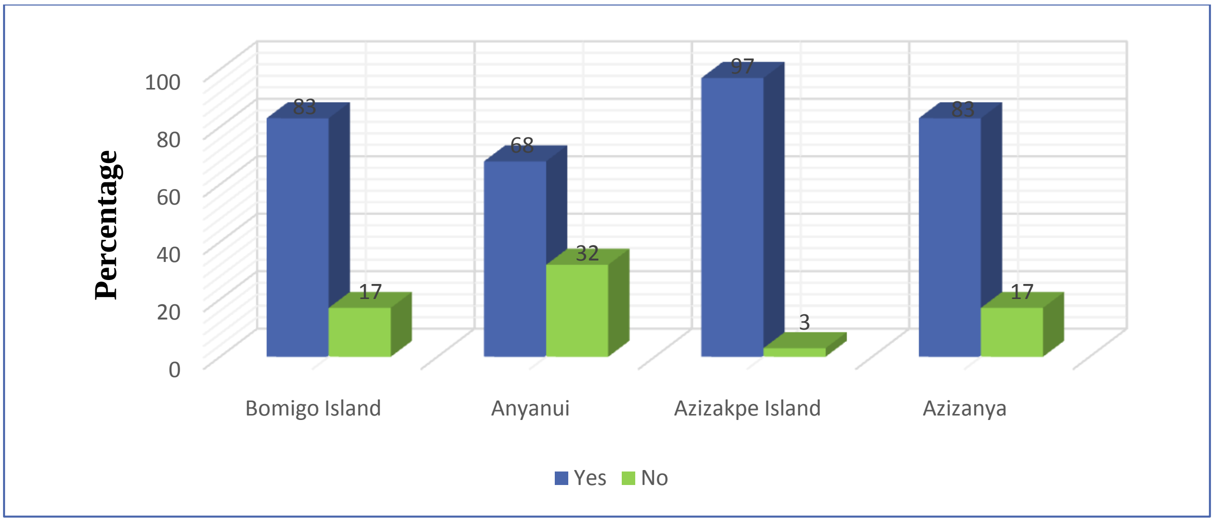


Figure 4.25 Knowledge on causes of flooding

Exact Causes of Flooding in the Study Communities

Of those who affirmed to the knowledge of the causes of flood events in the communities, an average of 26 % of them attributed it to heavy rainfall and opening of dam spill gates on the 1st of November 2010 (Table 4.8)

Table 4.8 Causes of flooding

Cause of flooding	**AN**	**BI**	**AZ**	**AI**	**AVERAGE**
Clear cutting of mangroves	15%	0	2%	0	4%
Filling of wetlands/blocking of waterways	5%	0	0	0	1%
Heavy rainfall	25%	77%	22%	16%	35%
High tide	2%	3%	5%	0	3%
Natural hazard	2%	0	0	6%	2%
No idea	6%	0	14%	26%	12%
Opening of dam spill gates	10%	0	37%	16%	16%
River sedimentation	0	0	0	33%	8%
Sand winning	0	0	3%	0	1%
Topography	3%	0	0	0	1%
Unavailability of drainage system	0	3%	0	0	1%
TOTAL	**68%**	**83%**	**83%**	**97%**	**84%**

(Codes: AN-Anyanui; BI-Bomigo Island; AZ-Azizanya; AI-Azizakpe Island)

Mangroves and wetlands were perceived by the respondents to be helpful during disasters; Bomigo Island has the highest percentage of that perception (90 %) while Anyanui has the lowest (55 %) (Figure 4.26).

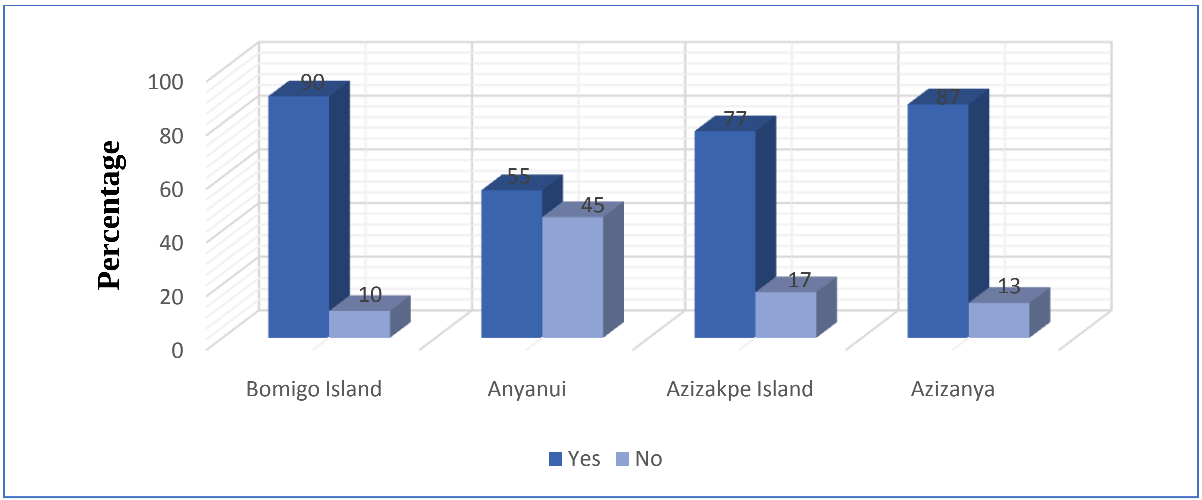


Figure 4.26 Effectiveness of mangroves/wetlands during disasters

Table 4.9 Effectiveness of wetlands and mangroves in reducing flood disaster

Effectiveness of wetlands/mangroves during disasters	**AN**	**BI**	**AZ**	**AI**
Conducive local climatic condition	10%	23%	0	0
Food and building materials from mangroves	5%	10%	18%	0
Limits on the rate of disaster occurrence	0	13%	0	3%
No response	4%	20%	11%	27%
Reduced windstorm	4%	17%	15%	40%
Reduction of fire outbreak	7%	3%	0	0
Reduction of flooding	25%	4%	43%	7%
TOTAL	**55%**	**90%**	**87%**	**77%**

(Codes: AN-Anyanui; BI-Bomigo Island; AZ-Azizanya; AI-Azizakpe Island)

Relevance of Ecosystems in DRR

From the findings, it can be seen that majority of the respondents in Bomigo Island, Azizakpe Island and Azizanya ascertain that ecosystems play important roles in disaster risk reductions. In Anyanui, only 38 % of the respondents attested to that (Figure 4.27)

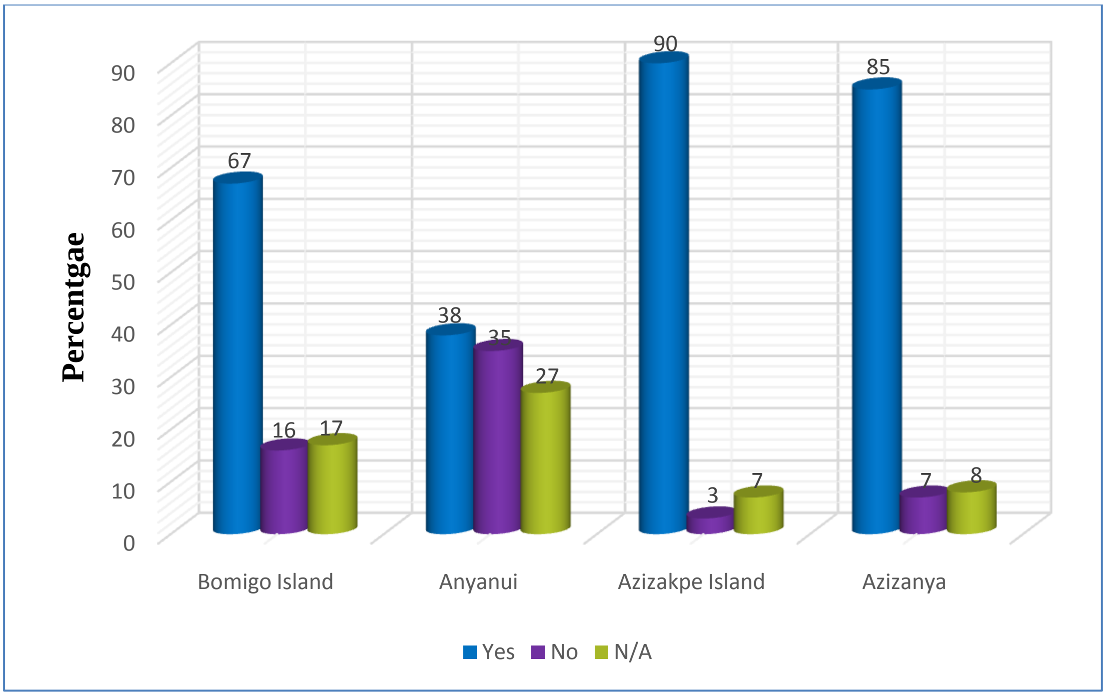


Figure 4.27 Roles played by ecosystems in disaster reduction

The percentages of respondents who identified the characteristics of the roles played by ecosystems in the study area are presented in Table 4.10.

Table 4. 10 Characteristics of ecosystems roles in DRR

	AN		**BI**		**AI**		**AZ**	
CHARACTERISTICS	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Coconut trees provide food, other source of livelihood and fencing materials	1	3%	4	13%	0	0	2	3%
Estuary: tourist attraction/sightseeing, source of livelihood	0	0	0	0	5	17%	3	5%
Grassland protects us from flooding and erosion	3	5%	2	7%	0	0	0	0
Mangrove and wetland reserve resources	0	0	0	0	2	7%	7	12%
Mangroves breaks windstorm and reduce damages	8	13%	6	20%	8	27%	1	2%
Mangroves limit damage caused by fire outbreak	0	0	3	10%	0	0	0	0
Mangroves woods for building houses	1	2%	0	0	0	0	0	0
Mangroves: provide fuel wood for domestic uses	0	0	0	0	2	7%	0	0
N/A	0	0	6	10%	3	5%	0	0
River water for drinking, bathing and to quench fire during outbreak	0	0	0	0	0	0	4	6%
Sea/River provides fish and crabs for the community (for domestic and commercial use)	0	0	0	0	6	20%	8	13%
Sea/River: means of transportation & provides	0	0	0	0	0	0	8	13%

	AN		BI		AI		AZ	
CHARACTERISTICS	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
employment								
Seashore: sand for moulding blocks	0	0	0	0	0	0	1	2%
Trees: reduced flood, windstorm and fire outbreaks	0	0	2	7%	0	0	1	2%
Wetland helps drain and control flood water	5	9%	0	0	2	7%	16	27%
Wetland helps to reduce the spread of bush fires	4	6%	0	0	0	0	0	0
TOTAL	**24**	**38%**	**23**	**67%**	**28**	**90%**	**51**	**85%**

(Codes: AN-Anyanui; BI-Bomigo Island; AZ-Azizanya; A-Azizakpe Island; F-Frequency)

Reduction in Ecosystems Services

On whether there has been reduction in these services provided by the ecosystems to the communities, there is an indication that a drastic reduction has occurred, based on high percentage of “yes” responses: 97 % in Azizanya, 93 % in Azizakpe Island, 87 % in Bomigo Island and 63 % in Anyanui (Figure 4.28).

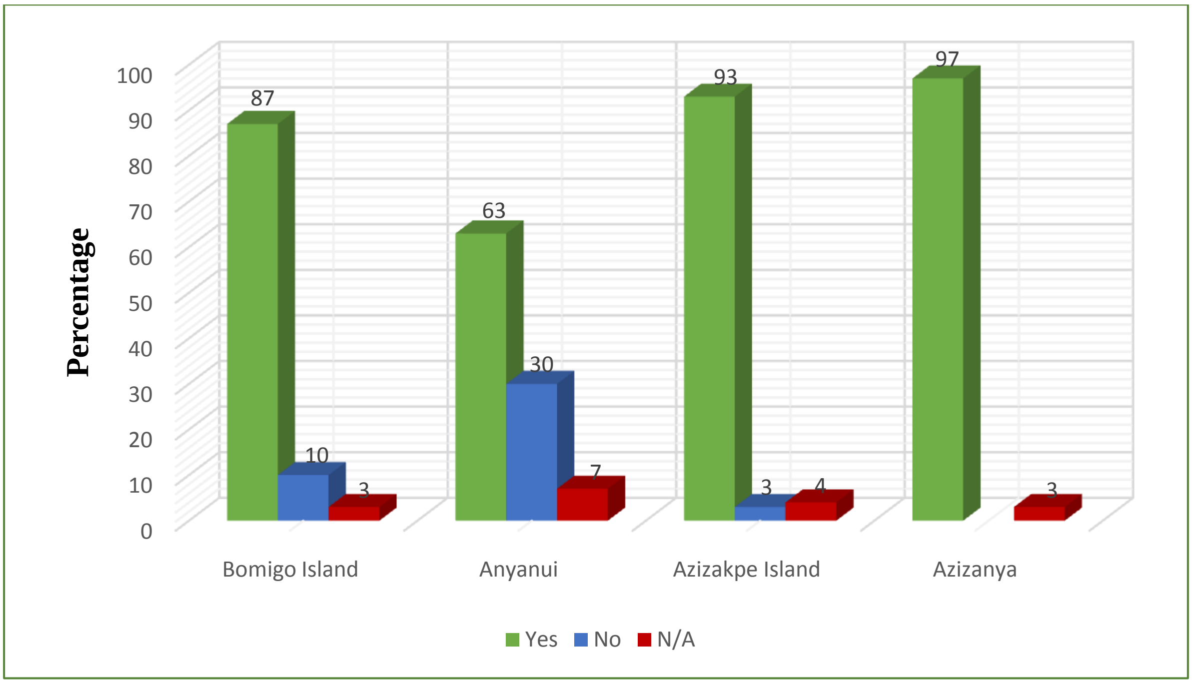


Figure 4.28 Reduction in ecosystems services

Causes of Reduction in Ecosystems services

Among those that responded "yes" to the question on ecosystems' services reduction, majority of respondents in all the study communities identified filling of wetlands and deforestation/cutting of mangroves and other trees as the major causes of the reduction (Table 4.11).

Table 4. 11 Causes of reductions in ecosystems' services

Causes of reduction in ecosystem services	AN	BI	AZ	AI
Climate change/Variability of rainfall	12%	3%	8%	0
Construction of dams	2%	17%	0	10%
Creation of new estuary	0	0	3%	0
Deforestation	13%	43%	31%	27%
Dredging	0	0	7%	0
Excessive flooding	0	0	0	43%
Filling of wetlands	17%	0	9%	0
Incessant bush fire	3%	13%	2%	0
Increase in population	0	0	7%	0
No idea	6%	11%	14%	10%
Sand winning	5%	0	2%	0
Spiritual activities	0	0	2%	0
Use of chemicals in fishing	5%		10%	3%
Water pollution	0	0	2%	0
TOTAL	**63%**	**87%**	**97%**	**93%**

4.5 The feasibility of sustainable approaches to DRR (Eco-DRR), based on the survey

The feasibility of an Ecosystem Disaster Risk Reduction (Eco-DRR) based on findings from the respondents is presented in this section. A summary is presented on the responses to questions of harvesting fuel woods from the mangroves, other sources of fuel wood, the use of fuel woods from mangroves (commercial and personal use), price of fuel wood for commercial purpose, views on human activities that contribute to disaster risk, respondents' willingness to reduce mangroves cutting, the incentives required for the reduction in mangroves harvest, amounts willing to be paid to protect families from disasters and to ensure conservation of mangroves, respondents' positions on either conservation or filling up of wetlands and the reasons for their answers.

Response on the the Harvest of Mangroves

In Azizanya community, the harvest of mangroves for fuel wood by respondents is relatively low (43 %), as compared to those in the other three communities (Figure 4.29).

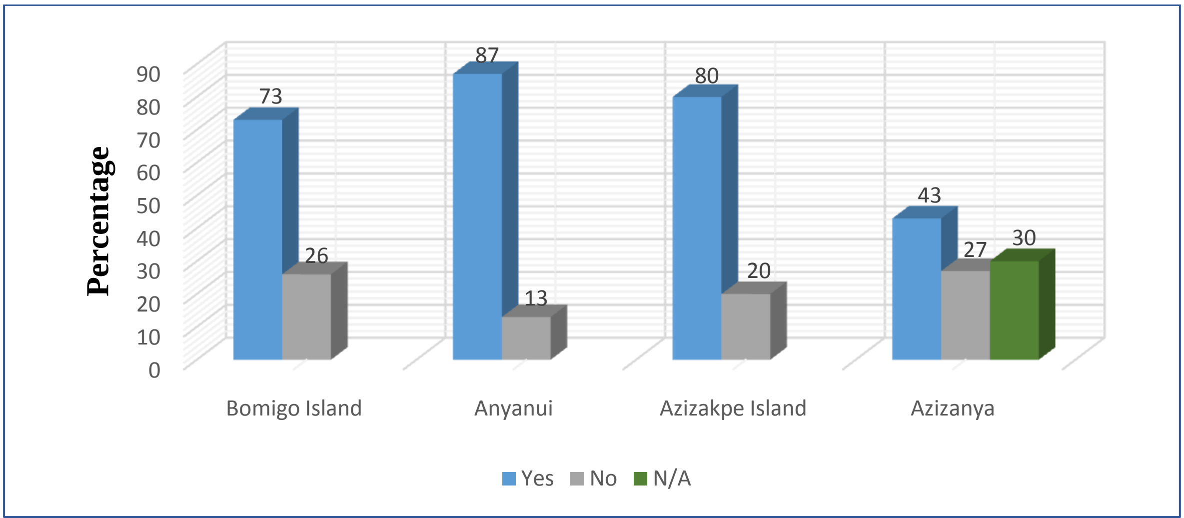


Figure 4.29 Harvest of mangroves

Other Sources of Fuel wood in the Study Communities

Apart from the harvest of mangroves for fuel woods, the respondents indicated other sources of fuel wood. A high percentage of respondents in Azizakpe Island harvest coconut branches and husks, and palm fronds in addition to mangroves, for fuel wood (60%) (Table 4.12).

Table 4. 12 Other fuel wood sources

Other sources of fuel wood	Anyanui	Bomigo Island	Azizanya	Azizakpe Island
Acacia tree	13%	20%	0	0
Bush tree	7%	0	0	0
Coconut branches/husks/fronds	11%	0	8%	60%
Mahogany	0	0	5%	0
Mango tree	8%	0	0	0
Neem tree	48%	53%	22%	20%
Sugar cane shell	0	0	8%	0
TOTAL	**87%**	**73%**	**43%**	**80%**

Exact uses of harvested Mangrove Woods

While 83 % and 57 % of the respondents in Bomigo Island and Azizakpe Island, respectively, sell the harvested mangroves, 5 % of respondents in Anyanui said their usage of mangroves is personal and 75 % of respondents in Azizanya did not specify what they use harvested mangroves for (Figure 4.30).

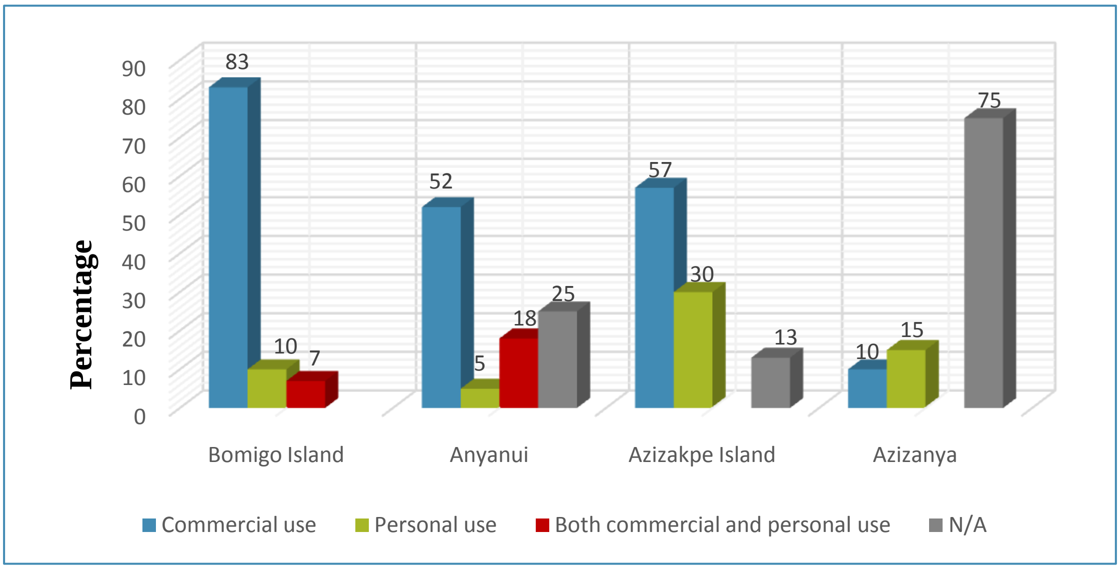


Figure 4.30 Use of fuel wood from mangroves

Some of the respondents who sell fuel wood from mangroves specified the amount a bundle of fuel wood is sold, and other benefits derived from mangroves (Table 4.13).

Table 4. 13 Price of fuel wood bundle from mangroves, other benefits of mangroves

Fuel wood price (GH₵)	**AN**	**BI**	**AZ**	**AI**
1	0	0	2%	0
2	52%	13%	2%	20%
3	0	70%	3%	0
5	0	0	3%	0
6	0	0	2%	0
8	0	0	2%	0
No response	0	0	0	37%
TOTAL	**52%**	**83%**	**14%**	**57%**

Other mangroves benefits				
Cultural heritage	0	0	0	3%
Fishery	70%	93%	33%	705
Herbs	7%	7%	35%	7%
None	23%	0	25%	0
Tourism	0	0	7%	20%
TOTAL	**100%**	**100%**	**100%**	**100%**
Uses of the benefits				
commercial	3%	7%	3%	17%
No response	95%	86%	84%	60%
personal	2%	7%	13%	23%
TOTAL	**100%**	**100%**	**100%**	**100%**

Contributing Factors to Disaster Risks

The survey also indicated that most disaster events in the study communities are exacerbated by deforestation and bush burning. The respondents' views on this are shown in (Table 4.14).

Table 4. 14 Anthropogenic factors contributing to disaster risks

Anthropogenic factors	**AN**	**BI**	**AZ**	**AI**
Deforestation	17%	40%	22%	23%
Filling up of wetlands	3%	0	24%	0
Improper handling of fire	37%	47%	15%	0
Land use/cover change near water bodies	0	0	0	16%
No response	34%	13%	15%	28%
Sand winning	7%	0	18%	33%
Unplanned housing	2%	0	6%	0
TOTAL	**100%**	**100%**	**100%**	**100%**

Willingness to Reduce Mangrove Harvesting

Most of the respondents in the study communities are willing to reduce the rate at which they cut mangroves since it can reduce flood disasters in their communities (Figure 4.31).

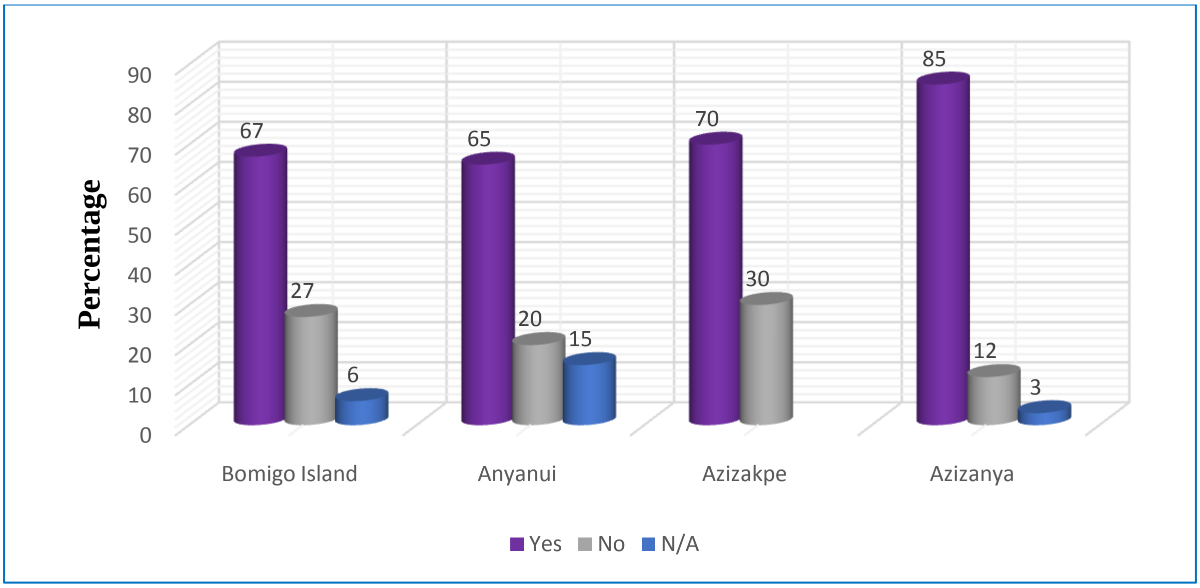


Figure 4.31 Willingness to minimize mangroves cutting

Incentives for Ecosystems Protection

Shown in Table 4.15 is a representation of incentives that respondents are willing to accept to ensure ecosystems protection. It is deduced from the table, that high percentages of respondents want financial assistance and public education/ law enforcement for ecosystems protection, as forms of incentives that would encourage reduction in ecosystems degradation. It is also notable that quite percentages of respondents are not willing to accept any incentive (Which could have many interpretations).

Table 4. 15 Incentive for ecosystems protection

Incentives	Anyanui	Bomigo Island	Azizanya	Azizakpe Island
Alternative livelihood	4%	6%	10%	0
Creation of jobs	5%	7%	0	0
Financial support	35%	50%	15%	27%
None	34%		32%	23%
Planting of other trees	20%	37%	5%	0
Public education/enforcement of ecosystems protection laws	2	0	38%	50%
TOTAL	**100%**	**100%**	**100%**	**100%**

Despite the low earning in the study communities, the respondents are willing to pay for the protection of ecosystems, to ensure that their families are protected from disasters and the effects of disasters. Bomigo Island has the highest percentage of respondents willing to pay between GH₵ 10 (approximately US$ 3) and GH₵ 100 (approximately US$ 28) (40 %). While in Anyanui, 33 % of the respondents did not respond to the question (Figure 4.32).

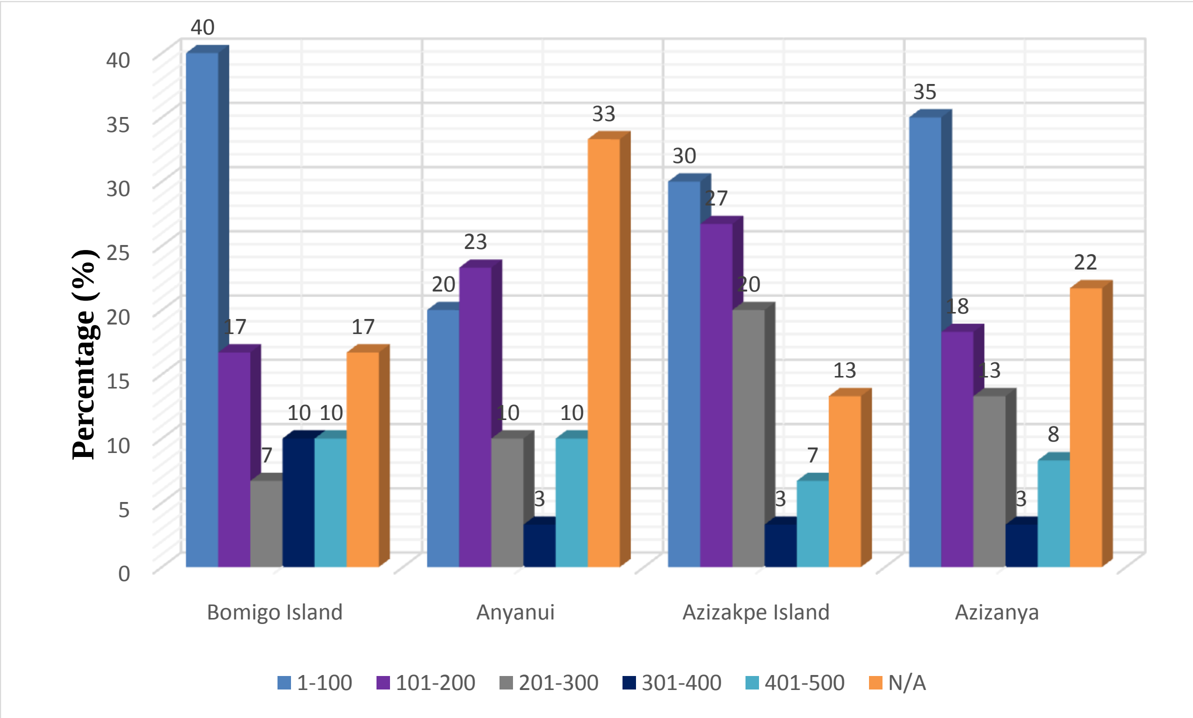


Figure 4.32 Amount (GH₵) respondents are willing to pay for family protection

Willingness to make Financial Commitment for Mangrove Conservation

Apart from Anyanui respondents, most of who are not willing to make financial commitment for mangroves conservation, respondents from Bomigo Island, Azizakpe Island and Azizanya are highly willing to make financial commitments to see that mangroves are conserved (Figure 4.33).

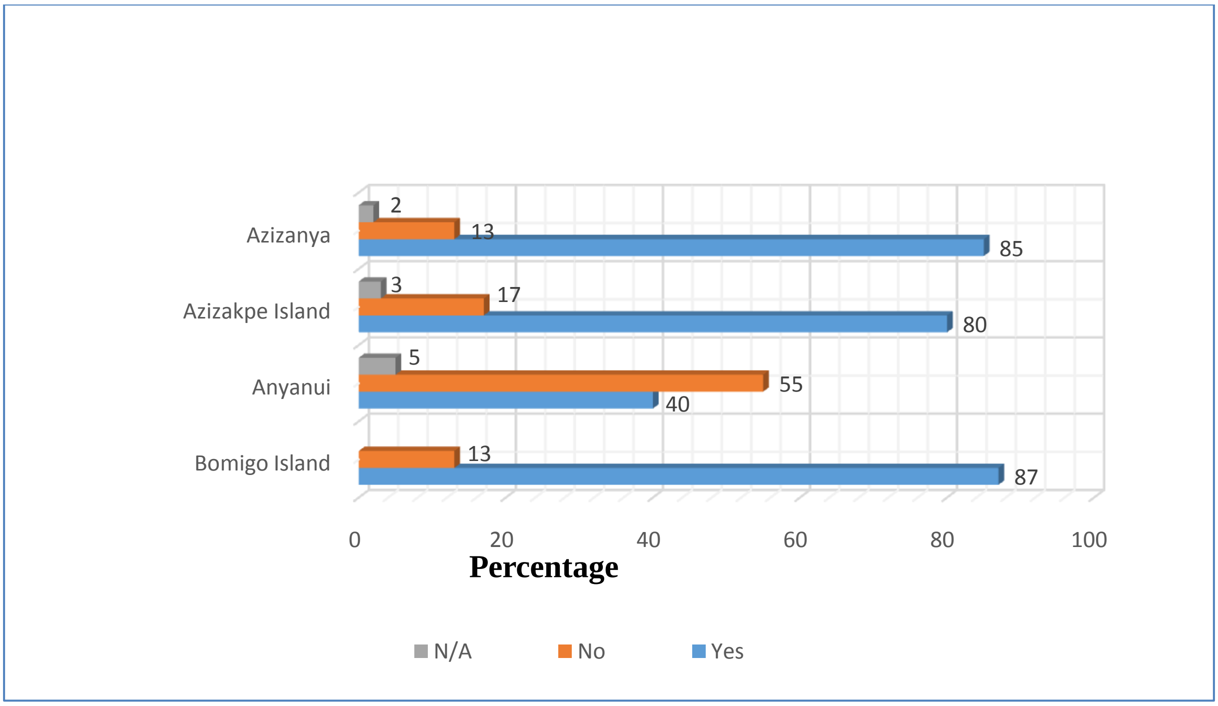


Figure 4.33 Willingness to make financial commitment for mangroves conservation

Amounts that Respondents are Willing to Pay for Mangrove Conservation

From the results, high percentages of respondents in Azizanya and Azizakpe Island are willing to pay between GH₵ 10 (approximately US$ 3) and GH₵ 500 (approximately US$ 143). When compared to their estimated monthly income in Figure 4.20: Azizanya (80 %), Azizakpe Island (60 %), Anyanui (40 %) and Bomigo Island (87 %), it is clear that they are willing to stake all their earnings to ensure that mangroves are protected, as long as mangroves protection is linked to the communities' protection from disasters (Figure 4.34).

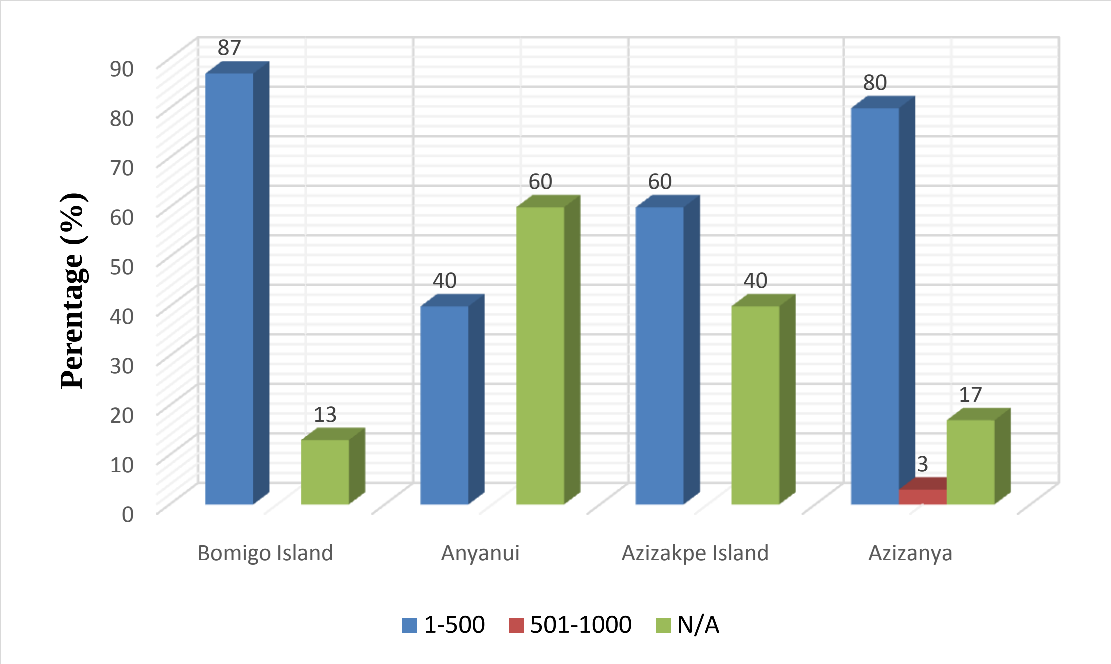


Figure 4.34 Amount (GH₵) willing to pay for conservation of mangroves

Respondents Views on Preservation or Filling up of Wetlands

Summarized below (Table 4.16) are respondents' position on either preservation of or filling up of wetlands for other uses, presented with frequencies and percentages.

Table 4. 16 Respondents' view on preservation of, or filling up of wetlands

	Anyanui	Bomigo Island	Azizanya	Azizakpe Island
Yes, preserve wetland	47 (78%)	17 (57%)	60 (100%)	27 (90%)
No, fill wetland for other uses	13 (22%)	13 (43%)	0 (0%)	3 (10%)
TOTAL	**60 (100%)**	**30 (100%)**	**60 (100%)**	**30 (100%)**

Chi-Square analyses determined the extent to which there is an association between respondents' perception of preserving and filling up wetlands. At significant levels of 1 %, 5 % and 10 %, the asymptotic p-value of the Pearson Chi-Square test points to a significant statistical association between responses observed as per preserving wetlands in the study communities (Table 4.17). For that reason,, the study rejects the null hypothesis of no significant statistical association for preserving wetlands in the communities, and accepts the alternative hypothesis that is a significant statistical association between responses for preserving wetlands.

Table 4.17 Chi-Square Test summary of the association between wetland preservation.

	Value	Degree of Freedom	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.17127	3	0.0000883
Likelihood Ratio	15.01	3	0.0000
Number of valid cases	180		

Reason for Preservation or Filling up of Wetlands

Table 4.18 shows the respondents reason for either preserving the wetlands or filling up the wetlands.

Table 4.18 Respondent' reason for engaging in the preservation or filling up of wetlands

Preservation of wetlands	**Reasons for preservation**	**AN**	**BI**	**AZ**	**AI**
	Breeding ground for fish	17%	17%	42%	17%
	Ecosystems protection and sustenance	0	40%	10%	0
	Flood and erosion control	14%	0	32%	47%
	Recovery during disaster	0	0	8%	26%
	Source of livelihood	47%	0	0	0
	Tourist site	0	0	5%	0
	Water regulation	0	0	3%	0
	TOTAL	**78%**	**57%**	**100%**	**90%**
Filling up of wetlands	**Reason for filling the wetlands**				
	For NGO projects	3%	3%	0	0
	Land reclamations for settlement	7%	33%	0	7%
	Planting of more trees/ farming	10%	7%	0	0
	To reduce mosquitoes	2%	0	0	0
	No response	0	0	0	3%
	TOTAL	**22%**	**43%**	**0**	**10%**

Suggestions on how to Improve DRR

Respondents were asked of their opinion on any other measure that could be put in place to enhance disaster risks reduction in the studied communities, below are summary of what they suggested (Table 4.19):

Table 4.19 General suggestions by respondents on how to improve DRR

DRR suggested measures	AN	BI	AZ	AI
Tree planting	32%	30%	15%	10%
Reduction in prices of building materials	0	3%	0	0
Availability of fire service	0	3%	0	0
Public education on causes of disasters causes and how to prevent disasters.	37%	41%	22%	30%
Restoration of wetlands and mangroves	12%	3%	0	0
Dredging of rivers	5%	4%	38%	0
Construction of drainage channels	7%	0	0	0
Roads and bridge constructions for easy access during disaster	0	0	0	0
Provision of alternative means of livelihood	5%	3%	0	12%
Implementing and enforcing by laws on ecosystems' conservation	0	3%	8%	0
No idea	0	10%	0	0
Prevention of usage of chemicals in fishing	2%	0	8%	0
Prevention of sand winning	0	0	0	45%
Systematic opening of dams' spill gates	0	0	2%	3%
Proper waste management	0	0	5%	0
Proper location of buildings	0	0	0	0
Sand heaping along river banks and around houses	0	0	2%	0
TOTAL	**100%**	**100%**	**100%**	**100%**

4.6 Summary

Findings and results of the research were analysed using tables, figures and texts. Bomigo Island was found to be experiencing flood disasters, though the VRA map showed that the Island was not prone to flooding. There is substantial knowledge of the benefits of ecosystems, especially as tools for disaster risks reduction. There is evidence of willingness, on the part of the respondents to preserve the ecosystems. The findings are fully discussed in the next chapter.

CHAPTER FIVE

DISCUSSION

5.1 Flood Hotspots based on VRA Inundation Maps and Socio-economic Survey

Remotely sensed and Geographic Information System (GIS) data from VRA hazard/inundation map, for the simulation of floodplains flooding processes, flood management and flood risk mitigations (Horritt *et al.*, 2010), were very useful as decision support tools, in the identification of flood prone communities in the lower Volta area. These maps were modelled based on the elevation of the communities downstream of the Akosombo dam, prehistoric flood events and hydrologic analyses of flow peak discharge (Ocran-Hammond, 2015). In line with works by Degiorgis *et al.*, (2012); who noted that the flow rate of most rivers are drastically reduced as barriers are introduced into the river channels. Before the construction of the dam, the Volta River flowed up to the rate of 11,800 m^3 per second (Ocran-Hammond, 2015). Since the construction of the dam, the Volta River flows sometimes at a rate below 1,000 m^3 per second.

The inundation maps were modelled with 3,000 m^3 per second as the least rate of spillage and 14,150 m^3 per second as the highest rate at which the dam could be spilled. From the maps, it was observed that at the least discharge level of 3,000 m^3/s, Azizakpe Island would be inundated, while at a higher discharge rate of 9,000 m^3/s, Azizanya community which initially was within the safe zone at 3000 m^3/s, would be inundated; and at the highest discharge level at 14,150 m^3 per second, Azizanya, Azizakpe Island and Anyanui would all be inundated. Bomigo Island was not prone to flooding, based on VRA maps. Bomigo Island's not being prone to flooding, according to the maps, could be attributed to the fact that model outputs could be affected, based on the fact that models are expensive, time consuming and require information that sometimes are not readily available for all areas. Model outputs can also be affected by:

- Significant approximation (observation uncertainty)
- Other forms of uncertainties like (a) parameter uncertainty due to imperfect model calibration (b) model structural uncertainty originating from model's inability to perfectly schematize the physical processes involved. All these contribute to make mapping of flood-prone areas far from being perfectly achieved even in developed countries (Degiorgis *et al.*, 2012; Götzinger and Bardossy, 2008).

To minimize these uncertainties for flood disaster management, additional efficient data were included (Di Baldassarre *et al.*, 2009); ground truth data from Bomigo Island was used. The survey showed that Bomigo Island had experienced series of flood events between June 1963 and February 2015 that were caused by heavy down-pours, and in some instances, by high tides. Due to poor drainage systems, surface runoff quickly accumulated into floods. The information gathered from Focus Group Discussions in Bomigo Island reveals that there was massive flood 40 years ago which was caused by high tide. Since then floods were mainly caused by rainfall and the clayed nature of their soil, and although not of high quantities, floods cause damage in the communities.

It was discovered from the study that, to effectively manage flood disaster, aerial photographs and mapping should not be used as the only risk indicator. Bomigo Island, for instance, according to the VRA inundation maps cannot be flooded at different levels of water discharge, but the community survey revealed that flood events are being experienced in the Island. Though mainly as a result of rain, high tide flooding is also being experienced. This was also experienced by the researcher during the administration of the questionnaires; though not a serious flood event, it is an indication that at a high discharge from the dam or high tides in the days of heavy downpour, a serious flood disaster would occur in the Island of Bomigo.

Flood disaster is the prevalent disaster in all the study communities. According to Keta Municipality's NADMO Coordinator, flooding is an annual event in most of the communities in the Municipality, as a result of increasing population and building on waterways, it affects more than 1,500 people, houses, schools, property with other health challenges (Kunii *et al.*, 2002).

From the results there is every indication that though models are useful in DRR, they represent only a small part of DRR exercise (Di Baldassarre *et al.*, 2009), hence the need to always incorporate multiple risk indicators, such as household surveys and the use of local knowledge. A case in point is shown in plates 5.1, pictures of a newly planted mangroves area in Bomigo Island, the place was marshy and without water in the morning, but by evening due to high tide, the area was flooded. The flood can get as far as the inter-community, depending on the level of the tide.

Plate 5.1 1 newly planted mangroves in Bomigo Island, marshy without water, in the evening the place was flooded.

5.2 Demographics

From the findings, there is close to equal representation of both male and female respondents who are mostly married. They have lived most of their lives in these communities as indigenes, and basically living in their family houses or personally built houses. The levels of education in these communities are low, with either no education or only primary education as the education status of respondents. The respondents are basically farmers, fishers, craft makers and traders, with a very low percentage of government workers, which could be attributed to the education status. On average, each household is made up seven (7) persons, with high dependency on the household heads, whose estimated monthly income are within the ranges of GH₵ 10 and GH₵ 1,200 (equivalent of US$ 3 and US$ 91, at the conversion rate of US$ 1 to GH₵ 3.5). The demographic and socio-economic characteristics found in the study communities have similar patterns with other works on coastal and riparian communities (Hanjra and Gichuki , 2008).

5.3 Existing Disaster Risk Reduction Measures and their Effectiveness

Many nations have institutions, ministries, agencies and other organisations for managing disaster in their various countries. Non-governmental organisations have been established with the aim of managing disaster risks in their host communities, regions, nations and sometimes with global mandates. In the study communities National Disaster Management Organisation (NADMO), Volta River Authority (VRA), Non Governmental Organisations (NGOs), Community Based Organisations (CBOs), Churches and Schools are various institutions that come to the aid of the communities during disaster events and carry out other risk reduction functions.

As per the disaster risk mitigation measures, most of the respondents in the study communities indicated that these institutions mainly distribute relief materials to them, especially NADMO and NGOs. This contrasts the functions of NADMO as indicated in the Ghana Disaster Management model; which has the function of defining and redefining the risk environment, and managing the risk environment at the risk reduction phase, and responding to the threat environment as the function at the emergency response phase It also contrasts the Philippines' disaster management approach, which is more holistic, comprehensive, integrated and proactive in reducing the socio-economic and environmental impacts of disaster, while adhering to transparency and accountability in the context of poverty alleviation and environmental protection (UNDP/NADMO, 2005; National Risk Reduction and Management Council {NRRMC}, 2014). Some respondents also attested to the fact that the VRA disseminates early warning information to them when they are about spilling water from the dam. Dredging of the river is another form of flood reduction by VRA in the opinion of the respondents. The finding on dredging is in line with studies by Gordon & Amatekpor (1999), who stated that a dredger has been brought to the lower Volta River basin, since 1991, and has been clearing a channel through sand bars that forms at the mouth of the river, enhancing the free flow of seawater into the river and eradicating bilharzias in Ada area, which has improved the dilapidated tourist industry in the area.

In the words of the Keta NADMO Coordinator, NADMO as an organisation educates and sensitizes the communities on some of their activities that exacerbate the impacts of flood disasters as a way of preventing flood disasters. He also stated that they search for and rescue flood victims in the face of disaster and then come with relief materials as recovery measures.

Disaster risk mitigation measures available in the communities are reactive instead of proactive, just like most developing countries (CRED, 2004).

Apart from dredging, the respondents stated that these measures, especially the distribution of relief materials have not been effective in reducing disasters. The NADMO Coordinator in

Keta Municipal also noted the same thing. In his words, distribution of relief materials have hampered the adoption of other measures, because of the media-friendly nature of reactive approaches, most government and non governmental agencies are more interested in emergency aid, rather than looking for proactive solution to disaster. Reactive measures also appeal to people, who always reason that it is morally justifiable and humanitarian to help those that have been incapacitated by disasters. This is in line with an earlier research by Ritchie (2004).

Proactive measures can tackle the underlying factors, and is among the outlines suggested by HFA for risk reduction (ISDR, 2005). From the FGDs, it was noted that the relief materials are not always enough, and can never match up with their losses caused by flooding.

5.4 Knowledge on ecosystems and their services

Since the 2004 Indian Ocean earthquake and tsunami, the importance of local knowledge and practice has been widely acknowledged by DRR specialists as indispensable factors in preventing disasters, increasing community's resilience and coping capacity in a disaster event; though they are yet to be integrated by scientists, practitioners, communities and policy makers (Turnhout *et al.*, 2012).

Results from the four communities indicate that most of the respondents have basic understanding of ecosystems; the understanding was demonstrated by the identification of existing ecosystems in the communities. The identified ecosystems include wetlands, mangroves, river, sea, estuary, coconut groves and grassland. These ecosystems are typical of riparian communities. The respondents specified some of the services provided by the ecosystems, ranging from water for domestic uses by river, fishery from the sea, river, wetlands and mangroves, food, oil, and fuel woods, to protection from floods, windstorms and erosions by mangroves and wetlands. Most of the services attributed to mangroves, for example, spawning place for fishes and building materials, are in line with the works of Diop *et al.*, (2002) and World Resources Institute (WRI, 2005).

The findings disagree with the works of Badola *et al.* (2012), which attributes ecosystems' degradation to information failure and lack of local awareness on ecosystem benefits. According to the findings, there is local-awareness of the benefits of ecosystems, and degradation of the ecosystems is as a result of poverty.

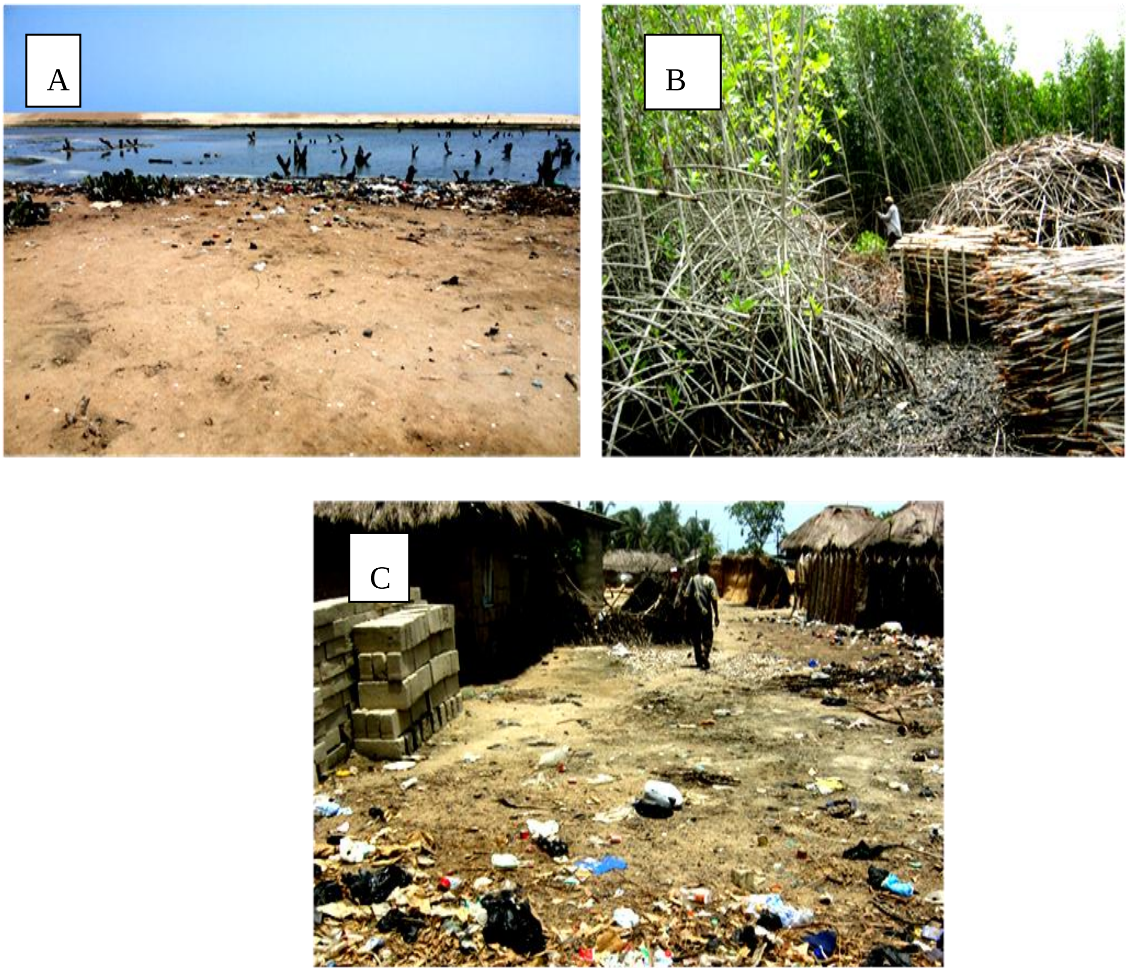
To further elicit the understanding of ecosystems and ecosystems' services, respondents were asked of the changes that have occurred in the ecosystems. A high percentage of the respondents confirmed that the services provided by the ecosystems are reducing drastically, and the drastic reduction was mainly attributed to the construction of Akosombo dam. This is in line with Velde (1978), who noted that most dams were constructed with little or no assessment of the downstream impacts of such projects. An interview with an official from VRA confirms that there was no Environmental Impact Assessment (EIA) conducted during the construction of the Akosombo dam, and their concern and provisions were mostly for upstream communities, who were resettled.

There was no provision for the impacts it would have on the downstream communities like public health (elimination of onchocerciasis or river blindness whose carrier vector thrives on lotic or swift flowing river [positive impact], and the arrival of vectors of schistosomiasis or bilharzias whose carriers thrive on lentic or slow moving water [negative impact]), social impacts (migration from downstream to upstream for lake fishing), nutritional impacts (fish depletion) and ecological impacts (on mangroves and wetlands) (Ocran-Hammond, 2015).

The information from Focus Group Discussions and guided interview with the Wildlife Coordinator show that mangroves and wetlands degradation are the major consequence of the construction of Akosombo dams. According to the findings, dam construction reduced the volume of river flow; this has direct negative impact on floodplains, by reducing the periodic flooding and deposition of nutrient-rich sediments. This has further impacted the vegetation cover and agricultural practises negatively. The finding agrees with the work of Sheppe (1985) who stated that the major downstream effects of the construction of dams are reduction in floodplain inundation and sediment deposit. The construction of Akosombo and Kpong dams have also brought about depletion in fish and the organisms they feed on, reduction in surface water and pasture for livestocks, build up on sand bars at the river mouth which form at a river flow rate of 1,000 m^3 per second, and salinization due to sea water intrusion.

Adams (1993) stated that floodplains are being depended upon by millions in Africa for their survival; the productivity and fertility of floodplains are related to water supply and deposition of sediments and spatial and temporal patterns of river inundations.

The major impact of dam constructions as related to this study is the negative impact it is having on mangroves and wetlands. Due to reduced volume of river flow, less fresh water gets to these mangroves, peats and wetlands to nourish them; exacerbated by the high level of salt water which destroys some species of mangroves, as the case is in Azizanya where the white mangroves have been destroyed by sea intrusion, and wetlands turned to wastelands as shown in Plates 5.2 (A) and (C).



Plates 5.1 (A) Mangroves cover destroyed by salinity, (B) a woman cutting mangroves for commercial purpose, (C) A wetland turned to a wasteland for land reclamation, in readiness for a house.

There is increase in alien aquatic plants due to shallowness of the river, and less sea water movement upstream. These aquatic weeds further reduce the amount of water that gets to mangroves marshes.

Forced out by sea erosion from their residences, people are left with no choice than to intensive clearing of the mangroves, and filling of wetlands to reclaim lands for resettlement purposes.

According to the findings, ecosystems are further degraded by excessive cutting of mangroves both for commercial and household uses, which they use as building materials and fuel woods as shown in Plates 5.2 (B).

Owing to non-availability of fresh water, there is less vegetation in the study communities to obstruct fast spreading fire. This fire outbreak, as attested to by the respondents is often caused by herdsmen, who set grasses on fire for quick sprouting of new growths, to ensure that pastures are made available for cattle.

From the findings, most of the surviving mangroves thrive on rain water. Rain, according to the participants in FGDs, guided interviews and questionnaires, has experienced series of change in pattern. This is believed to be as a result of climate change, and the climate change is also attributed to mangroves reduction.

Another issue raised by these community members is that since the construction of Akosombo dam, they have turned the floodplains to residential areas, as the natural periodic flood are not expected, this is one of the reasons why they are highly affected by spills from the dam gates.

The study indicates a positive attitude toward the conservation of the ecosystems, but the present ecosystems' degradation attitudes are being influenced by socio-economic conditions and demographics, and contradicts the notion that most communities have negative attitude towards ecosystems conservation (Badola *et al.*, 2012).

5.5 Feasibility of an ECO-DRR

From the results of this research work, the feasibility of an Eco-DRR is high in these communities based on the availability of ecosystems specifically for the management of flood disaster management (mangroves and wetlands) in the study communities, and the local knowledge of ecosystems and services (these are key to Eco-DRR). There is clear evidence of the knowledge of the impacts of the respondents' activities on the ecosystems and on the communities; but they are faced with the challenge of less diversified means of livelihood.

One of the FGDs participants in one of the communities, as shown in Plate 5.3, asked *"we know that mangroves harvesting is causing more harm than good, but how do we survive if we stop harvesting mangroves?"*

Plate 5.2 During one of the FGDs

Most of the participants affirmed the fact that they excessively harvest mangroves for commercial purposes. At Azizanya, close to 98% of their mangroves have gone into extinction, this is due to high salinity of the land, and cutting of mangroves for land reclamation. Other sources of fuel wood for household use were indicated. These include: Neem tree, acacia, coconut husk, bush trees, mango trees, dry coconut branches, sugar cane shell. Majority of the respondents have the willingness to give all their earnings, to see that their families are protected, and also to see that mangroves and wetlands are protected which is an indication that Eco-DRR is feasible in these communities, as this is one of the considered factors in planning for any conservation project (Blaine *et al.*, 2005), but the truth still remains that a higher part of their earnings come from mangroves sales. Most of the answers towards measures believed to mitigate disaster risk are geared toward resources conservation. This agrees with the study by Gupta and Nair (2012) that outlined some of the core elements needed for and Eco-DRR as:

- Recognition of the functions and services provided by ecosystem.
- Utilizing them and increasing their DRR values.
- Linking Eco-DRR to livelihood and development.
- Combination of Eco-DRR with other working measures (e.g. dredging and sea defence).
- Addressing risks which are associated with climate change and reduce their impacts on ecosystems
- Involvement of local stakeholders in decision making and implementation.

Flooding as a natural hazard can only be called disaster when it has negative impacts on people and property, other living things, property and the environment as a whole.

Ecosystems, both terrestrial and aquatic depend on ample supply of water; with other factors for its health, and the well being of people depend on healthy ecosystems.

Figure 5.1 is a summary, based on literature, and the findings from the study communities. It shows a flowchart of the causes, management measures, and suggested measures for flood disasters.

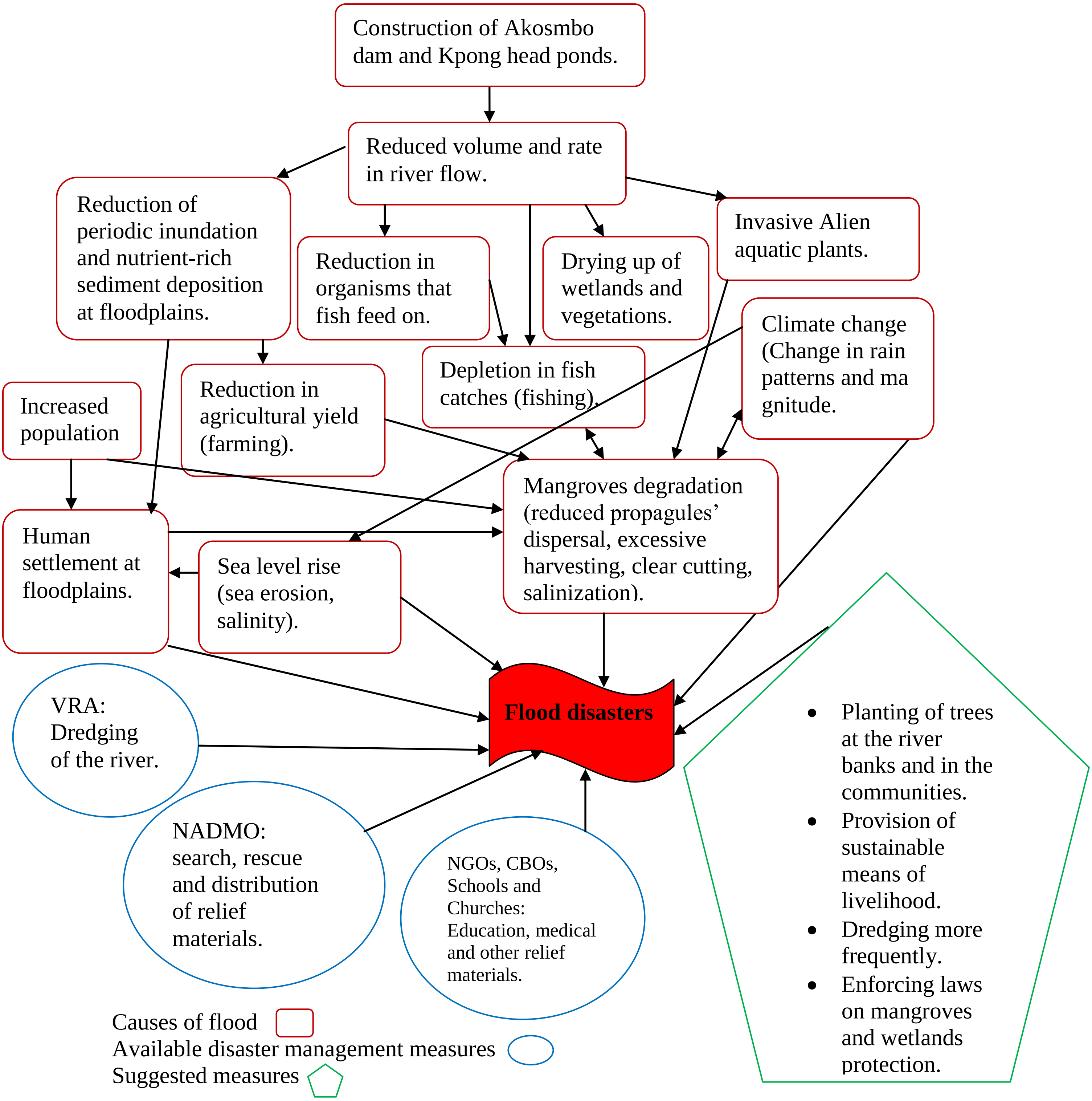


Figure 5.1 Flow chart showing causes, management measures and suggested measures for flood Disaster in the study area

From the study, it can be seen that participants (questionnaires respondents, FGDs participants, and guided interview participants) attributed their exposure to hazards and excessive cutting of mangroves to the construction of Akosombo and Kpong dams, which according to the findings has resulted in the reduction of river flow. This reduction directly impacts the floodplains through cessation of periodic flooding and deposition of nutrient-rich sediments that were nourishing the floodplains causing them to be fertile for agricultural practises. Not only were the floodplains affected, the reduction in river flow also means reduction in fish and plankton owing to the trapping of aquatic nutrients behind the dams upstream with the sediments. Mangroves are not spared these negative impacts as the propagules (mangroves seedlings) which are dispersed by flooding are no longer being dispersed, or at most, seedlings are dispersed at a very minimal rate. The communities, who were more into farming and fishing, are now left with no other means of livelihood. In a bid to survive, they took advantage of the mangroves by moving into the business of mangrove harvesting and selling.

With reduced volume of fresh water getting to the estuary, sea water intrusion has become another challenge, aggravating their problems through salinization of both soil and water. With sea erosion which has contributed to degradation of mangroves (mangroves thrive on brackish water), people were forced to move out of sea shore areas, which necessitated more cutting of mangroves, and filling up of wetlands, already being affected by non-availability of fresh water; as a way of reclaiming lands for settlement, farming and other developmental projects.

The reduced flow of water has also been blamed for the growth of alien aquatic plants due to shallowness of the river around these communities. Aquatic weeds further decrease the amount of water that gets to the creeks, and have caused problems in the communities by making the water unsafe for navigation with boats and destruction of fishing nets.

The participants were also quick to point out that it was after the construction of the dams with the attendant issues already mentioned above, that they started noticing changes in rain patterns, and temperature, which they believe contribute to flood disasters in the communities. They also attested to the fact that back in the years when they had robust mangroves, the impacts of the periodic flooding were never felt, which they believe it must have been because of the mangroves, though they did not understand the processes.

The floodplains which are naturally low lying in elevation, have been converted to settlements, exposing them to impacts of flood disasters anytime the dams' spillgates are opened to reduce the water in the reservoirs; meaning that in the event of dam failures, these communities would be wiped out. Without spilling of dams, they also experience flooding which is an annual occurrence in the communities and other riparian communities of the Lower Volta basin. This is also attributed to the construction of dams. According to a VRA official, the river before the construction of the dams were flowing up to 11,800 m^3per second during rainy seasons and at 6,500 m^3 per second in dry seasons. He noted that at a flow rate of 1,000 m^3/s, sand bars form at the mouth of the river, and in recent times, the river sometimes flow at a rate below the 1,000 m^3 per second. With the formation of these sand bars, when the river is topped up by torrential rains, because there is no channel for the water to be discharged into the sea, the water overflows the banks, entering the communities, and causing inevitable flood disasters.

From the findings, fire disasters have been linked to low flow of water. The vegetative parts of the communities are mostly dry due to reduction in fresh water that gets to the zones. To provide pasture for cattle, the Fulani herdsmen have resorted to setting the grasslands on fire as a catalyst to speed up the sprouting of new growths. In the event of an uncontrollable fire outbreak, the fire tends to spread fast into the communities due to the combustibility of dried vegetation. It was also noted that mangroves have saved them from the impacts of fire outbreaks in some instances.

5.6 Summary

There is evidence that the communities understand the need for robust ecosystems as a way of preventing or mitigating flood disasters and other disasters, but are challenged by limited source of livelihood. NADMO, the national disaster management organisation, works more as a relief distribution agency in the event of a disaster. Distribution of relief materials has hampered the adoption of other proactive DRR measures. Based on these, recommendations are discussed in the concluding chapter.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

Communities in the Lower Volta are prone to flooding and would continue to experience flood disasters, except for the timely implementation of policies: for maximizing the available ecosystems that have been proven to be effective in the prevention of flood disaster. Policy makers should take into consideration the underlying factors of disaster risks in the communities. While Bomigo Island was found to be a non-flood prone island, based on VRA inundation maps, it was discovered through household survey that the Island had experienced series of flooding.

In addition to flood disasters, other disasters like fire outbreak and windstorms are being experienced in the communities. While some of the disasters are tipping point disasters, which move from positive impacts to negative impacts, for example, the cessation of floodplain inundations due to the construction of dams. Disasters can also be chronic, which are mostly slow at the onset, but affects livelihood, health, ecosystems and other socio-economic aspects of lives, for example the intrusion of sea water.

The available disaster risk reduction measure in the studied communities are early warnings before the spillage of excess water from Akosombo dam and the dredging of the river by the Volta River Authority, (which is carried out less frequently), distribution of relief materials after flood disasters by National Disaster Management Organisation, Non Governmental Organisations and Churches, public sensitization on the need for relocations and efforts on the part of the community members to build stronger houses and fences.

It is worthy of note that despite the low level of education in these communities, as compared to larger cities like Accra, the communities had an appreciable awareness of the link between functioning ecosystems and the role the ecosystems play in Disaster Risk Reduction.

This awareness is a good entry point for policy makers in the district and the municipal, for Ecosystem-based disaster risk reduction and creation of structures that would encourage sustainable mangroves harvesting and local livelihoods.

6.2 Recommendations

Based on the findings, the following recommendations are made:

6.2.1 Environmental recommendations

Eco-DRR should be integrated into all phases of disaster management: disaster reduction, preparedness, emergency and recovery.

(i) Using the VRA inundation maps, Environmental Protection Zones (EPZ) need to be introduced as early warning signal and emergency approaches. This can be achieved by

- Planting specific trees along the water bodies to protect and stabilize the soil along the banks to prevent erosion. The use of other gauges close to water bodies, which should be monitored to determine different levels of water rise; the general public should be educated on the meaning of each level of water and what should be done. From 1m to 5 m water levels, for instance, at 0-1 m, people can still stand on water, but above 1 m, people cannot survive on water. With that understanding, anytime there is rise in water up to half a meter as would be indicated by the gauges, people should start making efforts to move to other safe zones.

- Artificial wetlands should be created as drainage systems for flood water, between the EPZs and some mapped-out elevated areas or rescue points; this would give community members ample time to be evacuated, before the flood water gets to the elevated areas. Public buildings should be constructed at elevated areas and used for vertical evacuation in emergency cases.
- Specific trees should be planted as indicators of pathways that are safe to be followed, such as planting mango trees on the right hand side of the safe paths from the communities to the nearest harbour or other safe community.

(ii) The frequency of dredging which is already an ongoing activity in these communities can be increased. Based on the information gathered ,dredging was to be carried out four-year intervals by VRA, but sometimes more than four years elapse before they are carried out,

- It is therefore recommended, that the river be dredged every 2 to 3 years to increase river flow, while also making enough room for river water. When weighed side-by-side with the economic, ecological and human losses due to flood disaster, the cost of dredging would be far more cost-effective.

(iii)The health of wetlands is important to coastal communities' resilience, therefore wetlands should be restored.

- Natural wetlands can be mimicked by redirecting the River to fill basins
- Decaying vegetation from wetlands can make up for fluvial sediment loss as manure
- Sluice mechanisms should be adopted upstream to allow the free flow of sediments through the dams.
- Trapping abilities of floodplain should be optimized to keep wetlands healthy by diverting river sediments before the sediments get to the sea.

(iv) There is the need to educate the citizens on the effects of ecosystem destruction, how the destructions contribute to disaster and how disasters can be managed properly, while also encouraging the community members to participate in soft engineering strategies that take advantage of natural processes and feedbacks;

- By digging multiple channels to spread sediments across the floodplains.
- Restoring mangroves and marshes.
- Planting of non-combustible trees to check fire outbreak.
- Compositing of fish wastes as a way of reducing river pollution, and making manure available for farming.
- Planting mangroves and other trees along the river banks as buffer zone and protection from flooding.
- Houses should be built based on building codes.
- Discouraging sand winning and indiscriminate felling of mangroves.
- Discouraging the general public from filling up of wetlands and dumping of wastes in wetlands and rivers.
- Community members should be educated on sustainable mangroves harvesting by cutting them at 1.5 m from the root to enable them sprout again after one month instead of clear-cutting and replanting which is being practised.

6.2.2 Socio-economic recommendations

Poverty has been identified as a major factor driving the decline of ecosystems, and the unsustainable use of natural resources. Poverty reduction through sustainable livelihood development is a core objective in Eco-DRR.

i. There is the need therefore for skills development:

- Seminars and skills-acquisition programmes should be developed and carried out, not just in the study communities but in other disaster prone communities, especially communities having ecosystems that are being threatened, and prone to threat, as means of survival. Community members should be trained on how to rear rabbits, mushrooms, snails, grass cutters and other means of livelihood to take their eyes off mangroves harvesting.
- The already acquired skills should be improved.

ii. There is also the need for financial and infrastructural provision.

- Provision should be made to ensure that the community members are furnished with capitals to start the businesses when skill acquisitions are certified.
- Provisions should be made for necessary equipment that would enlarge the scale of production for the community members who are already engaged in one skill or the other, like the women in Plate 6.1 below who are into coconut oil production.

Plate 6.1 Coconut oil production in progress at Azizakpe Island

Source: Field data, 2015

- In the words of one participant in FGDs, in one of the communities, "*Since we have suffered from the construction of Akosombo dam, at least light should be given to us.*" Serious consideration needs to be given to the downstream communities of River Volta, in the area of electricity for storing aquatic produce such as river and sea fishes.
- Storage facilities should be made available for the farm produce such as tomatoes.
- Enabling markets should be made available for the sale of the communities' products.
- Through conservation plans, more jobs can be created for the local people, as it was realised that taking a tourist on a boat ride round the mangroves costs as much as GH₵ 200 (US$ 55) per hour.
- The community youth members should be employed as mangrove guards.
- Investors should be encouraged to set up Eco-friendly hospitality industries which would further create jobs for the communities.

6.2.3 Governance recommendations

For carrying out the tasks above, this study recommends adequate commitment at all levels of governance, stemming from the National level; in disaster management, and especially flooding which has been on the increase in recent times and ranks among the disasters that cause major damages.

NADMO, which is the nation's arm when it comes to disaster management, is seen from this study to be more of Relief Distribution Arm of Ghana (RDAG), there seems to be personnel, skills and financial constraints in the agency that needs to be managed by government before this agency can go out to manage disasters affecting the nation.

- It is worthy to note that all these can only be achieved through integrated management that would involve all concerned institutions and stakeholders, like NADMO, VRA, Environmental Protection Agency, Town and Country Planning Department, Water Resources Commission, Wildlife and Forestry Commission, Hydrological Service Department, Ministry of Food and Agriculture, Chiefs, Districts, NGOs, without neglecting the general public, as their experiential knowledge is of utmost importance in Eco-DRR policy making and other safe environmental practises.

- NADMO, other interest groups (VRA, NGOs, churches, Schools and CBOs) and stakeholders on disaster management should be more proactive, go beyond emergency/ rescue measures to a long term reduction of the factors behind the frequency and magnitude of flood disaster. It should be well noted that disaster management is about prevention of disasters by identifying the sources of disaster and working towards reducing the loopholes, preparedness which involves putting on the ground every measure that would aid immediate and efficient response in the face of any disaster, and effective recovery and rehabilitation, while taking into consideration the social, economic and environmental implications of all disaster policies and weighing all policies both on short-term, mid-term and long-term basis. Apart from forecasting, early warning signs and emergency measures already in place, these workable and sustainable measures should be included.
- VRA should be mandated to come up with a sustainable way of mimicking the natural hydrological pattern of Volta River to ensure availability of fresh water in mangroves swamps and wetlands, along with the provision of hydro-energy to the nation.
- Government should look at these as an investment, not only will they be saving the amount spent and lost annually on relief materials and economic, social, environmental loss caused by flooding; mangroves can be a source of revenue through carbon trading. The current debates on Reducing Emissions from Deforestation and Forest Degradation (REDD) and payment for ecosystem services, provide ample

scope for development of sustainable livelihood options for local communities from the conservation of critical ecosystems such as mangroves.

- Workable and effective laws should be implemented and enforced to achieve Eco-DRR.

6.2.4 Future research

More research should be carried out as a follow up on this work to measure:

- The extent of mangroves available in the estuarine areas.
- Carbon sequestration capacity of the mangroves.
- Assigning financial worth to ecosystem services in the study communities, and Ghana at large. All these would make integration of Eco-DRR in disaster management more appealing.

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APPENDICES

Appendix 1

UNIVERSITY OF GHANA, LEGON

IESS-M.PHIL ENVIRONMENTAL SCIENCE

Thesis Title: Towards an Ecosystem-based Disaster Risk Reduction for Flooding in Downstream Communities of Lower Volta

HOUSEHOLD DISASTER RISK REDUCTION QUESTIONNAIRE

This questionnaire is designed to help gauge household knowledge of disasters and measures that assist in reducing disaster risk and loss from disasters. The questionnaire should be completed by an adult. The information you provide about your needs for disaster reduction could help improve public and private coordination of disaster risk reduction activities within your community. I ask that you please take a few minutes to complete this questionnaire.

A. GENERAL HOUSEHOLD INFORMATION

Interviewee's consent obtained Yes	Name of Community				
Name of Interviewer		Date of interview		Proximity to a water body (1=Far 500 m, 2=Near 200 m, 3=Very Near: Less than 100 m)	

Please what is your Age?	Gender Male Female	Highest education level No Education Nursery Primary Secondary Tertiary	Marital Status Single Married Divorced Widowed	Please indicate your occupation Farming Student Fishing Office worker Hand-work Trading Others: (Specify)	If office work, please indicate your employer Not office work Private Government Self Others (specify)

How long have you lived in this community	Please indicate your residential status	If a Settler, please state your place of origin	Please what kind of house do you live in?
<1 year 1-10 years 11-20 years 21-30 years 31-40 years 41-50 years >50 years	Indigene Settler Others (Specify)		Family Own Rented Shared Others (Specify)

Please how many persons are there in your household Female Male	What is the age of the oldest?	What is the age of the youngest?

Please are they all your dependants? Yes: All Some No: None	**Please what is your estimated monthly income?**

DISASTER RISK INFORMATION

i. Disaster Risk Reduction Approach

Please indicate the disasters experienced during the last 10 years	Please which is/are the most frequent	Please which caused the most damages	What Kind of damages	How concerned are you about the disaster's re-occurrence (Rank 1-4: 1= Not concerned, 2 =low, 3=Medium, 4=High)
Windstorm				
Flood				

Fire Outbreak				
Disease outbreak				
Other (Specify)				
Has there been any effort made by any institution to reduce the disaster/s and their effects?	Please indicate which institution	What measure have they put in place to reduce the disaster and their effects?	Which measure(s) is/ are the most helpful	What effort are you making on your own to reduce or cope with the disasters?
Yes No	NADMO Church VRA School NGO (Name) CBO (Name) Others (Specify)	Migration Compensation/Relief materials Early warning Engineering constructions Dredging Others (Specify) None		Relocation Building a stronger house Other (Specify)
What other measures do you think can reduce the disasters?		What human activities do you think contribute to these disasters?(Please specify)		

ii. Knowledge of Ecosystem and their services

Do you know what ecosystem is, and the services they provide	Please indicate the ecosystems found in your community	What Services do they provide to you?	Has the construction of Akosombo and Kpong dams affected these ecosystems?	How has it affected the ecosystems?
Yes No (Explanations given in case of 'NO')	Sea Estuary Mangroves River Wetlands	Fishery Sight seeing Water for domestic uses Protection from Windstorm Protection from Erosion	Yes No	

	Grasslands Others (Specify)	Protection from flooding Others (Specify) None		
What other human activities you know that affect your community's ecosystems? (Specify)	When was the last time you experienced flood disaster?	Do you know what caused the flooding? Yes No	If yes, please what caused the flooding?	Were the mangroves or wetlands helpful during the disaster? Yes NO
If yes, please how did the mangroves or wetlands help?		Have the ecosystems in the community played any role in reducing any of the disasters? Yes No	Please specify the ecosystems and the roles it played	

41. In the last 10 years, has there been any kind of reduction in the services these ecosystems provide?	42. What in your own opinion or observation do you think is the cause of the reduction in the services?
Yes No	

iii. Values placed on the ecosystems/Tradeoffs

43. Will you make any financial commitment for mangroves conservation?	44. If yes, how much will you be willing to pay for that?	45. Do you harvest fuel wood from the mangroves	46. Apart from mangroves, what other tree do you use for fuel wood? (Specify)	47. What do you use the fuel wood from mangroves for?
Yes No		Yes No		Commercial use Personal use Other uses (Specify) None

48. If the fuel wood is for commercial use, how much do	49. What quantity of mangrove do you harvest to get a bundle of fire	50. Apart from fuel wood, what other benefits do you get from the	51. Are other benefits of mangroves personal or

you sell a bundle of fuel wood?	wood: based on area coverage of the mangroves?	mangroves?	commercial? Commercial benefits Personal benefits Others (Specify) None
		None Herbs Fish Mangroves Watching Having it in your community Others (specify)	52. Will you reduce the cutting of mangroves if you know they can reduce flood disaster and their impacts? Yes No

53. What incentive will you take to ensure the protection of mangroves and other ecosystems? (Specify)	54. How much can you pay to see that your family is protected from disasters?	55. Would you rather preserve a wetland or fill them up for farming and other developments	56. Please what is your reason for the answer to wetland preservation or filling up?
		Yes I will preserve wetland No I would fill it up for other uses (Specify)	

57. Do you have any other general comments and ideas on ecosystems and disaster risk reduction?

………

…………………………………… **Thank you**

Appendix 2

Thesis title: Towards an Ecosystem-based disaster risk reduction for flooding in downstream communities of lower Volta River

INTERVIEW GUIDE FOR: National Disaster Management Organisation (NADMO) Coordinators.

Date of Interview:

Day....../Month......./2015

Name of Respondent: (Optional)

....

Male [ ] (b) Female [ ]

2. Official position

....

(3a) what are the common disasters in the district/municipal?

....

....

(b) Which of the disasters causes more damages?

....

(c) How frequent is this disaster?

[ ] regularly [ ] annually [ ] others (specify)

(d) What are the causes of flood disasters in this district?

....

....

(e) How many people on the average are affected by flood annually? ....

(4a) Is there any human activity that cause flooding in this district/municipal? Yes [ ] No [ ]

(b) If yes what? ....

....

(5a) Are there specific measures that you have put in place to reduce flooding incidence and their impacts in this district/municipal? Yes [ ] No [ ]

(b) If yes, what are these measures and how effective are they?

(c) If no, please give reasons for your answer ....

(8a) Are you adequately resourced to carry out your constitutional mandate?

Yes [ ] No [ ]

(b) If No in what areas are you challenged?

I. Human resource..

II. Financial resource...

III. Logistic and equipment..

IV. Others (specify)...

(9) What measures are being considered to address the above challenges?

....

(10) Do you collaborate with other bodies in flood disaster prevention and management?

Yes [ ] No [ ]

(b) If yes, please indicate the agencies/bodies?

....

(c) How will you rate the level of collaboration?

[ ] Excellent [ ] Very good [ ] Good [ ] Fair [ ] Poor [ ] Very poor

(11a) Does NADMO involve communities in disaster management activities?

Yes [ ] No [ ]

(b) If yes at what level? ....

(c) How do you rate the level of participation of the people?

Very high [ ] High [ ] Average [ ] Low [ ] very low [ ]

(d) What account for this level of participation?

....

(e) If no why not? ....

(12a) How will you rate the level of coping capacity of the people?

High [ ] average [ ] low [ ] poor [ ]

(b) What account for this level?

....

(c) How will a community report flood disaster?

....

(d) Who does the impact assessment?

NADMO [ ] Community leaders [ ] individuals [ ] others (specify)..........

(13a) Why should the flood problem be addressed?

....

(14a) Does the availability of disaster relief affect the adoption of other disaster prevention methods? Yes [ ] No []

(b) If yes should disaster aid be stopped to prevent further development of flood prone areas? Yes [ ] No [ ]

(c) Give reasons for your answer...

15) What management plan do you have in place for the victims before, during and after flood disaster?

a. Prevention..

b. Management...

c. Rehabilitation..

(16a) Is there any relationship between flood disaster and ecosystems degradation in the district/municipal? Yes [ ] No [ ]

(b)If yes how will you describe the relationship above?...

(17) What value would you place on environmental resources and their benefits in this district/municipal?

(18) Do you think these environmental resources can be incorporated in the management of flood disasters?

(19)) what other measure do you think will form the best strategy for flood disaster management?...

(20) Please state any other thing worthy of note..

Thank you

Appendix 3

CHI-SQUARE TEST

	AN	BI	AZ	AI	total
Y	47	17	60	27	151
N	13	13	0	3	29
Total	60	30	60	30	180

	AN	BI	AZ	AI	**Total**	115.836
Y	50.33333	25.16667	50.333333	25.16666667	151	
N	9.666667	4.833333	9.6666667	4.833333333	29	231
Total	60	30	60	30	180	
						0.501454545

O	E	O-E	(O-E)^2	((O-E)^2)/E	
47	50.33333	-3.33333	11.111111	0.220750552	
17	25.16667	-8.16667	66.694444	2.650110375	
60	50.33333	9.666667	93.444444	1.856512141	
27	25.16667	1.833333	3.3611111	0.133554084	
13	9.666667	3.333333	11.111111	1.149425287	8.83302E-05
13	4.833333	8.166667	66.694444	13.79885057	
0	9.666667	-9.66667	93.444444	9.666666667	
3	4.833333	-1.83333	3.3611111	0.695402299	
Total				**30.17127198**	8.83302E-05

Category	Observed	Expected	Residual= (Obs-Exp)	(Obs-Exp)^2	Component = (Obs-Exp)^2 / Exp	8.83302E-05

Appendix 4

UNIVERSITY OF GHANA
INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES (IESS)
(GRADUATE ENVIRONMENTAL SCIENCE PROGRAMME (ESP))

P.O. Box LG 209, Legon, Accra, GHANA   General Office: International House
Tel: +233 (0) 302 977 972   *Fax: +233 (0) 302 512 681*   *e-mail: infoiess@ug.edu.gh / infoesp@ug.edu.gh*

ESP.10435411

My Ref. No. ....   February 11, 2015

Your Ref. No ....

The District Chief Executive,
Ada East District Assembly,
Ada.

Dear Sir/Madam,

AN INTRODUCTORY LETTER: CHRISTINA CHERYL OKEKE

This is to introduce to you Miss Christina Cheryl Okeke (ID. 10435411), an M.Phil Environmental Science student of the University of Ghana, Legon.

She is embarking on a research project for the award of the M.Phil Degree in Environmental Science at the University of Ghana. Her project area is: ***Towards an Ecosystem based Disaster Risk Reduction for Flood in the Downstream of Lower Volta Basin.***

To achieve some aspect of her objective, Miss Okeke would need your assistance to have access to data and relevant information from the District relating to her research. She also wish to interview relevant personnel in the District for information to aid her research project. The data will be used for academic research work only.

On her behalf therefore, I am appealing to you for the necessary assistance, to enable her achieve her objective. Your assistance will be greatly appreciated and will contribute to a successful research.

Thank you for your cooperation in advance.

Yours faithfully,

For:

Dr Elaine T. Lawson
Coordinator
Environmental Science Programme

mm*/ETL

To meet the nation's needs for broad-based education, training and research in the science, policy and management of environmental and sanitation processes in the wider African and global context.

Appendix 5

ADA EAST DISTRICT ASSEMBLY

REPUBLIC OF GHANA

My Ref No.: *AEDA/*L.12/15
Your Ref. No.:
Tel: ....

Office of the District Administration
Post Office Box 20
Ada – Foah

17th February, 2015

AN INTRODUCTORY LETTER: CHRISTINA CHERYL OKEKE

Please find attached a self-explanatory letter in relation to the above subject.

I have been directed to inform you to kindly extend all necessary courtesies to the above-mentioned student.

Your maximum cooperation is anticipated in this regard.

ABDUL LATIF AMIN
ASSIST. DIRECTOR IIB
For: DISTRICT CHIEF EXECUTIVE

TO WHOM IT MAY CONCERN

Cc: Christina Cheryl Okeke
University of Ghana, Legon
Accra.

Appendix 6

UNIVERSITY OF GHANA
INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES (IESS)
(GRADUATE ENVIRONMENTAL SCIENCE PROGRAMME (ESP))

P.O. Box LG 209, Legon, Accra, GHANA General Office: International House
Tel: +233 (0) 302 977 972 *Fax: +233 (0) 302 512 681* *e-mail: infoiess@ug.edu.gh / infoesp@ug.edu.gh*

ESP.10435411

My Ref. No. ....

Your Ref. No ....

February 11, 2015

The District Chief Executive,
Keta District Assembly,
Keta.

Dear Sir/Madam,

AN INTRODUCTORY LETTER: CHRISTINA CHERYL OKEKE

This is to introduce to you Miss Christina Cheryl Okeke (ID. 10435411), an M.Phil Environmental Science student of the University of Ghana, Legon.

She is embarking on a research project for the award of the M.Phil Degree in Environmental Science at the University of Ghana. Her project area is: ***Towards an Ecosystem based Disaster Risk Reduction for Flood in the Downstream of Lower Volta Basin.***

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On her behalf therefore, I am appealing to you for the necessary assistance, to enable her achieve her objective. Your assistance will be greatly appreciated and will contribute to a successful research.

Thank you for your cooperation in advance.

Yours faithfully,

For:

Dr Elaine T. Lawson
Coordinator
Environmental Science Programme

mm*/ETL

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Appendix 7

UNIVERSITY OF GHANA

INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES (IESS)
(GRADUATE ENVIRONMENTAL SCIENCE PROGRAMME (ESP))

P.O. Box LG 209, Legon, Accra, GHANA
General Office: International House
Tel: +233 (0) 302 977 972 *Fax: +233 (0) 302 512 681* *e-mail: infoiess@ug.edu.gh / infoesp@ug.edu.gh*

My Ref. No. ESP. 10435411

Your Ref. No ....

November, 12, 2014

The Director,
National Disaster Management
Organisation (NADMO)
Accra

Dear Sir/Madam,

AN INTRODUCTORY LETTER:

CHRISTINA CHERYL CHINWE OKEKE

This is to introduce to you Miss. Christina Cheryl Chinwe Okeke (ID. 10435411) an M.Phil Environmental Science student of the University of Ghana.

She is embarking on a research project for the award of the M.Phil Degree in Environmental Science at the University of Ghana. Her project area is: ***Towards an Ecosystem based Disaster Risk Reduction for Flood in the Downstream Communities of Lower Volta River***.

To achieve some aspect of her objective, Miss. Okeke would need your assistance to have access to data relating to her research. The information from your Unit will contribute to a successful research.

On her behalf therefore, I am appealing to you for the necessary assistance to enable her achieve her objective. Your assistance will be greatly appreciated.

Thank you for your cooperation in advance.

Yours faithfully,

INTEGRI PROCEDAMUS

fn.

Dr Elaine T. Lawson
Coordinator
Environmental Science Programme

To meet the nation's needs for broad-based education, training and research in the science, policy and management of environmental and sanitation processes in the wider African and global context.