

**UNIVERSITY OF GHANA
COLLEGE OF HUMANITIES**

**EXPOSURE TO AND IMPACTS OF FLOODING IN SELECTED URBAN
COMMUNITIES IN ACCRA, GHANA: EXAMINING THE IMPLICATIONS
FOR BUILDING RESILIENCE**



BY

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ACCEPTANCE

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DECLARATION

I hereby declare that, except for reference to other people's works which have been duly acknowledged, this work is the result of my research and that it has neither in part nor in whole been presented elsewhere for another degree.

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Date

DEDICATION

This thesis is dedicated to my parents, Mr. Nelson and Mrs. Elizabeth Larbi, my siblings and my wife, Eugenia Tenkorang.

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LIST OF ABBREVIATIONS

AdMA: Adentan Municipal Assembly

AI: Aridity Index

AMA: Accra Metropolitan Assembly

ANOVA: Analysis of Variance

CRiSTAL: Community-based Risk Screening Tool: Adaptation and Livelihoods

FGD: Focus Group Discussion

GoG: Government of Ghana

GSS: Ghana Statistical Service

IPCC: Intergovernmental Panel on Climate Change

Landsat:

LULUCC: Land Use Land Cover Change

MI: Moisture Index

NADMO: National Disaster Management Organization

PD: Precipitation Deficit

PET: Potential Evapotranspiration

ROI: Region of Interest

SSA: sub-Saharan Africa

UNFCCC: United Nations Framework Convention on Climate Change

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ABSTRACT

There is increased exposure of people and critical livelihood assets to flooding globally due to climate change and modification of the biophysical system through human activities. Flooding has become an annual phenomenon in Accra in recent decades and has severe impacts on the poor and vulnerable. Using transdisciplinary techniques across the social and biophysical sciences, this study examined the extent of exposure of urban population to flooding, and the assets and structures that are necessary for building resilience in two communities of differing characteristics in the Accra Metropolitan Assembly (AMA) and Adentan Municipal Assembly (AdMA). The data encompassed participatory learning approaches using focus group discussing, transect walk, community workshops, and key informant interviews, as well as Remote Sensing/Geographical Information Systems (GIS) using Landsat imagery. Supervised land use/land cover (LULC) classification of Landsat imagery, followed by post classification change detection in land cover was undertaken. An exponential projection model was fitted for the defined periods 2030 and 2060 towards evaluation of flood exposure. A digital elevation model was overlaid on the land use maps to examine the influence of elevation on the flood hazard. The Community-based Risk Screen Tool-Adaptation and Livelihoods (CRiSTAL) was adapted from development oriented project management (with few modifications to suit the context) in analyzing the sex and age differentials in access and relevance to livelihoods assets, and the impacts of floods in the two communities. The study sites were Ogbojo and Glefe in the Adentan Municipal (AdMA) and Accra Metropolitan (AMA) Assemblies respectively. The results showed increased occupation of previously unoccupied landscapes such as forests and wetlands in low elevation areas, evident in the increasing proportion of the built up urban space between 1991 and 2017. The projections show that close to a quarter of natural land cover in AMA and more

than half in AdMA could be lost by 2030 with increased flood hazards. Furthermore, higher proportions of natural landscapes will be lost by 2060. Aside the increase in concretised surfaces, other factors including poor waste management, poor drainage system, poor spatial planning, and the land use in adjoining districts/ communities tend to exacerbate the flood hazard in the study sites. Thus, both external human and environmental/topographical factors influenced the extent of the flood hazard at the study communities. There was nuanced age and sex differential in the access and relevance of livelihood assets, but generally physical assets such as buildings and vehicles were the most relevant, followed by human assets. Glefe's location as coastal community created exposure to multiple sources of the flood hazard, but also enhanced its socioeconomic resilience due to the availability of additional livelihood options from the sea and lagoon. Flooding had economic, social, and health effects. The economic impacts were the most prominent, as a disruption of all livelihood assets had some economic implications. The communities' ability to respond to flooding was positively related to the robustness of community assets, adaptive capacity as well as engineering and socioeconomic resilience. Fundamental to the socioeconomic resilience was the capacity to access resources outside the community, engagement of community assets, and participation of diverse groups in responding to flooding. The study therefore recommends the enforcement of laws and regulations on land use practices, cross-regional planning, inter-regional and inter-district planning, and community involvement in planning in the quest to building resilient cities. Finally, the CRiSTAL tool should be amended to increase the number of assets under each asset category in order to enhance its usefulness in the highly heterogeneous urban settings.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The frequency and intensity of climatic events such as flooding are increasing due to climate change and modification of the biophysical system through human activities (IPCC, 2014). Using the Pressure-State-Response (PSR) model as the overarching framework, this study critically examines the degree of exposure, impacts and response mechanisms of urban population to flooding. The PSR model assess the linkages among the pressures exerted on the environment by human activities, the changes in the quality of the environment and the related effects or impacts, and the response of society in an attempt to release the pressure or to restore the environment (Zhang, Ma, Zhan & Chen, 2012; OECD, 1993). The effect of the ‘pressures’ associated with the human-environment interactions on the socio-ecological system tends to create a ‘state’ that exposes humans to extreme climatic hazards. The corollary is impacts such as death, diseases, displacement, and disruption of livelihoods of people (World Bank, 2016; IPCC, 2014; Keller & DeVecchio, 2012). The impacts on society may elicit response to cease or reverse the impacts that are already inflicted (Zhang et al, 2012). The response actions then feed back on the pressure, state or impacts directly, or sometimes driving forces of the pressure.

The growth of urban population and accumulation of assets in cities due to urbanization creates high dependence of humans on social services, supply chains, infrastructure, communications networks, and financial incomes for their livelihood construction (Banks, 2016; World Bank, 2015; Meikle, 2002). Urbanization results in the development of hazard-prone areas such as floodplains, marginal lands and hillsides into settlements often by the poor, since

those areas tend to offer affordable housing facilities, especially when urban planning regulations are not enforced (Owusu, 2017; Amoako, 2016). The consequence is the frequent occurrence of natural disasters such as flooding. Thus, the naturally occurring hazards coupled with anthropogenic disruptions to the highly interconnected biophysical and socioecological urban system, in the face of changing conditions due to climate change produces cascading effect on the ability of the system to support the survival and fundamental functions of humans (World Bank, 2016).

Over \$46 trillion worth of global assets are exposed to coastal and riverine flooding and is projected to reach \$158 trillion by 2050 (Jongman, Ward, & Aerts, 2012). From 1970–2010, Sub-Saharan Africa (SSA) observed the highest relative increase of 188% in the population exposed to flooding and is projected to rise in the coming decades (Winsemius et al., 2015). Extreme climatic events such as flooding deplete community and household assets causing greater vulnerabilities due to the eroding adaptive capacity (Afriyie, Ganle & Santos, 2017; Lamond et al., 2015). An estimated 325 million of the world's poor from 49 countries will be living in areas that are prone to flood hazards by 2030 (World Bank, 2016; Shepherd et al. 2013). The rising exposure of people and assets to flooding has been attributed to the accumulation of people, critical infrastructure, social services and livelihoods along the coast and floodplains (IPCC, 2014; Appeaning-Addo & Adeyemi., 2013; Lamond et al., 2013; Kaźmierczak & Cavan, 2011). In Accra, poor spatial planning and weak governance has given rise to several informal settlements in flood-prone areas which increases the frequency and intensity of flooding particularly among the poor who inhabit these locations (Afriyie et al, 2017; Frick-Trzebitzky et al., 2017). Thus, there is increased risk of inundation of infrastructure,

transportation systems, and other resources and services within the coastal zones of many countries globally due to rising sea level (Dovie, 2017; Brown, Kebede & Nicholls, 2011).

The exposure to and the impacts of floods are not homogeneous across population groups, but differentiated by sociodemographic factors, typically sex, age, and socioeconomic status (Koks et al., 2015; Dovie, Witkowski & Shackleton, 2005). The poor are disproportionately affected due to lower capacity to access resources and their tendencies to inhabit marginal lands that are already flood-prone (Afriyie, et al., 2017). Similarly, there are nuances in the access of livelihood assets by different population groups, and hence the activities that different people engage in. This underscores the disproportionate distribution of flood impacts across social groups; some activities are more sensitive to flooding than others (Garbero & Muttarak, 2013). Also, adaptation options tend to differ by such demographic factors as gender, occupation, and community of residence (Codjoe, Atidoe & Burkett, 2012). Communities in Accra differ significantly in the nature and extent of exposure to flooding, as well as the impacts and response mechanisms.

Flooding has become an annual phenomenon in Accra in recent decades and has severe consequences on the poor and vulnerable (Amoako, 2016; Rain et al., 2011; Karley, 2009). Accra experienced catastrophic flooding in 1968, 1995, 1997, 2001, 2010, 2013, 2014 and 2015 (Amoako & Boamah, 2015). The 2011 flooding in the city left 15 people dead and huge loss of critical assets (Amoako & Inkoom, 2017). About 83 lives were lost directly from floods, and 178,750 people have been displaced between 2000 and 2012 in Accra (Amoako & Boamah, 2015). In June 2015, flood-related events affected 52, 622 people and took over 150 lives. Loss and damage to assets including housing, water and vehicles amounted to US\$55 million; the estimated cost of rebuilding was US\$105 million (World Bank, 2017). Estimation of the impacts

of flooding and other hazards often neglected or underestimated the value of non-market assets such as some social and human assets due to limited knowledge of how much they are affected, as well as their contribution to the livelihoods of the poor and vulnerable (Barnett et al., 2016).

Owing to the rising exposure and losses from disasters, the Sendai Framework for Disaster Risk Reduction points to the need for improved understanding of exposure, vulnerability and hazard characteristics as dimensions of disaster risk (United Nations, 2015). Studies on exposure have estimated the proportion of exposed population and assets, but there are knowledge gaps on the contextual urban dynamics and the implications for exposure to flooding, the impacts on humans, and risk reduction measures (Amoako & Inkoom, 2017 p. 2). The United Nations International Strategy for Disaster Risk Reduction (UNISDR) explains exposure to extreme events as “The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas” (UNISDR, 2017). Increased exposure to floods attributable to human influences on the environment stems from the proportion of impervious cover such as roofs, pavements, parks and cement in urban spaces and well as the occupation of naturally low-lying areas. Similarly, the conversion of river channels into storm drains carries runoff into river and central drainage systems much faster than the natural river channels do, and thus increases flood hazard (Keller & DeVecchio, 2012).

The fifth assessment report (AR5) of the IPCC projects a higher risk from extreme climatic events, including extreme precipitation, and coastal flooding due to anthropogenic changes in climate (IPCC, 2014). Building resilient cities is therefore fundamental to minimizing losses from floods (World Bank, 2017; Miller et al. 2010). This requires improved understanding of the origin and diversity of exposure to floods (Aitsi-Selmi, Egawa, Sasaki, Wannous & Murray, 2015; United Nations, 2015). This study operationalizes resilience as “the existence,

development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise” (Magis, 2010, p.402). This definition explains how community members thrive in hazard-prone areas by developing and using resources available to them in responding to the flood hazard. Though the concentration of people and assets in flood-prone areas may intensify losses caused by disasters, the assets could as well provide the capacity to fight disasters or serve as resources of resilience (Bohle, 2001).

This study seeks to examine the degree of exposure of urban population to flooding, as well as the impacts and response mechanisms in two flood-prone communities in the Greater Accra Metropolitan Area (GAMA) - Glefe and Ogbojo- in Ghana. These communities were selected after a flood hazard map for GAMA was developed; they are located in high flood hazard zones. Understanding the degree of exposure of the urban population to floods and the associated impacts is a *sine qua non* for policies and practices aimed at building resilient cities.

1.2 Statement of the Research Problem

An estimated 450 million people and 430 000 km² of cropland will be exposed to twice the current river flood frequency by 2050 globally (Arnell & Gosling, 2016). In the absence of climate change, global flood risk is projected to experience approximately 187 % increase by 2050, with regional differences (ibid). The absolute global damage due to flooding is estimated to increase 20 times by 2100. In Accra, an estimated 650,000 people, 926 buildings and land area totalling about 0.80 km² along the shores of Accra are likely to be permanently inundated by 2100 if no measures are taken (Appeaning-Addo et al., 2011). The impacts of flooding in Accra including loss and damage of physical assets, loss of livelihoods, death and

injury is well documented (World Bank, 2017; Amoako and Baah, 2015; Asumadu-Sarkodie, Owusu & Jayaweera, 2015; Rain et al., 2011, Afeku, 2005). Many households in Accra report delayed recovery from the impacts of flooding (Erman, et al., 2018; Amoako and Baah, 2018). The increase in flood risk in African countries is primarily attributed to socio-economic change, and then climate change (Winsemius, et al., 2016). There are however knowledge gaps in the flood exposure pathways, the impacts and societal response mechanisms.

First of all, existing studies on exposure to flooding have focused on measuring the proportion of people and assets that are exposed to the risk of flooding (Jongman et al., 2012; UNISDR, 2015), regional differences in exposure (ibid), the differences in exposure between the rich and the poor (Bangalore, Smith & VeldKamp, 2016), and the proximity of human settlements to rivers (Ceola, Laio & Montanari, 2014a, 2014b; Winsemius et al. 2015). The gap in knowledge is the extent of exposure that is attributable to human influence on the environment that exacerbates the frequency and intensity of the flood hazard. This study contributes to this knowledge gap by examining the exposure pathway through the extent of human influence on the natural landscape in an urban socioecological context. An understanding of the exposure pathways is integral to response measures aimed at building resilient cities.

Secondly, one of the major impacts of flooding is the disruption of livelihoods (World Bank, 2017). Research on livelihoods have however largely focused more on rural communities, to the neglect of those in urban areas (Mechler & Schinko, 2016; Barnett, Tschakert, Head & Adger, 2016; Antwi-Agyei et al, 2015; Antwi-Agyei et al., 2013; Afriyiea, et al., 2016; Codjoe, Owusu & Burkette, 2014). Hence, there is limited scholarly knowledge on the livelihood assets that are relevant to the livelihood construction of people in cities. In addition, methods and

approaches for examining livelihoods such as the Sustainable Livelihoods Approach (SLA), and the Community-based Risk Screening Tool-Adaptation and Livelihoods (CRiSTAL) (IISD, 2010; Dovie, 2017) tend to be more inclined towards rural settings. Meanwhile, aside the fact that the proportion of urban population in Ghana and the world are both 54 percent, an increasing proportion of the low-income population in the developing countries reside in urban areas (Population Reference Bureau, 2016, Ghana Statistical Service, 2012). The contribution of this study to the scholarly literature is therefore the attempt to adopt and apply the SLA and CRiSTAL in an urban setting to examine livelihood assets and their relevance to different population groups in cities, how flooding affects local livelihoods, the livelihood resources that are most affected by flooding and the resources that are necessary for implementing coping strategies¹.

Thirdly, the impacts of flooding on the health and well-being of affected households, as well as the economic value of damage caused by floods have been reported (World Bank, 2017; Milojevic, et al., 2016; Abu, 2013; Maybery et al., 2009). An assessment of the impacts of flooding on people through the disruption of their livelihood resources is however scanty; mainly assessing vulnerability of assets to flooding in Accra and Northern Ghana (Afriyie, Ganle, & Santos, 2017; Armah et al 2010, Maybery et al., 2009). There also exist knowledge gaps on the socio-demographic differentials of the impacts of flooding on population groups. The corollary is an underestimation of the impacts of flooding on affected communities. Scholarly work on the impacts of flooding on non-market assets is also emerging (Barnett, et al., 2016; Mechler & Schinko, 2016). This study contributes to this gap by examining the impacts of flooding on

¹ CRiSTAL is a community-based risk screening tool used in examining the community livelihood assets, the effects of climatic and non-climatic hazards on the assets, and the contribution of assets to community adaptation programmes.

different population groups through the disruption of the five asset categories, namely physical, social, human, financial and natural assets.

Finally, it has been well documented that building resilient cities which have the capacity to anticipate, respond and recover from shocks will reduce losses due to flooding (Barnett et al., 2016; Maru et al., 2014; Tanner et al., 2014; López-Marrero & Tschakert, 2011). However, there are only fragmented evidence of the factors that are necessary for building resilient cities, and how they relate to the community's ability to respond to flood hazard (World Bank, 2017; Li et al., 2017; Gwimbi, 2009; López-Marrero & Tschakert, 2011). This study therefore contributes to the literature on resilient cities by examining the structures and factors as well as the assets that relate to the population's ability to respond to flooding. Against this back drop, the following research questions were asked:

1.3 Research Questions

1. How does human influence on the urban socio-ecological context modify exposure to flooding in the two communities?
2. What community assets are relevant for the livelihood construction of different population groups in the two urban communities?
3. How are community assets differentially affected by flooding in the two urban areas?
4. What community assets and structures are necessary for building resilience to flooding?

1.4 Objectives:

The overall objective is to investigate the exposure of urban dwellers to flooding, the effects on assets and resilience building responses.

Specific objectives:

- Examine how human activities on the urban socio-ecological context modify exposure to flooding in the two communities
- Investigate the community assets relevant to different population groups in constructing their livelihoods
- Examine how community assets are differentially affected by flooding
- Appraise the community assets and structures necessary for building resilience to flooding
-

1.5 Rationale

Building resilient cities and livelihoods is a current global developmental agenda, which is dependent on understanding the nature and the origin of exposure to floods (United Nations, 2015; Government of Ghana (GoG), 2015). As a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), Ghana has made much progress in mainstreaming the goals of the global climate change agenda into national and sectoral policies (Dovie, 2017). The Third National Communication of Ghana to the UNFCCC explains Ghana's determination to build a climate-proof society whilst pursuing development agenda that meets the socio-economic needs of Ghanaians, and at the same time contribute to the global effort of combating climate change and its impacts (GoG, 2015). While this ambition is worthwhile, the requirement of scientific evidence to drive programme actions is fundamental. The impacts of climate change are felt across many areas that are of relevance to urban livelihoods including

health, water and infrastructure. This threatens Ghana's ability to achieve the global development goals and the country's efforts towards economic development (ibid).

Secondly, the world's urban population has outgrown the rural population, and it is projected to increase in both absolute terms and as a proportion of the global population. Thus, the urban population is projected to experience a 68 percent increase from 3.6 billion in 2011 to 6.3 billion in 2050 (PRB, 2016). This increase in urban population will have significant influence on both the causes and impacts of flooding. There is also a projected increase in informal urban communities which are devoid of basic social services as the urban population increase. This will increase the pressures that alter the urban socioecological context, with consequent increases in impacts on the already fragile population. The United Nations New Urban Agenda highlights that:

Populations, economic activities, social and cultural interactions, as well as environmental and humanitarian impacts, are increasingly concentrated in cities, and this poses massive sustainability challenges in terms of housing, infrastructure, basic services, food security, health, education, decent jobs, safety and natural resources, among others (United Nations, 2017, p.3)

It is therefore imperative to study the changing dynamics of exposure of the urban population to flooding, the corresponding impacts, and appropriate societal responses that enhances resilience.

Also, Ghana's Nationally Determined Contributions (NDCs) to the UNFCCC *inter alia* seeks to build resilience for gender and the vulnerable, achieve city-wide resilient infrastructure planning and early warning and disaster prevention (GoG, 2015). These cannot be achieved without understanding the exposure pathways of the increasing urban population, and the type of assets affected by floods, as well as the differential impacts on the population groups. An

understanding of the impacts of flooding on segments of the population that are particularly vulnerable will enhance the prioritisation of allocation of scarce resources in building resilience among those population groups. The Sendai Framework prioritizes ensuring that policies and practices for managing disaster risk are based on an understanding of all the dimensions of disaster risk including exposure of persons and assets. This study which examines the exposure pathways of humans and assets is therefore timely and relevant to the achievement of Ghana's NDCs.

Finally, this study deepens the understanding of how key demographic processes such as morbidity/mortality, migration and population growth affect, and are affected by environmental factors such as flooding. The study examines the degree of human's influence on the natural landscape and how it could exacerbate exposure to flooding, as well as the consequent impacts and responses; a significant contribution to the population and environment literature.

1.6 Definition of key terms and concepts

Flood: The overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged. Floods include river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods, and glacial lake outburst floods (IPCC, 2014).

Flooding: The overflowing or failing of the normal confines of, for example, a river, stream, lake, sea or accumulation of water as a result of heavy precipitation through lack of drains or a situation where the amount of water exceeds the discharge capacity of drains, both affecting areas which are normally not submerged (Douben & Ratnayake 2005).

In operationalizing the flood hazard, the threshold was set at zero meter, meaning that any flooding occurring is described as hazardous. This threshold has been previously used by Winsemius et al. (2015).

Exposure: The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected (IPCC, 2014).

Resilience: The existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise (Magis, 2010).

Adaptive capacity: The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities (IPCC, 2014).

Livelihood: Capacities, assets, and activities required for a means of living (Chamber & Conway, 1992).

Asset robustness: A community's asset robustness is a function of the performance, diversity, and redundancy of their assets. Performance describes the level of capacity and quality at which an element of a system performs an essential role. Diversity is a measure of different types of available assets that perform a particular function. And redundancy is a quantifiable measure of a single asset type that performs a specific function (Longstaff et al., 2010).

Socio-ecological context: according to Redman, Grove, & Kuby, (2004, p.163) is "a coherent system of biophysical and social factors that regularly interact in a resilient, sustained manner.

Flood hazard was operationalized as accumulation of water with depth above 0 meter (Jongman et al., 2012), meaning that any condition where people have to walk through accumulated water was defined as a hazard. This is because any accumulation of water can pose threats such as foot rots or slipping and injuring a body part to people.

1.7 Organization of Chapters

This study is organised into eight chapters following the sequence of the Pressure-State-Response model. Chapter One is the introductory chapter, and it consists of the background of the study, statement of the research problem, research questions, and objectives, rationale of the study, then the definition of concepts used in the study. The review of relevant literature and conceptual framework are presented in Chapter Two. The third chapter focuses on the description of the study area and research methodology. The fourth chapter contains the first objective- the urban socio-ecological context and exposure to flooding in Glefe and Ogbojo of the Greater Accra Metropolitan Area. The second objective which examines livelihood assets and their contribution to livelihood construction of different population groups are presented in Chapter Five. Then Chapter Six is the third objective which examines the impacts of flooding on those critical population groups and the coping strategies. Chapter Seven is dedicated to examining how community assets and structures relate with the ability to respond to flooding, which is objective four. Finally, Chapter Eight is the concluding chapter comprising the summary, conclusions, and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.0 Introduction

In this chapter, literature on exposure to flooding, the role of land use and land cover change on exposure to flooding, the impacts of flooding as well as flood response interventions are reviewed. The chapter also contains a review of literature on flood-resilient communities, community-based adaptation measures, and exposure in the broader context of vulnerability. Finally, the theoretical underpinnings of the study and the conceptual framework are also presented in this chapter. Bohle's model of vulnerability, which discusses the determinants of exposure and coping capacity, and the sustainable livelihoods framework are the two frameworks that drive this study.

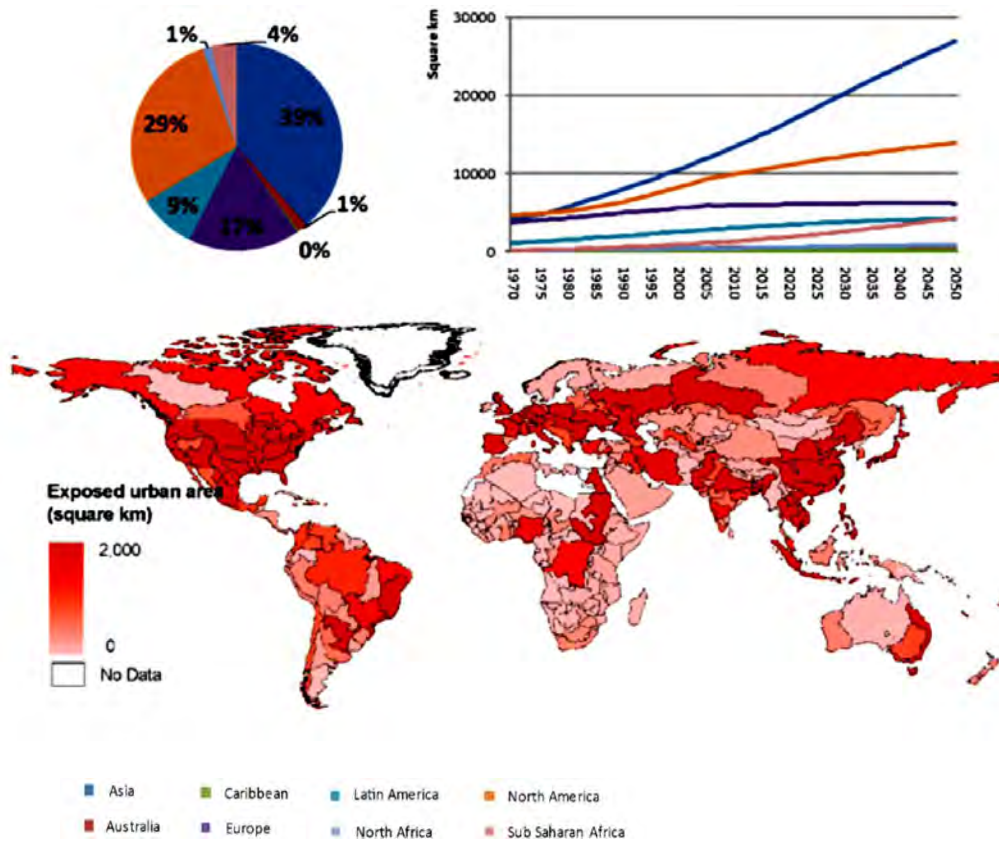
2.1 Urban socio-ecological context and exposure to flooding

The socio-ecological context refers to “a coherent system of biophysical and social factors that regularly interact in a resilient, sustained manner” (Redman, Grove, & Kuby, 2004, p.163). Biophysical factors on the other hand, refer to the biotic and abiotic surrounding of an organism or population that has influence on its survival and development (Kemp, 1998). Hence, the urban socio-ecological context refers to the “state” of the urban system comprising the biotic, abiotic, and social factors that have influence on the survival and livelihoods of humans. Urbanization, if unmanaged can severely alter the ability of the environment to support critical ecosystem functions, and thus creating a state the exposes humans to hazards.

2.1.1 Global overview of exposure to flood hazard in urban areas

The world is rapidly urbanizing, resulting in an increase in proportion of the population and assets exposed to flooding (IPCC, 2014). It is projected that a total of US\$ 158 trillion global assets will be exposed to riverine and coastal flooding by 2050 (Jongman, et al., 2012). This rising exposure and impacts are however not uniform across the globe; developing countries in Asia and Africa have the highest increase in exposed population relative to the total population growth (ibid) (Figure 2.1). The impacts also differ significantly across regions (IPCC, 2014). Whilst least developed countries represent 11% of global population exposed to flood hazard, but account for 53% of casualties, developed countries represent 15% of human exposure to hazards, but account only for 1.8% of all casualties (Jongman, et al., 2012). The increased casualties is mainly driven by low capacity of developing countries to adapt to the flood hazard; mainly due to poor or non-existent early warning systems, and emergency response measures (World Bank, 2015; Rain et al., 2011; Appeaning-Addo et al., 2011).

Figure 2. 1: Global urban area exposed to river flooding



Source: (Jongman, et al., 2012, p.828)

It is estimated that the number of people and economic assets exposed to coastal flooding will experience a three-fold and ten-fold increase respectively by 2070 compared to the 2005 levels globally (Nicholls et al., 2008). In Ghana, an estimated 400 square kilometers of land and 137,000 people are at risk of coastal inundation (Rain et al., 2011). This number is likely to increase due to rapid population growth in these communities resulting from both natural increase and migration. There is observed population growth in communities along rivers channels and other water bodies, even in areas where overall population is dwindling (Appeaning-Addo & Adeyemi, 2013), indicating the rising migration stream to coastal areas. This is because flood-prone coastal communities also tend to provide the environment for

socioeconomic activities. For this reason, the damage potential of these areas will rise (de Moel et al., 2009).

Thus, socio-economic change through population growth, urbanization, and economic growth has been the primary drivers of increased exposure to floods in both developed and developing countries, due to the rising settlement in hazard-prone areas (de Moel, et al., 2011). There are however differences in the degree of urban area increase across regions due to the differences in economic, political and land use practices (Seto et al., 2011). The increase in the proportion of global population that is exposed to flooding still remains even when climate change is not accounted for (IPCC, 2007). Meanwhile sea level is expected to rise by 1m or more by 2100, and is expected to result in greater exposure to coastal flooding (Neumann, et al., 2015).

2.1.2 Land use land cover change and exposure to flooding

Urbanization leads to the conversion of the natural environment including forest, wetlands, and farmlands into built up areas, and thus resulting in increased runoff (Hwang, 2017; Wheeler & Evans, 2009). Altered land cover has major influences on the water balance due to the effect on evapotranspiration, soil properties, percolation, soil water redistribution, as well as groundwater recharge (De Roo et al., 2001). Recent studies have reported substantial reduction in both peak and total runoff volume, as well as fluctuations in rainfall due to increased afforestation (Brookhuis & Hein, 2016; Tan-Soo, et al., 2016; Marengo & Espinoza, 2016; Paix, et al., 2013). For instance, studies in northern and eastern Illinois attributed increased flooding partly to severe rainstorms and to increased land use changes through the encroachment of rural farming lands (Changnon & Demissie, 1996). The degree of flooding is also a function of the

volume of water transmitted to the river channel or drainage system vis-à-vis the quantity that the channel can hold. Aside the concretisation, runoff is also influenced by land slope, type of vegetative cover, the soil type and the area covered by roofs, and sheets (Tellman, Saiers, & Cruz, 2016). This makes the conversion of forest and grassland to settlements problematic, as far as flooding is concerned. As concretization of urban surfaces, and the channelization of rivers significantly alters the rainfall-runoff dynamics of the integrated hydrological system (Nagasaka & Nakamura, 1999). These changes in surface and hydrological characteristics, coupled with increased rain frequency and intensity due to climate change are exacerbated by factors in local urban socio-ecological context as increased occupation of floodplains, poor waste management and lack of/ silted-up drainage (Douglas et al., 2008; Jankowska, Weeks, & Engstrom, 2011).

2.1.3 Causes of flooding

Urban flooding is largely due to prolonged rainfall that generates surface runoff volumes that exceed the capacity of drainage systems or river canals. In developing countries however, the situation is compounded by rapid formation of informal settlements that are devoid of drainage systems (Amoako, 2016). Flooding is a major issue plaguing Accra, the frequency of occurrence and the magnitude of the impacts are anticipated to increase due to factors including population densification, rising sea levels, more torrential rains, poor waste management, and unplanned building (Rain et al., 2011). Amoako & Boamah (2015) identified insufficient or undersized, or clogged drainage network and lagoons/rivers overflow, low-lying nature of the city, as well as the development of wetlands as the major causes of flooding in Accra. The peripheries of Accra are rapidly urbanising in an unplanned and uncontrolled way creating neighbourhoods that lack drains, access roads, and open vegetation places; a condition that causes and exacerbates flooding in the city (Doan & Oduro, 2012; Rain et al., 2011).

Furthermore, the paving of outdoor spaces, a locally understood strategy of reducing mud and dust is widespread in Accra, and this tends to transfer the flood risk on to communities and neighbourhoods downstream (Rain et al., 2011). This leads to increased runoff that overwhelms the usually undersized or clogged drainage channels. Additionally, unenforced regulation on housing has resulted in building at unauthorized places that tend to obstruct water flow (Afeku, 2005). The changing rainfall patterns evidenced through the short duration but intense rainfall attributable to climate change is also documented (GoG, 2015).

The role of poor urban planning and governance to the production of flooding is evident in Accra (Amoako and Inkoom, 2018). Rapid and unplanned urbanisation in Accra is driven by migration, poor urban planning and the traditional land ownership systems where lands are controlled by families rather than the government. This is exacerbated by weak government regulations which allows uncontrolled urban sprawl at wetlands and designated Ramsar sites such as the Densu delta, and thus creates flood-prone settlements within the city (Frick-Trzebitzky et al., 2017; Stow et al., 2016). Agbogbloshie and Old Fadama are examples of such informal settlements which have experienced annual flooding since mid-1980s. The condition is worsened when such communities lack legal status and are thus devoid of basic infrastructure such as drainage systems. Communities that do not have the illegal status often experience transformation over time, as some of the hitherto poor neighbourhoods are inhabited by the wealthy; but remain flood-prone.

2.1.4 Socio-demographics of flood risk

The impacts of floods are disproportionately distributed across social groups and it's a function of the degree of vulnerability (Garbero & Muttarak, 2013). It is therefore important to underscore the tendency of perceiving flood victims as homogenous and generalising

vulnerability in terms of their needs (Jeffers, 2013; Bhatt, 1998). Some authors have highlighted factors such as socioeconomic status, chronic diseases status, gender, age, disability, ethnicity, type of dwelling, and political or religious affiliation as creating variations in vulnerability within communities (Srikuta et al, 2015; Amoako & Boamah, 2015; Johnson et al., 2012; Few, 2003; Maskrey, 1999). The elderly, the very young and others who require special assistance are often the victims of direct death from flood events (Dewan, 2015).

The socio-demographic differential in availability and access to resources makes certain population groups such as migrants more exposed to flood risk (Adger et al. 2004). The age of a person determines how quickly the person can move away from a threat and how efficiently the individual's body will be able to adapt to a climatic hazard and maintain normal processes. Similarly, age is related to the pre-existence of diseases of ageing and some physical disability (Johnson et al., 2012; Johnson & Wilson, 2009). Gender is another very important determinant of vulnerability due to the differentials in access to resources and varied exposures of males and females; males tend to have a higher social support than females (Armah et al., 2010; Garbero & Muttarak, 2013). In addition, women tend to bear a higher brunt of impacts due to the limited access to livelihood resources, low participation in local adaptation measures, and their hefty domestic responsibilities (Owusu, 2017). Informal settlers who live in fragile housing structures in slums, around drainage channels and floodplains aside their higher levels of exposure also often lack the capacity to respond to floods (Amoako & Inkoom, 2017; Few, 2003).

There exists a complex relationship between exposure to flood hazard, poverty and vulnerability to flooding, as the two are closely linked and mutually reinforcing (Bangalore et al., 2016; Few, 2003). However, there is a rising proportion of the affluent settling in low-lying and flood prone areas leading to higher exposures of global assets (Winsemius et al., 2015). Due to

scarcity of land in Accra, the affluent tend to settle at flood-prone areas as well. Wetlands and water courses are converted to settlements and are thus exposed to flooding of transfer the hazard to settlements at lower elevations (Amoako and Inkoom, 2018; Rain et al, 2011). Notwithstanding, low-income households tend to face higher impacts due to the limited capacity to anticipate, respond and recover from flooding. Hence, inundation levels have been higher for poorer households, due to their proximity to watercourses in informal settlements (Bangalore et al., 2016; Winsemius et al., 2015).

2.2 Community Assets and Livelihood construction

A livelihood in its general term can be explained as people's capacity to maintain a living (Chambers and Conway, 1991). This requires a community resource base and its accessibility to different population groups including males and females, as well as the young and the old (FAO, 2005; DFID, 2000). The resource base comprises a stock of livelihood assets which can be accumulated and stored, exchanged or used to make a living (Fang et al., 2014; Babulo et al., 2008). These livelihood resources or assets have been grouped into human, natural, financial, physical, and social assets (DFID, 1999). In constructing a livelihood, people engage in a series and combination of choices and activities using the available assets in order to achieve the desired livelihood goals (FAO, 2005).

The choice of livelihood options is contingent on access to different amount and combination of assets and this influences the wellbeing of an individual or household. The distribution of these assets is however often disproportionately owned by the affluent (Eneyew & Bekele, 2013). For instance, while housing is a significant physical asset that provides both sleeping place and income when rented in cities, it is disproportionately owned by the elite (Banks, 2016). Livelihood construction however encapsulates the resources that people have

access to, as well as the strategies they adopt to make a living. This makes a sustainable livelihood not only dependent on the assets available, but also how they are used to meet basic needs (DFID, 2000). Hence there is the need to focus on both tangible assets such as housing, and land as well as other intangible assets such as social networks in the assessment of how people construct their livelihoods (Speranza, et al., 2014). For instance, whereas natural and human assets tend to enhance farm livelihood strategy, financial and social assets are generally major drivers of non-farm activities, though the extent of their usefulness varies with community (ibid).

The strategies for constructing livelihoods have been classified as only farm, farm and non-farm, only non-farm, and non-labor (Alemu 2012). Other classifications are forest/livestock-based livelihoods, crop farming/livestock, and non-farm livelihood strategies (Soltani et al., 2012). Recent studies however reveal the adoption of a mix of strategies. Also, in as much as these classifications fit the rural contexts within which they were formulated, they may be less applicable in urban contexts which are dominated by non-farm livelihoods (Fang et al., 2014). There are also gendered differentials in livelihood construction. There is a rising trend where women engaged in farm-based livelihood activities while their male counterparts pursue non-farm livelihood strategies in urban areas (Dovie, et al., 2005).

2.2.1 Factors militating against successful livelihood construction in cities

The livelihoods of people, particularly the urban poor are constructed around the opportunities and constraints in the communities they find themselves (Antwi et al., 2014; DFID, 1999). This is influenced by a number of factors including socio-cultural and power relations that drives access of different population groups to diverse productive assets that enables livelihood

diversification, and social networks (Owusu, 2017). Urban areas are more culturally diverse; hence tend to be more socially disjointed compared to generally more stable rural communities (Meikle, Ramasut & Walker, 2001). This presents challenges to the urban poor migrants, in their quest to make a living as social assets may not be as relevant as it is in rural areas. The high economic activities in cities presents an opportunity for the poor, while at the same time increasing dependence on cash incomes (World Bank, 2016; Banks, 2016).

This phenomenon, coupled with the high cost of basic needs such as housing, clothing and food, places much burden on the urban poor particularly those whose livelihoods are constructed around the informal sector. This is because the poor require higher cash incomes in order to survive and build a sustainable livelihood in the urban setting compared to the rural (Satterthwaite, 1997). For instance, a study in Bangladesh showed that only 45 percent of the sample could break even or have surplus after paying their rents and bills at the end of the month (Banks, 2016). This situation limits the capacity of the urban poor to accrue financial assets through savings to enhance livelihood construction and diversification, especially when confronted by a disturbance such as flooding.

The high cost of housing in urban areas compels the poor, often migrants to illegally occupy marginal lands, which lack basic infrastructure and are prone to multiple hazards including floods (Amoako, 2016). Hence, the livelihoods of many of the urban poor in Africa face severe disruptions from frequent and intense flooding (Douglas et al., 2008). This tends to erode their basic livelihood assets, resulting in a cycle of livelihood vulnerability (Afriyie et al., 2017). The poor housing conditions in turn places much constraints on their human capital through compromised health conditions. Therefore, diseases such as cholera and malaria resulting from proximity to waste dumping sites, lack of clean water and quality air are extensive

(Amoako, 2016; Meikle et al., 2001). It should however be noted that some migrants tend to improve their wellbeing and economic conditions at their destinations amidst the exacting urban conditions (Awumbila, Owusu and Teye, 2014).

2.2.2 The role of community support structures and neighbourhood networks in constructing livelihoods

A critical assessment of how local governance structures and social networks affect urban livelihoods is essential to understanding the influence of social and political processes on access to assets, social services and livelihood stability in the face of disturbance (Banks, 2015; Brocklesby & Fisher, 2003). Banks (2015) explains that communities could access sustained income through externally connected leaders. Similarly, individuals or households within the community may not have the capacity to access external resources directly but could access them through well-connected and influential residents of the community. The lowest hierarchy is individuals or households within the community that access resources or assets from 'survival'² networks. At this tier limited assets or resources in the form of housing, loans and services are accessed, which could come at higher cost, and often on exploitative terms (ibid). These networks and community support structures are however, very integral to livelihood construction.

Guarnizo, (1992) identifies the adjustment mechanism that communities in developing countries adopt to sustain their livelihoods after flood events; social, economic, cultural arrangements and technology. Social coping includes assistance from social networks and self-help groups; economic adjustment involves livelihood diversification and community credit

² Survival networks are those that can barely make a living with their resources

groups. The use of flood resistant or portable housing materials is the technological mechanisms; cultural transfer includes the passing of flood risk experience and perceptions through generations. Other communities use indigenous knowledge for early warning and flood prediction (Codjoe et al., 2014). These adjustment mechanisms are embedded in the general community support structures and networks and are enhanced by equity in access to resources.

Livelihood construction is not straightforward even within the same community with diversity of resources or assets. Rather, the assets are useful for making a living if appropriate policies and support structures that enhance access to assets, and also the capacity of the people to convert the assets to desired outcomes are in place (Fang et al., 2014; Brocklesby & Fisher, 2003). Thus, the quality of life of the poor in urban areas is influenced by the actions of the local government. The influences of the environmental, social, economic and political context on the population groups emanates from the community structures, policies, institutions and processes (Meikle, 2002). This in turn determines the adaptive capacity of the population groups (Rakodi, 2014).

2.3 Impacts of flooding and societal responses

2.3.1 Impacts of flooding

The impacts of floods are more pronounced in developing countries than in the developed countries, posing threats to human health, life, and well-being, as well as to critical infrastructure and livelihoods (Dewan, 2014). It is estimated that about two-thirds of all direct mortality related to flood events are caused by drowning; the remaining one-third is due to physical trauma, electrocution and heart attack (Wu et al., 2010; Dewan, 2015). However direct deaths from flooding are declining in many parts of the world where measures are taken to prevent them. Deaths from snakebites were estimated to be the second cause of death after drowning during the

2007 floods in Bangladesh (Osti, 2008). Flooding has a negative impact on the well-being and socio-economic development of people in developing countries. However, adaptive responses to disasters are predominantly reactive in these countries (Amoako & Boamah, 2016). For this reason, although the least developed countries constitute 11 percent of the physical exposure to natural hazards, they recorded 53 percent of casualties in 2005 (Khan & Ali, 2015; Peduzzi, 2005).

The impacts of floods on settlements could be very extensive; whilst high-velocity flood waters are capable of eroding entire slums, slow rising water can destroy buildings, especially ones with fragile building materials (Wu et al., 2010; Brouwer et al., 2007). Dewan, (2015) mentions that houses with walls made of mud, coconut leaves and tin tend to collapse during floods, leaving the inhabitants and assets exposed to the flood waters in rural Bangladesh. Destruction of public infrastructures such as schools, hospitals, clinics, and waste management and water treatment sites can have other protracted impacts on the populace. Like many other developing countries, it was reported that flood affects the city waste management system by clogging drainage systems and resulting in environmental pollution in Nepal (Jha et al., 2012). This has the tendency of contaminating the water system and triggering the transmission of infectious diseases such as cholera and diarrhea.

Whilst the potential damage of flood on exposure units such as physical assets, infrastructure, and agricultural products is easier to quantify, loss and damage to non-market values such as culture, ecology, and health and other indirect damages are still difficult to assess with matrices (Barnett et al., 2016). As a result, attempts to assess losses to such indicators have resorted to qualitative techniques (Moel et al., 2009). A number of studies have examined the direct damage to residential buildings, contents of buildings, economic losses, and loss of well-

being caused by the flooding (Chinh et al., 2015; Pistrika & Jonkman, 2010; Shaw et al., 2005; Navrud et al., 2012; Messner & Meyer, 2006). Others have also examined psychological effects such as post-traumatic stress disorders and have concluded that flooding can disrupt the psychosocial resilience of the affected people (Stanke et al., 2012). The challenge identified with psychological effects of floods is the difficulty in distinguishing the temporary or prolonged distressing experiences of disaster victims from symptoms of common mental disorders.

In Accra, loss of livelihood assets such as human life and health due to disasters has increased significantly in recent decades (Afriyie, et al., 2016; Asumadu-Sarkodie et al., 2015). These losses render affected communities and households more vulnerable to future hazards (Afriyie et al., 2016). Specifically, the 2015 floods that occurred in Accra and the related fire outbreak affected an estimated 53, 000 people; about a third had not recovered from the impacts after two years (Erman et al., 2018). It is expected that the frequency and severity of disasters will increase due to the rising exposure of persons and assets to climatic hazards at a rate faster than vulnerability has decreased (Aitsi-Selmi, et al., 2015; United Nations, 2015; Navrud et al., 2012).

Frequent flood events of a lower magnitude can still bring serious damage and disruption by ruining crops and causing food scarcities, disrupting infrastructure and access to services, suspending business activities, and exacerbating health risks in the home and local environment (Blaikie et al., 1994; Smith, 1996). The persistence of floodwaters means that people may continue to face those disruptions and hazards for extended periods. Aside the damage to property, flooding can cause contamination from solid waste, industrial waste, and sewage, which is a serious health and environmental in urban poor areas especially (Doocy et al., 2013; Rain et al., 2011). The main drivers of these losses and damage include flood depth, flood

velocity, household income, flood mitigation strategies, duration of flood and access to flood warning (Chinh et al., 2015; Navrud et al., 2012).

Floods could bring enormous benefits including irrigating and fertilizing fields, flushing out salts and toxins from soils and watercourses, and recharging reservoirs (Few, 2003). In many regions, annual flooding sustains current levels of agriculture, and residents may have different terms to distinguish beneficial floods from the more destructive ones (Few, 2003). Other studies have reported that flooding tends to wash mosquito larvae and thus limiting malaria transmission.

2.3.2 Responses to flooding

The response to a flood risk could be by developing resistance to prevent the permeation and spread of floodwaters via physical barriers or building resilience to moderate negative impacts from floodwaters (Few, 2003). Measures related to the latter include interventions such as evacuation or relocation, livelihood diversification, early warning, or distribution of emergency supplies to victims (Thulstrup, 2015; Tanner et al., 2015; Adger, 2000). Broadly, these interventions could be classified as “preventive, ante-flood preparedness, and impact-minimizing or post-event coping”. People who are at highest risk of flooding have the least ante-flood preparedness at the household-level and tend to face the worst community-level relief after floods (Brouwer et al., 2007). It should also be noted that many people experience distress following a flooding event, which though momentary, does not necessarily means they are resilient (Stanke et al., 2012). Jeffers, (2013) criticizes the prevailing approach for mitigation flood risk through physical measures aimed at engineering waters away from exposed population and property as a way of preventing losses.

There is a consensus within the field of flood research that complete flood protection is not achievable (Bamberg et al., 2017; Kubal et al., 2009; Few, 2003). The new paradigm that has caught attention in policy and practice is flood risk management through both risk mitigation using structural flood defense measures, and adaptation which tends to adopt soft measures. This paradigm focuses on both the hazard event as well as the possible consequences (Thaler & Hartmann, 2016; Merz et al., 2013). Hence, it has demonstrated the potential of minimising losses from natural disasters, as it encapsulates both hard and soft interventions that target the pre, during, and post disaster phases (UNISDR, 2015).

The minimal casualties recorded in developed countries mainly results from effective flood risk management (Thaler & Hartmann, 2016). For instance, Europe has adopted a flood directive which aims at creating a framework for assessing and mapping flood risk. This involves the creation of flood risk maps as a basis for developing flood risk management strategies (Moel et al., 2009). The flood maps are also used by governments and relief agencies mostly for emergencies such as evacuation and for spatial planning. Flood zones in the form of extent or danger zones are used as an informative tool for decision-makers in countries like Norway and Sweden (ibid). However, the paper highlights the prohibition of developments in flood-prone areas in countries like France, Poland, and Germany. Similarly, assets in flood zones have an obligatory flood insurance requirement; premiums are contingent on the flood zones (Moel et al., 2009). Flood maps are also a useful tool for the insurance industry in Britain; maps are provided by the insurance industry itself or supplied by the central government (CEA, 2005). In Nepal, some NGOs have initiated a number of activities including training for preparedness, training for flood response, information provision on flood shelters for victims, and for post-rehabilitation.

There were also monetary and non-monetary materials for effective emergency relief in some communities (Dewan, 2015).

Most developing countries, however, do not have such structures in place (Amoako & Boamah, 2016; Few, 2003). In some cases, however, such structures exist on paper but are non-existent in practice. The lack of law enforcement often result in major loses in otherwise preventable disasters. This generates mistrust between the local community members and the metropolitan actors. Abeka (2014) identified the challenges to adaptation to urban floods in Accra Ghana, to include a low level of local community participation in flood risk management and the unwillingness of formal institutions involved in flood adaptation to diversify their main goals. Flood response in Accra is often reactive through emergency response and humanitarian assistance for stakeholders including funders, research institutions and policymakers to the neglect of pre-impact interventions (Abeka, 2014; Tschakert et al. 2010). This approach lends itself to huge economic losses and injury to humans. Community-level support actions towards flood risk management are particularly important in developing countries where flood management capacities of governments are weak and where the potential for negative flood impact is high (Few, 2003).

In order to enhance the sustainability to flood management initiatives, flood prevention efforts need to be situated within the context of the community development agenda. This type of approach digresses from the traditional engineering-based approach of flood resistance approach. This is in line with Wong and Zhao, (2001)'s idea that sustainable development in a flood-prone area should focus on building the capacity for people to thrive in the floods rather than attempting to resist the flood hazard. The latter has the tendency of creating a more profound disaster should the engineering fails. Besides, some authors have pointed out that vulnerability

reduction is extremely difficult and expensive when implemented as stand-alone projects, but comparatively less expensive and easy when integrated into development projects (Maru et al., 2014).

Another dimension of community-based flood adaptation is using indigenous practices. Indigenous flood forecasting, early warning system and community-based flood management is reported to have saved many lives and properties in Nepal for instance (Dewan, 2015). Some indicators for forecasting heavy rains include movement of ants and some bird species, location and thickness of the cloud in the sky, rainfall in upper catchments, cry of certain animals and birds, and position of stars. These indicators have been documented in Ghana, Nepal and other developing countries (Codjoe et al., 2014; Dewan, 2015). This indigenous knowledge and practices form the most valued asset for flood management planning in Nepal (Dewan, 2015). This is because they serve as reliable pre-flood preparations signals for effective flood management. Adaptive measures adopted in response to the pre-flood signals include food storage, preparation for temporary relocation, discharging livestock, filling sand bags to divert floods, and acquiring essential drugs (ibid).

2.4 Community structures and resilience to flooding

Resilience thinking recognizes the unpredictability of change and thus encourages systems to live with risk, rather than an attempt to control or avoid it (López-Marrero & Tschakert, 2011; Magis, 2010; Berkes, 2007). This approach shifts focus away from the availability of resources towards a concentration on possible response options (Cote & Nightingale, 2012). Whilst ecological resilience which dates in the 1970s has observed much application in theory and practice, social resilience is emerging (Holling, 1973). Cote and

Nightingale, (2012) argue that with its roots in ecology, the concept of resilience has not been well incorporated into the human dimensions of environmental change. This is attributed to the neglect of the role of socio-political processes in adaptation. There is, however, a significant rise in the application of concepts of ecological resilience to socio-ecological systems over the past decade (Berkes and Ross, 2013; Magis, 2010; Janssen, 2007). This has resulted in the development of concepts and theories in social resilience in community development, health and agriculture (Maru et al., 2014; Magis, 2010; López-Marrero & Tschakert, 2011; Adger et al., 2005). The resilience approach enables a comprehensive response to uncertainties as it provides the common ground for social and environmental sciences in examining the human-environment interactions (Speranza et al., 2014; Cote and Nightingale, 2012; López-Marrero & Tschakert, 2011).

A key component of resilience thinking is the fundamental role of adaptive capacity or resources of resilience in living with risk (Berkes and Ross, 2013; Berman, Quinn & Paavola, 2012). This is premised on the notion that adaptive propensity is an intrinsic property of socio-ecological systems, which need to be developed to maintain stability in the face of change and adversity (López-Marrero & Tschakert, 2011). There has been a paradigm change from the concept of community stability to community resilience. Whereas community well-being is a major responsibility of the government while the community took passive roles in the former, the community is the principal and active agent of change in the face of a hazard in the latter paradigm (Berkes and Ross, 2013).

Communities have a variety of internal and external resources from which they draw to respond to change (Magis, 2010; Kretzmann & McKnight 1993). Economic resources, albeit important, are one of many resources and cannot alone make a community resilient (Speranza et

al., 2014; Tompkins & Adger, 2004; Fey et al. 2006). Additionally, communities need to draw on their social, cultural, human, political, natural, and environmental resources (Dovie, 2017; Sherrieb, Norris, & Galea, 2010; Donoghue & Sturtevant 2007). Community members collectively and strategically engage these resources to respond to change (Otsuki, Jasaw & Lolig, 2017; Berkes, 2007; Colussi et al., 2000). Resilient communities actively develop community resources and make individual and collective effort to respond to the change (Berkes, & Ross, 2013; Adger et al. 2005; Colussi et al., 2000). Community resilience is often used interchangeably with community capacity, in that both have “collective action” as a fundamental principle in developing and utilizing community resources for the community’s well-being. However, the former diverges from latter in its specific focus on the role of “community systems” in transformations (Maru et al., 2014; Cote & Nightingale, 2012). Community systems encapsulate the culture, indigenous knowledge, and institutions such as chieftaincy (Bohle, 2001; DFID, 1999). Community capacity is defined in Magis (2010, p. 407) as “the community’s ability to engage in collective action, and to address a variety of circumstances through the use of various community assets”.

Earlier studies have identified some dimensions of community resilience to include learning to live in hazardous environments through adaptation, social learning (which a key to enhancing adaptive capacity), diversity in institutions and stakeholders, knowledge and practices in responding to a hazard, management options, as well as flexibility in adaptation and recovery practices (López-Marrero & Tschakert, 2011; Berkes, 2007; Folke et al., 2002). The creation of both vertical and horizontal partnerships and collaboration to enhance networks and knowledge sharing has also been emphasized (Quinn et al., 2012). Similarly, diversity enhances adaptation

via the involvement of different stakeholders, worldviews, and experiences and thus strengthens community resilience (López-Marrero & Tschakert, 2011).

2.5 Theoretical framework

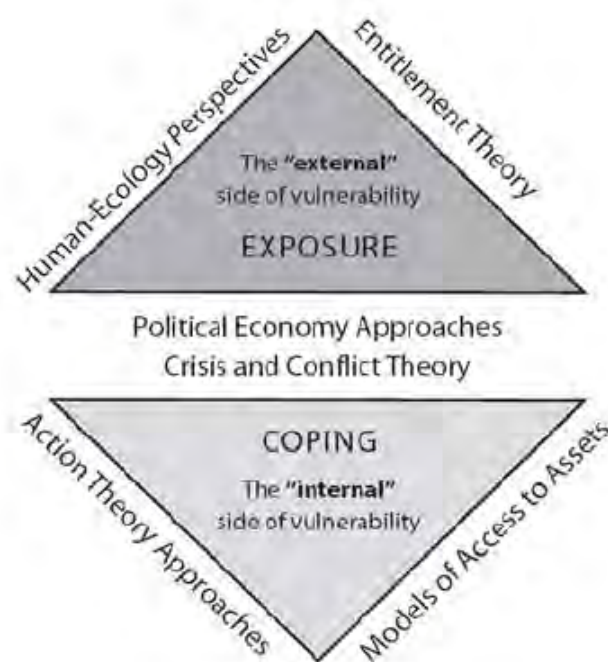
This study is premised on Bohle's vulnerability model and the sustainable livelihoods framework (SLF). Bohle's model explains vulnerability as a function of exposure (the external side) and coping capacity (internal factors that determines a system's capacity to cope). Similarly, the SLF explains the vulnerability context of assets, as well as the processes through which capacity is built for sustainable outcomes in response to the hazard. The sustainable outcomes of the SLF are indicators of a resilient community. A combination of the two models therefore, allows the examination of exposure of people and their livelihood assets to hazards (flooding in this case), and myriad assets that people can access to develop the capacity for building flood-resilient communities.

2.5.1 Bohle's Vulnerability model

Bohle's model explains the drivers of exposure to hazards and coping capacity. According to the model, exposure to hazards labelled as external vulnerability is influenced by the human-ecological perspectives, entitlements and the political economy (population dynamics and the capacity to manage the environment), Entitlement Theory (the economic incapacity of people to obtain or manage assets), and Political economy approaches (exposure of a group due to the control of assets by some upper classes leading to social inequalities and struggles). This means that exposure to flooding is a complex nexus of interrelated environmental, economic and socio-political factors.

The coping capacity, described as internal vulnerability on the other hand, is explained by action theory approaches (the ways and means used by the people to act either on their own or due to societal, governmental or economic constraints), models of access to assets (means by which people alleviate their vulnerability through access to various kinds of assets), and the crisis and conflict theory (the control of resources and assets, the capability to manage crisis, and the resolution of conflicts). This conceptualization of vulnerability expresses it as a function asset ownership, and the entitlement that the household or community can access when exposed to a hazard.

Figure 2. 2: Bohle’s Vulnerability Model



Source: Adopted from Bohle, 2001

2.5.1.1 Limitations of Bohle’s model

The model examines the external (exposure) sides and internal sides (coping capacity) of vulnerability. Though prior to assessing the coping capacity is the need for examining the effect of the hazard, the model does not provide the side for assessing the effects of the hazard.

Secondly, the model is silent on the environmental and human influences that are outside the place of interest. Thus, “beyond place” and cross-scale drivers of external vulnerability are not well explained by the model. This study therefore used the Pressure-state-response model as an overarching framework and triangulated the Bohle’s model and the sustainable livelihoods framework to compensate for this limitation.

2.5.2 Sustainable Livelihoods Framework (SLF)

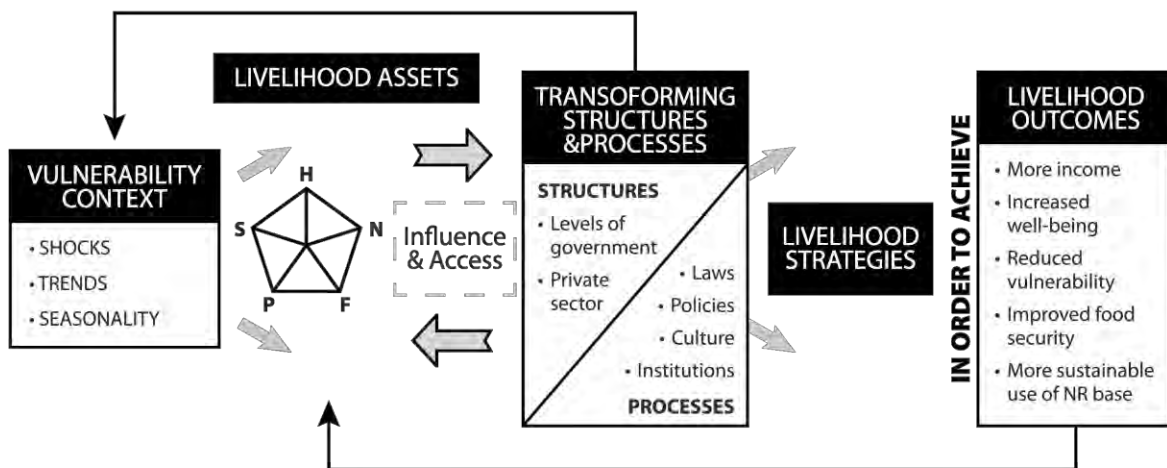
The SLF allows the assessment of community livelihoods on the basis of the hazards they are exposed to and their capabilities (DFID, 1999; Ellis, 2000). As a people-centred framework, it allows the valuation of the strengths of local communities in terms of their assets or capital endowments and how they manage to convert them into desirable outcomes. A livelihood encompasses the capabilities and assets including stores, resources and access, as well as activities required for a means of living Chambers and Conway (1992, p. 7).

The sustainable livelihood approach (SLA), developed originally to assess poverty levels of communities, is also applicable in assessing the capacity of communities to endure climatic and other non-climate stresses (Antwi-Agyei et al., 2013; Reid & Vogel, 2006). The main components of the SLA are the vulnerability context, livelihood assets, transformation processes and structures, livelihood actions, and livelihood outcomes (DFID, 1999; Serrat, 2017). The Vulnerability Context describes the external environment in which people live and work. Thus, livelihoods and assets of people are affected by trends such as population change and environmental change; shocks and seasonality of events such as health and production, which they have limited or no control over (Rakodi, 2014; DFID, 1999). The five livelihood assets or capitals in the framework are human capital such as human health, life and skills; physical capital such as tools, equipment and infrastructure; social capital including leadership, networks

and help groups; financial capital such as savings and credits; and finally, natural capital such as land and water.

Whilst the “Transforming Structures” refers to levels of government and the private sector, “Processes” includes laws, institutions, and policies which tend to substantially influence people’s access to, and use of assets. Thus, the structures and processes determine assets generation and accretion, and how people get access to assets (Serrat, 2017; DFID, 1999). An understanding of these intricate processes is very crucial for effective adaptation in the urban context. Assets and capitals are used interchangeably in this study. Additionally, the vulnerability context in this study is conceptualised as the exposure (external vulnerability) and coping capacity (internal vulnerability) as used in Bohle’s model in Figure 2.1.

Figure 2. 3: Sustainable Livelihoods Framework



Source: Adopted from DFID, 1999

2.5.2.1 Limitations of the sustainable livelihoods framework

The framework has been critiqued for neglecting key population factors such as the culture of power play in access to assets (Morse & McNamara, 2013). Thus, though the SLF is people-centred, it has little consideration for the culture of gender play in access to assets (Tao et al. 2010). Secondly, the SLA has been criticized for not providing a clear guide on how to analyse and measure the capitals within the framework. It is not clear if all the items under each capital are to be measured, or only some are to be measured (Morse & McNamara, 2013). This study addressed these challenges by segmenting the focus group discussions by age group and sex. This allowed an assessment of the nuanced gender play that is inherent in the culture of the communities. In addition, the relevance of all the assets under each asset category were scored by focus group participants.

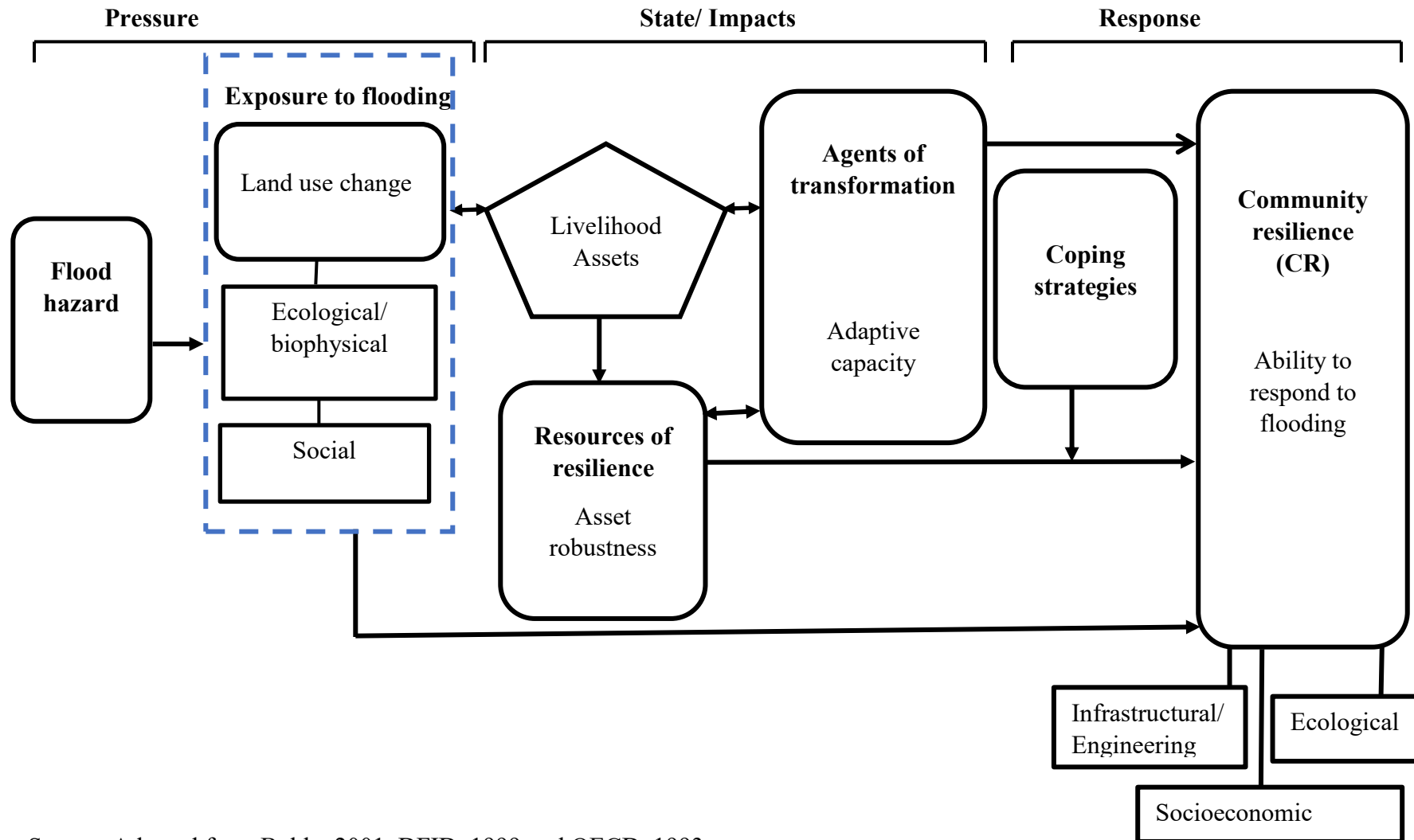
2.6 Conceptual framework

The conceptual framework of exposure of the urban population to flooding and response mechanisms was adapted from the SLF and the Bohle's Vulnerability model (Figure 2.4). This framework enables an examination of pressure exerted by human activities on the urban system, the consequent exposure of humans to floods and associated impacts, and finally the societal responses towards building resilience in heterogeneous urban contexts at the community level. This framework that combines exposure and resilience approaches enables the investigation of both longer-term system drivers associated with the latter and "actor- and issue-based" local socio-economic factors associated with the former (Maru et al., 2014). These will inform adaptation strategies that integrate community level priorities and larger socio-ecological factors

to produce robust framework for building resilient communities (López-marrero & Tschakert, 2011; Adger et al., 2005).

The conceptual framework shows that exposure to flood hazard could result from a complex interplay of human's interference with the natural landscape through land use change, ecological/ biophysical factors such as elevation, and social factors such as access to livelihood assets (Figure 2.4). These different components constitute the urban socio-ecological context. The framework suggests that the urban socio-ecological context influences the extent to which livelihood assets are exposed to and affected by flooding. The socio-political factors herein referred to as agents of transformation such as institutions, processes and the culture of collective action in the community are key components of adaptive capacity of a community (Adger et al., 2005). Adaptive capacity is defined as “the set of capitals and the ability to mobilize these resources to promote adaptation” (Nelson, 2011). This capacity is drawn from the myriad livelihood assets, and more importantly, the ability to adequately use these assets to achieve the desired outcomes of responding to flooding while maintaining fundamental livelihood activities.

Figure 2. 4: Conceptual framework of Exposure to and Impacts of flooding and the implications for building resilience



Source: Adapted from Bohle, 2001, DFID, 1999 and OECD, 1993

The conceptual framework shows that the adaptive capacity of a community could directly influence ability of inhabitants to respond to flooding. Thus, depending on the agents of transformation, assets can be used as capacity or resources of resilience, or otherwise serve as sources of vulnerability to the community (Bohle, 2001). The nature and extent of coping strategies moderates the robustness of assets and the ability of the community to respond to flooding. Thus, effective coping measures that draws on the adaptive capacity that is generated from the livelihood assets yields desirable resilience outcomes, which is determined in this study as the ability of the community to respond to flooding. Mal-adaptive measures on the other hand will provide negative feedbacks on assets.

Community resilience is classified as ecological, engineering/ infrastructural, and socioeconomic (Antwi et al., 2014; Berkes et al. 2003). Ecological resilience is measured by the extent of a system's ecological reorganization after a disturbance. With a flood disturbance, the heterogeneity in landscape and topography are key factors in absorbing the disturbance (Pickett and Rogers, 1995). Whilst some ecological landscapes such as forests and wetlands absorb the flood water and facilitates recovery, built up surfaces and bare soils increased runoff and exacerbates the system reorganisation (Antwi et al., 2014; Tilman and Downing, 1994). Engineering resilience focuses on the stability near equilibrium steady state, where resistance to the disturbance and the speed of bouncing back to equilibrium are key measures (Hodobod & Adger, 2014; Holling, 1973). Early warning systems and flood protection infrastructure are key indicators (Antwi et al., 2014). Socioeconomic resilience is measured by the presence and diversity of livelihood assets and alternate livelihood income sources to ensure socioeconomic

stability following a flood event. Therefore, a community's ability to respond to flooding is dependent on these three domains of resilience (Figure 2.4).

The ability to respond to flooding connotes the recovery capacity of the community. This is further a function of the engineering, ecological, and socioeconomic resilience. Hence the specific domains of resilience were examined for each community using the indicators provided in Antwi et al., (2014). Ecological resilience is the proportion of the forest and vegetation cover to the total land cover. Maru et al., (2014) distinguishes between normative and descriptive resilience, in that, whilst the latter incorporates the system's "long-term capacity to deal with change and continue to develop towards socially desired goals and values", the former does not consider whether the characteristic is desirable or not. As such, the normative interpretation of resilience is adopted for this study, as it enables the assessment of desirable outcomes and not the mere absorption of disturbance which is prone to mal-adaptive outcomes (Maru et al., 2014)

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.0 Introduction

This chapter focuses on the description of the study area and the methodology used in this study. The methodology explains the study design, sources of data, data collection approaches, and data analysis. The description of the study area, on the other hand, comprises the location, topography and drainage, population size and distribution, economic activities, and the climatic conditions of the communities. This study was conducted under Cities and Climate Change project at the Regional Institute for Population Studies and funded by the International Development Research Centre. Hence the selection of study sites for this thesis were informed by the initial flood hazard mapping of the project.

3.1 Study area

Two communities in Greater Accra Metropolitan Area (GAMA), Glefe and Ogbojo were selected for the study based on three key factors: their location in flood-prone areas; frequent flood occurrence and vulnerability of inhabitants, and the difference in the nature and source of the flood hazard in the two communities. Ogbojo is an inland community located in the Adentan Municipal Assembly (AdMA), and Glefe is a coastal community located in the Accra Metropolitan Assembly (AMA). The location characteristics, therefore, have significant implications on the types of livelihood assets available to residents as well as the sources and nature of the flood hazard. Whereas Glefe has several natural resources such as the sea and its associated livelihood activities including fishing and salt mining, Obgojo has limited natural resources and is mainly residential. The location also significantly influences the sources and

type of flood hazard. Glefe's proximity to the sea makes sea surges a major threat. In addition, the presence of two lagoons in Glefe and the low-lying topography exacerbate the effects of the floods (Amoako, 2016; Appeaning-Addo et al., 2014). The flood hazard in Ogbojo on the other hand is mainly driven by land use and land cover change. Thus, the internal characteristics and the vulnerability factors are different for the two communities. As a result, studying these two communities gives a broader view of the multi-dimensional exposure pathways of floods, resources affected and the response mechanisms. The differences in the livelihood activities and population characteristics also determine the sensitivities of these two communities, and approaches needed to build resilience. Despite these differences, these two communities are both in the coastal agroecological zone of Ghana and thus have similarities in the current and projected rainfall pattern.

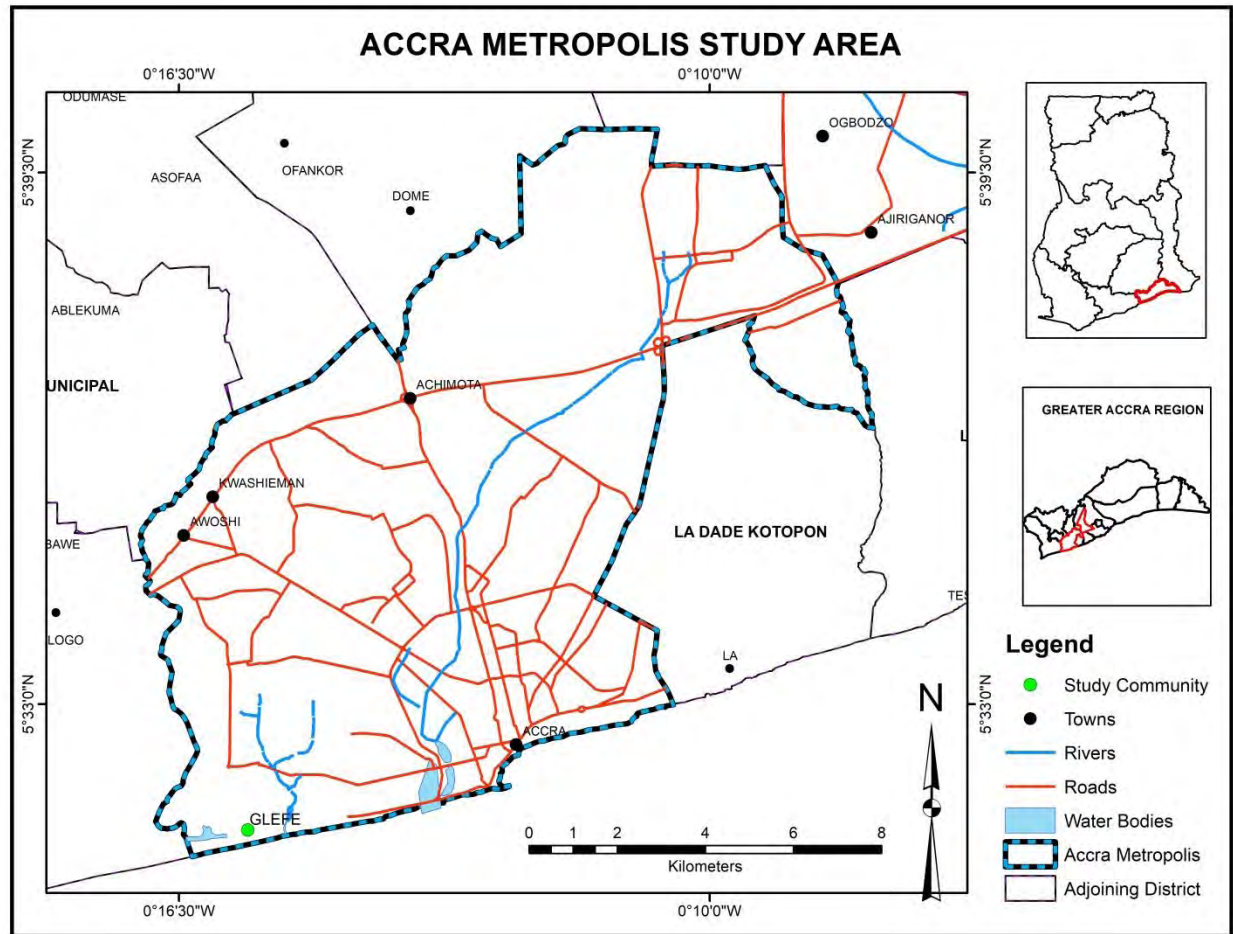
3.1.1 Baseline rainfall characteristics of the coastal zones in Ghana

Ghana's second and third assessment report to the UNFCCC shows declining total annual rainfall amount over the past six decades across the country. This is predominant in the coastal savannah zone where the study area is located. The zone is however experiencing rising intense rainfall clustered over shorter periods (Government of Ghana, 2011, 2015; Codjoe & Larbi, 2016). A 2.5 percent decrease in rainfall is projected across the country by 2040, followed by 1.1 percent increase in the mid-future (2060), then subsequent decline of 1.7 percent by 2080 (Appendix 4). This is an indication of the changing climate, meaning that the rainfall pattern, though declining could contribute significantly to flood exposure if other flood-enhancing conditions are not improved.

3.1.2 Glefe

Glefe is a coastal suburb of Accra, located at latitude 5°19'5" N and longitude 0°6'0"W along the Gulf of Guinea (Figure 3.1a). It is located between the Dzatapkor and Gbugbe lagoons, within the central geomorphic region of Ghana (Appeaning-Addo, Walkden & Mills, 2008). Glefe has an open coastline that enables considerably strong waves to reach the coast, hence experiences relatively severe erosion (Amoani, Appeaning-Addo & Laryea, 2012). There are stagnant water pools in some parts of the community even outside the major rainy season. The township is situated on the sand bar that separates the sea from the Densu wetland. Glefe has high dense population due to relatively lower cost of accommodation compared to adjoining communities. The houses are mainly made of sandcrete and are indiscriminately built along the coast (Appeaning Addo & Adeyemi, 2013).

Glefe developed in the 1970s as a small peri-urban community and was not known to be congested and flood-prone until the mid-1990s (ibid). The nature of flood events has been described by earlier studies as resulting from moderate to very fast run-off carrying huge amounts of debris from various parts of neighbouring communities (Amoako, 2016). Flood impacts are exacerbated by the lack of access to sanitation facilities.

Figure 3. 1a: Map of Accra Metropolitan Assembly (AMA) showing the study site

Source: Author's construct, 2017

3.1.2.1 Economic activities

Fishing is one of economic activity in the community due to the presence of the sea and lagoons, (Amoani et al. 2012). There is gendered dimension to this, as the men are engaged in fishing, the women work as fishmongers. Similarly, children provide fishing assistance by mending nets and scaling fish for their parents (Amoani et al. 2012; De- Graft, 2011). A significant proportion of the populace are also engaged in petty trading; an activity which is highly susceptible to the floods. This is because, aside the inundation of shops, there is no place to put the items for sale when the community gets flooded. A significant proportion of the people in Glefe have ever lost property including household assets, livestock, and housing structures due

to erosion and flooding (Attipoe, 2015). Some of the inhabitants are also engaged in skilled manual work such as masonry, hairdressing and carpentry.

3.1.1.2 Topography and drainage

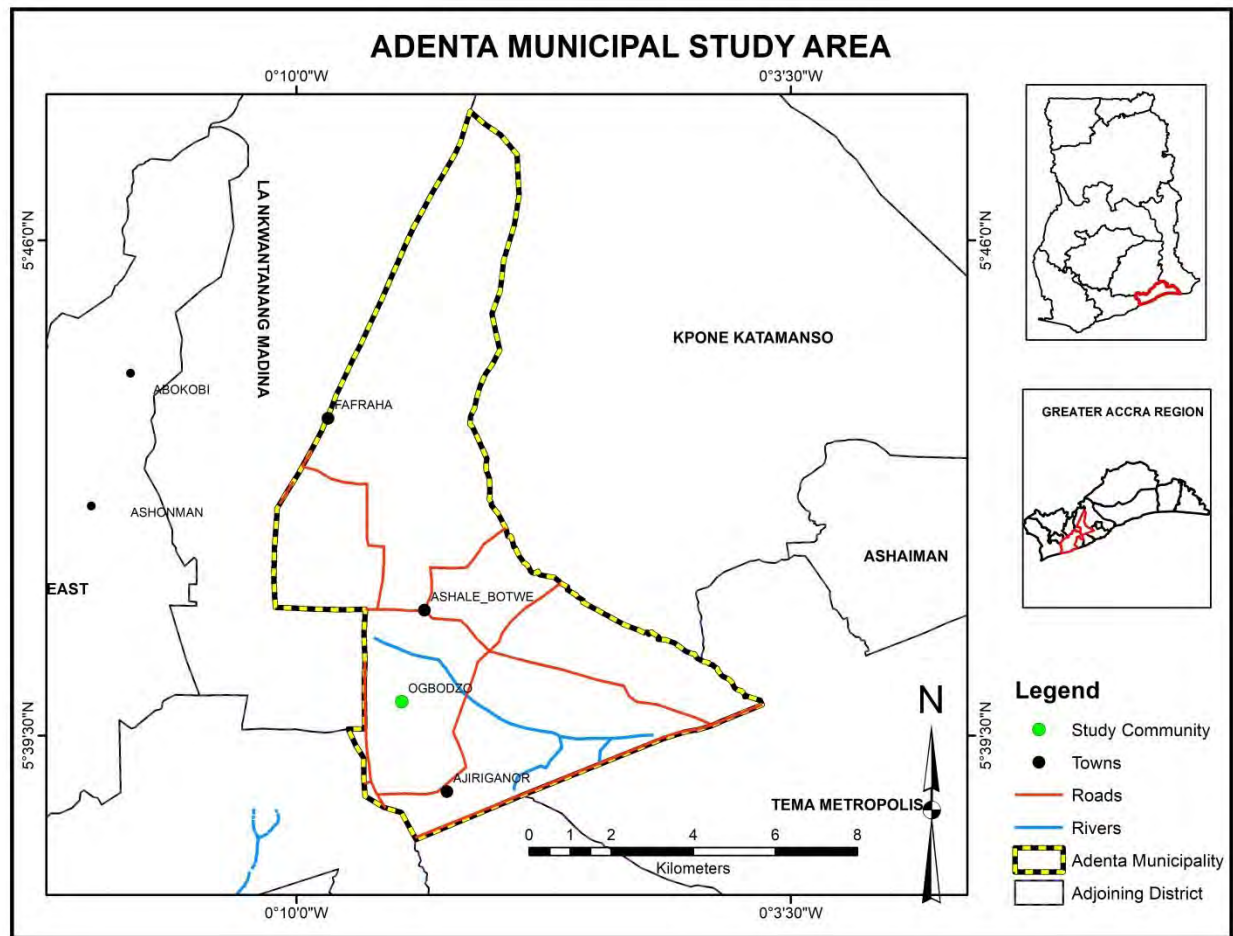
Glefe is a low-lying area; the elevation of is below 1m (Appeaning-Addo & Adeyemi, 2013). The community is generally marshy in a significant part of the year. Drainage system is a major challenge in the community. It is not uncommon to find compounds with patches of stagnant water during the rainy season or high tides which gives breeding grounds for mosquitoes. Land reclamation is also a common thing in Glefe, as the sea draws closer, people attempt reclaiming the lagoons for building structures. Many residents reclaim the land from the lagoon by filling it with refuse and building on it. This exacerbates the flooding condition as it reduces the capacity of the lagoons to hold water. As a result, the lagoons are heavily polluted with refuse and are gradually losing the economic and ecological essence in the community. Filth in the neighbourhoods is usually soaked up in the stagnant water producing unbearable stench in some parts of the community. Spillage from the Weija Dam³ is another major cause of flooding at Glefe. This occurs when the dam reaches its limit in terms of water holding capacity and the gates are opened. Some parts of the Glefe community have been submerged by the sea and it keeps advancing towards the remaining parts.

3.1.2 Ogbojo

Ogbojo is bounded to the south by Mpeasem and Otinshi, on the north by Ashalley Botwe and Sraha and on the west by Madina and is within the Adentan Municipal Assembly (Akrofi, 2013) (Figure 3.1b). This community is one of the flood hotspot zones in Accra. The

³ Glefe is located in a delta of the Densu River close the Weija Dam

geographical coordinates of central Ogbojo is 5⁰40'0" N, 0⁰80'0" W. It is an urbanized community with a population of about 5, 140 with 1, 009 households giving an average of about 5 people per household (GSS, 2012). The statistics indicate that Ogbojo experienced a population growth rate of 22.1 percent between 1984 and 2000 (GoG/MLG&RD, 2010). The rapid urbanisation resulted from the resettlement of the displaced community from Nima during the construction of the Nima Highway. Similarly, the proximity of Ogbojo to major educational institutions including the University of Ghana, and the Institutes of Professional Studies and Local Government Studies has contributed to its rapid population growth. The increasing population led to the conversion of the hitherto agricultural lands to residential area. In the process, the erstwhile floodplains became marshy neighbourhoods. Soil erosion became a major problem at other parts of the community due to absence of drains.

Figure 3. 2b: Map of Adentan Municipal Assembly (AdMA) showing the study site

Source: Author's construct, 2017

3.1.2.1 Topography and drainage

The Adentan Municipality where Ogbojo is located and its environs are in one catchment drained by rivers including the Ogbojo stream into the sea through Tema. The Ogbojo stream sometimes overflows its boundaries in the rainy season, causing flooding in the vicinity and thus depriving people on the opposite side access to some community resources including the Ogbojo Market and some schools (Akrofi, 2013). There are two major streams in the catchment surrounding Ogbojo, and this contributes to annual flooding in the community (Figure 3.1b).

Ogbojo is also located close to the foot of the Aburi Mountains and as such experiences much rainfall.

3.1.2.2 Economic activities

Ogbojo is typically a residential community and as such many of the residents go to work outside the community. Many of the women are involved in petty trading at Madina, a nearby commercial town in Accra. There are however few petty trading activities ongoing at the parts of the community that do not flood. A couple of the residents of Ogbojo are artisans such as mechanics and welders. A few others do petty trading in wooden structures at the part of the community that are not flood-prone. Since these structures and sheds are not able to withstand the flood waters, residents lose their items and at the same time are not able to engage in trade during floods. Thus, if the area gets flooded, there is stagnation of economic activities.

3.1.3 Biophysical characteristics for Glefe and Ogbojo

The biophysical characteristics of the study communities was examined using the New LocClim model and validated through transect walk on the field. New LocClim was developed by the Food and Agriculture Organization (FAO), and it estimates the local climate and other biophysical characteristics of any place on the earth from the FAO agroclimatic database (FAO, 2005). The database currently has observations from nearly 30,000 stations worldwide. Though originally developed for agricultural purposes, the inbuilt parameters make it useful for analysis in flood sensitive environments. The tool offers the options for user-provided station data and can also produce location specific information from the agroclimatic database once the geographical coordinates are provided. Alternatively, the name of the town can be selected from the country and continent list. In this study, the geographical coordinates for both Ogbojo and

Glefe were entered into the New LocClim tool to generate the bio-physical and climatic conditions of these two study areas. The parameters from the model that are useful for flood and flood control are the precipitation deficit, aridity index, radiative index of dryness, the climate class, the moisture index, and the runoff (Table 3.1).

Table 3.1: Biophysical and Climatic characteristics of study areas from New LocClim Model

Climate characteristics	Descriptions for communities	
	Ogbojo	Glefe
Climate class	Forest	Steppe
Aridity	Humid	Dry sub-humid
Radiation index of Dryness:	1.088	2.085
Effective rain	1171mm/year	663mm/year
Effective rain ratio	74%	82%
Rainy days	140 days/ year	76 days/ year
Evaporation	1144 mm/year	730 mm/year
Runoff	441 mm/year	81 mm/year
Evaporation rate	72.2 %	90%
Runoff ratio	27.8 %	10%
Aridity index	1.17	0.58
Moisture Index	17 %	-42%
Precipitation Deficit	-231 mm/year	597mm/year

Source: Output from the FAO New LocClim Model

The precipitation deficit (PD) is the amount of annual rain lacking to fully compensate the potential evapotranspiration (PET). Positive values of PD mean water deficit, and negative values means excess water. The model indicates that whilst Ogbojo has excess water (-231 mm/year), Glefe has a deficit (597mm/year). This means that Ogbojo has the propensity for

long-standing stagnant water than Glefe. Closely related to the precipitation deficit is the aridity index (AI), which is the ratio of annual precipitation to annual PET. A higher AI means the area is less arid. Ogbojo and Glefe respectively have AI of 1.17 and 0.58, buttressing the point that Glefe is more arid than Ogbojo. The radiative index of dryness is the ratio of local radiation balance and the energy needed to evaporate all precipitation. The lower the value, the higher the annual precipitation compared to the radiation energy available for evaporation and the wetter the area. Once again, whereas the index of Ogbojo is 1.088, that of Glefe is 2.085 indicating that Ogbojo is wetter than Glefe.

The climate class is defined by the aridity index of dryness; the higher the index the dryer the area. Thus, the climate class classification based in the AI are; $AI < 0.35$ is tundra, $0.35 < AI < 1.1$ is forest; $1.1 < AI < 2.3$ = Steppe, $2.3 < AI < 3.4$ = semiarid; $AI > 3.4$ = desert. Whereas Ogbojo is classified as forest based on its aridity index, Glefe is classified as steppe (defined by the Webster's dictionary as an arid and high temperature area often with loess soil and xerophilous vegetation). This classification was confirmed in the ground truthing where pockets of forest were observed at the areas of Ogbojo that are not yet developed into settlements. The moisture index (MI) is given as: $100 * (AI - 1)$; AI is aridity index. $MI = 0$ means that precipitation = PET; $MI > 0$ means precipitation > PET, and hence the wetter the area. The MI for Ogbojo and Glefe are 17% and -42% respectively. The runoff ratio, defined as the proportion of rain that runs off is 27.8 % for Ogbojo and 10% for Glefe.

Another factor that influences flooding is the rainfall pattern and percolation. This is a function of the effective rain and number of rainy days. The effective rain is the amount of water that enters the soil after rainfall; the affective rain ratio is the proportion of the total rain that percolates the soil. The New LocClim Model shows that Ogbojo has an average effective rain of

1171mm/year, 140 rainy days/ year and effective rain ratio of 74%. Glefe on the other hand has effective rain of 663mm per year, 76 rainy days/ year and effective rain ratio of 82%. This means Glefe receives lower amount of rainfall, and a significant proportion of it percolates the soil than that at Ogbojo. This difference in surface water behaviour has implications on the effects of floods. The national disaster management organization (NADMO) indicates that an average daily rainfall volume of 55 mm and above can result in major flooding in informal settlements, which means that flooding transcends the mere amount of rainfall (Amoako & Inkoom, 2017).

3.2 Study design and data sources

The study used a mixed method approach, drawing from a mix of participatory methods including transect walks, community workshops, focus group discussions (FGDs), and key informants' interviews (KII). Triangulating data from these methods added much rigor and depth to the study findings (Denzin, 2012; Silverman, 2015).

The study used data from both primary and secondary sources. The primary data provided socio-demographic, environmental, and infrastructural information. These were useful in determining the impacts of floods and the response measures. The secondary data on the other hand was 1991 and 2017 LANDSAT TM sensor imagery and were used for examining the extent of human influence on the environment that could influence exposure to floods. The 1991 image was captured on 4th March 1991 and the 2017 image captured on 27th January 2017. The two images which spanned 26 years interval allowed the detection changes over the period. Furthermore, conscious effort was made to use images captured around the same season to allow effective comparison, as the land cover tend to vary in the dry and rainy seasons. Additionally,

the images also satisfied the less than 10% cloud cover quality criteria. Also, a digital elevation model (DEM) covering the districts within which the study communities are located was used in examining locations which are likely to be flooded due to their elevations.

3.2.1 Workshop

A workshop was organised at the District Assembly level (AMA and AdMA) for each of the communities. The reason was to get a broader scope of the flood hazard and response measures from the District Assembly. The workshop provided information on flood exposure and adaptation practices and plans from the District Assembly as well as other key flood managers in the community and district levels. This was organized after the transect walk but preceded the FGDs. The sequence was purposeful, as it provided vital information for the design of the FGD and KII question guides. It was organised at the District Assembly where each study site is located. During the workshop, the purpose of the Cities and Climate Change Project of which this thesis is a component was explained to community members. Participants of the workshop were mainly District Assembly flood managers, representatives of the Assembly in the communities (assembly members and unit committee members), National Disaster Management Organizations (NADMO) officials, planning officers of the Assembly, resilience officers⁴, heads of schools, religious leaders, chiefs, and representatives of various livelihood groups such as traders, drivers and fishermen. Discussions at the workshops focused on causes of the floods, impacts of floods, as well as current and planned response measures.

⁴ This is a new portfolio at the Accra Metropolitan Assembly who oversees resilience initiatives in the city

3.2.2 Transect walk

Fauna and Flora International, (2013) describes a transect walk as “a tool for describing and showing the location and distribution of resources, features, landscape, and main land uses along a given transect”. It is one of the participatory methods for observation-based community studies (Antwi-Agyei et al., 2013; Chambers, 1994). During the transect walk, the researcher walked through the study communities in a serpentine path to ensure that key features of interest were not left out with the guidance of a community liaison. Attention was paid to sources of the flood hazard, flood-related infrastructure such as storm drains and sea defenses, the location and distribution of all the five asset types that are visible, land use, and other features that were of relevance to flood exposure or response. The construction dates of physical infrastructure and contributions to flood control were solicited through informal interactions with community members. The location of the key features was recorded with a global positioning system (GPS) device for ground truthing. A transect map indicating key features of interest to the study such as hazard spots was also produced in the process. These provided first-hand information on the causes and changes in flood exposure in the communities and guided the design of the interview guide. Attention was also paid to the location of social facilities like schools and hospitals, and housing conditions and waste disposal sites during the transect walk.

3.2.3 Key informant interviews

The KIIs focused on exposure in the communities and the corresponding flood response strategies. The impacts of those strategies were also elicited. The major livelihood groups in the community, and the assets available to them were also discussed. Then the role of community institutions and groups such as community development groups, disaster management groups in

building resilience to flooding was enquired. The key informants were traditional leaders, leaders of youth and community development groups, assembly members and opinion leaders. These leaders were not included in the FGDs due to power play that could restrict the free articulation of participants in front of their leaders. Hence KIIs were used to harness their narratives of the issues. Four interviews were held in each community. This is because meaning saturation was achieved after the fourth interview.

3.2.4 Focus group discussions (FGDs)

Participants of the FGD were selected using a strategy similar to what Sandelowski (2000) calls random purposeful sampling. Community members who had lived in the community for at least five years and were willing to participate in the study were purposively selected for the FGDs. This was at the researcher's discretion to ensure that participants had adequate knowledge of the community. Effort was made to include people with the main livelihood activities in the communities in each group. This was to give a wholistic representation of the different assets available to the different population groups. Organization of focus group participants was done by community facilitators including some unit committee members of the community. This was to ensure that each group consisted of people who were familiar with the community and are involved in the major livelihood activities in the communities.

Six FGDs were conducted in each community, with each group consisting of between 8 and 15 participants. To gain multiple dimensions of asset-based exposure and adaptive capacity to flooding, the groups were segmented by age and sex. With regards to age, participants were grouped into people aged 35 years and below, 36 to 59 years and 60+ years. The basis for this grouping was not only to obtain differences in exposure across age groups, but also to foster

effective intragroup consensus and disagreements in the discussions. Cultural norms which require young people to listen to the elderly could inhibit the young ones from freely expressing their views in the presence of the elderly. The sex dichotomy was to enhance intergroup harmony, maximise the different experiences of males and females, including the gender differentials in access to community assets and coping capacity. This is because previous studies have reported gendered differentials in vulnerability to flooding (Neumayer & Plumper, 2007; Sultana, 2010).

Figure 3. 3: A Research Assistant facilitating focus group discussion session at Glefe



Source: Field data, 2017

In all, 12 focus groups were conducted, with an average of 10 participants in each group. Each FGD lasted about an hour. The question guide followed the CRiSTAL template with few modifications to suit the context (DFID, 1999). The FGDs were conducted in Twi, the main local vernacular language and a few in English. The discussions were facilitated by trained personnel who were familiar with the communities, while researcher took notes. Participatory listing and scoring were conducted as part of the focus groups, where participants listed all livelihood assets

available in the community and subsequently ranked them according to their relevance to lives and wellbeing of the people in the communities (López-Marrero & Tschakert, 2011). Assets were listed under the five main assets categories- natural, physical, human, financial and social to ensure an exhaustive list. In order to enhance the participation of the group members, all the assets that participants mentioned were listed on a flip chart. The group subsequently ranked the listed assets in order of importance to the community, before scores ranging from 0 to 5 (where 0 means no influence, 3 means moderate influence, and 5 means much influence) were assigned to each asset listed. In scoring the contribution of the listed community assets to livelihoods of community members, the scores were written on the flip chart after the group had debated and reached a consensus on the score to assign an asset. In assigning the scores, the group was constantly reminded to consider the contribution of the asset as well as the proportion of the community that benefited from that asset. Similar methodology has been used in the literature (Afriyie, et al., 2017, Arbon et al., 2014; López-Marrero & Tschakert, 2011).

In addition to the community resources, indicators of other dimensions of community resilience explained by Magis (2010) such as engagement of community resources, active agents, collective action, strategic action, and equity, that relate to the capacity of the community to adaptive to disturbance were solicited (Figure 3.2). Participants were asked to score how each indicator applied to their community on a scale of 0 to 5, where 0 means ‘not applicable’, 3 means ‘somewhat applicable’ and 5 means ‘very applicable’. The dimensions of community resilience and the corresponding indicators are presented in Table 3.2.

Table 3.2: Specific indicators of CR dimensions related to adaptive capacity

Dimension of CR	Explanations
Collective action	the extent to which diverse groups share resources, knowledge and expertise when confronted with flood event
Strategic action	Extent to which information on community resources are used in planning Extent to which community members look outside the community for resources to support endeavors
Equity	Access of various groups to the community natural resources
Impacts	Changes in the community's resources over time Changes in the community's capacity over time to respond to flooding
Active agents	Community members' involvement in various groups and activities to address flooding
Engagement of community resources	Extent to which community organizations and associations contribute leadership and volunteers to activities
Community resource development	Development of flood response infrastructure over the last 10 years Extent to which community try new ways of responding to floods

Source: Compiled from Magis (2010), Longstaff (2010) and López-marrero & Tschakert (2011)

Also, respondents rated the current and future intensity of the flood hazard, respondents rated on a scale of -5 to +5, where:

-5 means complete cessation of flood compared to 5 years and 10 years ago

+5 means absolute increase in the flood hazard compared to 5 years and 10 years ago

and zero means no changes

3.3 Data analyses

This section provides a summary of the data analysis. The analysis followed several steps. The first was classification of the 1991 and 2017 Landsat imagery into five main classes to determine the proportion of the landscape that is concretised. This was done by computing the land use land cover change statistics and a projection to 2030 and 2060. Prior to the classification, two main corrections- radiometric and geometric were done to ensure that the image was a true reflection of the ground control points. Also, an error matrix, which is an accuracy evaluation of each of the classes was done using GPS points from each class type from the field. Then the proportion of the landscape that are built up was computed to represent the degree of flood exposure. A digital elevation model for the same districts were superimposed on the land use land cover classification to examine how elevation could contribute to flood exposure. Other socio-ecological and biophysical factors that influenced urban flooding was presented following a synthesis of the primary data. The next stage of the analysis was on the data from CRiSTAL. There were 12 data points from the 12 focus group discussions.

The scores on asset relevance, impacts of flooding and indicators of community adaptive capacity were imported into Microsoft Excel and SPSS for further analysis. Standardized scores of the flood impacts were computed in order to compare the impacts of flooding across communities and population groups. An analysis of variance (ANOVA) was done to examine the factors that explained the variance in scores assigned to the relevance of assets and the impacts of flooding, after a normality check was done. Further, Spearman rank correlation was used to examine how adaptive capacity, asset robustness, as well as socioeconomic and infrastructural resilience are related with the ability of the community to respond to flooding. Then thematic analysis was done on the qualitative data. The detailed write up on the analysis is presented in the subsequent sessions.

3.3.1 LANDSAT Image processing

Given the geometric distortions often associated with LANDSAT imagery, some pre-processing geometric corrections and radiometric calibrations were made to the images prior to the classification process. Geometric correction or geo-referencing involves modelling the relationship between the satellite image and ground coordinate systems (Devaraj & Shah, 2014; Armston et al., 2002).

Geometric correction check was done to ensure that the satellite images were well-aligned with the ground control coordinates. The images were further transformed to a common Universal Transverse Mercator (UTM) coordinate grid and registered using image-to-image digital correlation technique (Shlien, 1979). This was done using the Tools Tab in ENVI 5.3. Radiometric correction is the removal of sensor or atmospheric distortions from the imagery, to represent the ground conditions more accurately. ENVI allows the direct conversion Landsat data to surface reflectance. Standard calibration was done using the tools tab of ENVI to remove temporal differences due to environmental factors and sensor calibration in the image.

3.3.1.1 Land use land cover change classification

Five classes of LULC types that have implications for flooding were adopted for this study (Table 3.3). These include forest, less dense vegetation, open spaces, built area or settlements and water bodies.

Table 3.3: Land use and land cover classification and descriptions

CLASSES	DESCRIPTION
Forest	Areas dominated by natural high forests which are deciduous and evergreen, mixed forest land
Less Dense Vegetation	Areas with less canopy cover as compared to forest covers type, covered by shrubs with grass undergrowth, or natural grass and small shrubs such as Golf courses and lawns
Open spaces	Bare and exposed soils devoid of vegetation (due to erosion and or misuse and compaction) and without building structures
Built Area	Settlements and other concretized surfaces
Water bodies	Rivers, wetlands, lagoons, streams and estuaries

Source: Adapted from Zhu & Woodcock, (2014) and Yuan et al., (2005)

A supervised classification of the land use types was done, after an initial unsupervised classification. This was to improve the discrepancies in the classes produced in the unsupervised classification. In the supervised classification, each pixel in the image was classified using a user-defined classification algorithm known as training areas (Van der Sande, De Jong & De Roo, 2003). The ENVI tool allows the use of the ‘Region of Interest’ (ROIs) in the selection of training areas. Thus, different ROIs were selected for all the Landsat imagery based on the researcher’s prior knowledge of the field and some ‘ground truth’ data. In the process, five classes as listed in Table 3.1 were obtained for the different years. An evaluation of the image classification accuracy was then done using a confusion matrix (Adam, Elhag, & Salih, 2013).

3.3.1.2 Land cover change detection statistics

Post-classification change detection was done, as it has the efficiency in detecting the location and rate of land cover change. The percentage change in area of each of the land cover types between 1991 and 2017 were computed. This was followed by a projection to 2030 and 2060.

3.3.1.3 Projection of land use land cover change

An exponential growth model was fitted for the land use land cover change for 2030 and 2060 using equation (1). This was under the assumption that the LULC change is increased at a consistent rate over the projection period. The projections were made to 2030 because most development goals such as the SDGs and the NDCs are set to 2030. In addition, a projected 1.1 percent increase in rainfall is expected at the coastal savanna of Ghana, where the study areas are located by 2060 (GoG, 2015). Hence the 2060 projection was to examine the extent of human influence on the natural landscape, which in addition to the projected increased rainfall could contribute to the intensity and frequency of the flood hazard.

$$A_n = A_0 e^{rt} \dots \dots \dots (1)$$

The rate of change between 1991 and 2017 was computed as:

$$r = \frac{1}{t} \ln \frac{A_n}{A_0} \dots \dots \dots (2)$$

Where:

r is the rate of LULC change between the time interval

t is the time interval

A_t and A_o are the respective areas of the LULC type at the end of the period (2017) and base year (1991)

The projected LULC change in 2030 were computed using (1), where 2017 was used as the launch year and 2030 as the projected year.

3.3.2 Analysis with Community-based Risk Screening Tool-Adaptation and Livelihoods (CRiSTAL)

CRiSTAL is a community-level risk screening tool that helps in the design of climate adaptation activities. Among other things, the tool helps in the identification of resources that are most affected by climate change and resources that are most useful for livelihood construction of the people as well as for adaptation activities. The tool is useful in assessing vulnerability and livelihood profiles of a community. It can also be used in modifying community projects to suit the level and type of risks. CRiSTAL has been structured around two main modules- firstly for synthesizing information on climate and livelihoods, and secondly, for project planning and management for adaptation. This study which is based on the first module examined the climate and livelihood context. The mix of qualitative and quantitative data generated from the FGDs focused on six key areas: (i) characteristics of the flood hazard, (ii) impacts of the hazard on the communities, (iii) coping strategies adopted in response to the floods (iv) how livelihood resources are affected by the flood hazard, (v) livelihood assets that are necessary for implementing coping strategies and (vi) whether coping strategies are working and/ or are sustainable.

In response to the second and third objectives of this study which sought to examine the relevance assets for urban livelihood construction, participants of the FGDs listed and ranked the

relevance of each asset to livelihood construction in the community on a scale of 1 to 5, where 1= low influence, 3= some influence, 5= very strong influence. The impacts of flooding on livelihood assets were ranked on the same scale (0=no impact and 5=very strong impact). These were done for all five groups of assets- natural, social, financial, physical and human.

The composite weighted average of each asset category was calculated by deriving the percent contribution of each specific asset to a category *Asset_cat* using Equation (3) (Jongman et al., 1987; Dovie, Dzodzomenyo & Ogunseitan, 2017).

$$Asset_{cat} = \frac{1}{100}(x_{i1}w_{i1} + x_{i2}w_{i2} + \dots x_{is}w_{is}) \dots \dots \dots (3)$$

Where

x_i = the relative percentage value for each specific asset within an asset category

w_i = the weighting value (1 to 5)

The weighting allowed respondents to mention as many assets as there are, and not restricting the number of specific assets under each category to a maximum of three as the CRiSTAL tool requires. This study therefore adds to the methodology by allowing as many assets as are necessary to the livelihoods of the community. The composite average weights were plotted in Microsoft Excel to show the relevance of each asset category to the livelihoods in the two communities. Composite data on magnitude and frequency of the flood hazard, impacts of floods, how livelihood resources are affected by flood hazard, coping strategies and whether the strategy is working, and its sustainability or otherwise availability of alternate coping strategy was obtained from the disaggregated data across the two study sites. Since the CRiSTAL output was a descriptive report, the scores were imported into SPSS for further inferential statistics.

3.3.3 Effect of socio-demographic factors on asset relevance and impacts of flooding

Two Analysis of Variance (ANOVA) models were run for the second and third objectives:

- (1) The first was to investigate the effects of sociodemographic factors on the mean scores assigned to the relevance of assets for livelihood construction.
- (2) The second examined the effects of the sociodemographic factors on the variance in the mean scores of the impacts of flooding on livelihood assets.

The sociodemographic factors were age group, sex, and the community of FGD participants. The interaction effects of these factors were also examined. An ANOVA was done because the asset relevance scores and the flood impact scores were normally distributed.

Due to the low statistical power, the data was bootstrapped as a check on the significance of the estimated parameters. Bootstrapping is a process of resampling from an available sample data with replacement to generate many “phantom” samples known as bootstrap samples for estimating a parameter appropriately (Singh & Xie, 2008).

Additionally, since the objective of the study was to examine assets that are relevant to the community, Kendall’s coefficient of concordance was computed to assess the agreement among all the different focus groups in a community and the listed assets and their relevance to the community (Legendre, 2005). The Kendall’s W is computed such that:

If there were m groups rating k assets in rank order from 1 to k .

where r_{ij} is the score that group j gives to asset i

then for each asset i , let

$$R_i = \sum_{j=1}^m r_{ij} \dots\dots\dots (4)$$

where \bar{R} and R are the mean and squared deviation of R_i respectively

$$R = \sum_{i=1}^k (R_i - \bar{R})^2 \dots\dots\dots (5)$$

Then Kendall’s W is given as:

$$W = \frac{12R}{m^2(k^3 - k)} \dots\dots\dots (6)$$

The value of W is such that $0 \leq W \leq 1$

Where $W=0$ means no agreement between raters (individual focus groups) and $W=1$ means complete agreement between focus groups.

The final objective was to explore how community level activities and structures contributed to resilience to flooding. In achieving this, the community’s ability to respond to flooding was used as measure for community resilience. Participants of the FGD were asked to score their community’s ability to respond to flooding on a scale of 0 to 5 (where 0= no ability, 3= moderate ability and 5= very high ability). The community’s adaptive capacity was computed as the average scores of the indicators in Table 3.2.

Asset robustness on the other hand was computed using equation (3).

Where:

x_i = the relative percentage contribution of each asset category

w_i = the average weighting value for each asset category (asset category refers to the five asset types: natural, human, social, physical and financial).

3.3.4 Relationship between the categories of resilience and the ability of the community to respond to flooding

Spearman Rank Correlation was done to examine how adaptive capacity, asset robustness, and also the components of community resilience (socioeconomic and engineering/infrastructural) relate with the capacity of the community to respond to flooding. Engineering/ infrastructural resilience was measured by an inventory of the flood response infrastructure and the average efficiency scores of these infrastructures assigned by community members on a scale of 0 to 100 (0= no impact on flood reduction, and 100= completely stopped floods). Socioeconomic resilience was measured by the community's asset robustness computed as the weighted average of the livelihood assets (Antwi et al., 2014). Ecological resilience was measured as the proportion of the urban landscape that has vegetation (forests and less dense vegetation including lawns).

Spearman Rank Correlation⁵ was done because the scores for community resilience (measured as ability to respond to flooding) were not normally distributed.

3.3.5 Analysis of the qualitative component of the data

The qualitative data was analysed using themes following transcription (Attride-Stirling, 2001; Rabiee, 2004). In the process, basic or “in vivo codes” in the transcript (words or phrases in the respondents' own words that relate to themes in the research question) were identified (Strauss and Corbin, 1990). Then related codes were grouped into macro or organizing themes to reflect broader ideas related to the research question, a process called charting (Rabiee, 2004). While interpreting the results, attention was paid to the frequency of codes, the context, as well as the

⁵ Spearman rank correlation is a nonparametric measure of the statistical dependence between the rankings of two variables

conflicts, consensus, and absence of codes in the various transcripts (Silverman, 2012; Rabiee, 2004). In order to ease the interpretation process, a thematic framework indicating the basic, organizing and global themes was produced.

3.3 Limitations of the study

There are some limitations associated with this study. First of all, the capacity of the community to respond to flooding without disruption to livelihoods was used as a measure of community resilience to flooding. In as much as this represents the “buffer capacity” of the community or its ability to absorb flood disturbance (Holling *et al.*, 1995), it does not consider the speed of recovery period, which is a component of resilience (Adger, 2000). The buffer capacity of a community to absorb disturbance, which connotes a measure of resilience was used.

Secondly, though the participatory scoring technique used in the CRiSTAL tool generated quantitative data, it was lower in statistical power. Statistical techniques that lend themselves to continuous data with small samples such as Spearman rank correlation was therefore used in examining the relationship between variables (Bland & Altman, 2009). Where an analysis of variance was used, the data was bootstrapped as a check on the findings.

Thirdly, an attempt to examine the number of people exposed to or affected by the floods due changes in the urban space could not be done due to lack of data. It would also be revealing to overlay a population data on the LULCC image and DEM to examine the demographic dimensions of flood exposure. Spatial population data that spanned the study period was however not available.

CHAPTER FOUR

URBAN SOCIO-ECOLOGICAL CONTEXT AND EXPOSURE TO FLOODING

4.0 Introduction

Current and projected increase in the proportion of urban area exposed to surface flooding is attributed to conditions in urban socio-ecological system such as rising occupation of floodplains and increased runoff from impervious surfaces and exacerbated by rising rainfall intensity due to climate change (Amoako & Boamah, 2015; Jongman et al., 2012; Douglas et al., 2008). This chapter focuses on the extent of exposure to flooding by critically examining the proportion of the urban space that is impervious to water and could increase surface runoff. In addition, the contribution of flood interventions to the control of the flood hazard is presented. These are preceded by examining the nature of the current and projected flood hazard from community members' perspectives. Thus, this chapter elucidates how the "state" of the urban socioecological context exposes humans to flood hazard. Results in this chapter are a triangulation of data from FGDs, KIIs, workshop/townhall meeting, transect walk, land use and land cover change using remote sensing/GIS techniques.

In all, 150 people participated in the FGDS. A little more than half of the respondents were males (55.5%) and the rest were females (Table 4.1). Equal proportion participants (60%) were below 36 years and in the 36-59 years age category. The rest were above 60 years. Also, respondents from Ogbojo were moderately higher (53.3%) than those from Glefe (46.7%). Respondents included traders, skilled manual workers, professionals, fisherfolks, and some unemployed community members. Their levels of education varied from no education to tertiary education. This ensured that the different population groups were adequately represented. Similarly, key informants were representatives of the communities at the District Assembly

(Assembly members and unit committee members), chiefs, youth group leaders and other opinion leaders. These included both males and females with varied levels of education from no education to tertiary education.

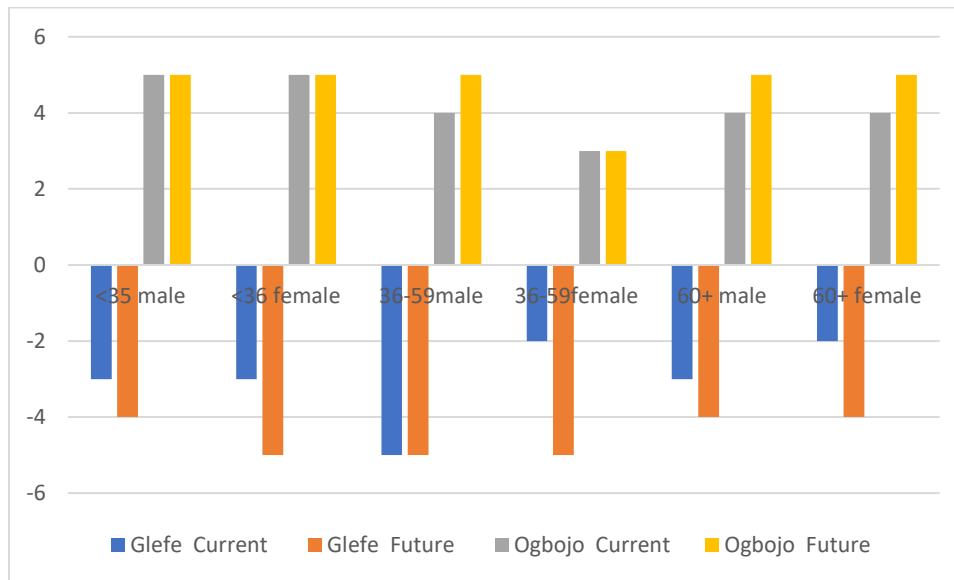
Table 4.1: Socio-demographic characteristics of FGD respondents

Socio-demographic characteristics	Frequency	Percent
Age		
35 years and below	60	40.0
36- 59	60	40.0
60 years and above	30	20.0
Total	150	100.0
Community of residence		
Glefe	70	46.7
Ogbojo	80	53.3
Total	150	100.0
Sex		
Male	83	55.3
Female	67	44.7
Total	150	100.0

Source: Field data, 2017

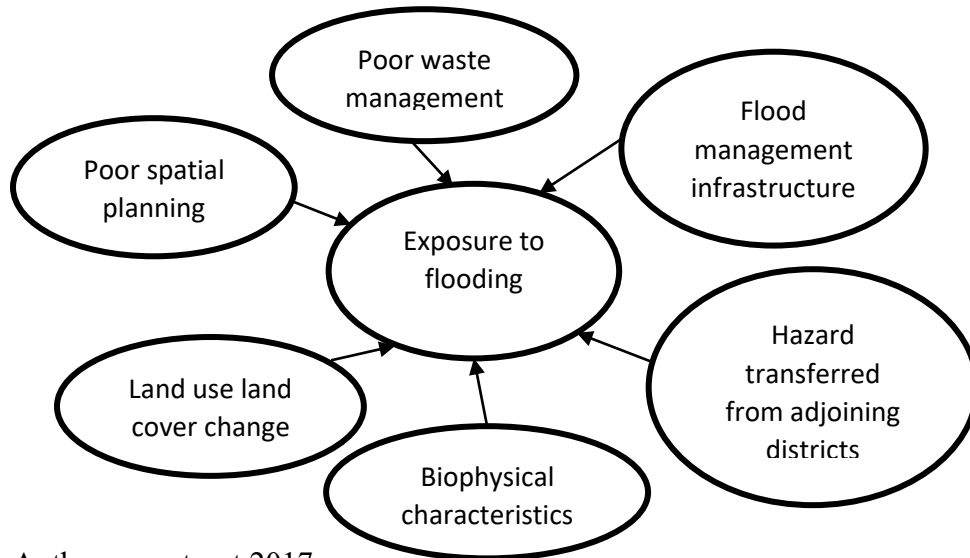
4.1 Factors influencing exposure of the urban area to flooding

In order to understand the factors that influence exposure of the study sites to flooding, a historical matrix of flooding in the study sites was done through FGDs. Respondents at Glefe observed a decline in the frequency and intensity of the flood hazard (consistent across all focus groups), whilst those at Ogbojo observed an increase within the same period (Figure 4.1). Residents of Glefe projected a further decline in the intensity of flood hazard or complete cessation when the ongoing projects including the sea defense are completed. Respondents at Ogbojo on the other hand indicated increased flood hazard and projected an increase in the coming years under business as usual conditions but expected a decline if storm drains are constructed.

Figure 4.1: Changes in flood frequency and intensity and projected changes

Source: Constructed from field data, 2017

A triangulation of data from the different sources showed that exposure of the study sites to flooding was created or modified through poor waste management, interventions/infrastructure such as drainage systems, land use land cover change, activities of adjoining districts and communities, poor spatial planning, and the biophysical characteristics of the urban space (Figure 4.2). These factors are broadly influenced by the changing rainfall patterns, which was attributed to climate change. Poor waste management results in clogged drains which overflows shortly after rainfall. This condition is exacerbated by the habit of disposing household waste into drains during rainfall with the intension that the runoff would carry the waste into the sea. Similarly, the conversion of deltas and wetlands into settlements creates urban neighbourhoods that are physically vulnerable to flooding. There was marked reclaiming of the lagoon in Glefe for building housing structures. There is this an interconnected web of factors the influence the presence of people at locations that could be adversely affected by flood events.

Figure 4. 2: Factors influencing exposure of the two urban communities to flooding

Source: Authors construct 2017

The pathways through which these factors contribute to urban flooding have been elaborated in subsequent sub-sections of this chapter.

4.1.1 Land use and land cover change

The land use land cover (LULC) change analysis shows a considerable increase in the built-up areas over the twenty-six years period (1991 to 2017) for both AMA (where Glefe is located) and AdMA (where Ogbojo is located). The built-up areas increased by 6.27 km² (7.2 percent) in AMA and 17.51 km² (50.0 percent) in AdMA and are projected to have respective increase of 96.42 km² (3.6 percent) and 64.01 km² (22.7 percent) by 2030 (Table 4.1). Built-up areas tend to increase the level of runoff resulting in an intensification of the flood hazard (Hwang, 2017). Similarly, whilst AMA observed a 2.14 km² (76.4 percent) increase in water bodies including wetlands, more than half (56.7 percent) of water bodies in AdMA totalling about 7.46km² was lost. The percentage increase in the area occupied by water bodies at AMA could be attributed to the expansion of the sea (Apeaning-Addo, & Adeyemi, 2013).

AMA gained 4.44 km² (15.8 percent) more vegetation (less dense) cover while AdMA lost 14.68 km² (60.9 percent) of its less dense vegetation (Figures 4.3 and 4.4). It is projected that, under business as usual conditions, whereas AMA may gain more vegetation due to urban tree planting (7.6 percent), AdMA will lose more than a third of its green spaces (37.5 percent) by 2030. Though, there was an observed and projected loss of forest cover in both districts, AdMA lost 59.8 percent of the forest cover while AMA lost 39.4 percent over the same period (Table 4.1). Further, AdMA is projected to lose an additional 36.6 Percent while AMA loses 22.2 percent of the current forest cover by 2030.

The analysis showed that 10.68 km² (63.6 percent) of the open spaces in AMA was converted to settlements, and an additional 3.69km² constituting two-fifths of the current open space area will be concretised by 2030. On the other, the open spaces in AdMA doubled over the 26 years interval (5.30 km²); an additional 43 percent increase is expected by 2030.

The projections for AMA show that under business as usual conditions, more than half (56.34%) of the current forest cover and 81.21 percent of open spaces will be lost by 2060 respectively. Whilst water bodies increase by over 150 percent, the built-up area will extend by 12.24 percent (Table 4.1). About 77.87 % of the forest cover and less dense vegetation (78.87%) in AdMA, is projected to be lost by 2060. The built-up area on the other hand is projected to increase by 96.66 percent by 2060. Open spaces in AdMA will increase by 223.87 percent in 2060 if the current situation prevails. Finally, it is observed that 74.94 percent of water bodies in AdMA will be lost by 2060.

The digital elevation model for AMA, presented in Figure 4.3 shows that Glefe is located at a very low elevation area. This predisposes the community to runoff from concretised higher elevation communities and districts including AdMA. Ogbojo on the other hand, though located

at a relatively higher elevation than Glefe, is predisposed to the runoff from communities and districts located at higher elevations (Figure 4.4).

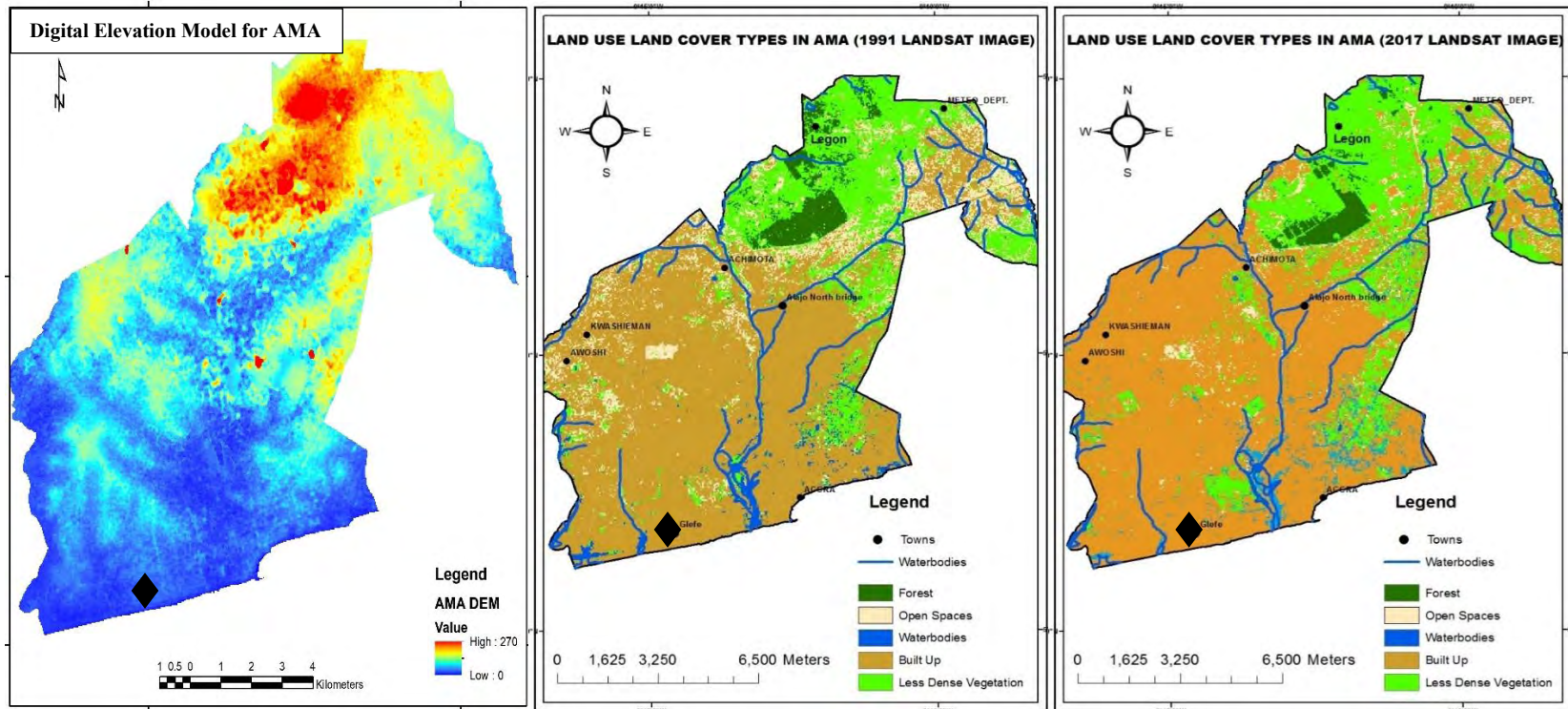
Table 4. 2: Land use/ land cover change for AMA and AdMA, 1991 and 2017 and projected change for 2030 and 2060

Land use/ cover types	1991		2017		1991- 2017		2030		2060	
	Area (km ²)	Percent	Area (km ²)	Percent	Area changed (km ²)	Percent	Projected Area change (km ²)	Percent	Area change	Percent
	AMA (Glefe)									
Forest	5.48	3.9	3.32	2.4	-2.16	-39.4	-2.58	-22.2	1.45	-56.34
Open spaces	16.79	12.0	6.11	4.4	-10.68	-63.6	-3.69	-39.7	1.15	-81.21
Water bodies	2.80	2.0	4.94	3.5	2.14	76.4	6.56	32.8	12.63	155.73
Built-up	86.83	62.0	93.11	66.5	6.27	7.2	96.42	3.6	104.51	12.24
Less dense vegetation	28.05	20.0	32.48	23.2	4.44	15.8	34.95	7.6	41.39	27.44
Total	139.96	100.0	139.96	100.0						
	AdMA (Ogbojo)									
Forest	1.12	1.4	0.45	0.6	-0.68	-59.8	-0.29	-36.6	0.10	-77.87
Open spaces	5.12	6.6	10.42	13.3	5.30	103.5	14.87	42.7	33.75	223.87

Land use/ cover types	1991		2017		1991- 2017		2030		2060	
	Area (km ²)	Percent	Area (km ²)	Percent	Area changed (km ²)	Percent	Projected Area change (km ²)	Percent	Area change	Percent
Water bodies	13.16	16.8	5.70	7.3	-7.46	-56.7	-3.75	-34.2	1.43	-74.94
Built-up	34.66	44.3	52.17	66.8	17.51	50.5	64.01	22.7	102.60	96.66
Less dense vegetation	24.09	30.8	9.41	12.1	-14.68	-60.9	5.88	-37.5	1.99	-78.87
Total	78.15	100.0	78.15	100.0						

Source: Computed from the LULCC class detection statistics

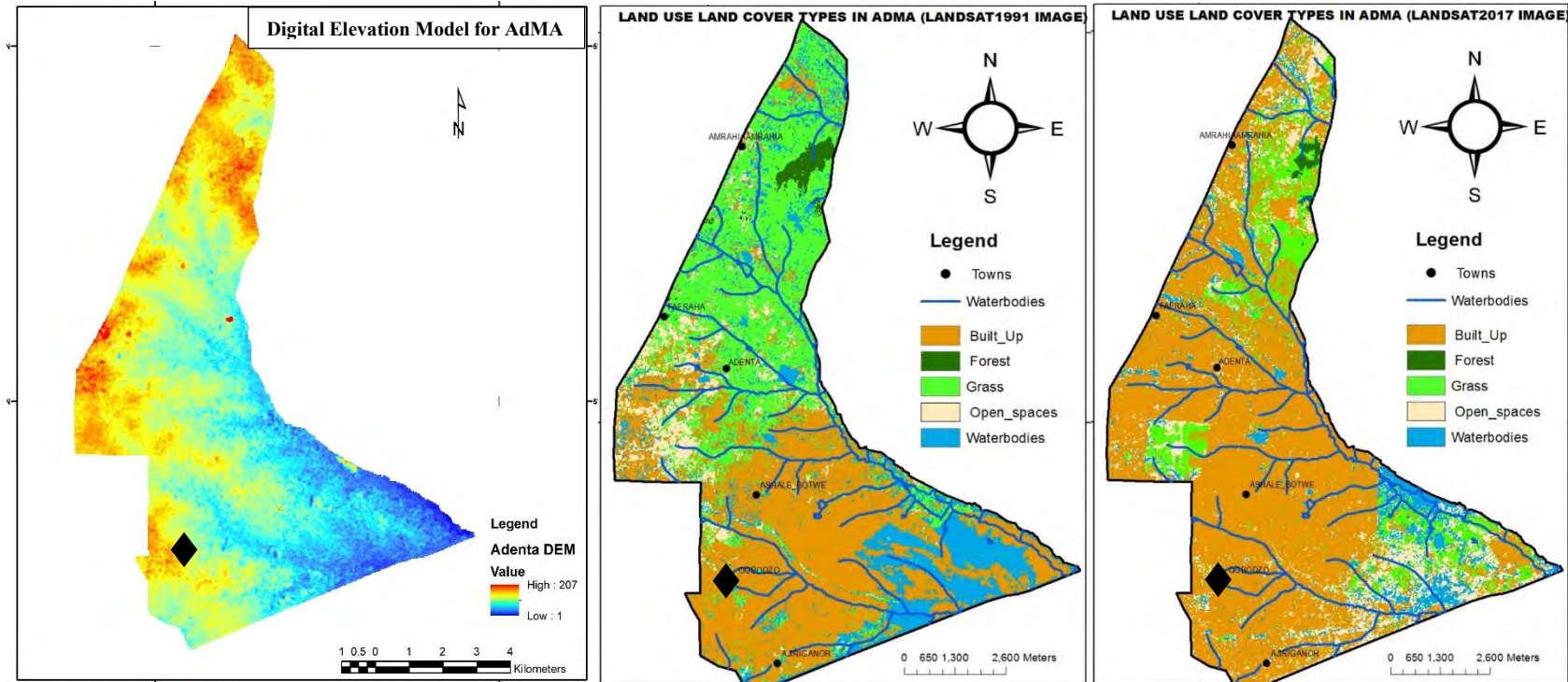
Figure 4.3: Digital Elevation Model, and Land Use/ Land Cover Change in AMA for 1991 and 2017



Source: Author's construct, 2017

◆ Location of study area (Glefe)

Figure 4.4: Digital Elevation Model, and Land Use/ Land Cover Change in AdMA for 1991 and 2017

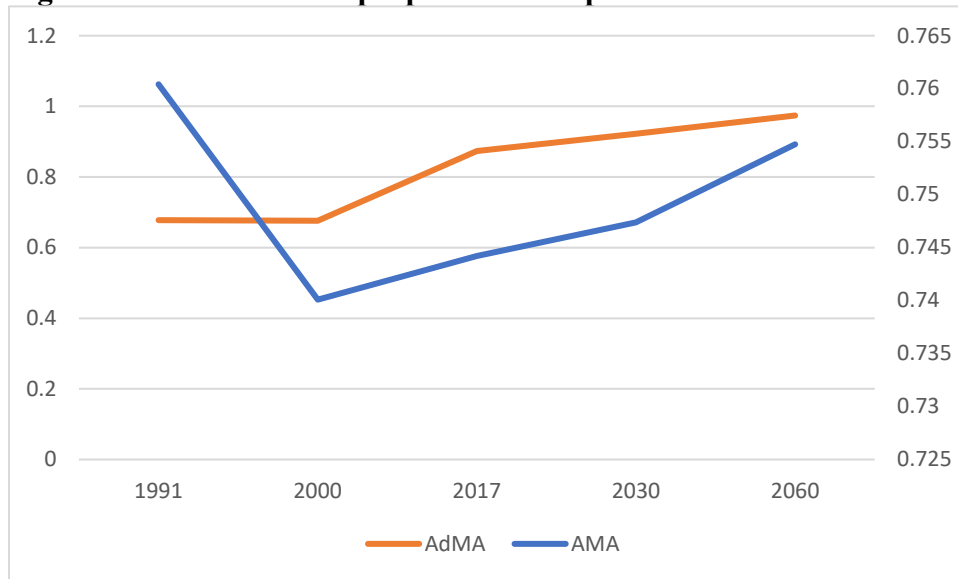


Source: Author's construct, 2017

◆ Location of study area (Ogbojo)

The proportion of the urban landscape that is built up is presented in Figure 4.5. The projections show a continuous rise in impervious surfaces under the prevailing conditions. Whilst AdMA experienced a consistent increase from 1991, AMA observed a decline in 2000 and a steady rise afterwards.

Figure 4.5: Trends in the proportion of impervious surface in AMA and AdMA



Source: Author's construct, 2017

4.2.1.1 Classification accuracy assessment

The accuracy assessment helps to determine how well a classification was done. The error matrix revealed that the classification of the 2017 image was done at 81.304 percent accuracy, and a Kappa coefficient of 0.721. This means that there is 72.1 percent agreement actual agreement than by chance. The 1991 image on the other hand had an overall accuracy of 79.002 and Kappa coefficient of 0.688. These are acceptable levels of accuracy, according to Nagamani et al., (2015).

Verification of the natural landscape change showed the conversion of water bodies such as river and lagoon to settlements (Figure 4.6 plates A, B, C and D). There was also evidence of

coastal inundation of an old building, as well as the creation of an artificial lagoon at a previously open space in Glefe (Figure 4.6 Plates E and F).

Figure 4.6: Verification of land use land cover change in the study communities



Conversion of a lagoon to settlement, Glefe



Conversion of wetland to settlement, Ogbojo



A river converted to settlement, Ogbojo



Wetland converted to settlement, Ogbojo



An ancient building, now located in the sea, Glefe



Conversion of open space to lagoon, Glefe

Source: Field work, 2017

4.2.2.1 Efficiency of infrastructure and other environmental factors on flood control

The average efficiency scores assigned by community members to the flood control infrastructure is shown in Table 4.3. The scores show a generally efficient infrastructure in Glefe than Ogbojo. The 12km emergency sea defense and drains at Glefe had significantly reduced the frequency and intensity of flooding in the community. There was however, mixed reaction regarding the efficiency of the storm drains at Ogbojo since the flooding had been intensified at sections of the community where the drains were terminated.

Table 4.1: Engineering/ Infrastructural interventions and their impacts on the flood hazard

Intervention	Description (Community)	Status	Effect	Mean (SD) efficiency score
Dansoman Emergency sea defense	12 km along the Dansoman-Glefe stretch (Glefe)	Was started in 2016 and ongoing	Prevented the surge from the sea	90.0 (6.45)
Glefe community street and drains	Constructed street with drains (Glefe)	Completed	Prevented the accumulation of water on the street after rains, and from entering houses	95.0 (6.92)
Connecting roads	Roads connecting Glefe to adjacent communities (Glefe)	Completed	Prevented water from entering houses Easy access to nearby communities	75.0 (9.57)
Ogbojo community drains	Drains through some parts of the community (Ogbojo)	Ongoing	Prevented flooding at parts of the community, but exacerbated for those downstream where the drains were terminated	40.0 (51.25) *

Source: Field data, 2017 *The large standard deviation is due to the varied opinions depending on the side of the community participants resided.

Some of the flood management interventions identified in the communities are presented in Figures 4.7 and 4.8. Evidence of the poor waste management is presented in Figure 4.9.

Figure 4.7: Some flood adaptation interventions



Emergency sea defense, Glefe



Uncompleted drain, Ogbojo

Figure 4. 8: Before and after of flood prevention infrastructure



Before street and drain construction, Glefe
Image A was taken in April 2015



After street and drain construction, Glefe
Image B taken during transect walk, 2017

Figure 4.9: Poor waste management at Glefe



Source: Field data, 2017

The voice of community members on the factors that causes flooding in the study sites is presented in Table 4.4. These corroborates the results of the remote sensing/GIS analysis on increased occupation of natural landscapes such as flood plains. The sample quotes represent the voice of participants of focus group discussions, key informant interviews and workshops. Participants explained the location of physical infrastructure such as kiosks and buildings on water ways, poor waste management, flood risk transferred from adjoining districts and communities, as well as infrastructural interventions as factors influencing exposure of their communities to flooding.

Table 4. 4: Other factors influencing exposure to the flood hazard in the study sites

Factor/ code	Description	Sample quotes
Location of physical infrastructure	Flooding was attributed to building on water ways, buffer zones of rivers and lakes, and areas designated for alleys/ streets	<i>You should also break down all the buildings on water ways. Many people have built their houses on the water ways! And that is what is causing all the problem!</i> (Male adult, Glefe). <i>... all these houses are on the water ways. This was a major street, but now, even a bicycle cannot pass there! And they have walled their houses, so the water passes here [pointing to the direction] to disturb innocent people</i> (Key Informant, Ogbojo).
Adjoining districts and communities	Flooding is caused by runoff/ river discharge from adjoining districts or communities.	<i>One of our major problems is the Weija Dam. This part of the community gets flooded whenever the Weija Dam is opened</i> (Key Informant, Glefe). <i>All the rainfall at East Legon (nearby community) ends up in this community...so with the slightest rain, all this place gets flooded</i> (Key informant, Ogbojo).
Drainage infrastructure/ Engineering	The intensity and frequency of the floods are influenced by the flood infrastructure (further details are in Table 4.3)	<i>Ever since the street and drains were constructed, we hardly experience flooding at this side of the community</i> (Male Adult, Glefe). <i>Before they constructed the drain, we were better off! They have not completed the drains so all the accumulated water is discharged here</i> (Female Adult, Ogbojo)
Poor waste management	Accumulation of waste in drains reduces the water holding capacity of the drains, leading to flooding in homes	<i>All the gutters are choked so the water does not flow when it rains. Once the rains start, that is when they dump all their household waste into the gutters. When you talk about it [indiscriminate waste disposal], they will ask you if the gutter is your property</i> (Male youth and member of the community police, Glefe). <i>The main cause of the flood is the big gutter down there, once you desilt it the flooding will cease</i> (Male youth, Glefe).

Source: Field data, 2017

4.3 Discussion

There is rapid conversion of previously unoccupied landscapes such as forest and wetlands into settlements in both study sites. This was more pronounced in AdMA than AMA,

which could be attributed to the fact that whilst AMA is 100 percent urban, AdMA is 63.9 percent urban and 36.1 percent rural (GSS, 2012). Therefore, whereas AMA has limited virgin lands to be cleared, farmlands and forests of previously rural communities in AdMA are rapidly being converted to urban and semi-urban settlements. The increased built up area in AMA is through the filling of previously open spaces, as well as the channelization of rivers or complete conversion of rivers and streams to settlement.

The conversion of natural landscapes into settlements is currently resulting in immense building on water ways and its consequent flood exposures in the city (Frick-Trzebitzky et al., 2017; Karley, 2009). The 2030 and 2060 projections indicate that respective proportions of more than a quarter and more than half of natural landscapes will be converted to settlements if land administration measures are not enforced. This has the potential of heightening the flood hazard. Rapid urbanisation without associated drainage systems has the tendency of exposing the population to frequent and intense flooding (Koks et al., 2015; Lamond et al., 2013; Okyere et al., 2013; Meikle, 2002). There is therefore the need for major shift in the governance of land in urban areas due to the increasing occupancy. This also applies to other developing countries globally (Mitchell et al., 2015).

Earlier studies have reported the significant role of rapid changes in land cover to flooding, as it alters the surface and hydrological characteristics of the geographical area (Paix et al., 2013; Dewan & Yamaguchi, 2008; Jiang et al., 2008; Nagasaka & Nakamura, 1999). Vegetation covers in urban spaces act as sink to rain water and thus reduces runoff and the volume of water that enters drainage systems, as it takes time for water to fill soil pores and thus delaying flood incidences (Paix et al., 2013; Kelly & DeVecchio, 2012). Open spaces or bare soils increases surface runoff, causing erosion in urban spaces and intensifying the flood hazard.

Ground truthing revealed that the rising open spaces in AdMA are due to the rapid conversion of vegetation to settlements, leaving considerable amount of bare soils between structures. Secondly, the roads in these new settlements are neither tarred nor have drains at the sides. These contribute greatly to the amount of surface runoff, and hence flooding in these areas. Also, the conversion of water bodies or wetlands to settlements, as is the case of AdMA creates urban areas that are physically vulnerable to flooding (Nagasaka & Nakamura, 1999). This therefore confirms the PSR and Bohle's models' postulation that humans' influence on the environment determines the extent of exposure to the flood hazard.

Keller and Devenchio, (2012) posits that urban runoff from larger storms could be five times more than pre-urban conditions. The extent of flooding is however, not only dependent on the peak discharge but also nature of the drainage systems. Moderate rainfall can result in flooding when drainage systems are choked with sediments and waste materials, as is the case of the study communities. Rainfall volume of 55mm and 59 mm have all resulted in major flooding in areas where the study communities are located (Amoako & Inkoom, 2017; Abu, 2013). High proportions of impervious surfaces due to urbanization also affect how rapidly floods develop. Areas with minimal concretised surfaces have consideration lag time between the onset of rainfall and the flood event, allowing for warning and preparation ahead of the flood (Keller & Devecchio, 2012). Current studies however reveal a consideration reduction in the lag time between the onset of rainfall and the flood event with urbanization (ibid).

Major differences are observed in the current and projected LULCC for AMA and AdMA. With regards to water bodies, though there is the conversion of wetlands and rivers/lagoons into settlements in both communities, AMA is plagued with the rising sea level and thus resulting in an increase in the proportion of the urban space occupied by water (Amoani et al.,

2012; Appeaning-Addo et al., 2008). This observation is consistent with earlier findings by Appeaning-Addo et al., (2011) that land area totalling about 0.80 km² along the shores of Accra are likely to be permanently inundated by 2100. Some studies have reported the frequent flooding in coastal communities in Accra in recent times attributable to the storm surge and rising sea level (Appeaning Addo & Adeyemi, 2013). This is however not unique to Accra, but all coastal communities globally (IPCC, 2014). The activities at AdMA could also contribute to the flood hazard in AMA since they share borders, and latter is located at a relatively lower elevation than the former, as indicated in the digital elevation model. This was evidenced in the focus group discussions when the flooding at Glefe was attributed to runoff from adjacent communities. The elevation of each community predisposes it to runoff from higher elevation areas, as shown in the digital elevation model. This explains the operation of more systemic “beyond place”, and cross-scale factors and processes that influence the frequency and intensity of the flood hazard in these communities.

4.4 Conclusion

This chapter has demonstrated the extent of human influence on the natural landscape in the two urban areas, and the implications for exposure of the population to the flood hazard. Specifically, the chapter shows rapid conversion of natural landscape such as forests, wetlands and water bodies into settlements and concretised surfaces. Expressly, more than a quarter of vegetation cover and about a tenth of water bodies in AdMA were converted to settlements and open spaces between 1991 and 2017. In AMA, about 40 percent of forest cover and 64 percent of open spaces were converted to concretised surfaces. These changes could be attributed to fast urbanization that is devoid of efficient land use management. Thus, the “pressure” exerted by

humans on the urban socio-ecological context through alteration of the natural landscape, as well as the socio-physical factors listed above could contribute to the “state” of exposed urban population and its consequent impacts. The study therefore concludes that the PSR and Bohle’s models have great utility in examining the human-environment interrelationships and the implications for exposure of the population to flooding. Bohle’s model could however be enhanced by including the effect of systemic and ‘beyond place’ factors on the study area.

CHAPTER FIVE

COMMUNITY ASSETS AND URBAN LIVELIHOOD CONSTRUCTION

5.0 Introduction

Building resilient community livelihoods is contingent on the availability of assets to the different population groups (Afriyie et al., 2017; Antwi et al., 2014; Maybery et al., 2009). This chapter examines the assets that are useful for the livelihoods of different population groups at Glefe and Ogbojo. Specific assets under the five categories of livelihood assets are scored by participants in focus groups according to the level of importance. Community members in focus groups assigned the scores based on the magnitude of the benefit derived from that asset, as well as the proportion of the community that benefit from the asset. The weighted relevance of the asset categories in the two communities and the differences in their relevance are also presented in this chapter.

5.1 Categories of assets and their relevance to urban livelihood construction

The five livelihood assets namely natural, social, financial, human and physical that are available to residents of the study sites are discussed in this sub-section. Table 5.1 shows the diverse array of assets, the ecological or socioeconomic service they provide, and their relevance for livelihood construction in the two urban communities. Aside the economic utility, some assets such as lagoons have ecological relevance in flood control.

5.1.1 Natural assets

The natural assets identified in Glefe included sea, lagoon, sand at the shore, land, a park, and the sun (sunlight), which supported several livelihood activities. Some community members

worked with Pambros Salt Production Limited, the biggest salt production company in West Africa which produces between 200,000 and 300,000 tonnes of salt a year located in the community (Amoako, 2016). Whilst some men were involved in fishing from the sea, the women processed the harvested fish, and others harvested crabs from the sea and lagoon.

5.1.2 Physical assets

The key physical assets listed are housing structures, road infrastructure, vehicles, household appliances, shops, telecommunication networks, pipe water, electricity, and working tools and equipment such as canoes. Physical assets were very integral in both formal and informal livelihood activities in both communities. Housing structures accommodates households and are rented out to individuals and business firms for income.

5.1.3 Financial assets

Financial assets listed included remittances, savings, access to loans, salary or cash, pension, poultry and livestock (Table 5.1). Persons involved in informal livelihood activities relied mostly on personal savings; whereas those involved in formal activities thrived in salaries. However, many people explained drawing from a multiplicity of financial assets.

5.1.4 Human assets

Human assets included formal education, indigenous knowledge, health, labour and livelihood skills such as carpentry and masonry. The contribution of these assets to various livelihoods varied. Community members explained that all livelihood activities resonated around good health and life, as such it was the highest rated human asset. Fishermen particularly used their indigenous knowledge of the seasons and signs for bumper catch to ensure a sustained livelihood. In addition, knowledge on the indicators of bad weather and turbulence on the sea

ensured safety of the fisher folk. Similarly, indigenes with knowledge of flood-prone areas in the community guided community members on where to acquire or rent houses.

5.1.5 Social assets

The major social assets listed are religious groups, political associations, family, landlords' association, fishermen association and ethnic groups (Table 5.1). Social assets were not ranked as high as other assets such as physical and human. Some community members who were affected by floods took refuge from their social networks. Family members provided financial and material support for each other. Similarly, politicians who are resident or identified with the communities serve as assets in facilitating the implementation of development projects in the community. They also helped members of the community find employment within or outside the community (Table 5.1).

Table 5.1: Categories of assets and their relevance to urban livelihood construction

Asset category	Livelihood assets	Service derived	Livelihood construction
Natural	Sand	For constructing houses, moulding blocks	Sand is used for moulding blocks for sale
	Sea	Fishing, sand and terrazzo for building, salt production, defecation, tourism, sea breeze	1. Males engage in fishing from the sea whiles females do fish mongering 2. Salt company in the community employs community members
	Land	Building, renting, infrastructure	1. Land space is rented out, leased or sold for money 2. Used for generating other property such as housing
	Park	Social gatherings, recreational activities, safe haven	1. Serves as training grounds for footballers and athletes 2. Serves as grounds for social gathering
	Lagoon/ river	Fishing, channels run-off water into the sea	Fish and craps are harvested for sale, and for food
	Sun (sunlight)	Processing salt, evaporating stagnant water	1. The sun essential for salt processing 2. Used for drying (preserve) fish
Physical	Street	Easy movement to work, easy business activities, children to school	1. Enhances the business activities through efficient transportation of people and goods 2. Facilitates access to jobs outside the community 3. Created employment for commercial vehicle drivers and bus conductors
	Electricity	For business activities e.g. sewing, welding, fridges in shops, sales at night, student use light for studying	1. Created employment opportunities in the community by attracting investors and businesses 2. Preparing ice blocks for sale 3. Used by artisans e.g. welders, seamstress
	Pipe water	For household use, used by food	1. Used by food vendors for preparing food

Asset category	Livelihood assets	Service derived	Livelihood construction
		vendors	2. Preparing ice blocks for sale 3. For domestic use e.g. cooking, washing
	Housing structures /shops	Housing, business (sales, services), renting, schools, banks	1. Renting rooms/shops for money 2. Trading activities in shops/ kiosks 3. Buildings used as schools (employment for teachers/ staff, income for school owners) 3. Renting buildings to banks, hospitals and other firms (creating employment) 4. Lotto kiosks useful for making extra money via lottery 5. Used as barbering shops/ hair dressing saloons
	Household appliances	For domestic use and for commercial purposes, people received information on impending rainfall and weather forecast from the television and radio.	1. Radios and TVs for accessing information (including weather information) 2. TVs are used for showing international football games for money 3. TVs and other electronic gadgets are used at video game playing centres for money 3. Freezers used for preparing ice blocks, storing sachet water/ drinks for sale
	Telecom networks	Business-related calls, family calls, assistance in case of emergencies, source of employment for retailers	1. Employment for recharge card/ sim card agents 2. Employment for mobile money agents 3. Enhances business transactions 4. Used for calls for emergency assistance
	Vehicles	Major means of transportation for humans and goods, income for owners	1. Income generation for commercial vehicle owners 2. Creates employment for drivers and bus conductors 3. Enhances commercial activities 4. Enables professionals to work outside the community
Financial	Savings	Paying fees, rents; for emergencies	1. Investing for profits 2. Used in acquiring property such as vehicles, houses,

Asset category	Livelihood assets	Service derived	Livelihood construction
			tools for other income generating activities
	Loans	Paying fees, rents; for emergencies	1. Investing for profits 2. Used in acquiring property such as vehicles, houses, tools for other income generating activities 3. For subsistence
	Remittances	Paying fees, rents; for emergencies, subsistence	1. Investing for profits 2. Used in acquiring property such as vehicles, houses, tools for other income generating activities
	Wages/ salary/ pensions	For household sustenance, responding to emergencies	1. Investing for profits 2. Used in acquiring property such as vehicles, houses, tools for other income generating activities
	Gifts	Used during difficult times	For subsistence, paying bills and fees
	Livestock/ poultry	Household consumption, sold during emergencies	1. Sold for money 2. Household consumption
Human	Artisans/Vocational	Constructions, renovation of houses, furniture	1. Source of income 2. Assisting other community members
	Fishing	Harvesting fish for sale and consumption	1. The fisherfolk earn income from selling fish 2. Enhances household dietary adequacy
	Trading	Generating income, food	1. Income generation 2. Makes goods/groceries available in the community
	Education	Enhances employment opportunities, teaching children, official interactions with people	1. Enhances employment and income generation capacity 2. Useful for teaching children 3. Enhances formal communication capacity
	Health	Survival and ability to work	1. Fundamental to all livelihood activities

Asset category	Livelihood assets	Service derived	Livelihood construction
	Human life	Ability to live and work	1.Fundamental to all livelihood activities
	Indigenous knowledge	Traditional flood control measures	1.Useful in fishing by knowing the seasons of abundance, the location for abundant catch, and ensuring safety while on the sea
Social	Religious groups	Spiritual and emotional support, buffer when affected by flood, mobilizing people for community activities	1. Spiritual, social, and financial support of members 2.Help communal labour activities 3.Employment for Pastors and paid church workers
	Political groups	External support from government	1.Enhances access to government support 2. Provide support candidates who vie for political positions 3. Enhances chances of getting employment
	Ethnic associations	Material and emotional support to members,	1.Material, financial and emotional support for members
	Fishermen association	Supporting each other with tools and ideas	1.Supporting members with ideas, tools and equipment 2.Negotiating standard prices of fish 3. Enhances access government support (e.g. fuel)
	Drinking group	Emotional support, share ideas	1.Emotional, social and financial support
	Landlords association	Join efforts in responding to needs	1.Social and economic support (e.g. when a member is bereaved) 2. Provide accommodation for community members 3. spearheading development activities such as drain construction and electricity connection
	Family	People relocate temporarily to family members during floods.	1.Providing financial support to unemployed members 2. Providing/ helping members find employment (e.g. as sales agents their shops)

Asset category	Livelihood assets	Service derived	Livelihood construction
			3. Paying school fees/hospital bills of members especially the elderly
	Community police/development association	Ensures law and order in the community	1. Ensuring law and order in the community 2. Protect community assets and property such as illicit sand mining at the shore.

Source: Field data, 2017

5.2 Socio-demographic differentials in the relevance of assets to livelihood construction

This sub-section examines the relevance of livelihood assets to people in two communities. In order to allow comparability of the relevance of the assets across groups and communities, standardized scores were computed.

5.2.1 Descriptive statistics of livelihood assets relevance by sex and community of residence

The standardized mean scores presented in Table 5.2 shows that human capital generally had higher relevance to livelihoods in Ogbojo than Glefe. Of this, it was more relevant to the livelihood of males in Ogbojo (mean= 0.502, SD=0.52) than the females (0.175, SD=0.95). On the other hand, it was more relevant to female livelihoods in Glefe (mean= 0.393, SD= 0.71) than males (0.265, SD= 0.91). The contribution of social capital to urban livelihoods in both communities was low compared to the mean contribution of all other assets (as shown by the negative sign). Notwithstanding, as expected, social assets had equivalent relevance to the livelihoods of both males and females in Glefe (mean= -0.153, SD= 0.82) compared to the lower relevance to their counterparts at Ogbojo (mean= -0.426, SD= 1.02). Natural assets had extremely higher scores for both males and females in Glefe than Ogbojo, which is not unexpected since Glefe has a number of natural resources such as sea and lagoon. Financial assets were also limited in both communities; notwithstanding, they contribute much to the livelihoods of males in Ogbojo and the females in Glefe than their respective male and female counterparts. Finally, physical assets contributed significantly higher to livelihoods in both communities than all other assets. Whereas the males in both communities had comparable relevance scores, physical assets contributed more to the livelihoods of females in Ogbojo (mean= 0.820, SD= 0.43) than those at Glefe (mean= 0.729, SD= 0.33).

Table 5. 2: Standardized mean relevance of livelihood assets by sex and community

Asset type	Community	Male	Female	Total
		Mean (SD)	Mean (SD)	Mean (SD)
Human	Glefe	0.265 (0.91)	0.393 (0.71)	0.229 (0.81)
	Ogbojo	0.502 (0.52)	0.175 (0.95)	0.338 (0.76)
	Total	0.284 (0.75)	0.284 (0.82)	0.284 (0.78)
Social	Glefe	-0.153 (0.91)	-0.153 (0.77)	-0.153 (0.82)
	Ogbojo	-0.262 (1.07)	-0.589 (1.00)	-0.426 (1.02)
	Total	-0.207 (0.97)	-0.371 (0.89)	-0.289 (0.92)
Natural	Glefe	0.393 (0.71)	0.502 (0.52)	0.447 (0.61)
	Ogbojo	-1.244 (1.45)	-0.480 (1.21)	-0.862 (1.36)
	Total	-0.426 (1.39)	0.011 (1.04)	-0.207 (1.23)
Financial	Glefe	-0.807 (0.95)	-0.480 (0.87)	-0.644 (0.90)
	Ogbojo	-0.371 (0.98)	-0.698 (0.85)	-0.535 (0.91)
	Total	-0.589 (0.97)	-0.589 (0.84)	-0.589 (0.89)
Physical	Glefe	0.829 (0.33)	0.729 (0.33)	0.775 (0.38)
	Ogbojo	0.829 (0.33)	0.820 (0.43)	0.829 (0.32)
	Total	0.829 (0.32)	0.775 (0.38)	0.802 (0.34)
Total	Glefe	0.065 (0.94)	0.196 (0.79)	0.131 (0.87)
	Ogbojo	-0.109 (1.17)	-0.153 (1.05)	-0.131 (1.11)
	Total	-0.022 (1.06)	0.022 (0.94)	0.000

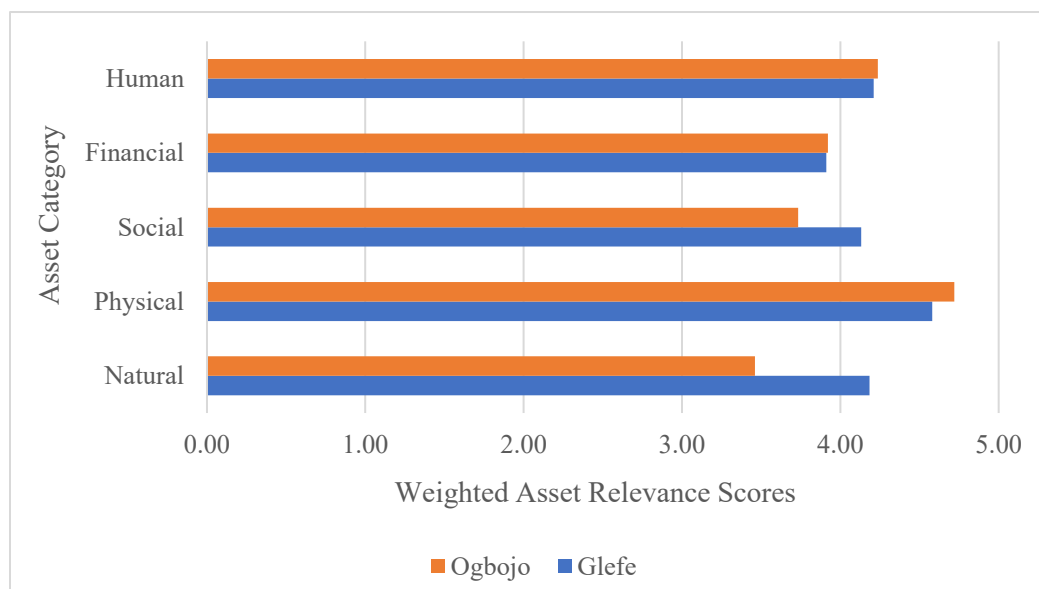
Source: Field data, 2017. Negative score means that the asset has less relevance compared to the mean standardized asset relevance score which is 0.00. Increasing positive scores means that those assets are highly important for that population group.

5.2.2 Weighted composite asset relevance to livelihood construction at Glefe and Ogbojo

The weighted composite of asset relevance presented in Figure 5.1 indicate that physical assets are generally the most relevant for people in both communities. However, natural assets are of greater relevance to people in Glefe than Ogbojo who have limited natural resources. Human assets comprising life, health, education, vocational and artisanal skills are a major part

of urban livelihoods in both communities. Social assets such as religious groups, families, fishermen association, and political groups were more relevant in Glefe than Ogbojo. This is not unexpected as Glefe is a more informal community than Ogbojo and that people relate more with their neighbours. Financial assets such as loans, savings, remittances, and wages have comparable relevance to the livelihood construction in both communities.

Figure 5 1: Weighted composite asset relevance by community of residence



Source: Author's construct, 2017

5.2.3 Socio-demographic factors that explain livelihood asset relevance

The results from the ANOVA shows that livelihood construction in the two urban communities is explained by the assets type ($F=15.07$, $df=4$, $p<0.01$, $\eta^2= 0.274$), community of residence ($F=4.32$, $df=1$, $p<0.05$, $\eta^2= 0.026$), and an interaction between asset and community ($F=4.63$, $df=4$, $p<0.01$, $\eta^2= 0.104$). The partial eta squared (η^2) values, which measure the effect size show that the type of assets has the highest effect on urban livelihood construction, followed by the interaction of community and assets (Table 5.3). This means that people's livelihoods are

attached to their community of residence, as the community defines the assets that will be available and the activities they will be engaged in. There are no significant age group differences in the relevance of assets to livelihood construction in both communities (Table 5.3).

Table 5. 3: Analysis of the factors that explain the variance in livelihood asset relevance

Source	df	F	η^2
Corrected Model	19	4.75***	.361
Intercept	1	3969.92***	.961
Sex	1	.12	.010
Asset category	4	15.07***	.274
Community	1	4.32**	.026
Age group	5	0.717	.028
Sex * Asset category	4	.66	.016
Sex * Community	1	.48	.003
Asset category * community	4	4.63***	.104
Sex * Asset category * community	4	.98	.024
Error	160		
Total	180		

Source: Computed from field data, 2017 ***p<0.001, **p<0.05, *p<0.1 Interaction effects of the other variables (such as age group* sex and community*age group) were examined but were not significant in explaining the variance in the dependent variable

5.3 Verification of the representation of community view

This section is verification that the scores assigned by each focus group is a representation of the community's view. The Kendall's Coefficient of Concordance (W)⁶ was used to check agreement in the rating among the different focus groups in each community. Due to the differences in the types of assets, an average score for each asset category was used. Table 5.4 shows the Kendall's W for Glefe (W= 0.786, p<0.05) and Obojo (W= 0.611, p<0.05). These

⁶ The Value of Kendall's W ranges from 0 to 1, where 0 means no agreement among raters and 1 means perfect agreement among raters or groups.

values mean that there is a strong agreement between the six focus groups in each community regarding the relevance of community assets. There was however higher consistency among the focus groups conducted in Glefe than Ogbojo. This confirms the ANOVA results that there is no significant group difference in the relevance of assets to the community. Thus, there is very little variance in the asset relevance scores assigned by individual focus groups.

Table 5. 4: Kendall’s W Test of Group Concordance

Parameters	Glefe	Ogbojo
Number of groups/ raters (m)	6	6
Number of subjects/ assets (k)	5	5
Kendall’s W	0.786	0.611

Source: Computed from field data, 2017

5.4 Discussion

The study shows that overall, physical assets such as houses, shops, vehicles and roads are the most important for livelihood construction in the two communities. On the other hand, financial resources offer the least contribution to livelihoods in the two communities. This was not as though the people did not need the financial asset; rather they have very limited access to financial resources. For instance, whilst some community members were not interested in taking loans due to the interest, and fear of not being able to pay back, others had no idea of how to access a loan. The relevance of financial assets however differed by community of residence and sex. Financial asset was marginally relevant in Ogbojo than Glefe. It was however more relevant to the females in Glefe than the males. Ogbojo is a more formal residential community where higher importance was attached to salaries, wages and loans. The informality of the Glefe

community reflected in the higher relevance attached to social assets than Ogbojo. Other studies have however found social assets as one of the most relevant for livelihood activities. Maybery et al., (2009) reported that social assets such as sporting clubs, ‘parents and citizens associations’, as well as service institutions like schools, then neighbourhood and economic assets including employment opportunities, family income and property, and local infrastructure were the most relevant community assets in some small inland rural communities in Australia. This means that the local context is very relevant in assessing the relevance of assets.

Also, natural assets were important for livelihood activities at Glefe than Ogbojo. This is consistent with previous studies that coastal ecosystem services are essential for economic activities of the populace. Comparing these urban study sites to rural contexts, there is proven evidence that natural resources such as cultivable land and rivers are the most important for rural livelihoods globally (Gwimbi, 2009; Carney, 1998). In rural communities, physical assets are also vital for livelihoods and in reducing the impacts of climate change. Good road networks in farming communities for example, helps in transporting farm produce to market centres, and also getting farm implements and relief items to vulnerable communities (Antwi-Agyei et al., 2012). Likewise, physical assets were the most important for both communities in this study; males and females alike. Finally, this study proves the utility of the Sustainable Livelihoods Framework and CRiSTAL in urban settings.

5.5 Conclusion

In conclusion, this chapter reveals that livelihood activities of people are connected to the community of residence and are explained by the types of assets available. The intra-community degree of relevance of the assets is differentiated by sex, as males and females access and

engages assets differently. Also, physical assets are of paramount relevance to both coastal and inland urban communities. On the other hand, natural assets, derived from coastal ecosystem services uniquely adds to the livelihood diversity of coastal communities. In addition, social assets such as families, friends and ethnic associations demonstrate key importance to the construction of livelihoods in Glefe, an informal community, while residents of Ogbojo, which is a more formal and residential community place much premium on human assets such as health and formal education. The Kendall's coefficient of concordance shows that community asset mapping using CRiSTAL is useful in assessing the diversity of livelihood assets and their relevance to different population groups.

CHAPTER SIX

IMPACTS OF FLOODING ON LIVELIHOOD ASSETS AND COPING STRATEGIES

6.0 Introduction

Flooding has the tendency of eroding livelihood assets leading to poverty and vulnerability to other hazards, in the absence of working and sustainable coping strategies (Srikuta et al., 2015). This chapter examines the impacts of flooding on people through the effects on their livelihood assets in the two urban communities and the expected adaptation solutions leading to resilience building. This was done by examining the impact pathways using thematic analysis of the impacts of flooding. The socio-demographic factors such as age group, sex and place of residence defining the differences in the impacts are also presented in this chapter. Finally, coping strategies to flood impacts, their sustainability, as well as available alternate strategies are examined in this chapter.

6.1 Impacts of flooding on the exposed population

The thematic analysis shows three main impacts of flooding on the study communities. These are health, economic and social impacts, which stem from the livelihood assets and activities that are affected by the floods.

6.1.1 Economic impacts of flooding

The economic impacts of flooding were found to be due to the disruption of livelihood activities through damage to physical assets, loss of financial assets, direct disruption of livelihood activities, and impacts on livelihood activities (Table 6.1). These may be direct or indirect, example through the disruption of social services such as electricity. Other economic impacts are

the economic cost associated with the replacement or repair of damaged assets, and the direct costs of adaptation. The most prominent economic impacts are the disruption of economic activities through the loss and damage of physical assets (Table 6.1). Likewise, reference was made to the economic cost associated with repairing or replacing damaged assets in all transcripts in both communities. An economic benefit of flooding that emerged in Glefe was the accumulation of sand for construction activities after the floods. The run off carries sand from communities uphill to Glefe due to its low elevation. The accumulated sand is used for moulding blocks for constructing houses.

Table 6. 1: Matrix of the economic impacts of flooding on urban population

Economic Impacts	Glefe/ sample quotes [frequency of occurrence]	Ogbojo/ sample quotes [frequency of occurrence]
Physical livelihood asset such as housing, shops, and vehicles which disrupt economic activities	<i>A woman used to sell groceries in front of our house, but she has stopped because her shop constantly got flooded</i> (Young male) [9/9]	<i>My wall has broken down several times. You see I am now constructing it! And that is extra cost! In fact, some people have left this area because they could not stand this continuous suffering</i> (Key informant) [9/9]
Financial assets such as livestock and savings	<i>When the flood water recedes, you will find a lot of dead chicks and lambs on the floor</i> (male youth). [4/9]	If you are not able to go to work, you will only use your savings, otherwise you and your children will go hungry [5/9]
Livelihood activities due to flooding	<i>When there are floods, Pambros cannot produce any salt because of the water, and we wait till the water dries up before we are able to work. During the rainy season, we are sometimes idle for weeks without producing any salt</i> (Elderly male and employee at Pambros).	<i>In the past four years since I started this work, I have moved the location of my workshop three times. We even had to fill up this place with heaps of sand before we got relieved a bit</i> (Male adult, Mechanic) [6/9]

Economic Impacts	Glefe/ sample quotes [frequency of occurrence]	Ogbojo/ sample quotes [frequency of occurrence]
	[7/9]	
Social services	<i>Once the rains start, the next thing is light out, and you can't do anything.....it makes our things in the fridge go bad</i> (Female adult). [4/9]	<i>The public vehicles (trotro) don't want to come here due to the bad nature of the road. It's even worse when it rains. You can stand at the road side for hours!</i> (Young female) [5/9]
Repairing or replacing damaged assets	<i>Sometime ago, I was not at home and the water entered your room. It damaged all things...the tv, my children's books, all the things in the hall were damaged</i> (Adult female) [9/9]	<i>I used to park my car somewhere and board a 'trotro' (public transport) home when it rains, otherwise the car would either break down or it get stuck in the mud</i> (opinion leader). [9/9]
Adaptation/ coping e.g. pumping stagnant water, or spraying with chemicals to prevent mosquito breeding	<i>People come do around to pump the stagnant water on the compound after the rains. But you know, not all of us can afford. You need to pay them and buy your fuel</i> (Adult male) <i>Some need to fill up the floor of their rooms with sand after the floods, and when the ceiling becomes too low, then you have to add one or two layers of block to raise the roof</i> (Male adult) [8/9]	<i>I am considering selling my house and leaving here. I cemented the whole compound. But you can hardly see any cement on the floor. All my children are not here, so I can't bear these things any longer</i> (Elderly female). [6/9]
Deposition of sand (benefit)	<i>Some people use the sand that is deposited after the floods for moulding blocks. Then you save the money for something else</i> (Young male) [3/9]	[0/9]

Source: Field data, 2017 [n/9]-> n is number of occurrence in the 9 transcripts for that community

Figure 6.1: Molding blocks from the sand gathered by the floods at Glefe



Source: field work, 2017

6.1.2 Social impacts of flooding

Socially, floods affected religious cohesion and activities, ethnic group activities, and also resulted in the relocation of family and friends from the communities. This had significant effects on social capital. Often when religious meeting places get flooded, activities are disrupted and thus affecting cohesion. This is loss of social networks when significant others relocate due to recurrent flooding. A description of these social impacts and sample quotes of the experiences of respondents are presented in table 6.2.

Table 6. 2: Matrix of the social impacts of flooding on urban population

Social impacts	Glefe sample quotes [Frequency of occurrence]	Ogbojo sample quotes [Frequency of occurrence]
Loss of social capital/ relocation of significant others	<i>Some of our friends have moved to Dansoman (nearby community) and other places because of the frequent flooding in the neighborhood</i> (Female youth group) [4/9]	<i>A bank manager who used to stay in my neighbourhood has relocated due to the floods. My wall has collapsed several times and I have reconstructed, but he has left</i> (Male youth). <i>You see that house over there? No one stays there! It has been abandoned. The whole whose gets inundated when it rains</i> (Adult male). [5/9]
Conflicts	Conflicts over location of neighbours buildings on water ways Mr. Thompson (pseudonym) can afford a mechanical pump to drain the stagnant water from his compound. The water however creates problems for his neighbours. [4/9]	Mr. Phil (pseudonym) constructs a channel to drain the stagnant water from his compound. Nonetheless, the drained water accumulates in front of Madam Afi's (pseudonym) house leading to conflicts. [6/9]
Mobility	Residents keep their shoes in your bag and wear wellington boots to cross the accumulated water. Vehicular obstruction to certain places [4/9]	<i>When the place gets flooded, you cannot go anywhere, until the water recedes then you can keep your shoes in your bag and wear your wellington booth to cross the flooded area. Vehicles cannot even ply this road</i> (Adult male). [4/9]
Security	Human security, especially children [5/9]	<i>Once the walls [of the school] are broken down, you know what it means! Security concerns for the children and other items in the building</i> (Key informant). [2/9]
Social gatherings	Religious, political, ethnic	Affects church attendance

	meeting are halted [5/9]	[2/9]
Impacts on school attendance	Impacts school attendance either because the school premise or the road to the school is flooded <i>Children stay at home till the water recedes. They risk drowning so we usually make them stay home</i> (Young female) [7/9]	<i>When the school gets flooded, the children have to stay home because its not safe. We tried resolving it by constructing the wall, but to no avail</i> (Key informant) [4/9]
Other social impacts	waste deposition [4/9]	nuisance noise from the croaking of frogs [2/9]

Source: Field data, 2017 [n/9]-> n is number of occurrence in the 9 transcripts for that community

6.1.3 Impacts of flooding on human life and health

The impact of flooding on health in the study cites was through avenues such as the creation of stagnant water for mosquito breeding, and ultimately transmitting malaria to the populace. This was evident in all focus groups in both communities (Table 6.3). Likewise, the risk of drowning was prevalent in both communities, but was more frequently cited in Glefe than in Ogbojo. Also cited at Glefe was the contraction of foot rot after wading through the stagnant water after flooding. Respondents in Glefe mentioned washing of debris and faecal material from gutters by floods as a benefit. Psychological impacts of flooding associated with the loss and damage of household assets was subtle in the narratives.

Table 6. 3: Matrix of the health impacts of flooding on urban population

Impacts on life and health	Glefe/ sample quotes [Frequency of occurrence]	Ogbojo/ sample quotes [Frequency of occurrence]
Total well-being	Risk of drowning <i>A child fell into the flood water about two years ago. He would have died if people did not get there on time.</i> [5/9]	Risk of drowning [3/9]
Malaria	Increased breeding sites for mosquitoes [9/9]	Increased breeding sites for mosquitoes [9/9]
Foot rot	Infected with Foot rot after walking through the flood water [4/9]	[0/9]

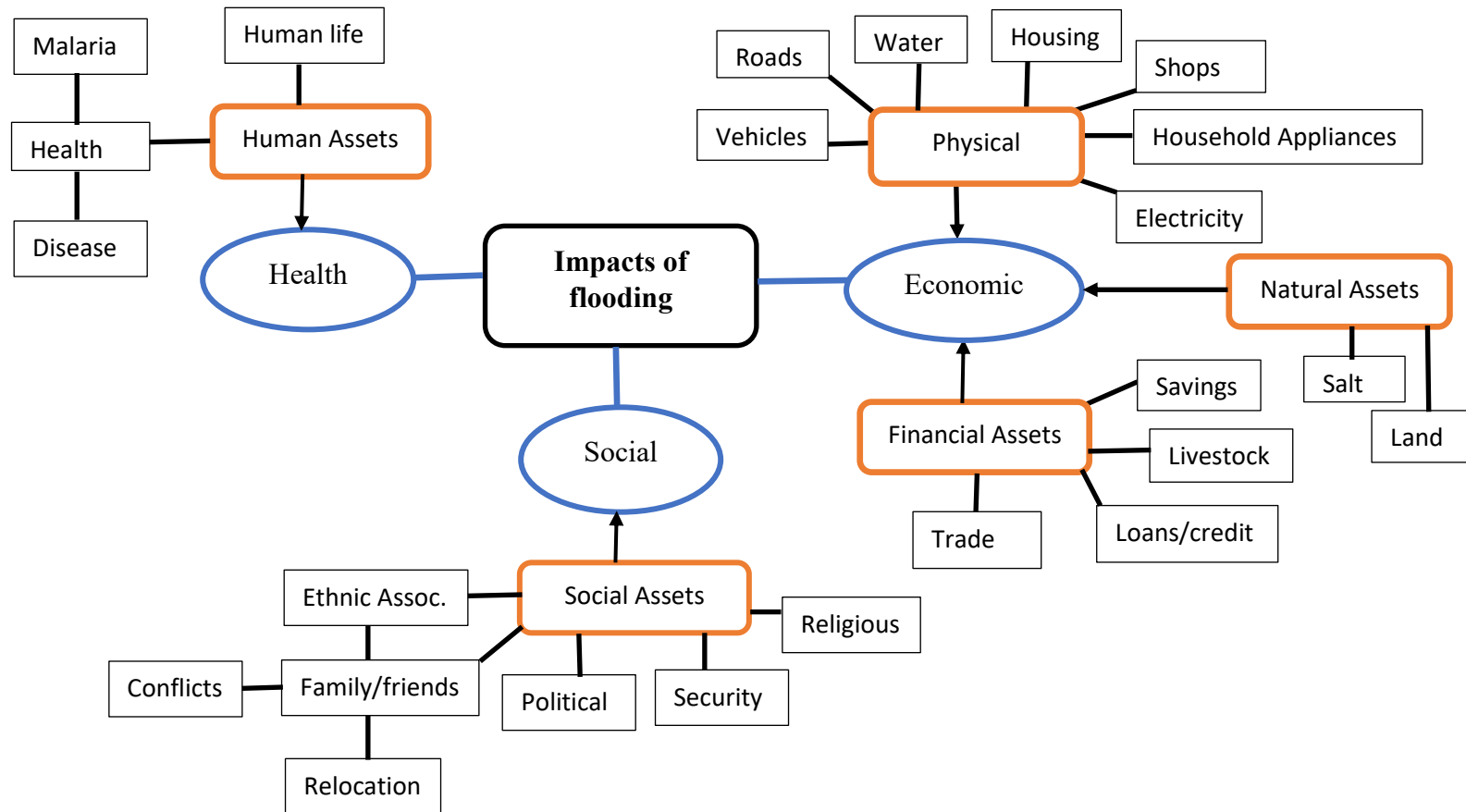
Source: Field data, 2017 [n/9]-> n is number of occurrence in the 9 transcripts for that community

6.1.4 Pathways of the impacts of flooding on the urban population

The thematic analysis of the impacts of flooding revealed that the dimensions of the well-being of the urban population that are impacted by flooding are health, economic and social/community identity (Figure 6.2). Flooding erodes assets that are central to the enhancement of these dimensions of the urban population. The disruption of financial, physical, natural, and human assets has direct impacts on the economic well-being of the populace. For instance, aside the fact that sick people cannot work, the treatment of diseases that are caused by flooding have economic costs and occupational health challenges. The health impact emanates from diseases such as malaria and foot rot. Also, urban flooding has social impacts. The social capital of people is disrupted through the relocation of some significant others due to flooding. Flooding also creates conflicts among neighbours as they attempt to implement individual level coping

mechanisms. Additionally, the collapse of walls exposes the inhabitants to theft from intruders. Another dimension of the social impact is on social cohesion due to the interruption of religious, ethnic and political group meetings.

Figure 6. 2: Pathways of the impacts of flooding on the population through the disruption of livelihood assets



Source: Constructed from field data, 2017

6.1.5 Estimating the impact of flooding on asset categories and population groups

The analysis of variance indicates that type of assets that are impacted is the main factor that explains differences in flood impact on the population ($F=15.52$, $p<0.05$, $\eta^2=0.280$). This impact is pronounced on physical assets (housing units, shops, roads, vehicles and electricity), human assets (human life and health), and financial assets such as savings and livestock (Figure 6.3). Multiple comparison test in Table 6.4 shows that whilst there is no significant difference in flood effect on human and physical assets, the latter is more impacted by flooding than natural and social assets (respective mean difference are 1.111 and 1.69, $p<0.05$). On the whole, social assets are the least impacted; has respective mean impact difference of 1.33, 0.58, 0.92 and 1.69 lower compared to human, natural, financial and physical assets (Table 6.4).

Table 6. 4: Multiple comparison of the mean impact of flooding on livelihood assets

Asset category (I)	Asset category (J)	Mean Diff. (I-J)	Sig.	95% CI for Difference	
				Lower Bound	Upper Bound
Human	Social	1.333*	.000	.838	1.829
	Natural	.750*	.003	.254	1.246
	Financial	.417	.099	-.079	.912
	Physical	-.361	.152	-.857	.134
Social	Human	-1.333*	.000	-1.829	-.838
	Natural	-.583*	.021	-1.079	-.088
	Financial	-.917*	.000	-1.412	-.421
	Physical	-1.694*	.000	-2.190	-1.199
Natural	Human	-.750*	.003	-1.246	-.254
	Social	.583*	.021	.088	1.079
	Financial	-.333	.185	-.829	.162
	Physical	-1.111*	.000	-1.607	-.616
Physical	Human	.361	.152	-.134	.857
	Social	1.694*	.000	1.199	2.190
	Natural	1.111*	.000	.616	1.607
	Financial	.778*	.002	.282	1.273

Impacts of flooding at Ogbojo is marginally higher than Glefe though the mean impacts are not significant different (Table 6.5). With regards to age group, flooding has higher impacts the livelihood assets of people aged below 35 years than those aged 60 years and above (mean impact difference= 0.400, CI:3.65-4.19, 3.25-3.79). The impact of flooding on people aged 36-59 is not significantly different from the other age groups. Generally, the impacts of flooding were assigned higher scores by males (3.74) than females (3.68). However, the impacts on males and females are not significantly different.

Table 6.5: Estimates of the mean impacts of flooding on urban population groups

Parameters	Mean impact score	Std. error	Confidence interval	
			Lower bound	Upper bound
Communities				
Glefe	3.667	.112	3.445	3.888
Ogbojo	3.756	.112	3.534	3.977
Age groups				
35 and below	3.917	.137	3.645	4.188
36-59	3.700	.137	3.429	3.971
60+	3.517	.137	3.245	3.788
Sex				
Male	3.744	.112	3.523	3.966
Female	3.678	.112	3.456	3.899

Source: Field data, 2017

6.2 Coping strategies to urban flooding and their sustainability

The communities had coping strategies to most of the impacts of flooding using resources within the community. However, majority of these coping strategies are either not working or not sustainable as indicated in brackets (Table 6.6). In all cases, the suggested alternate strategies required resources outside the communities as they are capital intensive beyond the capacity of the local community. This shows that community members merely cope with the impacts of

flooding through spontaneous responses. Interventions including sea defense, large drains and roads that had significantly altered the level of exposure of the community to flooding were all government funded. It is evident from the alternate strategies recommended by the community members that lack of, or silted drains are major contributing factors to the recurrent flooding episodes.

Table 6.6: Effects of flooding on livelihood assets and corresponding response strategies

Composite Assets	Livelihood assets	Flood impacts	Response strategies (Working/sustainability)	Recommended alternate strategies
Human	Health	Malaria	Spraying stagnant water (w/ns), sleeping under mosquito nets (w/ns), pumping the stagnant water (w/ns)	Construct drains, desilt drains
	Health	foot rot	Using salt water (w/ns), wearing Warrington booths (w/ns)	Construct drains, desilt drains
	Education	Children cannot go to school	Stay at home (nw/ns), parents carry them to school (w/ns)	Construct drains, desilt drains, demolish structures on water ways
	Human life	Both children and adults drown	Keep children at home (w/ns), pump stagnant water (w/ns), move to safer places in the community (w/ns)	Construct drains, demolish structures on water ways
Financial	Livestock	Kills livestock	Move livestock to high elevation areas (w/ns); sell livestock (w/ns)	Construct drains
	Trade	Disrupts trade activities	Sell when water recedes(w/s); sell in nearby communities (w/s)	Construct drains, widen existing drains, construct sea defense, build banks
	Savings	Savings are used up	Borrow money (w/ns), reduce expenditure (w/ns)	Construct drains, create more jobs, build banks and hospitals
Social	Religious groups	Cannot meet	Meet when water dries up (nw/ns), move to less exposed places (nw/ns)	Construct drains
	Political leaders/assoc.	Cannot meet	Do nothing (nw/ns)	Construct drains, desilt main drain

Composite Assets	Livelihood assets	Flood impacts	Response strategies (Working/ sustainability)	Recommended alternate strategies
	Family/ friends	Relocate	Pump stagnant water (w/ns), fill compound with waste and sand(w/s)	Construct roads and drains
Physical				
	Buildings	Damaged	Filling with sand (w/s), relocate temporarily (w/ns), construct wall (w/s), reconstruct the floor of rooms after the rainy season (w/ns).	Construct drains
	Vehicles	Damaged	Park at high elevation areas (w/ns), do nothing (nw/ns)	Construct drains
	Roads	Damaged, no vehicles for transport	Fill patches with sand (w/ns), use alternate routes (w/ns)	Construct drains, demolish buildings on water ways
	Shops	Damaged/ carried away	Relocate to unexposed places (w/ns)	Construct drains
	Household items	Damaged	Fill up room with sand (w/ns), pack items to high level (w/ns), constructing walls to block flood water (w/s)	Construct drains/ sea defense
	Electricity	Light goes off, items in the fridge goes bad	Do nothing(nw/ns), use torchlights and generators	Enhance the efficiency of the electricity system in the face of floods
Natural				
	Land	Inhabitable/ waterlogged	Wait for water to dry up (w/ns), do nothing (nw/ns)	Construct drains and sea defense wall

Composite Assets	Livelihood assets	Flood impacts	Response strategies (Working/sustainability)	Recommended alternate strategies
	Sea/salt	No salt production, accumulation of waste	Engage in other trade (w/s), learn a skill such as carpentry (w/s), wait for water to dry up (w/ns)	Desilt drain, construct drains
	Sand	Gathers more sand for use		
	Lagoon	Overflows its banks, filled with waste	Do nothing (nw/ns)	Construct sea defense, desilt main drain

Source: Field data, 2017 W=working, s=sustainable, nw=not working, ns= not sustainable

6.3 Discussion

Physical assets such as vehicles, housing, household appliances are the most affected by flooding, followed by human assets such as health and education. Social assets such as ethnic associations, families and friends are the least affected. This corroborates earlier findings in Northern Ghana and Kenya (Afriyie et al., 2017; Leauthaud et al., 2013) that farmlands, human health, housing and savings were the most vulnerable livelihood assets to flooding. Farmlands are generally not very important assets in urban communities. The disruption of livelihood assets had economic, social and health impacts on people, which compares with findings of Huq et al, (2015). The economic impacts were the most pronounced, as the disruption of all assets had some economic implications.

The impacts were however not uniform across population groups; mean impacts were marginally higher in Ogbojo than Glefe. Also, the impact of floods was higher among people aged 35 years and below than those aged 60 and above. This could be due to the fact that the elderly are not actively involved in livelihood activities like the youth. Hence the latter may experience a brunt of the flood impacts than the former. Furthermore, as far as sex of the population is concerned, there was no significant difference in the impact of flooding. There are however, nuanced differences when the asset categories are considered. This means that the sex differentials in the impacts of flooding are inherent in the livelihood activities and assets, which are sex specific in certain communities. Some studies have however identified women, children and the elderly as the most vulnerable to flooding due to their limited capacity to adapt (Koks et al., 2015).

In response to the impacts as explained in the PSR model, community members implemented individual level coping strategies including wall construction, filling up compounds

and rooms to higher elevations, pumping stagnant water and livelihood diversity. These individual level strategies were however either not working or were working but not sustainable. The three main sustainable coping strategies suggested in both communities are desilting clogged drain (Glefe), constructing roads and drains (Glefe and Ogbojo), and continuing sea defense (Glefe). Participants of the FGDs listed and ranked the community assets that are relevant for the implementation of alternate and sustainable coping strategies. It was noted that the implementation of those strategies is capital intensive and beyond the financial capacity of communities, and thus required external resources. Appendix 2 shows the various assets that community members are willing to contribute and their scored relevance to the implementation of the adaptation interventions. This shows that integrating community members in flood response initiatives could yield more sustainable outcomes because in addition to claiming ownership of the activities they could contribute with human and other material resources. Further, community members were aware of the causes of the frequent flooding and some had taken initiatives such as desilting drains and community policing to prevent perpetrators of flood-enhancing practices. Though these were not working, it gives an idea of potential entry points to enhancing community participation.

6.4 Conclusion

In conclusion, this study has shown that flooding has differential impacts on livelihood assets- physical assets bearing the brunt of the impact. Disruption of livelihood assets has economic, social, and health consequences on people. Economic impacts stem from the cost of implementing adaption measures such as wall construction, direct disruption of economic activities due to flooding, cost of repairing or replacing damaged assets, and the loss of financial assets such as livestock and savings. The social impacts include the interruption of group

meetings, loss of social capital through the relocation of significant others and conflicts with neighbours. The nature and extent of these impacts are explained by the livelihood activities engaged in by the population groups. In response to these impacts, communities implement spontaneous individual level and collective coping strategies which as mostly not working or are working but not sustainable. The preferred sustainable strategies such as drain construction however require resources outside the community, since they are capital intensive.

CHAPTER SEVEN

ASSETS AND STRUCTURES NECESSARY FOR BUILDING RESILIENCE TO FLOODING

7.0 Introduction

A community's ability to respond to a hazard is a function of the community's access to diverse and relevant assets, and the ability to use the assets or resources to meet the desired needs (Bohle, 2001; DFID, 1999; Longstaff et al., 2010). In this study, asset robustness is a measure of the diversity and relevance of assets in the community. Similarly, the community's adaptive capacity measures the ability of the community to engage or use assets, including those outside the community to respond to a flood hazard. In this chapter, the relationship between the robustness of community assets, adaptive capacity and the ability to respond to flooding is examined. Secondly, the relationship between the domains of resilience, (namely socioeconomic and engineering/ infrastructural) and the ability of the community to respond to flooding are examined. Finally, the various institutions or structures found in the communities and their roles in flood response are expounded in this chapter.

7.1 Robustness of assets, adaptive capacity and relationship with community resilience

The sustainable livelihoods framework explains that sustainable livelihood outcomes are contingent on the underlying livelihood assets and the presence of transformation structures and processes such as institutions, culture and byelaws. The relationship between the adaptive capacity, livelihood assets and the ability of the community to respond to flooding is examined in this section.

7.1.1 Indicators of adaptive capacity of the community

Seven broad indicators with a total of ten sub-indicators were used to measure the concept of adaptive capacity. A reliability test of the indicators yielded a Cronbach's Alpha of 0.928, which shows high internal consistency among the indicators. This means that there is a high reliability among the indicators for measuring the concept of adaptive capacity. The results indicate that 'active agents' which measures the involvement of members of the community in various groups and events to address flooding is the major contributor to adaptive capacity in both communities (Table 7.1). On the other hand, 'resource engagement', which measures the extent to which community organizations contribute leadership and volunteer to community flood management activities, is the least contributor to adaptive capacity at Glefe. Likewise, 'resource development', the indicator for measuring the development of flood response infrastructure and the adoption of new ways of responding to floods, contributed least to adaptive capacity at Ogbojo.

Table 7. 1: Average scores for indicators of community adaptive capacity

Indicators of Adaptive Capacity	Average scores	
	Glefe	Ogbojo
Resource engagement	1.50	0.40
Resource development	2.58	0.20
Active agents	4.33	3.80
Impacts	3.58	0.50
Equity	2.50	0.4 0
Strategic action	1.92	1.00
Collective action	3.50	0.60

Source: Computed from field data, 2017

7.1.2 Descriptions of robustness of asset and adaptive capacity

The average adaptive capacity and composite weighted average for robustness of community asset are presented in this section. Glefe has higher composite average for both robustness of assets and adaptive capacity than Ogbojo (Table 7.2). This is not unexpected, as there were more diverse and relevant livelihood assets in Glefe. This was typified by the existence of natural assets such as the sea, lagoon, availability of sand that supports coping strategies and livelihoods in the community. The more communal living at Glefe also enhances adaptive capacity, through the access of resources such as human assets including artisans, human labor from within and outside the community when individual households or sections of the community are affected by a flood hazard. Ogbojo, on the other hand, showed limited assets especially natural and social assets.

Table 7.2: Average adaptive capacity and weighted average resource robustness

Components of community resilience	Glefe	Ogbojo
Mean asset robustness (Std. Dev.)	0.042 (0.001)	0.040 (0.003)
Mean adaptive capacity (Std. Dev.)	3.76 (0.210)	2.04 (0.119)

Source: Computed from field data, 2017

7.1.3 Relationship between robustness of assets, adaptive capacity and community resilience

The results show that both robustness of assets ($r=0.692$, $p<0.05$) and adaptive capacity ($r=0.787$, $p<0.05$) are positively related to a community's ability to respond to flooding or resilience. Thus, higher community adaptive capacity and robustness of assets enhances community resilience. There is however a stronger correlation between adaptive capacity and flood response than asset robustness (Table 7.3).

Table 7. 3: Correlation between robustness of assets, adaptive capacity, and resilience

Ability to respond to flooding	Adaptive capacity	Asset robustness
Spearman rank correlation	0.692	0.787
Sig. (two-tailed)	0.013	0.002

Source: Field data, 2017

7.2. Relationship between the categories of community resilience and the ability to respond to flooding

As discussed in the conceptual framework, community resilience is categorised as ecological (the proportion of the landscape that has vegetation cover to absorb rainfall and reduce runoff), engineering (availability and efficiency of flood infrastructure that minimizes the likelihood of flooding), and socioeconomic (the availability and diversity of relevant livelihood assets to enhance coping or post-flood recovery). Each of the categories of community resilience contributes to the overall ability of the community to respond to flooding. This sub-section examines the relationship between the categories of resilience and the self-reported ability of the community to respond to flooding.

7.2.1 Descriptions of the domains of community resilience for the Glefe and Ogbojo

The average for each of the resilience categories have been presented for each community in Table 7.4. Firstly, about a quarter of the catchment area where Glefe is located has vegetation to absorb runoff (0.256), and a little over a tenth of the catchment area of Ogbojo has vegetation (0.126). These measures the ecological resilience of the study sites; higher proportions of green landscape lead to higher ecological resilience. Secondly, the efficiency of flood management infrastructure such as drainage system and sea defense averaged 80 percent at Glefe and 40 percent at Ogbojo based on the assessment of community members. Likewise,

Glefe's ability to access diverse livelihood assets (0.798) is higher than that of Ogbojo (0.605). Correspondingly, on a scale of 0 to 5, participants at Glefe gave an average score of 3.33 (SD=0.82) to their ability to respond to flooding without disruption to their livelihood activities. Participants at Ogbojo on the other hand gave an average score of 1.33 (SD=0.52).

Table 7. 4: Mean scores for the domains of community resilience

Categories of community resilience	Mean scores (Std. Dev.)	
	Glefe	Ogbojo
Ecological	0.256*	0.126*
Engineering/ infrastructural	80.00 (9.02)	40.00 (9.57)
Socio-economic	0.798 (0.134)	0.605 (0.122)
Self-reported ability to respond to floods	3.333 (0.817)	1.333 (0.516)

Source: Author's construct, 2017 *Single value computed from LULCC statistics for the community

7.2.2 Correlation between the domains of resilience and the ability of the community to respond to flooding.

The results presented in Table 7.5 show a strong positive relationship between engineering resilience and the ability of the community to respond to flooding ($r= 0.609$, $p<0.05$). There is also a strong positive relationship between socioeconomic resilience and the community' ability to respond to flooding ($r=0.720$, $p<0.01$).

Table 7. 5: Correlation between Socioeconomic, engineering resilience and community response to flooding

Ability to respond to flooding	Socioeconomic	Engineering/ Infrastructural
Spearman rank correlation	0.720	0.609
Sig. (two-tailed)	0.008	0.036

Source: Field data, 2017

7.3 The role of community institutions in building resilience to flooding

Local community institutions play major roles with flood control in both communities (Table 7.6). Institutions such as the community development association at both Glefe and Ogbojo had spearheaded the implementation of key flood-related developmental projects. For instance, the Glefe Community Development Association had accessed financial and political resources outside the community from the government through the Accra Metropolitan Assembly in the implementation of community drains and sea defense projects. There was a similar institution at Ogbojo. Another political capital that both communities had was the assembly members and their unit committee who represented their electoral areas at the district assembly. They serve as the liaison between the local community and the district assembly and play key roles in spearheading the implementation of developmental projects in the community.

Other institutions that exist in both communities are the National Disaster Management Organization (NADMO). It was established under the ministry of interior by ACT 517 of the Parliament of the republic of Ghana in 1996, faith-based organizations and traditional authority (Table 7.6).

Table 7. 6: Community institutions and their respective mandates in community development and resilience building

GLEFE			OGBOJO		
Institution	Activities or mandate	Key achievements	Institution	Activities or mandate	Key achievements
Glefe Community Development Association (Community police)	<p>1.Address, water, sanitation and security issues</p> <p>2.Mobilise the community for developmental projects</p> <p>3. Protect and safeguard safety in community (community policing)</p> <p>4. Educate the community on health, social matters and volunteerism</p>	<p>1. Petitioned the sub-Metro, members of parliament and other stakeholders for key challenges and needed developmental projects through which the motorable road at the western corridor of Glefe, and drains have been constructed. Construction of sea defense is in progress.</p> <p>2.Restrained indiscriminate sand mining</p> <p>3.Petitioned and confronted Pambros Salt Production Ltd. on the damming of the lagoon that causes flooding in the community</p>	Ogbojo development association	Spearhead non-partisan development activities in the community	<p>1. Mobilized residents to construct water channels at a section of the community.</p> <p>2. Petitioned the district assembly about the needed drains</p>

GLEFE			OGBOJO		
Institution	Activities or mandate	Key achievements	Institution	Activities or mandate	Key achievements
Assembly and unit committee members	Represent the community at the Metropolitan Assembly	Spearheaded the implementation of community drains, sea defense	Assembly and unit committee members	Represent the community at the Municipal Assembly	1. Lobbying the Municipal assembly for the construction of the drains
	Organize the community for developmental activities such as clean up exercises and desilting drains	Organized the youth to desilt drains and clean up the community			1. mobilized the community in desilting clogged drains
Traditional authority	1. Maintain law and order in the community 2. Responsible for the sale of stool or family lands land	Settled disputes among community members	Traditional authority	1. Maintain law and order in the community 2. Lead and coordinate some community development project 3. Custodians of stool, or family lands	Prevented the encroachment of some stool lands
Faith-based organisations	1. Provide spiritual and social needs of community members 2. Assist and mobilise members for community development activities	Provided financial and material support to some flood victims Organized clean up exercises and desilting	Faith-based organisations	Mobilise members for community development activities such as clean up exercises	Organized clean up exercises

GLEFE			OGBOJO		
Institution	Activities or mandate	Key achievements	Institution	Activities or mandate	Key achievements
	such as clean up exercises	of drains			
National Disaster Management Organization officials	Manage disasters by coordinating resources of both governmental and non-governmental institutions	Supplied relief items to some flood victims Identified and designated safe havens within the community	National Disaster Management Organization officials	Manage disasters by coordinating resources of both governmental and non-governmental institutions	Supplied relief items to some flood victims
	Develop the capacity of communities to effectively respond to disasters and improve their livelihoods	Conducted educational campaigns on safety during floods Identification of safe havens in the communities Provided relief items to flood victims	Develop the capacity of communities to effectively respond to disasters and improve their livelihoods	Educated the community on safety measures during flood events	Had conducted educational campaigns on safety during floods Identification of safe havens in the communities

Source: Compiled from field data and institutional documents, 2017

7.4 Discussion

Results from this study showed that both robustness of assets and adaptive capacity are directly proportional to the ability of the community to respond to flooding. This corroborates findings from earlier studies that adapting to climate change does not only depend on the availability of assets or the level of vulnerability, but also other social processes that are enhanced partly by collective community action, and the existence of transformative institutions (Otsuki et al., 2017; Afriyie, et al., 2017; Meerow, Newell & Stults, 2016; Adjer, 2003). This underscores why the resilience approach is systems orientated and integrates adaptive capacity as a central component of resilient social-ecological systems (Nelson, Adger & Brown, 2007). Referring to the sustainable livelihoods framework, these findings confirm that the ability of urban communities to respond to flooding while maintaining the normal livelihood activities is dependent on the robustness of the community's assets, and adaptive capacity (DFID, 1999). This means that availability of diverse and relevant livelihood assets is central to maintaining livelihoods in the face of a disturbance such as floods, as it enhances the capacity to diversify livelihood activities (Gwimbi, 2009).

Glefe has a more efficient flood management infrastructure than Ogbojo. This means that, though Glefe has multiple sources of the flood hazard, such as coastal inundation, overflow of the lagoon, spillage from the dam in Weija (a nearby community) and surface runoff from rainfall, the community has higher capacity to contain the floods than Ogbojo whose flood hazard is mainly due to surface runoff from rainfall. This is not surprising as Glefe has more vibrant community institutions such as Community Development Association in place. This also reflected in the average self-reported ability of each community to respond to flooding. Residents of Glefe reported higher scores of the ability of the community to respond to flooding than Ogbojo. This corroborates results from existing studies that higher and more frequent exposure

to natural hazards triggers the development of adaptive responses (Miranda et al., 2016; Nelson et al., 2007).

There was also significant positive relationship between livelihood asset robustness and the ability of the community to respond to flooding without disruption to livelihood activities. This means that socioeconomic resilience which is measured by the diversity of community assets and their relevance to the livelihoods of community members, as well as community agency in engaging these resources to meet their needs enhances their ability to respond to flood hazard. Ability to respond to flooding is the capacity to adopt adaptive measures that promote livelihood activities whilst the flood hazard persists. Some of these adaptive measures identified in this study are pumping stagnant water, temporary relocation, selling livestock and transferring trade activities to adjacent communities. Similar adaptive measures have been reported in other settings and countries such as Bangladesh and Nepal (Dewan, 2015; Jha et al., 2012). This tends to justify Tanner et al., (2014)'s argument for livelihood perspectives that prioritises the needs and agency of humans by considering their adaptive livelihood options within the broader context of transformational changes. Thus, changes that enhance the capacity of different population groups to access assets within and outside the community are ideal (Fang et al., 2014). This conceptualization of resilience does not connote a mere rigid outcome but reflects the desired state of what the community values. Adopting this asset-based approach that centres on people as the main actors and integrates livelihoods and resilience with a contextual framing is integral to the wide-ranging sustainable development processes (Meerow, et al., 2016; Tanner et al., 2014; Maru et al., 2014).

Thus, a community's capacity to adapt emanates from the presence of local institutions that promote the engagement of local resources, accessing external resources, and instigate

communal action to achieve desired community outcomes. Accordingly, a key dimension of community resilience is the ability to access resources outside the community to implement adaptation activities; the corollary is the achievement of desired outcomes amid a flood disturbance (Meerow et al., 2016; Friend & Moench, 2015; Cote & Nightingale, 2012).

7.5 Conclusion

This chapter makes two key conclusions as contribution to the sustainable livelihoods framework (SLF) and the resilient cities literature. Firstly, the SLF identifies livelihood strategies as a means to attaining desirable livelihood outcomes. Whilst these soft measures have proven high potential in rural communities (Li et al., 2017; Antwi-Agyei et al., 2013; Soltani et al., 2012), durable infrastructure such as drainage systems that are integrated in the overall community development agenda has also shown high relationship with the ability of the community to respond to flooding in this study. Thus, effective flood management infrastructure minimises the intensity and frequency of the hazard, hence could make livelihood strategies more effective, particularly in urban settings (Thaler & Hartmann, 2016; Friend & Moench, 2015; Rakodi, 2014).

Secondly, the robustness of community assets and adaptive capacity relate positively with the ability to respond to floods. This means that enhancing the capacity of local communities to respond to floods through mobilization and equitable access to assets is integral to building resilient cities. Also, as indicated in this study, durable community infrastructure is central to responding to floods. It can thus be summed up that the implementation of durable infrastructure such as drainage systems, coupled with equitable access to livelihood assets through the enhanced community capacity has the potential to keep the population away from the floods. This framing captures the central theme of the integrated urban resilience framework developed

by Abdrabo and Hassaan, (2015). The integrated framework can contribute to city level action to respond to floods through the incorporation of institutional settings comprising the formal and informal institutions, structures that enhance mutual participation of different population groups, and the enforcement of legislations. This approach aligns well with the current paradigm of disaster risk management, as opposed to the conventional flood protection through engineering, which though has the potency in keeping the flood away from the people, has the tendency of transferring the flood hazard or postponing it (Singh et al., 2015; Levy et al., 2007).

CHAPTER EIGHT

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.0 Introduction

The study sought to examine the extent of exposure of the urban population to flooding that is attributable to human influence on the natural environment, and the impacts of flooding as well as response mechanisms. These were organised into eight chapters. This chapter focuses on the summary of the study results, main conclusions in relation to the study objectives and recommendations. The summary of results has been made under each research objective, after which recommendations are made.

8.1 Summary

There is increased exposure of people and critical livelihood assets to pluvial and fluvial flooding globally and is projected that this rising exposure will lead to severe losses. Flooding has become an annual phenomenon in Accra in recent decades; it has severe impacts on the poor and vulnerable. This study examined the degree of exposure of the urban population to flooding, the impacts and community responses and structures related to resilience building in two study sites- Glefe which is located in Accra Metropolitan Assembly (AMA), and Ogbojo in the Adentan Municipal Assembly (AdMA). The novelty of this study was driven by transdisciplinary techniques across the social and biophysical sciences that encompassed participatory learning approaches and Remote Sensing/Geographical Information Systems (GIS). Population was at the heart of the study, as disaggregated data by age and sex was used in analyzing exposures and the construction of livelihoods in response to impacts of flooding over differing characteristics of two coastal communities. The Community-based Risk Screen Tool-

Adaptation and Livelihoods (CRiSTAL) was adopted from development-oriented project management in analyzing the sex and age differentials in access and relevance to livelihoods assets, and the impacts of floods in the study sites. Supervised land use land cover (LULC) classification of Landsat imagery, followed by post classification change detection in land cover was undertaken, and an exponential projection model introduced for the defined periods 2030 and 2060 towards evaluation of flood exposure. Increased population growth is confounding to urbanization and with more people expected in cities by the year 2030, the governance of land would feature prominently in city planning because of expected increased occupation of previously unoccupied landscapes, as demonstrated in this study.

The first objective sought to examine the how of human on the urban socio-ecological context modify exposure to flooding. Considering the rapidly increasing built up urban space in the study sites, it is projected that close to a quarter of natural land cover in AMA and more than half in AdMA could be lost by 2030, accompanied by increased flood hazards. Poor waste management, poor drainage system, poor spatial planning, disrupted topography of the communities, and transfer of flood hazard from adjoining districts/ communities tend to exacerbate exposure to flooding in the study sites.

In response to the second objective of examining the livelihood assets used by different population groups for constructing their livelihoods, the study demonstrated that the population in the study sites was aware of the relevance of specific livelihood assets that help to reduce exposure to flood hazards and therefore increasing their resilience. Among these were physical assets such as buildings, vehicles, road, electricity, water, and household appliances. There were however nuances in the relevance of natural, social and human assets in the two communities. Natural and social assets were more relevant to the coastal community which is informal

compared to the inland and more formal community. Conversely, human assets such as formal education and health were more relevant to residents of Ogbojo (the more formal and inland community). Financial asset was the least relevant in both communities. This demonstrates the nuances in livelihood construction even in communities within the same agro-ecological zone and plays major roles in building the capacity of the population to respond to floods beyond state level interventions.

The third objective focused on investigating the impacts of flooding on critical livelihood assets. The economic impacts of flooding were the most prominent, as disruptions in all livelihood assets had some economic implications expressed through cost of implementing adaptation measures and the repair or replacement of damaged assets, occupational health challenges, and unmet economic needs of social origins. The impacts of flooding on human life and health were also evident. Whilst the transmission of malaria was widely mentioned in both communities, foot rot affected the residents of Glefe. Generally, social assets were the least affected, though issues related to security, conflicts, and the relocation of family members and significant others were evident.

As postulated in the Pressure State Response Model, both communities responded to flood impacts through individual or collective coping mechanisms. However, a significant proportion of the individual level coping strategies were either not working, or were working but not sustainable, and at times, they came with residual impacts to further aggravate the already existing challenges. The strategies included pumping stagnant water using mechanized pumps, spraying the stagnant water with chemicals to prevent the breeding of mosquitoes, filling up the marshy compounds with rubbish and sand, constructing walls around houses, parking household items to higher shelves during floods, temporarily or permanently relocating, seeking refuge with

family members at higher elevation areas in the community, and diversifying livelihood activities. Thus, flood disaster risk reduction has become a function of multiple sectors and must not be left to a single sector to manage.

Finally, in assessing the factors and structures that are necessary for building resilience to flooding, the study strengthens the position that fundamental livelihood activities are positively related to adaptive capacities and the robustness of livelihood assets of populations to respond to flooding. However, this is achievable when there is resilient engineering / infrastructure and socioeconomic status. In general, though Glefe had multiple sources of flood hazards, they responded better than Ogbojo which is attributable to Glefe's soft adaptation of higher socioeconomic resilience, from diversity and relevance of livelihood assets and higher adaptive capacity. Glefe had more efficient infrastructure such as sea defense wall, and drainage system to contain the floods, demonstrating hard adaptation solutions, and showing methodological efficiency of the study in synergizing adaptation solutions in a single study. This is consistent with the resilience literature that the process of adaptation is characterized by the ability of people to learn to live in hazardous, changing and uncertain environments (López-Marrero & Tschakert, 2011; Adger, 2000), yet the extent of diversity and relevance of peoples' assets in responding to floods is unique. The reliance of the population on external resources in Glefe to attain higher resilience represents weakness in mobilization internal resources which may not be sustainable as compared to Ogbojo, hence described as resilience residing outside the community.

8.2 Conclusions

This study was premised on the Bohle's model of vulnerability that explained exposure to hazards as a function of the human-ecology perspectives, access to assets, and social inequalities (Bohle, 2001). The human-ecology perspective explains that the capacity of humans to manage the environment influences the degree of exposure to the hazard. The study found a rapid

conversion of the natural land cover into settlements which resulted in rapid increase in the impervious surfaces and thus increasing exposure to the floods, consistent with the Bohle model. Factors including waste management, poor spatial planning, biophysical characteristics and the activities of adjoining districts contribute to the flood hazard, which are implicit of policies of the urban setting. Thus, the study offers opportunities towards enhancing the Bohle's model by capturing the impacts of potential influence of other systemic and 'beyond place' factors within the coupled human – biophysical system. These factors include land use land cover change, and environmental/topographical influences on the place of interest. Findings of the study revealed that activities and topography of communities or districts that are external to the study areas contributed to the level of exposure to flooding and therefore could also become the effective origins for providing adaptation solutions. The strength of the analysis towards enhanced Bohle model originated from the CRiSTAL tool because it mainstreamed external factors whilst analyzing the livelihood assets.

Physical assets were the most relevant livelihood assets in both communities, followed by human assets. Natural assets contributed more to the livelihoods of people in Glefe than Ogbojo. This was due to the existence of coastal ecosystem services such as fishing and salt mining in Glefe, which provided additional livelihood options. The corollary is that, Glefe had higher socioeconomic resilience to the flood hazard than Ogbojo. Glefe's location as a low lying coastal community presents a disadvantage of multiple exposures to the flood hazard from sea inundation, surface runoff, and overflow of the lagoons. However, the coastal ecosystem services provide the avenue for building resilient livelihood through diversity of assets. This finding adds to the Maru et al., (2014)'s linked vulnerability and resilience framework for disadvantaged communities. The disadvantage associated with the location could have a co-benefit for building resilience. This phenomenon also feeds back into the sustainable livelihood framework, in that,

depending on the community institutions or agents of transformation, some assets could be sources of vulnerability or resources of resilience (DFID, 1999). For example, the lagoons in Glefe could be a major livelihood asset if properly managed; yet, they can become major sources of predisposition to floods if the current trend of disposing rubbish in them continues and impeding their natural flood regulation.

There were also major demographic differentials in the impacts of flooding. These differences could potentially help shape the character of the PSR model and Bohle's model. Though the PSR model anticipates that exposures will result in impacts on humans, it does not specify links with differences in populations (Malekmohammadi & Jahanishakib, 2017; Neri, Dupin & Sánchez, 2016). The high utility of the CRiSTAL tool in this study is demonstrated through the robustness and diversity of assets in relation to community's ability to respond to flooding without harming livelihoods hence could serve multiple uses by expanding the permitted number of assets from the current three.

The engagement of community resources in planning, participation of community members in flood response, and the ability to community members to access resources from outside the community are critical to building resilience to flooding. This is consistent with emerging literature that highlight the need for community participation in disaster risk management (Benson, Lorenzoni, & Cook, 2016; Dewan, 2015; Wehn et al., 2015). Local communities often have knowledge and skill but lack physical resources to implement major flood related adaptation solutions, and even with this, transdisciplinary approach will be required to unearth a community's potentials.

8.3 Recommendations

Based on the findings of this study, it is recommended that:

1. Laws and regulations on land use practices such as the Ghana National Spatial Development Framework should be enforced. The study found that building on water ways and places originally designated as roads was rampant in both communities. There was also observed conversion of water bodies such as lagoon into settlement. The district assemblies should therefore ensure that appropriate permits are obtained prior to the commencement of building construction. The Ministry of Lands and Natural Resources under the Lands Administration Project 2 (LAP-2) should hasten efforts towards effective land use administration. Urban landscape design, which has the tendency of managing the degree of concretization and enhancing the proportion of green spaces, would be ideal.
2. Secondly, given that the flood hazard in a community is influenced by activities adjoining districts and regions, an inter-regional or inter-district planning is recommended. This will ensure that development activities in one region or district does not create or transfer the flood risk to their neighbours. The proposed 40-year development plan for Ghana could provide the framework for such integration.
3. Thirdly, the CRiSTAL tool is very useful in examining the relevance of community assets to urban livelihoods and the usefulness of assets to the community's ability to respond to hazards. The tool should therefore be amended to accept a limitless number of assets listed under each of the five asset categories, in order to enhance its utility in the highly heterogenous urban context.
4. Finally, that the community's ability to respond to flooding without a much disruption to their livelihoods is contingent on community members' involvement in various groups

and events to address flooding, and the extent to which community organizations contribute leadership and volunteers to community endeavors, the communities' participation in planning is recommended. District Assemblies should involve the community in planning. This will also yield the co-benefit of taking the communities' resources into consideration when planning. In this study, community members indicated their willingness to contribute labour and other assets towards the implementation of sustainable adaptive responses. This will also serve the benefit of reducing the resource needed by communities in implementing projects.

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APPENDICES

Appendix 1: Question Guide

CONTEXT

1. **Livelihoods/ Groups:** The main livelihood activities practiced in the communities and the number and types of social groups involved (gender, age, ethnicity, livelihoods)
2. **Actors:** Names and activities of any relevant internal and external actors that are present in here or have an important positive or negative influence (e.g., government agencies, NGOs, private companies, etc.)
3. **Gender and Diversity:** Observations or secondary information on gender, diversity and cultural practices (e.g. differences in livelihood activities between men and women)

CLIMATE CHANGE

4. **Observed climate change:** Ask about how temperatures, rainfall patterns and other climatic variables may have changed over the past (5 years, 10 years, 30 years)
5. **Projected climate change:** projected changes in temperature, rainfall, extreme events in the community

CURRENT AND POTENTIAL FUTURE FLOOD HAZARD

6. How has the frequency and intensity of floods changed over the past decades?
 - i. Describe how often flood occurs (several times a year, once a year, every 5 years)
 - ii. how intense a typical occurrence is (height of flood, proportion of community affected)
 - iii. Has the frequency or intensity changed over the past years (ask them to rate on a scale of 1-5, + & - to showing increase & decrease)

CLIMATE RISK

7. For the flood hazard:
 - i. identify the impacts of the floods in the community
 - ii. identify the coping strategy to each impact in the community
 - iii. is the strategy working?
 - iv. Is the strategy sustainable?
 - v. Mention any other alternate strategy

LIVELIHOOD RESOURCES

- A. Ask the group to identify the resources that are most important to livelihoods and wellbeing in the community and rank on a scale of 0 to 5.
 - i. Natural: e.g. flood control) e.g. land, clean air, fish, trees.

- ii. Physical: basic infrastructure for transport, building, water mgt., communication
- iii. Financial: e.g. remittances, savings, cash, pensions, jewelery
- iv. Human: skills, health, traditional knowledge, weaving skills, education
- v. Social: e.g. church groups, political organizations, farmer associations

HOW LIVELIHOOD RESOURCES ARE AFFECTED BY FLOODS

Evaluate the extent to which floods influence the livelihood resources listed above on a scale of 0 to 5. 0= no influence, 3= some influence, 5= very strong influence

How important are livelihood resources in implementing coping strategies?

For each livelihood resource, indicate how important they are for implementing current or alternate coping strategies (do for each strategy, 3max).

Indicate the level of importance using a scale of 0 to 5; 0= not important at all, 3= somewhat important, 5= very important (probe for basis for ranking).

DRIVERS OF EXPOSURE TO FLOODS

1. Are there disparities in exposure to flooding?
2. What accounts for the disparities (Probe)

DRIVERS OF COPING CAPACITY

3. How would you rate your community's capacity to respond to the floods without major disruptions to livelihood activities (1 to 5)?
4. Are there differences in the in adaptive capacity across the community? Explain

DIMENSIONS OF COMMUNITY RESILIENCE

For each of the following items on your community, assign a score of 1 to 5; give reasons for the scores

Community resources

(1) to what extent community leaders networked with resources outside the community, for example, regional, Sub-Metro, businesses

Development of community resources

- (1) new kinds of business and employment opportunities
- (2) infrastructure developed in the community over the last ten years
- (3) the extent to which the community try new ways of responding to floods

Engagement of Community Resources.

- (1) the extent to which community organizations contribute leadership and volunteers to community endeavors

Active agents

- (1) community members' involvement in various groups and events to address flooding issues affecting the community

Collective action

- (1) the extent to which people from diverse groups share supports, resources, knowledge, and expertise when confronted with flood disaster

Strategic action

- (1) the extent to which information on community resources is used in planning community
Community
- (2) the extent to which community members look outside the community to find resources to support its endeavors

Equity

- (1) access of various groups to the community's natural resources

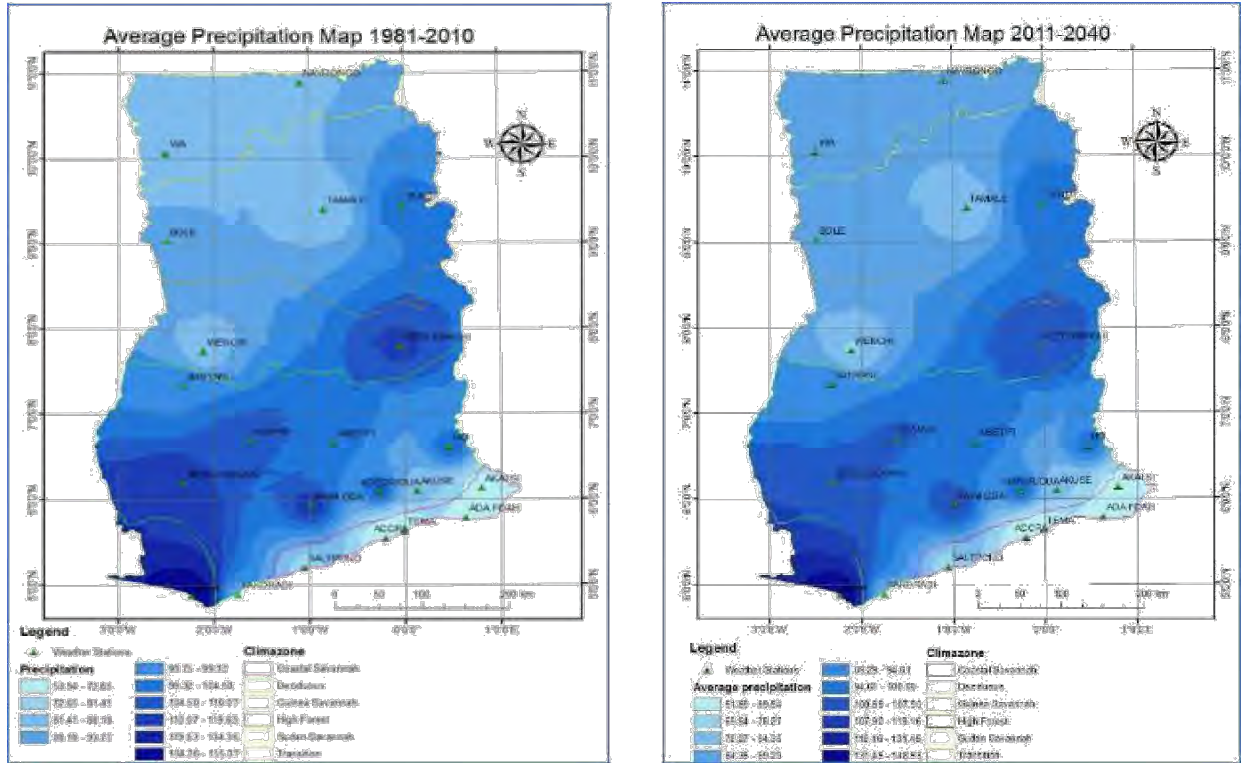
Impacts

- (1) changes in the community's capacity over time to respond to flooding problem
- (2) changes in the community's resources over time

SUMMING UP

We have come to the end of our discussion. Do you have any questions or contribution to add to what we have discussed?

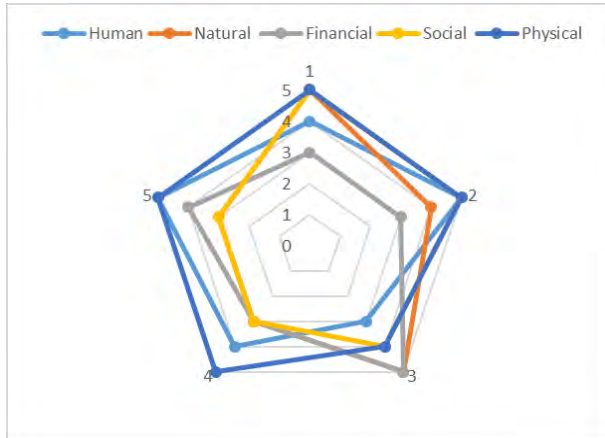
Appendix 2: Past and Projected Climate Rainfall of the Coastal zones of Ghana



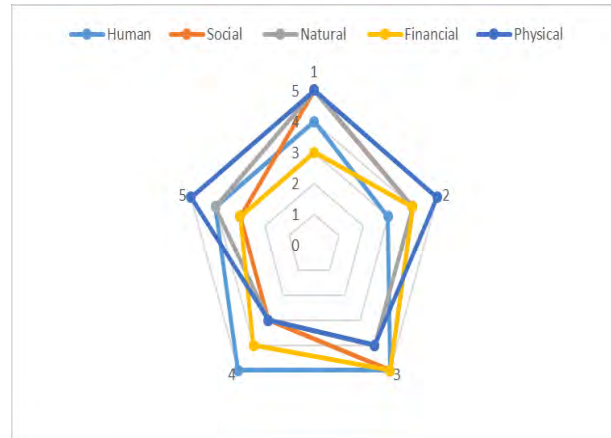
Source: Third National Communication of Ghana to the UNFCCC

Appendix 3: Categories of asset and their contribution to urban livelihoods

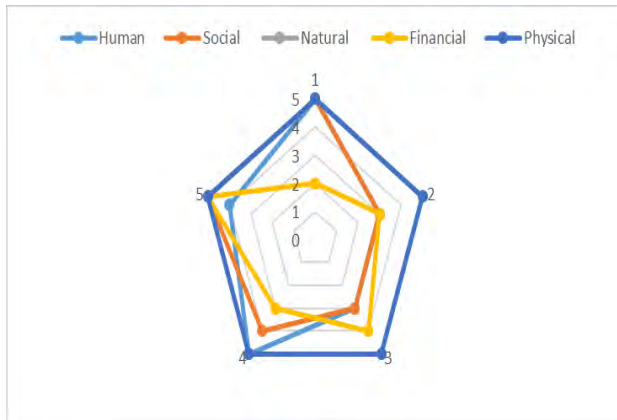
Adult male, Glefe



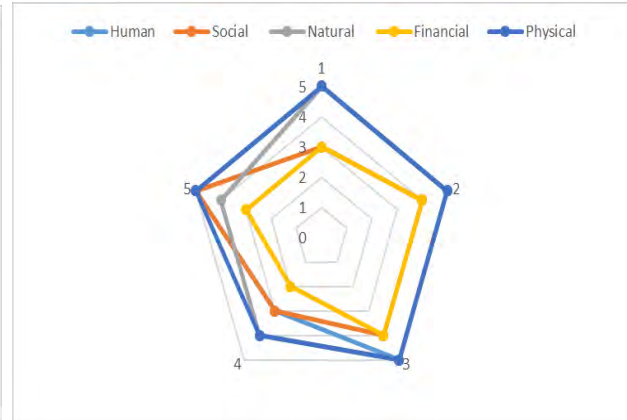
Adult male, Ogbojo



Adult female, Glefe



Adult female, Ogbojo



Appendix 4: Community assets necessary for the implementation of sustainable coping strategies

Asset types	Impacts	Damages buildings						Disrupts economic activities Damages buildings Causes diseases						Diseases (Malaria, foot rot)					
	Coping Strategies	Desilt the drains						Construction of the drains						Continue the sea defense (Glefe)					
	Assets	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Natural	Sand					X						X							X
	Land					X						X							X
	River/Lagoon	X						X						X					
Physical	Road					X							X						X
	Electricity				X							X							X
	Buildings			X							X								X
Financial	Livestock			X						X						X			
	Savings			X							X					X			
	Remittances			X							X					X			
Human	Education				X							X							X
	Health						X						X				X		
	Artisans						X					X							X
Social	Community Dev't. Assoc.					X							X						X
	Religious assoc.			X								X							X
	Political assoc.					X						X							X